Textbook of
REHABILITATION


S Sunder




3rd Edition

JAYPEE

Textbook of Rehabilitation

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THIRD EDITION

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Textbook of Rehabilitation

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Preface to the Third Edition

During my tenure as a medical intern I came across several 'cases' of hemiplegia, paraplegia and Parkinson's disease in the Department of Neurology. Our case discussions would cover the clinical presentation, the investigation and the therapeutics for the disease concerned, but would often stop short of rehabilitation and physical management. Considering that rehabilitation is a vital aspect of post-acute care, and that the 'cases' were actually patients who needed to get back to living their lives, I often would wonder why it was not touched upon. Later, when I went on to do my postgraduation in Rehabilitation Medicine, I realized the immense scope that it provided, and that it does not feature as a subject in our medical curriculum. There is, as a result, a need for a Comprehensive Textbook on rehabilitation medicine for our students.

This book, hopefully, will fulfil that need, and since it conforms to the syllabus of physiotherapy and occupational therapy, would immensely benefit students of those disciplines, or indeed anyone who is rehabilitation professional. Also, wherever possible, the use of appropriate technology has been included.

This revised edition follows-up on the enormous success of the second edition. Many chapters have been rewritten and photographs added. This book is divided into two parts—Part one deals with General Principles of Rehabilitation while the second part is concerned with the application of these principles in various conditions. There are many disabling diseases and it is beyond the scope of this book to list out all of them, as also the various lines of management. The focus is therefore to bring out the philosophy of rehabilitation and its importance in some of the common neurological and orthopedic conditions. Techniques and technology in rehabilitation (and the various specialties in rehabilitation) have advanced so dramatically in the last decade that it is virtually impossible to bring all aspects into a textbook of this nature.

I gratefully acknowledge the permission granted by Freedom Trust, KCRC, Electrocare Systems and Services, RASA Amar Seva Sangam and Callidai Motor Works to use photographs to illustrate some of the points in this book. I acknowledge with gratitude the contribution of Rupa Balaraman, in helping with some of the material for this book.

I realize that my own patients have been my clinical teachers and I dedicate this book to them.

S Sunder

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PART I

General Principles of Rehabilitation

This book is divided into two parts. Part one deals with general principles of rehabilitation, while the second part is concerned with the application of these principles in various conditions. There are many disabling diseases and it is beyond the scope of this book to list out all of them, as also the various lines of management. The focus is therefore to bring out the philosophy of rehabilitation and its importance in some of the common neurological and orthopedic conditions.

CHAPTER 1

Introduction to Rehabilitation Medicine

According to various estimates, about 5 to 10 percent of the world's population is affected by one or more disabilities. In our country (with a population of over 100 crores now) the National Sample Survey 2001 has estimated that about 2.19 crores or nearly ***two percent*** of the population, who experience difficulty in walking or using their limbs, or suffer from visual, hearing or mental impairment. Since over 70 percent of our population is in rural areas, the number of those with less severe disability could be much larger. Also the extent of disability and handicap is quite variable in the minds of several people, and what construes disability to one person seems perfectly normal to another.

Prevalence of disability was marginally more among males. In modern society, ***acting independently*** is of supreme importance—be it in the area of personal care, day to day activities, cooking, studies, or for that matter anything that requires human endeavor or pursuit. It is in these areas that a disabled person suffers most; socially, economically, psychologically and emotionally.

Due to physical or mental handicap a disabled person cannot act independently in many spheres of life and hence faces many problems in his social adjustment. His incapacity generates emotional problems like apathy, self-pity and resentment and he tends to isolate himself from society.

This is seen in the statistics, which show that an abysmally low percent of persons with disability in rural India have an educational level of secondary education, and above. A small minority of seven percent is employed regularly.

Rehabilitation is not just the responsibility of a few NGOs or the government. It is the collective responsibility of the society consisting of able bodied individuals. The role of rehabilitation is to minimize disability and handicap, and help a handicapped person lead a useful life within his limitations, in other words, to make a ***disabled person into a "differently abled" person***.

WHAT IS REHABILITATION?

Rehabilitation focuses on the existing capacities of the handicapped person, and brings him to the optimum level of his or her functional ability by the combined and coordinated use of medical, social, educational and vocational measures. It makes life for the handicapped individual more meaningful, more productive and therefore **adds more life to years.**

It is the third phase of medical care; after preventive and curative.

Preventive medicine is the first phase where a disease is prevented from occurring, by avoiding the interaction between agent, host and environment. ***Curative medicine***, the second phase focuses on attempting to cure the disease. Most doctors practice curative medicine. However there are several conditions like rheumatoid arthritis which has no cure, and others, like poliomyelitis in which the agent causing the disease has been eliminated from the host, but residual effects like paralysis still persist. Therefore, there is a need for a third phase, namely rehabilitation, which is not just medical but also a ***social responsibility***.

Rehabilitation must, be started at the earliest possible time in order to ensure the best results. It is administered in conjunction with specific medical or surgical treatment of the precipitating disease.

Rehabilitation may be medical or sociovocational. Medical rehabilitation is the ***utilization of medical and paramedical skills*** to help treat the patient. The role of medical rehabilitation is to limit disability. Sociovocational rehabilitation follows, or sometimes is delivered simultaneously along with medical rehabilitation. The role of sociovocational rehabilitation is to limit handicap.

MEDICAL REHABILITATION

Importance of Physiatry

Medical and sociovocational rehabilitation is the responsibility of a team of professionals headed by a ***Physiatrist,*** the key person in the guidance of the rehabilitation program. These professionals combine and coordinate to uplift the handicapped (Fig. 1.1).

The difference in the clinical evaluation by a physiatrist is that the physiatrist views the patient with social and vocational background in addition to the medical background. He tries to get a clear picture of how an illness has affected a person's life—what he or she can no longer do and how to get over the problem.

The other team members in medical rehabilitation are the physiotherapist, the occupational therapist, and many others while the social

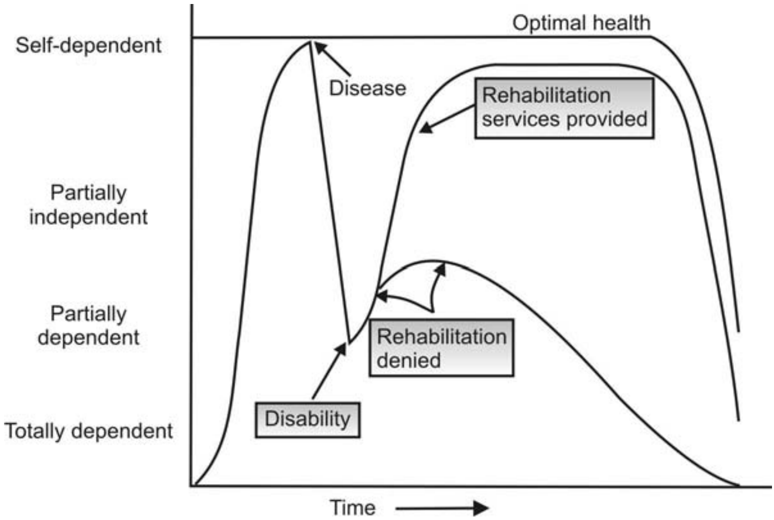


Figure 1.1: The importance of physiatry and rehabilitation services ensures functional independence, without which the patient remains partially dependent throughout his life

worker and vocational counselor are in the sociovocational team (Ref Chap 2).

Epidemiology of Rehabilitation

The word ***epidemiology*** is derived from the Greek word ***epidemios***; meaning "among the people" In the early 20th century, ***CO Stallybross*** defined epidemiology as "***the science which considers infectious disease—their course, propagation and prevention.***"

Epidemiology is concerned with the study of the causative factors of disease and the means to prevent or eradicate it. If complete prevention or total eradication is not possible, containment is the second choice.

WH Welch defined epidemiology as "the study of the natural history of disease."

Lillienfeld described it as the study of "the distribution of a disease or condition in a population, and of the factors that influence this distribution."

Health

The definition of health put out by the World Health Organization runs as follows:

"A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity." The fundamental goal of medical science is not to produce an immortal being but to maintain him in optimum health as long as possible, ideally until death.

It is often said "The fundamental goal of rehabilitation is to add life to years; not years to life".

It is now known that disease is caused by simultaneous interaction of host, agent and environment (Fig. 1.2).

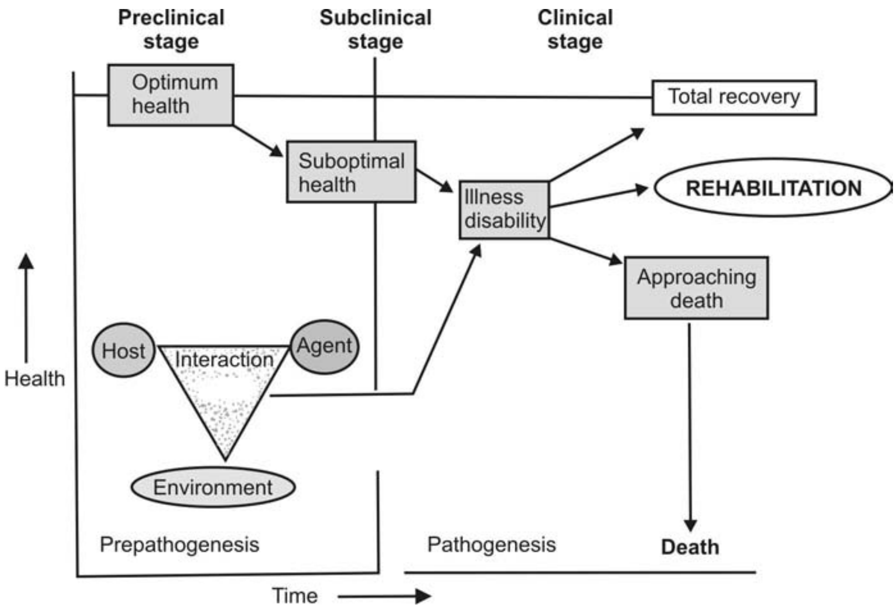


Figure 1.2: In the prepathogenesis period, the interaction between host agent and environment causes disease, which passes from the subclinical stage to the clinical manifestation of disease. The client slides down the health status scale from health to suboptimal health to overt illness. This could either be treated successfully on to recovery or, sometimes the patient succumbs to the disease. *On the other hand, in some diseases the patient lands in a zone of disability from where he needs to be rehabilitated*

PREVENTIVE REHABILITATION

Prevention of disability does not start only at birth, at the onset of disease or after a primary disability occurs. Sometimes it may be done ***even before the child is born,*** by anticipating disability due to genetic defects or blood group incompatibility and can be prevented by means of genetic counseling. For example in Duchennes muscular dystrophy, it is possible to counsel the parents on having another child who might later display the symptoms of the disease.

Current population growth, particularly of the aged, naturally would result in a sharp rise in people with disability in the near future. It is a paradox that because of the tremendous strides that medical science has taken, the number of patients surviving a potentially fatal condition like brain injury is much more. It therefore follows that with a ***fall in mortality levels there is a rise in morbidity levels. Rehabilitation deals with morbidity; it deals with***

quality of life. Unfortunately there is a great shortage of medical and paramedical professionals to care for the persons with disability, and this gap keeps widening.

In recent years, specialists in neurology, orthopedic surgery, and pediatrics are increasingly getting involved with and have a vital role to play in the field of rehabilitation medicine. This phenomenon shows the recognition and importance that is being given by other specialties to rehabilitation medicine.

Unless more effective methods of prevention are developed to protect the population from primary disability in the future, the newly detected persons with disability will face a critical situation. The cumulative shortage of health manpower will cause them to be without benefit of rehabilitation services, and superimposed secondary disabilities will render them totally dependent on society for everything. This will result not only in personal tragedy, but will create infinite economical problems for families, communities, and nation.

Consider a nuclear family where husband and wife are working for a living or for a professional career. The presence of a disabled child or senior member would rob this family of all its happiness, its leisure, and time available. A lot of personal sacrifice will be required by each one of its members to take care of the patient. The medical community must act to prevent epidemics of disability in much the same manner that we are now able to prevent communicable diseases.

Levels of Prevention

Any health care that tries to halt a person's slide down the slope of the health status scale is termed preventive health care and any attempt to push it up towards the peak, i.e. optimum health, is called therapeutic health care. This total spectrum is classified into three levels of prevention by the World Health Organization (Fig. 1.3).

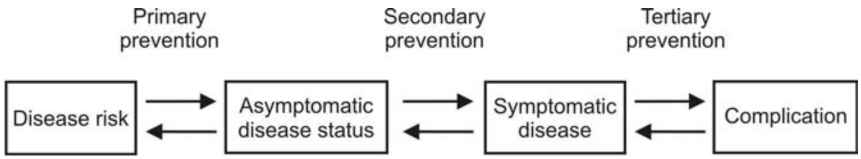


Figure 1.3: Levels of prevention: Primary, secondary and tertiary

Primary Prevention: It is explained as a measure taken before the onset of any disease, e.g. immunization against childhood infections or chlorination of drinking water. It is designed to promote general health and improve the quality of life. It incorporates health education for bringing about awareness of health problems before it occurs. This is similar to the first phase of medicine, i.e. preventive medicine.

Secondary Prevention: It is a measure taken to arrest the progression of a disease while it is still in the early asymptomatic stage of the disease. It involves early diagnosis and immediate treatment, e.g. ergonomic intervention to prevent clinical symptoms in a patient with spondylosis.

Tertiary Prevention: It is explained as a measure taken to minimize the consequences of a disease or injury once it has become clinically manifested, e.g. prevention of pressure sores in a paraplegic by turning the patient over regularly. Tertiary prevention is an integral part of Rehabilitation Medicine.

The Economic Impact

Every year, several crores of rupees are spent on maintaining disabled people. If they are rehabilitated to a level of self-dependence, there is a tremendous saving to the national exchequer. The economics also can be gauged by the fact that successful rehabilitation '***sets free***' the able-bodied person taking care of his disabled relative. In nuclear families today, when the breadwinner of the family becomes handicapped, it becomes a severe financial burden for the rest of the family, and any effort in making the patient take care of his daily activities like feeding or toileting can release the able bodied spouse to take up some work. It is often said that a ***handicapped individual means a handicapped family***, since most of the resources, time and efforts of the family members go into his maintenance.

IMPAIRMENT, DISABILITY AND HANDICAP

The World Health Organization's International Classification of Impairments, Disabilities and Handicaps (ICIDH 1980) defines these terms as follows:

Impairment: *Any loss or abnormality of psychological, physiological, or anatomical structure or function*, for example the loss of a finger, loss of conduction of impulses in the heart, or loss of certain chemicals in the brain leading to Parkinsonism. Not all impairments lead to disability; for example the loss of the pinna of the ear, an impairment, would not lead to loss of hearing but merely a cosmetic deficiency.

Disability: *Any restriction or lack of ability to perform an activity in the manner or within the range considered normal for a human being resulting from impairment*, e.g. difficulty in walking after lower limb amputation. It must be noted here that strenuous or rarely indulged in feats like rock climbing or wind surfing are not included in activities to be considered for disability. To be considered disabled a person should not be able to perform day to day activities considered normal for his age, sex or physique.

Handicap: *A disadvantage for a given individual in his or her social context resulting from impairment or a disability that limits or prevents the fulfillment of a role that* *is normal for him or her.* This depends on the age, sex, social and cultural factors for that individual. Many socioeconomic factors like family background, skills achieved and financial stability come into play while determining handicap. Various governments all over the world have recognized the social impact of handicap and are more inclusive in their approach (Ref Chap 4).

Impairment is a manifestation of a problem at the tissue or organ level, ***disability***, at the level of the individual, while ***handicap*** in the translation of the problem at the societal level (Fig. 1.4).

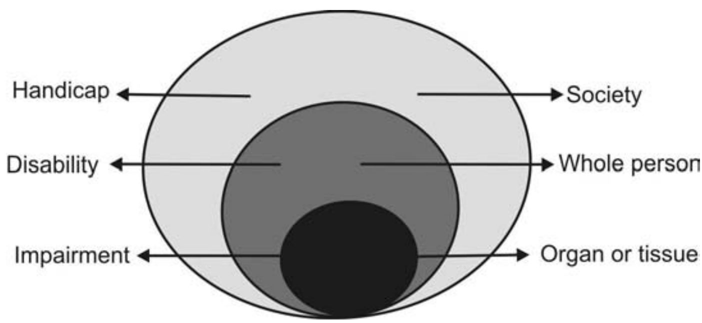


Figure 1.4: Impairment Disability and Handicap: Their impact at various levels affecting the organ, the person and society as a whole

Relationship Between Impairment, Disability and Handicap

On completing the conventional clinical evaluation of a person with disability, the physician treating the patient often can answer the following questions:

"Why does the person have the problem?" (i.e. the etiologic diagnosis or impairment), and

"What does he suffer from?" (The pathophysiological diagnosis or disability). Examples of impairments are: weakness due to polio, ankylosis of a joint, and so on. Most impairments lead to disability. The physiatrist comes into the picture to assess the extent of disability. The questions he would have to seek answers to are

"How does the problem affect the person's life?" or "What can he do in his day to day activities?" (i.e. the functional diagnosis).

In fact, it is ***these complaints with which the patient approaches the doctor in the first place***. To the patient, the functional consequences—what he or she is prevented from doing (e.g. typing, cooking, playing tennis)—are of more importance than the diagnosis. For example, a lady with periarthritis of the shoulder would complain of inability to toilet herself or to wear her blouse, in addition to reduce the pain that she is experiencing.

Furthermore, the relationship may be in both directions, for example, inability to walk due to polio, a disability, may lead to muscle weakness and contractures, which are impairments. ***Not every impairment leads to disability***.

For example, the loss of an earlobe does not give much of a functional loss. However a road accident leading to brain injury can lead to gross disability with multiple handicaps.

The relation between these three concepts of impairment, disability and handicap is very subtle, and can best be illustrated by examples. If a person has lost a leg, the loss of the leg is the impairment. The disability would be inability to perform all activities related to the leg, primarily walking. The handicap would relate this disability to the person's role in society, and for the same disability, i.e. inability to walk, the handicap would vary according to the person's economic background, job and distance that he would need to walk everyday

Examples of handicaps include difficulties with social integration or economic self-sufficiency.

It is apparent from this that a person may be handicapped without being disabled; an example would be a tailor with polio in one leg who may be physically capable of operating the sewing machine but his place of work may be too far off for him to be transported.

Sometimes a minimal disability would mean a gross handicap. Let's say a person has lost movement of his little finger. The disability is "inability to use that little finger." To the average person this little disability may make no great difference to his daily living. But if the person is a violinist or a typist then the handicap is obviously much greater. But, interestingly, the evaluation of handicap does not end with this. A series of questions relating to the person's age and lifestyle would throw more light on the extent of handicap.

Handicaps

The WHO has identified six handicaps:

1. Locomotor handicap (which forms 60 percent of all handicaps),
2. Visual handicap
3. Hearing and speech handicap
4. Cardiopulmonary handicap
5. Intellectual handicap and
6. Emotionally disturbed

Many patients suffer from multiple handicaps, which include combinations of any of the six given above.

Diagnosis of Disability

All specialties in therapeutic medicine require early and precise diagnosis in order to institute the most effective treatment. The same logic applies to rehabilitation, and the disabled should be given early evaluation and intensive treatment to prevent permanent disability.

The total person, physically, emotionally, vocationally and socially, must be considered in the diagnosis. The patient is evaluated as a ***human being and***

not as a "case". Patients with multiple disabilities need to be handled sensitively. Diagnosis of disability may be expressed either in terms of the amount of disability (disability evaluation) or in terms of the amount of remaining function (functional diagnosis).

Disability Evaluation

The quantum of disability evaluation varies according to the method used. The most common method of disability evaluation is given as a figure in either percentage or digits based on a specific scale. A Disability Rating rates the patient's inability to do any substantial gainful activity compared to what he was able to do before the onset of the problem. It is calculated by performing general physical, orthopedic, physiatric and neurological examinations of the patient in the rehabilitation center. It helps in identifying the extent of handicap in a person in order to make him or her eligible for certain concessions offered by the Government from time to time.

Functional Diagnosis

The diagnosis of the condition of the patient when he comes in to rehabilitation is usually known, but the amount of remaining function is not. Rehabilitation professionals are trained to arrive at a functional diagnosis to evaluate the residual capabilities of the individual and strengthen them. The functional diagnosis should be:

- Objective, using measurable factors so that the results are statistically more reliable.
- Descriptive so that the actual situation is accurately reflected.
- Simple enough so that rapid evaluation is possible.
- Reproduced, so that constancy may be maintained.
- Comprehensive, so that the diagnosis is complete and specifically utilized in the direct care of the patients and is relevant for epidemiological investigation.

An example would be in the diagnosis of cerebral palsy. While the diagnosis of cerebral palsy conveys very little in terms of the clinical picture, it would be ideal to functionally diagnose a child so that the following questions are answered:

What is the type of cerebral palsy?

How many limbs are affected—i.e. Is the child diplegic or quadriplegic?

Is there associated mental abnormality, communication impairment or hearing and visual impairment?

The answers to the above would certainly influence the outcome of rehabilitation.

Multiple Disabilities

About 12 percent of individuals with disability suffer from more than one type of disability.

For example, a child with cerebral palsy would probably have, in addition to the delayed milestones and motor problems, damage of the part of the brain responsible for sight and hearing. In addition it may have mental sub normality. As a consequence to these impairments, it may display temper tantrums and not cooperate with the therapist.

Primary and Secondary Disabilities

Disabilities that are direct consequences of a disease or condition are called ***primary disabilities***. Paraplegia following spinal cord injury or inability to walk following hip fracture are examples of primary disability.

On the other hand, disabilities that did not exist at the onset of the primary disability but develop subsequently are called ***secondary disabilities***. Secondary disability is indirectly related to the disease or condition that is responsible for the primary disability. Examples are joint contracture in poliomyelitis, subluxation of shoulder joint in hemiplegia, tendo-Achilles contracture in cerebral palsy and pressure sores in paraplegia. Elderly people and those who have had a primary disability for an extended period are more susceptible to a secondary disability. Further, when pain or spasticity accompanies the disease or condition causing the primary disability, the prevalence of secondary disability increases. Negligence or ignorance on the part of paramedical personnel or family members results in placing the person with disability in positions that promote secondary disability.

In general, the greater the size of the body segment and the longer the period of immobilization, the greater the intensity of the pathological condition and the number of organ systems that become involved.

Immobilization due to what ever cause has a major impact on disability and many a patient on the road to recovery encounters a road block on account of the secondary effects of disability. For example disuse atrophy occurs very rapidly, especially on muscles which are hardly ever used. One study found that muscle wasting was found even within three days following immobilization. It occurs much faster in antigravity muscles than in their antagonists. It has been shown that disuse atrophy is more for a muscle held in a shortened position. There was a greater degree of loss of strength when compared to the amount of muscle atrophy, as measured by reduction in muscle girth. In other words, the muscle was weaker than expected based just on the measurements of its bulk (Fig. 1.5).

Disability Limitation

The role of medical rehabilitation is ***disability limitation***. Disability limitation refers to preventing an increase in the intensity or scope of an existing disability. This measure, therefore, becomes necessary after termination of active medical or surgical treatment. For example, a patient with stroke gets

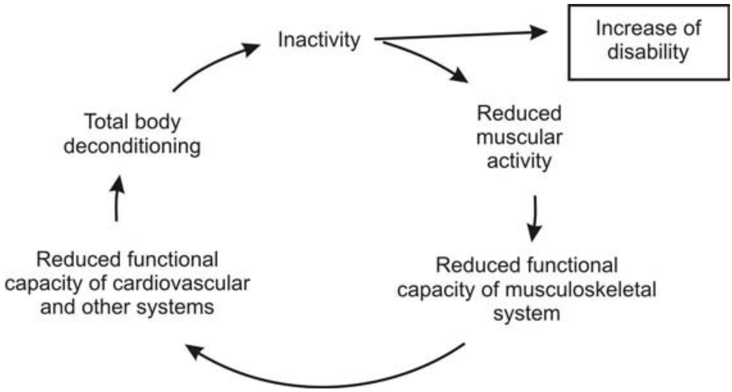


Figure 1.5: The vicious cycle of inactivity and immobilization due to disability leading to increase of morbidity and thence to secondary disability

admitted under a neurologist during the acute phase, which ensures that he survives the stroke. When he or she gets discharged from hospital, he needs to be taken through the recovery phase. This may take weeks or months. Disability limitation is particularly indispensable for those who are chronically ill or disabled and absolutely mandatory for geriatric patients.

Goals of Rehabilitation

Handicapped individuals have problems with

Orientation: For a person with head injury or cerebral palsy, the orientation to surroundings would hamper his activities of daily living like feeding or toileting.

Physical independence: It is the prayer of every handicapped person that he reduces dependence on the people taking care of him.

Mobility: Poliomyelitis and paraplegia are conditions that severely hamper mobility and thus even day to day tasks like moving around in the house can become very challenging.

Occupational integration: Training and placement in a suitable job.

Social integration: No man is an island, and attempts must be made to integrate handicapped people into society, and not isolate them.

Economic self-sufficiency: The job must ensure a means of livelihood

SOCIOVOCATIONAL REHABILITATION

No person is said to be fully rehabilitated unless all the above criteria have been looked into. Sociovocational rehabilitation is a team effort, which aims at providing the disabled a vocation, a barrier free place to live and the right social environment to reduce his handicap. It must not be misunderstood as just another employment agency. At the heart of vocational rehabilitation, is the concept of the ***'right to work'***; that is to treat work as much more than a means to money, but as a way of living and a mode of dignity to the individual. It is thus an outlet for his aspirations, and adds to his self esteem as an independent contributor to society.

It empowers persons—not just economically but in a more basic and meaningful sense. It makes a person stand on his own legs. It does not bind him to a job, it ***sets him free***. Obviously not every handicapped individual can stand on his own feet - literally or otherwise. A more realistic and pragmatic approach is needed.

In a country like ours where even the able bodied do not get work, questions are naturally raised on the need for the disabled to work. However, we must not forget that it is the constitutional right of every citizen to realize himself by mainstreaming himself into society.

The social worker tries to provide emotional support to the patient as well as to his family members and also creates awareness in the community about disability and its limitation. Training the patient in a job, ensuring that he gets placed with a good wage, is also the responsibility of sociovocational rehabilitation. This is a team effort which includes professionals like the vocational evaluator and trainer.

Employers must be encouraged to use the services of the persons with disability with incentives in the form of tax benefits awards and social distinctions. Towards this end, legislation will have to be enacted to give the differently abled their rightful place in society. The passing of the ***Americans with Disabilities Act (ADA) in 1991*** was a landmark in the life of the disabled in that country. In India the act passed is the ***PWD (People with Disabilities) Act 1995***.

The role of the community cannot be overemphasized. Awareness programs must be conducted; trust in one's abilities must be generated.

Now the emphasis is on community-based rehabilitation, where trained personnel, preferably from within the community are made available even to remote areas, linked to the primary health care set-up. Adults can be trained in a vocation suitable to the community and area. For example, a grass cutter who has lost his right hand can be given a device with a sickle and trained to go back to his original job in his village. There is also the in-built advantage that he is being trained in the profession of his choice and where he has the contacts and goodwill needed to generate employment.

The catchword today ***is empathy not sympathy***. In other words the message that the persons with disability are giving throughout the world is ***please accept us as we are***.

The person with disability is considered an equal and effective partner in the modern social order, and his contribution to the field of politics, administration, science and the arts is second to none. There are several shining examples for this. One has only to recall the name of Stephen Hawking the famous professor of physics who suffers from gross motor disability. Helen Keller was visual and hearing impaired, Milton was visually impaired, and Roosevelt had poliomyelitis. Such great people make us feel proud of the contribution of the handicapped to the progress of humanity.

As we march into the 21st century, we look forward to a disability-free population where each can fend for himself and lead a life of independence and dignity.

CHAPTER 2

Delivery of Rehabilitation Care: The Team

In the realm of persons with disability it is not possible for a single person to guide the whole course of rehabilitation. Due to the diverse symptomatology and the spectrum of diseases which lead to disability, optimum results can only be obtained when a group of qualified professionals (where available) get together and chart out a comprehensive program for the relevant disability. Each member contributes in his own area of specialization, and functions with empathy, not sympathy.

The members of this group are classified according to their areas of specialization and function as Medical or Sociovocational (Fig. 2.1).

MEDICAL

There is hardly any area of medical specialization that has no bearing on the course of rehabilitation. The specialists interact with the rehabilitation team on a case to case basis. The neurologist, for example, would prescribe drugs for epilepsy, the plastic surgeon would treat the pressure sores and the rheumatologist would assess the patient with ankylosing spondylitis. The medical team members are:

- *Physiatrist* – the leader of the team
- Orthopedic surgeon
- Neurologist
- Neurosurgeon
- Plastic surgeon
- Psychiatrist
- Pediatrician
- Obstetrician
- Geneticist
- Neonatologist
- Rheumatologist

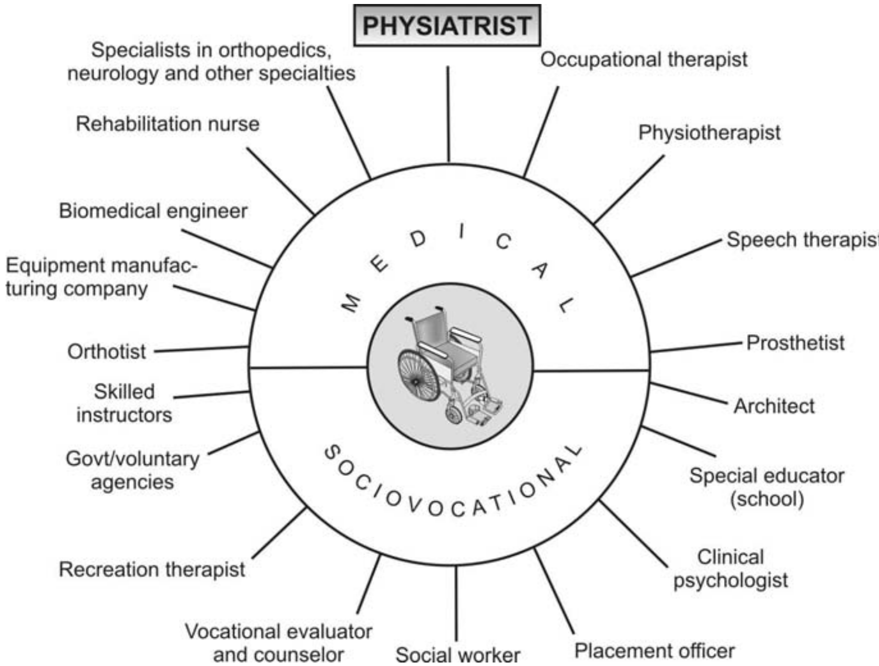


Figure 2.1: The rehabilitation team comprising of the medical team and sociovocational team

- Cardiologist
- Cardiac surgeon
- General surgeon
- Oncologist
- Urologist
- Ophthalmologist
- Otorhinolaryngologist
- General physician
- Family physician

Paramedical

- Physiotherapist
- Occupational therapist
- Creative movement therapist
- Recreation therapist
- Prosthetist-orthotist
- Rehabilitation nurse
- Speech pathologist
- Psychologist
- Biomedical engineer
- Horticultural therapist

Play and Drama Therapist

- Music therapist

Sociovocational

- Social worker
- Vocational counselor
- Vocational evaluator
- Skilled instructors
- Placement officers
- Child development specialist
- Special educator
- Employment agencies
- Industries
- Banks and funding agencies
- Nongovernmental organizations
- Community
- Family members

THE REHABILITATION TEAM

The Medical Team

Physiatrist: *Physiatry,* also known in some hospitals as the specialty of Physical medicine and rehabilitation has developed recently in to a very comprehensive and holistic field. There are very few trained physicians in the field of Physiatry today. ***The physiatrist is the leader of the rehabilitation team***. The functions of the physiatrist are, to clinically assess the patient, arrive at a functional diagnosis and coordinate with other members of the team to chart out a line of management.

The physical medicine specialist or Physiatrist is qualified in the evaluation of disability, prescription of physiotherapy, occupational therapy programs, orthoses and prostheses. He often needs to involve the vocational counselor for vocational evaluation, counseling, training and job placement, or with the architect to design barrier free environment for the person with disability. During the course of his review, he would need to interact with his peers in other fields like neurology or orthopedics. On the academic side, he needs to work on improving the specialty and do some original work, and teach other members of his team (or even learn from them) wherever required.

The physiatrist is in the best position to guide the patient and his relatives through the challenging course of rehabilitation. He keeps in mind the residual abilities of his patient, matches them with the skills of his team and limits the final disability of the patient.

It is imperative that the physiatrist has the knowledge sufficient enough in each of the paramedical, medical and socio vocational specialties relevant to rehabilitation to be able to provide the best possible course of therapy to the patient. He is seen as friend, philosopher and guide to his team members and patients. By nature a physiatrist must be compassionate, empathetic and understanding. He must be able to bring out the best in his team and listen patiently to individual opinions.

The other members of the medical team bring in their specialized skills for individuals needing them, on a case to case basis (Fig. 2.2).

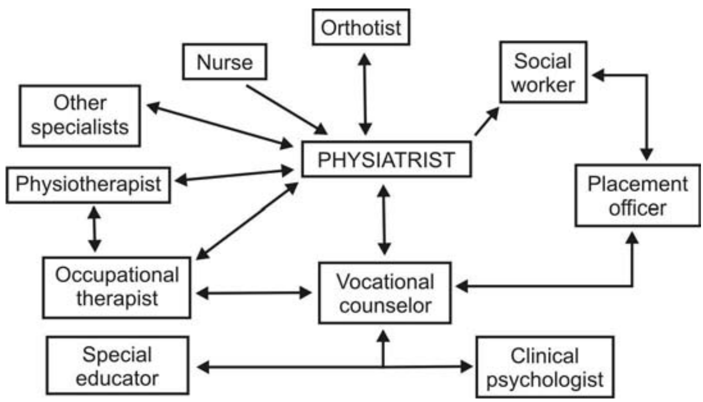


Figure 2.2: The interaction between physiatrist and other core members of the rehabilitation team

OTHER TEAM MEMBERS

Physical Therapist

The physical therapist assists the patient in ***movement restoration***. He is a very important member of the rehabilitation team. He has to perform a thorough muscle strength evaluation and quantification, spasticity assessment, and measurement of joint range. On the therapeutic side he would have to perform exercises to maintain and increase joint range of motion, train sitting and standing balance, or increase strength, endurance, and coordination for specific muscle groups or the entire body.

During the course of therapy he would have to use various therapy modalities, such as heat and cold, as well as hydrotherapy techniques, electrical stimulation, traction and massage for pain relief. For those confined to home he would visit them and aid in home evaluation to make the environment barrier free and accessible. The use of various mobility aids including the wheelchair and its maintenance has to be taught to the patient. For those who are not ambulant the physiotherapist does progressive gait training with or without ambulatory aids.

Occupational Therapist

The WHO defines occupational therapy as "***the art and science of directing mans participation in selected activities to restore, reinforce and enhance***

***function or performance or decrease disability and thus, to promote health*.**" The occupational therapist is involved with function. His duty is to evaluate and train the patient in self-care activities, such as dressing, eating, bathing, and personal hygiene to maximize independence.

During the course of the treatment he would aid in maintaining and improving joint range of motion, muscle strength, endurance, and coordination, generally of the upper limbs. This helps the patient explore vocational skills and avocational interests. The occupational therapist would thus have to work with the vocational counselor when a change in employment is anticipated.

For those confined to home he would provide holistic training in home management skills, using simple self help aids to minimize fatigue and conserve energy. The occupational therapist would evaluate the home and suggest modifications to provide a barrier-free environment, and train the patient to compensate for sensory and perceptual deficits taking personal social and cultural tastes into consideration. He would train the patient to use orthoses, self help aids or adaptive equipment when necessary and educate the patient's family by demonstrating techniques designed to maintain patient's independence and to minimize over protection.

In upper limb amputees, and severely handicapped patients he trains the functional use of a prosthesis or of environmental control systems and collaborates with the physiotherapist in achieving set goals using 'activities' instead of movements and with the orthotist in making splints.

Prosthetist-orthotist

The prosthetist-orthotist is responsible for the design, fabrication, and fitting of the orthosis or brace (Ref Chap 7) and prosthesis (artificial limbs *Ref Chap 8*). He makes certain that the device functions and fits properly and that the patient adjusts well to it. The patient and his family are instructed in the maintenance of the prosthesis.

He coordinates with the physiatrist, physiotherapist, occupational therapist and biomedical engineer, to decide the best appliance to be given. Before giving the appliance he would take measurements, fabricate them, making modifications and changes in design where required.

Once ready he fits it to the patient in static and dynamic alignment, repairs it when needed. He often needs to work with the biomedical engineer in the research and development of new material and design.

Rehabilitation Nurse

The rehabilitation nurse maintains the health of the bed ridden patient and helps him reach short and long-term goals. She takes care of his nursing needs during hospitalization and in the rehabilitation ward. In some cases she makes house visits and looks after the self-care activities of the inmate. She is responsible for:

- Transfers to and from the bed, wheelchair, chair, and couch
- Environmental factors such as sanitation, heat and noise, control of personal property, hygiene and safety
- The use and maintenance of adaptive equipment needed by patients to communicate, eat, move, defecate, dress, and ambulate (*Ref Chap 11*)
- Specific preventive measures to minimize the effects of inactivity and promote independence
- Integrating various therapies into his daily activities
- Medication and follow-up.

Speech Pathologist (Ref Chap 5)

The speech pathologist helps the patient in the area of communication and swallowing, by:

- Evaluation and treatment of neurological communication problems
- Vocal re-education
- Preoperative counseling prior to laryngectomy, glossectomy, and other procedures that will potentially influence communication abilities
- Laryngeal speech training (esophageal speech or use of a prosthetic larynx)
- Retraining speech inpatients with intra oral defects
- Cognitive retraining
- Training the patient in the use of communication devices
- Patient and family education
- Evaluation of swallowing function and management of dysphagia.

Psychologist and Child Development Specialist

The psychologist prepares the patient and his or her family members for full participation in rehabilitation. He conducts tests dealing with personality, style and studies the patient's way of dealing with stress. The problem-solving skills, memory and intelligence of the patient are also assessed. Any psychosis or neurosis is diagnosed and treatment initiated.

He then starts sessions in counseling. He would be required to counsel adolescents to adjust to body changes as age advances, job aspirants to develop problem-solving skills and alcoholics to get out of their habit. Marriage, sexual counseling and handling the disability itself which can give rise to a sense of inadequacy or depression, need to be handled with empathy.

Horticultural Therapist

Trees and plants soothe the mind. The cultivation of flowers, vegetables, and ornamental plants is thought to have therapeutic value in building confidence and self-esteem. Horticultural therapists give mentally retarded as well as physically disabled children and adults, the opportunity to work with a variety of plants and thus promoting independence, motor skills, and psychological wellbeing.

The patients are generally selected from those who show talent and aptitude, those who are not confined to bed, and those who may be physically fit but mentally subnormal. This activity can be of vocational relevance as they can be selected for work in gardens or parks.

Music Therapist

Who does not love music? Music is one of the finest of the fine arts. It can transport one to the highest plane of ecstasy.

The intervention of the music therapist may involve instrumental or vocal performance by the person with disability or helping him appreciate music or attend musical events. This goes a long way in helping children or adults with cerebral palsy or other paralytic conditions. Playing an instrument like the keyboard or the violin improves fine motor skills while dancing or exercising to music (creative movement therapy) is a novel way to improve gross motor milestones. Some children with Down syndrome respond naturally to music. Music helps in relaxation, sedation, or control of pain or anxiety, for those who sing, it improves speech through articulation training or melodic intonation

In those who are immensely talented and in those whose disability enhances musical aptitude, like the visually impaired, music therapy prepares selected patients for music related careers. It improves socialization skills, self-confidence, and esteem through group music activities. For patients in palliative care, it provides the much needed respite.

Creative Movement Therapist/Dance Therapist/ Play Therapist (Figs 2.3 to 2.5)

Dance therapy and play therapy is practiced more often with mental health patients than with physically disabled patients. The dance therapist sometimes called a movement therapist focuses on rhythmic body movement as a physical and psychological medium to:

Figure 2.3: Play therapy is introduced among children for building team spirit, improvement of concentration, coordination and muscle power; it is great fun too!

Figure 2.4: Drama and creative movement help in involving the child in self expression and gross motor skills

Figure 2.5: Dance as a form of therapy

- Improve gross motor control
- Relieve stress and improve awareness of tension in the body, expression of emotions, and communication, especially when verbal expression is limited.
- Improve body image and awareness
- Classify and describe body movements
- Improve group activity and competitiveness.

Recreational Therapist

The recreational therapist uses recreational activities to improve social and emotional behavior and promote the development of the patient.

The first step is, assessing in detail the patient's interests, social capability, cognitive and emotional functioning, level of orientation and awareness. His physical limitation and abilities, resources, perceived barriers in his immediate environment, also will help plan out his recreational activities.

Next, the therapist goes about educating patients in leisure activities, with specialized equipment, adapted sports, and alternatives to existing life styles, acquiring new skills. This is particularly beneficial to kids who would love to have a session of cricket instead of a session with the physical therapist!

These recreational activities like tours, adventure trips, picnics, games and dramatics have several benefits. They help to increase attention span, concentration, maintain physical strength, social skills and motivation.

They assist in family and patients adjustment to disability and thus decrease unwanted behavior, like depression. A group of special children playing in the part provides the much needed community integration, more than one would expect from awareness lectures.

Thus recreation therapy reinforces other forms of therapy.

Play and recreation enhance functioning level and thus improve the quality of life after discharge from the rehabilitation center.

Biomedical Engineer

The field of rehabilitation is an interface between the medical and engineering profession. With the advance of technology, we have newer user friendly environment control units, communication aids, orthoses and limbs. All these have to be designed by electronic and mechanical engineering professionals. The role of the biomedical engineer is to interact with the physiatrist orthotist or speech pathologist to design a piece of equipment, which will be of use to the persons with disability. In many cases the design will have to be unique or customized. Examples of technology used for the handicapped include environment control systems, voice activated wheelchairs and carbon fiber prostheses.

Social Worker

The social worker has a very important role in sociovocational rehabilitation. This is because he has to interact with the patient, family and rehabilitation team. He has a major role:

- To evaluate the patient's living situation, including lifestyle, family, finances, and community resources, and assessing the impact of the disease or disability on these areas. If there is any need to change the living conditions, he would suggest alternatives.
- Study of the home condition, family, interpersonal relations, and job situation. The aptitudes of the patient, i.e. his scholastic performance, his attitudes, hobbies, and interest are combined with the psychiatrist's findings, and physical examination for the purpose of chalking out education or career

- To explain to the family the patient's problem and the treatment recommended by the psychiatrist or psychologist.
- Help the patient and the family to work out a way for a more adequate social adjustment and plan group activities with the family members for imparting knowledge about the illness and care of the patient
- Whenever possible, to pool in the community resources for the benefit of the patient in terms of financial aid or material aid so as to promote better medical and psychiatric care. He also has to keep in touch with other social agencies so that a proper coordination of services could be offered to them.
- Teach nursing students and staff, medical students, school teachers on social aspects of rehabilitation
- Community contacts: As a part of public education, the social worker keeps in touch with the community through audiovisual methods, radio, TV, press, write ups in periodicals
- To maintain case records, registers, files, correspondence for future guidance and research purposes. A well-maintained record often helps in statistical analysis and brings out some useful information from social research point of view. It also helps in long-term follow-up

  Over a period, the social worker becomes almost like a part of the family, and helps in placement of the patient in a suitable job after training or to help seek a suitable life partner.

Vocational Counselor

The vocational counselor (*Ref Chap 12*) is an important professional in the sociovocational team who identifies the right vocation, skill or way of life of these patients. The skilled trainer trains the client in a particular vocation

Placement Officer

He places the disabled individual in a suitable job and visits him at the workplace frequently. He coordinates with the social worker, the counselor, the candidate and the employer regularly. He maintains a database of candidate requirements and also a list of prospective clients and matches the two lists. He may be employed by an NGO, or by the employment exchange of the Government.

Special Educator

The special educator is a teacher who teaches special children and who attempts to recognize the deficits in the child's functioning, works out compensatory teaching methods permitting the precise identification of the child's faculties and building an individual program around these assets. Early intervention may accelerate mental, social and psychological development and removes faulty learning habits. The needs are different, and so there is lessened emphasis on academic performance and more stress on practical life experiences and vocational training (Ref Chap 6).

Non Government Organization (NGO)

It is not only the responsibility of the government to take care of the disabled; the community is also alive to this need. Several philanthropists come together to set up organizations catering to the rehabilitative requirements of the handicapped. Some of these are run by handicapped individuals themselves. Some examples are the Spastics Society of Tamil Nadu, Amar Seva Sangam, NASEOH, and the Schools for the Deaf and Blind. Many NGO's tend to specialize in the care for specific conditions like the Multiple Sclerosis Society of India.

Banks/Funding Agencies

These help by giving money to deserving candidates to set up dealerships and businesses, at concessional interest or waiving certain clauses and requirements.

DELIVERY OF REHABILITATION CARE

The Need

It is estimated that, there are over 150 million people with disability all over the world, out of which the existing facilities can cater to only about two million, leaving a yawning gap of 148 million, mostly from the developing countries. Most of the welfare programs are concentrated in cities resulting in a lopsided development with PWD in rural areas deprived of facilities. Also the number of rehabilitation professionals in the third world is woefully inadequate.

The delivery of rehabilitation care is done through the following approaches:

- Institution based rehabilitation (IBR)
- Homes
- Day care centers (DCC)
- Outpatient clinics (OP)
- Camps
- Community based rehabilitation (CBR)
- Inpatient rehabilitation centers

	Characteristics	*Advantages*	*Disadvantages*
IBR	–urban based –large number of rehab personnel available –excellent infrastructure –referral centre for all diseases and conditions	–research programs –statistics generated –rare conditions can be treated –rigorous program initiated and carried out by professionals	–prohibitively costly –patients are mostly admitted; hence they are cut off from society –no follow up when patients are discharged

(Contd...)

(Contd...)

	Characteristics	*Advantages*	*Disadvantages*
Homes	–generally cater to patients of a homogeneous group –patients stay on the campus –limited number of rehab professionals	–empathetic approach among patients who are afflicted with the same problems –nursing care at a relatively lower cost	–patients are admitted; hence they are isolated from society –very little medical care or therapy, boredom, –no responsibility on family members except perhaps monetary
Day care centers	–patients, again of a homogenous group are brought daily to the center –some medical rehab work is undertaken –very often integrated with special schools	–patients who are afflicted with the same problems get treated with fairly holistic approach –family members get to interact with the PWD during the rest of the day, when the patient gets back home	–bringing the patient to and from the center is an arduous task –all rehab team members are not present; only those relevant to the particular affliction, e.g. dyslexia or CP, are present
Outpatient clinic	–caters to a large group at the same time on an outpatient basis –therapy/medical advice is given on a case to case basis –all members of the rehab team may be present	–useful in a developing country where resources are hard to come by and the number of rehab professionals is woefully short –diagnosis, investigations therapy can be given at cheaper cost for conditions which can improve over a short span of time, like backache	–cannot cater to moderately or severely disabled bringing the patient to and from the center is a difficult task –hardly any follow up of patients
Camp approach (Fig. 2.6)	–Single contact with a large number of rehab professionals at the same time –many people can be evaluated on the spot –usually organized by a local organization for people from the lower strata of society	–statistics can be obtained on incidence of disability –community awareness can be created about PWD –some management can be given where none exist to rural people who do not have the means to come to IBR for rehabilitation –evaluation is usually free, and therefore accessible to the poorest people	–depends entirely on the whims and sincerity of the sponsor –no follow up at all the PWD is not given any idea about his condition or how to go about it, since the contact with the rehab professional is so limited

Inpatient Rehabilitation Center

A large number of patients of all ages are regularly admitted into hospitals and nursing homes with orthopedic and neurological disorders such as stroke,

Figure 2.6: Patients with disability waiting for assessment at a community rehabilitation camp

fracture of hip, paraplegia and the like. Such hospitalization and treatment focuses on saving the life of the patient and limiting the disability, after which the patient is discharged from acute care service. The second phase of treatment, namely, rehabilitation of the patient has to follow through in order to improve the quality of life of the patient. To maintain such a patient in a hospital during this phase is not only expensive but also does not gainfully utilize hospital infrastructure. It is also potentially dangerous to the patient's health due to cross infections

Rehabilitation is often left to the family members, who though well meaning, are usually ignorant and ill equipped for the task of making the patient independent or re-integrate him or her into society. The ideal path to recovery, therefore, should be through a rehabilitation unit before domiciliary care. This center caters to intermediate care of patients (after acute phase management by neurologist, neurosurgeon, or orthopedic surgeon). Chronic patients like those with rheumatoid arthritis who have a good chance of recovery can also be catered to.

At this center emphasis will be placed on the maximal restoration of the physical, neuropsychological, social and vocational function of the person as well as prevention of secondary complications and alleviation of pain.

COMMUNITY-BASED REHABILITATION (CBR)

Community-based rehabilitation (CBR) is a strategy within the community for the rehabilitation, equalization of opportunities and social integration of people with disabilities. All members of the community - the disabled people themselves, their families, their friends, the local health, educational, and socio vocational services, help the rehabilitation professionals in the common goal of achieving self dependence among the disabled groups of individuals.

In the 1980's the WHO devised a strategy of service delivery to overcome deficits in other models of rehabilitation, and published a manual entitled "Training in the community for people with disabilities", and CBR evolved out of the concept. In recognition of this, the ESCAP (Economic and Social Commission for Asia and the Pacific) had declared the decade 1993-2002 as the Asia and Pacific decade for the disabled.

The goals of CBR are to ensure that the benefits enshrined in the Convention on Rights of Persons with Disabilities reach the majority by:

- Supporting people with disabilities to maximize their physical and mental abilities,
- Helping them access regular services and opportunities, and to become active contributors to the community and society at large
- Activating communities to promote and protect the rights of people with disabilities by removing barriers to participation, improve awareness about disability and lobby for their inclusion in society.
- Empowering PWD and their families.

Over 90 countries all over the world have been successful in implementing these concepts of CBR.

India is a vast country with a huge rural-based population. Mahatma Gandhi has said that India lives in its villages. It is not possible to provide professional expertise across the length and breadth of the land at the doorstep of the people with disability. Hence we have to take up an approach which is simple and benefits a larger population. The programs in CBR broadly aim at:

- Prevention of disabilities
- Identification of high risk infants and mothers
- Early detection of disability and management
- Assessment of felt needs of the people with disability and the family
- Home-based or neighborhood-based programs
- Parental involvement
- Play groups and integrated schooling for children
- Organization for and by the people with disability.

The basic concept inherent in the multi-layered approach to CBR is the ***decentralization*** of responsibility and resources, both human and financial to community level organizations. Those with disabilities are enabled to participate fully in the social, economic and political life of the community.

CBR is the appropriate rehabilitation program for the rural people with disability delivered at their doorstep with the use of local resources and with the involvement of local people (Fig. 2.7).

CBR is a need-based rehabilitation done in the community at the community level by utilizing the contribution of the community. The people with disability and their families are intensively involved in the decision making process, as are the members of the community.

Figure 2.7: Community-based rehabilitation—a paraplegic being exercised in her house in a village

CBR is a self-help movement based on:

- Awareness and concern of the community
- Initiatives from the community
- Planning from the community
- Resources from the community
- Implementation by the community
- Evaluation by the community
- Modification by the community
- Benefits to and from the community

Criteria

CBR programs must coordinate service delivery at the local level, and people with disabilities must be included in CBR programs; at all stages they must have distinct decision making roles.

Aspects of CBR

CBR has four important aspects.

- Medical
- Educational
- Economical
- Social

The medical aspect usually starts with evaluation of the disability by a group of professionals. A comprehensive program is charted out, which is followed up by diligent grassroots level trained personnel. Usually the relatives of the patient are also trained. Whenever required, education is imparted to those who need basic knowledge and skills. This gains more significance in children suffering from cerebral palsy. The educational vocational and avocational skills imparted will provide a springboard for the patient to register himself for a job, or open up opportunities for self-employment, and avenues for economic betterment.

***Society needs to be involved in CBR*:** The success of any CBR program depends upon factors like cost effectiveness, individualized values as well as social acceptability.

Members of the CBR Team

First and foremost, ***the patient*** has to be involved in all decision making processes, because he is the recipient of the services. People with disabilities can be more effective than non-disabled people as role models for and counselors of other people with disabilities. Local people, like families of people with disabilities, and members of the community who know the lie of the land, its economy and the local environmental conditions, are in the best position to implement the program. Support will be given by the Governments (local, regional, national), non governmental organizations and medical inputs by the medical professionals. Allied health science professionals, educators, social scientists and other professionals are often used in their capacity as educators. The corporate sector, comprising of profitable companies and industries have recently coined a term corporate social responsibility (CSR), implying an obligation to plough back some of the benefits of its operations to the community, in which it operates.

The other members are locally available skilled workers, e.g. carpenters who could be trained to make appliances and aids, local leaders who can try for barrier free environment, the school–teacher, who contributes her spare time for children with special needs, the multipurpose rehabilitation worker: (a trained person who can identify disability, and give the basic physiotherapy and prescribe orthotics), and the PHC staff. The medical officers and workers of the PHC need to be trained in identifying handicap and managing it. One of the largest orientation programs of its kind in the world was introduced by the Rehabilitation Council of India for PHC doctors all over India, to orient them towards rehabilitation.

Role of the Rehabilitation Professional

The rehabilitation professional, whether he is medical, paramedical or sociovocational, is seen as a leader, teacher and guide instead of as a health provider. He imparts training, demystifies the rehabilitation concepts, solves specific problems, organizes the set up and generally functions as an advisor.

Models of CBR

- WHO Model uses trainers and distributes booklets on health conditions
- *Neighborhood model:* A resource center in the community adopts another center, trains the personnel, and in due course this becomes another resource center
- *DRC models:* The District Rehabilitation Scheme (DRC) was launched by the Government of India in January 1985 on a pilot basis in collaboration with the National Institute of Disability and Rehabilitation Research, the US Department of Education and UNICEF.

The DRCs surveys disabled population, and works on all aspects of rehabilitation like prevention, early detection and medical intervention. Deformities are corrected surgically, physiotherapy occupational therapy and speech therapy are given and amputees are provided with artificial limbs. The entire gamut of sociovocational rehabilitation like training, job placement, and self-employment opportunities is also catered to under this scheme.

CHAPTER 3

Therapeutic Exercises and Other Alternative Techniques in Treatment

Exercises performed on a patient to achieve therapeutic benefit are called **Therapeutic Exercises**. These exercises are classified as follows:
- Coordination exercises
- Balance training
- Gait training
- Relaxation exercises
- Re education exercises
- Strengthening exercise
- Mobilization exercises
- Endurance exercises
- Postural correction
- Ergonomic exercises (*Ref Chap 30*)
- Hydrotherapy
- Suspension therapy

Apart from these exercises, there are some skills imparted to the exercise therapist, like manipulation, taping massage and other alternative healing techniques.

COORDINATION EXERCISES

Coordination is needed for performing purposeful movement that is both smooth and precise involving simultaneous activity of many muscles superimposed on a background of good posture. Motor units of multiple muscles are activated with simultaneous inhibition of all other muscles in order to carry out a desired activity.

Components of Coordinated Activity

Volition— the patient must have the voluntary control to perform the activity; the ability to initiate, maintain or stop it.

Perception— to be effective, proprioception that is, the peripheral sensation of the joints must be intact to integrate the motor impulses and sensory feedback with the sub cortical centers. When proprioception is affected it is compensated with visual feedback. This is the basis for Romberg's phenomenon, when the person starts swaying when he stands and closes his eyes.

Engram Formation—an engram represents the neurological organization of muscular activity developed in the extra pyramidal system. Most of the activities we do involve many muscle groups, and the brain perceives the final movement objective rather than individual muscles' performance. Research has proved that 20,000 to 30,000 repetitions of precise performance must be performed in order to develop an engram. This is why, to perfect an activity such as driving, it is necessary to keep practicing it over and over again till it becomes an engram. Once perfected, the brain goes almost into 'autopilot', and can concentrate on more demanding situations while still continuing the engram pattern. This is how one can talk while driving or read the paper while eating breakfast.

Indications for Coordination Training

Lesions of cerebellum resulting in **cerebellar ataxia** form the motor component of ataxia. On the other hand lesions in the posterior column of the spinal cord result in sensory ataxia.

Incoordination may also result from lesions affecting the muscle, the peripheral nerve or the upper motor neurons. In these cases since the incoordination is the result of muscle weakness, hypotonicity or hypertonicity, it is not **primary incoordination**, and the predisposing factors are treated, instead of labeling it as incoordination.

General Principles of Coordination Training

A suitable learning environment, i.e. an environment which provides for attention to tasks, is created. A list of activities is prepared. The activities are broken down into components that are simple enough to be performed correctly. If the patient has very poor coordination, it may be necessary to completely break down the multi muscular movement and practice the contraction of an individual prime mover. The patient is given instructions to perform these simple components which are then welded together to form the final job performance.

Whenever a new movement is trained, various inputs are given simultaneously, like oral instruction (auditory), with touch (sensory stimulation), or positions in which the patient can view the movement (visual stimulation). If necessary the therapist may demonstrate with a passive movement on the patient which will provide a kinesthetic feedback. The physiotherapist assists in the movement where ever necessary, for precise functions so that the patient concentrates on sensations produced by the activity. As stated before, several repetitions of precise performance must be performed for the engram to form (Fig. 3.1).

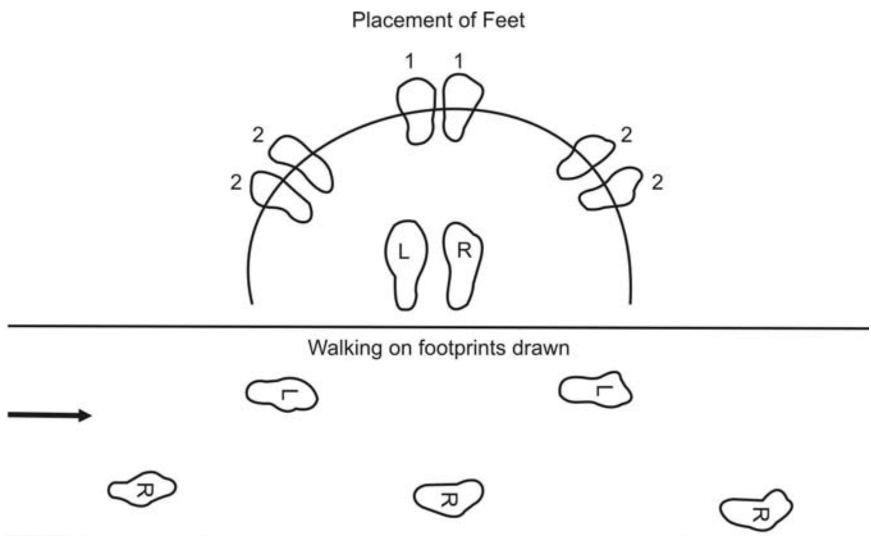


Figure 3.1: Placement of feet during training in coordination

The technique progresses in complexity by

- Increasing the speed of contraction
- Increasing the complexity where more muscles get involved.
- Increasing the range of movement during the activity.
- Removing the sensory feedback that is given.

The rate of performance should be slowed with each new addition to a pattern. Fatigue may occur during attempts for precision and may decrease the concentration of the patient. The patient should therefore have a short rest after two or three repetitions.

Frenkel's Exercises

Dr HS Frenkel was a physician from Switzerland who propagated the concept of using sensations of sight, sound and touch to establish control of voluntary of movement. This is by compensation for the kinesthetic sensory loss .

Principles

- Each patient should have individual attention, and should not be left unattended in case he should fall and injure himself.
- the patient should be adept in each exercise or set of exercises, before he is allowed to proceed to a more difficult one.
- Strong muscle contractions should not be given since progression is by complexity, not strength.

- The patient should practise exercises first with his eyes open, and then with eyes closed.
- In the beginning movements in full range are preferred to those in small range.
- Such movements should be given rapidly, then more slowly.
- Exercises are prescribed for the upper and lower extremities in various positions—sitting, lying, and so on.

Sometimes all this is quite boring especially for children. Diversionary activities such as playing with putty, building with toy bricks, or drawing on a blackboard, tailing the donkey lead to more useful movements such as using a knife and fork, doing up buttons and doing the hair. Transfers of objects from one container to the other, playing cricket or throw ball are examples of play therapy improving coordination.

BALANCE TRAINING

Almost all our daily activities are performed under the influence of gravity. Most of our effort and time is spent in reacting to the effects of gravity upon the body. Protective responses in maintaining balance are considered to have survival value by preventing us from falling as well as enabling us to maintain our sense of verticality.

Posture is the term used to describe a position of the human body. The human body is capable of several postures like lying, sitting, crawling, and standing. In all these postures the body needs to be stable in order to do its activities. Stability depends on whether the base and the position of the centre and line of gravity are either balanced in equilibrium or not. Balance and posture are interrelated.

Balance is maintained at a subconscious level, by integrating sensory inputs from the eyes, the vestibular apparatus, and the proprioceptors and super imposing them on a basic amalgam of posture and postural reflexes in the normal individual. While retraining a patient's balance he is given stimuli to which he must react. This is more important than his making a conscious effort to maintain equilibrium.

There are two types of balance—**static balance and dynamic balance**. Both of these are needed for normal activities. It need not be thought that balance training need be done only for neurological deficit. On the contrary balance retraining is an integral part of all gait training exercises or rehabilitation programs.

Static Balance

Static balance is the rigid stability of one part of the body on another. Even a person standing immobile is contracting his muscles in an isometric fashion. There is also contraction of muscles equally. As a general principle balance is developed progressively by moving from the more stable to the lesser stable position, for example from forearm support prone lying to sitting without support.

In the development of a child head control is the first to develop. This reinforces the fact that stability and control of the head should be given priority as it is needed in all positions. Later, the extensors of the neck and back and also spinal stabilizers can be stimulated to reinforce muscle contraction elsewhere, e.g. righting reactions, which are involuntary movement responses to stimuli, serving to maintain the alignment of the head and body in its normal upright posture.

Dynamic Balance

The body, unless it is fully supported and relaxed, like lying down, is in a constant state of adjustment to maintain its posture and its equilibrium. The force of gravity acts on it threatening to destabilize it. Maintaining balance means having the centre of gravity of the body within the base of support, i.e. with the trunk aligned over the feet. A soldier at attention might appear completely still, but he continuously transfers his weight and oscillates trying to maintain his center of gravity within his base. He is able to do this because of his sense of proprioception which provides feedback on the status of the body internally whether the body is moving and if so how, and whether the various parts of the body are located properly in relation to each other.

Equilibrium Reactions

These are involuntary automatic responses to a disturbance or destabilization in the structure of the body that serves to maintain or regain balance during posture and movement. These balance reactions may occur by an adjustment in tone or an adjustment in posture

Method of Stimulation

For balance to improve in a position, the patient must be assisted to assume that position. Man's body axis is vertical, and it is in the vertical position, that he needs the ability to withstand the effects of gravity. Analysis of balance reactions and body alignment in responses to shifts in weight will identify the deficient areas, which require specific stimulation. For example, if a person is pushed to his right, he moves his head and trunk in the opposite direction with corresponding compensatory reactions of the pelvis and lower limbs to bring his center of gravity within his base of support. Any one or all of the components of balance may be missing and must be stimulated by the therapist.

Alternate tapping stimulates balance in antigravity positions. Gentle taps are applied alternately to the upper trunk with the body in normal alignment. The effect should be to displace the patient slightly off balance in alternate directions, which will stimulate the necessary adjustments. It must be stressed that the displacement should be small so as to stimulate only fine adjustments.

Maintenance of Position

The patient is instructed to maintain the position, for example, prone kneeling, sitting or standing against the therapist's tapping technique to displace him backwards, forwards and laterally.

The use of a moving support is valuable in some positions. Objects used include balance boards, rolls which are made of a cardboard tube, and therapeutic balls. If balance reactions fail, protective extension (parachute reflex) of the arms is one of the most important reactions.

In general, movement for balance is stimulated smoothly and steadily, in a small range initially, gradually increasing the range as the patient gains more control. Any position can be made more stable by using pressure and approximation and by providing the patient a wider base by giving more than one fixed point of stability. Too much emphasis on stability would prevent the patient from moving or trying to move. On the other hand, too much stimulation of movement might result in loss of balance and the confidence to regain it. The use of weights worn by the patient on the trunk or lower limbs is sometimes suggested as a means of improving movement control.

Balance Boards consist of a platform, which may be either rectangular or circular, resting on a hemispherical base. They re-educate balance and increase strength of the muscles of the leg. The patient is given various positions on the balance board and he should learn to maintain his balance while sitting, kneeling or standing on it, while it is displaced in different directions. The Bobath ball is very useful in this training.

GAIT

Gait or human locomotion, may be described as a translatory progression of the body as a whole, produced by coordinated movements of body segments. **It is the forward progression of the center of gravity (a point in front of the 2nd sacral vertebral body) of the body, based on the reciprocal movements of the lower extremities.** Man is the only animal among vertebrates, possibly other than some primates who walks on two limbs. Each person has his own characteristic gait pattern.

Normal human gait needs good muscle power in the lower limbs, truncal stability, good proprioception, good balance and vision. The movement is rhythmic and smoothened out in to an elegant and sinuous pattern.

Gait Cycle (Fig. 3.2)

The gait cycle is a series of documented movements during walking which by convention is measured from the point of initial heel contact of one lower

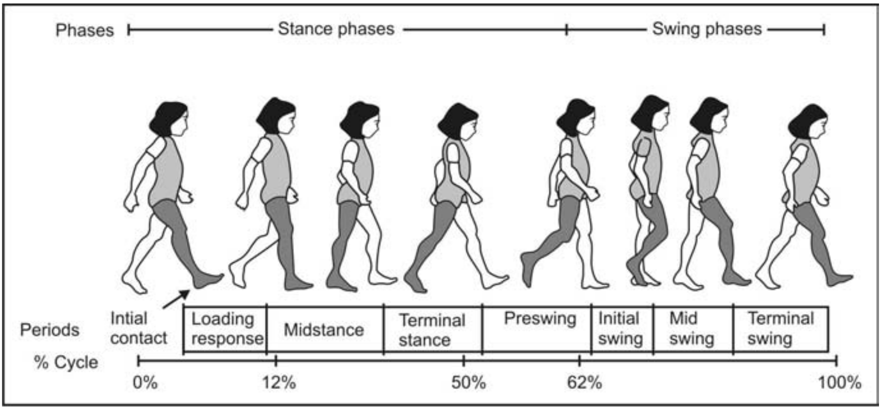


Figure 3.2: Phases of gait cycle

extremity to the **same** point when it occurs again, that is the point at which the heel of the same extremity contacts the ground again. It is divided into 2 phases **stance and swing**.

When movement is initiated it is called acceleration and when stopping it is called deceleration. Energy is consumed in both phases but more during deceleration. The path taken by the centre of gravity determines the energy expenditure and efficiency of gait. Given the situation, the ideal path should be a sinusoidal curve with minimum displacement. Stance, when the foot is in contact with the ground is the longer component of the gait cycle, using up to 60 per cent of the duration. Swing, which is when the foot is off the ground, forms the rest 40 percent of the cycle. There is a period called d**ouble stance** covering 11 percent of the cycle when both legs are on the ground.

Studying Normal Human Locomotion

In the analysis of the walking pattern of a person the external effects like the force of gravity, or inertia and internal effects like forces exerted by muscular contraction or angular relationship between the segments, are studied.

Kinematics is the division of mechanics, which deals with the motion of bodies. It does not study the forces acting to produce the motion. **Kinetics** is the division of mechanics that deals with forces acting on bodies.

Gait Analysis

Gait analysis commonly involves the measurement of the subjects given above, like the movement of the body in space (kinematics) and the forces involved in producing these movements (kinetics). It is done in a gait lab. Earlier, the analysis used to be done (and still is done in some places) by photography. Strobe lighting at a predetermined frequency was used in the past to aid in the analysis of gait on single photographic images. Another method is to use reflective balls as marker systems which are recorded simultaneously through cameras, placed at strategic positions. The patient is made to walk in a straight line on a modified floor embedded with force plates or transducers, which measure force systems, notably the ground reaction force and its magnitude and direction. The system then can calculate the forces and torques about each joint, and the power exerted by muscle groups, throughout the gait cycle. The cameras also measure joint angles and velocities. This information is then analyzed in a software that gives the parameters in 3 dimensions. It is possible for a gait researcher to generate information on the gait pattern and gait variables, description of all gait deviations, energy expenditure and endurance. Based on the analysis of the deviations he will be able to predict the patient's ambulatory capacity, in the home and community environment.

Observational Gait Analysis

Clinically it is possible to make a study of the gait. The physiatrist makes a study of the patient's history and condition. Having arrived at a diagnosis, he proceeds to analyze the way the patient walks. If we wish to observe the gait clinically, we need to:

- Measure the distance that the patient has to cover.
- Have an unobstructed view of the patient – in front and by the side.
- The joint or segment to be assessed is selected.
- Observe during the initial part of the stance phase and follow through the entire gait cycle.
- Perform observations on both sides (right and left).
- These observations are recorded for one segment at a time throughout each phase of the gait cycle. For example the physician concentrates on knee extension during the swing phase and records it on a video camera or even on his mobile phone!
- Repeat the process until all joints and segments are completed.
- Check if the gait is normal; if not note the deviations.

Qualitative Gait Analysis

Different reference systems are used in the qualitative gait analysis:

- ***Absolute spatial system:*** The environment is used as a reference, and the movement of the body in relation to the environment is studied.
- ***Relative system:*** The relative system describes the position of one body segment in relation to another body segment.
- **Absolute reference system**: The body is given a reference to the x and y and z axis and all segments moving are described in reference to the vertical or horizontal position of the body.

Electrogoniometry: A goniometer is similar to a protractor and measures the angles between the moving segments of the joint at a predetermined point approximately at the center of the joint. In a clinical set up it is measured manually but using an electrical transducer or a rotational potentiometer, it is possible to get more accurate measurements.

Determinants of Gait

The factors modifying the path taken by the centre of gravity, to smoothen out its extreme movements and reduce the amplitude of displacement, sideways and vertically, are called Determinants of Gait**.** They are:

Pelvic rotation: While walking, the pelvis rotates by 4 degrees on either side. This reduces the excursions of the center of gravity and elevates it by 6/16″.

Pelvic tilt: The pelvis drops on the side of the unsupported or swinging leg during walking and this saves vertical rise of the center of gravity by 3/16"

Knee flexion: During mid stance, the knee bends minimally on the stance leg. This decreases its length and therefore the height of center of gravity by 7/16". Thus the total saving in the vertical excursion of center of gravity 7/16″ + 3/16″ + 6/16″ = 1 inch.

Knee and ankle movement: There are movements between the knee, ankle, subtalar and mid tarsal joints which act to smoothen out the amplitude of the center of gravity to 2" by flexing, extending, pronating and supinating these joints in a coordinated fashion.

While some determinants act on the amplitude of movements of the center of gravity, there are others which are given below smoothen out the movement of the center of gravity into a sinusoidal curve, and which make the gait energy efficient and sometimes attractive.

Pelvic sway: This is the sideways sway of pelvis, which brings the center of gravity over one leg during stance and produces a side to side sinusoidal curve.

Limb rotation: The leg describes a 25 degree internal rotation on stance and external rotation on swing, smoothening out the sideways curve of the center of gravity.

Some Definitions

Stride length: This is the distance between heel strike of one leg and heel strike of same leg. This is approximately 156 cm on an average.

Step length: This is defined as the distance between heel strike of one foot to heel strike of the other foot (1/2 of stride length).

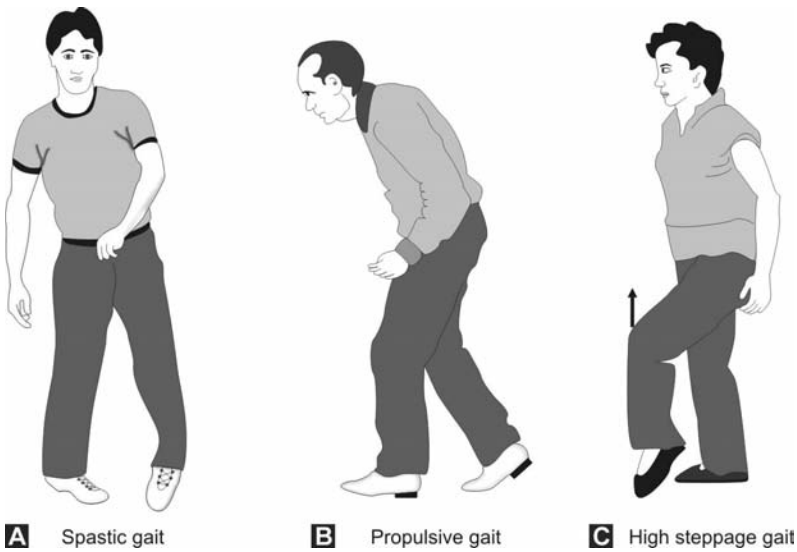
Stride width: This is the distance between midline of one foot to mid line of the other foot. It works out to 8 cm + 4 cm.

Toe out angle: The angle made by the midline of foot to direction of propulsion. It varies from 6-7 degrees.

Cadence: This is the number of steps per minute. It ranges from 60 to 120 steps per minute depending on the speed of the gait, the urgency of the person, the build and structure of the person. The mean duration of the gait cycle varies from about 1 to 2 seconds.

PATHOLOGICAL GAITS

Pathological gaits (Fig. 3.3) may be due to neurological or orthopedic causes as a result of:



Figures 3.3A to C: Pathological gaits. (A) Spastic gait: Usually occurring in cerebral palsy; (B) Propulsive/retropulsive gait or Festinant gait: Usually occurring in Parkinson's disease; (C) High steppage gait or Footdrop gait: Typically occurs in paralysis of the dorsiflexors of the foot

- Pain during movement
- Loss of muscle power
- Increased or fluctuating muscle tone
- Incoordination of muscles
- Skeletal deformities

Parkinsonian Gait (Festinant Gait)

This gait is seen in patients with Parkinsonism who are affected with rigidity, slowness of movement and a characteristic stooped posture. There is an increase in cadence, as if the person is trying to catch up with his center of gravity, and shortened stride length. The patient takes short rapid shuffling steps with the fore foot as initial contact. There is lack of heel strike and toe off, and diminished arm swinging.

Scissoring Gait (Fig. 3.4)

This is the characteristic gait of a spastic patient and is the result of a bilateral adductor spasm at the hips and equinus contracture in the ankle. The patient leans forward and outward and is unable to clear the ground when taking a step, unless he raises the corresponding shoulder and the knee and tilts his body to the opposite side. He then raises the knee and brings it forward when it comes into contact with the other knee in support. The hip serves as pivot for the pelvis. The subject walks on toes, because of spasticity of the tendo-Achilles.

Features

- The hip and trunk sway from side to side
- There is lack of symmetry in weight bearing and steps taken are unequal in length
- There is a flurry of activity of the arms in all directions to maintain balance.

Ataxic Gait

It is present in cerebellar disease, disseminated sclerosis, and cerebellar ataxia. There is increased base of support and the patient cannot rely on only his proprioceptive responses but needs to look around him to use visual cues for mobility. He walks in a reeling or staggering manner like a drunk and with a tendency to swing to one or other side in a bizarre manner. The step length and stride length are unpredictable with frequent falls.

Figure 3.4: Scissoring gait

Sensory Ataxic Gait (Stamping Gait)

In this case the patient has very little sensory cues due to which he has to look continuously at the ground, and walk with his feet wide apart. He raises the affected leg high, throws it forward and then stamps down, heel first, with an impact. This type of gait may be noted in tabes dorsalis, or a cauda equina lesion.

Waddling Gait

In a waddling gait, the body sways from side to side like that of a duck. The feet are placed wide apart to increase the base of support. In dystrophy patients they may also be plantar flexed, due to shortening of the calf muscle. The shoulders are thrown back and the abdomen thrust out. Very often there is partial or total paralysis of gluteus medius on both sides. The causes of this gait in children are congenital dislocation of hip and muscular dystrophy, and in adults severe osteoarthritis knee or late pregnancy.

High Stepping Gait

This gait is also called foot drop gait. It is present in conditions wherever the dorsiflexors of the foot are paralyzed, as in lateral popliteal nerve paralysis, compressive disc disease or poliomyelitis. During the swing phase the patient is unable to clear the ground well, and his toes drag on the ground because of the foot drop. So he compensates by lifting the knee and hip higher than normal on that side. During heel strike the fore foot slaps on the ground.

Hand to Knee Gait (Fig. 3.5)

During mid stance the knee is actively extended and locked. This stabilizing action is performed by the knee extensors. In patients with paralysis of quadriceps due to poliomyelitis or femoral nerve injury, the knee buckles because of instability. Therefore to stabilize the knee and therefore the rest of the body, the locking of knee is done by passively pushing the knee backward manually by the patient putting his hand over the front of the lower thigh. The patient limps as he walks bends forward and laterally and this combination of forces can result in deformities such as scoliosis or genu recurvatum.

Gluteus Maximus Gait (Lordotic Gait)

Normally when the body moves forward in midstance, there is a tendency for the body to fall forward unless restrained by a force that extends and stabilizes the hip. This forces provided by the gluteus maximus acting eccentrically to tilt the pelvis posteriorly and retain the centre of gravity over the supporting leg. This stabilizing factor is lost when the gluteus maximus is paralyzed. The patient leans backward during heel strike using extensors

Figure 3.5: Hand-to-knee gait in poliomyelitis due to quadriceps weakness

of the spine and throwing his head back to passively extend the hip and keep the centre of gravity over the stance leg. This causes backward lurch of the trunk. The gait of the patient resembles that of the English lords who used to walk with their head thrown back, which is why it is called lordotic gait.

Antalgic Gait

Antalgic means in the presence of pain. Hence this is the gait of a person with pain in one or both of the lower extremities, because of which he tries to avoid putting too much weight on the limb in stance. To minimize the pain, the person shortens the duration of the stance phase on the painful side and quickly transfers the weight to the painless leg. The swing phase of the uninvolved leg is reduced, and it is brought just in front of the affected leg. The result is shorter step length on the uninvolved side, with reduced number of steps per minute. This gait protects the painful and injured pelvis, hip, knee, ankle or foot.

Hip Hiking Gait

When the hip or knee is ankylosed or a plaster cast has been recently removed from the knee after one or two months of immobilization they cannot be flexed during the swing phase of gait to clear the ground. So the patient lifts the entire leg higher than normal to clear the ground. The gait thus results from stiffness, and it may be painful or pain free. During the gait cycle, the pelvis is elevated by exaggerated plantar flexion of the opposite ankle and circumduction of the stiff leg to provide toe clearance.

Hemiplegic (Circumduction) Gait

It is quite common to see stroke victims ambulating by bringing their affected leg round in a semi circle to place it in front of them. This is due to an extensor synergy of the lower limbs because of which there is spasticity of the quadriceps and calf muscles. Knee flexion is prevented during the late stance phase, and if the spasticity is marked, the initial contact is with the toes first with the ankle inverted. The foot is thus in a equinovarus position, and the knee goes into full extension. This 'pseudo lengthening of the affected limb' does not allow a proper clearance of the ground unless it is compensated by circumduction at the affected side or hip hiking on the involved side.

Bear Walking (Fig. 3.6)

When a patient is unable to walk erect and does not wish to crawl he adapts a different form of mobility pattern. He walks like a bear, using both his upper extremities as additional supports, but with his knees extended. Though termed bear walking, it is really not walking, in the strict sense of the word as applied to humans but a modified form of crawl.

Figure 3.6: Bear walking [poliomyelitis]

GAIT TRAINING

Crutch Walking: Patterns of Gait

A **crutch** is a staff or support used by the physically handicapped or disabled as an aid in gait, often used in pairs. To select the pattern of gait to be employed by a particular patient, the following must be evaluated.

The ability of the patient to:

- Bear weight and to keep his balance on one or both lower limbs.
- Push his body off the ground by pressing down on both crutches.
- Step forward with either one or both feet.
- Generate and sustain the increased expenditure of energy required in all assisted gaits.

The partial weight-bearing gaits using crutches (either axillary or elbow) require more energy (nearly a third more) than normal walking, whereas about 70 percent more energy is required by the three point and swing through gaits. Each patient must be encouraged to walk even if he does not use a recognized pattern of gait. **Any mobility is better than immobility.**

There are six different patterns of crutch gait. They are:

- Four-point gait
- Two-point gait
- Three-point gait
- Swing to gait
- Swing through gait
- Tripod gait.

The type of crutch gait to be taught to the disabled person will of course, depend on several factors like type, extent degree of disability and residual patterns of weakness. Sometimes the patient with lesser disability will find even the so-called difficult gaits easy to perform while the severely disabled will find the simplest gait difficult.

Four-point alternating gait: The four-point gait is the most stable of all the gait patterns, providing three points of support while one limb or an assistive device is moving. The person will start by moving one ambulatory aid, such as a cane or crutch, about 1-1/2 feet ahead, followed by the opposite foot forward. Next the opposite assistive device is moved forward, and finally the other foot is brought forward. The sequence is as follows: right crutch, left foot, left crutch, right foot. The feet always stay about six or seven inches behind the crutch. The center of gravity falls between the four points of support. The four point gait is most easily performed using hip hiking in which progression is accomplished by successive forward advance of each point. This gait is often taught to paraplegics.

Two-point gait: The two point gait is a natural progression from the four point gait. It requires more balance and stability, but has a natural rhythm and arm motion that resembles normal gait. With a two point gait, the person advances one assistive device and a foot ***at the same time***. Adequate power of hip muscles (flexors, extensors and abductors) is essential for two point gait. It can be accomplished in two ways, either the crutch and foot on the same side advance together or the crutch on one side advances with the foot on the other side. The latter is more stable as weight is borne on both sides. At the beginning of the stance phase of one limb, the assistive device on the opposite side simultaneously makes contact with the floor and provides support.

Three-point gait: The three-point gait is used where a single lower extremity is affected, like a fracture of the hip. The gait pattern is either non-weight bearing or partial weight bearing on that side. The assistive devices move forward with the involved limb. As the unaffected limb begins the swing phase, and is placed on the floor in front of the involved lower limb, the body weight is shifted to the locomotor aid. So the three points would be both crutches, normal limb and involved limb.

Swing to gait: To perform the **swing to** gait pattern, the initial phase requires balancing momentarily on both legs as the crutches are moved forward simultaneously. This is followed by shifting the weight to the arms and hands, and forcefully depressing the scapula as the weight is shifted to the hands. Both legs are then brought forward until the feet are evenly placed at the level of the crutches or slightly behind. At the end of the step the person should be in normal crutch stance, ready to take the next 'step'.

Swing through gait: This is an extension of the **swing to** gait mentioned earlier. It is practised by some amputees and paraplegics on gaining expertise with the **swing to** gait. It provides a much more rapid means of ambulation than the other crutch gaits. It is the least stable of the gait patterns, and therefore requires practice and balance to perform safely. When the weight is taken on the arms the legs swing forward through the crutches, landing on the floor **ahead** of them. As a result, the crutches are behind the patient when the feet touch the ground. Immediately the crutches have to be brought forward before the hip and trunk lose balance and lead to a fall (Figs 3.7 and 3.8).

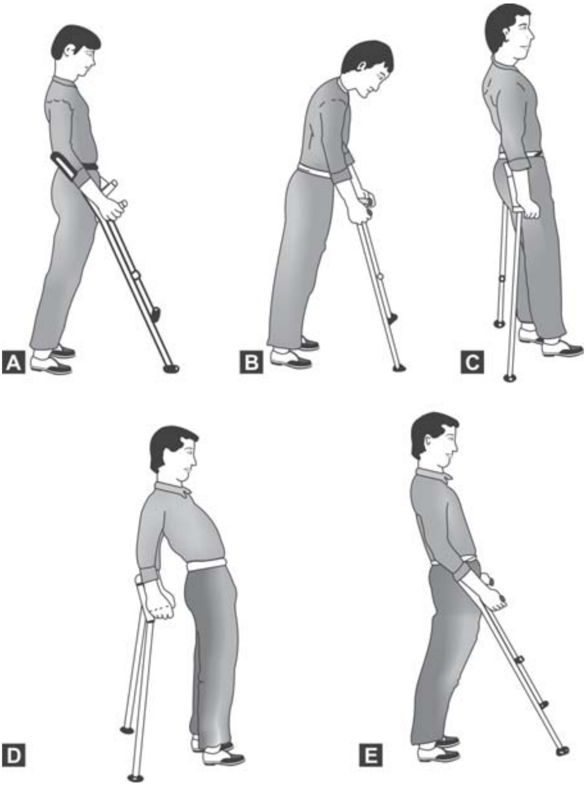
Tripod gaits: This is used by paraplegics and polio patients. The sequence is right crutch, left crutch and **drag the body**. This can also be modified as follows: Both crutches at the same time in front of the body then drag the body.

The feet rarely leave the ground so that a tripod base is constantly maintained, which provides the extra balance and stability. Sometimes gaits are taught within a walking frame or parallel bar (Figs 3.9 and 3.10) to ensure better stability.

RELAXATION EXERCISES AND MANAGEMENT OF SPASTICITY

Definition: 'Relaxation' is defined as a state in which the muscles of the body are comparatively free from tension. This is because functioning muscles can never be **completely** free from tension as they retain a certain degree of tension known as **muscle tone.**

Figure 3.7: Stabilization after swing through



Figures 3.8A to E: Swing through gait training with elbow crutches

Figure 3.9: Gait training in parallel bars for a paraplegic

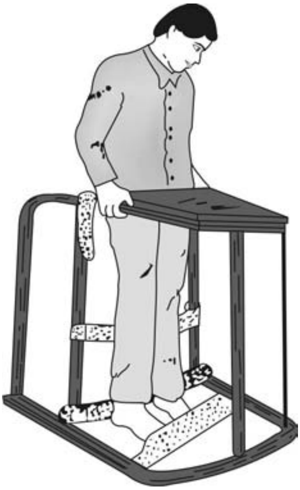


Figure 3.10: Standing frame

Indications: Relaxation exercises are indicated whenever there is muscle spasm due to acute or chronic pain, mental stress that is due to any cause, e.g. a systemic disease, stressful lifestyle, certain psychological disorders or hypertonicity resulting from an upper motor neuron lesion.

General Principles

- A position that ensures full support to the body (which reduces mechanical tension on muscles or ligaments) should be selected. Conditions of individual patients should be kept in mind, e.g. for aged patients with inspiratory disorders—prone lying may not be ideal
- Constrictive clothing or orthosis such as corsets and belts should be removed

- The treatment room should be as quiet as possible
- Strong colors and bright lights should be avoided. The room should have dim, diffuse light
- The manner of the physiotherapist should be pleasant and understanding
- The therapist explains gently what is going to be done to the patient so that any fear is removed
- Attention to minor irritants like a full bladder emptied before treatment can ensure a very cooperative patient.

METHODS FOR TRAINING RELAXATION

These methods may be of two types:

- Methods for general relaxation—which relax the total body.
- Methods for local relaxation—which relax a specific part of the body

Meditative Techniques for General Relaxation

Mental techniques: Meditative techniques focus on the mind and comfort level, where the patients' thinking is the major component. It involves bringing all the thinking processes to one point and later letting go. The mind is kept blank which surprisingly is a very daunting task. It is very nearly impossible to keep the mind free of thoughts and emotions. Elton and Stanley described the use of imagery for persons who find creating a blank mind difficult. The trainer tries and projects images on to the patients mind which need to be pleasant and relevant to the patient. Benson's controlled breathing produces a relaxation response, which produces in the patient a state of deep quietness that significantly changes one's physical mental and emotional responses to stress. It slows heart rate, decreases blood pressure, and muscle tension.

Transcendental meditation is a technique described by Maharishi Mahesh Yogi in which the practitioner is taught methods to subdue his thoughts and bring it to a state of peace. A mantra or sequence of syllables that may make no meaning to the meditator is taught. The mantra is utilized as a focus in the meditation process, and the individual's attention is directed naturally away from the surroundings to a quieter state of mental activity (inactivity). The meditator is said to have transcended his being or body state.

Visual imagery is based on the assumption that individuals have the ability to think up images that affect functions of the mind and body, like blood pressure or cardiac rate. Audio recordings promoting this imagery are commercially available. When a person thinks of beautiful scenery like a star studded sky or a tranquil lake it induces relaxation and encourages self healing. It has been tried out in patients with anxiety, those undergoing surgery and results have shown decreased length of time spent in the hospital when imagery was used. Studies of brain activity during imagery show that the same region of the brain is activated whether a subject imagines an image of an object, or whether the object is actually seen. This concept can be extended to inducing relaxation by listening to soothing music.

Consciousness of breathing: The patient is asked to breathe deeply, slowly and regularly with a slight pause between expiration and inspiration. He is asked to concentrate on his own rhythm of breathing. During expiration, he is instructed to feel like 'letting go' of the whole body. **Respiratory control** is also encouraged with instruction directed towards diaphragmatic and lateral costal breathing.

PHYSICAL TECHNIQUES

Jacobson's Progressive Relaxation: This method encourages the patients to tense, and then relax sequentially, groups of muscles while concentrating on to the components of tension and relaxation that are being experienced. The rationale is that by teaching the patient to contract a muscle and recognize the symptom or feeling of tension, reduction of tension in daily life would be possible. The method appears to be of clinical value, particularly in hypertension, epilepsy and respiratory distress. The muscle groups targeted in this method are shoulder depressors, elbow extensors, shoulder abductors, finger and thumb extensors in the upper limb and hip lateral rotators ankle dorsiflexors, trunk flexors, neck extensors.

Mitchell's Simple Physiological Relaxation: This is based mainly on the physiological principle that in an action involving group muscles, there is reciprocal innervation of opposing groups, whereby contraction in agonist muscles is accompanied by reflex relaxation of antagonists. This eliminates tension while preserving ones awareness about relaxed posture.

Rhythmical Passive Movement: Passive movements of the limbs and head may assist in general relaxation in some cases. Group movements of joints are preferable.

Local Relaxation

If the joint is the source of pain - passive movements should be given in the pain free range. Deep rhythmical massage also helps in relaxing the area where it is given. Hold relax and contract relax techniques are given to muscles under tension in the area of pain or their antagonists. First they are put into isometric contraction by applying maximal resistance, and then the patient is instructed to voluntarily relax those muscles.

Progressive Relaxation Training (PRT): The trainee is asked to focus attention on a particular group of muscles. This group of muscles is held tense for

5 – 7 seconds during which the trainee concentrates on the sensation of muscle contraction. On a predetermined word 'release', 'let go', the muscle group is relaxed.

Passive Neuromuscular Relaxation: The client imagines that he or she is relaxed and is asked to state the phase, "I am relaxed", and repeats it every time he breathes out. The technique consists of one continuous wave of relaxation which begins at the crown of head and progresses down.

The Alexander Technique: Alexander was an actor and teacher who found out a process called **respiratory reeducation in which** breathing and vocalization improved respiratory function**.** This evolved into a method to treat other physical problems through movement posture and breathing. A person's posture is the way that individual habitually holds himself against the forces of gravity. This can become distorted by emotional and physical influences. This technique re-educates the body to perform and conserve energy. For example, commands are given "keep your neck free, bring your head forward and up, lengthen and widen your back and shoulder" This technique deals with the psychological and physical coordination of the whole person, called as "the use of the self".

Feldenkrais Technique: Moshe Feldenkrais was an engineer, in whose view the body functions like a machine which could be programmed to work with minimum effort but maximum efficiency. He therefore formed exercises to reinforce new patterns in the brain, a sort of **awareness through movement**. In the process, the brain develops an 'image' of how movements should be made and recognizes strain is produced on muscles and joints if faulty.

SPASTICITY

Spasticity is one type of hypertonia, i.e. increased resistance to passive movement. Not all increased muscle tone is spasticity - it may have other causes, e.g. rigidity, or myotonia. The term spasticity comes from the Greek word **'Spasticos'** which means to tug or pull.

Definition

Spasticity is a state of hyperactivity of the stretch reflex mediated by muscle spindle stretch receptors. It is velocity-dependent, i.e. it increases with the speed of joint movement, maximum at the beginning of movement, smoothly sustained and sudden lapse at the end of movement - the 'clasp-knife' type of spasticity. It is seen after lesions in the cerebral cortex, brainstem or spinal cord, e.g. cerebral palsy, hemiplegia, and multiple sclerosis.

Pathophysiology

It is important to understand spasticity through Sherrington's concept of the '**final common pathway**'. The motor neurons in the brainstem and spinal cord are the final common path through which all motor output is conveyed. Each motor neuron receives excitatory and inhibitory signals from 2 major groups of neurons: The **supraspinal,** and the **reflex spinal**

Summation of inputs from these two major groups causes stimulation of the motor neurons. Spasticity occurs when there is loss of the supraspinal input and consequently over action of the reflex spinal input. Some of the common conditions presenting with spasticity are stroke, cerebral palsy and some types of paraplegia.

In the acute stages of a CNS lesion, there is often a state of spinal or cerebral shock. This is postulated to be due to the loss of facilitation from the supraspinal neurons and thus insufficient excitatory input from spinal reflexes to depolarize the motor neurons. Soon after, neuronal mechanisms within the spinal cord compensate for the supraspinal loss and cause an increase in reflex excitability by denervation super sensitivity, collateral sprouting or growth of new synaptic connections within the spinal cord.

These mechanisms develop sequentially and mediate the onset of spasticity and the appearance of hyperreflexia.

Classification of Spasticity

Modified Ashworth scale

- 0 = Normal tone
- 1 = Slight hyper tonus, a 'catch and release' or minimal resistance when limb is moved.
- 1+ = Mild hyper tonus, the catch is followed by minimal resistance throughout the ROM,
- 2 = Moderate hyper tonus throughout ROM, affected part moved easily.
- 3 = Increased hyper tonus, passive limb movement is difficult.
- 4 = Severe hyper tonus, limb is rigid in flexion or extension.

Types of Spasticity

- *Immobilizing type:* spasticity in the absence of attempted movement
- *Mobility type:* spasticity with attempted movement
- Spasticity causing inability to relax after a voluntary movement

Effects of Spasticity

- Helps maintain muscle mass
- Decreases severity of osteoporosis in the spastic extremity.
- Reduces risk of deep vein thrombosis
- Reduces dependent edema
- In the lower limb, may help in standing and walking, (if not too severe).

Deleterious Effects

- Loss of balance
- Interference with ADL, e.g. driving, sleep, perineal hygiene, sexual function
- Contractures at a later stage
- Decubitus ulcers
- Pain
- Gait abnormalities

Spasticity is increased by temperature, stress, trauma, pressure sores, urinary infection, faecal impaction, and excessive sensory stimuli. It is reduced by fatigue, drugs, and alcohol.

Clinical Evaluation

- A clinical history followed by a physical examination is mandatory, including the functional impact of spasticity.
- Severity of the hypertonia is assessed with the Ashworth scale.
- Tendon reflexes, amplitude, spread to other muscles and presence of clonus should be noted.
- Flexor spasms, mass reflexes, Babinski sign should be looked for.
- Voluntary muscle strength and control should be assessed. **Power grading in the presence of spasticity is of limited use.** ROM and synergy should be noted.
- Functional impairments should be looked for and identified.

Management

The goal is to reduce deleterious effects of hypertonus without compromising function. Graded care for spasticity begins with conservative methods that carry the fewest side effects and progresses to aggressive treatments with more risks of side effects. Sometimes spasticity need not be aggressively treated where the patient "walks" on his spastic limbs. First any sources of pain should be eliminated. Urinary tract infections, bowel impaction, pressure sore, fracture, infections of nails are all painful sources that may increase spasticity.

Second, **the patient is educated on** the benefits and adverse effects of spasticity and he is taught the use of slow movements and daily stretching. Utilizing extensor or flexor spasms during transfer or bed mobility can be taught. Patients are instructed to use foot protection devices and to remove heel-loops from wheel chair footrests to prevent skin break down. Waist or chest straps may be needed, if spasms are severe. Education allows patient to minimize adverse effects and to function despite spasticity.

Principles

All treatment for spasticity aims at the inhibition of hyper tonicity as far as possible, giving the patient a chance of adopting a normal posture and inducing normal movement patterns.

Hyper tonus predisposes the patient to fixed muscle shortening and joint capsule tightening. Daily range of movement exercises can reduce stretch reflex hyperactivity and improve motor control.

Standing is a form of static stretch. It can reverse early contracture and may reduce stretch reflex excitability. In children with cerebral palsy, spinal extensor muscle activity can be altered by adjusting head position and back angles of seating systems.

Biofeedback using electromyography or joint position sensors and providing auditory or visual feedback reduces spasticity in patients with voluntary motor control.

Prolonged static stretching of muscles with splints, and serial castings has also been used. Ankle foot orthoses are used to control spastic equinus deformity at the ankle. Medial or lateral T straps or a plastic brace can be added to help control varus or valgus.

Muscle cooling reduces phasic stretch, reflex activity and clonus. Muscle cooling requires prolonged application of ice for 15 minutes or more for spasmolysis. The early effect of skin cooling often is to increase hyper tonus. Because cooling is only transient, the benefit lasting a few hours, it is often not practical for patient use. It can be used with static stretch to overcome hyperactive stretch reflexes predisposing to contractures. Painful spasms may also be controlled.

Deep rhythmical massage with pressure over muscle insertions has proved effective in some cases.

Movement itself will reduce spasticity if it follows normal patterns. Rotational movements of the trunk and limbs are important and spiral-rolling patterns involving head, shoulder girdle, pelvis and limbs should be encouraged. Those functions which do not produce pattern abnormalities should be encouraged and progress should be made relative to this.

Use of reflex inhibiting patterns of movement—may be done actively with or without assistance.

Compression through joints: This encourages co-contraction and thereby reduces increased tension in any one group of muscles.

Stretch of trunk muscles: In particular rotational and side flexion encourage righting and this may inhibit the increased tension.

Vestibular stimulation within a rocking chair or hammock is reported to be useful in relaxing hypertonic muscles.

PHARMACOLOGY IN TREATMENT OF SPASTICITY

Oral Medication

Commonly used drugs to reduce spasticity are

- Baclofen Central action
- Diazepam Central action
- Dantrolene Sodium Peripheral action

Motor Point Blocks

Motor point blocks are most effective for clonus and phasic stretch reflex, but less effective for tonic stretch reflex, rigidity and fluctuating dystonia. It has a selective action on spasticity with relative sparing of voluntary movement.

Phenol (2-10%) and ethyl alcohol are commonly used. The most commonly performed motor point blocks are to triceps surae, tibialis posterior, hamstrings, fingers and wrist flexor muscles. The procedure can be extremely painful, which makes its use in children difficult.

Botulinum toxin is one of the most toxic neurotoxins known to mankind, produced by a bacterium called **Clostridium Botulinum.** Used in minute doses, it can reduce muscle spasms or spasticity. Botulinum A exotoxin is very safe and is well tolerated. Spasticity due to disorders of the central nervous system reduces after injections of Botulinum toxin. Sometimes two or more injections are needed.

Injecting hyperactive muscles with minute quantities of Botulinum toxin type A decreases muscle activity by blocking the release of acetyl choline at the junction between nerve and muscle. The toxin heavy chain attaches to proteins on the surface of axon terminals, taken into neurons and degrades a protein called SNAP 25, which is needed for the release of neurotransmitters from the axon endings. This blocks neuro transmission though not completely or permanently. The benefit of this is a reduction in the spasticity of the injected muscle for up to six months. Obviously this treatment has to be followed through with intensive therapy, splinting or even serial casting. There has been an improvement in gait patterns in spastic children, and in ADLs for stroke victims after **Botox** injections. Adductor spasms, writer's cramps and hemi-facial spasms also respond to Botulinum toxin injections. This injection also has a major role in cosmesis due to its capacity to reduce wrinkles. **Botox** is being used more and more in rehabilitation units for indications like:

Conditions with spasticity like traumatic brain injury, stroke, multiple sclerosis, or cerebral palsy

Spasmodic torticollis

Chronic focal painful neuropathies.

Incontinence due to overactive bladder, or neurogenic bladder

Writers' cramp and focal dystonia affecting the limbs, face, jaw, or vocal cords

Nerve Blocks

Epidural or intrathecal injections of phenol or ethanol for severe spasticity of the lower limbs have been used. Losses of voluntary movement, bowel and bladder control and sexual function have limited the use of this procedure.

When spasticity is severe, it might lead to contractures, which cannot be corrected by non invasive means. Surgery is indicated in such cases. However, the assessment has to be done very carefully, since surgery would only correct deformities, and is not a guarantee for standing or walking.

Intrathecal Baclofen Pump

Baclofen is a drug used to reduce spasticity in conditions like multiple sclerosis, spinal cord injury and cerebral palsy. It is generally given orally by tablets. However it has been found to act at the spinal cord, when it is directly injected into the intrathecal space, in a minor neuro surgical procedure. The advantage of this delivery is that only minimal doses are required, and the side effects are minimal since the drug does not circulate systemically. This is called the Intrathecal Baclofen pump. It consists of a catheter linked to and delivering the drug from a computerized programmable pump that is surgically placed under the skin in the abdominal wall near the waist. It is a round metal disc that stores and releases prescribed amounts of baclofen through the catheter to the spinal cord by means of a tiny motor. The dose rate and timing of release is programmed by the Physiatrist or the neuro physician. Once the drug is finished the patient must return for pump refills and medication adjustments, regularly three to four times a year. The adjustments are made based on the spasticity grading. Since the Intrathecal Baclofen pump is powered by a battery it is replaced at the end of the battery’s life.

RE-EDUCATION EXERCISES

Bobath Neurodevelopmental Treatment (Ref Chap 15)

First developed in the 1940’s by **Berta Bobath** a physical therapist and her husband **Dr Karel Bobath**, NDT is based on normal development and movement. The term **Neurodevelopmental treatment** was first coined by the Bobaths from their work with children with cerebral palsy. Also known as **Bobath approach,** NDT has been used successfully in the treatment of adult hemiplegia too.

During recovery a patient typically overuses the uninvolved side, compensating for the loss of sensory and motor function on the hemiplegic side. The technique is based on relearning normal movements that promote highest level of functional recovery rather than compensation. The person is encouraged to use both sides of the body. Alignment and symmetry of trunk and pelvis are necessary for good positioning of the extremities. Adaptive equipment is used when absolutely necessary for safety, but not as a first resort and certainly not as a replacement for treatment. For the neurodevelopmental approach, postures and movements that inhibit tone and abnormal reflexes **are as important as** those that promote recovery.

Specifics of NDT Treatment

Some simple movements are
- Weight bearing over affected side
- Trunk rotation
- Scapular protraction
- Positioning pelvis forward
- Facilitation of slow, controlled movements
- Proper positioning of head and trunk.

Proprioceptive Neuromuscular Facilitation (PNF)

It is based on normal movements and motor development. In normal motor activity the brain registers total movement and not individual muscle action. These PNF movement patterns are spiral and diagonal in nature and resemble those seen in functional activities. In this multisensory approach, facilitation techniques are superimposed on movement patterns and postures through the therapist's manual contact, verbal commands and visual cues. It is effective in the treatment of numerous conditions including Parkinson's disease, spinal cord injury, arthritis, stroke, and hand injury.

STRENGTHENING EXERCISES

Strength

It is referred to as the ability of a muscle/muscle group to produce a force in one maximal effort either dynamically or statically. The strength of a muscle varies relatively upon the demands placed by it. Strengthening exercises are a set of exercises that are used widely by the physiotherapist in improving the power of the muscle or muscle groups.

Strength Training

To strengthen a muscle, its contraction must be loaded or resisted so that increasing levels of tension develops. The force output of a muscle is directly proportional to the amount of tension developing in the muscle.

The muscle undergoes adaptive changes in response to strengthening, like increase in the size of muscle fibers, amount of stored nutrients, contractile actin and myosin filaments and the amount of enzymes used for metabolism inside the muscle.

In the nervous system too, there are changes, like synchronization of motor units so maximum number of motor units produce maximum tension in the muscle. Also there is more activation of the CNS and more number of muscle fibers recruited with inhibition of central neural inhibitory mechanisms, which will result in increased force output

The body undergoes other physiological adaptations, for example, in the bone there is an increase in the mineral content, while in connective tissue there is an increase in strength of tendons and ligaments. Strengthening is done whenever there is weakness due to a lesion in anterior horn cells, e.g. poliomyelitis, or in efferent motor pathways, like neuropraxia, as a consequence of muscle injuries or disuse atrophy due to prolonged immobilization.

General Principles

- When designing a strengthening program, the therapist must always consider the overall level of fitness of the patient, the type of injury or disease, the stage of healing after injury and, most importantly the desired functional outcome.
- Specificity of training—exercises incorporated should mimic the desired function in terms of range, types of contraction, and velocity of contraction of muscle work, e.g. training a person for coming down stairs should include training in descending steps, one leg after the other.
- If the activity needs endurance also, then endurance exercises are given accordingly.

Types of Contraction

Eccentric Contraction: An eccentric contraction occurs when a muscle is contracting and an external force is trying to lengthen the muscle. It is a common cause for muscle strain. Muscles working eccentrically become longer and thinner as they pay out and allow their attachments to be drawn apart by force producing the movement. For example the extensors of the back elongate while doing abdominal crunches, and this can lead to lumbosacral strain.

The muscle spindle is stretched throughout eccentric movement and provides additional peripheral reflex support for contraction. Eccentric training improves only the eccentric strength of the muscle. Control is easily learnt in eccentric activity of muscle.

Isometric Contraction: The length of the muscle remains the same throughout the muscle work and no movement results. The hold period for this contraction should be at least 6 seconds for maximal recruitment of motor units. It has been suggested that isometric training of a weak muscle would strengthen the muscle only up to 5 weeks, and after this period, it maintains the strength gained during the training.

Isometric strength gains occur at the specific angle of the joint at which the muscle is strengthened. Therefore, for the muscle to function better throughout the available range, isometric strengthening at 4 or 5 angles throughout the ROM is essential.

Concentric Muscle Work

Muscles working concentrically become shorter and thicker as their attachments are drawn closer together and joint movements results. A patient doing concentric muscle work performs a movement and in so doing overcomes some force which offers resistance such as friction, gravity, manual pressure by the physiotherapist, or some other form of mechanical resistance.

The physiological cost of this type of work is high, as only about a quarter of the energy liberated during contraction is available as mechanical work. Concentric muscle work, e.g. lifting weights, is used to build up muscle power.

Intensity of Training

The absolute level of overload will vary according to the individual. It has been suggested that a certain threshold point of intensity must be exceeded for strengthening to occur. The threshold for isometric training is generally 40 percent of the maximum load that the patient can lift.

Velocity of Training

In the case of concentric contraction as the velocity increases, force output from the muscle decreases. Therefore when a weak muscle is rehabilitated, low velocities are used so that it can generate more force and later the velocity is progressively increased. In the case of eccentric contraction as the velocity decreases force output from the muscle increases.

Range of Muscle Work (Fig. 3.11)

The outer range of muscle work is used extensively in muscle re-education and strengthening of a weak muscle, as concentric contraction is initiated more easily from stretched position of a muscle. Middle ranges can be used for training eccentric contractions. Inner range is added to the program as a progression.

Inner Range: The muscle works either concentrically from the position in which it is partially contracted to a position of full contraction or vice versa if it works eccentrically. Exercise in the inner range is used to gain or maintain movement of a joint in the direction of the muscle pull.

Outer Range: The muscles work concentrically from the position in which they are fully stretched to a position in which they are partially contracted, or vice versa if working eccentrically. It is used extensively in muscle re-education for good initiation of contraction in full stretch.

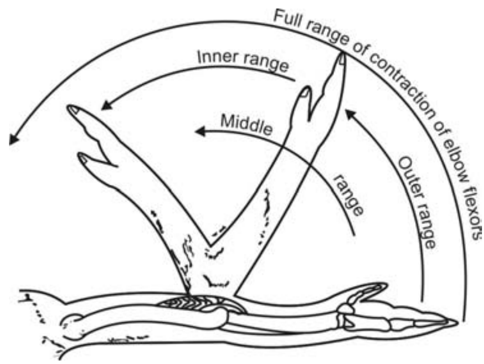


Figure 3.11: Range of contraction (elbow flexion)

Middle Range: The muscles are never either fully stretched or fully contracted. Exercises in this range maintain muscle tone and power but full joint movement is never achieved during the exercises. Facilitatory techniques which inhibit the central mechanism and result in the increased force output of the muscle such as tapping, verbal prompts, manual contact and repetitions are used.

Recovery from active exercise has been shown to be more rapid with light exercise following a strengthening program, than with total rest. Appropriate stabilization of proximal segments should be done to avoid substitution. The affected muscles must be strengthened progressively by resisted exercises, which are specific for the group to which the muscles belong.

Progressive Resisted Exercise

For strengthening not only overload is important, but it must be progressively increased as the individual adapts to the training and increases in strength. This approach is known as Progressive resisted exercise. This term was coined by DeLorme. DeLorme and McQueen based their progressive resistance program on the concept of 10 RM, i.e. the maximum load which can be lifted ten times (Figs 3.12 and 3.13).

Isotonic Exercise

Isotonic exercise consists of dynamic movement with a constant weight through a range as the muscle shortens or lengthens. Many gymnasiums use machines and free weights based on this concept. It is recommended to gradually build up to the 10 repetition maximum in progressive percentages of the 10 RM (i.e., 40%, 50%, and so on till 100%). A repetition maximum (RM) is the maximum amount of weight lifted correctly for one repetition. When the RM is reached, muscle fibers are fully recruited and the muscle is working at high intensity. Most physiotherapy centers

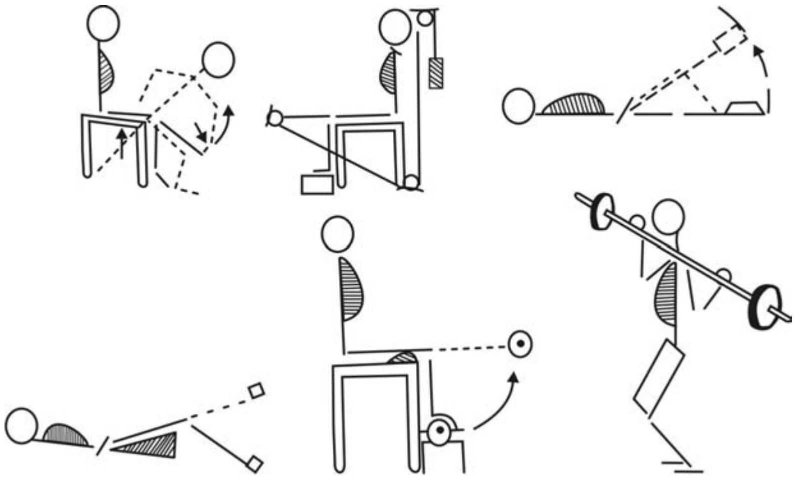


Figure 3.12: Free and active resisted [strengthening exercises]

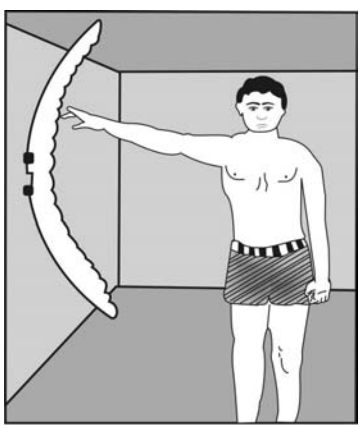


Figure 3.13: Wall climbing—active range of movement for the shoulder

gradually build up to or work down from the RM as an effective method of resistance training.

Isotonic Resistance Equipment

Resistance

The resistance is increased by:

- Increasing the poundage of the resistance
- Increasing the leverage of the resistance.
- ***Free weights:*** These are graduated weights that are hand held or applied to the upper or lower extremity and include dumbbells and sand bags
- ***Elastic resistance devices:*** Elastic resistance materials and surgical tubing such as Thera-bands, Bull worker and exercise tubing are available in several grades or thicknesses.

- ***Pulley systems:*** Free standing or wall mounted pulley systems (with weights or springs) provide either fixed or variable resistance and can be used for upper and lower extremity and trunk strengthening (Fig. 3.14).

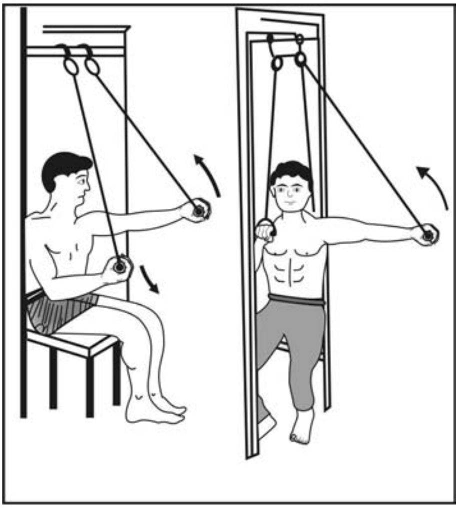


Figure 3.14: Pulley exercises

- ***Variable-resistance equipment:*** Designed to provide variable resistance throughout the range of motion as a muscle contracts concentrically and eccentrically.
- ***Exercise bicycle:*** The stationary exercise bicycle is used to increase lower extremity strength and endurance. Some exercise cycles provide resistance to both the upper and lower extremities.
- Other resistance devices that are often available in a gymnasium, are Minels apparatus, wrist exerciser, FEPS Flexion-extension-pronation-supination, grip exerciser, stepping machine and sliding seats, to name a few.

Isokinetic Exercise

Isokinetic exercise is performed using special equipment that only permits movement at a preset angular velocity. The muscle shortens or lengthens through a range at a constant angular velocity. This is dictated by the machine moves at the same rate no matter how much force is applied to it. However, the load or force exerted may be variable. This causes maximum tension at all angles. Motivation of the person performing the exercises must be very high because he has to recruit all his muscle fibers. Another is that strength gained at one particular velocity may not transfer to other velocities.

Precautions while doing Strenuous Exercises

Valsalva maneuver: It is the expiratory effort against closed glottis. This increases the intra-abdominal and intrathoracic pressure which in turn decreases the venous flow to the heart. This leads to a temporary drop in blood pressure and increase in heart rate. Valsalva maneuver is commonly seen in isometric and heavy resistance training like weight lifting. Care should be given to avoid the effects of Valsalva maneuver when framing these training programs for patients with cardiovascular problems, cerebrovascular accidents, myocardial infarction, herniation, unhealed incisional scar, or those who belong to the geriatric age group.

Local or general fatigue: Persons may get fatigued due to decrease in blood glucose, K^+ ions, oxygen in blood and advanced age. Persons with multiple sclerosis may function well in the early morning, and their strength deteriorates due to fatigue as the day passes on, while in early evening their strength improves. Persons with cardiopulmonary disease may fatigue more rapidly and require longer periods for recovery after exercise. So training for such conditions would require low intensity strengthening with rest intervals to avoid tiring the muscles.

Osteoporosis: It is common in neuromuscular disease, inflammatory joint diseases, post-menopausal period, and due to sedentary lifestyle. Resistance during exercise should be added gradually with care, especially for aged persons.

Inflammation: When a muscle or a joint is acutely inflamed, strengthening is too stressful and is therefore contra indicated.

MOBILIZATION EXERCISES

Mobilization is defined as a passive movement performed in such a manner or speed that the patient can stop the movement at his will. It is a method of restoring or maintaining joint movement.

General Principles

- The patient should be positioned such that he feels comfortable and relaxed.
- Techniques of relaxation can be used if necessary.
- Warming of the tissues using massage/heating modalities can be done prior to mobilization.
- The joint to be mobilized is placed in the least painful position.
- The bone proximal to the joint is fixed manually or mechanically with straps or belts.
- The treatment force should be applied close to the joint.
- Progression of the technique depends on how the joint reacts to mobilization.
- Dosage is decided in terms of the grade, speed and duration of treatment.

Indications

Pain and associated muscle spasm: The technique can reduce muscle spasm directly by stimulating type III joint receptors which can inhibit the activity of the motor neurons of the nearby muscles. Small amplitude oscillatory and distraction movements used in the pain free range stimulate types I and II mechanoreceptors located in the joint capsule, ligaments and fat pads in the joints. This also inhibits pain at the spinal level through the pain gate mechanism (Ref Chap. 6).

Restriction of joint ROM due to capsular tightness, meniscus displacement, ligamentous tightness or adhesion formation within the articular structures. Most of these can result due to prolonged immobilization. When connective tissue is immobilized there is desiccation (reduction in water) and depletion of glycosaminoglycans while the total collagen remains the same. This reduces the space and leads to formation of cross-links between collagen fibers, leading to tightness. It is better to use joint play stretching techniques to mechanically distract the contracted tissue.

Progressive limitation of joint ROM, e.g. as in rheumatoid arthritis. Mobilization helps to maintain the functional ROM required for daily activities.

Contraindications

1. Hyper mobility of joints
2. Joint effusion
3. Infection of joints
4. Recent fracture involving articular surfaces
5. Neoplasm
6. Acute inflammatory conditions of the joint
7. Hemarthrosis (Hemophilia)

Effects of Joint Motion

Movement of the joints is beneficial to the patient as it stimulates activity by increasing circulation of synovial fluid, and maintains extensibility and tensile strength of the articular and peri-articular tissue. It also gives sensations on speed, direction, and tone relating to the joint.

Other benefits are:

- Pain relief - through pain gate mechanism
- Improving tissue nutrition by increasing cellular diffusion rates and tissue fluid transport
- Kick starting the healing process by helping in scar tissue formation and myofibroblast formation
- Placebo effect of the human touch and satisfaction to the patient
- Improving quality of life by maintaining/restoring the ADL's as in Rheumatoid arthritis.

Grades of Mobilization

The grade refers to the amplitude of movement and the range in which the movement is performed. Different systems of grading have been devised and used in mobilization. The most common ones in practice are those of Maitland and Cyriax.

Maitlands concept or technique: This is a method to treat pain and stiffness due to mechanical reasons by applying skillful oscillatory movements to the vertebral joints. The techniques try to restore movements between joints like spin, glide and roll. They are graded according to their amplitude.

Grade I: A small amplitude movement performed at the beginning of the range within the resistance free part of the range

Grade II: A large amplitude movement performed within the resistance free part of the range.

Grade III: A large amplitude movement performed into resistance or up to the limit of resistance.

Grade IV: A small amplitude movement performed into resistance or up to the limit of resistance.

Grade V: A high velocity, short amplitude, thrust often near or at the limit of abnormal movement (at a speed outside patient's control).

Selection of Dosage

Dosage depends on the patient's condition.

In cases where the pain is experienced before tissue resistance, mobilizing the joint can induce pain relief and in cases where pain is experienced after tissue limitation, the effect desired is increase in ROM.

Here the dosage in Grades III, IV and V can be given at- 2-3 cycles/sec, for a duration of 2 to 5 minutes. This is different from **manipulation**, which is a passive movement done with greater force when the patient is under anesthesia.

Obviously the type of motion occurring between bony participants within a joint is influenced by the shape of joint circumference, the type of joint, the freedom of movement permitted, and accessory movements.

Techniques

1. Passive angular stretching
2. Joint glide stretching
3. Compression
4. Traction.

Cyriax Techniques

Cyriax was a physician who made medical diagnosis of musculoskeletal disorders localizing the “lesion” to a particular anatomical structure. The concept of referred pain which meant that the location of the pain was not always the exact location of the lesion was adapted by his method of examination. Later it included selective tissue tension to localize the lesion precisely. The treatment of the soft tissue lesions consisted of manipulation, massage, traction and injection.

ENDURANCE EXERCISES (REF CHAP 23)

Endurance exercises are any activity that challenges the cardiorespiratory function and increases heart rate and breathing for an extended period of time. Examples of endurance exercises are:

Moderate: Examples of moderate exercise are bicycling, or cycling on a stationary cycle, and walking briskly on a level surface for three to five km. For housewives who may not be able to take time off for their exercises, mopping or scrubbing the floor itself is a good exercise. In our country several ADL’s like working out in the fields or at home without gadgets would construe moderate exercise.

Vigorous: Climbing flights of stairs, brisk cycling up gradients, playing tennis (singles) swimming, hiking or jogging.

Therapeutic endurance exercise may be recommended for persons with Duchennes muscular dystrophy. Duration of exercise and its intensity should be based on each individual’s tolerance to exercise, and spontaneous walking speed. The physical medicine specialist and physical therapist design an exercise program that won’t aggravate the problem or cause muscle damage. The patient is advised to walk as much as he can, use a stationary bicycle or elliptical trainer in moderation to work a number of muscles groups at the same time or go swimming. Sometimes light weights can be included. It is better to increase repetitions than weights.

Suspension Therapy

Sling suspension therapy is a form of physical therapy where joint movement and tissue stretches are achieved through pendular movements in a suspension frame fixed on to a bed. Motion may be assisted, neutral or resisted. Weights are added to the slings, which are all suspended through hooks and pulleys to the overhead meshed frame. Correct placement of the suspension point above is important to get a good range of movement and also strengthen the muscles. Suspension can be used for all parts of the body.

Factors used in suspension therapy:

- Positioning of patient
- Size and shape of slings
- Fixing methods
- Supports above
- Control of ROM

Hydrotherapy

The uniqueness of water lies mainly in its buoyancy, which relieves stress on weight bearing joints and permits movement to take place with reduced gravitational forces. The other properties of water that are used in pool rehabilitation are hydrostatic pressure, surface tension, and hydrodynamics. The upward buoyancy exerts on an immersed body reduces the weight on the recovering muscles and joints in chronic arthritis.

Buoyancy varies according to depth; the deeper it is, the lesser is the weight in comparison to land-weight.

Hydrostatic pressure, which is the pressure exerted equally in all directions by the fluid on the surface of an immersed body in the water is used in management of edema.

Force is necessary to overcome the viscosity of the water, or its **surface tension**. This property of **hydrodynamics** can be used by progressively increasing resistance during strength training programs. Swimmers have extremely well developed Latissimus dorsi due to this property. In sports rehabilitation, the athletes are motivated to move their limbs or swim faster through water, by which more muscle fibres are recruited and strength increases.

The use of the **Bad Ragaz** technique in the rehabilitation of a child with spasticity, where proprioceptive neuromuscular facilitation is used, utilizes tubes or rings are used to support it in the water. Incorporation flotation devices to either assist or resist movements adds variety and interest to the treatment. The therapist provides the source of manual stability as well as resistance to a functional pattern of movement, typically by pushing or pulling against a movement that the child is making. Stability and resistance are promoted with the patient suspended at the surface. Like PNF techniques on land, this enhances muscle activity to recruit the inactive muscle into the functional movement pattern.

The benefits of using an exercise pool are:

a. the relief of pain and muscle spasm,
b. the maintenance or increase in range of motion of joints,
c. the strengthening of weak muscles and an increase in their tolerance to exercise,
d. the re-education of paralyzed muscles,

e. the improvement of circulation,
f. the encouragement of functional activities, and
g. the maintenance and improvement of balance, co-ordination and posture.

Some of the conditions which benefit from hydrotherapy

1. Cerebral palsy and stroke
2. Arthritis
3. Poliomyelitis.

MASSAGE TECHNIQUES (FIG. 3.15)

The massage techniques are:
- Stroking
- Effleurage
- Kneading
- Hacking
- Rolling
- Friction

Figure 3.15: Vacuum therapy—Mechanical form of massage
(For color version see Plate 1)

STROKING

It is usually performed with the fingers or finger tips. The operator's hands are relaxed and passed over the patient's skin in a rhythmic manner with pressure on the finger tips producing a sedative effect.

Effleurage: It is performed by the palmar surface of the hands with moderate pressure and speed from distal to proximal in the direction of venous and lymphatic drainage and ending into the major lymphatic glands of the body. It produces an increase in venous and lymphatic drainage and also soothing effect, and is used in cases of gross lymph edema.

Kneading: Here the fingers are used for moulding the part by alternate compression and release in a circular manner, mainly performed for the soft tissues such as muscles. Occasionally thumb kneading may also be applied for irregular areas such as eyebrows. It increases blood circulation to the tissues.

Hacking: It is performed by the ulnar borders of ring and little fingers with alternate pronation and supination of the relaxed hand and the wrist slightly in extension. It produces a sensory stimulation to the tissues treated as in muscle re-education.

Rolling: Here both the hands are moved gently with constant pressure generally on the lower back. Lifting and releasing of the part occurs which helps in stretching of soft tissue adhesions and skin, apart from release of tension and improvement of blood supply.

Friction: These are similar to kneading but are applied to the joints. These are done with the finger tips and thumb and range from superficial to deep frictions. Friction may be performed in circular manner with considerable pressure on the fingers and thumb.

ALTERNATIVE HEALING TECHNIQUES

There are several alternative healing techniques that are practiced by some people like **Pranic healing** which utilizes the **prana** or life force to balance harmonize and transform the body's energy processes.

Reiki: The word Reiki is made of two Japanese words - **Rei** which means "God's Wisdom or the Higher Power" and **Ki** which is "life force energy". Reiki is "spiritually guided life force energy."

It is a technique for stress reduction and relaxation that also promotes healing, and is based on the idea that an unseen "life force energy" flows through us and is what causes us to be alive. Improving this energy is how Reiki is claimed to treat the whole person with beneficial effects like relaxation and feelings of peace, happiness and wellbeing.

Vipasana: Is a meditative technique of Lord Gautama Buddha, which requires the practitioner to be aware of his or her breathing. Though not propagated as a therapeutic technique, but as an inward journey for spiritual upliftment, **vipasana** is said to have long reaching benefits to health.

CHAPTER 4

Sociolegal Aspects of Rehabilitation

INTRODUCTION

India is a sovereign socialist democratic republic with a federal structure and an estimated population of over 100 crores. It is enshrined in the Constitution of India that there shall be equal opportunity for citizens of India, and protection of their rights. The persons with disability constitute a large percentage of our population, and it has been felt obligatory to include certain articles to provide for their rights to be enforced as ***law***.

LEGISLATION AS A MEANS OF ACQUIRING EMPLOYMENT FOR PERSONS WITH DISABILITY (PWD)

- The government supports in principle the employment of the PWD.
- It introduces employers to the idea of employing PWD.
- The government recognizes the need for reservation for the persons with disability for specified occupations or posts.

However, there are some points raised against legislation, that person with disability placed in this way might be less efficient than other workers or that he might feel that undue attention was being focused on him, and that the jobs are being "doled out", and not given on merit.

Areas of Concern

There have been problems in the implementation of this legislation. This can be overcome by enforcing a simple practical definition of a ***person with disability,*** with a system for disability evaluation. The Government must have effective machinery for the registration of persons with disability, a specialized employment service to assist employers and a system of enforcement.

Who is Handicapped?

According to the Oxford English Dictionary a handicapped is 'a person placed at disadvantage.'

In order to be eligible for various concessions a person with disability has to be certified by a medical authority that he or she is suffering from not less ***than forty percent of the disability. Disability Evaluation is the quantification of the residual lack of ability of the individual to carry out his day to day activities. It is individualized and is subject to several factors***.

The Government of India in 1986, through its gazette put out by the Ministry of Welfare has notified the definitions in order to extend concessions and facilities for disabled persons as part of its overall strategy to provide equal opportunities and equal rights to them. The WHO has classified disability in relation to physical and social function. Disability may also be classified as temporary or permanent.

Despite several guidelines like those given in ***International Classification of Impairment Disability and Handicap (ICIDH)***, there are several vagaries in the ultimate evaluation because of lack of qualified personnel, varying perception of disability and environmental factors. As per the Medical Council of India, only a medical doctor registered under the first schedule of MCI Act (1950) can issue the physical impairment certificate. Disability evaluation and definitions of IDH vary according to organizations which define these terms differently. The certificate of permanent disability is issued by a board deputed by the Central and State Governments. It consists of the Chief Medical Officer in the district, or the director of a major governmental institution working for the cause of rehabilitation and other experts in the specified field as follows:

- Ophthalmologist—visual handicap
- ENT Surgeon—speech and hearing handicap
- Orthopedic surgeon or physiatrist—locomotor handicap
- Psychiatrist/clinical psychologist or special educator—mental handicap
- Cardiologist/chest physician—cardiopulmonary handicap

Sometimes a board consisting of more than one specialist may be needed to evaluate multiple disabilities.

Chart 1: Example of a disability certificate; details given may vary

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CERTIFICATE FOR PERSONS WITH DISABILITIES

Certificate No. ……………………………….. Date ……………………

NAME & ADDRESS OF THE INSTITUTE Issuing the Certificate

………

This is to certify that Mr/Mrs/Ms……………………………………………… Son/wife/ daughter of Mr. ……………………………………… Age ………………… male/female, from address………………………………………………………….is a case of………………………

He/She is physically disabled/visual disabled/speech and hearing disabled/mentally disabled and his/her percentage of disability is ………… % (……..………………… percent)

1. This condition is progressive/non progressive/ likely to improve/ not likely to improve.
2. Re-assessment is not recommended/ is recommended after a period of …………….. months/years.

Signature/Thumb impression of the patient
Countersigned by the Medical Specialist./
CMO/Head of Hospital (with seal)

A combination of the following methods, depending on the application and recommendations of the local authorities may be used to arrive at an acceptable evaluation.

- Clinical examination, including psychological examination, investigations
- Earning capacity and wage loss
- Mc Brides method (anatomical, functional and economical)
- ***Pulhem's profile*** (used in US Army) P—Physique U—Upper extremity L—Lower extremity H—Hearing E—Eyes M—Mental stability
- ***Other methods:*** Henry Howard Kessler reviewed the disability evaluation also mentioning the McBride's method. Function alone represents a true measure of disability, the ROM strength, coordination, prehension, sensation are each given 100 percent score and telescopically combined using a formula.

The American Medical association has published guidelines to the evaluation of permanent impairment. Functional outcomes in ADL measured in scales like the Barthel Index or The Medical Outcomes Study Physical Functioning measure, or the Functional Status Ratings system are taken into consideration. Even the term ***Disability is re-termed as activity limitation***, indicating that a person may not do an activity expected of him in an environment, and there fore become disabled relative to the environment. For example in remote rural areas in India, people have to walk long distances and this is an activity expected of them. It is also expected that the certifying physician uses his individual judgment based on his experience, skill apart from his clinical evaluation. Of course, this is time consuming and many doctors may not have the time to assess in detail.

Detailed assessment includes checking the:

- Coronary and Cardiac disease
- Respiratory disease and disability
- Endocrine, sexual functions
- Bladder and bowel impairment
- Swallowing and digestion
- ENT, hearing and speech
- Vision
- Mental functions
- Neurological assessment including detailed ROM, power, gait, coordination, sensation
- Skin and contractures
- Pain
- Behavioral disorders

Grades of Disability

- Mild—less than 40 percent
- Moderate—40 percent and above

- Severe— 75 percent and above
- Profound—100 percent

For all concessions eligibility for the certificate is only for those with 40 percent and above. Persons suffering from cardiopulmonary handicaps are not eligible in reservation of jobs.

Practical Difficulties Experienced in Disability Evaluation

- Formulae in most methods are complicated.
- Assessment of impairment alone can never give the total picture of functional disability, e.g. reduced power in the lower limb due to polio does not give an idea whether the person is ambulant.
- The figure given corresponds to the disability at the time of evaluation and not discounting future secondary disability (contractures) or progression of the disease (muscular dystrophy).
- No strategy for quantifying multiple disabilities, e.g. behavioral problems or dysphasia in a hemiplegic may prevent him from carrying out day to day activities but are never considered in the evaluation. It is also impossible to bring together all specialists to evaluate various disabilities of the same patient.
- No objective evaluation in sensory dysfunction.
- No provision for a reduction in disability following medical intervention, e.g. a patient with AK amputation can walk if fit with a prosthesis but may still get more compensation than a patient with amputation of thumb on the dominant hand.
- Handicap is not taken into consideration, e.g. a patient with ulnar nerve palsy may not be able to work as a data entry operator but will get the same disability evaluation as another similar patient working as a college lecturer who can still carry out his duties.
- Several anomalies in the existing scheme of evaluation which may give more disability rating for a person with triple nerve palsy in the hand, than a wrist disarticulated person.
- A certain element of subjectivity in the mind of the evaluating physician can alter the rating.

Constitutional Responsibilities

The State shall strive to promote the welfare of the people by securing and protecting as effectively as it may, a social order in which justice—social, economic and political, shall be delivered. The State shall, ***within the limits of its economic capacity and development*** make effective provisions for securing the right to work, education and to public assistance in cases of unemployment, old age, sickness and disablement and in other cases of want.

"The objective of social welfare is to secure for each human being the economic necessities, a decent standard of health and living conditions and equal opportunities with his fellow citizens".

Rehabilitation is primarily the responsibility of the state. ***It is not a matter of charity but a matter of right***.

Limitations

Rehabilitation is essentially conditioned by a variety of factors, such as the financial resources of the State, education and medical facilities, availability of trained personnel, efficient sympathetic administrative machinery and public co-operation.

LEGISLATION IN INDIA

In India there were two early enactments aimed at the rehabilitation of the handicapped:
- The Lepers Act, 1898,
- The Indian Lunacy Act, 1912.

Social Security in India was given a start by the Workman's Compensation Act passed in the year 1923. Then followed the Employees State Insurance Act 1948 which marks the first important step towards social security for employees in the organized sector. It came into force in July 1950.

Benefits to Employees

The Act has made provision for the following benefits to insured persons or as the case may be, to their dependents.
- Medical benefit
- Disablement benefit
- Rehabilitation allowance.

Disablement Benefit

The Act provides for cash payment, besides free medical treatment, in the event of temporary or permanent disablement as a result of employment injury. The rate of temporary disablement benefit is about 2/3rds of the wages as long as the temporary disablement lasts. In case of total permanent disability, the insured person will be given pension at this rate for life. In case the disability is permanent but partial, the pension is given as a portion of the salary.

Landmarks in Legislation in India

- 1947-59—50 Employment exchanges
- 1977—3 percent job reservations
- 1970-80—4 National institutes set up by the Government of India
- 1985—DRC scheme
- 1992—Rehabilitation Council of India Act
- 1995-96—Persons with Disabilities Bill (PWD) and Act
- 1998—Ministry of Welfare changed to Ministry of Social Justice and Empowerment

THE PERSONS WITH DISABILITIES (PWD) BILL, 1995
(Equal Opportunities, Protection of Rights and Full Participation)

Purpose of the Bill

The purpose of the Bill which was made law in 1996 (Gazette No. 1 of 1996) is to fix responsibilities on the Central and State Governments to the extent of their resources, to provide services, create facilities, and give support to people with disabilities in order to enable them to have equal opportunities in participating as productive and contributing citizens of this country to the fullest extent of their abilities.

The Central Coordination Committee

The Central Government shall constitute a central co-ordination committee (CCC) headed by the Minister of Social Welfare.

The State Coordination Committee

Each state shall appoint a state coordination committee consisting of 23 official and five non-official members.

Their responsibilities are:

- Prevention and early detection of disabilities
- Education
- Institutions for persons with severe disabilities
- Allotment in concessional land
- Research and manpower development
- Recognition of institutions for persons with disabilities
- Reservation in vacancies
- Provision of free aids/appliances
- Social security.

The government shall, within its economic capacity undertake rehabilitation of all persons with disabilities or grant financial assistance to non governmental organization undertaking rehabilitation for persons with disabilities.

Americans with Disabilities Act (ADA)

In 1990 the Congress passed the ***Americans with Disabilities Act*** *(ADA)*. Accessibility guidelines for buildings and facilities were finalized and became effective in 1992. The law stated that "Title III of the ADA (effective (1/26/92) prohibits discrimination on the basis of disability in places of public accommodation by any person who owns, leases or leases to, or operates a place of public accommodation." Public accommodation was defined in the law to include 12 categories of private entities (Figs 4.1 and 4.2).

Categories of places of public accommodation defined in the Americans with Disabilities Act

Figure 4.1: A disabled person being transported on his wheelchair upstairs through a stairlift this can be used in places of public accommodation

Figure 4.2: Disabled friendly public transport—Several schemes available for transportation of disabled

- A place of lodging like an inn or hotel
- An establishment serving food or drink like a restaurant
- A cinema house, concert hall, stadium, or other place of exhibition or entertainment
- A place where the public gathers, like an auditorium, convention centre, or lecture hall
- A sales or shopping establishment like grocery store, clothing store, hardware store
- A dry-cleaner, bank, office of an accountant or lawyer, barber shop, beauty salon, travel service, funeral parlor, gas station, pharmacy, insurance office, doctors clinic or physiotherapy center, hospital, or other similar service establishment
- A station terminal, bus depot, for public transportation
- A park, zoo, amusement park, or place of recreation
- A school or other place of education, at whatever level

- A day-care centre, senior citizen centre—home, childcare center, adoption agency
- A gymnasium, or other similar place of exercise or recreation

Rehabilitation service providers are expected to make physical accommodation for the handicapped. This includes physical therapists, physicians, chiro practitioners, nurses, hospitals, and ambulatory care centers.

The Federal Register, July 26, 1991, details the accessibility guidelines for buildings and facilities. The guidelines are extremely specific in terms of building requirements, some of these, are still open for interpretation as to the extent of the accessibility.

CONCESSIONS AND SUBSIDIES GIVEN TO THE HANDICAPPED BY THE MINISTRY OF SOCIAL JUSTICE AND EMPOWERMENT, GOVERNMENT OF INDIA

These concessions may vary from time to time based on the policies of the Government.

Travel Concession for the Persons with Disability

By rail:

Persons with disability	*Percentage of concession*
Visually impaired, orthopedically handicapped, Hearing and speech impaired, Intellectually impaired.	Up to 75%; includes the fare for an escort in certain cases.

Concession Certificate

Form for the purpose of issue of travel concession to Orthopedically Handicapped to be used by the Govt. Doctor/Orthopedic Surgeon.

This is to certify that Shri/Smt.______________whose particulars are furnished below is a bonafide orthopedically handicapped/Paraplegic person/patient:

a. Age
b. Sex
c. Personal identification marks (1) ____
(2)____
d. Signature or left hand thumb impression of the person patient____
e. Nature of handicap
f. Causes of loss in functional capacity_____________________________________
g. Percentage of disability____

Place____________ ________________
Date_____________
* Government Doctor
* Orthopedic Surgeon

By Air: Fifty percent concession to the visually impaired is given

Orthopedically handicapped are allowed to carry orthotic or prosthetic devices free of charge.

Communication

- *Postage:*
  Payment of postage, both inland and foreign for packets containing literature for the blind is exempted if sent by surface route only.
- *Telecommunication:*
  - Concessional telephone connection to the visually impaired:
  - Rental rebate—50 percent.

Children's Education allowance

Reimbursement of tuition fee to Central Government employees will be governed by the Central Civil Services orders.

Scheme of Integrated Education for Children with Disability

The education of handicapped children with the help of necessary aids, incentives and specially trained teachers is sought to be integrated in the normal school system under this scheme. Full assistance to the States is provided for this purpose.

Reservation of Jobs

One percent for each impairment in grade C and D posts is reserved for the visually impaired, mentally subnormal, hearing impaired and orthopedically disabled.

Customs Concessions

The following items are exempted from customs duty or additional duty when imported by a person with disability for his personal use.

- Orthopaedic appliances and books in Braille.
- Optical and environmental sensors.
- Artificial electronic larynx
- Tactile displays.
- Specially adapted clocks and watches.
- writing equipment and erasers
- Wheel chairs, canes, electronic aids.
- Arithmetic aids like calculators

Central Government Schemes for the Rehabilitation of Persons with Disability

- Scheme of assistance to organizations for the persons with disabilities—provides up to 90 percent of recurring and non-recurring expenditure.
- Manpower development in the fields of cerebral palsy and mental retardation is taken up by voluntary organizations by training teachers and other personnel.

- Program for rehabilitation of persons with mental illness. Assists voluntary organizations to provide psychosocial and economic rehabilitation to those who have recovered from mental illness.
- Program for rehabilitation of leprosy cured persons. Assistance up to 90 percent of the total expenses is given for all the above schemes.
- Scheme of assistance to disabled persons for purchase/fitting of aids/ appliances.
- Scheme of scholarship to the persons with disability
  Scholarship - From class IX onwards but the income limit of parents/ guardians of the candidate should not be more than Rs. 2000/- per month.
- Fifty percent subsidy for purchase of petrol/diesel in addition to being exempted from road tax.
  – Vehicle up to 2 HP : 15 lt per month
  – Vehicle more than 2 HP : 25 lt per month

OTHER SCHEMES

National Institutes

- National Institute for the visually handicapped—Dehradun
- National Institute for the orthopaedically handicapped—Calcutta
- Ali Yavar Jung National Institute for the hearing handicapped—Bombay
- National Institute for the mentally handicapped—Secunderabad
  The above four institutes provide a complete package of welfare services.

Other Institutes

- Institute for the Physically Handicapped (IPH)—New Delhi
- National Institute of Rehabilitation, Training and Research (NIRTAR)—Bairoi Cuttack
- Government Institutes of Rehabilitation medicine in Chennai, Trivandrum, Jaipur, and other states.
- National Institute of Mental Health and Neurological Sciences NIMHANS, Bangalore.

National Awards

- Best employer of handicapped.
- Best-handicapped employee and self employed among persons with disability
- Best individual working for handicapped welfare.
- Best institution working for handicapped welfare.
- Best placement officer in the Government.
- National technology awards for welfare of the handicapped.

These awards are given away by the President of India each year on the World Disabled Day

Artificial Limbs Manufacturing Corporation (ALIMCO)

ALIMCO was established in 1972 in Kanpur with the objective of promoting, developing, manufacturing and marketing of artificial limbs, aids and appliances.

District Rehabilitation Centre Scheme (DRC)

Operates in eleven different parts of the country. This scheme provides services for all persons with disability.

Rehabilitation Council of India (RCI)

This is to enforce uniform standards in training of professionals in the field of rehabilitation, maintenance of central rehabilitation register and other related matters.

Miscellaneous

Family pension is given to the guardians of children with disability even if they have been born after retirement of the government servant.

Income-tax Concessions

- Tax deduction from total income of persons with disability.
- A deduction from the taxable income of the parents/guardians of handicapped children has been allowed provided this amount is deposited in any approved scheme of LIC, UTI, etc. The deductions vary from year to year.

CONCLUSION

Every Act and legislation brought into force by the Government is subject to change from time to time, but the core principle of welfare to the disabled remains unchanged, and should be.

CHAPTER 5

Principles in Management of Communication Impairment

INTRODUCTION

A very large percentage of patients who seek rehabilitation services usually suffer from multiple disabilities. These are secondary to complex conditions following cerebrovascular accidents/brain trauma, cerebral palsy, and other neurological diseases. Many of these individuals also suffer from speech and communication disorders which add on to the backdrop of existing disability. Speech and hearing handicap constitute one of the six handicaps listed out by the WHO.

COMMUNICATION

Definition

Communication is a process by which information is exchanged among individuals. It is primarily accomplished verbally, but non-verbal gestures and written communication are also included.

Communication comprises all of the behaviors human beings use to transmit feelings and ideas, including gestures, pantomime, and the processes of speaking, writing, reading, hearing, and understanding visible and oral symbols. The modalities by which we express information are referred to as ***expressive*** or encoding processes and those used in the understanding and interpretation of symbols are ***receptive*** or decoding processes.

The descriptive natural science that deals with message transmission, among speakers of any language is called ***Linguistics***.

With the explosion of multi media today there is no need to think of communication as comprising only of speech and its processing. Indeed several messages today are conveyed through email and sms (short messaging service). Sometimes even the written word is replaced by icons!

Communication may be studied under the following categories

- Speech and its disorders
- Communication for the hearing impaired
- Augmentative communication
- Communication for the visually impaired
- Other aids in communication

SPEECH

Speech disorders are classified under:

- Aphasia
- Dysarthria
- Dysphonia

The smallest units of speech, called ***phonemes***, generally divided into consonants and vowels, are the basic units from which words and sentences are constructed. The changes in overall shape or dimensions of the oral cavity produce the various sounds known as ***vowels***. On the other hand, ***consonant*** production is a result of interruption or modification of the air stream by the articulatory organs—the lips and the tongue. Consonants combine to form syllables, which generally have a vowel as the central phoneme.

During speech the breathing cycle is adjusted; inhalation is brief but adequate to accommodate the long expiratory phase. There are five areas of articulation: the lip ("labial consonants"), the foldable front of the tongue ("coronal consonants"), the middle and back of the tongue otherwise called ("dorsal consonants"), the root of the tongue along with the epiglottis adjacent to it ("radical consonants"), and the larynx ("laryngeal consonants"). These articulators act independently or together in what is called ***coarticulation***. The size and shape of the vocal tract and the characteristics of the sound wave are changed by:

- Vibrating the vocal cords, thereby converting air into audible sound (phonation).
- Moving the tongue, lips, and pharyngeal wall.
- Closing the nasopharynx with the soft palate.

Fricatives are consonants heard when air is forced through a narrow channel made by approximating two of the organs of articulation close together like 's' or 'f'. A ***plosive***, or ***occlusive*** is a consonant sounded when airflow in the vocal tract is stopped e.g. 'p''t'. ***Velars*** are consonants articulated between the back- upper part of the tongue and the soft palate like 'k'. When a block is made along the course of the tongue while air escapes on both sides of it, the consonants produced are called ***Laterals*** (example "l"). When both lips are brought together the sounds are Labials (bilabial articulation) like 'p' or 'b', while those sounds with the lower lip and the upper incisors are labiodental like 'v'.

How well the listener understands the end products of articulation during speech is called ***intelligibility***. It depends not only on the precision of articulation but on the listener's interpretation of the loudness of the speaker's voice, his anticipation of the utterance, his familiarity with the subject matter, despite background noise. For example, on the noisy trading floor, stock brokers communicate to each other above the din using a mixture of lip reading and gestures to buy or sell their shares.

Language

All languages comprise the following four systems

- ***Phonology***: The study of the sound system of a language.
- ***Semantics***: The study of meaning of words in the language including the relationships between language, thought and behavior.
- ***Lexicography:*** The vocabulary or list of all the words in a language.
- ***Syntax***: system of grammar

Etymology is the study of the roots and origin of words; and how their structure and meaning have changed over time. English, which is widely used internationally, owes its acceptability to the fact that it has accommodated words from many languages. Many scientific words, however are of Latin and Greek origin.

Language is thus a system of rules for combining words (i.e. symbols comprised of meaningful combinations of phonemes) into sequences that express thought. The grammatical or syntactical system dictates the format of acceptable sentences. Word choice depends on the meanings of words and the logic of their inclusion in a sentence.

A speaker's prosody or stress and intonation variation often conveys nuances of meaning or emotion. Sometimes the meaning could be just the opposite as in the sarcastic exclamation 'Super try!', when a team mate has just floored a sitter of a catch, in cricket. Even the location of a word in a sentence can change the meaning, as in the placement of the word ***only*** in the sentence 'The physiatrist is the leader of the team in rehabilitation'

Only the physiatrist is the leader of the team in rehabilitation, or

The physiatrist is ***only*** the leader of the team in rehabilitation, or

The physiatrist is the ***only*** leader of the team in rehabilitation … and so on

In literature, the choice of words adds to the aesthetics and great classics are born.

Wernicke's area, associated with parts of the temporal and parietal lobes in the dominant hemisphere, assumes an important role in decoding speech and translating it into meaningful thought by the listener. The receptive use of language is not limited to listening but extends into the area of reading. ***In roughly 90 percent of the population, the left is the dominant hemisphere***. This is the reason why many right-sided hemiplegics, with a lesion in the left cerebral hemisphere are often aphasic.

APHASIA

Definition: It is a communication disorder caused by brain damage and characterized by an impairment of language comprehension, formulation and use.

It affects the sounds, vocabulary or grammar, both in speaking (expression) and in understanding (reception), and excludes those language disorders associated with visual or hearing deficits, mental deterioration or psychiatric aberrations. An aphasic patient may have difficulty in reading ***(dyslexia)***, writing ***(agraphia)*** and calculation ***(acalculia)***.

Types of Aphasia (Fig. 5.1)

Global Aphasia: When a patient manifests with non-fluent aphasia where there is a severe loss in comprehension and repetition the aphasia is global. Severe deficits are found in all language processes, including speech production, auditory comprehension, reading and writing.

Isolation Aphasia: All language processes are poor, except for the ability to repeat.

Broca's Aphasia (Fig. 5.2): Speech production is poor and slow, with impaired articulation, and grammar. Comprehension is relatively good except for complex sentences and reading is superior to writing.

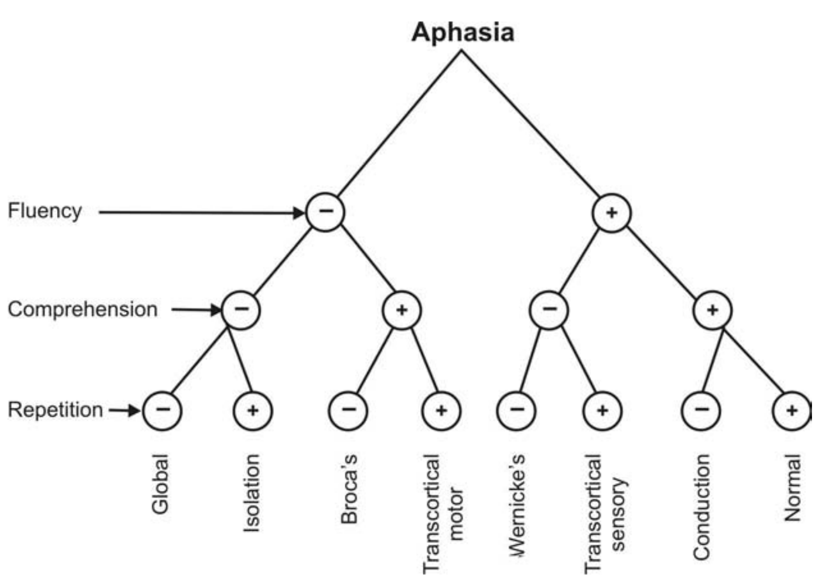


Figure 5.1: Classification of aphasia

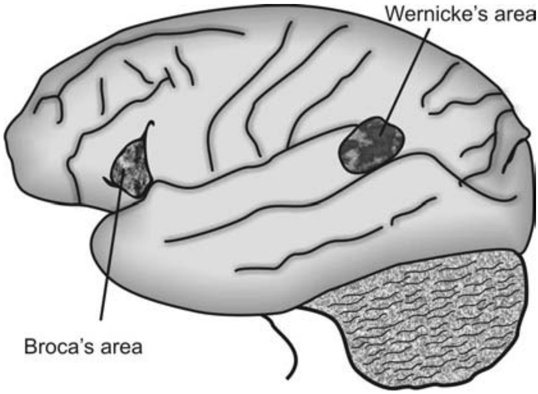


Figure 5.2: Broca's and Wernicke's areas in the brain

Transcortical Motor Aphasia: The speech in some ways is similar to Broca's aphasia. However the main feature of this rare syndrome of aphasia is the preserved ability to repeat fluently.

Wernicke's Aphasia: Speech is fluent with paraphasic errors (sounds in words may be substituted). Comprehension of the spoken, written word is also impaired. The fluent aphasic produces speech effortlessly. However, the content of speech is not clear. Some aphasic patients produce jargon or repeated unintelligible and stereotyped phrases (jargon aphasia). They are unaware that they are not communicating to the listener.

Transcortical Sensory Aphasia: This rare syndrome is similar to Wernicke's aphasia; however the ability to repeat words is preserved. The affected persons have poor comprehension, but their speech is fluent and grammatical. Aphasics do not use the correct word, but use another word of similar content like 'biscuit' for 'bread'.

Conduction Aphasia: Spontaneous speech is relatively fluent with good understanding of the spoken language, but there is selective loss of the ability to repeat what somebody else says. The person is able to understand what is spoken and is fluent in his speech with word substitution in the speech production. Patients will display frequent errors during spontaneous speech, substituting or transposing sounds

Anomic Aphasia: Speech is well articulated, grammatical and fluent, but is marked by severe word finding difficulties. The patient always seems to search for the right word for an object, though he knows what its function is. Auditory comprehension is good and reading and writing are variable.

Many aphasia tests are tests of intelligence adapted for use with aphasic patients, without the benefit of standardization on populations of aphasic patients. Aphasic tests are not diagnostic. A retarded person, an illiterate, a schizophrenic, or even a non-native speaker of English might fail items on an "aphasia test".

Some examples of tests for Aphasia are ***Minneapolis Test for Differential Diagnosis for Aphasia (MTDDA) and The Porch Index of Communicative Ability (PICA)***. MTDDA is the most comprehensive and accepted of the tests for aphasia; on an average the examiner takes about three hours to administer. It consists of 46 subtests divided into 5 sections namely,

- Speech and language disturbances
- Auditory Disturbances
- Disturbances of numerical relations and arithmetic processes
- Visual and Reading Disturbances
- Visuomotor and writing disturbances

DYSARTHRIA

Dysarthria refers to motor speech defects that results from trauma or disease of the nuclei or fiber tracts in and adjacent to the brainstem that sub serve the speech musculature. The pattern of speech produced by a specific dysarthric individual depends on the site and severity of lesion.

Articulation, loudness, rate, phonation, resonance, pitch, rhythm and stress patterns are the aspects of speech to be noticed. Articulation is optimal when speech is produced slowly.

Disorders of rhythm and stress are peculiar to cerebellar lesions. The cerebellar speaker produces errors primarily related to the timing of speech.

If the patient is asked to speak more rapidly, dysarthric symptoms will usually become more apparent. Mechanisms responsible for dysarthria are usually produced by inability of muscles of the larynx to initiate or stop contractions quickly. Hypotonicity of the larynx could produce a slurring in the pronunciation of consonants, slow speech, prolonged pauses or uneven stress on syllables and may also be responsible for the inability to increase loudness or vary pitch of the voice.

Types of Dysarthria

Flaccid Dysarthria: Damage to the nerves or their nuclei will result in speech characterized by a breathy voice, hypernasality, imprecisely produced consonants, slowness, incoordination of speech mechanism, reduced volume, and escape of air through the nose (nasal emission). Flaccid dysarthria occurs in patients with a brainstem lesion, stroke, polio, myasthenia gravis or bulbar palsy.

Spastic Dysarthria: If the site of neurological lesion involves upper motor neurons, a spastic condition may result in a speech pattern characterized by imprecise consonant production, monotonous pitch, a strained-strangled voice quality, hypernasality and occasional pitch breaks. Spastic dysarthria patterns are observed with spastic or athetoid cerebral palsy and pseudo bulbar palsy.

Patients with amyotrophic lateral sclerosis will often exhibit a combination of flaccid and spastic dysarthria.

Cerebellar Dysarthria: Word selection is not altered, but the melodic quality of speech is changed.

Patients with cerebellar disorders produce a characteristic speech pattern that includes irregular breakdown and distortion of speech articulation. Prosodic patterns are unusual in that some patients stress nearly all syllables equally.

Scanning speech is a typical example of cerebellar dysarthria. Words or syllables are pronounced slowly, accents are misplaced and pauses may be inappropriately short or long. Clients may also display explosive speech or staccato speech. The voice can become monotonous in pitch and loudness, tremulous, and nasals are very soft.

These dysarthric speakers usually exhibit irregular, imprecise consonant production, distorted vowel production, excessive loudness, variation and occasional harsh voices. Ataxic dysarthria is found in patients with ***Friedreich's ataxia***, multiple sclerosis and some patients with severe head injury.

Hypokinetic Dysarthria: Patients with movement disorders also demonstrate unique dysarthric patterns. Parkinsonism is a neurological disorder of the basal ganglia and the rapidity of speech is often reduced. Hypo kinetic dysarthric individuals usually speak with reduced speech stress, short rushes of speech, inappropriate silence and reduced volume. The speech is typically monotonous.

Hyperkinetic Dysarthria: Patients with movement disorders resulting in excessive motor activity, such as dystonia and chorea, exhibit hyperkinetic dysarthria, with fast paced speech.

DISORDERS OF PHONATION

Aphonia refers to an absence of sound. ***Dysphonia*** refers to a number of phonatory disorders of sound quality e.g. Vocal nodules, laryngitis, vocal polyps. Dysphonia may also result from vocal cord paralysis or cancer of the larynx. Primary objectives of voice evaluation are:

- A detailed history of the phonatory problem
- A physical examination of the laryngeal structures by a laryngologist
- Evaluation of voice dysfunction
- Evaluation of pitch, quality and loudness control
- The identification of use and abuse patterns that are contributing to the disorder
- The determination of the patient's ability to modify phonatory patterns.

The term '***Laryngectomy***' refers to the removal of the larynx (partial or total). An incomplete laryngectomy may or may not influence voice quality. A total laryngectomy results in complete loss of voice, and an esophageal voice may be needed. An esophageal voice is produced by vibration of the upper narrow portion of the esophagus when air is ingested into the esophagus and released.

COMMUNICATION FOR THE HEARING IMPAIRED

Classification of Types of Hearing Impairment

According to the PWD Act 1995, ***hearing impairment means loss of 60 decibels or more in the better ear in the conversational frequencies***. Peripheral hearing impairments can be usefully divided into three categories for rehabilitation purposes, based on the side of the lesion responsible for the hearing impairments.

- Conductive impairments prevent transmission of sound to the cochlea. Such lesions occur in the outer or middle ear.
- Sensorineural impairments prevent reception and transmission of sound stimuli to the brain. Such lesion occurs in the cochlea or auditory nerve.
- Mixed or combined impairments - both conductive and sensorineural impairments are present.

Causes for Conductive Impairment

- Congenital atresia of external auditory meatus
- Foreign bodies, e.g. tumor, cartilage or bone in external auditory meatus
- Collapsed ear canal
- Otosclerosis
- Otitis media
- External otitis

Causes of Sensorineural Impairment

- Noise induced hearing loss
- Viral and bacterial disease of inner ear
- Meniere's disease
- Consumption of ototoxic drugs, e.g. aspirin, quinine, neomycin
- Tumors involving cerebellopontine angle.

Audiometry

It is a measurement of hearing, the basic test to determine the degree and type of hearing loss. An ***audiometer*** provides pure tones of selected frequencies. The patient records the level at which the tones are heard and the results of the test are recorded on an audiogram which comes out as a graph showing hearing sensitivity. The range between 10 dB and 25 dB in the audiogram is considered to be within normal limits. The test results represent thresholds for air conduction, for stimuli transmitted to the external ear through earphones. Another way of presenting stimuli to the ear is bone conduction in which a vibrator is placed on portions of the skull, usually on the mastoid process.

The area of involvement that has caused hearing impairment can be determined by comparing air conduction to bone conduction thresholds. Bone conduction measurements must be performed with the judicious use of masking the signal to the other ear, which is not tested. Through the bone conduction test an attempt is made to bypass the middle ear system and conduct sound directly to the inner ear.

Management of Hearing Impairment

Management depends on type of loss, degree and age of onset. Management falls into three categories:

- Surgical and medical intervention,
- Corrective amplification and
- Counseling.

Conductive hearing losses usually respond to medical or surgical treatment. The ENT surgeon has an option to repair and reconstruct the tympanic membrane or replace bones of the inner ear, or do plastic surgery to open up the external auditory meatuses. Recently cochlear implants are becoming popular**. A cochlear implant** is a device used by the hearing impaired which stimulates the auditory nerve inside the inner ear. This electronic device which is surgically implanted has a microphone, speech processor and a radio frequency transmitter. This transmitter is attached by a magnet to another magnet placed beside a radio frequency receiver. This receiver, which is implanted beneath the skin in the skull, relays the incoming signal to electrodes which are implanted in the cochlea. A computerized speech processor allows the individual to adjust the sensitivity of the device but not the volume of the sound. The device gives auditory inputs, and enables the hearing impaired to understand speech in a quiet environment. Post-implantation rehabilitative therapy is very important.

Conductive losses have a better prognosis than mixed losses. In a patient with mixed loss, the conductive component of the loss can be removed, thus restoring at least a portion of the hearing ability. For example, if there is a tumor on the eighth nerve tumor surgery may preserve some hearing, and also there may be an additional advantage in that it gives relief from vertigo.

Speaking Aids

Artificial larynx (Fig. 5.3): The electrolarynx is a sound source implanted in the body. In these small devices, a reed is vibrated by the exhaled air from the lungs. One of the designs places the electronic parts, speaker and power supply within a denture. The user can turn the electro larynx on and off using a tongue switch. The speaker is a small earphone with a tube attached to direct the sound into the resonant chamber in the back of the mouth.

Another technique is a surgical implant device placed in the area where tissue was removed during laryngectomy.

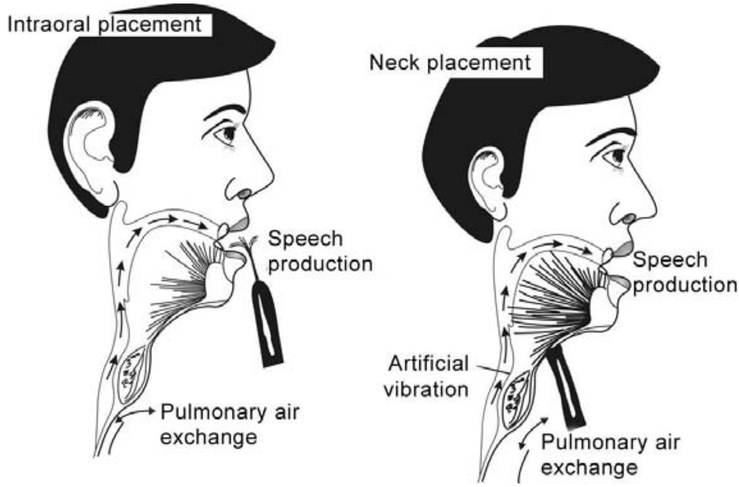


Figure 5.3: Artificial larynx—intraoral and neck placement

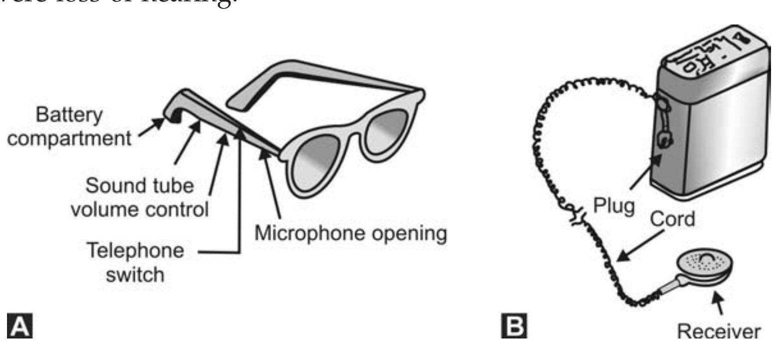
Hearing Aids

A hearing aid (Figs 5.4 and 5.5) is any device that brings sound more effectively to the ear of the listener. Hearing aids are commonly classified by their location on the body. The types are:

- Behind the ear
- In the ear
- Eye glasses

They may also be classified according to function as ***monaural***, ***binaural***, and ***pseudo binaural***. Monaural type fits a single ear. Binaural type includes two microphones, two amplifiers and two receivers, which fit each ear separately. In the pseudo binaural type, each ear has its own receiver but they both share the same microphone and amplifier.

The ***behind the ear*** hearing aid—It is intended for those who present a mild to severe loss of hearing.



Figures 5.4A and B: (A) Eyeglass hearing aid, and (B) Conventional hearing aid

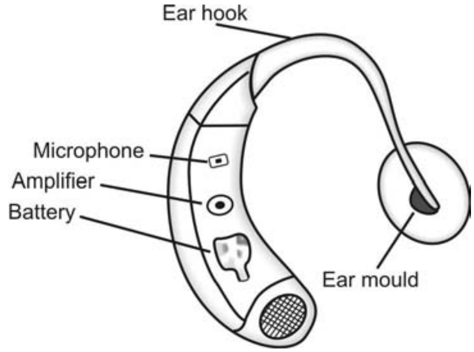


Figure 5.5: In the ear hearing aid

The ***in the ear*** hearing aid—It is intended for those who present a mild to moderate hearing loss. It entirely fits into the concha of the ear.

One side of the ***eye glasses*** contains the three basic components and the battery, thus forming a single monaural hearing aid

Auditory Prosthesis

This is an implantable cochlear prosthesis for the hearing impaired, which bypasses the non-functional parts and stimulates the remaining viable parts of the auditory system, by inserting flexible electrodes into the scala tympani through the round window.

Cortical Stimulation

Another type of auditory prosthesis attempts to bypass the ear and the auditory nerve completely by electrically stimulating the auditory processing areas of the cerebral cortex. The subjects experience subjective sensations of hearing. This technique might be beneficial to a hearing impaired person with a non-functioning cochlea, a non-conducting nerve, or a lesion of the central nervous system.

SPEECH THERAPY

Speech therapy is the treatment administered by a speech pathologist. A ***speech pathologist*** is an individual trained to diagnose and treat speech disorders.

Generally, it is best to set up weekly goals with the long-term in mind. The direction of treatment must be geared toward patient's daily language needs. The following is the sequence of learning tasks:

- Imitation of gross body movements, by feeling movements of and touching the articulatory apparatus, comprising the mouth, lips and tongue.
- Repetition of a small repertoire of phonemes, usually the labial syllables 'ma' or 'pa', which are incidentally the first words uttered by a new born.
- listening to the oral production of a word and attempting to imitate it

- matching identical objects, pictures, flash cards,
- using alphabet boards and writing devices, and, more recently, computers as a substitute for speech for aphasic patients.

The speech pathologist should try to be at his eye level of the patient whenever possible, communicate with the child with noises and speak slowly and distinctly but not with exaggerated articulation. The child should be able to see the therapists face in good light during speech. She can start by saying names of familiar objects or colors, or demonstrating and naming parts of the body. She can make the child play lip and tongue games lick off jam, ice cream or jaggery or encourage him to participate in songs, rhythms, body movement and hand finger plays. She should reward the child with a sweet or clapping when it makes a good attempt to use speech and not finish sentences for him if he can do so in his own time.

Tape recordings of the patient's speech are used in the treatment of dysarthria. The patient may assess his own performance comparing his oral movements to the therapist's in a mirror.

Exercises to increase muscle strength of the tongue or muscles of the oropharynx are prescribed for the patient with a weakness of the speech apparatus. When sounds are taught, the order of presentation proceeds according to difficulty—first the easier bilabial "p, b, m" (which are more visible) and vowel sounds and then the more difficult "s, r, k and g" sounds.

Clusters of consonants in words and sentences are presented after the patient has mastered the individual phonemes. The most effective method, in addition to pronouncing the alphabet, consists of teaching and getting the patient to repeat a selected group of high-frequency words (you, food, me) which are commonly used by the patient for his day-to-day activities.

Auditory Training

Systematic training in speech discrimination in various listening situations will be necessary for many persons with sensorineural hearing impairments.

Lip Reading

The hearing impaired person looks for movements of face and lips, which may be slightly exaggerated, with the face of the speaker in full light. He then perceives learned patterns of movement to form words and then associates these patterns with meaningful concepts.

Sign Language (Figs 5.6 and 5.7)

Is a mode of communication in which, a combination of hand gestures, orientation and movements of the body and face transmits visual signs to convey meaning. Though some sign languages have legal recognition, they have generally evolved geographically and vary from place to place. There

Figure 5.6: Alphabets of manual sign language

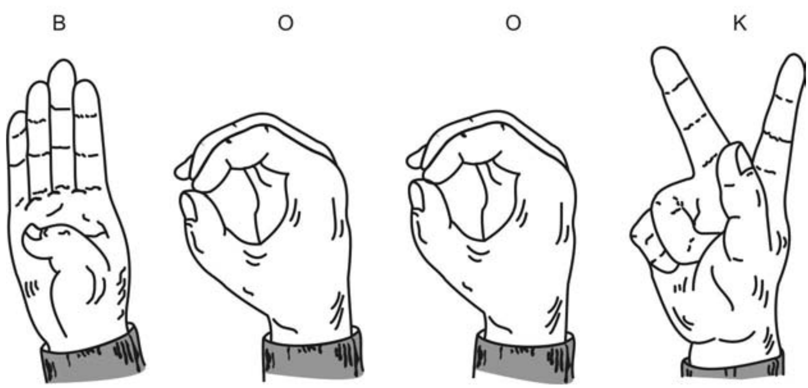


Figure 5.7: Sign language signifying the word BOOK

is an attempt to use international signs in deaf Olympics and meetings of world federations of the deaf to standardize sign language. The elements of a sign language are hand shape, palm orientation, place of articulation, movement, and markers like facial expression. There is a misconception that they are based on existing oral languages. Actually they are not oral languages spelt nor have they been evolved by normal hearing persons. They have just evolved locally by and for persons with hearing and speech impairment. Manual alphabets or finger spelling are used for proper nouns or for words not known by the other person like technical words. Some examples of letters spelt out with hands are shown in the figure in this chapter.

Conditions Treated with Speech Therapy

Cleft Palate: The congenital deformity of cleft palate with or without cleft lip occurs in approximately one in 900 to 2000 births. The voice is nasal in nature. Surgical repair of cleft lip and palate by a plastic surgeon is usually the treatment of choice. Orthotic appliances are often fitted to maintain or restore the contour of the arch.

Mental Retardation and Cerebral Palsy: It is customary to expect a child to speak two word phrases by years of age. The corollary of this obviously is that any child who by this age does not have clear words must be referred for further evaluation. Speech therapists and special educators have a vital role to play in language facilitation work with the mentally handicapped. Where speech is not possible, augmentative or communicative aids may be used.

Autism (Ref Chap 6): The autistic child often has bizarre language patterns along with behavioral and interpersonal problems. Many fail to develop language and are mistakenly suspected of being hearing impaired early in their development.

Bells Palsy (Ref Chap 19): Facial muscles usually on one side are paralyzed due to affliction of the facial nerve and speech can be affected. Massage and stimulation of the facial muscles, mirror exercises and speech therapy are initiated.

Drooling Management

Drooling is the abnormal spillage of saliva from mouth onto lips, chin, neck, clothing or floor. Minimal drooling is normal until two and half years of age. Extensive drooling is often seen in children with cerebral palsy.

Treatment Options

- Correct anatomical problems related to the oral cavity
- Behavior modification—keep reminding child not to drool
- Oro-neuromotor exercise and feeding program, stimulation of the oral apparatus
- Surgery (e.g. repositioning of salivary duct).

DYSPHAGIA

Dysphagia or difficulty in deglutition is defined as any defect in the intake or transport of endogenous secretions and necessary food for maintenance of life. The swallowing process for liquids and solids involves three phases; first, the oral phase, the voluntary act of swallowing followed by the involuntary pharyngeal (second) and esophageal (third) phases.

Some of the problems in oral and pharyngeal phase like food spillage, lack of tongue action to form bolus, pooling of food in anterior part of the mouth can be dealt with by the speech therapist. There is lack of chewing, tongue thrust, delayed and piecemeal swallow, nasal regurgitation and pooling of saliva.

Therapeutic Techniques for Dysphagia

Dysphagia is diagnosed through reviewing a patient's medical history, physical examination, and various diagnostic tests. Tests may include:

- Barium swallow and upper GI series
- Chest x-ray
- Endoscopy
- Esophageal acidity test (used to test for gastroesophageal reflux disease)
- Esophageal manometry

Treatment would be aimed at

- Introduction of easily digestible food in slightly forward bent posture
- Facilitation technique, teach swallowing maneuvers
- Compensatory strategies—texture, taste, temperature and the right quantity of food at the right time.

At times there is a narrowing or stricture of the esophagus, which may be stretched or dilated surgically.

Augmentative Communication

The term augmentative communication refers to ***any approach designed to support or augment the communication of individuals who are not independent verbal communicators, and who cannot speak***. It refers to those techniques and specialized equipment that are used by the individual to convey a message to a listener.

Some messages are designed to request wants and needs. Others are intended to share information. The types of messages produced by individuals are dependent on their age, cognitive and social capability and life styles.

The non speaking person uses a sophisticated electronic system that processes in coming speech, stores the data and also transmits it. The selection of the communication aid depends on the extent and type of communication disorder. The device may or may not store, convert or encode the signal.

General Form of Communication and Environment Control Aids

A communication or control device has three main parts. In this case, the user is at the input to the system, and device output is applied to the environment. The user interacts with any of these communication or control systems via the interface.

Vocaid: Vocaid contains very simple vocabulary for use in hospital settings. By pressing the keys, the user can generate a word or phrase. The speech is of high quality because it consists of stored code words.

Autocom: The autocom is a computer-based direct selection aid that can be configured to meet the specific needs of disabled individuals. The aid has a programmable input vocabulary, with either character or symbol based vocabulary.

Deaf Blindness

'The term "deaf blind" is used to describe a diverse group of people who suffer from varying degrees of visual and hearing impairment. Often these individuals are a major challenge for rehabilitation because they have communication, developmental and educational problems due to severe learning difficulties and physical disabilities which accompany the primary impairment.

Early Education must concentrate on
- Use of multi-sensory approach and use of residual senses like smell and touch.
- Communication and language taught in meaningful natural situations
- Development of bonding, body contact, awareness of self and others.
- Parents are the active copartners in the teaching process.

COMMUNICATION FOR THE VISUALLY IMPAIRED

Blindness:The person with visual impairment faces limitations in the range and variety of experiences, problems in mobility and communication and lack of control of the environment he is in.

Low Vision: WHO (1992) defines that a person with low vision is one who has, even after treatment and / or standard refractive correction, a visual activity of less than 6/18 to light perception or a visual field of less than 10 degrees from the point of fixation.

Legal Blindness: Legal blindness is defined as visual activity not exceeding 6/60 or 20/200 (Snellen) in the better eye with the correcting lenses or limitation of the field of vision subtending an angle of degree 20 or worse.

Common Eye Diseases

Cataract is a defect due to the aging process, in which the transparent lens becomes opaque and the person is unable to see well. It is insidious and if left alone can lead to total blindness which is reversible with implantation of an intraocular lens.

Glaucoma is defined as an increase in the intraocular pressure. Glaucoma can present as a mild ache behind the eyes to slight burning to complete blindness.

Corneal Ulcer: Sometimes facial palsy can lead to corneal ulcers following exposure keratitis. A foreign body like a flying speck of dust is the cause for most common corneal ulcers, which start off as simple abrasions initially. When these abrasions get infected due to bacteria or viruses or fungi, or when there are hypersensitivity reactions, or vitamin A deficiency, corneal ulcers result.

Xerophthalmia: The patient complains of blindness at night in the early stages of this disease, which is due to vitamin 'A' deficiency. At the onset, the conjunctiva and cornea lose their normal brightness and become dry and thickened. Later a severe form of xerophthalmia called Keratomalacia can develop leading to blindness.

Retinal Detachment: The retina can get detached from the choroid and if close to the site where the optic nerve enters the eye, can result in blindness. The patient complaints of gradually developing lack of vision in one eye following minor trauma and in some cases a serious blow to the head. It has also happened in patients with myopia.

Astigmatism: There is a refractive error that prevents the light rays from coming to focus on the retina because of different degrees of refraction in the various meridians of the eye.

Optic Atrophy: This is due to degeneration of the optic nerve which is the tract carrying light impulses to the brain, and the patient becomes blind over a period.

Types of Visual Aids

For those who are partially sighted low vision aids like magnifiers are useful. Use of tactile sense like Braille helps the blind communicate. Recent advances in technology have expanded the scope of visual impairment and we have today concepts like auditory vision, spelled speech and direct stimulation of visual cortex.

Low Vision Aids are divided into three categories:

Optical aids	*Non-optical aids*	*Electronic low vision aids*
Hand held magnifiers	Enlarged print	Closed circuit TV
Stand magnifiers	High intensity lamps	Opaque projectors
High contrast objects	Slide Projection	
Telescopes	Microfiche readers	

Tactile Visual Aids

Braille: Braille (Fig. 5.8) is one of the oldest reading aids for the visually impaired population. Originally used during the French Revolution, the Braille code has been in existence for about 150 years.

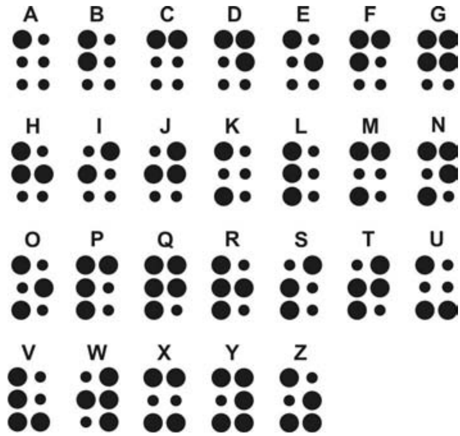


Figure 5.8: Braille characters

Braille is a matrix of embossed dots on ***stout*** paper, which represents a letter or a combination of letters. A Braille cell is a six dots matrix is in the form of two columns and three rows. Large quantity of encoded Braille can be stored on a standard 60-min. cassette thus reducing paper storage requirements.

Disadvantages: The tactile reading speed is much lower than that of the visual reading speed, and there is increased expense in transcription. Braille is also bulky and expensive to store.

Tactile Vision

Tactile vision means seeing by touching. It utilizes the direct conversion of an optical input to a tactile output to provide direct accessibility to printed text.

A tactile vision substitution system (TVSS) is an electronic device that converts visual information into a pattern displayed on a matrix of stimulators in contact with the skin. The net effect of such a system is to convert an optical image to an adapted visual perception through the tactile sense.

Tactile Reading Device (Fig. 5.9): Reading with this device is a two handed procedure. One-hand moves a small solid optical sensor used as a camera across a line of print to optically detect the printed characters. A finger on the other hand, usually the index finger, detects the processed optical signal from the tactile array. It feels an enlarged moving image of whatever the camera displays.

Auditory Vision System

An auditory vision system, which produces a sound pattern from detected letter shape, allows visually impaired people to hear what is being read.

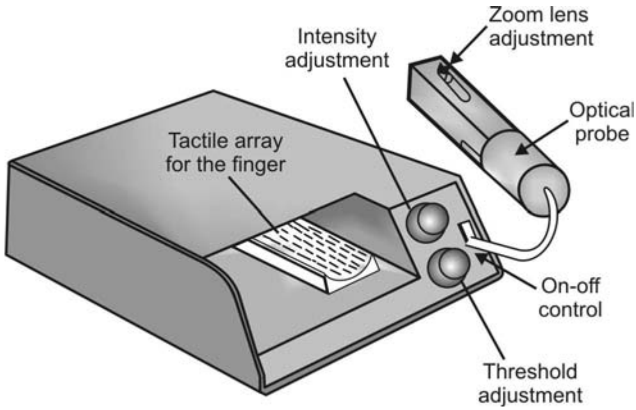


Figure 5.9: Conversion of visual characters to tactile characters in a reading device

Computers today can read out today entire passages using software to decode the visual symbols into uttered words.

Recent innovations convert optical inputs to electrical signals that directly stimulate the visual cortex. Electrical stimulation of the visual cortex causes a real visual perception. This has had limited success and is still under research.

OTHER AIDS THAT HELP IN COMMUNICATION

Writing Aids

Pencil and Paper Aids (Fig. 5.10): For those who have minor difficulties in holding a pen or pencil aids that assist in handling are sometimes necessary. Finger motion is needed to grasp the pencil while the tripod structure supports the fingers.

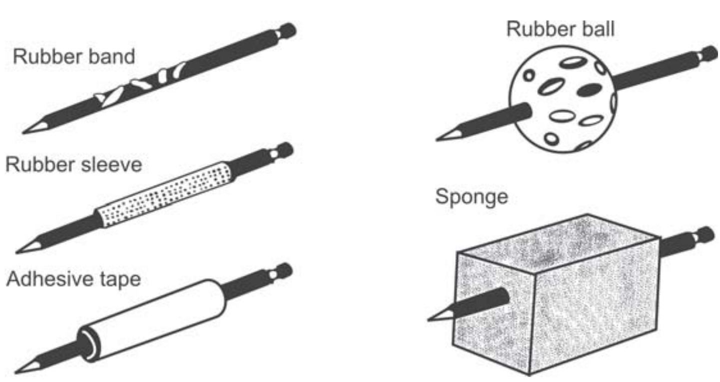


Figure 5.10: Pencil grips

Aids Primarily Intended for Assisting Conversation

Communication boards are frequently used words and letters are shown on a display (Fig. 5.11) and the patient points out to them in an effort to communicate.

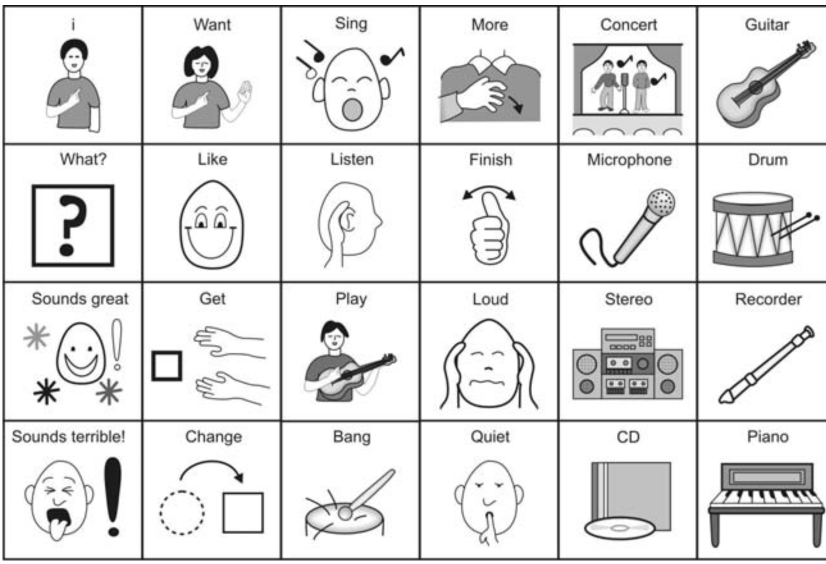


Figure 5.11: Communication boards

Portable printers are typically small, microprocessor-based hand held aids. They are characterized by small keyboards, possibly a line display (usually a LCD type) and a printing mechanism.

Writing Aids Based on Microcomputers

The graphical capabilities of microcomputers can give the handicapped the ability to draw. A number of small computers are now available, some of which have built—in multiline displays, printers, and tape storage mechanisms. In addition they can be used as a back up to voice output systems and can also function as communication aids.

Retrieval and Manipulation of Paper

The handling of paper has always been a problem for the physically handicapped population. Paralysis, amputations or the lack of motor control makes the insertion and removal of paper from typewriters very difficult without assistance. A system is available that allows a severely disabled person to manipulate a computer printout using a mouth stick and a small key pad.

For bilateral upper extremity amputees and quadriplegics, manipulating a book, magazine, newspaper or other document is an impossible task without help from an attendant or an assistive device. The handicapped person can use a mouth stick in a purely manual mode or a powered page turner to turn the pages in an automated mode.

A typical powered page turner utilizes a friction-action rubber roller to separate the next page (forward or backward) from the rest of the pages. The entire roller then moves from left to right (forward through the book) or right to left (to review previously read material) to turn the page. Many interfaces for controlling this page turner are available including a joy stick, puff/sip switches, pedal or push-button control.

Other mechanisms for turning pages use a coupler with adhesive putty, tapes, suction or vacuum. All these page turners require an attendant's help in placing and removing the reading material.

CONCLUSION

With the advance of technology, there are many more avenues open for communication by the person with disability. There is no single, blinkered approach. A judicious blend of common sense, ingenuity and simple engineering techniques can open up a lively two way traffic between the abled and the differently abled.

CHAPTER 6

Behavioral and Learning Problems in the Disabled

INTRODUCTION

Behavior is defined as the manner or treatment shown to others. It is based on the premise that, all human actions can be analyzed into stimulus and response, and that the ability to predict these actions is based on exhaustive study of behavior and attitudes. Behavior may be overt; like speaking, or covert like winking; it may be verbal (communicating by words, like talking over the telephone) or non-verbal (gestures and body movements like miming). The study of altered behavior and emotions is the realm of the psychiatrist and clinical psychologist. In this chapter we will have a bird's eye view of this important field and its influence on the course or rehabilitation.

BEHAVIORAL MEDICINE

This is a subspecialty in mental health that deals with the interaction of psychological factors with those of medical intervention.

There are two types of behavior.

Respondent Behavior

This is behavior which is reflex in nature and controlled by involuntary smooth muscles and glands. It is involuntary and instinctive, e.g. when a person is chased by a dog, his pulse starts racing, adrenaline gets pumped into his system, he gets goose pimples; these are typical features of a **fright and flight response** to a perceived threatening situation. There is no time to think, judge and react.

Operant Behavior

Operant behavior is voluntary behavior based on earlier stimulation. Hospitality shown to a guest, anger and irritation directed at someone who has hurt you, these are operant responses to a pre-existing stimulus.

The strength of an operant response is subject to the consequences. If the consequence is positive, the frequency will increase and vice versa. If one has to do well in an exam, the positive consequence of getting a medal will make one study more and more to come out with flying colors. On the other hand, the fear of being fined by a cop would bring down the incidence of traffic violations; careful driving would thus be operant response to this 'negative consequence".

In some disabilities, adjustment begins at birth, e.g. congenital anomalies. In some cases this occurs much later. This 'coping' with disability is a function of behavioral repertoire prior to the disability and response of environment to it.

Behavioral repertoire is a complex function of biological predisposition, learning and environmental stimuli. The disabled person faces a lot of aversive consequences due to his disability- the pain in rheumatoid arthritis, the exertion to do even simple ADL's like toileting in paraplegics, can lead to negative changes in behavior.

Disability is viewed as a punishment, an act of God by some, who will refuse to co-operate with any attempt to change the situation. Very often such negative attitudes can combine to produce an emotional catastrophe. The person with disability resorts to escapism, avoidance behavior, and depressive psychosis.

Sometimes, the rehabilitation program itself may be viewed as a punishment. The rehabilitation team has to face verbal abuse and non co-operation by the patient. If rehabilitation-appropriate behavior is reinforced by family and team on the patient, then improvement is exponentially more.

Behavior problems may result from **organic and inorganic** causes. Organic causes means that the problem may be linked to pathology in the brain. Examples of this are dementia, head injury, cerebral palsy, epilepsy and stroke. But disabled people can undergo behavioral changes without any organic neurological lesion; e.g. amputees, paraplegics (Fig. 6.1).

PSYCHIATRIC PROBLEMS IN THE DISABLED

Psychosis

This is a group of major mental illnesses.

- ***Organic Psychosis:*** This is a type of psychosis characterized by or associated with impaired brain tissue function. The patient exhibits clinical disturbances of consciousness, memory, intelligence and orientation.
- ***Functional Psychosis:*** This is a group of mental illnesses where the symptoms of psychosis are present even though there is no demonstrable disturbance of brain tissue.

Neurosis

This is a group of mental illnesses where the patient's symptoms do not interfere with his capacity for insight and judgment; he is well-oriented to his

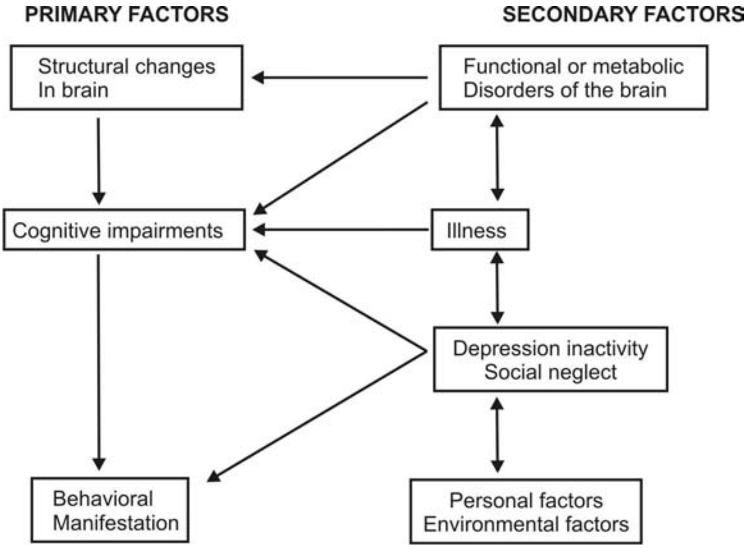


Figure 6.1: Primary and secondary factors in psychiatric illness

surroundings and his mental dysfunction is comparatively milder than psychosis. On the whole this group of patients suffers problems of a "minor" nature.

- ***Anxiety Neurosis:*** Anxiety reaction is a state of chronic apprehension with recurrent symptoms of acute episodes of anxiety. Many people get anxious before an exam or an interview but when the client becomes hyperactive, his pulse is fast, his blood pressure shoots up, his sleep gets affected, and he cannot concentrate on the job at hand, then he or she could be suffering from anxiety neurosis.
- ***Phobic Neurosis:*** Unexplained and irrational morbid fears about animate or inanimate objects are known as phobias. Some people are scared of closed spaces (claustrophobia); while others cannot stand the sight of spiders (arachnophobia) or are terrified of heights (vertigo).
- ***Obsessive-compulsive Neurosis:*** Obsessions are persistent recurrences of unwelcome ideas. The ideas usually revolve around sex, dirt, or religion. Some people are obsessed about starting for work at auspicious timings. Others are obsessed about cleanliness and would not mind taking bath even a dozen times a day. They often are miserable and guilty about these obsessions and try to remove them from their mind without much success ***Compulsions*** are irresistible urges to carry out meaningless and irrational activities, if the patient does not carry out his impulse, he experiences discomfort and tension. We see people constantly checking if they have brought their keys, purse or tickets with them, or inspecting if their room is locked—these are **compulsive disorders**.

- ***Hysteria—conversion reaction:*** When the tension of the unconscious or subconscious mind manifests itself in to somatic symptoms the resulting illness is known as **conversion reaction**.
- ***Reactive depression:*** This type of depression occurs usually in persons of anxious, melancholic or obsessive personality. The illness is preceded by a physical, physiological or psychosocial stress situation like a death in the family, loss of job or prestige, financial stress, marital and sexual disharmony, etc. The patient suffers from insomnia, and feels better in the evening than in the morning. He is more comfortable when in company than alone.
- ***Temper Tantrums:*** This is one of the behavioral problems exhibited by some children who will scream to get their way done when frustrated. This may be accompanied by breath holding spells.

Boys are more likely to show temper, aggressive behavior and hyperactivity, while girls are more likely to be anxious, fearful, shy and clinging.

Delusion: It is a false or mistaken belief, which has for the patient the force of conviction and is firmly held despite all evidence to the contrary, e.g. delusion of grandeur—a mere commoner believing that he is a king.

Hallucination: A hallucination is a perception through one of the senses, which does not correspond to any stimulus in the outside world. People have visual hallucinations of forms appearing in front of them, auditory hallucinations of voices speaking to them, and occasionally they complain of a feeling as if someone is touching them or strangulating them (tactile hallucination).

Illusion: An illusion is a perception, which although produced by an external stimulus, is misinterpreted by the patient in purely subjective terms. The classic example is that of a person seeing a rope and mistaking it for a snake.

Behavioral Problems in the Disabled

Dementia: These are pathological conditions where behavior gets altered due to atrophy, age related changes or ischemia in the brain. Public figures may keep poking their ears or gesticulating to no one in particular on the platform of a political meeting. Shameless and inappropriate behavior, such as crude sexual advances to casual acquaintances or masturbation or micturition in public, may be the first sign of something very seriously wrong in a hitherto normal elderly and respected person.

Head Injury and Stroke: Some brain injured patients display disinhibited, aggressive, self-abusive or otherwise inappropriate behavior. They may also become depressed or withdrawn. In hemiplegia they may not be aware of the affected side, anosognosia, and may exhibit inappropriate emotions and as emotional liability. The primary objective is the modification of inappropriate behaviors and the teaching of more effective means of communication and social interaction.

Assessment

Treat the patient with respect. Listen to him, and chart out a program and specify goals with his participation. The psychologist would have to monitor patient's improvement in the program and reinforce staff and family behavior. This is very important because the staff and family are in constant contact with the patient and need to be highly motivated to handle him.

Psychological Evaluation: It is essential to look at the mental framework of the patient to predict his prognosis. The better the persons coping skills are prior to the mishap the better the outcome. This is where the history taking skills of the examiner comes into play. He would have to delve into the past of the patient, the educational background, his nature, whether gregarious or withdrawn, details of the members of his family, his friends and their comprehension of the situation. This would have to be matched with the patient current behavior samples by keen and continuous observation. The reason for such elaborateness is because of the fact that **future behavior is based on past behavior.**

Tests for behavior assessment: Portland adaptability inventory is an instrument that measures degree of impairment in the areas of temperament, emotion, activities, social behavior and physical capabilities.

Halstead-Reitan Neuropsychological Battery: It is a fixed battery approach in that a specific set of tests is given to all patients. Here sets of seven standardized tests are administered which include Wechsler Intelligence scale, trial making test, sensory perceptual examination, and Reitan-Indiana Aphasia screening examination.

Behavior Disorders in Children

Behavior disorders are the result of complex interactions between the child and his environment.

"If a child's behavior has a negative effect on its own adjustment or if it interferes with the lives of other people, then it is said that the child is behavior disordered."

It is generally estimated that six to ten percent of school age children have noticeable behavior problems. The incidence is greater in boys than girls.

Characteristics of Children with Behavior Disorders

Delay in social cognitive development:

- They do not learn from their own past experiences or the experiences of other children.

- They are not sensitive to the fact that their behavior affects others in a negative way.
- They are isolated from their peers.
- They lack a sense of right and wrong.

Low academic achievement: Most of these children are poor in academics, do not like school, and are poor in time bound tasks like finishing home work or assignments. They have a poor self image which interferes with learning and they resist change.

AUTISM

Autism means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age three that adversely affects a child's educational performance. Autistic children generally engage in repetitive activities and stereotyped movements. There is lack of eye contact, resistance to change of daily routine and abnormal responses to sensory experiences.

It is generally accepted that autism is not a single entity but a series of behaviors.

THE MANAGEMENT OF BEHAVIOR DISORDERS

Drug Therapy: Drugs have to be prescribed by a psychiatrist. Combinations of the following may be used:

- Antipsychotic drugs
- Antianxiety drugs
- Antidepressant drugs.

Group Therapy: When the patient is in a group he gets to interact with others like him. This visual feedback gives him information of what others are going through. He sees that there are others worse off than him, and decides that life is worth living after all.

Family Therapy: Sometimes the family members in all good intention end up by doing more harm. They discourage rehabilitation -appropriate behavior by doing all functions for the patient, or by giving them unwanted sympathy. Giving a concrete job to the patient and family member can prevent day dreaming and negative attitudes.

Behavior Therapy

Whenever called up on to correct a deviant behavior, psychologists use behavior therapy which lays emphasis on current individual behavior rather than the historical origins of its problems.

First, the behavior to increase or decrease is identified. It is also noted how often this behavior occurs and reinforcers are identified. Reinforcers are nothing but stimuli that increase or decrease the frequency of a behavior. Positive reinforcers (carrot) increase the frequency while negative reinforcers (stick) decrease its frequency.

For example a child not co-operating to therapy can be offered a sweet, or the therapy can be converted into a game. An adult can be given the option of listening to music while doing therapy. It is not enough to reduce unwanted behavior it is equally important to provide alternate behavior.

For complicated tasks which do not find approval or cooperation with the patient, the tasks are broken down into smaller steps and the patient is instructed on what he can do. Encouragement increases performance

Leisure and prevocational activities have to be given. We must remember that the patient has a lot of time on his hands. An idle mind is the devils workshop. Hence he must have something to occupy his mind throughout his tenure.

Behavioral modification techniques are classified as:

Techniques for reducing anxiety including relaxation training

Graded exposure treatment involves exposing the subject to the feared stimulus one step at a time. Aversion therapy aims to reduce maladaptive behavior by associating it with an unpleasant experience, such as pain or a noxious smell.

Summary of contingency management techniques is shown in Table 6.1.

Table 6.1: Summary of contingency management techniques

Techniques	*Main features*	*Applications*
Negative reinforcement (Punishment)	A known negative stimulus is given to reduce the frequency or intensity of undesirable behavior. This is maintained till the behavior becomes desirable and then stopped. For example the person can be suspended from work till he gives up alcoholism and reinstated when he has given up the habit.	This stimulus can suppress behaviors likely to interfere with therapeutic programs. This technique is not recommended as it encourages avoidance.
Fading	Reinforcement of a desirable behavior is gradually withdrawn to bring it under naturally occurring reinforcement	Used as a special feature in programs with children who have frequent bedwetting at night.
Attention to discriminative stimuli	The environment of the setting is changed to give positive cues, for example a rehab center for children can be decorated brightly with lots of toys and games.	This technique is helpful when negative behavior is predictable in a particular scenario, like a doctor’s clinic.

Techniques to Increase Desired Behavior

- Rewards
- Behavioral contracts—written agreements between people who desire a change in behavior
- Shaping—gradual development of complex pieces of behavior by reinforcement of the constituent parts. This technique is used to develop basic skills (such as eating and dressing) in cases of mental retardation.
- Psychological treatment—hypnosis

MENTAL RETARDATION

Mental retardation is a term applied to a condition where the mental development is retarded at birth or in early childhood. The child has limited intelligence with difficulty in adaptation. Mental retardation is an educational, psychological and social problem.

It may influence all aspects of human functioning including speech, language development, hearing and visual functioning as well as muscular co-ordination.

Prevalence

A study conducted by the National Sample Survey of India in 1991 said that 3 percent of our children have developed mental delays often associated with mental retardation. Several non-official studies have also suggested that 2 to 2.5 percent children have mental retardation. India has about 300 million children less than 16 years of age. This means that the country has a huge young population with retardation.

Definition

"Mental retardation means a condition of arrested or incomplete development of mind of a person which is specially characterized by sub-normal intelligence."

- Intelligence should be significantly sub-average
- This should have occurred in the developmental period, i.e. up to 18 years of age
- Behavior should be significantly inappropriate.

Classification

1. According to gross physical characteristics
   - Familial types
   - Microcephaly
   - Hydrocephalus
   - Cretinism
   - Mongolism

2. Classification according to American Association of Mental Retardation (AAMR)

Degree of Retardation	*IQ Range*
Profound	0 – 24
Severely retarded	25 – 39
Moderately retarded	40 – 54
Mildly retarded	55 – 69
Borderline	70 – 84

IQ Scores, percentile ranges, and classifications for the Wechsler adult intelligence scale are shown in Table 6.2.

Table 6.2: IQ Scores, percentile ranges, and classifications for the Wechsler adult intelligence scale

IQ Score	*Percentile range*	*Classification*
130 and above	98 or greater	Very superior
120-129	91 to 97	Superior
110-119	74 to 89	High average
90-109	25 to 73	Average
80-90	9 to 23	Low average
70-79	2 to 8	Borderline
50-69	< 2	Mild mental retardation
35-49	< 1	Moderate mental retardation
20-34	< 1	Severe mental retardation
Below 20	< 1	Profound mental retardation

Prevention of Cerebral Palsy and Mental Retardation

- Public education
- Maternal and child health services
- Genetic counseling
- Consanguinity
- Malnutrition.

SPECIAL EDUCATION

Special education is the customized methodology to help learners with special needs achieve a level of independence, academic proficiency and success in school and also among peer groups. The improvement is more than would be expected if he or she were in a routine school environment. The goals are planned and progress systematically monitored. Teaching procedures, adaptive equipment and other interventions make all the difference. Focus is on early intervention, because the earlier the access to education, the faster the all round development.

There are four models in special education

Inclusion: Classes in a regular school for all day or nearly as much are referred to as *i*nclusion. Children with special needs are given special education services separately.

Mainstreaming: in this case the child is given routine education with normal children and later given special education classes along with special children

Segregation: Full-time learning in a special education set up is referred to as **segregation**. In our country, there are several special schools for spastics or Downs syndrome children, where the children are engaged full time. This may be in a classroom in a normal school or in a special school. Other facilities may be available in a special school like speech therapy and occupational therapy.

Exclusion: Sometimes the child is homebound or in a medical institution due to severe disability. In such a scenario, he or she may receive one-on-one instruction or group instruction within the institution.

In our country the SARVA SHIKSHA ABHIYAN (SSA) ensures that every child with special needs, is provided meaningful and quality education. No child having special needs irrespective of the kind, category and degree of disability, should be deprived of the right to education and should be accommodated in special schools, or even in normal schools with special guidance. SSA provides a sum per child for the identification, assessment, study placement and inclusion of disabled children. There is also a budget for the provision of aids and appliances, teacher training, removal of architectural barriers, research, monitoring and evaluation with a special focus on the female child with special needs.

Some characteristics of special education are:

- There is lessened emphasis on academic performance and greater stress on prevocational and vocational training and on practical life experiences.
- The special educator attempts to recognize small rather than major units of the child's functioning, permitting the precise identification of his faculties and building an individual program around these assets.
- Psychological guidance and consultation by teachers and instructors.

Teaching Strategies (Fig. 6.2)

The teacher has to remember that the child with mental retardation picks up information slowly. She has to be patient and make the child learn by imitating others and repeating the action often. Instead of taking a huge task to perform, the teacher divides it in to smaller units and takes the child through the initial hesitant steps slowly and gradually. Everyone proceeds from the known to the unknown. Hence the child is made to do what it knows first and later proceeds to skills that need to be trained. The child must spend some time with other children of his or her age. The parents of the child especially the mother must be instructed on the special nature of her child's education and she must take a role of a teacher for her child at home. Sometimes it helps to make learning a lot of fun and games, role play, drama or dance can be interspersed with the regular curriculum. The progress may be slow but the team including the parents should not get despondent, but instead reward even small mile stones, even though they may appear simple.

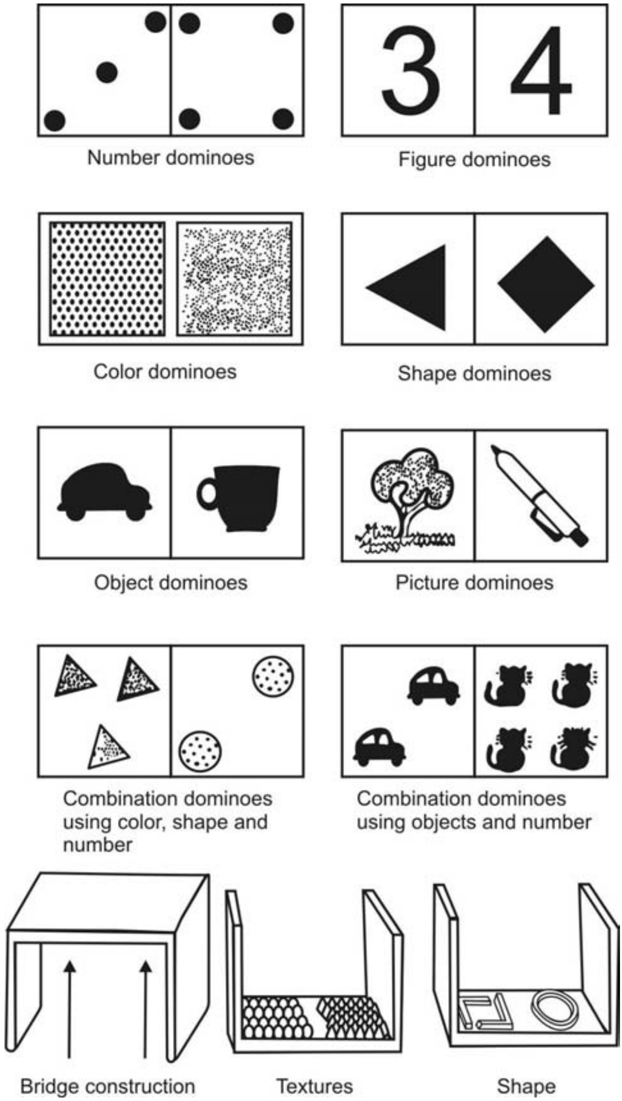


Figure 6.2: Educational aids and charts

There is no need to use expensive teaching aids rather simple and cheap materials can be used.

Use training materials which are appropriate, attractive and locally available. The child must be periodically assessed for its progress. Volunteers from the community can come in to teach what ever they are good at. This helps in participation from society.

The educable child can often reach the class four or five level. In some cases they may be integrated in the ordinary school. The trainable child may have to go to a special school. There are over a thousand special schools in India.

SENSORY INTEGRATION

Sensory Integration (Ref Chap 15) is a theory developed by A. Jean Ayres, an occupational therapist who defines sensory integration as "**the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment**"

Sensory integration is the ability to imbibe information through the senses, to analyze these inputs in comparison with existing memories and experiences and finally derive meaning out of this process. This is usually done in the mid-brain and brainstem in the early stages, which are also involved in subconscious processes like autonomic function, coordination, and arousal. These incoming inputs are processed in these centers, and later stored in areas of the brain sub serving emotions, memory, and higher level cognitive functions (Fig. 6.3).

Dysfunction in sensory integration is the "inability to adaptively discriminate, modulate, coordinate or organize sensation"

Children with problems in sensory integration have problems with their senses, which may be special senses, vestibular or proprioceptive. Children can be congenitally more or less sensitive and may have trouble in one or more sensation. They may be hyper sensitive to certain smells, sounds, textures and tastes. Some may be so hyposensitive that they may even feel very little pain, and in the very extreme, may actually enjoy unpleasant sensations like strong smells of ammonia, intense cold or unpleasant tastes. One example of this is inappropriate and insensitive reaction to pain, is when a child smiles or laughs on being given an injection or getting a second-degree burn.

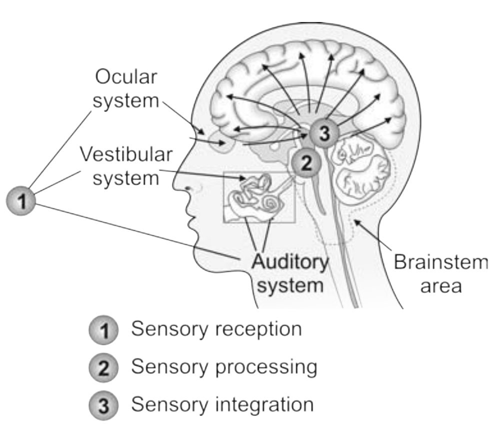


Figure 6.3: Sensory reception processing and integration

Scientists are not able to explain exactly why this happens, but possibly it may be that the brain seems unable to balance the senses or to filter out background stimulation, yet at the same time permit what is important. This is not the same as visual or hearing impairment, where children are unable to see and hear and therefore no stimulation is happening. In this case, inputs are received by these children with sensory integration disturbances, but the information is processed by the brain differently causing distress or confusion.

Some children hate to be hugged or kissed, and this causes so much distress among their parents. It just needs to be understood that any touch is perceived as unpleasant, and it is not that the child rejects the relationship.

Hypersensitivity is also known as sensory defensiveness. Examples of hypersensitivity are feeling pain from wearing a watch on the wrist, or an inability to withstand the breeze from a normal fan in the room.

Signs of Sensory Integrative Dysfunction

As mentioned earlier, SID can manifest with the following signs:

***Being overly sensitive to sights, touch, sounds or movements*:** The child avoids physical contact and refuses to participate in games.

***Abnormally low or high activity*:** The person may be continuously moving or conversely, very slow and fatigued.

***Less reactive to sensory inputs*:** The person may not respond to loud sounds or even pain, and in some occasions indulges in intense sensory experiences like twisting continuously, whirling, or running into pieces of furniture and getting injured in the process.

***Poor self concept*:** The child does not easily approach to learn a new skill and may appear to be lazy, or bored. This is often interpreted as stubbornness or shyness. There are deficits in studies or activities of daily living, despite normal or sometimes above average intelligence.

***Coordination deficits*:** Has poor eye hand coordination and finds it difficult to learn fine motor tasks. Even walking may appear to be stiff or clumsy. Daily activities, such as writing, use of a tool such as a phone, or self care activities such as tying shoes, wearing clothes may also present problems.

***Difficulty in adjustment to a new situation*:** The child is easily distracted, impulsive, or cannot follow simple directions. This results in frustration when the new task cannot be completed. Some get aggressive and get violent.

Identification and assessment of Sensory Integrative Dysfunction

A skilled professional, when encountering a situation of a child's performance being below par based on inputs from the teachers or parents, must gather complete information about the child's performance whether it be the classroom or home. The methodology involves careful observation of the child after interviewing the parents, and running through check lists and questionnaires with them. There are standardized tests of general development and motor functioning, like the sensory **Integration and Praxis Test Battery (SIPT) which** can be applied.

SENSORY PROCESSING DISORDERS (SPD)

Sensory Processing Disorders is often used as an all encompassing term that includes all forms but they are also classified into three types.

Type I - Sensory Modulation Disorder (SMD). Hyper or hypo responses to sensations or seeking sensory stimuli, even self inflicted.

Type II - Sensory Based Motor Disorder (SBMD). When the sensory information is wrongly processed in the brain, it can result in an abnormal motor output, like twirling, crashing into furniture or hyper reactivity to light touch.

Type III - Sensory Discrimination Disorder (SDD). A child not able to perform well in academics, or shows a delay in learning simple daily tasks may be suffering from discriminative problems that manifests as inattentiveness, or lack of organization.

Sensory Modulation Problems

Unusual responses to sensory stimuli are common in autism and in some other developmental disorders, which may result in them being clubbed as Attention-Deficit/Hyperactivity Disorder (ADHD). The child may appear to be hyperactive, but actually he may have a sensory problem in the vestibular system due to which he runs around seeking extra inputs to achieve postural stability.

SENSORY INTEGRATIVE DYSFUNCTION

Sensory integration dysfunction, or sensory processing disorder, is only recognized and treated when it interferes significantly with ADL's of the child. There is a wide spectrum of likes and dislikes and it needs some skill and experience to discriminate between SID and a normal preference or otherwise to a sensory input, like some noise in the environment.

SID can also be a presentation of other neurological conditions, including ADHD, autism spectrum disorders, or developmental dyspraxia.

Sensory Integration Therapy

Sensory Integration therapy is customized, not "one size fits all." According to SI theory, children with sensory integration issues respond differently and uniquely to the environment and what is calming for one child may be irritating for another. Treatment often has to be tailor made to these responses.

This can carry on into adulthood and when neglected, interferes with their work, organization at home and work.

Sometimes this different perception of the world around can result in these children developing an uncanny aptitude for the arts, eye for details that escape others. We thus find some children sketching or drawing like professionals, but are unable to button up their own shirts. This should be developed in to a possible future career.

INTERVENTION BASED ON SENSORY INTEGRATION THEORY

Intervention starts with teaching teachers and parents about Sensory Integrative Dysfunction and help them develop strategies that help adapt or compensate for dysfunction.

This could mean changes in the environment, daily routines, people's attitudes to the child and the goals set for achievement.

Environmental Modification

The environment is the source of most sensory stimuli. When someone is deprived of these inputs it is termed sensory deprivation. Sensory deprivation is a condition where the senses are deprived of stimulation totally or severely. There have been war prisoners who have had to endure solitary confinement and have been found to suffer major psychological changes. This is because the subjects have been confined to a room without light, touch or sounds, which happens very often in severely handicapped people. Over a period of time they become disoriented and display severe mental disturbances.

The flow of external stimuli into the brain activates its potentials, bereft of which the brain goes numb. It is almost as if these sensations provide nutrition for it, since they are responsible for the "alpha" or baseline brain waves in the conscious state. Hearing imparts probably the most important input for sensory function. The sensory system stimulates the Reticular Activation System of the brainstem which is responsible for arousal, alertness, coordination of actions, and reacting to challenges ahead. RAS is essential to learning and to behavior management. This is because sensations need to flow constantly into our brain at a rapid rate, and one needs to act upon, react to and organize ones self to these inputs if learning has to take place.

Sensory Diet

Vestibular and auditory inputs are very important to learning disorders, and aid in building concentration and emotional well being. Individuals who cannot listen and concentrate are very likely to have developmental problems like autism, dyslexia, or speech and language disabilities, or find it difficult to interact with others.

An input in one modality often influences others; for example, it is found that children who are swung or bounced on a Swiss ball improve in their speech. This is seen across the spectrum, with some children improving in learning and concentration after a lot of visual stimulation is given. The brain acts like a central processing unit, with an impact on one sensory modulating modality spilling over into other modalities too. The part of the brain that does this sensory processing is the brainstem, including the midbrain, the pons, the medulla, the cerebellum and the limbic system.

The sensory integration therapist and parents should create a "sensory diet," (a term coined by occupational therapist Anna Jean Ayres) which is a schedule of daily activities that gives the child requisite sensory inputs like a diet designed to meet an individual's nutritional needs. The amount of sensory stimulation is just enough so that they can cope with. The sensory diet is based on the premise that externally controlled sensory input can affect one's functional abilities. Children with hyposensitivity are given strong sensations, while children with hypersensitivity are given quieter activities. For example we can play music in the class room, hang bright pictures in it or give a lot of interactive play. Otherwise, one can refrain from too much hugging, reduce distracting visual materials in the classroom, or avoid wearing strong perfumes.

There is a technique called the Wilbarger Protocol, which uses deep pressure to certain parts of the body followed by proprioception in the form of varied joint compressions. Children are given simple changes to their daily routine, like skipping, jumping, or just closing their eyes and listening to music that will help them over come their sensory problems.

Traditional Sensory Integrative Therapy

There is no known cure for this problem; that is why there are so many approaches and protocols. Therapists all over the world have used prism lenses, sensory stimulation like **deep pressure,** physical exercise and music, but there is no standard evidence-based treatment, because of the wide spectrum of disorders.

Traditional sensory integrative therapy is done by a therapist directly on her patient, in a one on one approach without influences from others. This is done in a room with suspended equipment that provides a variety of movement and sensory experiences, called a sensory integration room. It is important not to impose oneself on the child, but rather artfully select and modify activities according to its responses.

All inputs can be given – visual, tactile, auditory and proprioceptive input in a way that provides just enough challenge for the child to respond adequately to environmental challenges. It has been observed that the child is happier to initiate hugging rather than receiving it. The child is more comfortable with a firm unmoving touch that is anticipated. Later on, the child tolerates even light touch. Stimulation which may be initially perceived as unpleasant is tolerated later.

Overwhelming environmental stimuli such as bright colored lights or tight clothing should be removed for hypersensitive kids to increase the child's comfort and ability to engage his attention. This is called the "just right" challenge, which is redundant if the activity and the child's perception of activity does not match.

Principles

- Just right challenge (the child must be able to meet the challenges /activities)
- Child-directed (the child's preferred activities are used in the session).
- Active engagement (the child actively meets the challenge of activity, because it is fun)
- Adaptive response (the child modifies its approach to the challenge over a period of time)
- Rewards may be used to encourage children to tolerate activities they would normally avoid.

Some tips:

1. When the child likes a sticky texture, give art and craft activity with a lot of glue. If the child likes to play on sand, we can give materials like clean river sand, rice or ragi.
2. Some children, especially autistics, like pressure all over the body. They can be given regular hugs, involved in a game of hide and seek under blankets.
3. Those who detest odors can be given fragrances mixed in materials used in day to day activity. If they react too violently the fragrance can be given very mildly.
4. Music is a universal favorite, but again it depends on the genre that the child likes. Toys or musical instruments can be given as an experiment.
5. Group programs like Bhajans, clapping together, imitating the sounds of animals or birds singing rhymes in different pitches, are given and a child's reaction gauged.
6. To improve proprioception (which is often poor in autism) we may include playing with heavy toys, bouncing on a trampoline or a large ball, skipping, pulling or pushing heavy objects. Playing a game of cricket or basketball can also help. Some times we can take the children on excursions or a visit to a park or playground, but it is important to ensure the child's safety before planning such activities.

Balance

Our sense of balance and coordination are dependent on the stimuli given to the semicircular canals that stimulate responses to movement and gravity. Therapy can include creative dancing rocking on a rocking horse, hanging upside down, swinging on a rope, spinning, and rolling on the ground. Obviously the child should be able to tolerate this and we should not stimulate in excess. Rocking back and forth motion will usually calm a child (watch a mother rock her crying baby) while vigorous motions like dance will stimulate them.

Skill Training

Sequential activity such as wearing a shirt or cleaning the teeth can be trained by giving preliminary activity like swimming, tackling obstacle courses. Hand function is promoted by giving toys and building blocks and asking the child to make a particular object.

Using both sides of the body or both hands together or in sequence can be trained by giving activities like crawling, skipping, playing a keyboard, juggling, cricket and such games. Eye and hand coordination can be improved with activities such as playing catch the ball, hitting a ball with a bat, tailing the donkey, tapping balloons across the room, and bouncing over beanbags and therapy balls.

CONCLUSION

Every person with disability has difficulty coping with his own handicap, and we need to look at him holistically and not just at the specific problem. We need to realize that within him is a heart that yearns to be normal and we need to give him a lot of emotional and mental support. The special educator, clinical psychologist and psychiatrist are thus important members of the rehabilitation team. No program is complete unless it includes the treatment of the human mind and the various aspects of learning and behavioral disorders.

CHAPTER 7

Orthotics

INTRODUCTION

Modern orthotic devices play a vital role in the field of orthopaedic and neurological rehabilitation. They are given to improve function, restrict or enforce motion, or increase support to a part of the body, like the spine or lower limbs. In India, where several adults suffer from the long term effects of childhood poliomyelitis, orthotics are an integral part of the life of persons with disability.

DEFINITION

An ***orthosis*** is a mechanical device fitted to the body to maintain it in an anatomical or functional position.

GENERAL PRINCIPLES OF ORTHOSIS

- ***Use of forces:***
  Orthoses utilize forces to limit or assist movements, for example
  - Rigid material spanning a joint prevents motion, e.g. posterior tube splint.
  - A spring in a joint is stressed by one motion and then recoils to assist the opposite desired motion e.g. leaf spring orthosis.
- ***Sensation:*** An orthotic device often covers skin areas and decreases sensory feedback. Proprioception should be preserved where possible.
- ***Correcting a mobile deformity:*** A flexible deformity may be corrected by an orthosis, like the one given in genu recurvatum or mobile scoliosis. The corrective force must be balanced by proximal and distal counter forces (three point force systems).
- ***Fixed deformity:*** If a fixed deformity is accommodated by an orthosis, it will prevent the progression of the deformity.

- ***Adjustability:*** Orthotic adjustability is indicated for children to accommodate their growth and for patients with progressive or resolving disorders.
- ***Maintenance and cleaning:*** The orthosis should be simple to maintain and clean
- ***Application:*** The design should be simple for easy donning and doffing. The more complicated the gadget the less likely it is to be accepted for permanent use.
- ***Limitation of movement:*** Limiting motion to reduce pain, e.g. knee brace
- ***Gravity:*** Gravity plays an important role in upper limb orthosis, especially in those joints where the heaviest movement masses are present. For example, a Rolyan shoulder cuff can be used in hemiplegia to prevent subluxation of the shoulder, which is the largest joint prone for the deleterious effects of gravity.
- ***Comfort:*** The orthosis should be easy to wear and comfortable to use. This is possible if the forces meant for correction are distributed over the largest area possible.
- ***Utility:*** The orthosis must be useful and serve a real purpose. If one hand is functional and normal, an upper extremity orthosis for the affected side may not be used as most activities of daily living can be performed with the good hand.
- ***Cosmesis:*** Cosmesis is important especially in the hand. A functional but unsightly orthosis is often rejected if the patient values appearance over function.
- ***Duration:*** Use only as indicated and for as long as necessary.
- ***Appropriateness:*** It should allow joint movement wherever appropriate.

Principle of Jordan

The basic mechanical principle of orthotic correction is the "**Three point system of Jordan.**" This system applies corrective or assistive forces, which are implemented at the surface of the orthosis through the skin and are transmitted to the underlying soft tissues and bones.

To remain stable, the body has to have one point of pressure opposed by two equal points of counter pressure in such a way that $F_1 = F_2 + F_3$ (Fig. 7.1).

The corrective force is directed toward the angular or deformed area to be corrected, and other two counter forces are applied distal and proximal to the corrective force. The greater the distance between the force and the counter forces, the less the counter force required.

BIOMECHANICS OF ORTHOSIS

There are four different ways in which an orthosis may modify the system of external forces and moments acting across a joint.

- Control of rotational moments across a joint

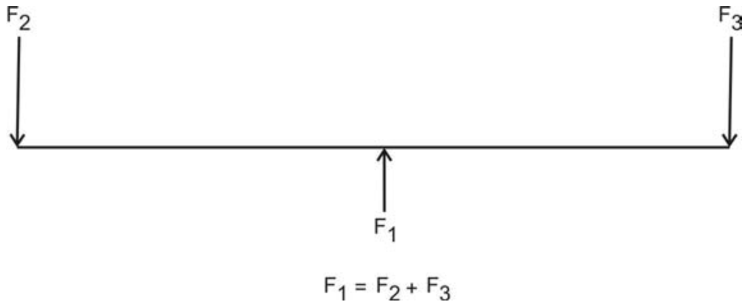


Figure 7.1: Principle of Jordan to remain stable, the body has to have one point of pressure opposed by two equal points of counterpressure in such a way that $F_1 = F_2 + F_3$

- Control of translational forces around a joint
- Control of axial forces around a joint
- Control of line of action of ground reaction force. This involves modifying the point of application and line of action of the ground reaction force during static or dynamic weight bearing.

The first three are termed as "**Direct**" in that the orthosis actually surrounds the joint being influenced. The fourth may be termed "**Indirect**" as the orthosis modifies the external force system acting beyond its physical boundaries.

Factors affecting tissue response to the orthosis:

- ***Extrinsic Factors:***
  - Pressure
  - Shear
  - Interface with the microenvironment.
- ***Intrinsic Factors:***
  - Tissue mechanics—the compressibility of the soft tissues influences their susceptibility to the breakdown process; the more compressible the tissues the more likely it is that blood vessels will be occluded.
  - Load transmission across the interface between the orthosis and the tissues.

The Patient-Orthosis Interface

The patient-orthosis interface may be defined as the junction between the body tissues and orthosis. This is the support surface through which forces are transmitted.

When force is applied through an interface there will be some deformation of both surfaces, depending on their relative thickness, the relative shapes of the underlying rigid structures and the level of the applied force. This leads to a progressive breakdown of that tissue and, in the case of paraplegia with loss of sensation and the shift reflex; this is the basis for the formation of a pressure sore.

CLASSIFICATION

According to Function

Supportive: It stabilizes the joints and supports the body in its anatomical position, e.g. calipers, gaiters.

Functional: It stabilizes the joint and also makes up for a lost function, e.g. foot drop splint in common peroneal nerve palsy or dynamic cock-up splints in wrist drop.

Corrective: To correct deformities, e.g. club foot boot in congenital talipes equinovarus.

Protective: To protect a part of the body during its healing, e.g. rigid four post-collar for fracture cervical vertebrae.

Prevent substitution of function: In a full length caliper, substitution of hip flexors by abductors or adductors of hip and other similar trick movements are prevented.

Strengthen certain groups of muscles: Tenodesis splint

Relief of pain: The lumbosacral corset supports the lower back, preventing painful movement.

Prevent weight bearing: A weight relieving orthosis, prescribed for conditions like fracture calcaneum will take weight away from the injured site to a proximal site like the patellar tendon bearing area.

Regional Classification

They are classified according to the anatomical area fitted with the orthosis.

- Cervical Orthosis
- Head-Cervical Orthosis (HCO)
- Head-Cervical-Thoracic Orthosis (HCTO)
- Sacral Orthosis
- Lumbo-sacral Orthosis (LSO)
- Thoraco Lumbo-sacral Orthosis (TLSO)
- Upper Extremity Orthosis
  - Shoulder and Arm Orthosis
  - Elbow Orthosis
  - Wrist Orthosis
  - Hand Orthosis
- Lower Extremity Orthosis
  - Foot Orthoses (FO)
  - Ankle-Foot Orthoses (AFO)
  - Knee-Ankle Foot Orthoses (KAFO)
  - Hip-Knee-Ankle-Foot Orthoses (HKAFO)

Orthosis Serving Specialized Functions

- ***Swedish knee cage:*** It is a knee orthosis that is used to control minor or moderate genu recurvatum.
- ***Pediatric orthosis: Standing Frame:*** Used for a toddler with spina bifida or a T12 neurosegmental level lesion or a child with cerebral palsy.
- ***Parapodium (Swivel Orthosis):*** It is used for leg length discrepancy and has a wide abdominal support pad to assist in upright posture.
- ***Reciprocating gait orthosis (RGO)*** These are bilateral hip, knee, ankle, foot orthosis to provide contra lateral hip extension with ipsilateral hip flexion. When one hip flexes, the contra lateral hip extends (Fig. 7.2).
- ***Twister:*** It is prescribed for lack of control of internal or external rotation or torsion of lower limb.

Orthosis Used in Specific Conditions

Orthosis are used for hand injuries, flexors and extensor tendon injuries like volar and dorsal wrist splints.

Orthosis used for nerve injury:

- ***Radial nerve injury***—a radial nerve glove is given with the wrist held in extended position or a wrist drop splint is given.

Figure 7.2: Reciprocating gait orthosis

- ***Ulnar nerve injury***—Splints that maintain the flexion of metacarpophalangeal joints and extension at interphalangeal joint with a lumbrical bar, e.g. knuckle duster splint.
- ***Median nerve injury***—Splint is applied to the thumb in an abducted, opposed position. (Opponens splint).

Orthosis used for inflammation of joints and tendons: Static thumb spica orthosis with the proximal interphalangeal joint kept free.

Orthosis used for burns: Splinting done to hold the part in neutral position and this prevents stiffening of the metacarpophalangeal joints.

Orthosis used in rheumatoid arthritis: Static three point proximal interphalangeal orthosis for Boutonniere deformity.

Orthoses used for stroke and brain injury: In stroke, large arm slings are used to prevent subluxation of the shoulder.

Contraindications to Orthoses

- Severe deformity which cannot be accommodated in the orthosis.
- If it limits movements at other normal joints.
- Skin infections.
- When the muscle power is inadequate to perform its function because of the weight of the orthoses.
- Where the orthosis interferes grossly with clothing or limits ones style of living.
- Lack of motivation or other psychological problems.
- Very young or old patients.

Disadvantages of Orthosis

- Lack of cosmesis: an unsightly orthosis is often the reason for a patient discontinuing its use.
- Muscles supporting the spine can become weak.
- Wherever segments are immobilized, we find increased movements at ends of these segments.
- The person becomes psychologically dependent on it.
- Reduction in bone density.
- Skin ulcerations or calluses at the patient orthoses interface.

Physical Assessment

A thorough assessment is imperative before prescription of an orthosis and will include:

- Type of paralysis and prognosis.
- Posture static and dynamic.

- Range of movement of joints.
- Muscle power; also of the hand grip especially when crutches are needed.
- Coordination.
- Deformity.
- Sensations touch and proprioception.
- Skin condition—ulceration, abrasions, dermatitis.
- Alignment of limbs
- Gait.
  - Need for assistive devices
  - Duration of gait
  - Deviation of gait
  - Ability to rise from various types of chairs
  - Ability to climb stairs and ramps.
- Dexterity—ability to manage buckles and other fasteners.
- Vision—walking safely indoors and outdoors needs good vision, especially in dim light.
- Spasticity.
- Limb length discrepancy.

Subjective Assessment

- Goals—what the patient hopes to achieve with his caliper
- Complaints from the patient about the orthosis on its performance and appearance, and whether there is pain.
- Whether the patient has used an orthosis previously.
- Comprehension—Understanding of oral and written instructions on how to use the orthosis.
- Economic considerations like the funding of the treatment and the patient's social environment.

MATERIAL AND FABRICATION FOR LOWER LIMB ORTHOSES

A wide variety of materials have been used to fabricate orthotic appliances, among them metals like steel, aluminium and alloys, rubber, leather and canvas. Some of them used more often recently are plastics and synthetic fabrics.

Considerations while Selecting the Material

- Strength
- Durability
- Flexibility
- Weight
- Should accommodate a simple and inconspicuous design
- Comfort

- Cosmesis
- Distribution of forces over sufficiently large surface area
- Material which can be accurately contoured and padded to the body.

Metal: Traditional orthotic devices are made of metal while leather is used for straps.

Plastics: They are lighter and close fitting and provide a fairly broader distribution of forces than the metal orthosis. They are usually lined internally with thin padding.

They are of two types:

- Thermo setting
- Thermo plastics

Thermo Setting: Plastics designed to be set after heating will not return to fit their original consistency if reheated, but they will soften.

Thermo Plastics: Thermo plastics are plastics that are heated and moulded to the patient. They have a capacity to return to their original shape when dipped again in hot water. Polypropylene is more commonly used than thermo setting plastics to make orthosis, sometimes combined with other plastics. Its unique advantage is that it provides a close fit by heating and moulding to the part of the patient's body that needs orthotic fitting.

Combination of Plastic and Metal: Usually aluminium and stainless steel uprights may be needed for heavy individuals. Lighter combinations of plastic and metal are used for those with medium build to reduce the weight of the orthosis.

Carbon – Graphite: It offers strength and low weight with increased durability.

CALIPERS

Calipers are orthosis fitted to the lower limb. They may be

- Foot orthosis (FO)
- Ankle Foot orthosis (AFO)
- Knee Ankle Foot orthosis (KAFO)
- Hip Knee Ankle Foot orthosis (HKAFO).

Considerations While Prescribing Calipers

Orthoses need to be prescribed, just like drugs. The specifications would include the nature and number of joints, the positioning of the straps and suspensions and accessory attachments to the shoe or boot. The reason for prescribing it must be explained to the patient, else there will be rejection. It would be good to check out the following, before delivering the orthoses.

The stability of the hip and knee should be good before deciding how high the caliper should be. This can only be done after doing a muscle power grading, paying special attention to the hip abductors extensors and knee extensors. Alignment is checked whether the ankle joint is over the medial malleoli, the knee joint over the prominence of medial femoral condyle and the hip joint permits a patient to sit upright at 90°. The caliper should be functional throughout all phases of gait and the static and dynamic alignment.

FOOT ORTHOSES (FO)

The essential difference between a shoe and a boot is that a boot covers the malleoli, while a shoe does not. The foot orthoses is nothing but a boot that has components like supports and wedges to manage different foot symptoms and deformities. These modifications are made of various materials like rubber, foam or leather.

The FO can be divided into a lower part and an upper part (Fig. 7.3).

Components of the Lower Part

Sole: It is the part of the shoe in contact with the ground. The inner part of the sole against which the foot rests is the insole. Bars straps and wedges, which are common attachments to the foot orthoses get their leverage and attachments through the sole and exert their forces (Fig 7.4).

Ball: Widest part of the sole that is located in the region of the metatarsal heads.

Shank: Is the narrowest part of the sole between the heel and ball. The uprights of the AFO attach themselves to a stirrup at the shank region.

Toe Spring: It is the space between the outer sole and the floor, which helps to produce a rocker effect during toe off phase of the gait cycle.

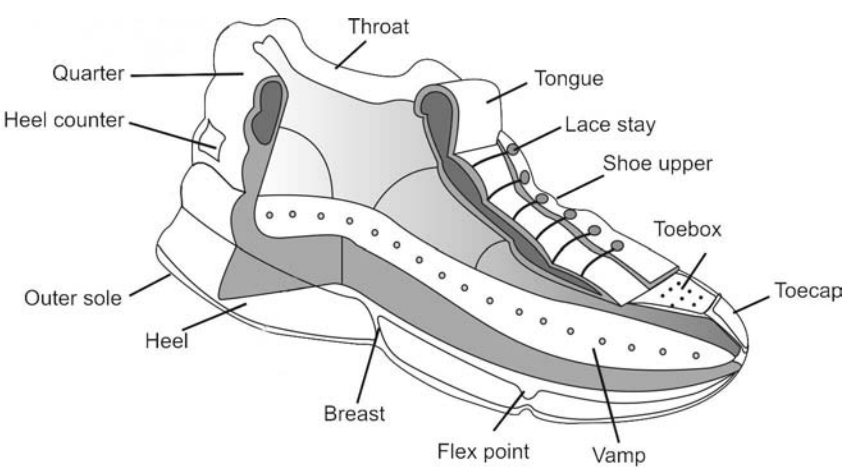


Figure 7.3: Parts of a shoe

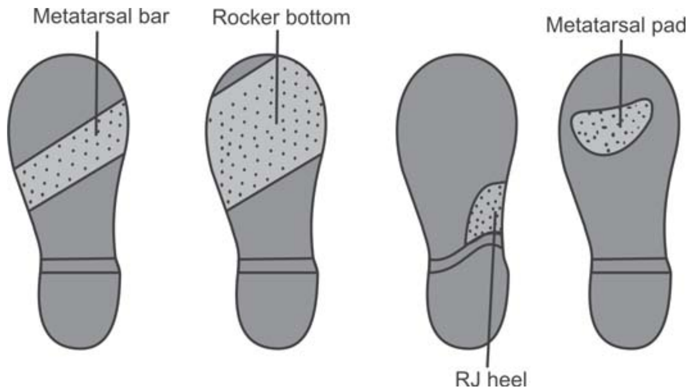


Figure 7.4: Modifications to the outer sole

Heel: is the posterior part of the sole, which corresponds to the heel of the foot. Since it is the portion where most of the body weight is taken it needs to be resilient and thicker so that it can prevent shoe components from "wearing out" and shift weight to the fore foot.

Upper Part (Also Called Shoe Upper) Components

Quarter: This is the posterior portion of the shoe upper. A high quarter is referred as a "high top" and is used by runners and footballers for greater sensory feedback, and to prevent retrocalcaneal pain.

Heel counter: In sports shoes there is a reinforcement of the quarter posteriorly called a heel counter which provides posterior stability to the shoe and supports the calcaneus.

Vamp: Vamp is the anterior portion of the upper and is often reinforced with a toe box anteriorly. In front is the tongue which protects the upper fore foot behind the lace stays. Extra-depth shoes allow more room inside the shoe for orthotic intervention.

Throat: This is the opening of the shoe located at base of the tongue, through which the foot is inserted.

Toe box: It prevents the toes from suffering trauma when the person kicks as in football. Even normally it is provided in the shoe to avoid stubbing of the toes.

Tongue: This is the part of the vamp which extends down in front of the throat.

Stirrup: This is a piece on the outer sole in the shank region just in front of the heel offering attachment to the metal uprights.

Modifications of the Orthopedic Shoe

The shoe can be modified according to the deformity, disease process or congenital anatomical configuration of the patient to:

- Maintain the foot in anatomical position
- Treat symptoms of pain burning or fatigability.
- Prevent further deformity
- Afford cosmesis
- Provide symmetry
- Provide a better stance and gait.

Clinical condition	*Objectives of modifications*	*Modifications*
Limb shortening	Provide symmetric posture	Heel elevation: If < ½ in: internal If < ½ in: external Heel and sole elevation (if > 1 in) High quarter shoe
Arthritis, fusion, or instability of or instability of subtalar joints	Improve gait Support and limit joint motion	High-quarter shoe Reinforced heel counters Long steel shank Rocker bar
Pes plano-valgus	Reduce eversion support longitudinal arch	For children High quarter shoe with broad heel, long medial counter, medial heelwedge For adults: Medial heel wedge Medial longitudinal arch support
Pes equinus (fixed)	Provide heel strike Contain foot in shoe Reduce pressure on MT head Ease putting on of shoe Equalize leg length	High-quarter shoe Heel lift & Metatarsal pads or bars Heel and sole elevation on other shoe depending on LLD Modified lace stay for wide opening Wide open throat – open vamp
Pes equinovarus	Realign for flexible deformity and accommodate a fixed deformity Increase medial and posterior weight bearing on foot	High-quarter shoe Long lateral counter Lateral sole and heel wedges for flexible deformity Medial wedges for fixed deformity
Pes cavus	Distribute weight over entire foot Restore antero-posterior foot balance Reduce pain and pressure on MT Heads	High-quarter shoe High toe box Lateral heel and sole wedges Metatarsal pads or bars Molded inner sole Medial and lateral longitudinal arch support
Calcaneal spurs, calluses and corns	Relieve pressure on painful area	Heel cushion Inner relief in heel and fill with soft sponge
Metatarsalgia	Reduce pressure on MT heads Support transverse arch	Metatarsal pad Metatarsal or rocker bar Inner sole relief
Hallux valgus	Reduce pressure on 1st MTP joint and big toe Prevent forward foot slide	Soft vamp with broad ball and toe Relief in vamp with cut-out Low heel

Contd...

Contd...

Clinical condition	*Objectives of modifications*	*Modifications*
	Immobilize 1st MTP joint Shift weight laterally	Metatarsal or sesamoid pad Medial longitudinal arch support Soft vamp
Hammer toes	Relieve pressure on painful areas Support transverse arch Improve push off	Soft vamp, extra-depth shoe with high toe box or balloon patch Metatarsal pad
Foot fractures	Immobilize fractured part	long steel shank Longitudinal arch support Metatarsal pad Metatarsal or rocker bar

ANKLE-FOOT ORTHOSIS (AFO) (FIG. 7.5)

Metal Ankle-foot Orthosis

The AFO is a boot to which an ankle joint is fixed through the stirrup. There are metal uprights (medial and lateral bars) ascending up to the calf region. The components are:

- Proximal calf band with leather straps
- Medial and lateral bars articulating with medial and lateral ankle joints help in control of plantar and dorsiflexion.

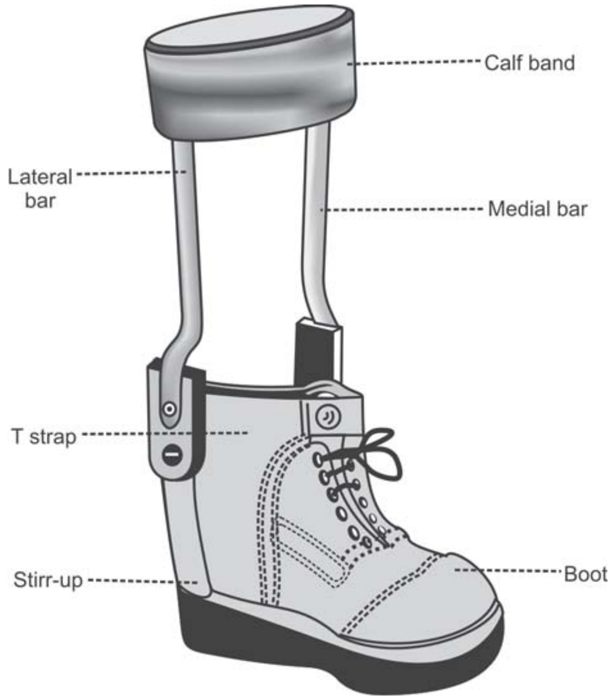


Figure 7.5: Ankle-foot orthosis

- Stirrups anchor the uprights to the shoe.
- Other modifications to the shoe, like medial and lateral supports can also be prescribed for the AFO concomitantly.

Ankle Joint

There are five types of artificial ankle joints (Figs 7.6A to E) fit to the AFO, prescribed according to the power of the muscles controlling the ankle. They are:

- ***Free ankle***, given when there is normal ankle power;
- ***Limited ankle joint*** is prescribed when the muscles operating the ankle are totally flail and have no power.
- ***90° foot drop stop*** is when the ankle joint allows dorsiflexion but stops short at the neutral position that is at 90 degrees. Thus it does not allow plantar flexion. It is recommended when there is foot drop—when the dorsiflexors are weak and plantar flexors are normal, or when the dorsiflexors are normal or near normal and plantar flexors are spastic.
- ***Reverse 90° ankle joint:*** This is an ankle joint which allows plantar flexion but stops short at the neutral position that is at 90 degrees. Thus it does not allow dorsiflexion and is prescribed to prevent a calcaneus deformity. This happens when plantar flexors are weak, while dorsiflexors are normal. It is not commonly used.
- ***Fixed ankle joint:*** Sometimes the foot needs to be protected and weight is taken off injured portions as in fracture calcaneus when in combination with a weight relieving orthosis it takes the weight off the foot. It is not very commonly used.

Indications

Ankle-foot orthosis is prescribed for,

- Muscle weakness affecting the ankle and sub-talar joints.

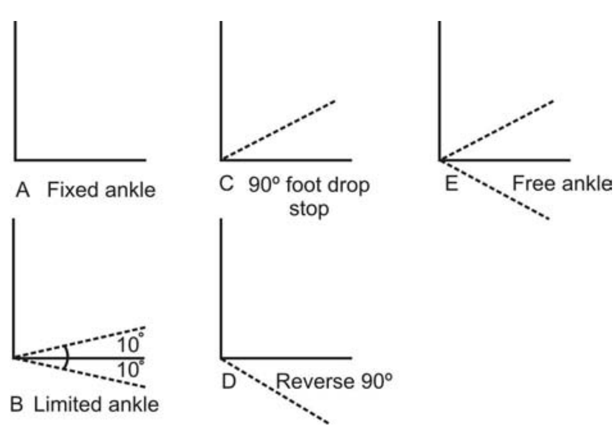


Figure 7.6: Types of ankle joints

- Prevention or correction of deformities of the foot and ankle.
- Reduction of inappropriate weight bearing forces.

Dorsiflexor Muscle Paralysis

Aim: To prevent contracture of the Achilles tendon, and to assist dorsiflexion during heel strike a dorsiflexion assist plastic posterior leaf spring AFO can be prescribed that can be inserted in to shoes. This facilitates the client to wear different shoes. The rationale for this option is that the spring prevents the foot from dragging during swing, and permits only slight plantar flexion during early stance, thereby enabling the client to achieve a foot flat position without undue knee flexion. Tension on the Achilles tendon counteracts any tendency to form contracture.

Ankle and Foot Paralysis

This is prescribed to provide stability and reduce gait deviations during the swing and stance phases. A polypropylene solid ankle AFO to be worn with a shoe prevents the foot from dragging during swing; the brace rigidity also prevents ankle dorsiflexion during midstance. Another option is to prescribe a hinged AFO. Adjustable hinges enable the clinician to alter the range of ankle excursion. The limited ankle joint, prescribed quite often, permits ankle movement about a small range, usually 10°-15° of dorsi and plantar flexion. A third option is to prescribe a metal and leather AFO with adjustable ankle joints for plantar flexion and dorsiflexion and corrective straps for valgus and varus deformities. This AFO provides some mediolateral stability.

Spasticity

AFO's are used in children with cerebral palsy to stabilize the foot during heel strike and foot flat phase. A polypropylene orthosis given as a shoe insert prevents plantar flexion, and also dragging of the toe during the swing phase. If neglected the foot goes in for equinus contractures and may require injection of Botox or surgery. The sidewalls of the orthosis control pes valgus or varus during early stance.

Limited Weight Bearing

This is a rarer indication for the AFO, to reduce loading on the leg and foot in conditions where the foot needs to be protected (e.g. fracture calcaneus). There is a socket at the patellar tendon bearing area, which has a weight-relieving brim similar to the socket in the below knee prosthesis. The heel of the foot does not come into contact with the innersole, and a window is provided for a finger to be introduced and confirm this. This enables the weight to be taken higher up at the patellar tendon.

KNEE-ANKLE-FOOT ORTHOSIS (KAFO)

It provides stability to knee, ankle and foot.

Components

The components are the same as those in a metal AFO. In addition there are uprights extended to the knee joint and lower thigh band. Thigh bands are suspension mechanisms to which the uprights are attached. They are worn by the patient to fasten the orthoses to the leg or thigh.

Knee Joints

Knee joints are provided in calipers, so that the wearer can **sit down**. During walking the joint is locked in full extension for stability, but at the expense of a good gait pattern because the person walks with a stiff knee gait.

There are three basic types of knee joints:

- ***Straight set knee joint:*** allows free flexion and prevents hyperextension. The upper segment rotates about a single transverse axis. It is used in combination with a drop lock to give further stability. This is the joint usually prescribed in our country. It is cheap and easy to repair.
- The ***polycentric knee joint*** uses the double axis system to simulate the flexion/extension movements of femur and tibia at knee joint.
- ***Posterior Offset Knee Joint:*** This is given for patients with minimal quadriceps weakness, since it keeps the knee extended, though there is not enough stance control. The criteria for prescribing a posterior offset knee joint is adequate power of hip flexion and extension and the ability to generate enough momentum to walk. The placement of the joint is just behind the anatomical knee joint to increase knee stability when walking.

Stance Control: The ideal joint should have stability during weight bearing and flexion during the swing phase of gait when it is non-weight bearing. This is more energy efficient, and decreases the exaggerated movements of the hip which is seen when the knee is locked. Some of these joints are mechanically operated while others are powered by computerized mechanisms controllers.

Knee Locks

These are locks incorporated into the knee joint, to stabilize the knee joint in extension.

- ***Drop lock*** is a wedge shaped metal piece that is placed on the lateral upright bar. When the knee extends it drops over the joint and locks it. This is commonly used in our country.
- ***Spring loaded lock:*** Sometimes the patient is unable to reach the knee or may lose balance while doing so; or might feel embarrassed to do so in public. So a spring loaded lock may be added to the drop ring lock. It

provides automatic locking using a spring action rather than depending on gravity to do it. This lock is easier for locking and unlocking.

- ***Cam lock*** with spring loaded cam fits into groove in full extension. It is also easier to release and gives good stability. In the double upright bar it provides simultaneous locking and unlocking thereby provides maximum rigidity. It is indicated in weight bearing braces when semiautomatic unlocking is desired.
- ***The ball lock*** provides an easy method of unlocking medial and lateral knee joints. The patient can catch the ball on the edge of the chair to release the lock mechanism to permit sitting. This is useful for adolescent young men and women who are conscious about their appearance and can wear the caliper beneath their saree or salwar kameez. The trigger lock is connected to a switch through a cable enabling patients to unlock the knee joint at a point higher up. It is commonly used for patients with limited balance and dexterity.
- ***A dial lock*** may be adjusted every 6° for precise control of knee flexion.
- ***Plunger type lock:*** It is cosmetically more acceptable since it is concealed in the knee mechanism. It is indicated in persons having hand weakness.

Indications

The biomechanical indications for the use of KAFO'S (and HKAFO's) are divided into three parts

Muscle Weakness: Weakness of the muscles of the lower limbs, mainly those controlling the knee and hip joint (more specifically the quadriceps and hip extensors). This will most commonly result from spinal cord damage or lower motor neuron disease such as poliomyelitis or injury to a nerve.

Upper Motor Neuron Lesions: Upper motor neuron lesions impair locomotor function through loss of the normal control of the lower limb muscles. There is an extensor synergy in the lower limb, which is used by the hemiplegic to achieve stance stability. The orthotic device must additionally incorporate knee joints, which limit hyperextension.

Loss of Structural Integrity: This is due to injuries to the main ligaments of the knee and joint disease, either due to inflammatory (septic arthritis) or degenerative (osteoarthritis) processes.

Genu Varus/Valgum: Damage to the medial joint compartment with resultant varus instability, will result in a concentration of the joint force on the damaged condyle. In addition the increased knee adduction moment will result in increased tension on the lateral collateral ligament. Conversely there can be damage to the lateral joint compartment with a concentration of pressure on that side of the joint, resulting in abduction movement and stress on the medial collateral ligament.

The orthotic device will need to incorporate knee joints which resist abduction or adduction but which permit a normal range of flexion-extension. It is recommended to prescribe a single upright KAFO with free knee and ankle joints. The upright may be on the medial or lateral side of the leg, depending on whether it is genu varus/valgum to be controlled.

Problem in Load Bearing: This form of structural impairment may be a consequence of either a joint or bony defect such as failure of a hip or knee joint replacement or a delayed or non-union of a femoral fracture. The orthotic prescription is a "weight-relieving" knee-ankle-foot orthosis (explained earlier).

Knee Braces: Knee braces are prescribed in severe osteoarthritis of the knee, to provide stability to the knee joint. They come with bilateral uprights and knee joints, and usually extend from mid thigh to mid calf.

HIP-KNEE-ANKLE-FOOT ORTHOSIS (HKAFO)

The HKAFO is an extension of the KAFO. In addition to the KAFO there is an attached hip joint which allows hip flexion and extension only. The suspension is with a pelvic band, which is a padded rigid steel band extending posteriorly and laterally, which fits between iliac crest and greater trochanter and which is used to control rotational movement at the hip joint. In the front it is fastened with a soft Velcro or buckle strap fastener. On the lateral side it is connected by a lateral upright, or bar to a normal KAFO and on the medial side the upright stops short of the ischial region. Movement at the hip is with an uniaxial hip joint with a drop lock, which is locked during walking. In conditions where weight relief from the lower part of the body is needed, the body weight is taken away from the foot or leg and transmitted from ischial seat through metal uprights to the ground.

HKAFO provides improved posture, and balance during standing and a better controlled forward leg swing in patients with weak hip muscles. However it is difficult wear and remove, and permits only limited step length. There is also an increase in lumbar spine movements to compensate for limited hip motion (Figs 7.7 and 7.8).

Uses

The HKAFO is prescribed whenever the muscles controlling the hip and its stability are strained or weak. Of course muscles controlling the knee and ankle may also be weak, and there may be tendency to varus or valgus of the ankle which can be accommodated in the orthosis. The prescription of the HKAFO must also take into consideration the problems at the knee and ankle.

Hip Rotation Control

Abnormal rotation at the hip, seen in some children with cerebral palsy is not resolved by a general HKAFO, but by using:

Figure 7.7: Trigger lock

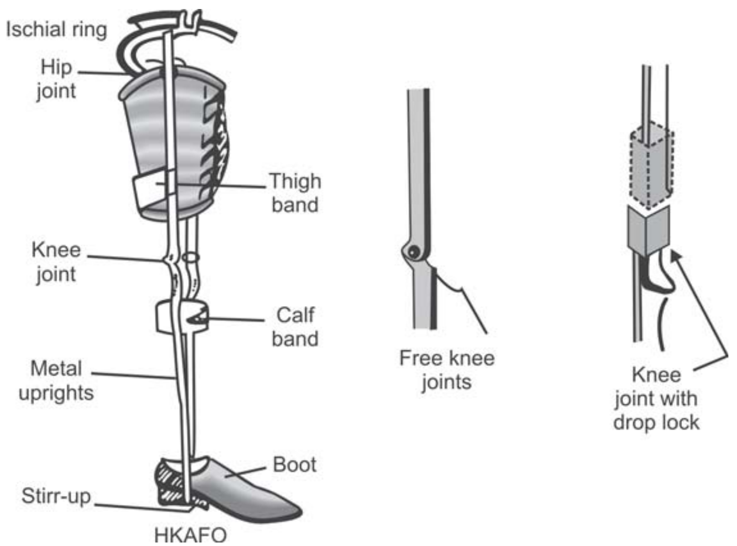


Figure 7.8: Hip-knee-ankle foot orthosis (HKAFO). Types of knee joints

- Pelvic bands with hip joints
- Spreader bars
- Silesian bandages.

Single-axis hip joints attached to pelvic bands are quite common but are heavy and it is difficult donning and doffing them. Spreader bars lock both legs but this restricts the leg from taking a step though each leg prevents the other's rotation. Silesian bands are bands that begin laterally posterior and superior to the greater trochanter, encircle the pelvis on the normal side between the greater trochanter and the iliac crest and attach anteriorly to achieve some hip rotation control. It reduces gait deviation, particularly toeing-in that is attributable to faulty hip control. Hip rotation control straps are prescribed and for preventing internal rotation, the client wears a waist belt. Tied to the posterior aspect of the belt in the midline are two straps, each having its distal attachment on each of the uprights of the HKAFO. The bilateral hip joints control frontal and transverse plane motion.

FUNCTIONAL ELECTRICAL STIMULATION (FES) (FIG. 7.9)

The concept of FES was introduced by Liberson and co-workers to control foot drop during the swing phase in hemiplegic patients. The theory is based on the survival of the motor neuron in UMN lesions such as hemiplegia. Such stimulation is done to obtain a functional movement, such as picking up objects or walking. Multichannel stimulators are being used for paraplegics in research laboratories, to simulate walking. The emphasis today is on miniaturization and portability.

A typical functional stimulator consists of:

- Stimulator
- Leads
- Electrodes which may be superficial or implanted.

A miniature electrical stimulator producing currents between 90 and 200 mA, of pulse duration between 20 and 300 microseconds, and voltage between 50 to 120 V is fitted to the patient. It must be light in weight and portable.

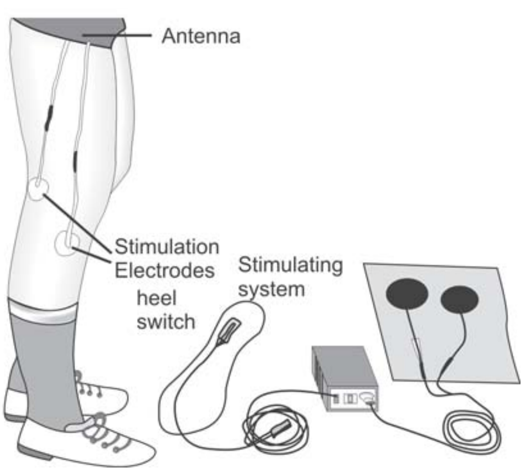


Figure 7.9: A functional electrical stimulator. The surface electrode is near the common peroneal nerve and the other stimulating electrode on the motor point of tibialis anterior

A power pack which powers the stimulator is worn on a waist belt and in the typical peroneal stimulator, one skin electrode is applied to the common peroneal nerve below the fibular head on the affected side, while the inactive electrode is applied to the leg at the motor point of the tibialis anterior. A heel switch is incorporated in the shoe that turns **on** the stimulator when the heel leaves the ground and turns it **off** on heel strike. Thus at heel off the tibialis anterior and other dorsiflexors are stimulated, affording clearance, and at heel strike the stimulation is switched off, allowing the foot to become plantigrade.

Sometimes electrodes are surgically implanted instead of being placed directly on the skin. This eliminates the need for wires passing all over the affected site.

When an implanted electrode is used, it must be placed directly on the nerve with a flexible wire lead connected to a subcutaneously implanted receiver located over the antero-medial aspect of the thigh. There is an antenna located over the implanted receiver, responding to signals from a transmitter incorporated into the shoe. Phasing of the stimulation during the gait cycle is controlled by the heel switch. The power pack for the stimulator and transmitter is worn at the waist.

Criteria for Selection of Patients

The selection of patients who can use the FES has to be done very carefully:

- Such patients should be able to walk independently at a speed more than 25 m/min without an orthosis, and have good balance and saving reactions.
- The major gait problem should be foot drop, without equinus contracture.
- Proprioception should also be intact.
- The regular use of a FES system could result in an increase in the strength of foot dorsiflexors in the long-term, and may improve the gait pattern through re-education and over a period the patient may reach a stage where he may no longer need it.

This principle is also used to major hip and thigh muscle groups in patients with spinal cord injuries for muscle strengthening, maintaining standing posture and ambulation.

SPINAL ORTHOSIS

The common thoracic or lumbar orthosis consists of a plastic or aluminium frame, anterior abdominal support, two posterior uprights, and pelvic and thoracic bands, which are fitted to the spine.

Mechanism

The three point force control system of Jordan is used in these orthoses by working on the principle of pelvic positioning, which acts as a base of support for spinal column alignment. Relief of longitudinal forces is then provided by anterior abdominal compression. Counter pressure is provided by a rigid posterior positioning system. This arrangement provides increased comfort as the forces are distributed over a wider area than with the three-point pressure system.

In the three-point pressure system in the anterior spinal hyperextension (ASH) brace, two anterior pressure points are balanced by a third opposing posterior pressure point. This control system is effective in preventing flexion deformities of the spine from becoming worse.

Principles

The client must be able to sit and stand comfortably while wearing the orthoses. There should not be any problem with breathing, chewing or digestion.

Functions

The functions of spinal orthoses are manifold. They prevent and sometimes even correct deformities like scoliosis and kyphosis. Where there is instability or displacement they offer stability as in spondylolisthesis. Chronic back sufferers get relief because these orthoses limit movement and weight bearing, by limiting axial loading and relieving muscle spasm. After a spinal surgical procedure or fracture vertebra, they protect against further injury.

TYPES OF SPINAL ORTHOSIS

Cervical Orthosis (Fig. 7.10)

Cervical orthosis surround and protect the cervical spine. They include the collars which are the least restrictive and providing partial range of motion. They are made up of foam plastic and surround the neck from the lower jaw to the occiput and have rigid anterior and posterior struts. They can be used in restriction of neck flexion and extension up to some extent. Cervical collars are freely available in 3 readymade sizes—small, medium and large and may be soft hard or medium depending on the restriction needed.

Conditions Used

- Crush injuries of cervical spine
- In case of hyperextension injuries of cervical spine this type of collar is used to hold the neck in a slightly flexed position.
- Whiplash injuries. These are caused by a sudden impact in which the head and neck are thrown forward and backward abnormally. This sort of impact is usually seen in car accidents, sports injury and child abuse.
- Sprains or strains of the neck.
- Degenerative diseases of the spine like cervical spondylosis.

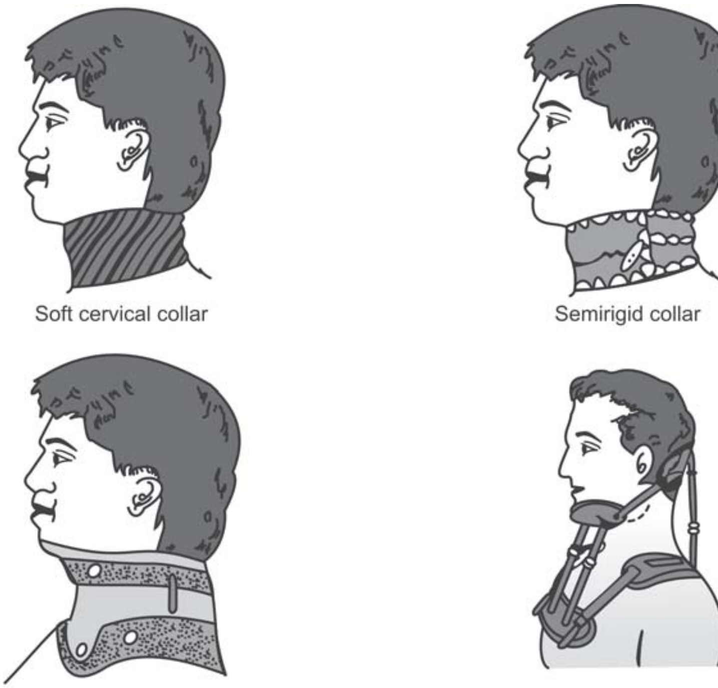


Figure 7.10: Cervical orthoses

Uses

- In the above-mentioned conditions the collar reminds the wearer not to move abruptly, thus reducing stress on the damaged tissues.
- The collar retains body heat, which enhances circulation to the injured structures.
- Immobilization of spine also helps in relieving pain.
- Prescription of the collar should only be done if the neck movement causes severe pain, giddiness or is otherwise injurious to the anatomical structures. Long term use is to be discouraged except when there is severe giddiness or instability.

Head Cervical Orthosis (HCO)

The head cervical orthosis incorporates both head and the cervical spine into the device, thus providing additional support and motion restriction.

Four Poster Cervical Orthosis

It has padded mandibular and occipital supports attached to anterior and posterior plates by four rigid adjustable uprights. Laterally leather straps connect the mandibular and occipital supports. This orthotic device provides greater restriction of flexion, extension, lateral bending and rotation than the ordinary collar.

Minerva Jacket

It is a suitable modified jacket, which is applied to the head and trunk.

Anteriorly, the orthosis has a forehead strap that secures the upper posterior shell and a rigid mandibular plate. The axillae are also covered by a wool roll.

Uses

- This provides excellent motion limitation in all directions.
- There is also the facility of selecting the optimal alignment of the head on the neck.

Head Cervical-Thoracic Orthosis (HCTO)

Halo Orthosis: Better stabilization of the cervical spine is achieved through external fixation of skull with reference to the chest. Three major components include the rings and pins, plastic vest, and connecting adjustable uprights. The pins penetrate the skin and outer table of the skull and are treated to fix the halo ring assembly on the skull. Aluminium turnbuckles connecting the jacket and ring are adjustable to provide variable traction, flexion or extension. The orthosis is uncomfortable and cumbersome during exercises.

Conditions Used

- Paralysis with or without fracture of the cervical spine.
- Major cervical vertebral fracture with dislocation.

SOMI Brace (Fig. 7.11)

SOMI stands for Sterno Occipito Mandibular Immobilization, named for its points of attachment, the sternum, occiput and mandible. The orthosis consists of three parts; a chin cup with adjustable bar, an occipital support attached to two bars for the anterior section and from which straps arise to attach to the chin piece, and a sternal plate with straps for the shoulder pieces. SOMI restricts flexion, extension, rotation and lateral bending.

Conditions Used

- Fracture of cervical vertebra (Lower level)
- In the case of non-operative or post-operative immobilization of spine.

Thoraco-Lumbar-Sacral Orthosis (TLSO) (Fig. 7.12)

These braces fix the pelvis and shoulder to prevent spinal movements in all directions. They may be classified according to whether they control flexion, flexion-extension, flexion-extension-lateral movement and all these including rotary movements.

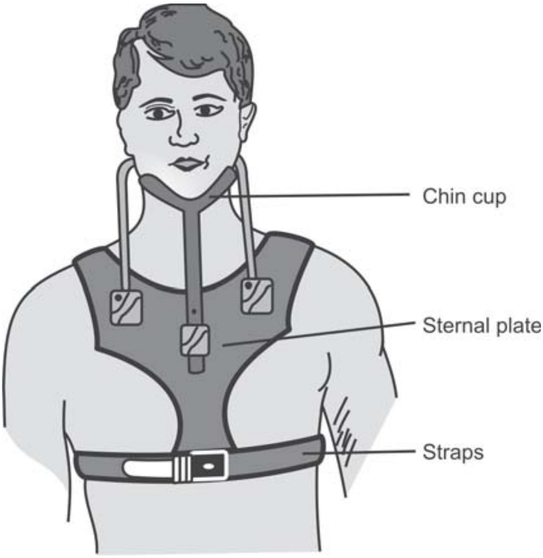


Figure 7.11: SOMI (Sterno-occipito-mandibular immobilization) brace

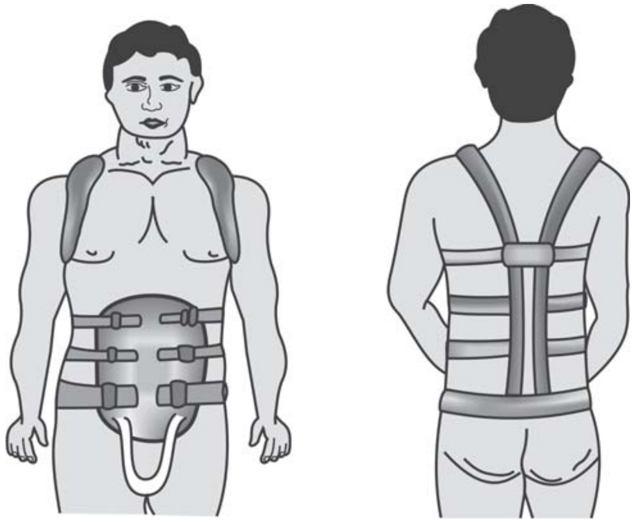


Figure 7.12: Thoracolumbosacral orthosis (TLSO)

Hyperextension braces like the Jewett and ASH orthosis do not prevent lateral or rotary movement. Flexion extension control orthosis like the Taylor brace consist of two spinal uprights posteriorly. These are attached to a pelvic band inferiorly and a band in the interscapular area above, providing attachments to axillary straps which are held tight in order to effectively control flexion extension. In addition an abdominal corset holds the abdominal muscles bracing them against the spine. An optional plastic body jacket is prescribed if maximum immobilization is needed as in Potts spine, or fractures of the spine. The Knight-Taylor brace has additional lateral uprights to prevent lateral motion of the spine. The Flexion-extension-lateral-rotary control orthosis has an additional interscapular band extended anteriorly and superiorly to control rotary movement.

Jewett Orthosis: This is an anterior hyperextension orthosis which has a rectangular frame exerting pressure over the pubis and upper thorax. There is a fulcrum maintained by a thoracic strap attached to the sides of the frame offering counter support.

Conditions Used

- Compression fracture of the vertebra.
- Intervertebral disc desiccation and prolapse.
- Non-operative and postoperative immobilization of spine.

Uses: Restriction of flexion, extension and lateral flexion of the thoracolumbar spine.

ASH Brace (Fig. 7.13)

This spinal brace consists of a cross like frame anteriorly fixed with pads on the sternum and the pubic symphysis with the pads at the extremes. Posteriorly, in addition (in the Jewett orthosis) there is a padded support in the thoraco lumbar region which maintains the spine extended by the principle of Jordan. The ASH brace is more comfortable than the Jewett brace.

Figure 7.13: Anterior spinal hyperextension brace (ASH) which works on Jordans three point principle

Milwaukee Brace (Fig. 7.14)

The Milwaukee brace is a brace given for growing children with **dynamic scoliosis** (refer Chap 20). It directs transverse and longitudinal forces actively and passively.

The orthosis consists of a custom moulded or prefabricated plastic pelvic girdle that serves as the foundation for pelvic positioning to control the lower spine. This is accomplished by flattening of the abdomen to encourage pelvic tilt and decrease lumbar lordosis. The anterior pelvic girdle is extended superiorly to just below the xiphoid and the ribs, providing an anterior compressive force. The remainder of the frame consists of anterior uprights leading to a neck ring. The neck ring has an anterior throat pad and two occipital pads that provide an additional longitudinal distraction force. The lateral pads hold the lateral curves, but do not correct them. The pelvic band fixes the pelvis and decreases lordosis. The collar head-band applies distracting forces that elongate the spine.

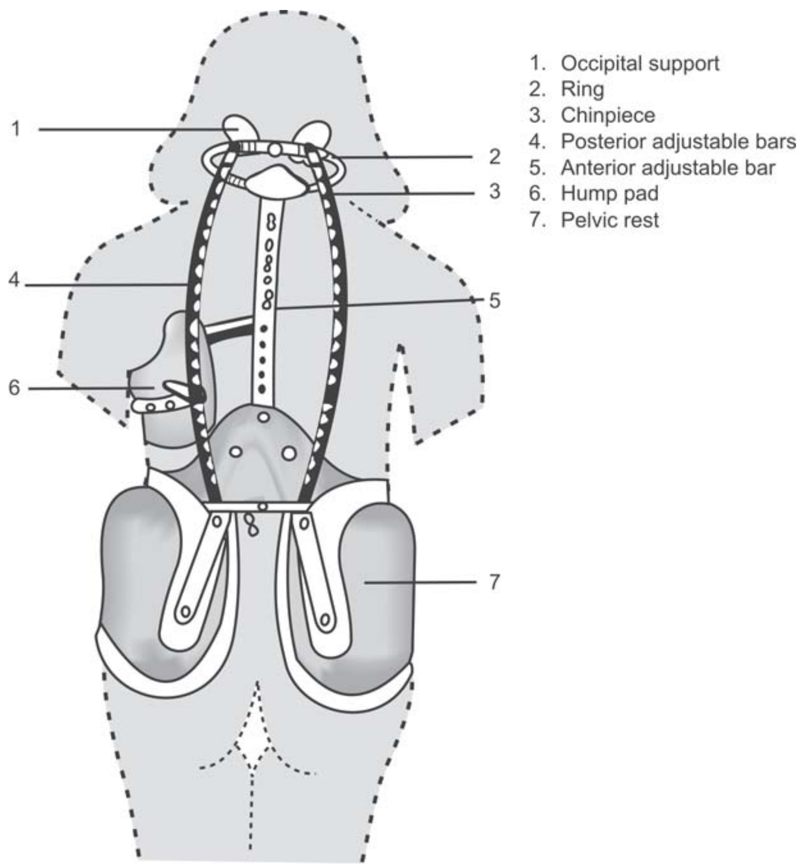


Figure 7.14: Milwaukee brace

Further modifications include pads attached at various levels of the Milwaukee brace to correct other deformities of spine. There are buckles used to distract the brace according to the height of the child. **This is thus a dynamic spinal brace that can 'grow' along with the children.**

Conditions Used: Any lateral curvature of the spine - scoliosis and kyphoscoliosis.

Lumbosacral Orthosis (LSO)

Knight Brace: It is a short spinal brace consisting of a pelvic band and a thoracic band joined by two posterior and two lateral metal uprights which, provide considerably more rigidity than a corset.

Boston Brace: The Boston brace is an example of modular orthosis that provides varying control and is useful for the treatment of scoliosis. It is made up of semi rigid plastic and supports the lower trunk by controlling all lumbosacral motion.

Conditions Used
- Low back pain.
- Spondylolisthesis.
- Intervertebral disc diseases.

Uses
- The orthosis reminds the wearer to avoid abrupt motion.
- Motion control is achieved by means of various three-point force systems—support for the spine is also by abdominal pressure.

Lumbosacral Corset (Fig. 7.15)

These are very common, and routinely used. Lumbosacral corsets may vary in rigidity based on the amount and type of metal stays included. Longer length corsets generally are used for more extensive spinal problems. A corset has vertical reinforcements or a rigid posterior plate, but no rigid horizontal bands. They are made of leather or canvas and contain elastic straps with Velcro fastening for a close fit, and available off the shelf in various sizes (28″ to 42″ waist circumference).

Conditions Used: Many painful low back conditions associated with:
- Osteoporosis
- Lumbar spondylosis
- Malignancy
- Bad posture
- Spondylolisthesis
- Lumbosacral strain
- Sciatica.

Figure 7.15: Lumbosacral belt

Uses: Reduces pain by avoiding movement and in reducing contraction of the erector spinae and consequently compression of intervertebral discs.

Sacral Orthosis

Sacral orthosis are the least restrictive spinal orthosis. They provide control of the pelvis as a supportive base for the rest of the spinal column. They are used in healing pelvic fractures, and relieving sacro-iliac pain (sacroiliitis).

Sacro-Iliac Corset

It is a prefabricated device that can be adjusted anteriorly, posteriorly or laterally with laces or hooks. Its superior borders lie at the level of the iliac crest. Inferiorly its anterior border lies 0.5 to 1 inch above the pubic symphysis and its posterior border extends to the gluteal fold.

This orthosis is thought to act by elevation of intra-abdominal pressure and stabilization of the sacro-iliac joint and pubic symphysis.

SPLINTS

Technically the term splint refers to a temporary device that is part of a treatment program.

Classification

- Static
- Dynamic.

Static Splints

Static splints have no moving parts, prevent motion and are used to rest or rigidly support the splinted part.

Uses: These are used to stretch joint contractures progressively or align specified joints after a surgical procedure for optimal healing. A static splint should never include joints other than those being treated and should be discontinued the moment its usefulness is over.

Disadvantages: Immobilization causes atrophy and stiffness.

Dynamic Splints

Dynamic splints are moving splints; their parts permit, control, or strengthen movement. The movement in a dynamic splint may be intrinsically powered by another body part or by electrical stimulation of the patient's muscles. Extrinsic power may be provided by elastic bands or pulleys.

Uses: Dynamic splints provide prehension and also static positioning of the hand in a functional position.

General Functions of Splinting

- To prevent undesirable movements
- To provide a functional position for the hand.
- To reduce pain
- To hold fractured bone ends in position until they are united.
- To maintain the position after reduction of a dislocation until the joint capsule is healed.
- To strengthen specific muscles.
- To promote grip and pinch.
- To diminish muscle spasm

TYPES OF STATIC SPLINTS

Aeroplane Splint (Fig. 7.16)

The Aeroplane splint maintains the shoulder in abduction and external rotation. It immobilizes shoulder and elbow joint. It consists of chest, arm, fore arm and wrist pieces joined to one another almost at right angles.

Indications

1. Erb's palsy. (Ref Chap 19)
2. Supraspinatus tendon rupture
3. Avulsion of the greater tuberosity of the humerus.
4. Tuberculous arthritis of the shoulder joint.
5. Paralysis of the deltoid muscle
6. Abduction fracture of the neck of the humerus.

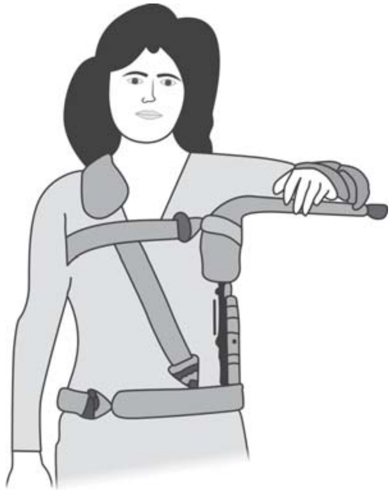


Figure 7.16: Airplane splint

Advantages and Disadvantages

- The advantages of this splint are that it keeps the shoulder joint in its optimal position and does not confine the patient to the bed.
- The disadvantages are that it is inconvenient to the patient and that it tends to slide down the torso.

Cock-up Splint

The cock-up splint immobilizes, or stabilizes the wrist in dorsiflexion with volar or dorsal support (Figs 7.17 and 7.18). It may be static or dynamic. It allows full metacarpophalangeal flexion and carpometacarpal motion of the thumb. The splint should be worn all the time except during exercise and bath

Indications: Wrist drop (radial nerve palsy) (Ref Chap 19), hemiplegia.

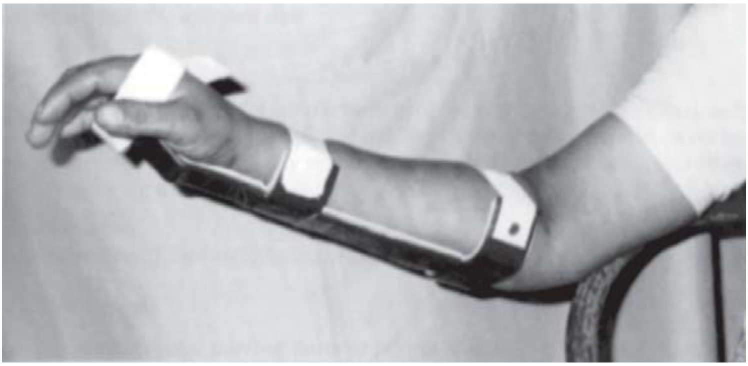


Figure 7.17: Static cock-up splint

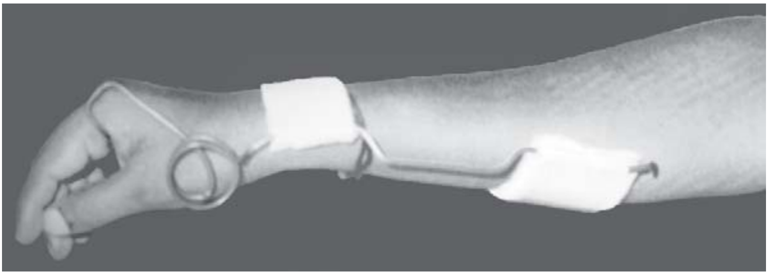


Figure 7.18: Dynamic cock-up splint

Knuckle Bender Splint (Fig. 7.19)

Maintains the metacarpophalangeal joint in 90° flexion and interphalangeal joint in extension.

Function

- Immobilization of fingers.
- It provides support and stabilizes the wrist in extension.
- It maintains the transverse palmar arch.
- It assists in prehension.

Indication

- Total claw hand in case of medial and ulnar nerve injury, as in Hansen's disease (ref Chap 19).
- Ulnar claw hand.

Hand Position: This splint comprises a light padded bar across the dorsal aspect of the proximal phalanges of the third and fourth fingers and a similar one over the upper end of the metacarpal. These are attached to another padded bar in the palm of hand by a small spring which pulls the metacarpophalangeal joints into flexion but allows the patient to extend them. The interphalangeal joints of fingers are placed in extension. This is a typical example of a splint using the 3-point principle.

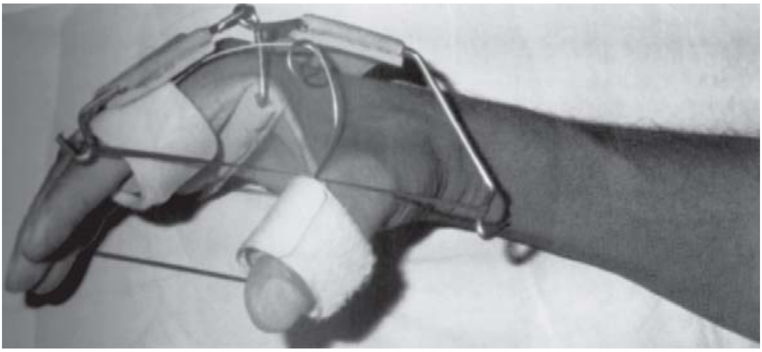


Figure 7.19: Knuckle bender splint

C-Splint

This splint maintains the thumb in abduction and partial rotation under the second metacarpal and supports it. It also stretches the first web space.

Indications
- Median nerve injury
- Contracture
- Burns.

OPPONENS SPLINTS (FIGS 7.20 AND 7.21)

Short Opponens Splint

The short opponens splint maintains thumb in abduction and partial rotation under the second metacarpal. The wrist and other fingers are free.

Functions
- Immobilization of the thumb
- Improves prehension by providing a stable position against which the fingers can pinch.
- Protects the joint from pain.
- Stretches the web space.

Indications
- Low median nerve injury.
- Opponens transfer (6 weeks after surgery postoperative splint).

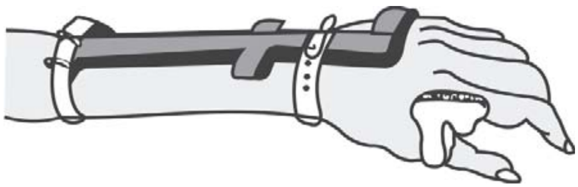


Figure 7.20: Wrist hand orthosis (Short opponens)

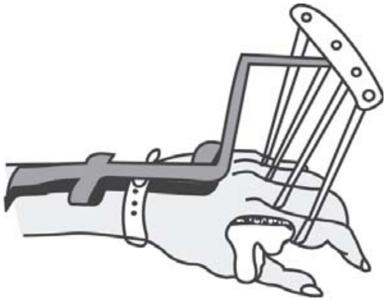


Figure 7.21: Wrist hand orthosis with dynamic MCP extension assist

Dorsal Long Opponens Splint

This splint holds the thumb in abduction and partial rotation under the second metacarpal, and in addition supports the wrist dorsally in a functional position. The wrist is in 20° to 30° of dorsiflexion, and the thumb is abducted and rotated under the 2nd metacarpal, with the metacarpophalangeal joint in 0 to 5° of flexion. The interphalangeal joint is free unless required to be held in extension. Other fingers are free.

Function: To immobilize and protect the thumb.

Indications
- Scaphoid fracture
- Bennet's fracture
- de Quervains tenosynovitis.

CONCLUSION

Orthoses have to be 'prescribed' like drugs or surgery, since very often they are not available off the shelf and have to be customized. Also judicious prescription of orthosis can actually prevent costly surgery and unpleasant deformities. It is the prime responsibility of the rehabilitation team to explain the reason why the orthosis is being prescribed, and the need for renewing the prescription, since they are often needed lifelong.

CHAPTER 8

Amputation and Prosthetics

INTRODUCTION

Amputation of a limb is one of the oldest surgical procedures practiced even in prehistoric times. History recounts tales of thousands of limbs lost in battle or removed after injury. With advances in anesthesia, blood transfusion and aseptic techniques, more and more lives have been saved, leaving more and more survivors but without limbs. The phenomenal increase in road traffic accidents all over world has also led to an exponential increase in the number of amputations.

Amputation is the severing of a part of the body in order to save the rest of the body.

Ferguson (1865) has said "**Amputation is one of the meanest and yet one of the greatest operations in surgery–mean when resorted to where better may be done, great as the only step to give comfort and prolonged life.**" Ambrose Pare' (1510 to 1590) was the surgeon who introduced amputation surgery and is therefore appropriately called the "Father of Amputation Surgery."

Restoration of the lost function of the limb has been the prime endeavour behind the design and fitting of prostheses.

CAUSES

Congenital

The case of the Thalidomide tragedy where several children were born without limbs, and just flipper like tags attached to the body, is well-known and documented. This gives them the appearance of a seal, which is why the condition is called phocomelia (phocos = seal).

Acquired

Trauma

- Failed revascularization surgery
- Knife and gun wounds
- Industrial and road traffic accidents
- Late problems after fractures, e.g. non union
- Burns which may be due to heat, electricity or chemicals. Electrical burns are a common cause of bilateral amputation, especially in electricity department workers, who handle live overhead wires with both hands by mistake.

Vascular: In Western countries this is a commoner cause for amputation

- Diabetes mellitus—predominantly by its effect on the blood vessels and non healing ulcers
- Frost bites and gangrene
- Intra-arterial injection (drug addicts)
- Arteriosclerosis
- Thromboangiitis obliterans (TAO)
- Arterial thrombosis, spasm or embolism

Infection

- Gas gangrene
- Actinomycosis
- Bites and other injuries
- Hansen's disease (auto amputation).
- Osteomyelitis

Neoplasm

- Primary tumors of bone or soft tissues, like osteosarcoma
- Post-irradiation problems like gangrene.

Iatrogenic

Arterial cannulization
(Diagnostic or therapeutic).

Neuropathic

Brachial plexus injuries.

GENERAL PRINCIPLES OF AMPUTATION SURGERY

Amputation surgery is no longer crude but a refined reconstructive procedure, to prepare the stump not only for its motor functions of locomotion but for even sensory feedback and cosmesis. Ideally, **the physiatrist is involved while planning an amputation surgery**, so that a suitable prosthesis can be fit early during the rehabilitation program.

In general, surgeons try to save as much length of the limb as possible while providing a residual limb that is able to tolerate the stress of the prosthesis and return to mobility. Sometimes, compromises are necessary between retaining maximum bone length and avoiding anything that may cause interference with prosthetic fitting. During the surgery, attention is paid not only to the bones but also to the muscles and nerves.

Types of Amputation

They may be classified according to the surgical technique or the emergency of the situation.

Some surgeons prefer to amputate provisionally and later definitively.

Provisional: Used when primary healing is unlikely or delayed because of infection, ischemia or inadequate wound debridement. It is done as an emergency procedure, to save the life of the patient.

Definitive: Used after provisional amputation as an elective surgery. In this amputation, the level is well-defined and thought out, with the ultimate prosthesis kept in mind.

According to the anatomical level: Depending on whether the amputation is through the joint or the bone, these may be classified as:
- Disarticulation: amputation through a joint or
- Through the shaft of a long bone.

Surgical Principles

There are two surgical procedures to managing the muscles during amputation: **myodesis and myoplasty.**

In **myodesis** (Fig. 8.1), the muscles and fasciae are sutured directly to the distal residual bone through drill holes. The muscles inserted function better, resulting in good prosthetic control. The procedure compromises blood supply to the muscles and hence is contraindicated in patients with severe peripheral

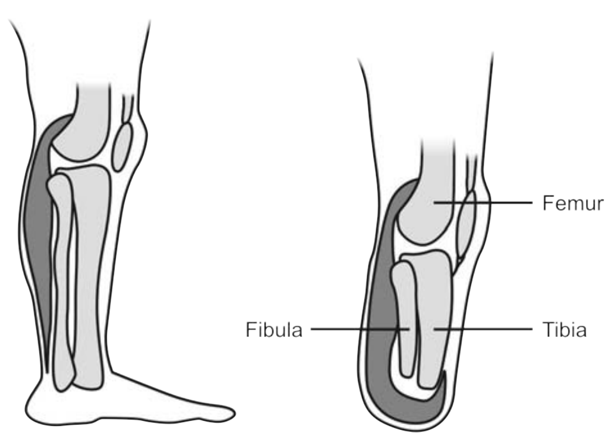


Figure 8.1: Level of the below knee amputation and myodesis

vascular disease. Sometimes myodesis fails even with the best of care.

Myoplasty, on the other hand, requires the surgeon to suture the opposing muscles in the residual limb **to each other** and to the **periosteum** or to the distal end of the cut bone. The muscles must be stretched just enough so that they control the residual limb. The muscles sutured to each other provide distal soft-tissue padding over the residual bone. Sometimes a painful bursa develops between the soft tissues and the underlying bone. Some of these bursae can become infected and painful.

Some of the principles of surgery are:

- The use of a tourniquet is advised to obtain a bloodless field—except in ischemic conditions.
- Level of amputation—efforts should be made to preserve all possible limb length, keeping in mind the prosthesis to be fit.
- Skin flaps—skin should be mobile, sensation intact, and with no adherent scars.
- Muscles are divided 3 to 5 cm distal to the level of bone resection.
- Nerves are gently pulled and cut cleanly so that they retract well proximal to the bone level. This reduces the complication of a neuroma.

Osteomyodesis: This is a procedure similar to myodesis but the periosteum is stripped. This enables bone growth in that area.

Complications of Amputation (Fig. 8.2)

- Failure of healing due either to wrong shaping of the flaps or inadequate blood supply.

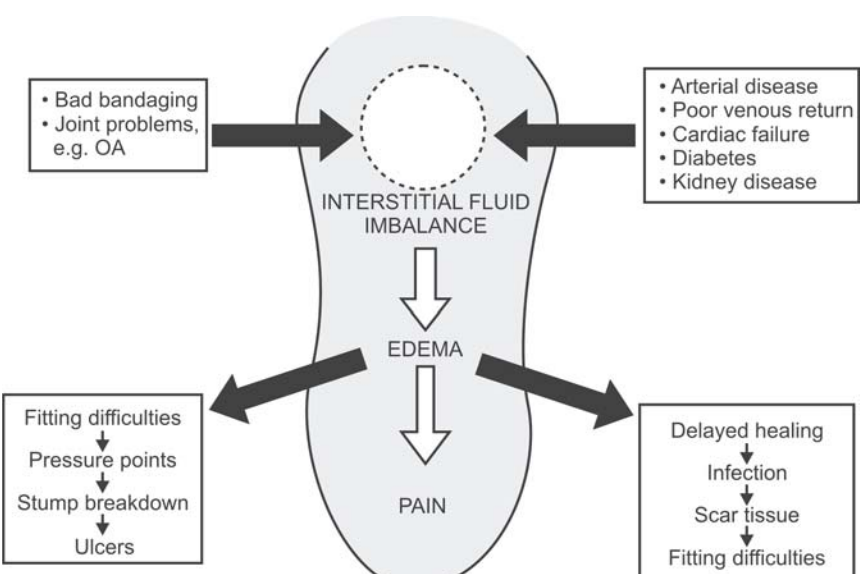


Figure 8.2: Complications delaying prosthetic fitting

- Recurrence of the disease, infection or neoplasm for which the amputation was performed.
- Painful neuroma.
- Phantom limb pain.

UPPER LIMB AMPUTATION

Upper extremity amputation is psychologically devastating, as it deprives the person from performing several activities, functional or recreational. Depending on the condition, upper limb prostheses are fitted to preserve functional ability wherever possible and maintain cosmesis.

Following surgery, the patient faces several problems in his daily activities. He has to use his normal contra lateral limb for all his activities, which may lead to over use syndromes in the soft tissues and joints. There is loss of acquired skills at work, at home and in recreational activities and he is seriously hampered by the lack of sensory feedback from his absent hand. He cannot use his hand for communication and all this added up leads to frustration and severe depression.

LEVELS OF AMPUTATION IN UPPER LIMB (FIG. 8.3)

Though the level of amputation is determined by the extent of the injury the surgeon may be able to influence the success of prosthetic fitting by careful

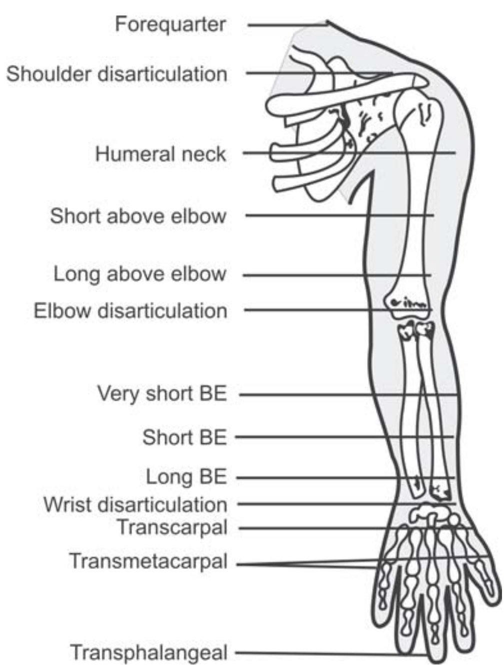


Figure 8.3: Levels of amputation in upper limb

technique and knowledge of prosthetic components available. Often it is difficult to select the level, as it has to be a compromise between saving as much of the limb as possible and stump viability, appropriate bone padding, and optimal prosthetic fitting.

Finger Amputation

The thumb is the "emperor" of all fingers and hand function without it would be very limited. So, as much length as possible in the thumb should be maintained. Compensations for loss of fingers vary according to their importance, and levels. It is thought that the index and middle contribute 20% each and the ring and little fingers 10% each to the function of the hand, but this obviously depends on the functions the hand is expected to perform.

Finger Ray Amputation

This is sometimes undertaken as an elective procedure consequent to a disability resulting from a previous injury to a digit. It is worth while to remember that the little finger is more important than the others for grasp and hook function.

Wrist Disarticulation

This is popular, since the operation conserves supination—pronation of the forearm. Fitting of a wrist unit however can make the prosthetic fitting unsuitable from the cosmetic point of view, since the prosthesis fitted on to the limb would make it appear longer owing to the length of the wrist unit.

Below Elbow (BE)

By and large the most common amputation, the BE amputation is 8 cm above the ulnar styloid or at least 10 cm below the elbow joint. A minimum length of 6 cm proximal to the wrist joint is required to install an adequate wrist unit allowing for interchange of the various terminal devices.

At this level 70% of pronation and supination is usually preserved, and decreases as the length of the stump decreases. When 60% or more of the forearm is lost, minimal rotation is possible. The longer the BE stump, the better the leverage for the prosthesis.

Elbow Disarticulation

This is an amputation through the elbow joint. It has some advantages and disadvantages; surgically it is considered more convenient because the blood loss, duration of the procedure is reduced. However, during prosthetic fitting it offers some problems.

Cosmesis is affected, since the overall length tends to be more and fitting an external elbow mechanism is difficult. The only saving grace is that it is a desirable alternative to transhumeral amputation.

Transhumeral Level (Above Elbow)

The preferred level is 6 cm above the elbow joint and at least 10 cm below the shoulder joint. However this measurement is quite arbitrary as the surgeon will have to make the decision based on several factors. The length of the stump is at 3 levels: long, medium and short

Among the AE amputations, the long arm residual limb (7-10 cm from the distal humeral condyle), is optimal for fitting the prosthesis. Many patients with medium and short residual stumps prefer a cosmetic terminal device.

Shoulder Disarticulation and Forequarter Amputation

This is an extensive operation where the entire limb is amputated, often-made necessary as part of the surgical intervention to remove a malignant lesion. Patients with these levels of amputation are the most difficult to fit with a functional prosthesis, and the outcome very poor in our country. Hence cosmetic hand and prosthesis is indicated. Of late, research has enabled some functions of daily living through a **bionic arm.**

In a 'bionic arm' nerves are surgically removed from the shoulder and rerouted to the muscles of the chest. This allows the user to move his or her prosthetic arm as if it were a real limb – by simply thinking about what he wants the arm to do, by activating the muscles of the chest. The user's own thought generates electrical signals from the muscles of the chest, carried through surface electrodes from the available pectoral muscle and carried through to the mechanical arm, causing it to move. There is also some sensory feedback, from sensors placed on the fingers of the arm, which detect pressure on the pads and which enables the person to modulate his grip on the object held.

BILATERAL UPPER LIMB AMPUTATION (FIG. 8.4)

The rehabilitation of such victims is difficult since the hand functions are so diverse and difficult to artificially duplicate. It is these patients who will benefit most from the myoelectric or bionic hands. The patient may have his upper extremities amputated below elbow, above elbow or a mixture of the two. One of the most common causes is electrical burn due to both hands coming into contact with a live wire or multiple fractures over the upper extremities which do not heal. Some bilateral amputees give a history of both hands being run over by a train. It is worthwhile to keep in mind that as much limb length should be preserved as possible, and in children, the epiphysis should be preserved to conserve bone growth. Sometimes a revision amputation may be required.

Krukenberg Procedure

This reconstructive procedure is performed in bilateral below elbow amputation on both stumps to convert them into partially functional organs, with

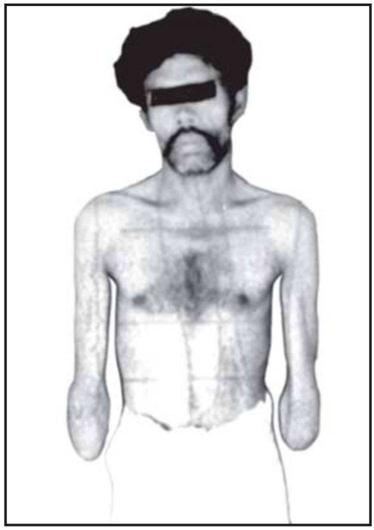


Figure 8.4: Bilateral below elbow amputation

a pincer grip thus making a bilateral hand amputee into a partially independent individual.

This is achieved by splitting the below elbow stump longitudinally at the interosseous membrane into radial and ulnar rays. The ends of the bone are separated and the skin deficit closed below the rays by the use of skin grafts. A crude pinching mechanism is provided after the operation. The advantage is sensation and prehension is preserved, though partially. All this is at the expense of cosmesis, as the resultant limb looks rather unsightly.

LOWER LIMB AMPUTATION

DISARTICULATION

Transpelvic Disarticulation (Hemipelvectomy)

This type of amputation is usually performed for malignancies like Ewing's Sarcoma, or severe trauma to the hip or pelvis, and is similar to hip disarticulation except that this surgical procedure includes removal of all or part of the ilium. In some cases, an internal hemipelvectomy can be performed. Finally the gluteus maximus is reflected with skin flaps and sutured to lateral or anterior abdominal muscles. People who have been operated in this fashion may not be able to use an artificial limb or may be able to walk only with the help of crutches. The elderly and infirm might have to use a wheelchair due to the high energy consumption for walking.

Hip Disarticulation

The entire hip is disarticulated and the limb removed. It is a surgical procedure usually performed either for malignancy of hip or thigh that is not treatable by other means or for severe trauma. On rare occasions it may be used to correct a severe congenital deformity. Closure without tension is allowed because all muscles have been removed except for the gluteal flap that cushions the impact of weight bearing.

Knee Disarticulation

This is a relatively less common amputation in adults. Although it provides a long muscular lever arm for prosthetic mobility, the bulbous end created by the femoral condyles leaves a cosmetically poor residual limb.

However it has advantages and is preferred by some surgeons.

In children, it is seen as an alternative to an above knee amputation, because the growth plate at the end of the femur is preserved. Cancer or trauma patients benefit with knee disarticulation when the tibia is affected while the femur remains intact with adequate soft tissue for padding. The thigh muscles are preserved, as is the femur, and weight is borne on the end of the stump. The surgical procedure too, is less traumatic and relatively easier to perform.

Syme's Amputation (Fig. 8.5)

Syme's amputation is performed at the distal level of tibia and fibula, proximal to the ankle joint, and passing through the dome of the ankle centrally. It includes ankle disarticulation, removal of malleoli, and anchoring the heel pad to the weight bearing surface. It is usually done when there is infection. It should not be done if there is no palpable posterior artery pulse. It provides a distal weight bearing stump which is however bulbous. It is done in a two

Figure 8.5: Symes amputation

stage procedure if the limb is infected or gangrenous, the first by ankle disarticulation and the second by resection of the malleoli flush with the joint surface. This is followed by fixation of the heel pad to residual bony stump, and revision of redundant skin. It is an end bearing stump for intermittent weight bearing but skin break down may occur if the prosthesis is used on a regular basis. The major disadvantage of the Syme's prosthesis is the bulbous end, which detracts from the cosmesis. This is because of the malleoli which can be shaved at the time of surgery. The Syme's prosthesis given for this amputation has a window to accommodate this bulbous end.

LEVELS OF AMPUTATION LOWER LIMB (FIG. 8.6)

When the limb is removed at the joint it is disarticulation, as given above, and the levels at which the amputation is done by cutting through the bone, are as follows:

Transfemoral (Above Knee) Amputation (Fig. 8.7)

During and after the world wars, the transfemoral level was the most common for amputation in individuals with impaired circulation and gangrene of the foot and toes. This level is still indicated if gangrene has extended to the knee or if the circulation is not enough to heal at the lower level. There is tremendous energy loss during ambulation with a transfemoral prosthesis as compared to a below knee prosthesis, hence with modern advances in surgical techniques if there is a chance to preserve most of the limb, it is better to amputate below knee than above.

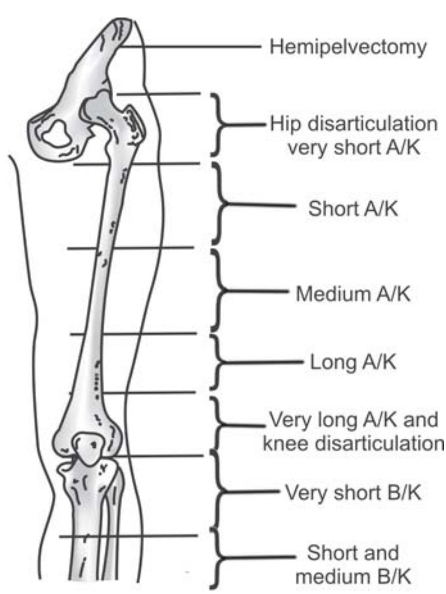


Figure 8.6: Levels of amputation lower limb

Figure 8.7: Above knee amputation (shows dog earing)

Below Knee (Transtibial or BK) Amputation (Fig. 8.8)

The BK amputation is the most common level of lower extremity amputation. However, the amount of remaining viable tissue and the vascular condition of the skin flaps determines the level, which optimally is about 15 centimetres from the knee joint. The tibial tubercle is the shortest level of transtibial amputation compatible with knee function. Most surgeons use a long posterior skin flap in which case the scar is seen on the anterior surface of the stump. The tibia and fibula are sectioned for proper shaping of the distal residual limb. Myoplasty is usually preferred over myodesis, and care is taken to see that there is no dog earing. Dog earing is a term given to the stump when

Figure 8.8: Below knee amputation

there is too much muscle and redundant tissue and flops down like the ears of a spaniel in the distal end of the stump and looks unsightly. When amputation is performed for other than vascular reasons, flaps of equal length are used and the resultant scar is at the distal end of the limb.

Amputations Through the Foot (Fig. 8.9)

Transmetatarsal Amputation: Transmetatarsal amputation is removal of the toes and distal ends of the metatarsals. It is a very functional amputation for problems with toes but requires a properly fitting prosthetic replacement.

Lisfranc amputation: This technique was used to treat gangrene from frostbite in cold countries. It consists of a partial amputation of the foot at the tarso-metatarsal joint, with the sole of the foot being preserved to make the flap. If the deformity is severe, a repeat amputation at a higher level may be required later. The dorsiflexors of the ankle are removed from their insertion and therefore there is a chance for an imbalanced ankle and an equinovarus deformity. The tendons of the tibialis anterior and the peroneus brevis in the distal part are reattached proximally to the neck of the talus and to the cuboid, respectively. The residual foot is misshapen and short, which does not go well with a good prosthetic fit. The prosthetic design should cover the ankle.

Amputation of the tarsals proximal to anterior tibial insertion is called **Choparts amputation**. It consists of disarticulation through the midtarsal

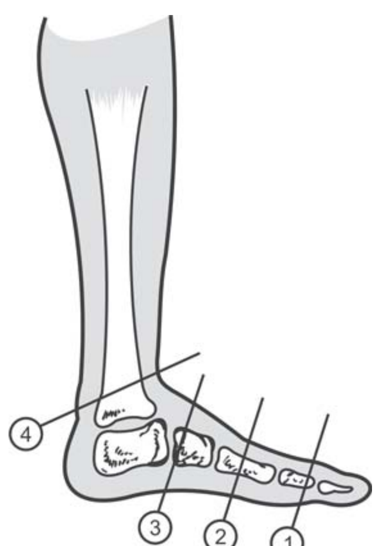


Figure 8.9: Levels of amputation in the foot (1) Disarticulation of toes, (2) Lisfranc's transmetatarsal amputation, (3) Chouparts transtarsal amputation, (4) Syme's amputation

joint. The forefoot and midfoot are removed, and the talus and calcaneus preserved. The peroneus brevis tendon is transferred to the cuboid and to prevent equinovarus deformity the tibialis anterior is transferred to the neck of the talus.

The stump is even more difficult to fit with partial foot prosthesis than the Lisfranc amputation. This is an unstable amputation, because the tendons around the ankle joint have been removed from their insertion into the foot. The heel has a tendency to go into equinus contracture and may need to be fitted with a prosthesis that extends up to the PTB level. As with all amputations of the foot, there will be some loss of normal arch of the foot

Boyd's amputation is amputation at the ankle with removal of the talus and fusion of the tibia and calcaneus.

Toe or ray amputations (Transphalangeal, digital amputations)

Toe amputations are generally indicated for localized demarcated gangrene of the distal end of the toe. An entire ray (toe plus metatarsal) must be removed, in some cases of congenital anomalies, gangrene secondary to frostbite, neoplasms or severe chronic infections of a metatarsal.

REHABILITATION OF LOWER LIMB AMPUTATIONS

The rehabilitation program can be divided into:
- The preoperative period.
- The postoperative period, which is in two stages, the preprosthetic stage and the prosthetic stage.

PREOPERATIVE PERIOD

Exercise management

- Breathing exercises to clear secretions in the lungs
- Strengthening exercises for shoulder extensors and adductors, elbow extensors and other crutch muscles, hip extensors, abductors and quadriceps.

POSTOPERATIVE PERIOD

Assessment of the Stump

The assessment of the stump is very important, since the patient expects a functional or cosmetic limb fitting (or both), and the following aspects need to be looked into especially for the lower extremity.
- Cause of the Amputation
  Associated diseases like diabetes and symptoms leading to neuropathy, visual disturbances, imbalance or incoordination, cardiopulmonary disease, renal failure, or congenital anomalies.

- Skin
  - Ulcer and trophic changes
  - Scar (is it healed, adherent, invaginated or flat)
  - Sensation (is it absent, diminished or increased)
  - Dermatological lesions (is there psoriasis, eczema, cysts, gangrenous changes)
- Increased bulk noted by measuring the circumference. Is there wasting or edema
- What is the residual limb length, bone length?
- Is the end of the stump bulbous, and dog eared?
- Shape (conical for below knee, quadrilateral for above knee)
- Vascularity (both limbs) Pulses (femoral, popliteal, dorsalis pedis, posterior tibial), to be taken on the unaffected limb also
- Pain (type, location and duration)
- Temperature
- Color (is it red, blue, black, or cyanotic)
- Range of motion of residual limb (remaining joints) of other lower extremity (for major joints)
- Muscle strength of major residual muscle groups operating the stump and other extremities
- Neurological—phantom sensation pain, neuroma, neuropathy, cognitive status (alert, oriented, confused), emotional status (acceptance, body image)
- Functional status, transfers (bed to chair, chair to toilet, wheelchair to car), Balance (sitting, standing reaching, moving), mobility at home and family situation, architectural barriers, activities of daily living (bathing, dressing).
- Others—post amputation status (work, activity level, degree of independence, lifestyle)
- The level of motivation of the patient. The desire for prosthesis, to walk, the anticipated activity level, and lifestyle, and presence of depression can be assessed by spending some time with the patient.

Preprosthetic Stage

The aim of treatment is to prevent postoperative complications like, deformities, decubitus contractures, stump oedema, and phantom pain. For the patient whose amputation was the result of diabetes or TAO, the preprosthetic phase can last longer, even 2 to 3 months. Since healing is delayed because of poor blood supply enhancing the patient's nutritional status and treating anemia will improve wound healing. In addition, the patient should be taught to handle the stump and knead the suture line, to reduce adhesions and desensitize the residual limb. Efforts are given to maintain:

- Strength of whole body and muscles controlling the stump
- Balance and transfers

- General mobility
- To re-educate walking and train crutch gaits
- To restore functional independence.

Exercises (Figs 8.10 and 8.11)

Mobilization for hip extension, knee flexion and extension since there is always the danger of the patient developing hip and knee flexor deformity.

Mobility in bed is brought about by bridging, moving up and down the bed, and rolling from prone to supine.

Transfers from bed to chair or wheelchair and back.

The patient may have a wheelchair supplied preoperatively. He must develop wheelchair mobility-develop the ability to stop, start, turn and control it.

Stabilization for the trunk in sitting and standing.

Isometric Exercise

These are given to the quadriceps in a below knee amputation, to the hip extensors and adductors in a high above knee amputation and to the extensors and abductors of the hip in a low AK amputation.

PREVENTION OF POSTOPERATIVE COMPLICATIONS

- Patient is placed in prone lying for as long as convenient
- ***Positioning in bed (Fig. 8.12):*** The stump should be parallel to the unaffected leg in the neutral position without resting on pillows. A hard

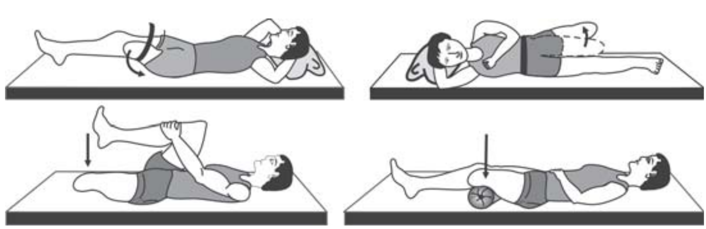


Figure 8.10: Exercises for above knee amputees—abduction at the hip and (bottom) extension of the hip

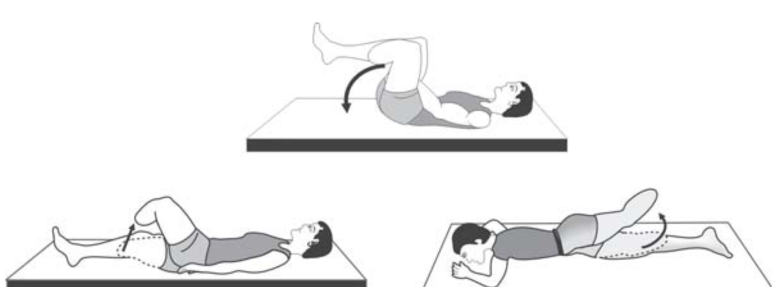


Figure 8.11: Exercises for below knee amputees

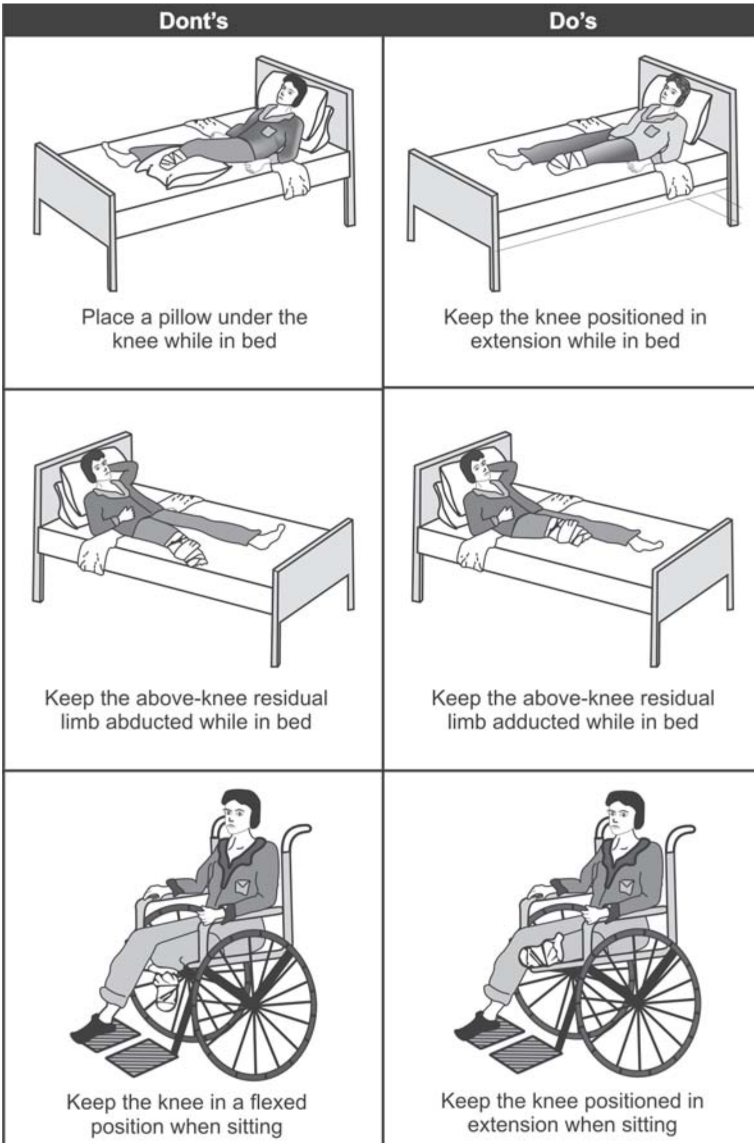


Figure 8.12: Do's and Dont's for below knee amputation

board placed under the amputated side will prevent a knee flexion contracture and reduce dependent edema. The patient should lie prone whenever possible. Those unable to lie prone should lie supine and keep the affected stump extended.

- The patient should be encouraged to handle the stump as much as possible as it helps to overcome the shock of realization that the leg has actually gone. Use of a compressive bandage will reduce edema and shape the residual limb in preparation of fitting a prosthesis. Imperative postoperative fitting (IPOF) of a temporary prosthesis will also help. Counseling is done to lessen the feeling of loss and deprivation. It is possible to motivate the patient, showing video clips of amputees running or climbing mountains

Control of stump edema: A swollen stump is slow to heal and will make fitting a prosthesis difficult as the socket becomes loose if there is too much edema. The stump exercises and stump hygiene will help to control edema. In addition the bed end should be elevated.

Functional independence: The patient is taught to move up and down the bed by pressing on the sole of the remaining leg. He is encouraged to dress each day, propel himself in a wheelchair, do resisted pulley work, and mat exercises (Fig. 8.12).

Stump Bandaging and Hygiene (Figs 8.13 and 8.14)

The skin on the stump is exposed to stress as it was not designed for weight-bearing nor the uneven pressures and friction against the skin. The stress is maximal near the brim of the prosthetic socket. The sockets (made of resin or plastic) accumulate sweat against the skin of the stump, and do not allow air from circulating around it to dry it. Rashes and abrasions can occur frequently in the warm, moist environment in India and if not attended to can lead to extensive skin lesions and ulcers. Often we see scratch marks on the stumps or near the contact areas, which can get infected. Of course all this can happen even if the socket measurement is correct.

Hence stump hygiene is essential.

The skin problems are:
- Ulcers
- Contact Dermatitis
- Cysts
- Folliculitis
- Fungal Infections
- Adherent scars

Care of the Stump

The stump is enclosed in the socket through out the day and tends to sweat a lot. This can be mopped up by wearing a sock which can have a cooling effect as well as providing shock absorbent padding for the stump. The stump sock needs to be changed every day, otherwise the stink is terrible. The patient is trained to wash the skin thoroughly with warm water and clean with mild soap. This is done generally before going to bed because if cleaning is done in the morning the damp skin can swell and stick to the inside of the socket. The stump is then washed with clean water, removing all soap. It is then dried thoroughly. A little talcum powder is sprayed.

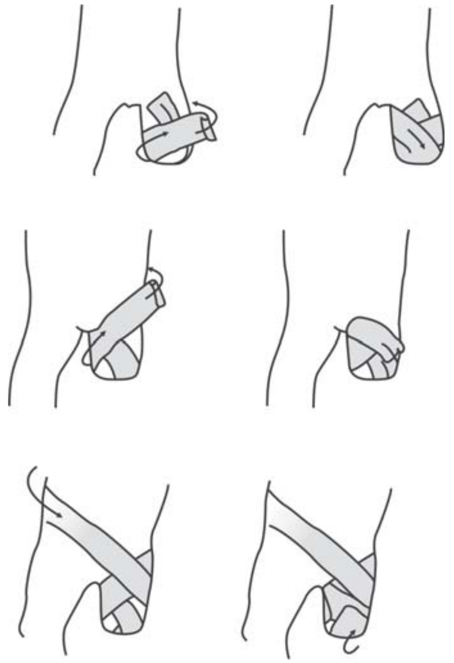


Figure 8.13: Stump bandaging (above knee)

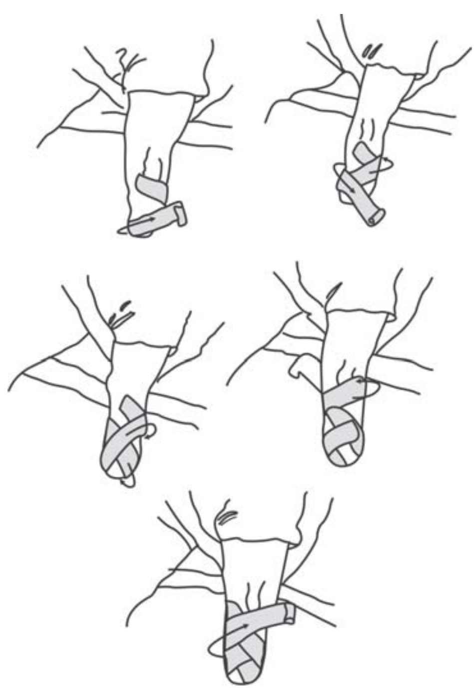


Figure 8.14: Stump bandaging (below knee)

PROSTHETICS

Prostheses are used to replace a missing limb and to restore or provide function. They are manufactured by a prosthetist and fit on a custom made basis on to the patient. The replacement must be as faithful as possible to the missing organ in terms of **function and cosmesis**. Ideally, prosthesis must perform its function, be easy to maintain, don and doff, be comfortable to wear, and it should preferably be light weight, durable, and cosmetic to look at.

The team member who fabricates the prosthesis in a workshop is called a prosthetist, upon the prescription by a physiatrist (Figs 8.15 and 8.16).

The upper limb has always posed a major challenge for prosthetics. Developments in external power to operate the artificial hand are the bane of modern upper extremity prostheses. Myoelectric prosthetic controls are now used fairly routinely for transhumeral and transradial amputations. However, they too have their own limitations. Many prosthetic joints are not powered and some of the movements of the normal joint such as flexing and extending of the knee during weight bearing are no longer possible. As a consequence, prosthetic walking in the above knee and hip disarticulated patient always involves an adapted form of gait.

Figures 8.15A to D: Steps involved in prosthetic fitting; (A) Prosthetic workshop; (B) Mounting the socket; (C) Finishing touches to the socket and (D) Alignment in standing *(For color version see Plate 1)*

Figure 8.16: Measurement taken for socket

However, for the lower limb, where the primary function is ambulation, prostheses have been very successful in functionally replacing the lost limb. Lower extremity prostheses include a foot, knee joint for transfemoral and higher levels, a socket, and a method of suspension.

There is a South African runner with bilateral amputation, who runs on custom made carbon fiber prostheses, giving him the nickname 'Blade runner'. He has set world records for Paralympics for the 100, 200 and 400 meters in timings less than gold medal Olympic timings set in earlier games (1906 and 1920). There is the instance of a quadruple amputee (one who has lost part or a major portion of all four limbs) who has taught himself many sports like sailing, swimming, running, skiing, snow-boarding, paragliding, caving, and even mountaineering!

Newer technology is now available. Hydraulic-based microprocessor-controlled knee systems provide several benefits over purely mechanical knee systems by improving upon the timing and reducing energy expenditure.

Considerations when choosing prosthesis

- Level
- Cause of amputation
- Shape of stump
- Expected function
- Motivation and cognitive function of the patient
- Vocation and hobby of the patient
- Cosmesis
- Financial resources of the patient

Outcomes

Level 0: The patient has minimal ability to walk or transfer safely. For these persons the prosthesis is not of much benefit.

Level 1: The patient walks on level ground without much change in pace. This applies to those confined to home.

Level 2: The patient has the ability to overcome some architectural barriers and moves around in the society, and quite freely at home.

Level 3: The patient is able to travel all over the community irrespective of barriers, achieving all functions.

Level 4: Athletes who perform above the normal demand from the prostheses, and are able to run, climb or swim.

CLASSIFICATION OF PROSTHESES

Prosthetic Construction Design

- Exoskeletal
- Endoskeletal.

Exoskeletal Prosthesis

An exoskeletal prosthesis gains its structural strength from the outer laminated shell, through which the weight of the body is transmitted. This shell was usually made of a resin socket, which is quite durable, over a filler material of wood or foam, and the whole prosthesis is shaped to provide a cosmetic appearance of the amputated limb. The opposite surviving leg is taken for reference for shape length and skin color. Of late other materials like high density poly ethylene are also being used. The prosthetic fitting should be very perfect; otherwise lack of alignment and adjustability would pose great problems.

Endoskeletal Prosthesis (Figs 8.17 and 8.18)

This is more modern in design. It gains its structural integrity from the inner endoskeleton—a pylon made of metal or carbon fibre, which is a light internal modular component to provide weight bearing. The cosmetic appearance is provided by shaped foam covers slipped over the modular components.

Advantages of this design include the ease of alignment of the components and their adjustments, and the ability to interchange components by removing the foam cover.

The **disadvantage** of this design is that the foam cover is not very durable, and needs to be replaced often.

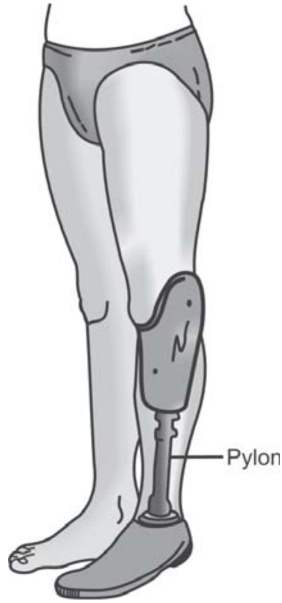


Figure 8.17: Endoskeletal below knee prosthesis

Figure 8.18: Endoskeletal prosthesis

Power System Used

The concept of power for operating the terminal device is more relevant to the upper limb, and may be derived internally from the body powered (conventional) or externally powered, like the myoelectric hand. Purely cosmetic hands, obviously, are not powered.

According to Materials Used

The socket is usually made of resin or plastics, which have the capacity of mouldability under certain conditions and later hardening to offer the necessary structural stability.

- *Wood* has several advantages; it is lightweight, strong and easy to work on. Earlier, willow wood was the most preferred wood, because of its durability and light weight (a property used to advantage by batsmen in cricket)
- *Plastics* increase strength and elasticity, but are unfortunately not biocompatible. Many, like polypropylene and polyethylene are durable, cheap and easy to mould.
- Fiber glass which is light in weight, but expensive.
- Carbon fiber material

COMPONENTS OF A PROSTHESIS

The basic components of prosthesis are:

- Socket made of plastic or resin
- Body of the prosthesis
- Harness/suspension system
- Control system (not relevant to lower limb prostheses)
- Terminal device. For the upper limb the terminal device is the hand and for the leg it is the foot.

Socket

The prosthetic socket must support the body weight and yet hold the stump firmly and comfortably during all times. Relief over pressure sensitive areas and socket convexity over pressure tolerant areas is provided. The movement between the socket and the skin must also be reduced. Its design varies with the level, size, shape, and contour of the stump.

Terminal Devices

The most significant component of the prosthesis is the terminal device, which provides function, cosmesis or both. The terminal device of the upper limb is the hand while for the lower limb, it is the foot. Some terminal devices are designed to resemble in appearance the natural hand or foot. They are called cosmetic devices. Others are designed solely for their functional use and bear no such resemblance.

Body of the Prosthesis

Used to be made of wood; nowadays exoskeletal prostheses use resin, high density poly ethylene, while endoskeletal prostheses bear weight through the pylon. Fiber glass and carbon fiber are also used these days. These custom made prostheses can absorb shocks and permit sports activities.

Suspension and Harness

Figure-of-eight harness suspends the upper limb prosthesis and controls the terminal device, while the Silesian band and suspension cuff are suspension systems for the lower limb prosthesis.

Cosmetic Components

Cosmetic components are those parts of a prosthesis, which are used solely to satisfy the psychological and cosmetic loss.

- They replace the soft tissues of the limb and give shape and contour
- The surface may be a simple flesh coloured glove, which resembles the human skin as closely as possible.

Cosmetic covers can be manufactured for a single digit, for the hand foot or elbow. They are colored to resemble the appearance of normal skin and may have superficial veins and even hairs.

UPPER LIMB PROSTHETICS (FIG. 8.19)

Plastic Laminate Socket

The socket is that part of the prosthesis into which the stump is inserted. There must be an intimate and comfortable fit between the socket and the stump. The socket of upper extremity prosthesis has a double wall framework made of resin, lightweight plastic or composite materials. The inner wall conforms to the stump and an outer wall provides length and contour to the forearm replacement. The wrist unit is fixed onto the distal end of the forearm piece.

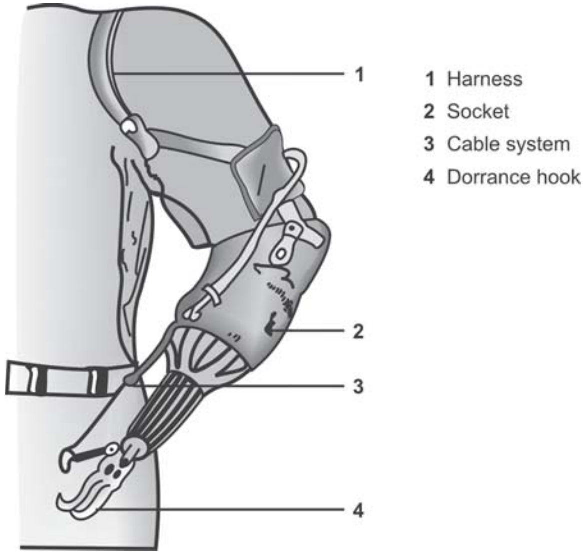


Figure 8.19: Below elbow prosthesis with voluntary opening Dorrance hook

The forearm socket is reinforced by strong plastic or resin so that it can be used by the above elbow and the below elbow amputee to carry objects like a handbag or packages or to push or pull large or heavy objects. Some sockets are single-walled and contoured to the stump as well as provide a forearm replacement.

Sometimes the stump is too short and gives problems during fitting. The **Muenster** type socket was devised mainly for this sort of BE stump to eliminate problems of fit, security and poor leverage. It consists of a single, double-walled forearm socket that extends just proximal to the olecranon process posteriorly and fits around the biceps tendon anteriorly. The socket is flexed at about 35° to increase stability.

Harness

The harness is attached directly to the socket. Its function is to:
- Provide stable support of the prosthesis.
- To provide attachment for the control cables.
- To help in controlling the terminal device and/or the elbow unit through the control cables.

Straps are formed in a figure of '8' pattern, or figure of '9' pattern, the latter generally used with the below elbow Muenster prosthesis.

Bowden Cable and Control Mechanism

The control mechanism may be body or externally powered to activate the terminal device or elbow. These movements of the shoulder and the upper part of the torso are specific and have to be taught to the patient when he is fitted with the prosthesis. The movements are transmitted by the Bowden's cable, which attaches to the elbow unit and terminal device. One of the movements of the shoulder lifts up the elbow unit. The forearm piece is locked in a particular position and the next movement opens the terminal device. These movements which operate the control mechanism through the cable need a fair amount of effort and power which is not available if the residual limb is short, painful and has limited motion or if the prosthetic socket does not fit well. They require intense practice and control before the prosthesis can be operated.

Control mechanisms are not needed for cosmetic terminal devices.

Elbow Units

In the treatment of AE (transhumeral amputation), prosthetic elbows providing reach to the midline of the body, are available with either external or internal joints. Mechanical elbows have a locking mechanism that is manually applied.

Wrist Units

The terminal device is connected to the forearm socket by the wrist unit. This unit allows interchange of cosmetic and functional terminal devices and rotation for the terminal device.

The type of prosthetic wrist most commonly used allows passive pronation and supination. Spring assisted rotation is available for the bilateral amputee.

Quick disconnect wrists permit rapid interchange of different terminal devices with the wrist unit. In addition, when it is locked, the quick disconnect wrist provides a secure control for wrist rotation. The tools of the trade in bimanual vocations, like stone breakers or grass cutters can be fit to the stump directly, and it is easier to relocate them back to their original professions. In the case of a stone breaker the chisel or the hammer can be fit to the wrist unit while the other normal hand continues with its function. In a poor country like India, it is difficult to train such skilled workers in any other profession, and even if one did, placing them in a new job is even more difficult.

TERMINAL DEVICES

The functional or mechanical hand can be attached to the wrist unit of most upper extremity prosthesis and is operated by cable control. It consists of a plastic, spring-controlled device with fingers that are controlled by the control cable of prosthesis. The thumb can be placed manually in either of two positions to grasp small objects or larger ones. Only the thumb index and middle finger participate in the pinch; known as the **3-jaw chuck pinch.**

Terminal devices are classified as:

- Cosmetic hands (discussed earlier)
- Body-powered hooks and hands
  - Voluntary opening (VO)
  - Voluntary closing (VC)
- Externally powered hooks and hands.
  Myoelectric
  - Digital
  - Bionic arm

Comparison between Terminal Devices is shown in the Table 8.1

Table 8.1: Comparison between Terminal Devices

Features	*Hooks (VO)*	*VC GRIP*	*Myoelectrically controlled hands*	*Hands VO*
Cosmesis	Considered poor; does not replicate a hand	Poor cosmesis	Cosmetically good	Cosmetically appealing
Pinch force	Depends on number of rubber bands	Depends on amount of force the individual can exert on the cable	Strong pinch; proportional control allows for variable pinch	Pinch force stronger than VO hook but less than myo-electric hands

(Contd...)

(Contd...)

Features	*Hooks (VO)*	*VC GRIP*	*Myoelectrically controlled hands*	*Hands VO*
			force up to about 25 lb	
Prehension pattern	Precise, fine pinch possible	Fine pinch possible	Cylindrical grasp rather than fine pinch	Cylindrical grasp identical to myoelectrical hand
Weight	Lighter in weight than hands	Heavier than VO hooks, but lighter than hands	Heaviest	Heavy
Durability	Very durable	Very durable	Less durable; glove is delicate; control systems may need servicing	Less durable; glove is delicate; spring mechanism may need repairs
Reliability	Little servicing needed	Little servicing needed	Most servicing needed	Needs more servicing than VO and VC TD but less than myoelectric

Dorrance Hooks (Fig. 8.20)

The voluntary opening (VO) device consists of two hooks which are maintained in the closed position by rubber bands or tension springs, and which are opened by the cable system. The tensility of the springs or bands determines the maximum prehensile force possible.

Voluntary closing (VC) system is just the opposite of the VO system. In this the hooks are wide apart and need to be closed manually by the patients movements transmitted through the cable system. The patient closes the device by "pulling" with the cable on the harness system to grasp an object and keeps

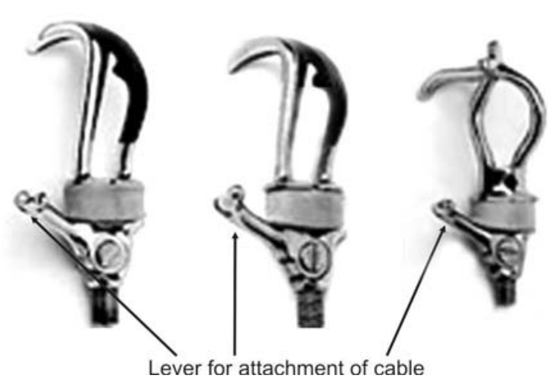


Figure 8.20: Dorrance hooks

up the gripping force as long as he wishes to hold it. It can be used to grasp brittle objects with just enough force that it does not break. However, the disadvantage is that the user will have to keep exerting pressure to retain his hold on the object. This is less popular than VO devices.

ABOVE ELBOW PROSTHESIS

The AE prosthesis (Figs 8.21 and 8.22) has an upper arm unit and a below elbow unit, connected to each other by an elbow joint. The upper arm unit

Figure 8.21: Above elbow prosthesis (with harness, cable and Dorrance hook)

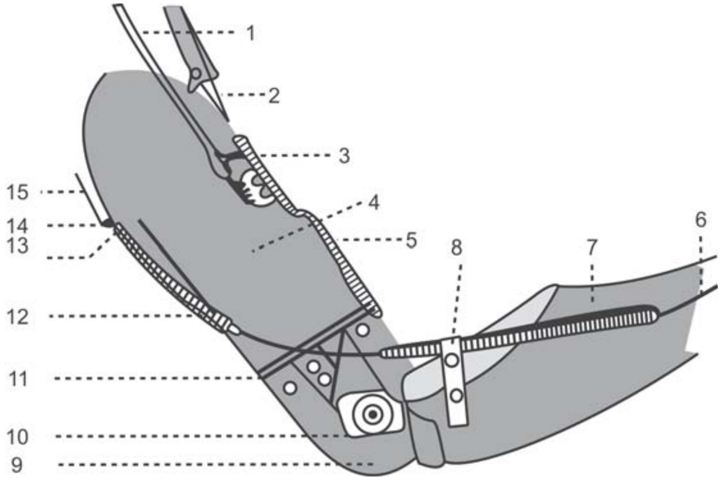


Figure 8.22: Above elbow prosthesis (1) Elbow lock strap, (2) Cable for elbow lock, (3) Elastic suspension, (4) Upper arm double walled socket, (5) Cable housing, (6) Cable to terminal device, (7) Single wall forearm socket, (8) Forearm level loop, (9) Locking elbow unit, (10) Rigid elbow hinge, (11) Turntable for internal and external rotation, (12) Cable housing, (13) Base plate, (14) Retainer, and (15) Cable to control attachment strap

of the above elbow prosthesis has a double-walled socket with a locking elbow unit laminated on to the socket. Since the above elbow amputee lacks independent elbow flexion and extension, these are provided mechanically by an elbow joint which is activated, locked and unlocked by the cable control system. This cable control system is called the **Bowden dual control** cable system, because it controls movement of both elbow and terminal device (hook or hand).

A turntable between the elbow unit and the upper arm socket is provided which can be manually rotated internally and externally. Stump socks are worn by the amputee to absorb perspiration, provide warmth and to enhance comfort and fit of the socket.

Prescription of an AE prosthesis should be done with care, since a unilateral AE amputee manages several of his ADL activities with the residual normal limb, and training in the use of the prosthesis is an arduous task. Hence, v**ery often a unilateral AE amputee chooses to use a cosmetic hand, without function.**

BELOW ELBOW PROSTHESIS

The components are the same except that the elbow unit and the dual control cable are absent. **The cable system is used in this case only to operate the mechanical terminal device and not the elbow unit, because the anatomical elbow is present.** Use of the BE prosthesis is more convenient since the normal elbow joint is present, and many quick change terminal devices for bimanual activities can be used, for example a screwdriver, sickle or knife.

MYOELECTRIC PROSTHESIS

A **myoelectric prosthesis** uses signals or potentials from muscles through electromyography, within a persons stump. The signals are picked up by electrodes on the surface of the skin which activates a battery-driven motor that operates a prosthetic component, like the finger. Control of the motor regulates the extent or speed of the prosthesis, such as elbow flexion or extension, or opening and closing of the fingers of the terminal device (Figs 8.23 and 8.24).

Advantages

- Use of natural muscle stimuli.
- More accurate control with less energy expenditure.
- Eliminates the shoulder harness.
- Decreased body movement to control prosthesis.

The myoelectric prosthesis provides more mobility, pinch force, and cosmetic appearance than body powered prostheses.

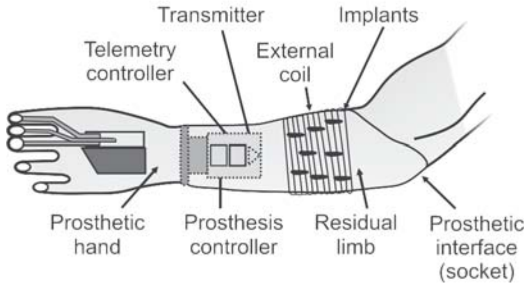


Figure 8.23: Internal components of the myoelectric hand

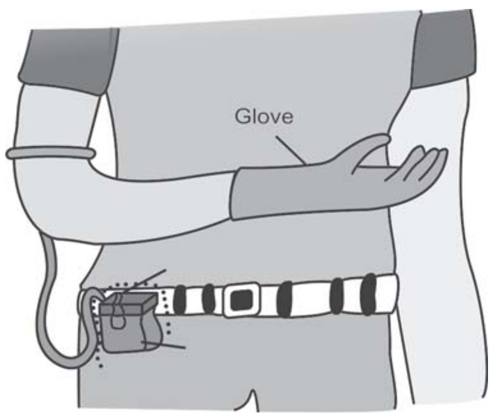


Figure 8.24: Myoelectric prosthesis

Disadvantages

- They are very expensive
- In the event of a breakdown, it needs very skilled technical backup to repair. Also they need servicing on a regular basis
- Component operation is noisy and slow.
- The energy source is from a battery, which would have to be recharged regularly.
- Lack of proprioceptive feedback as from the harness in body powered systems.
- It is heavy.
- It cannot control fine rhythmic and fast movements.
- There is poor control of co-contracting muscles and poor motor control. Myoelectric components get dysfunctional in water or around magnetic or electronic fields.
- The cosmetic/protective gloves get dirty very easily

OCCUPATIONAL THERAPY IN PROSTHETIC FITTING (FIGS 8.25 AND 8.26)

General Goals

- Independence in self-care activities
- Return to the former job or train for a different job.
- Return to hobbies and recreation.

The occupational therapist gives priorities to the patient in:

- Developing level of performance to the maximal potential, which is challenging in bilateral amputation.
- Using the prosthesis only as an aid in bimanual activities, when the amputation is unilateral.

First Therapy Session

First, the patient is guided on:

- When and how to wear it.
- Donning and removing it
- Stump hygiene
- Care of the prosthesis.

Later he is given prosthetic controls training and muscle strengthening

Exercises for the Upper Limb Amputee

Full AROM is maintained in all remaining joints of the upper limbs to ensure good control over the prosthesis. All bilateral upper limb amputees need maximum flexibility and range of motion of the trunk and lower limbs. For the shoulder disarticulation amputee, the only movement available is scapular. The therapist works with the above elbow amputee in diagonal planes, strengthening the muscles by varying the amount of resistance, and improves function. Isometric exercises are also given to maintain muscle bulk and ensure that the limb does not pop out of the socket. The above elbow amputee needs to strengthen external rotators and biceps to prevent the prostheses from slipping or rotating during shoulder flexion and abduction. The same applies to BE amputees where the muscles of supination and pronation are effective stabilizers.

In general the muscles to be strengthened are those of:

- Chest expansion
- Shoulder depression, flexion, extension and abduction
- Elbow flexion and extension.

Functional Training with the Prosthesis

Controls Training: Patients with an above elbow prosthesis must learn elbow activation as well as use of the terminal device with the help of the dual control cable system. They must be trained in the use of the turntable and shoulder joints.

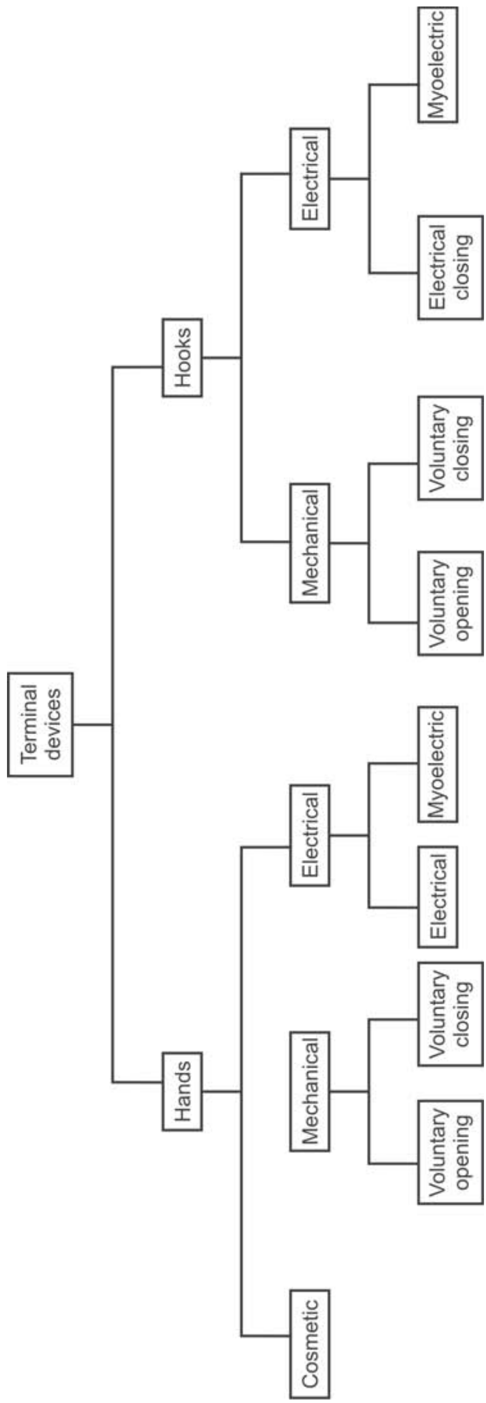
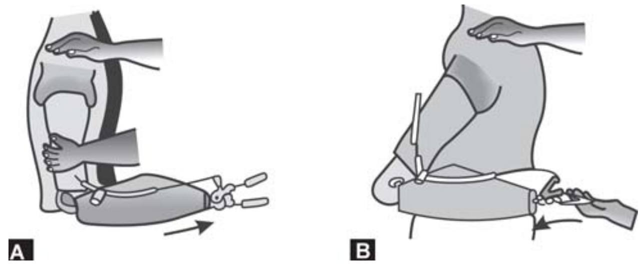


Figure 8.25: Classification of terminal devices



Figures 8.26A and B: (A) Teaching activation of voluntary opening TD, when the elbow is locked the therapist pulls the patients upper arm forward (arrow) to open the TD, and (B) Teaching activation of elbow lock the therapist pushes the patients arm (arrow) into extension to lock or unlock the elbow

Practice in Control Requires

- Coaching the patient in patterns of reach, grasp and release for objects that vary in weight, size texture and configuration. Ordinarily the sequence is from "larger and hard objects to smaller and fragile ones.", like holding a plate and later holding a pencil.
- Functional activities:

Given below are some activities, which need training with the prosthesis in unilateral upper extremity amputation

Activity	*Prosthesis*	*Sound Limb*
Dining table		
1. Cut	Hold fork	Cut with knife
2. Butter bread	Stabilize bread	Spread butter
3. Fill glass from tap	Hold glass	Turn tap on
4. Peel orange	Stabilize orange	Peel
5. Carry tray	Hold side of tray with Terminal device in mid position	Hold opposite side of tray
6. Open carton	Stabilize carton	Open
Desk skills		
1. Write	Stabilize ruler/paper	Write/turn pages
2. Put letter in envelope	Hold paper envelope	Open side of envelope. Insert letter and seal.
3. Draw line with ruler	Stabilize ruler	Draw line
4. Use paper clip	Hold paper	Apply clip
5. Use phone	Hold receiver	Dial number
General skills		
1. Take money from wallet	Hold wallet	Remove money
2. Use key in lock	Grasp lock	Insert and turn key
3. Light match from book of matches	Hold book with cover closed	Remove match and strike

Sports and Recreation

Interest in customizing prostheses for sports and recreation is much more developed recently. Modification of terminal devices is being increasingly done to enable the patient to go back to the occupation of his choice, or the one he is skilled at.

The training program of the child amputee must involve activities natural to the child's level of development. The most successful method of teaching a child prosthetic function is through play. Hence incorporate all activities with the prostheses with games and activities interesting to an inquisitive child. One could make him hold a cricket bat or bowl a couple of times with a small ball to make him interested.

CONCLUSION

Fitting an upper limb amputee with prosthesis is a time consuming process. The patient must also be involved in the decision making process so that he can choose the limb that suits him best.

It must be explained to the patient that mere assembling and fitting prosthesis cannot replace the multifarious activities that a hand can perform. Indeed, it would not be out of place to mention the limitations of the prosthesis so that the expectations of the client would not be too high.

PROSTHESIS FOR THE LOWER EXTREMITY

Disability limitation is very good for the lower extremity amputee; inevitably he or she can be assured of an independent gait, whatever the level of the amputation, because a lot of technological advances have been made in the field.

Socket Construction

Sockets are individually constructed for each client from a cast of the client's residual limb. The prosthetist notes the individual characteristics of the residual limb, takes measurements of both the residual limb and the other normal limb, and makes a cast of the residual limb with Plaster of Paris. Later the mould is filled with plaster of paris powder and a positive model is made from the case. The prosthetist modifies the model to improve pressure distribution and socket fit with computer aided design and manufacturing techniques (CAD/CAM). In this a computerized digital representation of the amputated limb is obtained. Then follows the process called rectification in which software is used to modify the digital shape from an exact mold of the amputated limb, to the shape of a functioning prosthetic socket. This is done by introducing troughs or indents on regions that can tolerate more weight and relief in regions that cannot. Once the design is ready, a CAM or computer aided manufacturing unit which need not be attached to the prosthetic lab can be used to fabricate the socket.

In advanced methods, the prosthetist uses an electronic scanner to determine the shape of the amputation limb, and then fits a test socket to ensure comfort, to provide for appropriate weight bearing and to stabilize pressures.

The prosthetist may also construct the socket moulding plastic directly over the positive model of the residual limb. This plastic HDPE is made soft by heating in a hot air oven prior to moulding. Then the socket is connected to the appropriate component, and then a static alignment with the client standing is performed. Depending on the client's ability to walk, dynamic alignment may also be performed at the same time.

Sockets may be end bearing or proximal weight bearing. Examples of proximal weight bearing prosthesis are the PTB below knee prosthesis and the ischial weight bearing above knee prosthesis, while examples of end bearing prosthesis are the knee disarticulation and Symes prosthesis.

Body of the Prosthesis

The emphasis is on stability, weight bearing and light weight of the limb. In exoskeletal prostheses, resin, HDPE and willow wood are used, while metal alloy pylons are used in endoskeletal prostheses.

THE FOOT

The prosthetic foot should ideally:
- Perform plantar flexion and dorsiflexion, inversion and eversion.
- Simulate muscle activity. The prosthetic foot substitutes for muscle action primarily through stance phase stability and passive dorsiflexion in swing phase.
- Absorb shock.
- Provide a stable base of support during the stance phase of gait.

Nondynamic Response Feet

Solid Ankle Cushion Heel (Fig. 8.27)

The solid ankle cushion heel (SACH) foot is a nonarticulated device with a solid wood or aluminium heel, a sponge rubber heel wedge, and a moulded

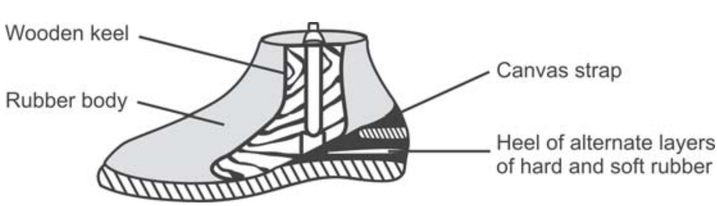


Figure 8.27: SACH (Solid Ankle Cushion Heel) foot

cosmetic forefoot with or without individual toes. Mild hyperextension of the rubber toe and forefoot is possible in late stance and push off.

Jaipur Foot

The SACH foot has disadvantages that it has to be used only with shoes since the shapes of the toes are not discernible. In India, where barefoot walking is prevalent in villages, together with the practice of not wearing shoes inside the homes and temples, it was but natural that there was a need for a cheap alternative to the SACH foot which would also be cosmetic. It was developed at SMS Medical College, Jaipur by Prof PK Sethi and team. It provides bare foot walking. The foot and ankle assembly is made of uncured rubber material.

Advantages

- Cosmetically well-accepted in the rural population who prefer barefoot ambulation.
- The elasticity of the rubber provides enough dorsiflexion to permit an amputee to squat, transverse rotation of the foot on the leg to facilitate walking and cross- legged sitting, and sufficient range of inversion - eversion to allow the foot to adapt itself while walking on uneven surfaces.
- Exterior is made of a waterproof durable material, for work in fields
- Less expensive
- The raw material is locally available.

Dynamic Response (Energy Conserving) Feet

Dynamic response feet were developed initially for amputees who wanted to be active and perform such activities as running and jumping. The feet have toe springs or flexible heels that increases shock absorption and push off. They store and return energy when walking, giving a sense of "push off," achieved by the arch of the human foot

There are many other dynamic response feet that use a variety of carbon graphite, plastic, and other materials. These are comfortable and enable the wearer to try out more athletic activities.

Multiaxis Feet

Single axis feet allow movement of the foot in one axis, up and down. Multi-axis feet differ from single-axis feet, in that they move up and down as well as side to side to conform to uneven surfaces better than single-axis feet. While SACH feet have solid ankles multi axis feet have ankle motion, which absorbs the stress of walking, reducing wear and tear on the prosthesis.

SYME’S PROSTHESIS (FIG. 8.28)

Syme’s amputation provides a weight-bearing surface at the distal end, the heel, along the shaft of the tibia. A window is cut along the medial wall of the socket to allow the bulbous end, created by the tibial condyles, to slide down to the end bearing part of the prosthetic foot. The window is covered by a panel that fits snugly into the opening and is secured by two straps. The standard Syme prosthesis is functional but not very cosmetic because of its thick distal end and straps. The medial window also reduces the mechanical strength of the prosthesis. The design is exoskeletal, but the weight is born distally.

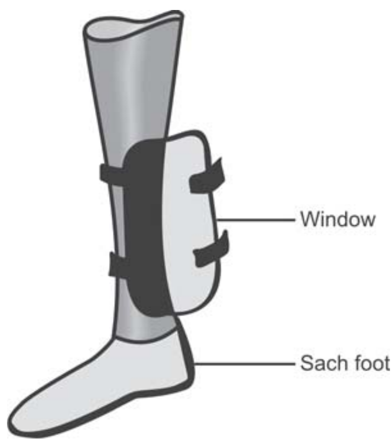


Figure 8.28: Syme’s prosthesis

The closed, expandable socket Syme prosthesis was developed for modified Syme amputation. The smaller distal end created by shaving the malleoli eliminates the need for a window.

Types of Syme’s Prosthesis

- ***Conventional Syme’s Prosthesis:*** It provides full weight bearing on the distal end of the stump. An amputee can walk even without prosthesis in case of emergency like going to toilet in the night. However for a female, it is cosmetically not acceptable since it is bulky.
- ***PTB Syme’s Prosthesis:*** When the heel pad is not sufficient or in cases of sensory impairment at the end of the stump, then partial weight is taken on the patellar tendon as in a conventional PTB socket [see below]. The method of fabrication, alignment and fitting, etc. is also as of PTB prosthesis. The suspension of PTB Syme prosthesis is by a cuff, as in PTB prosthesis.

CONVENTIONAL BELOW KNEE PROSTHESIS FOR TRANSTIBIAL AMPUTATIONS

PTB Socket

The prosthesis is sometimes called PTB prosthesis (Fig. 8.29) after the special socket of the same name. The patellar tendon bearing (PTB) socket is the standard transtibial socket. It is a laminated plastic socket. The body weight has to be taken on the patellar tendon, an area which can stand pressure. A part of the weight is borne over the condylar flares and the distal end of the residual limb. Stabilization is provided by moulding the socket over the relatively flat flares of the proximal tibia and the shaft of the fibula, if it is long enough. Areas of relief from pressure include the head of the fibula, the distal ends of both the tibia and the fibula, and the shin.

The proximal posterior wall of the socket bulges posteriorly to allow for the muscle bulk. The level of this wall must be low enough to allow the client to sit with the knee flexed at least 90° degrees, yet high enough to prevent undue bulging of flesh over the brim. The proximal edge is rounded to prevent sharp pressure on the back of the knee; grooves are provided at the medial and lateral corners for the hamstring tendons. The anterior wall reaches to midpatellar level and has a shelf that corresponds to and shifts the weight on the patellar tendon. The medial and lateral walls reach approximately to the level of the adductor tubercle.

Liners

Most PTB prostheses are constructed with a soft-liner made of polyethylene foam or silicone gel that acts an interface between the residual limb and the hard socket. The liner absorbs some of the compressive and shear forces generated during ambulation, thus cushioning and protecting the stump; however, it may wear out over time, and will have to be replaced.

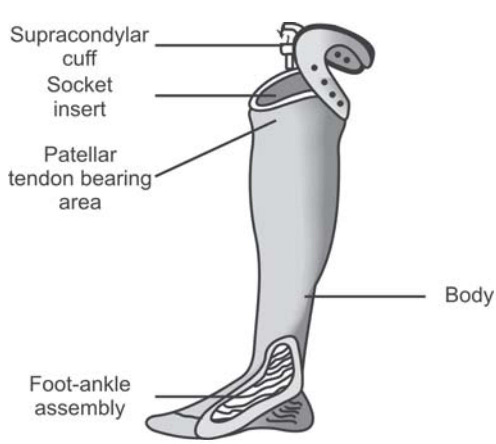


Figure 8.29: Patellar tendon bearing (PTB) prosthesis

Supracondylar Cuff

The Supracondylar cuff is a leather fastening system that holds the prosthesis in position attaching itself by buckles to the distal thigh. It is attached to the proximal part of the socket in the posteromedial and posterolateral aspect.

Advantages
- Relatively cheap
- Easy to don and doff.
- Allows normal knee movement
- Durable and easily replaceable.
- Provides auxiliary suspension

Disadvantages
- No mediolateral knee stability.
- May interfere with circulation and pinch the distal thigh in obese clients.

ABOVE KNEE PROSTHESIS FOR TRANSFEMORAL AMPUTATION

The Quadrilateral Socket (Figs 8.30 and 8.31)

It was developed in the late 1950s and is named for its four walls that have a specific function. Distally, the socket is contoured to provide total contact for the residual limb.

The Posterior Wall: Most of the weight is borne along the posterior wall. The ischial tuberosity and some gluteal muscles rest on top of the wall, which is

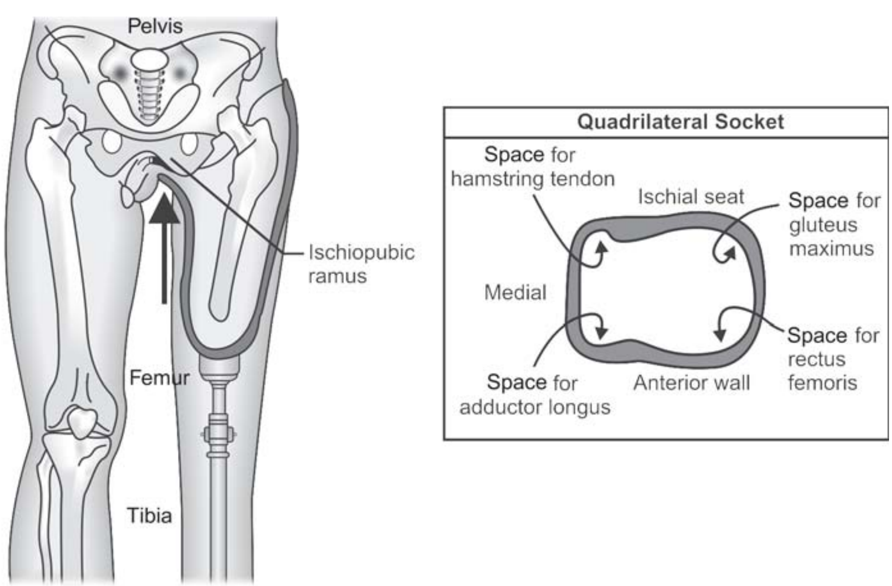


Figure 8.30: The socket in above knee prosthesis

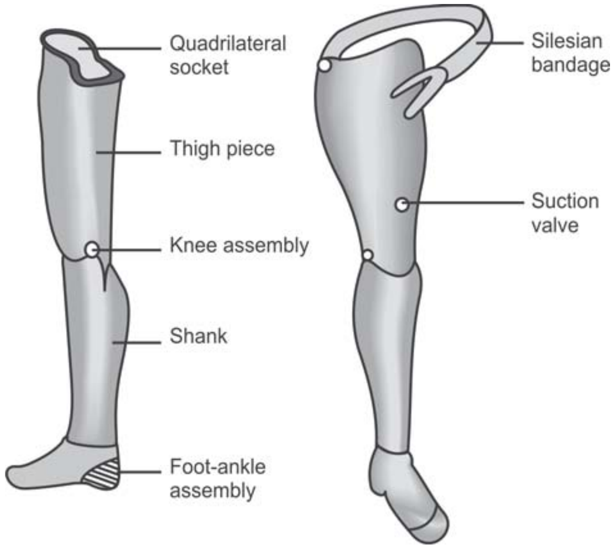


Figure 8.31: AK (above knee) prosthesis

thicker medially than laterally. Internally, the wall is contoured for the hamstring muscles, while externally, it is flat to prevent rolling of the thigh in sitting. The height of the posterior wall is determined by the position of the ischial tuberosity.

The Anterior Wall: It rises about 5 centimetres above the height of the posterior wall. It is convex laterally to allow space for the bulk of the rectus femoris muscle.

The Lateral Wall: The lateral wall is as high as the anterior wall. Inside, the wall inclines medially to set the residual limb in about 10° of adduction. The lateral wall is contoured to distribute pressure evenly over that side, and bear some of the weight.

The Medial Wall: Is vertical and prevents medial movement of the residual limb within the socket, especially during stance. A relief channel is built into the corner of the medial and anterior walls for the adductor longus tendon. The medial wall and the posterior wall are of the same height. Hitching on the pubic ramus, which causes a lot of irritation, is avoided by lowering the medial wall.

Other Sockets

The Ischial Containment Socket: The ischium and the ascending ramus are enclosed within the socket, used for short transfemoral amputation and weight-bearing forces are distributed through the medial aspect of the ischium and the ramus as well as surrounding soft tissue. The lateral wall is extended well over the greater trochanter to add to stance phase stability of the pelvis. The socket is contoured for total contact throughout and is reported to be comfortable.

Flexible Sockets: Flexible sockets incorporate a malleable thermoplastic socket supported in a rigid or semi-rigid frame. They are best used for individuals with mature residual limbs of optimum length and reported to provide better proprioception, suspension and comfort.

The suction socket is worn with the limb in direct contact with the socket without a sock. The process of donning the socket pushes all the air out of the valve hole at the medial distal end of the socket, which prevents air from re-entering the socket. Negative pressure within the socket along with muscle tension helps to retain the socket on the limb.

It is difficult to maintain adequate suspension with suction alone if the limb size fluctuates or is perspiring. Sometimes an auxiliary suspension is needed.

Suspension Mechanisms

Silesian Band: The Silesian band is a soft strap of leather that is attached to the lateral socket wall, encircles the pelvis, and connects with a strap on the anterior wall. The Silesian band aids suspension and provides some control of rotation.

Pelvic Belt: The pelvic belt provides some mediolateral stability in patients whose weight fluctuates widely. It is made of metal and leather and encircles the pelvis. There is a hip joint which connects it to the superolateral aspect of the socket. It is useful for individuals with weakness on the glutei or with hip disarticulation or very short AK stumps.

Knee Joints (Fig. 8.32)

The knee joint is aligned in the prosthesis with the client's knee in extension. The best knee mechanism is one that offers adequate stability in stance phase, yet requires the least amount of alignment. In some cases, if the knee mechanism does not fully extend before heel contact, it buckles causing the prosthetic knee to flex suddenly when weight is applied.

The term **stance phase control** refers to the degree of stability when standing on the prosthesis. It is most important during single limb support when standing on the prosthetic limb. An inter play of forces and alignments between knee mechanism and the foot designing decides the stance phase control of most conventional A/K prostheses.

Knee mechanisms can be classified into:

- Constant friction
- Stance control
- Polycentric knee

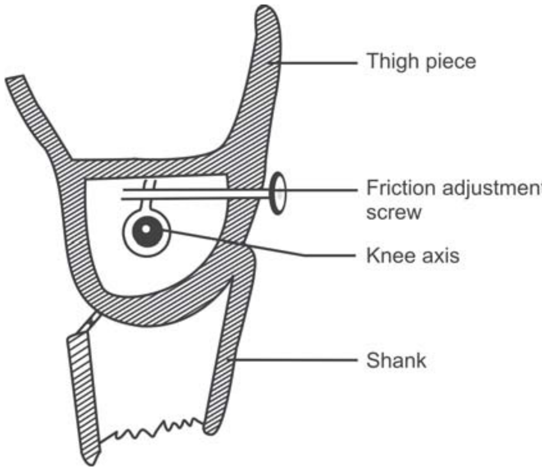


Figure 8.32: Constant friction knee joints

- Manual locking (rare)
- Fluid controlled.

For the foot to be in proper position for heel contact, the knee mechanism must exert some control over the rate of knee movement in swing phase. This is referred to as **swing phase control**.

Multiaxis knee joints are usually four bar linkage systems. They are polycentric axis knees. They are complex and are used primarily for knee disarticulation prostheses. The knee axes keep changing as the person walks. This gives some swing phase control by allowing for better toe clearance. They also offer some stance phase control by varying stability through the different axes. Multiaxis systems allow knee flexion to 130°-150°. Turn tables and torque mechanisms exist that allow the individual wearing a transfemoral limb to even sit cross-legged, something that is done often in India. Pneumatic control knee mechanisms use an air filled cylinder embedded within the upper part of the shank to provide variable swing phase control.

The manual lock knee provides absolute stance phase control as the knee remains locked and stiff in extension throughout the gait cycle. They are occasionally used for individuals with bilateral amputations or those occupations that may require considerable standing in one place, like traffic policemen.

PROSTHESIS FOR HIP DISARTICULATION/TRANSPELVIC AMPUTATION

The prosthesis for both hip disarticulation and trans pelvic amputation is similar in components and alignments, except in the socket design. Rejection rate of this prosthesis is high, as the cadence is slow and requires great energy. Wearers find the prosthesis heavy and uncomfortable.

Sockets

The **hip disarticulation socket** is made of plastic, encloses the ischial tuberosity for weight bearing and covers the iliac crest for stability in swing phase. It encircles the pelvis with an anterior slit to allow ease for wearing and removing. The medial aspect is cut to provide clearance for the other leg and genitalia. Relief is provided over the anterior and posterior iliac spine.

The **transpelvic socket** is similar except that it must include the contralateral iliac crest for proper stabilization and suspension. Weight bearing is primarily on the remaining soft tissue and the contralateral ischium. Care must be taken when constructing both sockets so that no excess pressure exists on a bony prominence or in the perineum.

Both hip disarticulation and transpelvic sockets are made of plastic which may be rigid or flexible and padded for increased comfort. Recently flexible silicone rubber sockets in rigid frames have been developed. This socket provides a softer, more intimate fit that increases range of motion and comfort.

Any knee joint can be used in the hip disarticulation prosthesis. The constant friction knee is probably more popular because of its lightweight and lower cost. Any of the prosthetic feet can be used with these prostheses.

Prostheses for Partial Foot and Ankle Disarticulation

A moulded shoe insert can be constructed to provide a firm support base for the end stance and to distribute pressure evenly over the foot. Shoe fillers of soft foam, cork or cloth can be used. The major problem of single digit, ray, or partial foot amputations is the loss of push off at terminal stance..

Bilateral Amputations

Transtibial: In an individual with bilateral transtibial amputations (BK), we must prescribe bilateral BK (PTB) prostheses.

Bilateral Transfemoral Amputations Stubbies (Fig. 8.33)

Stubby prostheses or "**stubbies**" are generally prescribed only for individuals with bilateral transfemoral AK amputations who are motivated to ambulate but who are not candidates for fitting with full length prostheses. They are most effective for individuals with short residual limbs. They may be used as temporary prostheses. Stubby prostheses do not have any knee joints. They have above knee sockets, as with AK prosthesis and to prevent the wearer from falling backward are provided with modified rocker bottom feet. They are shorter than the original limbs, to bring down the center of gravity, and thereby increase stability. Stubbies allow easy balance and the patient walks with lesser expenditure of energy. Ambulation causes exaggerated truncal rotation. Short canes or crutches are usually needed for support. Sitting in a

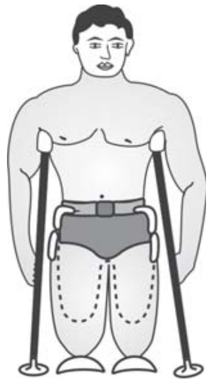


Figure 8.33: Stubbies given for bilateral above knee amputation

chair and climbing stairs are very difficult because of shortness of prosthesis. Many people find stubbies cosmetically unacceptable because of the extreme reduction in height.

Gait Training after Prosthetic Fitting

The patient should initially be taught the basics of prosthetics care, including how to don and doff it and how to do transfers. Dynamic alignment is performed by a prosthetist to fine tune the alignment to the patient's gait pattern. The patient is then asked to bear weight on the prosthesis. Then he has to be taught balance in standing and walking. The physiotherapist makes the patient stand and later walk in parallel bars. The patient graduates to use of assistive devices, like axillary crutches or walkers. Once the patient has mastered walking on level ground, training to climb stairs or ramps and gradients or to negotiate uneven surfaces should begin. A proper gait analysis is done for various phases of the gait cycle, and corrections made in the prosthesis.

Energy Consumption

An amputee who walks with crutches uses 65% more energy than does someone with a normal gait. But when the artificial limb is fitted, energy consumption increases as follows: Below-knee, unilateral amputation - 10-20%, Below-knee, bilateral amputation - 20-40%, Above-knee, unilateral amputation 60-70%.

Recent Advances in Prosthetic Fitting

Advances have been made not just at improving the prosthesis but also in the entire approach to the amputee. Where the disability is maximum, these techniques like targeted muscle and sensory reinnervation are being tried and researched. Targeted muscle reinnervation (TMR) is a technique where surgery is performed on nerves which controlled muscles previously on the amputated hand. These nerves are made to reinnervate a region of a large, intact muscle, such as the pectoralis major. The patient is then given muscle reeducation and a robotic prosthesis controlled by the muscle movement. When he thinks about moving the thumb of his missing hand, a small area of muscle on his chest where it has been rerouted will contract. The sensors attached to this area will then control movement of the concerned part of the robotic prosthesis.

Targeted sensory reinnervation (TSR): This is more or less the same as above except that the nerves rerouted are sensory. After rerouting the sensory nerve, a sensory stimulus to that area of the chest is felt by the patient, as if it were occurring on the similar area of the amputated limb which the nerve originally supplied. The science of robotics has progressed to the level that limbs have improved in their ability to take minute signals from the cortex and convert them into the required motion in the artificial limb.

Direct Bone Attachment

Direct bone attachment is a new surgical method in which first a titanium bolt is inserted into the bone at the end of the stump. Over a period the bone gets attached to the titanium bolt which offers attachment to the artificial limb. The wearer gets much better control over the prosthesis by this method. Unfortunately the bone tends to break on heavy impact.

CONCLUSION

Disability limitation in a lower extremity amputee is extremely gratifying, because with the development of newer techniques in prosthetic fitting, alignment, and materials, it is possible to make him walk, run and climb, and even compete in sports with other handicapped individuals quite competently. Endoskeletal prostheses, high-density polyethylene limbs, Jaipur rubber foot, squatting prostheses, these are all examples of the contribution of technology to the handicapped.

CHAPTER 9

Mobility Aids

INTRODUCTION

Mobility aids are appliances used to help people who have difficulty in walking. They enable some of the body weight to be supported by the upper limbs and thus build up the stability and thus indirectly the mobility of a patient. As the condition of the patient improves he may progress through different types of walking aids. Each aid gives a varying amount of stability, and accordingly, a varying extent of mobility. Usually the stability of an aid is inversely proportional to the mobility it can help achieve. For example, the stability of a walker is more but it restricts the user from using narrow areas which is easier with a cane or an elbow crutch (which is much less stable)

Selection of a walking aid depends upon:

- The diagnosis and prognosis of the condition.
- Strength of the patient's upper and lower limbs, especially the cylindrical or power grip, with which the patient needs to hold on to the aid.
- Gait of the patient.
- Stability of the patient.
- Extent of improvement or deterioration of the patient.
- Other factors like motivation, age and acceptance.
- Relief from weight bearing needed.
- Co-ordination
- Vision and proprioception
- Architectural barriers

FUNCTIONS

- to improve balance
- to give proprioception
- to decrease pain

- to reduce weight bearing on injured or inflamed structures
- to compensate for weak muscles
- to scan the immediate environment (for the visually impaired)
- to indicate to the bystanders of the disability of the individual (e.g. the white cane with a red tip indicates the user is visually impaired).

When prescribing any appliance we must pay attention to:
- The height of the appliance.
- The location of the grip (hand piece), which usually corresponds in most cases to the height of the appliance.
- The rubber ferrule which effectively prevents slipping and sliding on smooth surfaces.
- The material out of which it is made
- Its stability.
- Its cost.
- Whether used indoors or outdoors.

PARALLEL BARS (FIG. 9.1)

Parallel bars are used when the patient is unstable, or to correct a gait pattern. They are rigid and support the patient right through the length of the bars. A full-length mirror should be placed at one end of the parallel bars. The patient is taught the correct sequence of upper and lower limb movement while walking towards the mirror. In it the patient can observe his movements and thus avoid looking at his feet, a common mistake made when any type of walking aid is used initially. The parallel bar is particularly useful in posterior column lesions if the patient has lost proprioception. The height of the parallel bar is from the ground to the greater trochanter of that side.

Figure 9.1: Gait training within a parallel bar

WALKING FRAMES (FIGS 9.2 AND 9.3)

Walking frames or walkers are more stable than the others because their bases are quite large and the centre of gravity falls within the base. They are prescribed for debilitated or elderly people who are usually confined to home, unable to climb stairs, and who have been advised not to venture outdoors.

Figure 9.2: An amputee using a walker in the initial stages of gait training with a prosthesis

Figure 9.3: A child walking in rural India using a walker with casters

A patient is not usually given a walking frame unless he is not able to walk even with walking sticks, or crutches, as the pattern of gait acquired in a walking frame is difficult to change. There are three main types of walking frames:

- The standard walking frame, including the pulpit frame
- The reciprocal walking frame
- The rollator

Advantages of the Walker

- Allows maximum stability i.e. 4 point contact on floor.
- Allows sense of security for patients fearful of ambulation.
- Light in weight & adjustable.

Disadvantages of the Walker

- They can not be used safely on stairs.
- They are difficult to maneuver through a doorstep or entrance

Standard Walking Frame

The standard walking frame consists of four almost vertical aluminium alloy tubes arranged in a rectangle, and joined together on three sides by upper and lower horizontal tubes. One long side of the rectangle is left open. The vertical tubes, heights of which may be adjusted by means of spring loaded catches have their lower ends fitted with rubber tips (ferrules) to prevent sliding and slipping. Handgrips are fitted to the upper horizontal tubes on each side. The walker should be light, rigid, stable and easy to use.

The patient stands in the walking frame, lifts and places the frame forward a short distance away and then walks up to the frame still holding the hand grips.

Gutter Frame

The main structure of the ***gutter frame*** is the same as that of the standard walking frame except that the tops of the upper horizontal tubes on each side is modified by the addition of two gutters in which the patient's forearms rest. The patient takes most of his weight through the forearms. The hands grasp upright projections to lift and turn the frame. The forearms may be fastened in the gutters with light Velcro straps.

This type of frame is useful when the patient cannot extend his elbow fully or is unable to take his full weight through his hands due to weakness, deformity of the hands or when there is a plaster cast.

Reciprocal Walking Frame

It is prescribed when the patient cannot lift the walker or needs more stability. It is similar to the standard frame but with each side of the frame capable of being moved forward alternately. There are swivel joints between the front horizontal and vertical tubes. As the frame does not have to be lifted with each step, the patient's stability is increased. Stability is also more because the line of gravity always falls within the base (the parallelogram formed by the four uprights of the frame)

Rollators (Fig. 9.4)

A rollator is a walker with two small casters at the front and two short legs at the back, protected by rubber ferrules. Care must be taken when recommending a rollator for elderly patients as it may roll too far forward and they may lose their balance. The rollator is best suited for children who may find it difficult to lift walkers.

The patient holds the handgrips, lifts the rear legs just off the ground, wheels the rollator forward a short distance, lowers the rear legs on to the ground and then walks forward into the rollator holding the handgrips.

Figure 9.4: Rollator

As the patient becomes more and more confident with his walker and desires more mobility he can migrate to a stick, a quadripod or a tripod. These aids are used on one side of the body and help improve weight bearing, enhance proprioception and reduce pain. If the grip of the upper limb is poor owing to some pathology like rheumatoid arthritis, which prevents the person from using canes and crutches the physiatrist has to prescribe specially designed gait aids. The grip of a properly measured cane should be at a height located at the upper border of the greater trochanter. The grip of the cane should be, with the patient standing erect, at the level of greater trochanter and the distal end placed 6 inches from the lateral border of the foot (during standing). It is better to ensure that the elbow is flexed 20-30ˆ to help in shock absorption.

The important factors to be considered are the hand grip and the ferrule.

The patient should be instructed to hold the cane in the hand **opposite** to the affected limb and to advance it along with the affected leg. This is called a three point gait pattern. When ascending stairs the good leg is advanced first, but when descending, the order is reversed.

These aids are most commonly made of hardwood or aluminium telescoping tubes, but can vary in design. The reason they are hollow and telescoping is that they can be adjusted according to the patient's height. All of them should be fitted with a deeply grooved 1 to 2 inch wide rubber tip called ferrule for good friction and safety at the lower end, and the clinician should check these regularly for wear and tear. The ferrule must have concentric circular depressions radiating inwards, creating a vacuum effect for better floor grip.

WALKING STICK (FIG. 9.5)

This ubiquitous appliance is seen in almost every household. Walking sticks take away the body weight from the lower limb during walking and therefore can compensate for muscle weakness and relieve pain in the legs. In addition the use of a walking stick or sticks can increase the stability and the confidence of a patient. However, the stability is not as much as the quadripod or tripod.

Figure 9.5: Walking stick or cane

TRIPODS

Tripods and quadripods are more stable than canes. They can stand on their own legs, unlike a cane which falls off. Tripods have three rubber-tipped legs, which touch the ground at the corners of an equilateral triangle. The handgrip lies in the same plane as a line joining any two of the legs. The height of the handgrip can be adjusted; the measurements being taken similar to that of the cane.

The tripod and quadripod walking aids, which may be used single or in pairs, confer more stability than walking sticks or elbow crutches. They are usually prescribed for patients suffering from neurological conditions, but they may be used for elderly patients who have degenerative problems like osteoarthritis, and therefore not confident without a stable aid.

QUADRUPED WALKING AID (QUADRIPODS) (FIG. 9.6)

This has four rubber tipped legs. The handgrip lies vertically above the two inner legs, which are more widely spaced than the two outer legs. The height of the handgrip is adjustable as given earlier.

Figure 9.6: Quadruped walking aid

CRUTCHES

A crutch is a staff or support, often used in pairs, by the physically handicapped, as an aid in gait. There are three basic types of crutches. They are used to reduce weight bearing on one or both legs, or to give additional support where strength is inadequate and balance is imperfect.

Axillary Crutches

They are made of wood or aluminium with an axillary pad, a hand piece and a rubber ferrule. The length and the position of the hand piece are usually adjustable.

The axillary pad should rest against the chest wall approximately 5 cm below the apex of the axilla and the handgrip should be adjusted to allow the elbow to be slightly flexed to 20° when weight is not being taken. Weight is transmitted down the arm to the hand piece. It is inadvisable to take weight through the axillary pad as this could lead to a neuropraxia of the radial nerve or brachial plexus (crutch palsy).

Measurement*:* There are many ways of measuring the patient for crutches, usually carried out with the patient in supine,

- Remove the patient's shoes and measure from the apex of the axilla to the lower margin of the medial malleolus. This is an easy measurement and is practically reliable.
- From the anterior axillary fold measure 6 cm in front of and lateral to the little toe.

- Two inches below axilla to 2 inches from the lateral foot and 6 inches anteriorly (during standing). The hand grip adjusted to allow 20-30° elbow flexion.

Elbow Crutches (Fig. 9.7)

These are made of metal or plastic and have a band which fastens on to the forearm prevent the crutch from slipping out of ones grip. They are usually adjustable in length by means of a press clip or metal button. They have a rubber ferrule to afford a good grip. These crutches are particularly suitable for patients with good balance and strong arms but in whom the grip is suspect. Weight is transmitted in exactly the same way as for axillary crutches. Many patients graduate to elbow crutches from axillary crutches.

Measurements: The measurement is usually taken with the patient in the lying position with the shoes on. The elbow is slightly flexed (approximately 15 degrees) and the measurement is taken from the ulnar styloid to a point 20 cm lateral to the heel of the shoe. Once the patient is standing with the support, the length must be rechecked.

Figure 9.7: Elbow crutch

Gutter Crutches (Fig. 9.8)

These are used for patients who require some form of support but cannot take weight through hands, wrists and elbows because of deformity and/or pain. They are usually made of metal or plastic. There is a padded forearm support parallel to the ground, on which the forearm is placed and strapped on. Velcro fastenings around the forearm keep the crutch in place. The hand piece is adjustable to the grip available to the patient.

The crutch is adjustable in length in the same way as the elbow crutch. It should also be adjustable in the length of forearm support. The measurement is taken from the elbow flexed at 90° to the ground with the patient in standing.

Figure 9.8: Gutter crutch

Crutch Walking

The function of crutches is to prevent undue weight-bearing. Sometimes crutches are needed only temporarily, at other times their need is permanent. The majority of patients are apprehensive when they take up crutch walking because of the social stigma of being dubbed as a cripple. The patient's ability to use them depends upon a number of factors.

- A good sense of balance.
- The correct selection and adjustment of the crutches.
- The strength of the muscles required in the use of crutches
- Good vision
- Proprioception.
- The correct crutch stance.
- The pattern of gait envisaged and the energy necessary for it.

Crutch Maintenance

- The wood or metal must be strong enough to take the patient's weight
- The catches used for height adjustments must be functional.
- The rubber ferrules must be in good condition.
- The handgrips and axillary pads must be in good condition.
- All the adjusting nuts must be tight.

Crutch Muscles

The characteristic muscles used for the use of a locomotor aid are called ***crutch muscles***. These are:

- Depressors and adductors of the shoulder girdle.
- Flexors of the shoulder.
- Extensors of the elbow to stabilize the elbow in slight flexion when the body weight is taken through the upper limb.
- Dorsiflexors of the wrist to get the best functional position for the cylindrical grip.
- Flexors of the fingers and thumb to hold the handgrips firmly.

The handgrip must also be tested to see that the patient has sufficient power and mobility to grasp the hand piece. The results of this assessment will determine the type of crutch chosen.

In case of non-weight bearing on the affected leg; the mobility and strength of the normal lower limb should be assessed, paying particular attention to the hip abductors and extensors, the knee extensors and the plantar flexors of the ankle which must be sufficiently strong to take weight. The patient is taught hip hiking on the non-weight bearing side if required.

Balance

Sitting and standing balance must be tested and trained if necessary. Righting and saving reactions must be present.

SCOOTING BOARD (FIG. 9.9)

The scooting board, or skate board is basically a wooden platform with casters or wheels below and which is a sport very popular amongst kids in the Western world. In our country we often see handicapped people with residual polio move around on contraptions similar to the scooting board or skate board, squatting on it and pushing themselves forward with their hands. Sometimes it is more popular among housewives who need to sit on the floor and cook with all their utensils spread out around them. The concept is not high in technology but is appropriate for Indian homes where furniture is minimal and sitting cross legged on the floor (or ground) for a meal or for studying is quite common. A wheelchair would not be useful in such homes as it also occupies space and needs many barriers to be overcome before it can be of use.

Figure 9.9: A modified scooting board for use at home where all utensils are at floor level

WHEELCHAIRS (FIG. 9.10)

A wheelchair is not just a 'chair with wheels'. It is a ***second "home"*** to the patient, since he spends so much time in it. The patient's wheelchair should be designed for comfort and ease of manipulation. Wheelchairs differ in design and construction based on the needs of individuals and their disabilities.

Wheelchairs come in three sizes: adult, child and tiny tot.

Since many of the disabled individuals live out of wheelchairs it is important to prescribe the most comfortable one for a patient in the given circumstances.

PARTS OF A WHEELCHAIR

Frames

Wheelchair frames are either ***rigid or folding***. The type of frame affects the maneuverability of the chair. A rigid frame in one solid piece is lighter and

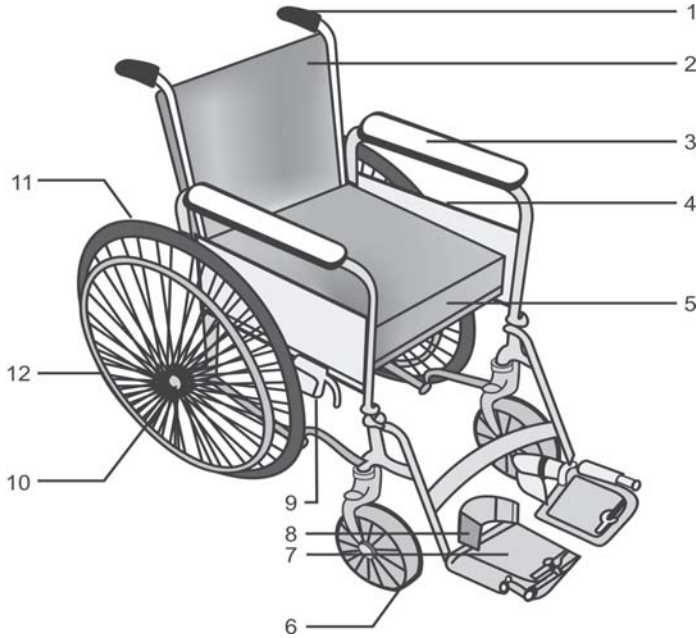


Figure 9.10: The wheelchair and its parts: (1) Handgrip (2) Backrest (3) Armrest (4) Clothes guard (5) Seat (6) Footrest (7) Casters (8) Heel-loop (9) Brake (10) Axle/anti-tip bar (11) Handrim (12) Wheel and tyre

used more for sports and other rugged activities. A folding frame is heavier and requires more effort to maneuver but is more convenient for storage in the home and for placing into the car while travelling since it occupies much less space.

Tyres

The selection of tyres depends on the use of the chair. Tyres made with solid, hard polyurethane and having a smooth tread are designed for indoor use, allowing for easy maneuverability on smooth surfaces. If used outdoors these tyres offer no shock absorption or traction.

Pneumatic (air filled) tyres provide for shock absorption and a smooth ride, particularly outdoors on uneven or rough terrain. These tyres require more effort to maneuver and add slightly to the overall width of the chair. Greater tread depth and lower tyre pressure provide more traction but require more effort to propel the chair.

Wheels

Two types of wheels are available: solid magnesium and with spokes (Fig. 9.11 and 9.12)

Solid magnesium wheels never lose their shape or need adjustments. Spoked wheels are lighter and therefore easier to manoeuvre. The disadvantage of

Figure 9.11: Wheel with spokes

Figure 9.12: Solid cast wheels

spoked wheels is that the spokes are easily broken and will cause the wheel to lose its shape. They must therefore be tightened frequently.

Wheel sizes may vary depending on the size and weight of the user. There are two sizes- 12″ and 18″ diameter. A smaller wheel size requires more pushing strokes than a larger wheel size to propel the chair over the same distance. A small wheel reduces height to the wheelchair during transfers.

Brakes

There is a separate brake for each wheel of the chair. Brakes must be put on when stopping the chair, whenever the person is being transferred in or out of the chair, or whenever a procedure like standing up in the wheelchair, or eating from a tray placed on it is contemplated.

Casters

There are 2 casters in front of the wheels. They are different from wheels in that they can revolve in all directions, and allow for better front end maneuverability on smooth surfaces.

Casters are pneumatic, semi pneumatic, or solid. The semi pneumatic type is better on uneven terrain. Pneumatic casters provide for greater shock absorption; however, there is an increased drag during propulsion if not filled with air properly. This increases the expenditure of energy. Solid casters are good on smooth terrain. Casters may also have locks.

Push Rims (Hand Rims)

The type of push rim depends on the user's grip. There are basically three types:

- Standard metal rims,
- Friction rims, and
- Rims with projections.

Standard metal rims are used when grip is not a problem. Friction rims are standard rims covered with friction tape or foam tubing to provide additional grip on the rim surface. Projection rims are used by people with limited reach and grip, like quadriplegics. These are knobs are placed at intervals to give the user better grip and leverage for propulsion. The greater the number of knobs the greater is the facilitation for movement. Projection knobs may be either at an oblique angle or vertical. However, they may hit against the sides of the wall or furniture and add to the overall width The chair used by a hemiplegic has two hand rims on the same (unaffected) side and the user propels it using the same hand. To negotiate turns he uses either one of the hand rims.

Footrests

Footrests maintain the feet in neutral and prevent deformities like equinus. They are either fixed or movable. Swing away footrests are more convenient but increase the length of the chair, which affects turning and maneuverability. These lack toughness and require frequent repair. Heel loops or leg straps can be added to the footplate. Either or both of these accessories add length to the wheelchair.

Tilt Bars

Tilt bars, which project from the back of frame, usually 2 to 3 inches above the floor, are used by the individual who is pushing the wheelchair. By placing the foot on the tilt bar and pushing down with the foot, the person can tilt the wheelchair back, allowing the casters to rise off the surface, thus enabling them to clear a doorstep or kerb. This can also be done by doing what is called a '***wheelie***', which is the same action as above, done by ***the wheelchair user himself***.

Backrests

High wheelchair backs provide trunk support and are ideal for a high level quadriplegic or a child with cerebral palsy with poor sitting balance. Low chair backs provide a greater freedom for movement and are preferred by individuals with low level spinal cord lesions and by those who participate in sporting activities. The angle of chair backs can be changed and many wheelchairs have their backrests detachable, permitting a back transfer. Chest straps are provided to the back rest when sitting balance is poor.

Armrests

Removable armrests are convenient, provide support, and make transferring easier when detached. Armrests can also be fixed or adjustable in height and may be partial length or full length. However, they restrict movement during propulsion. Environment control units, keyboards, books or trays can be placed on these armrests.

Foldability: Many wheelchairs are lightweight, foldable and modular, which makes it convenient to transport it in buses, trains or cars. The seats in such wheelchairs are usually canvas.

Seats: Patients come in all sizes and it makes sense to take the measurements for the seat, so that he is most comfortable. The dimensions to be taken into consideration are the seat height, depth and width (Fig. 9.13).

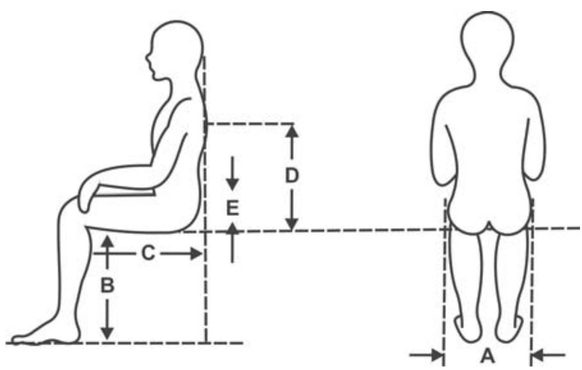


Figure 9.13: Wheelchair measurement; Seat width: 1 inch wider than the width of the widest part of the buttocks (A); Seat height: 2 inches higher than the distance from the bottom of the heel to the popliteal area (B); Seat depth: 1 to 2 inches longer than the distance from the popliteal area to the back of the buttocks (C); Backrest height: 2 inches less (may vary) than the distance from the inferior angle of the scapulae to the sitting surface (D); Armrest height: Distance from bottom of buttocks-to-elbow (E)

Cushions

Cushions are used to achieve the most comfortable and supportive position possible and sometimes can make all the difference in the prevention of a secondary disability like pressure sore. Seat cushions may be air-filled, gel-insert, contour foam, or gel filled. Some have individual inflatable air cells, which are available in varying thicknesses and can be customized for posture control and pressure relief.

Head-rest: It is prescribed for those who have no head control, and have primitive neck reflexes. It is also detachable.

Clothes Guard: This prevents loose fitting clothes from getting entangled in the wheels.

Anti-tip Bars: Anti-tip bars keep the chair from tipping too far backward. They are used primarily by new users and by those with a high-level spinal cord injury.

Training to Use the Wheelchair: The patient is taught basic movements within the wheelchair. He learns to use the brakes, remove and replace the arm back and footrests. In the maneuvering of the wheelchair, he practices to lift his buttocks in the chair, perform a wheelie, to push on a flat surface or slope, and to turn it. Objects which he can use on the chair like a tray or computer keyboard are also given to him during the practice session.

Transfers

The physical act of moving a patient from one surface to another is described as a transfer. Wheelchair users generally need to transfer to the toilet, another chair or to the bed. When performing transfers attention must be given to the use of body mechanics and forces needed by both the patient and the assistant. When a patient is lifted by a family member, the family member relies on his own strength to carry out the transfer. Sometimes this is risky, hazardous to the patient and caregiver, and impractical. Use of contraptions that help transfers is called dependent transfer. This is done by use of a transfer board, hydraulic lift or hoist

Hydraulic Lifts or Hoists

These are the devices that are used for safer transfer of patients by raising them with minimal effort of the helper. Hoists must have the capacity to lift weights of 100-150 kg, be stable enough and have a braking system. Mobile hoists are used for severe disability like quadriplegia, while static hoists are used where transfers are more, like bathrooms. They work with hydraulic devices or electric motors and consist of a metal frame with a canvas swinging from it. The patient is suspended from it, and the hoist generates enough power to lift him and transfer him. The care giver must ensure good body alignment and positioning.

First, one must assess the patient's weight, and check if it is within the capacity of the particular lift. Then the hoist is moved to the bedside, and then brought to a level where the leverage is minimal. Using the canvas sling, the patient is positioned and gently transferred to the sling, and later to the location where he or she needs to be transferred. Care should be taken to prevent the head and lower limbs from damage.

- A manual pivot helps swivel the patient when getting out of a car, or wheelchair
- *Transfer board:* These are simple boards that come in many designs, but essentially enable a patient to slide from wheelchair to bed, commode or car seat. They often come equipped with discs to enable pivoting and turning.

- *Manual lift:* This is virtually the same as the hydraulic lift except that manual power is used instead of motors.

Wheelchair Lifts (Ref Chap 24 and 22)

This is a device that lifts the wheelchair as a whole on to an area hitherto inaccessible to it, like the first floor of a building or a bus. In some railway stations these are placed so that wheelchair bound persons can access the coaches. Wheelchair lifts may be electrically or hydraulically operated.

Wheelchair Maneuvers

Initially, simple home based maneuvers are taught, like wheel chair to bed, wheel chair to chair, or toilet (sideways and backwards).

Later, advanced operations like mobility in open areas, in crowded areas, up and down ramps and elevators are taught.

Wheelchair Maintenance

The wheelchair should be cleaned regularly. Soap water and wax should be used on the painted surfaces.

- One should check whether the wheels run parallel in a straight line.
- Oil may be used for all movable parts except bearings for lubrication.
- Nuts and bolts must be tightened.
- Metal parts should be sprayed and wiped clean, followed by application of polish.
- The upholstery should be cleaned.
- Telescoping parts like footrests should be polished.
- Tyre pressure should be checked; Low pressure in the tyres will damage rims and make the chair more difficult to propel.
- As spokes keep the wheel shape patent, they should be tightened periodically and replaced immediately if broken.
- Bearings in the wheel and caster should be checked for freedom of spin and smoothness.
- Once every 6 months, the wheelchair should have a complete overhaul by the manufacturer, particularly if used outdoors.

WHEELCHAIR MODIFICATIONS

There are five justifications for modifying specific wheelchair parts and presenting new models.

- to facilitate transfers,
- to facilitate proper positioning,
- to allow its own transportation, in a car or van
- to allow self-propulsion
- to permit transportation of objects, in the wheelchair
- to overcome architectural barriers,
- For specific conditions, like hemiplegia or quadriplegia.

One Arm Drive Wheelchair (Hemiplegic Wheelchair)

The one arm drive wheelchair is propelled and steered by one upper limb. This type of wheelchair is designed for those who cannot walk, and cannot use one upper limb, e.g. hemiplegia. This chair allows control of both wheels on one side of the wheelchair. The chair has two rims on that propelling side, one rim activating each wheel. Using the two rims simultaneously, the individual can move the chair in a straight line. The outside hand rim is smaller than the inner and controls the opposite wheel. Propulsion using the outer rim turns the wheelchair towards that side and propulsion of the inside or standard rim turns it in the opposite direction. This helps the user steer with one hand.

Growing Wheelchair

This model is designed to grow with children ranging in age from 6 to 12 years. When the child outgrows the chair, a simple conversion of upholstery and footrest extensions can be made.

Powered Wheelchair (Fig. 9.14)

These are more sophisticated wheelchairs that can be used outdoors, for longer distances, propelled by a motor system. They have special features such as:
- Power seat adjustment
- Power tilt adjustment to avoid constant pressure over one region.
- Power adjustable leg-rest and backrest

Some models even have a mechanism to enable the individual to stand up within the wheelchair. They have an easy control panel with feather touch buttons and joystick for changing directions.

Joystick Power Seating System: This allows the user to push the joystick and thereby control up to six different seat positions.

Basic shear compensated back power recline system: The back slides downward as it reclines. This system reduces the "shear" or pulls on the user's clothing and skin. The back rest gives a more comfortable reclining motion that reduces the necessity of repositioning.

Basic power seat elevator: The seat and back rise together a full 6 inches of movement, thereby elevating a standard 21" seat height up to a maximum of 27 inch high.

TRICYCLE (FIG. 9.15)

In many parts of rural India, patients need to travel distances on poor roads to do odd jobs, or to go to school or college, and public transport where available is often not disabled-friendly. Hence adults with disability prefer a simple form of transport called tricycle. A tricycle as the name suggests has three wheels fitted with pneumatic tyres, and propelled by hand. Obviously use of a tricycle needs good hand strength, which is often the case with adult

Figure 9.14: Modifications to wheelchairs clockwise from top stand-up wheelchair, seat lift, motorized wheelchair and tilt in space

Figure 9.15: A batch of tricycles to be donated to beneficiaries at an appliance distribution camp

polio, so in rural camps there is a good demand for and distribution of tricycles so that PWD's can go about their jobs. Another advantage is that tricycles are made with indigenous technology and are easily serviced when there is a problem.

CHAPTER 10

Architectural Barriers

INTRODUCTION

A person's self-image depends greatly on interaction with others and with the environment. We have to shape the living environment, so that it becomes a series of tools rather than a collection of obstacles. ***The process of rehabilitation is not complete unless it also helps the patient live in an environment in which he can be independent***.

"What is obstacle-free for one person could be a barrier for another".

For example a person with visual impairment may be more comfortable in smaller spaces where most items are within reach, whereas a person in a wheelchair maneuvers better in open spaces. Persons with disabilities often are not able to perform as well as normal people because of physical, social, educational, vocational and attitudinal **barriers.**

The modern team approach is to deal with these problems by ***normalization***, which refers to an attitude whereby people with disability are treated as ***normal rather than special***. Normalization includes promotion of barrier-free environment design. In many developed countries almost all public places are accessible to the handicapped. The ***architect*** plays a very important role in designing a barrier free environment.

Independence within an environment is not the only requirement in the design of an accessible environment. ***Energy expense*** is also a critical concern for the disabled person in his environment. The disabled person often does not have optimum co-ordination, strength, flexibility or sensation, and may not respond vigorously or precisely to an emergency.

Finally, it should be remembered that each person wants his environment to be homelike, stimulating, secure and aesthetically pleasing. The question is how we can design an environment that meets all these requirements.

ECOLOGY OF HOUSING

This is a specialized field of sociology, in which the consumer takes part in his own environmental design. It is defined as ***the study of the spatial aspects of the symbiotic relation between man and institution***. This includes not only the social, psychological or economic aspects of family living but also the world of designing, construction and industrial production.

The decision-making process for environmental modification involves four steps:

1. Determining patient's needs
2. Prioritizing them
3. Mobilizing the necessary funds and getting the job done.

Determining the Patient's Needs

The patient has to be assessed in detail using a chart to identify and modify environmental barriers as follows:

- Diagnosis—type of disability, impairment or handicap
- Duration and severity of disability and prognosis
- Orthoses or prosthesis hindering activity
- Educational and vocational training
- Mental ability and comprehension
- Strength and co-ordination
- Mobility
- Balance
- Motivation
- Home/school/office situation
- Location of each and every room in the house
- Requirements and tastes of individual patients

Establishing Priorities

Because most people have limited financial resources, priorities usually have to be established. If a thorough patient examination and his environmental assessment have been done, the team should be able to assist the patient in setting his priorities.

This process must focus both on present and future needs and abilities. The following should be considered before setting priorities:

Is the disease that created the disability progressive?

Will fatigue be an important future consideration?

Priority determination should also be based on life style values, interests and family demands

Getting the Funds

Once the needs have been defined, the patient should be encouraged to mobilize whatever finances are available to design the environment to suit him. With few exceptions, today's technology can provide viable (though expensive) solutions to almost any access problem. There are stair glides, elevators, and adjustable-height kitchen counters, vans with "zero-effort" steering and elaborate wheelchair systems with environmental controls that can literally be operated with a blink of an eye or a puff of air. The solutions are usually limited by availability of finance and not by lack of ideas or technology.

Getting the Job Done

The final step in this problem solving process involves decisions on specific design and selecting contractors to do the work. The physiatrist should be able to refer patients to sources of information and make design recommendations. It is here that the architect functions as a member of the rehabilitation team.

ARCHITECTURAL DESIGN FEATURES AND THEIR ACCESSIBILITY

FEATURES PROVIDING ACCESS OR EGRESS

Doors

- The entrance door to the dwelling should be at least 2 feet 10" wide if door opens 180 degrees, otherwise 3 feet width should be sufficient.
- There should be no entrance step or riser.
- Letter or numbers identifying the dwelling should be etched on the door and be visible day and night. Raised numbers are used for persons with visual impairment
- Horizontal sliding or folding doors are easiest to operate from a sitting position and they eliminate the danger, especially to the persons with visual impairment, of walking into the edge of a partially open door.
- Hinged bathroom doors should swing outward. If the latch includes a lock feature it should be the type that can be released from outside.
- Two way swinging doors are hazardous and should not be used.
- Round or oval polished and plated doorknobs are the most difficult for impaired hands to operate. Instead handles are provided with ends looped back to the door surface to prevent catching of clothes, with a good power non slipping grip.
- The weight of the door is decided by attaching a spring scale to the door handle and pulling on the spring from a seated position until the door opens. The weight should not exceed 8 pounds.
- Safety glass vision panels are recommended on doors so that people can spot a disabled person approaching from the other side.

Stairs (Fig. 10.1)

It has been noticed that amputees, crutch or cane walkers prefer steps to ramps. However, single-run stairs between floors are not desirable. At least one

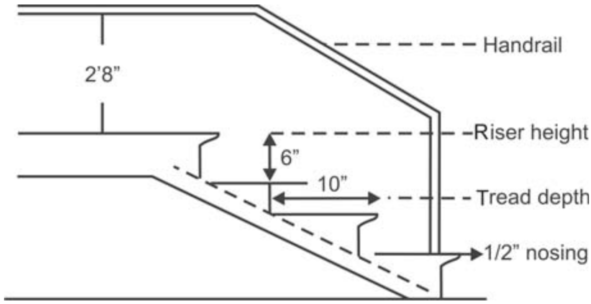


Figure 10.1: Staircase measurements

landing should be used with 90 degree or 180 degree turns for resting, between 2 flights of stairs to conserve energy.

The most desirable stair would have a 6″ riser and an 11″ minimum tread which places the ball of descending foot well inside the stair nosing. A safety nosing which does not project more than 1½″ beyond the riser and which is distinct in color from rest of the tread should be used

All risers should have uniform heights. Many people get proprioception by using the back of the step as a guide for foot placement. If the stair lip is too big, the toes may catch on an open step or stair lip, and the person may fall forward. Others compensate for balance deficits, by wedging the crutches or cane tips against the back of step.

Handrails are placed on both sides approximately 30″- 34″ from the surface and 1.5" from wall. Pictures and other objects on stairway walls are discouraged, since it will distract people going up or down. Lighting sources are provided at the top and bottom of stairways to minimize shadows.

Carpeting reduces the size of steps and may cause soles to slide or toes to catch the edge and therefore, is to be avoided as far as possible. Gradual changes in levels of lighting must be provided for people with visual impairments and for senior citizens.

Ramps (Fig. 10.2)

Most wheelchair users can negotiate a ramp sloped 5 - 8.3° (1:20 - 1:12) or less without assistance. Any ramp longer than 30 feet should be divided into sections with a 5 feet × 5 feet platform for resting between sections.

Platforms or landings should also be included at points where ramps change directions, because it is hard to turn a wheelchair on a slope. The recommended width for a one-way ramp is 3 feet between handrails. At least 6 feet should be provided for 2-way traffic. Handrails are placed on both sides of the ramps and they should extend at least 12″ or 24″ beyond both ends of ramp to assist persons with poor vision. Ramps come in all sizes and can be made of wood, concrete or metal. There are portable ramps also, but they are hazardous because their ends are not fixed.

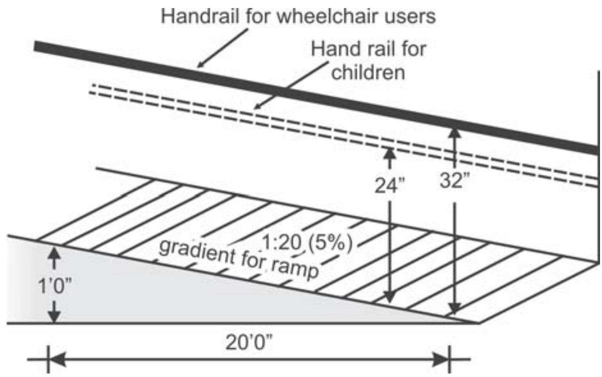


Figure 10.2: Design of a suitable ramp

Elevators

Self-service elevators should level automatically at landings and have automatic sliding cab and doors with delayed closing, Two push buttons overriding the delay timing, one holding doors open and the other to close the door should be provided. An emergency sound alarm system and telephone for emergency should be installed. The control panel should be set at a height convenient for a wheelchair user. Lighted buttons with raised figures and automatic floor announcement should be used to assist those with poor vision. Most of the modern elevators are equipped with the additional features given above.

Kerbs

Kerbs should be with ramps. The ramp should not protrude on to the street but be constructed well into the kerb. Needless to say it should be non-slippery and coloured.

SPACE ENCLOSURES

Floors

For those who find walking on smooth surfaces difficult or dangerous, it has been calculated that a coefficient of static friction greater than 0.4 will produce safe walking surfaces. Locomotion on wheelchairs always consumes more energy and places cardiopulmonary stresses, which are higher than for walking.

The floor should be non-slippery. Uneven joints or bumps in the floor can pose problems not only for the wheelchair user but for those using canes and crutches, and even those with chronic respiratory and cardiovascular problems. Heavily patterned designs may make it difficult to judge distances and delineate the edge of a surface. For bathrooms, unglazed ceramic floors are recommended. Smaller sized tiles provide some friction at the joints and are safer to use.

Carpets may increase the friction with the wheelchair, cause a drag and thus decrease the propelling force. If at all there is one provided, its thickness should not exceed 0.5″.

Windows

Windows that project outside or inside beyond the wall line should be avoided. Window sills should not be too low. The recommended window sill height is 28″-32″. The handle of the window should be at convenient reach, from sitting (on a wheelchair) or standing position and be of the type easily grasped by arthritic or weak hands.

LIGHTING

All light fixtures should be controlled by wall switches. The switches should be uniformly located 2 feet 10″ to 3 feet above the floor. Tap-type or rocker switches are best for persons with hand impairment. Switches are placed near the entrance door. Adequate light should be provided outside entrance doors so that residents can easily locate their door locks at night. Brighter lights are needed for visually impaired persons especially in the kitchen and bathroom. Switches controlling electrical outlets in the bathrooms should be located outside for safety purposes.

SPECIAL ROOMS RELATING TO VARIOUS ACTIVITIES

Kitchen (Figs 10.3 and 10.4)

The three basic work centers in a kitchen are: the cooking area, the refrigerator and freezer, and the sink. Work centers are best aligned following a right to left progression for right-handed people. The three work centers are most efficiently arranged in a ***U shaped configuration***, with the stove or oven in the center.

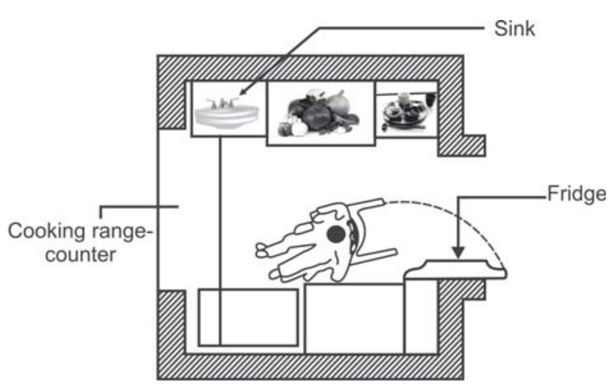


Figure 10.3: Adaptable features in the kitchen for wheelchair users

Figure 10.4: A paraplegic lady carrying out her daily chores at home on the floor of her kitchen *(For color version see Plate 2)*

A minimum of 5 feet width should be provided for the wheelchair to turn within the kitchen. Counter tops should be set at a workable height from both the wheelchair and standing positions.

The drain should be at the rear of the kitchen sink and provide maximum clearance for knees. A single lever handle, water mixing faucet for hand infirmities should be provided. Shelves should be ‘pull out ‘and adjustable in height at 2"intervals from about 2 feet above the floor to the under counter position.

Wall storage cabinets when mounted 1.2" above the counter provide the maximum convenient storage, accessible from sitting position. Cabinets should never be installed above counter top as such placement creates a fire hazard to the lady reaching for stored articles. To assist the persons with visual impairment, the control dials, in addition to visual markings, should be provided with click stops, so that the fingers can feel such clicks representing the various intensities at the burner. Whenever possible, natural light and ventilation in kitchens should be provided through windows.

Bathroom (Figs 10.5 and 10.6)

The bathroom presents more hazards than any other room; therefore planning for safety is of utmost importance. It must be broader than normal, with a minimal floor area around 40-45 sq. feet.

Grab bars capable of supporting 100-150 kg. should be provided at the water closet, shower and elsewhere in the bathroom. They should be devoid of sharp corners, no jutting ends and with ends returning to the walls. Bath tubs or showers are also made accessible for a disabled person, like a hand held shower. Bathtubs should be at the same level as the wheelchair. A back drain

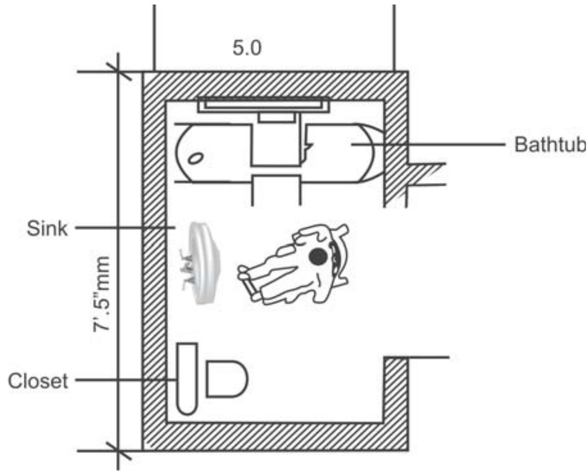


Figure 10.5: Adapted bathroom for wheelchair user

Figure 10.6: Grabrails in the bathroom and at the water closet

and slight floor slope to the drain will prevent water from running over the bathroom floor. Water controls should be placed on the wall adjoining the spray and within reach of the occupant. The design of public rest-rooms should also include the above features.

Toilet

The lavatory should be set 2 feet-10″ above the floor. The minimum depth is 4″. Single lever water control-aerator spout is provided. Grab bars are attached wherever accessible. A western type closet is always preferred; otherwise a 'commode' is used. Some wheelchairs have adaptations, which will permit them to be wheeled back over the toilet. The opening in the seat can then be opened for the patient to relieve himself or herself. The Indian toilet is too low for people with neurological or orthopaedic disorders to squat. The height of the lavatory seat should be 17″ and that of the grab bar is 19″. A bathtub seat facilitates transfer from a wheelchair or crutches. It is also of utility in enabling people to sit while removing orthotic or prosthetic devices. Showers offer the possibility to wash independently.

Living Room (Fig. 10.7)

The front door should be easily and if possible electronically operated. The room should be spacious for the wheelchair to negotiate turns. The chairs may be designed at the level of the wheelchair and with removable armrest to facilitate transfer. The television should have a remote control system. Carpets need to be avoided all over the house. Burglar alarms or closed circuit cameras may be installed for safety.

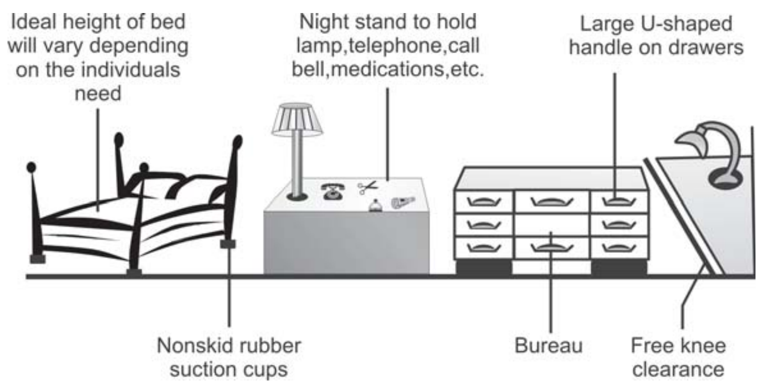


Figure 10.7: Bedroom adaptations

Study or Office

The table should be 2″ higher than the wheelchair height. Books are arranged at reachable heights. The cupboards should be adjustable in height. Lighting facility should be adequate to ensure good visibility. Computers or laptops can be installed keeping in mind the office ergonomic norms.

FURNITURE MODIFICATIONS FOR THE DISABLED (FIGS 10.8 AND 10.9)

We use furniture daily, at home and in the office. Sometimes the very furniture that we use can increase the disability or deformity. Hence, there is need to modify furniture to suit the specific needs of the individual. The carpenters must be specially commissioned to make the chairs customized to the child based on:

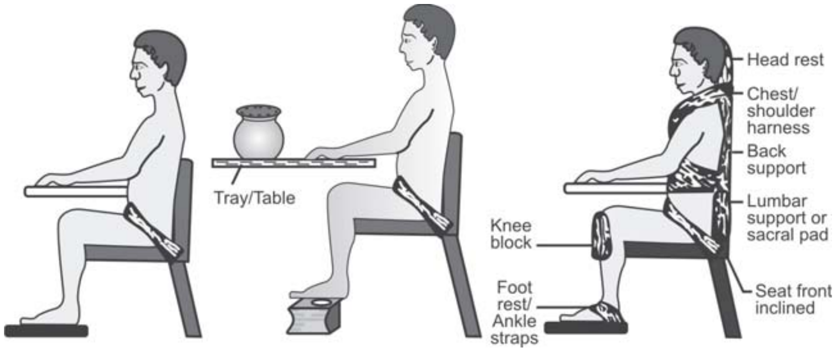


Figure 10.8: Use of furniture for positioning

Figure 10.9: Furniture modifications

- The diagnosis
- Prognosis and future possibility of improvement or deformity
- Age of child/adult
- Maintenance
- Deformities to be prevented
- Adaptability to growth of user
- Interfacing with educational and vocational implements.
- Weight and size of furniture
- Safety to the user
- Durability of material used
- Presence of deformities
- Skin contact and allergy
- Prevention of secondary problems like pressure sores
- Cost
- Space occupied by furniture
- Size of room

Furniture has to be designed keeping in mind the ADL (for example, potty modifications), the prognosis of condition (e.g. for a progressive condition like muscular dystrophy), the handedness (hemiplegia) and the need for incorporating environmental control units.

Some examples of modifications are cushioning to prevent pressure sores, providing a back support to prevent spinal deformities, or a pommel for adductor tightness, and a foot rest to prevent equinus. Patients with ankylosing spondylitis or low back pain prefer a firm seat while those with rheumatoid arthritis favor soft upholstery. All chairs should be of the height of the wheelchair, with an armrest, backrest (with lumbar pads), neck rest and foot rest. The seats should be adequately cushioned. The table corners should not be sharp. Tables should provide knee space below. Chairs should be stable, light and have slight slant to the rear to transfer body weight to back of chair.

PUBLIC PLACES

The Americans with Disabilities Act (ADA 1990) has laid down some guidelines (Chapter 4) for accessibility to Public utilities.

Public Telephones

The standard public telephone booth is not used by most physically impaired people. To assist persons with hearing disabilities, telephone receivers should have adjustable amplifiers. The push button dial is more desirable than the rotating dial.

Transportation

In India people travel by two wheeler or car. A car may not be affordable for many, but a two wheeler may not be preferable for most of the people with disability.

Those who can afford a car, if they can afford to, can modify it as follows:

- The car seat should be of the height of the wheelchair seat.
- Proper foot rest to get into it
- Removable doors.
- Ample space for storing crutches or folding wheelchairs in the rear.

Some high roof vans have a ramp in the back side so that the person with the wheelchair can drive it up the ramp while remaining seated in the wheelchair. The person in the wheelchair would sit in the rear while another driver would drive the van. For this, modifications to the van such as lowering the floor, swiveling seat, restraints for the wheelchair and space for storing wheelchair accessories and prosthesis or orthosis have to be given.

Wheelchairs may be motorized for travelling a long distance. A special elevated platform, or mechanical lifts attached to vehicles must be provided to facilitate boarding and disembarkment by wheelchair bound people from mass transit vehicles.

Parking

The following rules are adopted:

1. Parking spaces of greater width than normal are necessary for people who are disabled.
2. These spaces are placed as close as possible to the major entrance of building, preferably not more than 100′ feet away.

Restaurants

They should have a ramp and elevators. The door should be wide enough to allow a wheelchair user without any difficulty. The aisle should provide a path at least 3′ wide for passage. Movable seating must be provided.

Movie Theaters

The seating is arranged in such a way that there is always a slot near the entrance vacant for the wheelchair user. The aisle should be 3 feet wide to accommodate a wheelchair. Access to the theater should be easy as ramps must be provided.

VISUAL DISABILITY AND THE ENVIRONMENT

In public places information is displayed on a large screen. The kiosk screen inside telephone booths is made large and visible. Sign boards with Braille output and sometimes speech output are seen in public buildings, city halls, community houses, banks, libraries, train stations, bus stations, airports, hotels in many Western countries. Alternating black and white steps are provided in stairways for easy discrimination. Changes in floor covering, such as from tile to carpet, help persons with visual impairment distinguish different areas in the room. The sound of footsteps announces an arrival, so carpeting is avoided in buildings where many visually impaired persons stay or work. Carpeting dampens the sound of footsteps. Announcements in elevators have to be made regarding the floors reached and the offices to be accessed.

Curved rather than sharp margins on furniture and recesses for guide sticks along walls are other commonly used design elements for people with visual disability.

Recent technology enables design of an adjustable length, lightweight, battery-operated electronic cane which couples a laser detection unit to auditory and tactile signalling devices which warns a visually impaired user of nearby hazards while walking. Three laser beams emanate from the handle of device, in 3 different directions upward, parallel to the surface, and downward respectively. Vibratory signals in the region of the index finger register obstacles in the path of the beams.

Letters and numerals on signs and clocks may be designed with enlarged dimensions and placed on sharply contrasting backgrounds for maximum legibility. Abbreviated rather than fully spelled words are easier to read for people with visual impairment. Braille is used below visual signs. Color is commonly used as a means for attracting attention to key elements of the environment, and furniture in the room is colorful and contrasting.

AUDITORY DISABILITY AND THE ENVIRONMENT

Assistive Devices

The SMS (short messaging service) and vibratory mode in the ubiquitous cell phone has enabled many hearing impaired persons communicate to each other and also in an emergency to the airport or hospital.

For those who cannot hear the telephone ringing a light flickers when a call comes in, or subtitles are provided while watching a movie. In our country there is a separate time slot when the news is delivered in sign language.

Accessibility for Disabled Children

Household furnishings are a hazard to children. During the learning process, youngsters stumble frequently and often attempt to stabilize themselves on nearby objects. Failure to adequately grasp table's results in some injury and usually, children's heads are the first casualty.

Placement of padding at pointed edges on furniture, use of safety glass in furniture, is recommended in homes housing children with motor or learning defects. The expression of personal tastes within spaces allotted to individuals is encouraged, in developing character and personal style. So, if a child likes his toys to be arranged in a particular way, or his room to be furnished to his taste, it is better to accede to his wishes.

Environment of Disabled Senior Citizens

Slowed reaction time in the aged is an important consideration in arranging a well-conceived environment. A simple environmental setting in a circular pattern with familiar surroundings is of benefit to elderly persons, because orientation is easier. In designing facilities for elderly people, rooms are best arranged in groups to simulate a family atmosphere in an old age home.

Open spaces that afford a good view of adjacent functional areas like the toilet or bedroom make location of the pathway to them much simpler. Some designs provide opportunities for interaction of residents, like a common leisure room or breakfast lounge. Accommodations range from housing for elderly people, to specialized care for the senile and critically ill.

Emergency Escape

The following appliances may be used in case of emergency: Flashing lights to alert those with visual impairments, vibrating pagers for hearing impaired individuals, two-way radios to persons confined to wheelchairs and tactile maps for visually impaired persons. In case of a fire people are instructed to follow the exit signs placed near the floor below the smoke level, directing them towards the nearest stairway. Each lobby or corridor must be serviced by at least one fire escape.

Technological Innovations to Improve Accessibility

Technological advances are providing great benefits to people with physical disabilities. Voice synthesizers use microprocessor technology to provide instructions to elevator users in special circumstances, as well as routine floor announcement to benefit those with visual disabilities. Electronic sensors meter toilet and urinal flushing, soap dispensers and shower operation. Bathroom fixtures designed for the convenience of the people using wheelchair include hand held showers or bathtubs and tilt down mirrors. Electronic window controls open and close windows. Innovative design has produced a module located outside the house that prompts to close the window when it rains. Devices which sense the approach of a wheelchair hold the door open for a pre set time, allowing it to pass unassisted.

There is a recent kerb-climbing aid for standard manual wheelchairs. Intended for use by paraplegics, it consists of bilateral ramps that are placed in a bag hung behind the wheelchair backrest. The user retrieves these from the seat using attached telescopic rods.

CONCLUSION

Rehabilitation falls short of its goals if it provides independence for the individual only while at the treatment centre and then sends him home a ***prisoner*** to environmental barriers.

The rehabilitation team helps the disabled individual to access his environment, so that he is made as independent as possible in it.

CHAPTER 11

Activities of Daily Living

Activities of daily living (ADL) are ***tasks of self-maintenance, mobility, communication and home management*** that enables an individual to achieve personal independence in his or her environment. The purpose of an ADL program is to train the patient to optimally perform, within the limit of his physical disabilities, all activities inherent to his daily life.

Activities of daily living are usually taught in the following manner:

1. Any given activity is broken down into its simplest components.
2. Patient performs these specific motions, in the form of graded exercises.
3. This activity itself is practiced in a real life situation.

The role of exercise therapy is, after all, to improve the patients ADL. Therefore, therapy programs are so designed as to restore or maintain range of motion and to develop strength and co-ordination. The different exercises learnt are incorporated into useful activities in real life situations. For example, exercises to improve range of movement of the shoulder can help in reaching out for objects placed above his head, or wash himself during his toilet. Strengthening his grip is later useful to shave himself, eat food or handle crutches.

ADL GROUPING

ADLs are grouped according to various areas of activity in the day to day life of the patient. Residual disability, skills acquired, job, home plan, and office designs are all taken into consideration while grouping ADL's. Obviously, all activities need not apply to any one patient. In rural India, the challenges are more, since self help aids are not available; neither has technology penetrated to that level.

Daily activities are classified as:

- Bedside activities
- Wheelchair activities

- Self care activities
- Miscellaneous hand activities
- Ambulation
- Elevation
- Traveling
- Management of environment control devices
- Communication

Activity Grading

The extent to which the activity can be performed is graded as,

- Independent in performing the activity
- Needs assistance to do so
- Needs to be lifted to perform the activity
- Dependent—activity cannot be performed by the patient
- Activity contra indicated, as it may be harmful to the patient or those around him, like driving a public vehicle.

Barthel's Index of Activities of Daily Living (BAI)

The patient is assessed according to his or her status in the following daily activities and based on whether he is dependent or independent, given a score from 0 to 3:

- Bowel status (0-2)
- Bladder status (0-2)
- Grooming (0-1)
- Toilet use (0-2)
- Feeding (0-2)
- Transfer (0-3)
- Mobility (0-3)
- Dressing (0-2)
- Stairs (0-2) and
- Bathing (0-1)

There is also a Modified Barthel score which further increases the sensitivity of the score ranging from 0 to a maximum possible 100 without increasing difficulty of undertaking test or time involved, and with scores from 0-5 in individual tasks.

Modified Barthel Score

Items	*Unable to perform task*	*Attempts task but unsafe*	*Moderate help required*	*Minimal help required*	*Fully independent*
Personal Hygiene	0	1	3	4	5
Bathing Self	0	1	3	4	5
Feeding	0	2	5	8	10

Contd...

Contd...

Items	*Unable to perform task*	*Attempts task but unsafe*	*Moderate help required*	*Minimal help required*	*Fully independent*
Toilet	0	2	5	8	10
Stair Climbing	0	2	5	8	10
Dressing	0	2	5	8	10
Bowel Control	0	2	5	8	10
Bladder Control	0	2	5	8	10
Ambulation (wheelchair)	0(0)	3(1)	8(3)	12(4)	15(5)
Chair-Bed Transfers	0	3	8	12	15

Functional Independence Measures (FIM)

A broad based measurement of function, which is used by several rehabilitation centers, is the Functional Independence Measure (FIM), a chart that consists of 18 categories of function (sub grouped under self-care, mobility, locomotion, sphincter control, communication, and social cognition), each scored on a scale from 1 (dependent) to 7 (independent). Overall scores may range from 18 (totally dependent) to 126 (totally independent).

Bedside Activities

These include all gross body motions necessary to move about in bed, like changing position, rolling over, moving to the sitting position, and sitting up. After coming to sit, the patient must maintain sitting balance while moving trunk and arms in all directions. He must be able to cover himself with bed sheets, reach out to the side table and manipulate objects (like ringing a bell or attending to the telephone). Eating food and toileting are also bedside activities, which need to be trained. Patients with quadriparesis and muscular dystrophy are often evaluated for bedside ADL.

Wheelchair Activities

Very often people have to spend their lives in a wheelchair. They have to be taught how to select their wheelchair, and then trained in:

- Wheelchair transfers to bed, chair, bathtub, or toilet.
- Wheelchair management—handling parts, propulsion, steering, and negotiating obstacles, and maneuvering in and out of rooms.
- Maintenance of the wheelchair parts.

Personal Care

- Self care activities
  - Personal hygiene (e.g. bathing, cleaning teeth, combing hair etc)
  - Personal image (care of hair and nails, use of makeup, shaving)
  - Attending to toilet needs (bedpan, urinal)

- Dressing activities/undressing: (Fig. 11.1) various modifications to the dresses, like Velcro fastening instead of buttons may also be made to facilitate easy wearing and removing.
- Eating activities: (Figs 11.2 and 11.3) the patient is given exercises to improve hand functions so that he can eat on his own. Modifications of spoons and forks may have to be done.

Miscellaneous Hand Activities

- Handling the telephone, signal buttons, coins, etc.
- Using spectacles, watch, lights, etc. while sitting reclining and other positions.
- Fine motor skills, like writing, cutting vegetables.

Figure 11.1: A device to help button-up the shirt

Figure 11.2: Modified knife to cut foodstuff *(For color version see Plate 2)*

Figure 11.3: Modified spoon with built-up grip and modified fork for taking food *(For color version see Plate 2)*

Ambulation and Elevation

The patient is evaluated on

- Gait patterns within the home or out of doors on different ground surfaces.
- Help to stand up and sit down from various heights.
- Need for Locomotor aids.
- Ability to negotiate staircases and kerbs.

Traveling (Fig. 11.4)

He should be able to drive and maintain a two wheeler or car, use the garage, and practice to get in and out of the vehicle. The vehicle itself can be modified to accommodate his wheelchair. Public transport in several countries is modified to enable senior citizens to step on and off buses or trains. The entire bus level is lowered so that the passenger can embark or disembark.

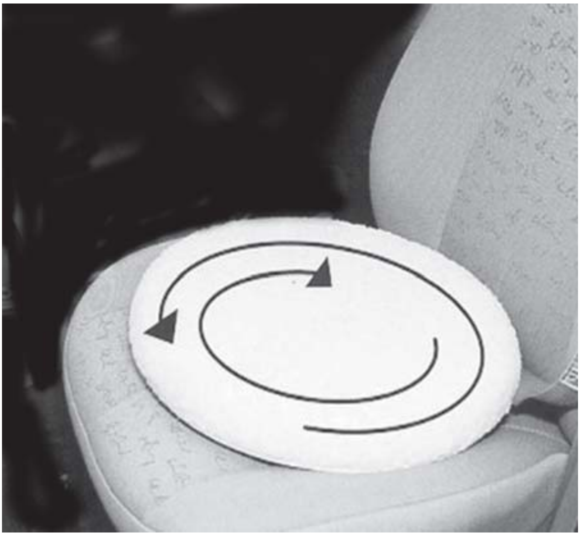


Figure 11.4: A swivel mechanism on the seat of the car to enable the person turn in the seat and get-out of the car

Environmental Control System (ECS)

Environmental Control System (Figs 11.5 and 11.6) is defined as a means to control and interact with the environment by switching on and off devices through switches or voice activation, by remote control. The purpose of the ECS is to maximize functional ability and independence in the home, school, work and leisure environment.

An ECS basically consists of the following:

- An input method via single, dual or multiple switches. The selection may be direct or through a method of scanning various target devices.

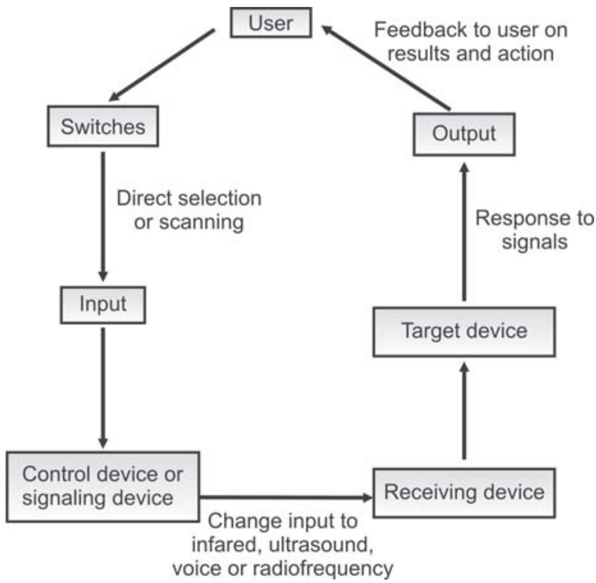


Figure 11.5: Schematic diagram of an environment control system

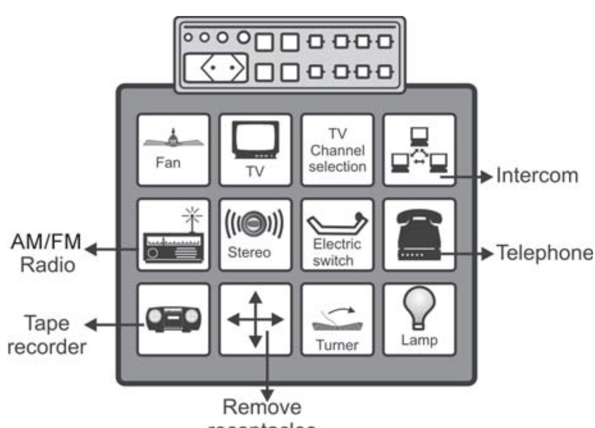


Figure 11.6: Scan and selection system for target devices in an environment control system

- A control or signaling device to change input into infrared pulses, ultrasound, voice or radiofrequencies.
- These input signals are received by a device which activates the target, like fan or computer.
- A target device that responds to the signals relayed.
- The connection or interface between the signaling devices and the target device.
- Output or feedback mechanism to inform the user of the results and actions.

Some are simple systems that control two or three appliances like the fans and lights; others are more complex and can control several appliances simultaneously.

Devices that can be Controlled by an ECS

Telephone	TV	Electric bed
Lights	VCR	Window opener
Call bell	Stereo	Drapes/curtains
Alarm systems	Compact disc player	Door opener
Air conditioner	Computer	Door lock/unlock
Fan	Tape recorder	Page turner
Intercom	Tape player	Radio

Communication (Fig. 11.7)

The importance of communicating to ones fellow human beings cannot be underscored enough. Every person needs to transmit his or her feelings and thoughts and today's modern technology comes to ones aid while doing so.

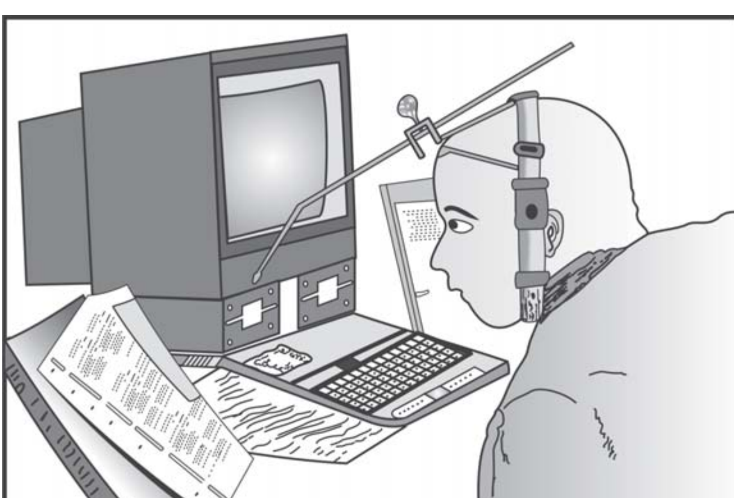


Figure 11.7: Headpointer that can be used by quadriplegics to communicate on a keyboard

Communication includes the ability to write, operate a personal computer, read, type or use the telephone, a tape recorder, or a special communication device. Several devices are used by the Person with Disability to keep in touch with the outside world.

Transfers

The patient is evaluated as dependent, assisted dependent or independent in his ability to transfer himself to and from tub or shower stool, bed, toilet, chair, wheelchair and car.

He is also evaluated for balance in various activities from which he can perform his ADL's.

The occupational therapist fills out a chart, as given below to indicate the ADL status of the patient and follows through with the progress.

A Typical "Activities of Daily Living" Chart

Eating/Drinking

Remarks (dependent, assisted dependent or independent)
Mix rice, idli with spoon/hand
Cut meat/chapati
Eat with hand/spoon
Eat with fork
Drink with straw
Drink from glass/cup
Pour from vessel

Undressing and Dressing

	Dates	Remarks
Pants or shirts		
Banian		
Underwear		
Blouse or shirt		
Brassieres		
Underskirt		
Sari		
Night clothes		
House coat		
Belt		
Coat		
Dhoti		
Salwar kameez		
Sweater		
Glasses		
Braces		
Shoes /Slippers/sandals		

Fastening

	Dates	Remarks
Button		
Snap		
Zipper		
Hook		
Shoelaces		
Velcro		

Communication

	Dates	Remarks
Speech		
Read		
Hold book		
Turn page		
Write		
Use telephone/cell phone		
Use computer		

Hygiene

	Dates	Remarks
Blow nose		
Wash face, hands		
Wash extremities, back		
Brush teeth or dentures		
Apply makeup		
Clean nails		
Comb hair		

Hand Activities

	Dates	Remarks
Handle money		
Use scissors		
Open cans, bottles, boxes		
Tie package		
Sharpen pencil		
Seal and open letter		

Combined Activities

	Dates	Remarks
Open-close refrigerator		
Open close door		
Remove and replace objects		
Carry objects		
Pick up objects from floor		
Remove, replace bulb		
Plug in cord		

Operate

	Dates	Remarks
Light switches		
Door bell		
Door locks and handles		
Faucets/Taps		
Washing machine		
Remote control device		

The above chart is only indicative and would vary according to the culture, nationality and personal taste and lifestyle of the patient.

Home Evaluation

The hospital environment is very much different from the home. Very often a situation arises when a locomotor aid or device is prescribed or given away, only to find out later that it is of no use to the patient in his home. A rehabilitation center ideally should have a 'stay in home' simulating the patients environment so that the transition from center to home is smooth. Therefore it is essential that the physiatrist and therapist perform a visit to the patient's home, preferably together. The patient and a family member should be interviewed to determine their expectations.

ADL TRAINING

In India, where the joint family system is still prevalent in some areas and family bonding is still taken for granted, the patient tends to be looked after with great and sometimes excessive care by the family members. Though it can't be denied that family is paramount in the rehabilitation of the individual, this leads to a situation when the patient depends on his family to take care of him for everything, even simple activities of daily living that he can do. Motivating such a patient to take care of himself is a challenge.

The occupational therapist should estimate which ADLs are possible and which are impossible for the patient to achieve. He should explore the use of alternate methods of performing the activities and the use of assistive devices. In order to motivate the patient the objectives are framed with a short and long-term perspective

- The training program may be graded by beginning with a few simple tasks and gradually increasing their number and complexity.
- The methods of teaching the patient to perform daily living tasks must be tailored to suit each patient's learning style and ability.
- Patients who have perceptual problems, poor memory, and difficulty following instructions of any kind will require a more concrete, step by step approach which is easy to comprehend.

- Before beginning training in any ADL the therapist must begin by providing adequate space and arrange equipment and furniture for convenience and safety.
- Architectural barriers must be removed at home and office.
- Performance is modified and corrected as needed and the process is repeated to ensure skilled performance.

Dressing Training

Upper Limb Dressing:

- The neck has to be stable on the shoulder girdle
- The muscle strength in the upper limb should be 3/5 to 4/5.
- The range of movement at the shoulder must be at least 0-90 degree of flexion/abduction, 0-30 degree of medial or lateral rotation, and 15-140 degree elbow flexion.
- Sitting balance without support in bed and wheelchair
- Ability to use buttons or fasteners. A flexor hinge hand splint may be used if the patient has good wrist extensor power.

Lower Limb Dressing: The trainer, usually a physiotherapist enhances the muscle strength and ensures the extent of movement at the knee and hip that must permit the person to sit with legs fully stretched and reach out to his calf. Generally a range of 0-120 degrees would be adequate. Body control, such as ability to transfer from bed to wheelchair with minimum assistance rolling from side to side, or balance when lying on side, must be developed. If patient has spasms and can control them, they are used to his advantage to flex and extend the lower limb

Clothing Recommendations

- Clothing should be loose and have front fastenings.
- Zippers or Velcro fasteners are preferred to buttons.
- Since patients often use the thumb to fasten zippers, loops are recommended.
- Shoes should be carefully selected so as to provide foot stability during patient transfer.
- Personal preference is given a lot of importance and the rehab professional must have a ‘What can I do for you’ instead of a ‘I think you must have this’ approach.

Hygiene and Grooming

Adaptations:

- A brush with grip is used for bathing or shampooing hair.
- A bath brush is provided with a long handle to reach behind the back
- A position-adjustable hair dryer.
- A long handled toothbrush, lipstick applier or razor.

- A short reacher
- Dressing sticks to enable the person to pull on clothes.
- The bathtub can have safety rails, and extended or built up handles on faucets.

Environmental Adaptations (Self Help Aids)

"*When you cannot change the patient, change the environment*". If a patient with rheumatoid arthritis repeatedly comes to the department saying that she cannot open the tap, it is far easier to change the tap than to keep strengthening her grip.

Communication Adaptations (Ref Chap 4)

A vast array of adaptations are improvised to keep pace with the revolution in communication

- Adaptations to the computer and keyboard
- Telephones should be placed within easy reach. A clip type receiver, a dialing stick or push button phone may make usage of the phone easier.
- Built up pens and pencils with an easier grip

Some Home Management Tips

Store frequently used items on the lower shelves of the cabinet. Sit on a high stool to work comfortably. Use a reacher to get items beyond your reach. Stabilize mixing bowls and dishes or vegetables with some aid. Use lightweight utensils, and where possible and safe use powered can openers and mixers. Use long handled taps and a top loading automatic washer and an adjustable ironing board.

Problems Encountered During ADL Training

The general health condition (apart from the disability), like respiratory infection, cardiac problems or diabetes which can inhibit ADL training, are regularly monitored. Daily checks must be carried out for pressure sores. The patient may not be co-operative to the idea of dressing even if in the presence of a professional. Any pain in neck or trunk that persists when attempting training can interfere with activities of daily living. Affordability is another question, with most of the population in India unable to even buy a good wheelchair, let alone sophisticated items like an environment control system or a motorized wheelchair.

Animals in Rehabilitation

Animals have been giving companionship to man since time immemorial. The relationship between dog and master, over the ages borders on almost complete dependence and understanding. They provide a loving comforting presence, which is unconditional, and undemanding.

In the breakdown of the joint family system today, especially in the West, animals are seen as a viable alternative as a companion. In Western countries, there are organizations which provide service animals (usually dogs or monkeys) that are trained to assist a person with disability. They are trained in bringing objects that the person cannot reach or in obeying simple commands like 'Fetch' or 'play'. For persons living alone, they can be of great security against burglars.

Such trained are used in institutions for lonely and depressed patients to alleviate boredom, give affection and help in their activities of daily living. They are used along with treatment sessions with physical, occupational and speech therapists, and also for petty jobs like bringing in the paper.

Patients, especially children are more willing to participate in treatment sessions with an animal around. There is good interaction between dog, handler and therapist .The patient develops self-confidence; because the animal obeys his command. It also enhances self-esteem; the animal does not know about handicap and hence does not discriminate. In activities of daily living like bringing a cup of water, or the shoes or the dress, animals can be of great help. For the blind the animal leads the person where he wishes to go, and that is a great liberation for them, since they alert people with vision impairments to danger.

It is also possible to involve animals in goal oriented activities. For example to achieve tone inhibition and improved coordination, we can throw objects for the animal to retrieve, or use hand signals to communicate to it.

CHAPTER 12

Vocational Rehabilitation

INTRODUCTION

Vocational Rehabilitation is a process that assists individuals with impairments to overcome their handicaps and try to reintegrate them into society in to a job or vocation using their ***residual physical and intellectual capacities***. Vocational evaluation procedures take many forms, ranging from tests for specific functions to more complex assessments. This process is undertaken by the vocational counselor, an important professional in the sociovocational team who identifies the right vocation, skill or way of life of these patients. He or she uses information and procedures to identify the right vocation of the patient.

Medical Records: These provide valuable medical information about the patient, the cause for his disability, and what to look out for when planning a course of treatment.

Observation: The key to successful evaluation lies in the skills of history extraction and observation, which build the foundation for rapport and trust between patient and counselor.

Inventories and Checklists: A patient is asked to respond to queries regarding hobbies, interests, and desires. This data is used to screen his personality and qualitative aspects.

Psychological, Psychiatric and Cognitive Evaluation

These criteria are used to tap into the subconscious recesses of the patient's mind to determine interests and capability.

Psychological tests frequently used in work assessment

Category	*Name*
Achievement and reading	Adult basic learning examination Gray oral reading test Peabody individual achievement test Test of adult basic education
Personality	Minnesota multiphasic personality Inventory Draw-a-Person test
Intelligence	Wechsler adult intelligence scale Peabody picture vocabulary test
Vocational aptitudes	General aptitude test battery Non-reading aptitude test battery Stromberg dexterity test
Vocational interests	Picture interest inventory Importance questionnaire Occupational interest survey Wide range interest-opinion test

Based on the findings of these tests one can categorize the client into purely academic or purely vocational streams; for the severely physically handicapped, like polio, where the higher functions are normal, an academic career can be planned, while for the mentally handicapped where the motor capability is good, a career in lathe work, or carpentry can be planned.

FUNCTIONAL ACTIVITIES OF THE HAND

Vocational evaluation cannot be complete without assessing ***hand functions***. The hands are irreplaceable when it comes to performing any sort of movement or skill.

The prime function of the hand is to grip, and movement in its numerous joints enables it to be moulded to the wide variety of shapes and sizes with which it comes into contact. For example the hand can grasp with felicity a cylindrical object like a hammer, a spherical ball, or even manipulate small items like pins or keys. The secret of this ability is the thumb, which opposes the rest of the fingers in abduction.

The representation of the hand in the brain is quite in variation with its physical size; in fact the mapping of the cortical and sensory areas of the brain reveals quite a sizeable area for the hand, with a major share for the thumb.

Hands can take many shapes and sizes and fulfill many functions, which will be influenced by a person’s life style. For example, there is the person who does not use them for any specialized purpose except those of daily living like dressing or shaving. Next, there is the manual worker whose hands have become strong, rough and callused from years of hard labor. Then, we have persons who use their hands in a skilled and delicate manner such as the painter and the typist.

Most people have a dominant hand - usually the right, in which case the other hand plays a submissive role. If the object is very heavy or fragile two hands carry it to minimize risk. One hand may work, while the other stabilizes an object; for example, the right hand may write while the left hand stabilizes the paper. A few people are equally proficient with both hands. This is called ambidexterity. The famed archer Arjuna was an ambidextrous warrior and his name *Savyasachin* is derived from his ability to use both hands with equal felicity.

Major Functions of the Hand

The hand has seven main functions:

- Manipulation/Release
- Stabilization
- Sensation
- Expression
- An essential factor for daily living.
- Protection
- Support

Manipulation: Napier has divided the movements of the hand into two major groups.

- ***Prehensile movements***—or movements in which an object is grasped and held encompassed within the hand.
- ***Non-prehensile movements***—where no grasping or holding by the hand is involved but by which objects can be moved by pushing or lifting. This may also be done by the fingers individually. These include skilled individual finger movements such as piano or violin playing or a skilled combined finger movement as in smoothening a surface. In all these movements there will be control of direction, intensity and rate.

Release: In the functioning hand the release is as important as the grip. It is accomplished by the relaxation of the flexors and later, by the opening of the hand by the extensors.

Stabilization: In a bilateral movement very often the non-dominant hand carries out an important stabilizing function. This allows a skilled movement of the dominant hand to occur; for example in stabilizing the palette while the dominant hand is painting.

Sensation: The hand has been called a second eye. It is a highly developed sense organ and for the visually impaired, the only means to reach out to the external world. It provides proprioceptive and sensory feedback to the central nervous system, which will influence the force, posture and movement to achieve purposeful function.

The palm of the hand, the finger tips and the deep tissues of the palm are very generously supplied with sensory nerve endings, which give information on the size, shape, texture and temperature of an object handled. Indeed this is the reason there is such a large representation of the hands in the motor and sensory cerebral cortex.

Sensory information from the hand combines with the other senses to bring about movement, build up knowledge and aid function. No other part of the body has such a wide variety of movements.

Expression and Communication: The gestures of the hands may express a myriad of emotions like excitement, jubilation or fear. By their touch and contact hands can be welcoming, reassuring, stimulating or inhibiting. The persons with speech impairment converse, the people with visual impairment read and the writers communicate through them.

An essential tool for daily living: The hands provide the only means of exploring all parts of the body. They are essential for countless activities in daily life from dawn to dusk, like bathing shaving, dressing and eating.

Protection: A single hand or both may act as a protective shield, for example, to ward off a blow or to protect the sensitive parts of the body from danger.

As a means of support: They may act as transmitters of force to lift the body from sitting to standing. They are often used to stabilize the body when it loses balance. Persons with locomotor handicap need to grip locomotor aids with their hands and take their weight on them.

THE PARTS OF THE HAND IMPORTANT TO FUNCTION

The Thumb

The thumb plays a major part in hand function. It can perform a wide range of motions like flexion extension abduction rotation and circumduction. It is controlled by the four intrinsic and five extrinsic muscles, which contribute to the versatility of its function. Opposition, which is an essential function of the hand, increasing the cup shape of the hand, and adding precision and stability to the grip, is mainly due to the thumb. The width of the web between the thumb and the index finger will influence to a great degree the overall span of the hand.

Hypothenar Eminence

The hypothenar eminence provides the mobile ulnar control of the hand. The muscles here, though fewer and smaller are similar to the thumb in action. Their prime function is to help bring about opposition between the thumb and the little finger and together with the third and other metacarpals help to cup the hand.

Metacarpophalangeal Joints

These allow flexion, extension, abduction, adduction, circumduction and a certain amount of rotation of the fingers. From the fully extended to the fully flexed position in the palm of the hand, the ulnar three fingers converge towards the base of the thumb.

Interphalangeal Joints

Allow only the movements of flexion and extension.

The hand cannot function either as a manipulator or as a sensory organ, unless finger flexion and thumb opposition are available to sufficiently allow sustained contact.

Functional Position (Fig. 12.1)

This is the best position in which the hand is usually immobilized to interact with its surroundings. The following parameters are maintained:

- Wrist: Slight extension—20°
  Ulnar deviation—10°
- Fingers
  - Moderately flexed (45°) at the metacarpophalangeal joint
  - Slightly flexed 30° at proximal and distal interphalangeal joints

The thumb is midway into opposition. Its metacarpophalangeal joint is half flexed and the interphalangeal joint very slightly flexed. The degree of flexion increases regularly from the index to the little finger. The normal transverse and longitudinal arches are preserved.

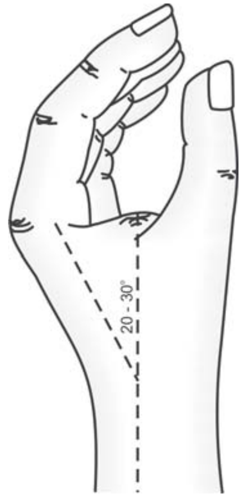


Figure 12.1: Functional position of the hand

Prehension

The ability of human hand to assume a variety of positions and to apply only the precise amount of pressure necessary to hold an object is because of the mobility and stability supplied by the skeleton and ligaments of the hand, the power of the muscles, backed by a remarkable degree of sensory feedback from the nerves.

The brain then determines which type of prehension to use for a particular object. Prehension of the hand involves the grasping or taking hold of an object, between any two surfaces of the hand, with or without the participation of the thumb. The number of ways that objects of varying sizes and shapes may be grasped is nearly infinite. However, a broad classification system for grasp has evolved that will permit easier evaluation. Prehension can be categorized either as ***grip (gross motor) or precision pinch (fine motor)***. Each of these has subgroups.

Pinches/Precision

A major function of the human hand is to manipulate fine objects to perform delicate activities. Pinches may involve static contraction of some force as opposed to precision.

Three Jaw Chuck Pinch (Fig. 12.2): This is tested by pinching the pulp of the thumb against the pulp of the index and middle fingers

Lateral Pinch (Key Pinch, Pad to Side Precision) (Fig. 12.3): The pad of the thumb makes contact with radial side of index, middle or distal phalanx. This pattern is used in holding a pen, or turning a key etc.

Palmar Pinch: This pattern is also called three-jaw chuck pinch. The thumb makes contact in opposition to index and middle finger. In this pattern, the thumb rotates to achieve pad-pad opposition. This pattern is used in lifting objects from a flat surface, in holding small objects, in tying a shoelace, and writing with a pen.

Tip Pinch /Pulp Pinch (Fig. 12.4): In this pattern the IP joint of the thumb and the DIP and PIP joints of the finger are flexed to facilitate tip to tip prehension.

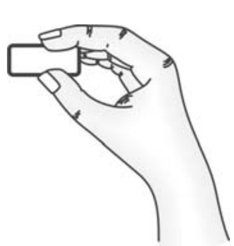


Figure 12.2: Three jaw chuck pinch

Figure 12.3: Lateral pinch

Figure 12.4: Tip-to-tip pinch

This pattern is used to pick very small objects like a pin, a nail or a coin. This pinch is primarily used for manipulation of objects.

Grips or Grasps

Cylindrical Grasp (Fig. 12.5): The most common static grasp pattern is used to stabilize objects against palm and flexed fingers, with the thumb acting as opposing force. This pattern is assumed when grasping a hammer, tumbler, or the handle on a walker or crutch. This is also called Power grip.

Figure 12.5: Cylindrical or powergrip

Spherical Grasp (Fig. 12.6): Also called ball grasp. This pattern is the one, which the hand assumes when holding a round object such as ball or apple.

Hook Grasp (Fig. 12.7): This is the only grip that does not need the thumb for opposition. The MCP joints of fingers are held in slight hyperextension and the DIP and PIP joints in flexion. This grip is used in holding the handle of a shopping bag, or a briefcase. This is also the grip that is available in the hook provided for upper limb amputees, where there is no need to exert to open the hook.

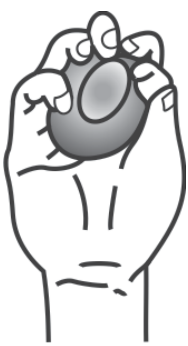


Figure 12.6: Spherical grip

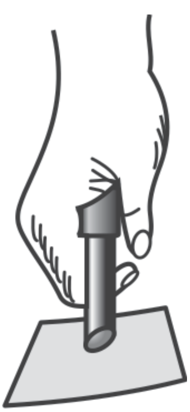


Figure 12.7: Hookgrip

Intrinsic Plus Grasp: This grasp pattern is characterized by the positioning of all the MCP joints of the fingers in flexion, the DIP and PIP in full extension, and the thumb aligned in opposition to the third and fourth fingers. This grasp pattern is used in grasping and holding large flat objects such as books or plates.

Lateral Prehension: In this, the object is held between any two adjacent fingers other than the thumb. Conductors on some of our Indian buses hold rupee notes in this fashion

THE DISABLED HAND

Many people experience hand disabilities either through trauma to bone, muscle, nerve, skin (or a combination of these) or through a neurological or systemic disease such as hemiplegia or rheumatoid arthritis. The progress in the case of the severely handicapped person will depend on his urge for independence or do a particular task.

The finer the hand control needed, the more difficult rehabilitation may become because of the structural complexity of the hand, the number of joints and muscles involved and the versatility of movement necessary for daily life.

Even a minor injury may prove to have a serious effect on the patient especially if it is the dominant hand. Most patients with a hand disability like amputation are sensitive about its appearance and see it as a cause of shame and disfigurement.

In treating the patient the therapist aims to:

- Assess his functional problems.
- Stimulate his interest and motivate him to work.
- Relieve pain and oedema.
- Regain movement, strength, stability and fine co-ordination in the hand.
- Regain some degree of independence in daily life as soon as possible.
- Set goals for achieving work and recreational needs.
- Translate the movement achieved into vocational and functional performance

MANAGEMENT OF THE DISABLED HAND

EXAMINATION

Keeping in mind the nature of the disability, a careful and detailed assessment is done. Both hands and arms are examined. The presence or absence of oedema, pain, colour changes, wasting, structural integrity or deformity is noted. The texture of the soft tissues is noted. Standard tests assess joint range, muscle strength and endurance, co-ordination, speed and sensation. Tests of function related to the lifestyle of the patient are examined.

Tests Used in Evaluation

- Milestone development test
- Manual dexterity and motor function test
- Sensory integration test
- Psychological test
- Intelligence test
- Minnesota board.

Physical Capacity Evaluation

A physical capacity evaluation typically assesses isolated parts of the body or functional units, e.g., lumbar region. In some programs aimed at return to work high-tech, instrumentation is used, e.g. the Sagittal Strength Device.

The Smith Physical Capacity Evaluation is used by many occupational therapists. It has 154 performance items and was found to be very accurate in predicting re-employment of workers with physical disabilities.

Effectiveness of sensory re-education

Classification of sensory recovery	
Sensory grade	*Recovery of sensibility*
S0	Absent sensation
S1	Recovery of deep pain sensibility
S1+	Recovery of superficial pain sensibility
S2	Recovery of pain and some touch sensibility
S2+	Recovery of pain and some touch sensibility with over response
S3	Recovery of pain and some touch sensibility with disappearance of over response; static two-point discrimination greater than 15 mm
S3+	Recovery of touch localization; static two-point discrimination 7-15 mm
S4	Complete recovery; static two-point discrimination 2-6 mm

Sensory Re-education

A combination of techniques that help the patient with sensory impairment learn to re-interpret the neural impulses reaching his conscious levels. This re-education is done at two levels Compensatory and Remedial treatment

Compensatory Treatment

Patients must be made aware of his or her specific sensory deficit and taught the safe way of performing ADL. Some of the precautions explained to patients are:

- Avoid exposure of involved area to heat and cold.
- Safer handling of sharp objects.
- Constantly observe for any skin change.

Remedial Treatment

This has two phases.

Early phase: To train identification of moving touch, constant pressure and localization the patient is asked to keep his eyes open, and a stimulus is given, and he is asked to see it. Then his eyes are closed and the stimulus is continued, and then the patient opens his eyes to verify stimuli. In the next stage the patient is asked to verbalize what is felt

Late phase: Is initiated once patient gains touch sensation and good localization. The goal in this phase is to train tactile sensation. First large objects that are used in activities of daily living are held (e.g. a glass tumbler) and later progressively smaller objects like a pen are also trained in the above method.

Hand and Pinch Strength Testing

Hand strength is measured with the patient gripping a dynamometer. The dial is calibrated in pounds. The indicator stays at highest reading until reset manually.

Pinch strength is measured by a pinch gauge. The dial is calibrated in pounds and measures finger prehension.

Endurance Testing: Many patients either due to neglect or disuse atrophy will lack the requisite strength and are tested for ability to reach or maintain the energy output necessary to perform an activity.

REHABILITATION

During the early case of hand injury, suitable positions and simple exercises are taught which can be practiced, without deleterious effect by the patient. For example, a patient with a fractured wrist should exercise his fingers actively during the day and take his arm out of the sling to exercise his shoulder and elbow. This will prevent the stiffness and pain, which can occur following this injury.

The patient with rheumatoid arthritis is shown positions of advantage and positions to avoid which may lead to excessive trauma or to deformity. For example they should try to open a tap with the left hand and close it with the right. The patient with a nerve injury is warned of the dangers of burns or injury to the insensitive area of the hand.

The most satisfactory position, if it is possible, for treatment of a patient with a hand injury is with the patient sitting on a chair in front of a table. The patient should sit correctly, with weight evenly distributed, shoulders straight with undue tension eliminated. Both shoulders should be slightly flexed and abducted to bring both hands forward on to the treatment table.

This is a normal working position in which the patient can see his hands and watch their movement and the physiotherapist can work comfortably and efficiently.

Preferably there should be a mirror for those who are not aware of that side of the body, e.g. anisognosia in hemiplegia. The greatest aid the patient has in re-establishing function is the use of his normal hand as a model so he can both see and feel the necessary movement before attempting it with his disabled hand.

In the early stage of treatment, active or assisted movement and the encourage-ment of light functional activities are the methods of choice.

VOCATIONAL REHABILITATION TEAM

The members of the rehabilitation team are the vocational counselor, the evaluator the trainer and the placement officer (Ref Chap 2).

The principles of vocational counseling and training are as applicable to normal people as they are to the disabled.

Counselor

The counselor is one who offers time, attention and respect to another person who is temporarily in the role of a client. Information and options are provided, but the counselor does not take part in the decision which rests with the client.

Basic Skills Involved in Counseling

The counselor must have the necessary skills to empathize with the patient and work in a participatory fashion to arrive at a solution for the patients vocational needs. He/she must have:

- The ability to listen
- The ability to share the client's views
- The ability to establish 'rapport'
- The ability to clarify and summarize
- The ability to tolerate idiosyncrasy
- The ability to match the client's pace
- The ability to ask specific and seemingly non-specific questions

Concept of Counseling

'*Empathy*' refers to the capacity of the counselors to gain entry into the experience of the client, and to see the world through the client's eyes as it were.

VOCATIONAL GUIDANCE AND COUNSELING

Ability

It is the innate capacity and potential for performance and relates mainly to the speed of acquisition of a new skill. Ability may be general or special.

The General Aptitude Test Battery (GATB) tests the individual on principal components of ability considered important in work. These are ***intelligence or general learning ability, verbal aptitude, numerical aptitude, spatial aptitude, form perception*** (ability to perceive details of shape and form in objects) ***clerical perception*** which is the ability to spot details in tabular and data based material, motor co-ordination, and dexterity.

Aptitude

It is the ***special ability or talent in*** different areas like verbal, numerical and spatial. Some people are extremely talented in music dance or art which makes them ideal members for training in those specific areas.

Skill (Fig. 12.8)

It is a learned proficiency that comprises a major part of every person's vocational behavior. It represents an achieved level of performance resulting from training or practice. One can thus become a skilled carpenter, lathe operator or cobbler after years of working in the field. Naturally, skills can be trained faster if one has the aptitude.

Figure 12.8: Skilled-training unit in electronics for a young man with poliomyelitis

Interest

It is one's own preference or a thing one likes. When one's interests, aptitudes and skills coincide, the job satisfaction and output is optimal.

Sometimes the impression is given that guidance and counseling are synonymous and yet there are many activities, which come under the general title of vocational guidance for example career education, group work, vocational testing, occupational placement, which do not involve counseling

The principles discussed are also equally relevant in the vocational matters of the people with disability. Here the counselor must not only discuss the priorities and aspirations of the individual but also co-ordinate with the occupational therapist and skilled trainers to improve upon the residual abilities of the patient.

What the Counselor must do?

Some of his responsibilities include:

Evaluating vocational interest, aptitudes, and skills, counseling patients who may shift to alternate occupations and organizing activities, to improve job-related behavior (i.e., interview skills, work skills, employer-employee relationship behavior). He acts as a liaison between training and placement agencies and the patient. The same process is also provided to potential employers.

He must provide information about all the occupations suitable, and also about those in which the client expresses an interest, however apparently unsuitable. He must arrange, where possible, for the client to obtain direct experience of the working environment. He must ensure that the client has a clear grasp of career structures so that he has accurate expectations of where different 'ladders' lead and of the status, salary, security, workmates, satisfactions and possible frustrations that await him.

Skilled Trainer

Many institutions offer courses for the people with disability to get trained in various skills. Common vocations that are taught include carpentry, data entry, tailoring, lathe work, press composing, book binding, operating Xerox machines, block printing, screen printing, greeting cards manufacture, and other small scale operations. Some of these are oriented towards self-employment, where by, the person can obtain a bank loan and start off on his own. To impart training to these individuals there are "skilled trainers" who are experts in their own fields. Some of the trainers may have disability themselves, who help motivate the 'students'. The training need not be 'hands on' all the time, but include playtime and household activities which may later come in handy for job training

Leisure and Household Activities that Promote Vocational Development

There are many games that stimulate the interest and fantasy, or train the fine motor movements of children, like construction sets, drawing games or helping out with the housework. The recreation therapist can contribute by prescribing leisure activities.

Placement Officer

In the social welfare section of the institution, there is a Placement officer who liaises with the industry and commercial circles and sometimes the Government. He is aware of vacancies for positions as and when they arise. He will place the candidates according to seniority, proficiency, nearness from their home to the industry, aptitude, communication and mental skills required for that job.

It is possible that all the professionals in the team- counselor, evaluator, skilled trainer, placement officer may not be available in a single institution. Some non-governmental institutions co-ordinate with each other, knowing each others strengths, to get the process of vocational rehabilitation completed. In rural and semi rural areas where trained professionals may not be available a single person who may be a social worker or even a dedicated physiotherapist might be called upon to perform all the above activities. In developing countries such as ours, the relevance of Community Based Rehabilitation (CBR) is all the more, because of the yawning gap between the requirement and availability of trained rehabilitation professionals.

Broadly, employment can be provided in the following models:

- Open employment
- Self-employment
- Co-operatives formed by the people with disability
- Sheltered workshops and supported employment
- Home based Employment
- Disabled in the service of the disabled.

Open Employment

In open or competitive employment the person with disability is considered an equal partner in the industry or skill which he is employed or proficient at. He competes with the able-bodied for the allotment of jobs or output. An example would be a skilled carpenter or lathe worker who is employed alongside other able-bodied workers. Sometimes there is reservation for the handicapped which ensures preferential training or job allotment, but once absorbed, the person with disability will have to be as competitive as others in output and performance.

Self-employment

In self-employment the person with disability starts a business and generates income on his own. He may be assisted in this endeavor by banks and other funding agencies. Self-employment can be through set up of gas agencies, oil pump dealerships or telephone booths.

Co-operatives

The concept of co-operatives has ushered in a new era of profit sharing. The group of members with impairment come together and provides some services, the proceeds of which are marketed by them without assistance of the able-bodied. Whatever profits realized are shared equally among members of the co-operatives.

Sheltered Workshops (Fig. 12.9)

Running co-operatives may be an arduous task for moderately and severely disabled persons. So a group of people like-minded philanthropic individuals get together and start sheltered workshops. In this scheme the persons with disability are entrusted with the job of production alone, while the responsibility of marketing, administration of finances is taken on by the social service organization.

Figure 12.9: A sheltered workshop where differently abled children are trained to make greeting cards

Home Based Employment

The fifth model of Vocational Rehabilitation concerns all those persons with severe disability who find if very difficult to go to their places of work. They are hence *home bound*. There are two ways by which these individuals can be employed. In one model, popularized in Japan, parents of the people with disability get together and form a co-operative. The parents bring home the work to be done which may be simple jobs like making wax candles or rolling beedies. They then sell the products, the profits of which are distributed amongst their children.

A slight variation of this model is seen in self employed home based schemes where the person with disability remains at home and members of the society who wish to avail all his services come to him to avail all services provided. An example would be a person with poliomyelitis running a circulating library or consultancy.

Disabled in the Services of their Disabled Brethren

In this case the person with disability acquires a skill which makes him work for the cause of the disabled, just as any other rehabilitation professional like a special educator or orthotist. He is employed in an organization taking care of the handicapped. The advantage of this model is that these individuals approach is empathetic and without bias or purely profit motives.

Legislation

According to the ILO (Geneva) 1985, the disabled person must meet the requirements of the job, which will utilize his residual capacities. He must:

- Not be a hazard to himself or others
- Not be segregated
- Be treated with empathy not sympathy

The employer must

- Not earmark specific jobs for disabled people
- Not give the job without training
- Be given only lay facts about the disabling condition

CONCLUSION

Job placement is not the end; sustaining it is equally important. Modification of the environment to suit the individual is necessary. For example, ramps have to be constructed to accommodate wheelchairs, toilets have to be modified, equipment of daily use has to be redesigned and manufactured. It is only in this manner that the disabled person is made “differently abled.” The computer revolution has enabled several persons with disability to find gainful employment without even leaving the confines of their homes.

CHAPTER 13

Physical Agents Used in the Management of Pain and Paralysis

INTRODUCTION

Pain is an unpleasant subjective sensory and emotional response to a stimulus, which causes actual or potential tissue damage. It is a subjective experience that cannot be narrated or explained but is intensely personal. Different people perceive pain differently. What is more, the same person perceives the same noxious stimulus differently at different times! The psychological aspect of pain is as important as the physical aspect.

Pain is a protective mechanism for the body, occurring whenever any tissues are being damaged. The stimulus causing pain makes the individual to react to avoid it, e.g. when the skin on the buttocks becomes painful as result of prolonged sitting the person normally shifts weight unconsciously. But a person who has lost the sensation of pain fails to shift which very soon results in ulceration at the site of pressure, as in the case of paraplegia.

Acute pain is useful pain, a symptom of underlying disease or trauma. It is localized, sharp and self-limiting, lasting for at the most 3 months. The head and lower extremities are the commonest locations of acute pain.

Chronic pain is defined as pain that lasts longer than 3 months; some define it as lasting longer than 6 months. It is pain that has lost its biological purpose, differing significantly from acute pain.

Pain behavior is characterized by verbal expression of pain symptoms, grimacing, guarding movements, decreased activity levels, limited ROM, avoidance of certain activities, overuse of pain-relieving medication, signs of depression and inability to work.

ETIOLOGY

Broadly speaking, pain can have a somatic, neuropathic or a psychogenic origin. But the specific causes may be:

- Viral, bacterial or fungal
- Inflammatory
- Cancer pain
- Degenerative
- Ischemic
- Endocrine/metabolic
- Autoimmune
- Traumatic.

Pain Perception Threshold: This is the least intensity of noxious stimuli at which a subject perceives pain.

Pain Tolerance Level: The greatest intensity of noxious stimuli that an individual can tolerate

Classification

The International Association for the Study of Pain classifies pain based upon:

- Anatomical region affected
- System affected
- Temporal characteristics – for example the pattern of occurrence, whether recurring, paroxysmal or continuous.
- Intensity and time since onset of pain
- Etiology

FACTORS AFFECTING PERCEPTION OF PAIN

1. ***Personality:*** Extroverts express pain more freely but are less sensitive to pain whereas introverts feel the pain more intensely but complain less.
2. ***Social context:*** Pain is perceived differently during wars, elective surgery, labor, rituals and ceremonies. For example in war, extreme pain is suffered in the larger context of patriotic fervor.
3. ***Culture:*** People of some cultures tend to withdraw and face pain alone whereas others openly seek support to endure pain. Some propagate the view that pain is a necessary evil that has to be tolerated for future spiritual benefit.
4. Past experience of pain, e.g. an earlier childbirth.
5. ***State of mind:*** Anxiety and depression increase the perception of pain. Information about the disorder, familiarity with the medical personnel and a sense of control over the situation, all decrease anxiety and hence decrease the intensity of pain.
6. ***Threshold:*** as mentioned, varies from person to person.
7. Site of origin of pain, extent of pathology.

Pain Receptors and their Stimulation

Pain receptors in the skin and other tissues are all free nerve endings. They are found all over the body in the superficial layers of the skin and also lining the arterial walls, and the joint surfaces. Most of the deeper tissues, as in the gut are not extensively supplied with pain endings.

The different types of stimuli that excite pain receptors are:

- Mechanical
- Thermal and
- Chemical.

Mechanical pain lasts only as long as the deformation is present and resolves when the deformation is corrected.

Chemical pain occurs when noxious chemical substances occur in quantities sufficient to irritate the nociceptors. Chemical pain is dull and aching and is relieved only when the concentration of chemicals returns to a sub threshold level.

Thermal pain is pain that occurs as a result of thermal causes like burns.

Nociceptive pain may be classified further as:

Superficial pain caused by a minor laceration to the skin or surface tissues producing a sharp, well-defined pain of short duration.

Deep somatic pain; this is dull, or deep pain that is difficult to localize, like a sprain and which comes from musculoskeletal tissues like fasciae, tendons, ligaments, muscles, bones or blood vessels. It is usually more chronic than the superficial pain.

Visceral pain originates from body's viscera, or organs. Patients describe this pain as colicky or cramping.

ORIGINS OF PAIN

Pain from the CNS

Pain from lesions in the CNS is topographical: The site of the lesion determines the location and character of the symptoms, which range from paresthesia to pain. The onset is variable: CNS pain can occur immediately after the insult or much later.

- Pain from injury to the dorsal horns is felt ipsilateral to the injury in a pattern corresponding to the nerve root distribution.
- Pain from cortical lesions is referred to regions of the body with the greatest cortical representation, usually areas of the face, hands and feet.

Thalamic Pain Syndrome

Thalamic pain (central post stroke pain) is a unique example of chronic nerve originated pain that starts when part of the central nervous system has been injured. It is commonly seen after a stroke, but can also be manifested in Parkinson's disease, tumors, brain or spinal cord trauma, or multiple sclerosis. The contralateral side of the body can be affected, in the limbs and the pain is frequently fleeting. The triggers of CPSP may be innocuous movement, skin contact (even air blowing over the skin), heat, cold and vibration. The thalamus which is one of the most important sensory processing areas, can also be implicated in about ten percent of the infarctions. Pain is typically continuous and non fluctuating, may be severe and made more acute by emotions, and temperature changes, usually cold. Some experience one or more types of pain, the most frequent being burning

Pain from the ANS

Sympathetic and parasympathetic fibres travel in the walls of the blood vessels, and because the major vessels serve different quadrants of the body, ***autonomic pain is spread throughout the involved vessel's distribution***. Because of the sympathetic/parasympathetic connection with emotion, pain originating from the autonomic pathways is far more sensitive to mood changes than in CNS pain.

Phantom limb pain: French military surgeon Ambroise Paré, who is also called the father of amputation surgery, first described phantom limb pain when he reported that, "For the patients, long after the amputation is made, say that they still feel pain in the amputated part". Phantom limb pain is pain seeming to originate from a missing limb believing it to be still intact. It commonly occurs after amputation. Phantom sensations may also occur after the removal of the breast, or eye or extraction of a tooth. Transcutaneous electrical nerve stimulation and Ultrasound, massage to the stump neuroma is effective in treating it, however, local percussion or vibration to the stump with strengthening programs also have been found to be effective. The patient is advised to handle the stump more frequently. Immediate post-operative fitting of the prosthesis is also said to be effective. Experiments with amputees have shown improvement with use of a mirror box to give visual feedback. The patient views his normal side in the mirror and gets a feel that it is his absent hand. He then clenches and unclenches his normal hand, views it in the mirror giving his brain a feedback as if his absent hand is functional. This helps him unclench the phantom limb from potentially painful positions. This is thought to be due to cross wiring of the somatosensory cortex.

Pain from the Periphery

Peripheral pain results from irritation of the nociceptors. Its character depends on the source of the irritation. Mechanical pain results from deformation of the receptor and is usually sharp in nature. When there is pressure on a neural structure, there also may be paresthesia and "pins and needles". This is seen in diabetic neuropathy. ***Causalgia*** is characterized by an intense burning and hyperaesthesia throughout the distribution of an incompletely damaged peripheral nerve.

Causalgia usually occurs as healing takes place and is so easily elicited by minor tactile stimulation that the individual refuses to move the affected limb for fear of stimulating the pain. Frequently there are concomitant trophic changes. Sympathetic nerve block and sectioning of the involved nerve have been found to be effective in treating it.

Referred Pain

Often pain is extremely difficult to localize, and seems to be felt in a distant area completely unrelated to the site of injury. This is called 'referred pain'. A classic example would be angina referred to the jaw or pain in the neck radiating to both upper extremities.

Two theories have been put forth for referred pain. One is the existence of bifurcated axons in peripheral sensory nerves which originate from a single cell body in the dorsal root ganglion and a single axon travelling to spinal cord from ganglion cell. Pain messages are thus transmitted to a distant location. Another theory proposes the convergence of separate peripheral sensory units into the same cell of spinal cord.

THEORIES OF PAIN

Pain Pathways (Fig. 13.1)

The physical nature of pain is a product of its site of origin. Pain can arise from the central nervous system-CNS, autonomic nervous system and the periphery. Emotional and psychological aspects of pain are due to projections to limbic system, thalamocortical system and frontal lobe which identify pain as an unpleasant experience.

Pain memory results from projection to storage areas of the temporal lobes. A memory bank of pain is developed from these projections as well as those from limbic and sensory cortical areas.

- ***A-delta:*** Small, myelinated fibres transmitting pricking pain at a speed of about 15 m/sec.
- ***C-fibres:*** Large, unmyelinated fibres transmitting dull, burning, aching or boring pain at a velocity of 1 m/sec.

Both types of fibres enter the spinal cord through the dorsal roots. A-delta fibres synapse in laminae I and V (called the marginal zone) whereas C fibres synapse in lamina II called ***substantia gelatinosa***, of the spinal cord.

From these areas, second and third order neurons cross to the opposite side and ascend in two separate pathways.

The spinothalamic tract conducts stimuli from A-delta fibres carrying pricking pain. It is fast conducting and terminates in the ventrobasal nuclei of the thalamus after relaying to the peri-aqueductal gray matter. From the thalamus, projections are sent to the post-central gyrus of the cerebral cortex, from which pain can be localized and qualified as pricking, throbbing and so on.

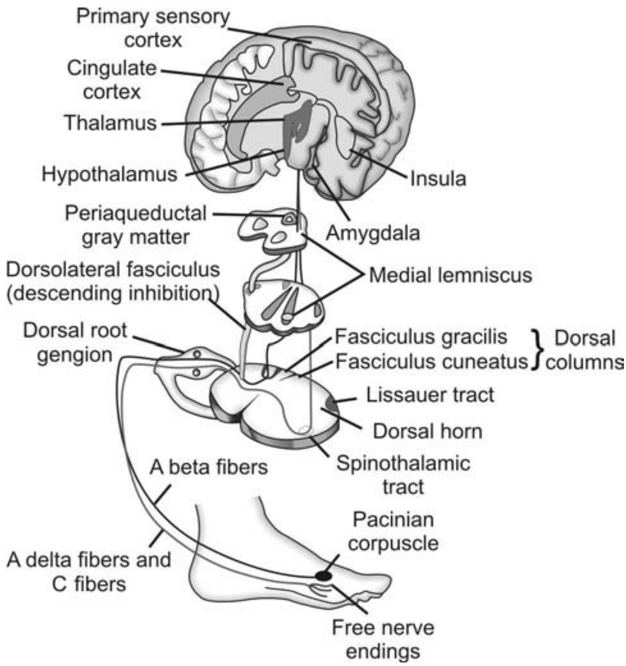


Figure 13.1: Pain pathway

The spinoreticular tracts conduct stimuli from the C fibres to the interlaminar nuclei of the thalamus and later diffusely to the cerebral cortex, predominantly the pre-frontal lobe. They are polysynaptic and hence slow conducting. They are related intimately with the reticular formation, limbic system and hypothalamus.

The earliest ***theories*** were proposed by ***Goldscheider*** and ***Gelhard*** who associated pain with the summation of impulses to non-specific receptors and with the patterns of impulses travelling along non-specific nerves from the periphery to the brain. These theories became outdated with the identification of receptor fiber specialization.

In the late nineteenth century, ***Von Frey*** proposed specific receptors and neural pathways associated with pain as well as a specific cortical pain centre. The current theory identifies stimulus-specific peripheral nerves that cause pain when activated by mechanical or chemical abnormalities.

According to the ***Gate control theory*** proposed by ***Melzack*** and ***Wall*** (Fig. 13.2) presynaptic inhibition in the dorsal gray matter of the spinal cord blocks pain impulses coming from the periphery. The dorsal gray, Laminae II, III (substantia gelatinosa) and V (transmission "T" cells) have been implicated in pain impulse transmission by ***Melzack*** and ***Wall*** in the following manner:

Information entering the dorsal horn via small diameter A-delta has a stimulatory effect on T cells, but an inhibitory effect on the substantia gelatinosa. When the substantia gelatinosa is inhibited, the T cells are

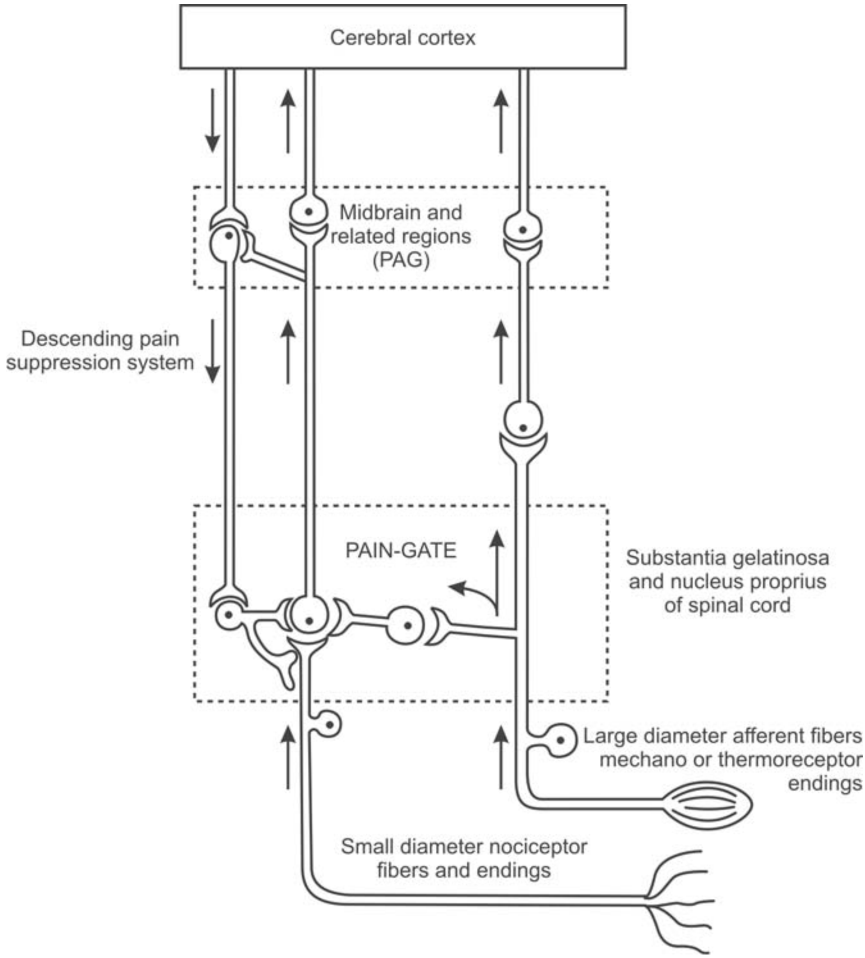


Figure 13.2: Pain 'Gate' theory

activated and pain impulses are transmitted to multiple pain centers in the brain including the cerebrum, brainstem, thalamus, and cortex. The gate is in effect ***open***.

On the other hand, inputs from large diameter A-beta fibers (pressoreceptors and mechanoreceptors) stimulate both the "T" cells and the substantia gelatinosa. Stimulation of the substantia gelatinosa presynaptically inhibits the T cells and transmission of pain impulses does not occur. Now, the gate is closed. Thus stimulation of the large, myelinated fibres from the periphery into the substantia gelatinosa of the spinal cord which receives nociceptive inhibition from higher centres causes the pain gate to be closed and inhibition of further pain transmission by other nerve fibres

The theory failed to explain why pain persists when the small fibers are destroyed or why pain can be modulated with cognitive measures. There is a modified gate control theory to recognize a descending system, which originated in the higher centres and influenced activity in the dorsal gray matter. It is suggested that the limbic system, reticular formation, and neocortex all affect pain perception.

Biochemical Theory

Research in the 1970s and 1980s supported Melzack's modified theory, when endogenous opiates and other neuromodulating neurotransmitters were discovered within the central nervous system (CNS). Endogenous opiates are divided into ***endorphins, enkephalins, and substance P***.

Endorphins are long-lasting morphine-like-chemicals found primarily in the thalamus, midbrain, pons, medulla, and hypothalamic pituitary axis that produce analgesia as well as effects on mood. Endorphin levels in individuals with chronic pain vary depending on whether the pain is of neurogenic, somatogenic, or psychogenic origin. Endorphins are thought to be significant in activating a central regulatory system that inhibits transmission in the dorsal gray matter.

Enkephalins mediate a second central pathway in which the descending neurons originate in the reticular formation and inhibit transmission by the interneurons in the dorsal gray as above. This system is enhanced with increased blood concentrations of catecholamines.

Depolarization of the secondary neurons in the dorsal gray matter is mediated through release of ***substance P*** which decreases pain perception. Increased mechanoreceptor input inhibits the release of substance P, thereby decreasing pain transmission. However, some conflicting evidence suggests that high concentrations of substance P result in excitation of the afferent neurons, thus facilitating pain transmission.

Although serotonin is not classified as an endogenous opiate, it exerts a profound effect on analgesia and enhances analgesic drug potency. High concentration of serotonin decreased pain while low concentrations increased pain. Serotonin also inhibits transmission of nociceptive information within the dorsal horn.

There are two cortical modulating systems, both of which can function as either excitatory or inhibitory, depending on the neurons on which they terminate.

CHRONIC PAIN

Chronic pain is a complex medical, psychological, social and economic problem. It is now considered an independent disease state. Chronic pain without an organic pathology and associated with pain behavior is called chronic pain syndrome or idiopathic chronic pain. It persists longer than the course of natural healing that is taken after an injury or disease process and associated with continuing pathology (e.g. cancer, arthritis) or may remain after the pathology has resolved. It is poorly localized and continuously present. The back is the most common site for chronic pain. In fact, a huge majority of people goes through life with complaints of having suffered from back pain at sometime or the other.

Depression: People with chronic pain have a high risk of developing psychiatric symptoms — and depressed patients have three times the average risk of developing chronic pain.

Sexual dysfunction in chronic pain is very rarely discussed, but nevertheless is a genuine problem and it is estimated that a vast majority of all pain sufferers have sexual problems.

EVALUATION OF THE CLIENT WITH PAIN

History

- ***Origin/Onset:*** Date and circumstances of the onset of pain. How was the pain precipitated? Gradually or suddenly? Was there any injury? If so, what was the nature, or intensity of injury? If not, can the client correlate the onset to a particular activity or posture?
- ***Position:*** where?
- ***Severity***
- ***Quality*** throbbing, burning lancinating, piercing, etc.
- ***Pattern:*** when is it more? Aggravating and relieving factors
- ***Radiation:*** where does the pain spread?
- ***Functional and psychological components*** of pain; what daily activities are prevented by pain?
- ***Visceral symptoms***
- ***Treatment:*** previous/current treatment being given.

Pain Intensity (Fig. 13.3)

Pain is a highly subjective phenomenon and attempts to quantify pain have varied from individual memory of the pain experience to using external stimuli to reproduce pain of the same intensity. It is not easy to measure the intensity of chronic pain (which is usually overestimated), but has been of some limited value with acute pain, which is remembered accurately for up to 5 days.

Pain induced by experimental tests utilizing mechanical pressure, temperature, vascular occlusion, and electric stimulation bears little resemblance to the pain produced by disease. Actually, experimentally induced pain measures only the client's pain threshold and pain tolerance at the time of testing.

There are a few methods of quantifying pain as follows:

- ***Verbal rating scale:*** The client rates the pain on a scale that is subdivided into gradually increasing pain intensities. The quality of pain intensifies according to the words used

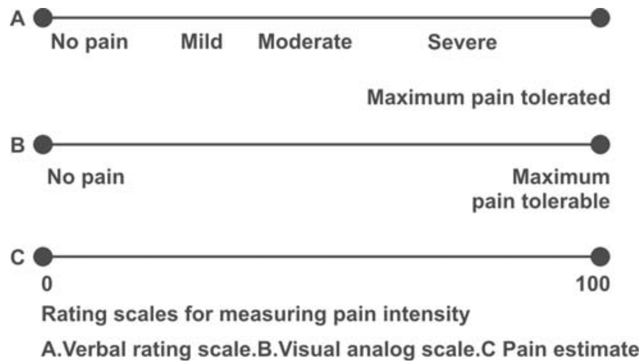


Figure 13.3: Visual scales for estimating and evaluating pain

- ***Visual analogue scale*** the client rates the pain on a scale from zero to ten where zero denotes no pain and ten indicates maximum pain/ killing pain. The scale has no sub division.
- ***Pain estimate:*** The patient rates the pain on a scale of 0-100 where 0 represents a lack of pain and 100 represents most severe pain felt.

Other Pain Scales

- Verbal description scale
- Behavioral rating scale
- Simple numerical rating scale
- Pain relief scale.

Submaximal Effort Tourniquet Test

Tie a blood pressure cuff over the arm. Inflate the cuff above arterial pressure and ask the patient to rhythmically clench and unclench grip his hand. As the hand becomes progressively ischemic, ask him to match this ischemic pain to actual pain felt.

McGill Pain Questionnaire

Developed by Dr Melzack at McGill University, it is a questionnaire that has questions like "how does your pain feel like?" "Does your pain change with time and if so how?" "And how severe is your pain?" and evaluates the responses in patients with chronic pain. The questionnaire can be completed in less than half an hour. It has been researched and validated for chronic and acute pain as well as for a variety of specific pathological states.

This involves 20 categories of descriptive words covering the various parameters or properties of pain. Each word has a number. The patient circles the three words in groups 1-10 that most convey his pain response. If no word in a particular group is suitable, the category is skipped Then he picks the two words in groups 11-15, one word in group 16, and one word in groups

17-20. Ultimately we would be left with seven words that describe the nature of the pain felt. When completed, the test provides a series of adjectives describing what the client is experiencing as well as a numerical score that can be used to monitor changes in the pain pattern.

Group 1 Flickering, Pulsing, Quivering, Throbbing, Beating, Pounding
Group 2 Jumping, Flashing, Shooting
Group 3 Pricking, Boring, Drilling, Stabbing
Group 4 Sharp, Gritting, Lacerating
Group 5 Pinching, Pressing, Gnawing, Cramping, Crushing
Group 6 Tugging, Pulling, Wrenching
Group 7 Hot, Burning, Scalding, Searing
Group 8 Tingling, Itching, Smarting, Stinging
Group 9 Dull, Sore, Hurting, Aching, and Heavy
Group 10 Tender, Taunt, Rasping, Splitting
Group 11 Tiring, Exhausting
Group 12 Sickening, Suffocating
Group 13 Fearful, Frightful, Terrifying
Group 14 Punishing, Grueling, Cruel, Vicious, Killing
Group 15 Wretched, Binding
Group 16 Annoying, Troublesome, Miserable, Intense, Unbearable
Group 17 Spreading, Radiating, Penetrating, Piercing
Group 18 Tight, Numb, Squeezing, Drawing, Tearing
Group 19 Cool, Cold, Freezing
Group 20 Nagging, Nauseating, Agonizing, Dreadful, Torturing

Reliability and validity of this test are based on examiners and clients objectivity.

Pain Clinic

The first pain (nerve block) clinic was started in 1936, by Rovenstine at New York.

A pain clinic should be holistic and offering a wide range of treatment techniques by people of different disciplines. Here the assessment of the patient's pain is made, differential diagnosis is done and depending on the outcome, patient is treated individually or in a group setting or referred to another department for further management.

Team Members

Team members typically include a physician, psychologist, physical therapist, vocational counselor, occupational therapist, social services counselor, pharmacist, dietician and nurse. Other professionals such as acupuncturists, pranic healing specialists, or exercise physiologists, also form part of the team. The physiatrist leads the team, co-ordinates the program, and provides overall medical management. The psychosocial- vocational team, consisting of the psychologist, social worker, and vocational counselor evaluates and treats behavioral changes that are a result of chronic pain.

PAIN MANAGEMENT

Aims

- To identify and treat the organic cause
- To improve the patient's ability to cope with the pain
- To improve function—as measured by ADL, distance walked vocational activity, etc.

Acute pain, by definition, resolves quickly when the cause is removed. Management includes drugs, medical or surgical intervention.

Based on the origin of the pain the management is:

Pain of mechanical origin responds better to manipulative procedures, e.g. corrective exercises, postural realignment.

Pain of inflammatory origin responds well to physical modalities, e.g. heat, cold, short-wave diathermy, ultrasound. This depends a lot on when the intervention is started, whether it is a acute or chronic pain

The emphasis today has shifted from applying pain-relieving modalities to developing pain-relieving behavior.

Medical Intervention

The modalities used to manage chronic pain are:

- Pharmacological
- Physical
- Behavioral

Vocational Rehabilitation

Pharmacology and Surgery

- Non-steroidal anti-inflammatory drugs like ibuprofen or nimesulide
- Narcotic drugs like morphine or pethidine
- Adjunct analgesics like paracetamol.
- Anesthetic treatment-nerve blocks
- Surgery is also done where abscesses or compression of structures, are present.

Vocational rehabilitation should be an integral part of pain management and should be started early in the rehabilitation process. Employers should be encouraged to make reasonable accommodation and to consider the patient returning to work in a modified or part-time position. Ergonomics- modifying the place of work to suit the worker and vice versa is increasingly being adopted at the workplace as a means of ensuring the health and thereby better productivity of the worker. This assumes great relevance in jobs involving lifting heavy weights, which could lead to back pain, or usage of computers, which could lead to repetitive strain injury.

Cognitive Behavioral Methods

Relaxation exercises	Music
Aroma therapy	Group therapy
Hypnotherapy	Counseling
Hypnosis	Biofeedback
Operant conditioning	Body scanning Reiki and Pranic healing

PHYSICAL AGENTS USED IN MANAGEMENT OF PAIN AND PARALYSIS

Several physical agents are used in the therapeutic management of pain and paralysis. Indeed, some of these modalities, like heat have been used from time immemorial. Today, scientific application of electric currents, heat and cold are gaining wide acceptance all over the world as front line modalities independently or in conjunction with drugs and surgery. Some of them are invaluable in regaining power and mobility and relief of pain.

Physical Agents Used

Therapeutic cold (cryotherapy)
Ice packs, ice immersion, ice stroking

Heat
Superficial heat, deep heat

Light Radiation
Infrared radiation, ultraviolet radiation, LASER

Electrical Currents
Diathermic currents (deep heat), Interferential currents, TENS, Faradic and Galvanic currents, diagnostic electrotherapy

EMG
Biofeedback

Sound
Ultrasound therapy

Mechanical effects
Vibration, traction and compression, massage, orthotics, therapeutic exercise, hydrotherapy.

THERAPEUTIC COLD (CRYOTHERAPY)

Cryotherapy is the treatment of a pathological lesion by the use of low temperatures for the relief of pain, muscle, spasm and oedema. Cooling by ice cube massage at 0° C will act as a counter irritant, cause a reduction in acetylcholine production and produce an asynchrony of impulse which can break the pain pattern and relieve chronic pain.

Cold can decrease the activity of the fusimotor efferent systems in muscles and thus relieve pain and muscle spasm. The reaction to cold in pain and muscle spasm is more long-lasting than the reaction to heat. This effect is also used for the control of spasticity.

Properties of Cold

When cold is applied to the body, skin temperature changes, the speed of which depends on various factors as follows:

- Temperature of the application.
- Duration of the cold application.
- Density of skin, subcutaneous fascia, fat and muscle
- Region to which it is applied
- Pathophysiology of the lesion.
- Fluid content, vascularity and specific resistance of the tissue.

Methods of Cooling

Convective cooling which the transmission of heat in a liquid or gas by bulk movement of heated particles to a cooler area

Evaporative cooling – evaporation of a liquid, typically into the surrounding air, cools an object or a liquid in contact with it. Latent heat , the amount of heat that is needed to evaporate the liquid comes from the liquid itself and the surrounding gas and surfaces

Conductive cooling – the transmission of heat is by conduction.

Physiological Effects of Cold

- Reduces skin temperature
- Constriction of blood vessels
- Decreases afferent nerve velocity
- Decreases vascular permeability
- Increases blood, water, and lipid viscosity
- Reduces muscle contraction
- Increases sympathetic reactions
- Reduces cellular metabolism

Circulatory Response (Fig. 13.4)

The initial response of the skin to cooling is an attempt to preserve heat and this is accomplished by an initial local vasoconstriction. After a short period there follows a vasodilatation and then alternate periods of constriction and dilatation. This apparent 'hunting' for a mean point of circulation is called '***Lewis' Hunting Reaction***'.

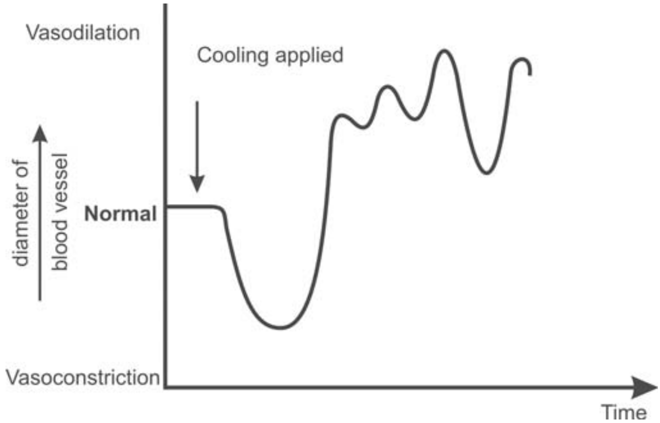


Figure 13.4: Lewis 'Hunting reaction'

Neural Response

Reduction of pain: The mechanism involved is the stimulation of cold receptors, which send back impulses, which have to pass into the spinal cord via the posterior root.

Reduction of spasticity through reduced velocity of nerve conduction, and depressed sensitivity of receptors such as the muscle spindle.

Excitatory Cold

Slow stimulus of ice can be used to increase the excitation around the anterior horn cell. Combined with the patient volition, this can produce contraction in an inhibited muscle and can be used for muscle re-education.

Techniques of Application

- Ice towel
- Ice packs
- Immersion
- Ice cube massage
- Cryokinetics – cold with exercise
- Cryostretch – cryotherapy followed by stretching
- Trigger point massage
- Cryosurgery
- Whole body hypothermia

Indications

- Pain and muscle spasm of an acute nature, like sports injury
- Chronic inflammation following trauma
- Spasticity
- Facilitation of movement
- To reduce swelling.

Contraindications to Ice Treatment

- Peripheral vascular and vasospastic disease.
- Myocardial infarct – Up to 6 months after a myocardial infarct ice treatment should be avoided.
- Sensitivity following the application of ice to the patient who reacts adversely to ice with development of local histamine- like urticaria. A rash and itchiness may develop.
- Throat, ear and neck infection—should be avoided as an adverse visceral reaction may occur.
- Cancer and sickle cell anemia
- Psychological—the thought of ice terrifies many a patient, particularly the elderly. Sometime the fear of cryotherapy makes the condition worse.

THERAPEUTIC HEAT

It is the most common form of treatment for pain. It can be used for subacute and chronic conditions like musculoskeletal spasms, chronic inflammatory joint disease, bursitis, epicondylitis, muscle and tendon tears, and tenosynovitis. Heat may be superficial or deep depending on the depth to which it can penetrate and be felt in the body.

- ***Superficial heat***—can be applied in the form of hot packs, paraffin wax baths and infrared rays. Hot packs and paraffin wax produce a slow rise in temperature and are sedative in action as they reduce nerve conduction velocity of the sensory nerves. Infrared radiation causes a moderate rise in heat to the level of the superficial muscles and also relieves pain.
- ***Deep heat***—vigorous heating produced by conversive diathermy agents can relieve pain. Deep heat is applied in the form of ultrasound and diathermy.

PARAFFIN WAX

Paraffin wax therapy is one of the most convenient, reasonably efficient methods of applying conducted heat to the extremities. Paraffin wax is applied as a liquefied form, after heating to a temperature of 40-52° C on the surface of the skin. It gives up the latent heat of fusion as it solidifies, without any temperature change. The specific heat of paraffin wax at 2.72 kJ/kg/°C is lower than water which makes it easier to immerse the hand in liquid wax at these temperatures. Also it is postulated that some wax solidified in contact with cooler skin acts as an insulating agent along with trapped air, against the hotter liquid wax surrounding. Wax baths, though classified as superficial heat can heat up deeper tissues like joint capsules.

Physiological Response to Paraffin Wax Therapy

Heat production

- *Circulatory effect:* Local hyperemia and reflex vasodilatation.
- *Analgesic effects:* Soothing effect or marked sedative effect on the tissue.

- *Stretching effects:* It stretches scars and adhesions prior to mobilization.
- It leaves skin supple and moist by avoiding water evaporation

Indications

- Pain
- Muscle spasm
- Oedema
- Inflammation
- Adhesions
- Scar

Contraindications

- Impaired skin sensation
- Circulatory dysfunction
- Infections and open wounds
- Gross Oedema.

LIGHT RADIATION

The electromagnetic spectrum consists of radiation, ranging from cosmic ray photons, gamma rays, X-rays, ultraviolet radiation, visible light, infrared radiation, microwaves and radio waves. Light radiation is a source of heat that is produced in the middle of this spectrum from luminous and non-luminous sources. The visible light spectrum or optical spectrum is the portion of the electromagnetic radiation spectrum that is visible to the eye. The wavelength ranges from approximately 400 nm (4×10^{-7} m) to 700 nm (7×10^{-7} m). The entire spectrum includes infrared radiation, visible radiation, ultra-violet radiation and laser beam.

Infrared Radiation

These are longer wavelength (760 nm to 1 nm) radiations than the visible red spectrum. Depth of penetration of infrared radiation is around 1 - 3 mm through the skin surface. The technique of application consists of focusing the lamp at a particular distance of 18-20 inches from the treatment area so that the rays strike at 90° for maximum penetration. The duration of treatment is 10 - 15 minutes.

Effects and Uses

Pain relief, reduction of muscle spasm, healing and repair of tissues.

Healing of Pressure Sores

IRR increases the circulation to the part being treated, increasing the metabolic rate and dehydration of tissues thereby retarding growth of infection and thus promoting tissue healing in pressure sores. The effect of infrared radiation depends upon the size of the ulcer. There are possible dangers like burns due to poor sensation and eye damage.

Ultraviolet Radiation

Ultraviolet radiation has wavelength from violet end of visible spectrum to the X-rays (390 – 400 nm). They are produced therapeutically by air-cooled and water cooled mercury vapor lamps and also by Kromayer lamps. The former lamp is used to treat a larger area of skin while the latter is used for a localized area.

Indications

- Pressure sores
- Skin diseases–psoriasis
- Hair disorders like alopecia
- Rickets.

Laser Treatment (Fig. 13.5)

One of the most recent treatment modalities available to physiotherapists is the Laser. Laser is an acronym formed from the words "Light Amplification by Simulated Emission of Radiation".

Treatment units may combine helium - neon laser which produces a red light beam at 630 nm with an infrared laser at 904 nm. The useful depth of penetration with an infrared laser could be up to 30 mm, which is considerably deeper than the infrared from a conventional lamp.

There are three types of lasers based on their application.

- Power laser is used for destructive or surgical purposes.
- Soft lasers have a very superficial effect and are used for treating the skin.
- Mid lasers are the type used by physiotherapists as their penetration is sufficient to produce a biological effect on deeper tissues without damaging them.

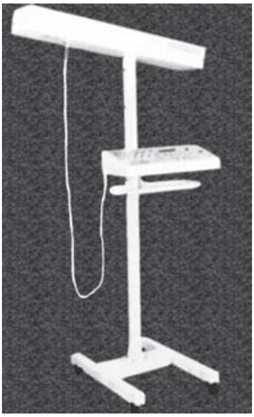


Figure 13.5: Laser therapy unit (*Courtesy:* Electrocare Systems and Services)

Effects of lasers: Lasers are claimed to have several physiological effects that promote healing and pain relief. There are many theories concerning the therapeutic effects of laser therapy on wound healing, like long-term erythrocyte membrane protein structural changes, ATPase activity changes, resulting change in membrane ion pumps, and activation of enzymes like phospholipase.

It also is shown to have the following effects:
- Promotes the synthesis of collagen and growth hormone
- Activates cells promoting healing like keratinocytes, or endothelial cells
- Increased delivery of oxygen and nutrients like Ca and K in the area of healing
- Generates new blood vessels (angiogenesis)
- The immune response is stimulated
- Lymphatic drainage is improved

Indications
- Wound healing by virtue of the physiologic effects above.
- Soft tissue injuries- tendons and ligaments- pain relief

Contraindications
- Epileptics
- Cardiac patients
- Patients with pace maker
- Skin infection.
- Cancer.

DEEP HEAT: SHORT-WAVE DIATHERMY (FIG. 13.6)

Short-wave diathermic currents are high frequency currents commonly used for medical work at a frequency of 27.12 MHz and sets up radio waves with a wavelength of 11 m. It is set up by capacitor or coil method. There are 2 circuits; the patient circuit and the machine circuit. The electromagnetic energy is transmitted by induction to the patient circuit.

Physiological Effects of Diathermy Currents

These currents do not stimulate nerves since the impulses last less than 0.001 ms, which is beyond the range used for nerve stimulation. Thus when such a current is passed through the body there is no discomfort or muscle contractions. The evenly alternating current does not produce chemical burns. Therapeutic effect of deep heat is also evident. This is because free ions in the tissues vibrate in response to high frequency. The friction between the ions produces heat. Molecules of water too act as dipoles and move to opposite charges on the plates in an oscillatory motion producing deep heat in the tissues. Circular currents at right angles to the line of force produced by the

Figure 13.6: Short-wave diathermy apparatus
(*Courtesy:* Electrocare Systems and Services)

Electromagnetic field give ***eddy currents*** which leading to friction of tissue particles and produce heat in blood and muscles.

Therapeutic Uses of Short-wave Diathermy

Relief of Pain: It is found that a mild degree of heating is effective in relieving pain, presumably as a result of a sedative effect. There is a theory that pain may be due to the accumulation of the waste products of metabolism or of pain producing chemicals in the tissues and that augmenting the flow of blood through the area assists in removing them. Strong superficial heating probably relieves pain by counter irritation. Short-wave diathermy assists in bringing about the resolution of inflammation and so indirectly relieving the pain. Active exercises can thus be performed more efficiently after application of diathermy currents.

Duration of Treatment: This, too, depends on the nature and duration of illness; however, some protocols recommend 20 minutes as the optimum treatment time as the tissue temperature will usually reach a 'steady state' within this period.

Intensity of Short-wave Diathermy: The only safe measure of the intensity of treatment is the sensation of mild, comfortable warmth described by the patient—anything hotter than this could result in the development of a burn. There are variations in electrode placement like flexible pads which are metal electrodes in rubber casing. Other forms of electrodes used are space plates, coil electrodes, monodes, and diplodes. The therapeutic effect of the current will ultimately depend on the spacing between the electrodes, the placement (coplanar or contraplanar) ,the size of the electrode and whether we pass the current in a pulsed fashion or not.

Indications: Disorders of the musculoskeletal system (sprains strains)
- Muscle and tendon tears
- Capsule lesions
- Degenerative joint disease
- Chronic inflammatory or infective conditions like, tenosynovitis or bursitis
- Sinusitis

Contraindications
- Malignancy
- Ischemic tissues
- Moderate oedema
- Metallic implants
- Pacemakers
- Tuberculous joints
- Impaired thermal sensation
- Unreliable patients like small children and intellectually impaired adults
- Recent radiotherapy
- Acute infection or inflammation
- Pregnancy / menstruation
- Severe cardiac conditions
- Severe blood pressure abnormalities.

INTERFERENTIAL THERAPY (FIG. 13.7)

Interference therapy is a method of producing low frequency alternating currents around 4000 Hz to evoke interference currents between 1 and 100 Hz, selectively at any tissue depth, to overcome the problem of skin resistance.

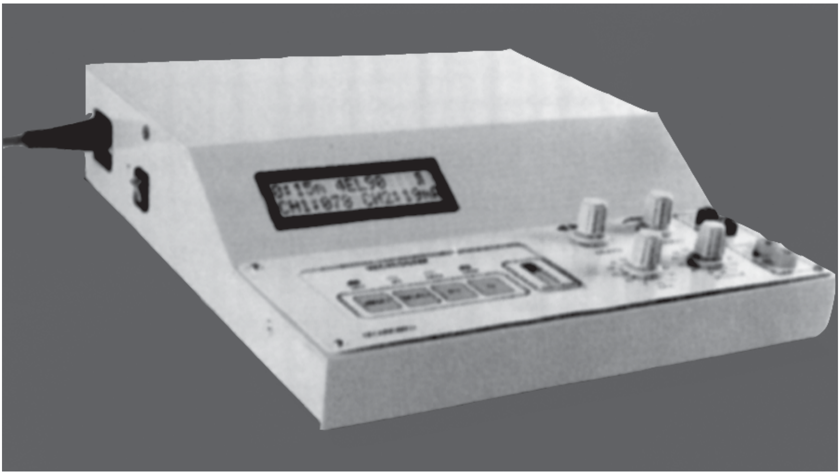


Figure 13.7: Interferential therapy (*Courtesy:* Electrocare Systems and Services)

Physiological Effect of Interferentical Therapy (IFT)

Skin usually has high impedance that is resistant to current that is a result of three factors: the resistance to the current, the reactance, which is the resistance offered by the capacitive and inductive elements in the skin to alternating current, and the frequency of the current. The impedance is measured in ohms. The frequency is inversely proportional to the skin impedance. In interferential therapy, two medium frequency currents are crossed. Naturally when the frequency is high the impedance decreases and thus depth of penetration increases.

Direct stimulation by the interference current at a constant 100 Hz produces inhibition of the sympathetic system. The passage of interference currents through the stellate ganglion will relieve causalgia seen inpatients with reflex sympathetic dystrophy, such as the shoulder-hand syndrome. Skin temperature changes can be noted if the interference current is given to the cervical sympathetic ganglion.

Increased vasodilatation is seen following the use of interference currents on the sympathetic ganglion. This could also help to relieve pain by removing the pain metabolites, and mobilizing exudate if present.

Interferential therapy or didynamic currents are made to activate the large 'A' alpha fibers. In patients with postherpetic neuralgia then pain can be inhibited at the spinal level, based on the Gate theory of Melzack and Wall.

Method of Application (Fig. 13.8)

Interferential therapy currents are applied by metal or rubber electrodes coated with water sponges or lint. It is better to interface the carbon rubber electrodes

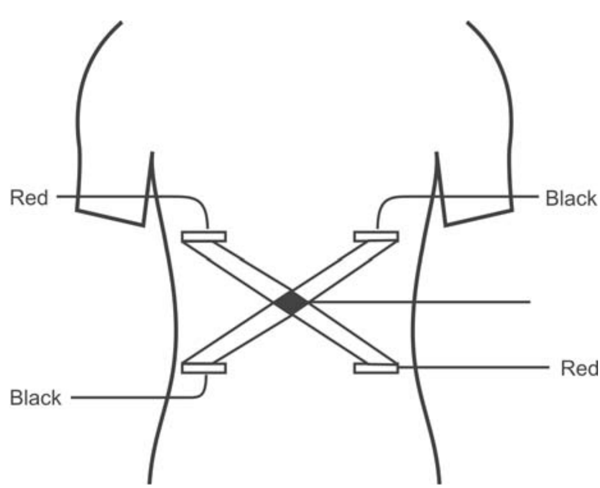


Figure 13.8: Placement of electrodes of interferential therapy for back ache

with conducting gel. Four poles technique is generally used and the electrodes are fastened by rubber straps or bandages to maintain good electrical contact without causing discomfort, and so that the current crosses one another in the target tissue. They are positioned in a co-planar manner to treat a flat surface such as the back. The leads are color-coded (red, black) to obtain correct arrangement of the circuit.

IFT can be applied through various units. A vacuum unit will create a negative pressure, which helps the placement of electrodes.

Bipolar mode: In this only two electrodes are used; in such case the two medium frequency currents are super imposed within the machine already. The interference occurs throughout the region between the electrodes. In case of a larger treatment area, such as the back, the interferential mode is applied by means of vector method.

Indications

Pain occurring from reflex sympathetic dystrophy or shoulder-hand syndrome can be treated by applying interferential currents or didynamic currents to the appropriate sympathetic ganglion, such as the stellate ganglion for the shoulder hand syndrome. In general, the symptoms of pain muscle spasm or edema are treated. Interferential therapy is not effective in post-traumatic pain in the acute stages, but is effective in cases of chronic pain with or without swelling, particularly after prolonged immobilization.

Contraindications

- Artificial pacemakers
- Infective conditions, e.g. tuberculosis
- Malignant tumors
- Unreliable patients (mentally retarded).

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

Transcutaneous nerve stimulation is a popular form of pain management based on the application of pulsed rectangular wave current forms through surface electrodes on the skin. It works on the principle of the Gate theory of pain and achieves pain relief by stimulating large afferent fibres preferentially and thus inhibiting transmission of pain impulses. These are usually battery operated with a current output (intensity) of 0-60 mA, and are thus portable, enabling the physical therapist to provide pain relief even at home for patients who cannot come to the physiotherapy centre.

Parameters

- Pulse—rectangular
- Pulse width—varies from 50-300 microseconds, but it is often fixed at 200 microseconds

- Frequency—varies from 5 Hz to 500 Hz
- Intensity—can be altered until a tingling sensation is felt. It should not be painful or cause muscle contraction
- Application of electrodes—the electrodes (2 or 4) are applied with conducting gel on the patient skin, above and below or even over the painful spot, or sometimes over acupuncture points, trigger points, affected nerves or dermatomes.

Method of Application

- ***High-TENS:*** Frequency 100-150 Hz. Pulse width 100-500 microseconds. At intensity of 10-30 mA, these fall into the muscle stimulating range, with higher intensities tetanic contraction may result, with a strong tingling sensation.
- ***Low-tens:*** Frequency 1-5 Hz. Pulse width 100-150 microseconds. Intensity more than 30 mA. Gives a sharp nociceptive stimulus and a muscle twitch.

Indications

- Chronic pain syndromes like back pain and cervicobrachial neuralgia.
- Phantom limb pain
- Trigeminal and Postherpetic neuralgia

Contraindications

- Cardiac pacemakers
- Cardiac arrhythmias
- Poor sensation.

FARADIC CURRENT

A faradic type current is a short duration interrupted alternating direct current with pulse duration of 0.01 to 1 ms and a frequency of 50 to 100 Hz. Faradic type current is a muscles stimulating current acting directly on nerve fibres. These currents are normally used therapeutically for stimulating muscles with ***an intact nerve supply***.

The current is also surged at a variable controlled speed, ranging from 4 - 30 surges per minute with varying rest (surged faradism). The faradic type currents are always surged to produce a near normal tetanic like contraction and relaxation of muscles. The circuit can be modified to give surges of various duration, frequencies and waveforms. The various forms of pulse may be trapezoidal, triangular and saw tooth.

Pause duration: as a rule the pause duration should be at least 2 to 3 times as long as that of pulse to give the muscle sufficient time to recover.

Pulse Duration: Pulse duration is 0.02, 0.05, 0.1 or 1 ms. generally the most comfortable pulse is either 0.1 ms with frequency of 70 Hz or 1 ms pulse with a frequency of 50 Hz.

Faradic type current is always surged when used for therapeutic purposes.

GALVANIC CURRENT

This is an undirectional current also known as constant direct current (Galvanism). The constant DC current can also be interrupted giving a series of impulses repeated at a defined frequency (IG). The impulse duration is a long duration current of 1 MS and more. The pulse shape varies from rectangular waves, triangular; saw tooth, trapezoidal, etc. The pulse separation can be 1 MS to several seconds. The interrupted galvanic currents thus produce motor and sensory stimulation of denervated muscles.

The technique of application of IG currents is concentrated on the muscle bulk rather than the nerve trunk.

DIAGNOSTIC CURRENTS

Electrical Tests (Figs 13.9 to 13.11)

A strength duration curve may be plotted on a graph by starting with a long duration pulse and using the minimum intensity of current to produce a response ***(rheobase)*** and then gradually decreasing the duration of the pulse until we get a response with a current of double the rheobase ***(chronaxie)***.

Denervated muscle can be stimulated directly but the shorter the pulse the greater is the intensity needed to produce a contraction. Eventually the pulse is too short to produce a response regardless of the intensity of the current and the graph shows complete reaction of degeneration. Sometimes a variable number of nerve fibres supplying a muscle have escaped damage whilst others have been severed. When this happen the strength-duration curve shows a combination of a normal curve and that of a denervated nerve. If more nerve fibres become degenerated the 'kink' in the curve will move to the left. As the nerve starts to regenerate and some nerve fibres are remyelinated a similar curve showing partial innervation will develop, and the 'kink' in the curve will move to the right.

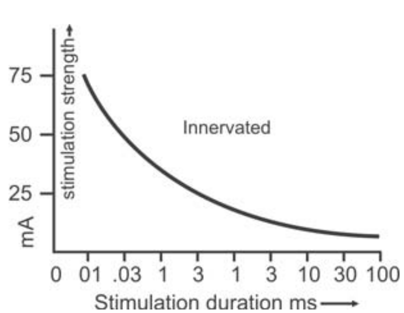


Figure 13.9: Strength duration curve for innervated muscle

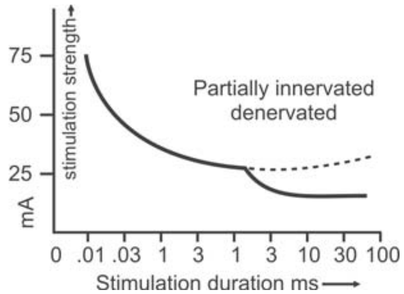


Figure 13.10: Strength duration curve for partially innervated and denervated muscle

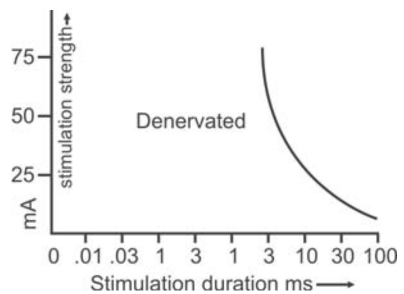


Figure 13.11: Strength duration curve for denervated muscle

If the muscle tissue degenerates to fibrous tissue there will be no response to any type of electrical stimulation, which is known as the ***absolute reaction of degeneration***.

Electrical tests are not carried out for the first 3 weeks as the changes of degeneration may not be complete and the tests could give a false picture of the changes.

The level of recovery needed will vary according to the occupation, as some patients may undertake their type of work with an incomplete recovery whereas others such as concert pianists cannot continue to play to the standard required.

IONTOPHORESIS

Iontophoresis is a process by which electrically charged molecules and ions are driven into tissue with the help of an electric field. During iontophoresis, the tissues are attached with electrode pads containing drugs in electrolyte form are attached to the sides. When the electric charge is applied, there occurs movement of charges (ions) from the positive to negative pole through the skin and vice versa. The ions exert their action in the tissues which they pass. Thus the drugs are locally activated in the tissues for therapeutic purposes. Usually the active electrode placed on the treatment area liberates more ions (drugs) in the tissues. Iontophoresis is extremely effective in hyperhydrosis and soft tissue inflammatory conditions.

The dosage of current and duration depends upon the condition of the drugs used for iontophoresis. Anticholinergic compounds in distilled water with Glycopyronium bromide at the anode is used for hyperhydrosis.

BIOFEEDBACK (FIG. 13.12)

Biofeedback may be defined as the technique of using equipment to reveal to a person some of his internal physiological events, in the form of visual and auditory signals. This technique makes the person react voluntarily in an open feedback loop in a machine—hence the name artificial biofeedback. Using a special equipment and sensors to record muscle contractions and skin temperature, the patient gets a feedback of his efforts and later he can recognize and control facets of the stress response by himself. There are no negative side effects have been reported with biofeedback, but it is not recommended for persons with severe psychosis, neurosis or diabetes.

Figure 13.12: Biofeedback

The word "biofeedback" was coined in the late 1960s to describe procedures by which people are trained to control their internal milieu including involuntary processes, such as heart rate blood pressure, muscle tension, and skin temperature, measured with electrodes and displayed on a monitor that both the participant and therapist can see. The patient sees the internal working of some specific systems in her or his body on it and can then be taught to try and control these so-called "involuntary" activities.

Biofeedback thus works on the premise that we have the inherent ability to modify and influence the automatic functions of our bodies through our will power. It is an effective therapy for many conditions, like hypertension, headache, stroke, cerebral palsy, chronic pain, and urinary incontinence. Many of these techniques have been scientifically proven, but scientists cannot yet explain how biofeedback works.

Principles of Electromyographic Biofeedback (EMGBF)

Muscle potentials are changed into auditory or visual cues for increasing or decreasing voluntary activity. Feedback statements as "try harder" or "relax more" are difficult for most patients to identify. Biofeedback needs to be fast and the feedback needs to be specific. In fact, EMG biofeedback is instantaneous and 'real-time' and relies on visual or auditory cues. Typically, surface electrodes applied to the skin overlying a given muscle or muscle group will sense small voltage changes (muscle action potentials). The changes are then amplified and converted to a digital value, which is displayed to the patient in the form of a graph, a dial or as a sequence of lights. Increases in muscle activity are also displayed as an increase in pitch, repetition or amplitude of sound. Electrical silence is noted when a needle electrode is placed in a muscle that is not actively contracting.

EMG Activity During Movement

Initially the muscle is chosen and the area of skin overlying is cleansed. The needle is inserted into the muscle, and the oscilloscope is observed while the muscle is at rest. A muscle that is in a state of irritability will react to the movement of a needle electrode by insertional activity or injury potentials which is seen as a burst of short duration potentials for less than a few milliseconds.

Following patient preparation and electrode placement, the patient is oriented to the EMGBF unit and instructed in the meaning of the visual display, threshold detection, and auditory signals.

As the physician interacts with the patient and shows him or her the normal EMG activity, and compares it with and his or her performance, they work together to determine how the patient can alter postures and movements to get normal EMG activity.

Biofeedback Instrumentation

All biofeedback instruments have three major components: the transducer, the processing unit and the output display unit.

Types of Biofeedback

- Electrogoniometric Biofeedback
- *EMG Biofeedback:* EMG is more useful for learning specific muscle contraction or relaxation.

Thermal biofeedback, which measures skin temperature

Neurofeedback or electroencephalography (EEG), which measures brain wave activity

Therapy Using Biofeedback

In upper motor neuron lesions like stroke or cerebral palsy, even when a person has no sensation in a paralyzed limb and cannot move it voluntarily, EMG can often detect some electrical activity in the muscles. The EMG machine amplifies these electrical signals coming out of the affected limb, and as the patient becomes aware of the activity, he can condition his musculoskeletal system to stimulate more muscle activity. Eventually, it is postulated that new nerve endings may grow in the affected muscles and the patient may regain some control over the muscle.

Temperature biofeedback devices monitor skin temperature and can be helpful in certain circulatory disorders like Raynaud's disease. In ***temperature biofeedback***, a sensor is attached to the extremity. When there is tension or anxiety, the skin temperature drops and blood is redirected inward to muscles and internal organs.

There is an electrodermal device that measures electrical conductance in the skin, which is proportional to the activity of the sweat glands. This is correlated to the emotional status of the person and the electrical conductivity of the skin. The machine translates the physiologic responses into a tone that varies in pitch, a video signal that varies in brightness, or a graph on a computer screen that varies in height. For example if the tone feedback is taken, a buzzing sound which is just audible at the beginning of the session gets louder as there is more perspiration. This means more tension, more the noise. The biofeedback therapist then teaches the person mental exercises. The patient will start imagining different scenes, or different colors till he puts himself in a frame of mind when the sound is no longer there. If the person becomes calmer and there is less perspiration, the noise reduces and is finally eliminated. In practice, and without linking to the machine, he will recall the imagery and keeps it up. He or she just relaxes and recalls how the state of mind was when the feedback was continuously extinguished.

This principle can also be used to promote relaxation in muscles that are tensed and bunched up in response to stress. When the electrodes pick up the muscle tension, as in neck muscles in repetitive stress injury, the machine gives a signal, such as a colored light or sound. In this way, the patient can see or hear the muscle activity and begins to focus on what the activity (or tension) feels like. In offices where stress levels are high and posture and ergonomic principles are followed too well, biofeedback can be a tool that continuously monitors the person at work and later there can be training to control the tension before it gets worse or causes other physical problems.

The ***EEG (electroencephalogram)*** monitors the electrical signals of various frequencies in the brain. These signals do not necessarily correlate to specific disorders or mental states. The brain waves are as follows:

- Beta (awake)
- Alpha (calm relaxation)
- Delta (deep sleep)
- Theta (light sleep)

Those with sleep disorders are taught to control theta waves, and another possible application is to monitor waves produced during seizures in epileptics. Other machines monitor heart rate and blood pressure, and their change in response to stress, or hypertension.

Indications

Stroke victims are helped to regain movement in paralyzed muscles. Psychologists use it to help patient's combat stress. People with chronic postural pain get relief out of biofeedback. In the treatment of ***urinary incontinence***, biofeedback is said to improve bladder function without any adverse effects. Thermal biofeedback is used in Raynaud's disease while EMG biofeedback has been shown to help people overcome insomnia.

Thus it is claimed that biofeedback helps in conditions like stroke, traumatic brain injury, back pain, high blood pressure, muscle spasms and spinal cord injuries. It is said to be beneficial in other disorders like anxiety, seizure disorders, learning disabilities, bed wetting, and sexual disorders.

ULTRASOUND (FIG. 13.13)

The human ear has a capacity of hearing sounds between the frequencies of 40 Hz to 20 kHz (20,000 cycles per second). Ultrasound is at frequencies well above this, the therapeutic frequency being in the region of l to 3 MHz.

Figure 13.13: Ultrasound therapy (*Courtesy:* Electrocare Systems and Services)
(For color version see Plate 3)

Effects of Ultrasonic Waves

The conduction velocity of a nerve is reduced if it is insonated with a dosage of 1 to 2 W/cm^2 of ultrasonic energy. Micro massage effect with pulsed ultrasound will block pain pathways by lowering the nerve conduction velocity. If the cause of the pain is due to adhesions or contractures, then ultrasound is effective in causing depolymerization of the mucopolysaccharides, mucoproteins, or glycoproteins, with increased elasticity and thereby reduced adhesions.

Ultrasound is also able to alter the distribution of ion concentration at the pain receptor sites, and thus cause increased diffusion of the pain producing plasma peptides and H^+ ion concentrations and thus remove the cause of pain.

In ischemia and swelling ultrasound alters the permeability of cell membrane and accelerates phagocytosis and the absorption of exudate. It is also thought to cause release of histamine like substances.

Thermal Effect

- Local rise of temperature - accelerates healing
- Extensibility of collagen increased
- Stretching of scar or adhesion
- Reduction of pain.

Non-thermal Effect

- Cavitation
- Mechanical micro massage.

Uses of Ultrasound

- Recent injuries
- Calcified tendinitis
- Chronic synovitis
- Localized pain and muscle spasm, Trigger nodules
- Scar tissue and adhesions
- Bursitis, Supraspinatus tendonitis, Plantar fascitis
- Chronic indurated oedema
- Plantar warts (verucca vulgaris)

Wound Healing

In the proliferative phase of wound healing ultrasound stimulates collagen secretion by fibroblasts, helping the process of wound contraction. Tensile strength and contractility are also increased. It is given with a hydrogel sheet over the wound and then a coupling gel for the treatment head. Treatment is also given to the tissues surrounding the wound.

Treatment Parameters

- ***Intensity:*** It is the total output of energy per second supplied by the ultrasound source. The rate of absorption in the tissues can be approximately determined by a value called the half value depth - this is the tissue depth at which 50% of the ultrasound delivered at the surface has been absorbed. It varies with the thickness of various tissues (e.g. skin or fat). Some of the energy delivered at the skin level is lost before it reaches the target tissue. More intensity is delivered at the surface than is required, to account for such absorption.
- ***Pulsed ratio:*** Transmission of ultrasound - When travelling from a medium in which its velocity is low into an area in which its velocity is high, ultrasound is refracted away from the normal. Ultrasonic beam produced in short bursts or pulses is called pulsed ultrasound. The time interval between pulses is called space ratio to the pulse and also reduces the time average intensity to the tissues, e.g. pulse of 2 ms and interval of 8 ms gives the pulse ratio as 2 ms: 8 ms, i.e. 1:4.
- ***Attenuation of ultrasound:*** It is the term used to describe gradual reduction in intensity of the ultrasonic beam once it has left the treatment head. Two major factors that contribute are:
  - Absorption of sound- the conversion of sound energy into other forms of energy
  - Scatter of sound – reflection of sounds in direction other than original direction of propagation.
- ***Ultrasonic fields:*** Depth of penetration and intensity of the ultrasonic beam.
- ***Coupling media:*** Ultrasonic waves are not transmitted by air, thus some couplant must be interposed between treatment head and patients skin. Common couplants used are water, oil, liquid paraffin, and aquasonic gel.
- Size of the transducer head
- Frequency used
- Duration of therapy

Generally if the depth of the lesion is less than 2 cm, 3 MHz freq is selected, and for deeper lesions 1 MHz is selected. For acute lesions the sound may be pulsed 1: 4 or 1:3, and for chronic ones it may be continuous or pulsed 1:2.

The intensity too varies according to the acuteness of the problem, with 0.2 W/cm^2 for the acute lesions and increasing to 0.8 W/cm^2 for the chronic problems. Rarely high intensities are used. The duration of treatment would depend on the area needed to be treated – one minute per treatment head area multiplied by the number of times the treatment area is bigger than the area of the treatment head.

Techniques of Application of Ultrasound

Direct Contact Application: In this technique the ultrasound head is kept directly on the treatment area with the help of an couplant medium. The transmission gel provides high transmissivity and viscosity (lubrication). The transducer head is placed in the treatment area with the gel and moved continuously with mild pressure in a slow rhythmic manner in circles, parallel strokes, etc. such that the head and treatment area of the skin are parallel to each other.

Immersion Method: When the treatment area is of irregular shape and tender areas, such as ankle, immersion method can be applied. The transducer head is kept in a trough of water and the part is also immersed in it at a comfortable temperature. The head is moved parallel to the treatment surface of 1 to 2 cm away from skin. Care should be taken that there are no air bubbles during therapy.

Water Bag Technique: This is an adjunct to previous method, in which a water bag forms a medium between the treatment head and the skin. Ordinary hot water bag can be used with air seal. The treatment head is moved along with the bag over the surface on which the couplant is kept.

Contraindications
- Vascular conditions
- Pregnancy
- Cardiac disease (pacemaker implant)
- Tumor
- Pain over bony prominences.

MECHANICAL METHODS OF TREATMENT

TRACTION (FIG. 13.14)

Traction is defined as ***the act of exerting a pulling force***. It involves the application of both manual and mechanical forces to adjacent body parts away

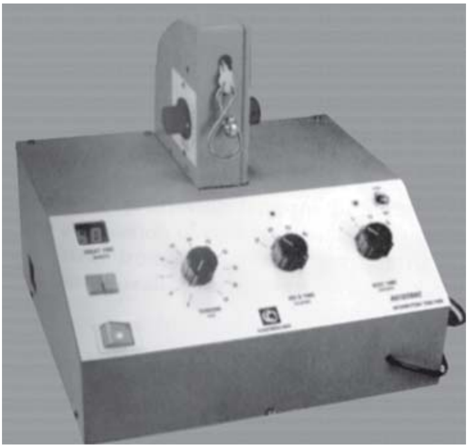


Figure 13.14: Electronic traction unit for intermittent cervical and lumbar traction (*Courtesy:* Electrocare Systems and Services) *(For color version see Plate 3)*

from each other. The resulting separation can decompress irritated tissues, realign parts, and relax tight structures. It helps in straightening fractured bones or relieving pressure on the vertebral column. In orthopedics it is applied as skin traction or skeletal traction, but in physiotherapy, cervical and lumbar traction are commonly applied.

Traction can help:
- To lessen or eliminate muscle spasms and thereby pain.
- To prevent or reduce skeletal deformities
- To reduce muscle contractures in early stages
- To regain normal alignment, especially in fractured bone.
- To relieve pressure on spinal nerves and relieve pain due to it.

Spinal Traction

Traction on the spine applies a longitudinal force to the spinal column, pulling it in opposite directions in order to stabilize or correct damaged parts of the spine. It is often given to release pressure on nerve roots, or herniated discs. It is being recognized as a very good stabilizer for cervical spines when they are injured or dislocated. ***Continuous traction: A*** light weight is applied for prolonged periods of time to achieve spinal stabilization in cervical spine fractures, spinal fusion procedures. In severe cases tongs are applied to the skull for stabilization.

Sustained traction: This traction applies a constant amount of force, which can be used for a longer period of time.

Intermittent traction: This involves the application of different and increased traction forces that are alternately applied and released (hold / rest), by electronic means. The treatment time is 15 minutes to half an hour, with variation in hold time and relax time. This is an inexpensive and non invasive treatment that produces surprisingly good results in some, even avoiding surgery.

Types of Intermittent Traction

Cervical traction: Intermittent or continuous

Traction force is 1/8th of the body weight position, higher lesions–neutral position. Lower lesions-flexion position.

Patient position:
- If the head is on the table with the cervical spine in a neutral or extended position, traction will exert its maximal effect anteriorly on the inter vertebral structures.
- However, if the head is maintained in a flexed position, it will exert pulling effect on the posterior structures.

- The greater the angle of flexion, the lower in the cervical spine is the area affected by the traction force.

Angle of Pull

- An angle of 0 to 15 degrees is used for the upper cervical spine.
- The angle should be increased by 5 degrees for each progressive lower cervical segment.

Lumbar Traction: A minimal force of one fourth of the patient's body weight is required. Joint hypo-mobility and degenerative disc disease are usually treated with the patient supine and lumbar spine in a flattened position.

Angle of Pull: To affect the lower thoracic and upper lumbar segments (L-1 to L-3), the angle of pull must be 15 to 30 degrees.

Manual traction: This involves the application of manual forces to the joints of the body and last for few seconds at a time in rhythmic manner e.g. neck stiffness, disc problems.

Indications for Spinal Traction

Inter vertebral disc prolapse—Disc protrusion can be reduced and spinal nerve root compression symptoms can be relieved by spinal traction.

- Degenerative disc or joint lesions—spondylosis, spondylolisthesis.
- Joint dysfunction—muscle spasm can be reduced and spinal mobility can be improved by traction.
- Lumbago or sciatica.

Contraindication

- Structural disease secondary to tumor (or osteomyelitis)
- Joint instability or fractures in the vertebra.
- Pregnancy.
- Acute stage of joint sprain.
- Osteoporosis
- Recent abdominal or pelvic surgeries.
- Claustrophobic patients.
- TAO.

PART II

Applied Rehabilitative Conditions

This book is divided into two parts. Part one deals with general principles of rehabilitation, while this second part is concerned with the application of these principles in various conditions. There are many disabling diseases and it is beyond the scope of this book to list out all of them, as also the various lines of management. The focus is therefore to bring out the philosophy of rehabilitation and its importance in some of the common neurological and orthopedic conditions.

CHAPTER 14

Congenital Malformations

INTRODUCTION

Congenital malformation is a defect of one or more parts of the body that is present at birth and resulting from an intrinsically abnormal development process

Causes of Malformation

- Chromosomal abnormalities
- Uterine factors
- Drugs, e.g. Thalidomide
- Maternal conditions like diabetes
- X-rays

CONGENITAL MALFORMATION OF CENTRAL NERVOUS SYSTEM

Dysraphism (Neural tube defects) (Fig. 14.1)

Dysraphism results from the failure of the neural tube to close spontaneously between the 3rd and 4th week of intrauterine development.

SPINA BIFIDA

This is a condition that results from a development defect in the vertebral column resulting in a lack of fusion of the vertebral arches and so the vertebral canal is not closed. There may or may not be defects of the spinal cord and meninges, and in some cases there are little or no symptoms.

Pathology

There are two main types of this abnormality, spina bifida occulta and spina bifida cystica.

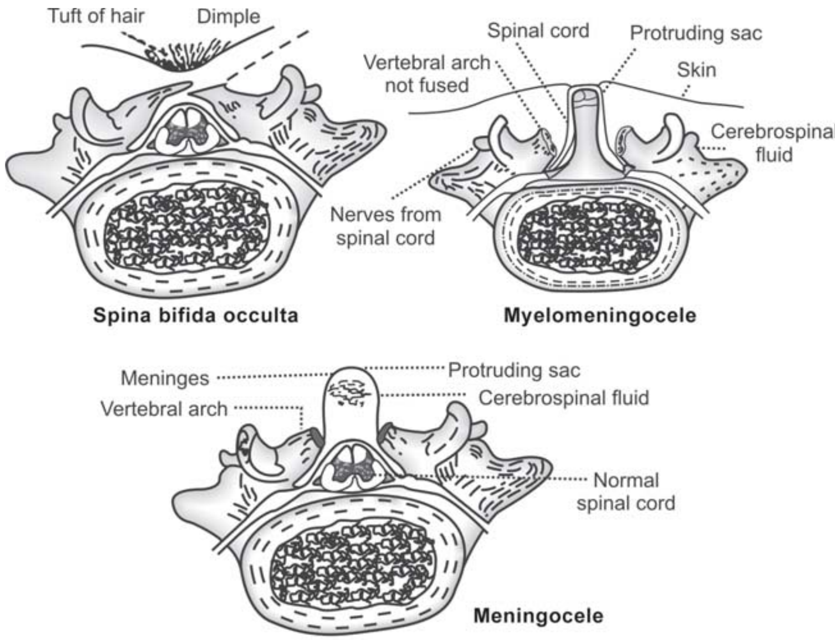


Figure 14.1: Spinal dysraphism (Spina bifida)

Spina Bifida Occulta

This is the mildest form of the defect and is observed in only a small percentage of children with spina bifida. The actual number may be larger because there may not be any obvious defect or abnormality externally. There is a defect in the fusion of the laminal arch but this may only be evident on X-ray. There is a dimple in the skin over the vertebrae, and sometimes there may be small tuft of hair over the area. A common feature of this type of lesion is abnormality of bladder control with either enuresis or urine retention.

Spina Bifida Cystica

Meningocele: The vertebral arch is not fused and a sac containing meninges and cerebrospinal fluid protrudes out.

Myelomeningocele (Fig. 14.2) this is the most severe form of spina bifida and inevitably there is neurological damage. Depending on the level of the lesion, the protruding sac contains part of the spinal cord or the cauda equina. Because the cerebrospinal fluid does not flow properly due to the obstruction, over 80% of children with this disorder have an associated hydrocephalus.

Clinical Features

- There is an obvious lesion over the vertebral defect on the back.
- Muscle paralysis or weakness - This will depend on the levels and the extent of the lesion. If the upper motor neurons are affected there may be a spastic paraplegia; otherwise there is a flaccid paralysis.

Figure 14.2: Meningomyelocele
(For color version see Plate 4)

- Sensory impairment can be variable depending on the extent and level of the lesion.
- Rectal and/or bladder incontinence (neurogenic bladder) is very often a troublesome complaint and the parents find it very difficult to send the child to school because of the continuous need for sanitary pads.
- Hydrocephalus may be an associated problem.
- Other congenital abnormalities of the lower limbs or spine (spina bifida or CDH) may be present.
- Mental retardation is not very common but could be present.

Management

The management is not unlike that of paraplegia.

- ***Surgery*** may be necessary to repair the spinal defect and prevent further damage.
- ***Counseling of parents:*** Counseling and support for the family is an important aspect of management.
- ***Education:*** Integration into a normal school is the goal whenever possible, but it must be after a careful assessment of the child to see whether he will be able to cope with the various aspects of school life.
- ***Physiotherapy:*** The problems that the physiotherapist may have to deal with are lack of movement or abnormal movement patterns. In addition, there are deformities, anesthesia over buttocks and heels, and psychological problems. The physiotherapist will try to prevent deformities from occurring by correct positioning and teaching parents. Passive movements will be carried out to prevent contractures.

- ***Psychological problems:*** There may be frustration, depression, irritability or anger. If the reactions are severe the child may need help from a clinical psychologist or from an educational psychologist if there are learning problems.
- ***Functional activities:*** All treatment is designed to gain as much functional activity as possible. The physiotherapist must work with other members of the team, the child and the parents to achieve this.
- ***Orthosis:*** may be designed to train the patient's gait

HYDROCEPHALUS (FIGS 14.3 AND 14.4)

Hydrocephalus is not a specific disease, but it represents a diverse group of conditions, which results from impaired circulation and absorption of cerebrospinal fluid (CSF) or from increased production by choroid plexus

Classification

- ***Obstructive hydrocephalus:*** There is an obstruction to the circulation of the CSF, either within the ventricles or aqueduct. It can be caused by
  - Aqueduct stenosis
  - Vein of Galen aneurysm
  - Arnold-Chiari malformation
- Communicating hydrocephalus most commonly follows a subarachnoid hemorrhage.
- Over production of CSF

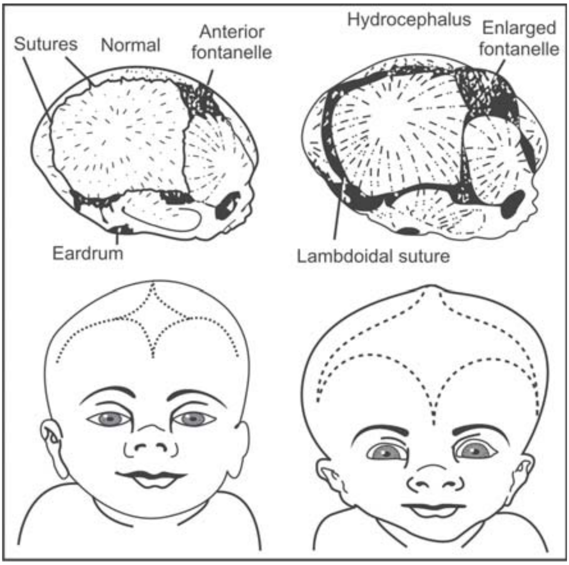


Figure 14.3: Hydrocephalus

Figure 14.4: Hydrocephalus

Clinical Manifestations

- Enlargement of head is the prominent sign.
- Anterior fontanelle is wide open and bulging, and scalp veins are dilated.
- The forehead is broad and the eyes may deviate downward producing the "setting-sun" sign.
- Vomiting, headache and deterioration of consciousness.
- Disturbance in the muscle tone, reflexes and co-ordination.
- Percussion of the skull may produce a "cracked-pot" or Macewen sign including the separation of sutures.
- Papilledema, abducens nerve palsy, and pyramidal tract signs are apparent in most cases.

Treatment

Surgical

Shunting techniques*:* Ventriculoperitoneal shunt—this surgery relieves intracranial pressure in hydrocephalus by shunting fluid from the ventricles of the brain into the abdominal cavity through a catheter and valve system. The pressure effects on the brain are thus relieved.

Non-shunting techniques*:* Choroid plexotomy (removal of choroid plexus the tissue that manufactures CSF), use of Rickham's reservoir and catheter (part of a mechanism to drain fluid in hydrocephalus)

Rehabilitation*:* According to residual spasticity or weakness (Refer Chap 15).

CONGENITAL MALFORMATION OF BONES AND JOINTS

CONGENITAL LIMB DEFICIENCIES (FIGS 14.5 TO 14.7)

Amelia

The Frantz and O'Rahilly classification describes congenital limb deficiencies.

Amelia is the complete absence of one or more limbs. Meromelia or hemimelia is the partial absence of a limb. These are further classified into terminal and intercalary (intermediate), each of which may have horizontal or longitudinal deficits. Thus broadly skeletal limb deficiencies may be classified as

- Failure of formation of parts
- Failure of separation of parts
- Generalized skeletal syndrome and developmental defects.

Figure 14.5: Congenital partial absence of limb components (Hemimelia) *(For color version see Plate 4)*

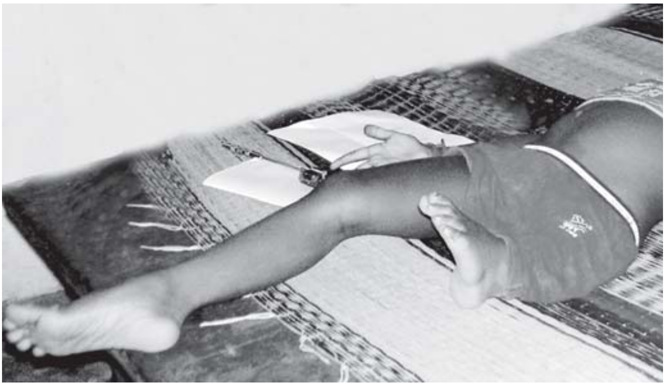


Figure 14.6: Congenital partial absence of limb components (Hemimelia)

Figure 14.7: Congenital absence of limb (Amelia)

ARTHROGRYPOSIS MULTIPLEX CONGENITA

Arthrogryposis multiplex congenita is a non-progressive disorder of congenital origin; characterized by marked stiffness and contracture of joints affecting the limbs and trunk.

Classification

There are two distinct types:

- The neurogenic type, which is more common.
- The myogenic type.

The ***neurogenic type*** is due to degeneration of anterior horn cells in certain segments of the spinal cord. The corresponding muscles are paralyzed *in utero*.

The ***myogenic type*** is due to myodystrophy in the intrauterine state with replacement of muscles by fibro fatty tissue.

Clinical Manifestation

In the myogenic type the hips are flexed and abducted and knees are flexed. The feet may be in gross equinovarus deformity. Sometimes the hips are dislocated congenitally. Contractures are produced from non-progressive muscular dystrophy. Muscles of the extremities become replaced by fibrous and fatty tissue, a condition known as Amyoplasia. There are associated pointers to the condition like micrognathia [small jaw], short neck, low set ears, wide flat nose, congenital heart disease, high arched palate, hypo plastic lungs and cryptorchidism. However the sensory system and intelligence are normal.

In the neurogenic type, muscle imbalances force the limb into contractures in early intrauterine life. The hips are in flexion and the knees hyperextended (genu recurvatum). The feet are in calcaneovalgus position. In the upper limb the elbow may be extended, or in flexion with skin webs. The forearm is pronated and wrist flexed.

Treatment

Deformities in arthrogryposis are difficult to correct; surgical correction of the deformities must be followed by splinting and exercise therapy. For lower limb deformities, club foot is corrected by talectomy, genu recurvatum by quadriceps plasty and open reduction with Kirschner's wire fixation, hip treated with open reduction, and scoliosis with braces.

OSTEOGENESIS IMPERFECTA (FIG. 14.8)

It is an inheritance disorder characterized by soft and brittle bones resulting from deficient collagen synthesis, and is an autosomal dominant disorder.

Figure 14.8: Osteogenesis imperfecta

Clinical Manifestations

The child is prone to multiple fractures that occur with trivial trauma. The muscles are usually hypotonic; the skin is thin with subcutaneous hemorrhages. The triad of fractures, blue sclera and deafness is diagnostic. The person has kyphoscoliotic deformities and is of short stature

Sprengel's Shoulder (Fig. 14.9)

There is a short scapula located at an abnormally high position with respect to the child's neck and thorax; the scapular muscles are poorly developed. Limited shoulder range of motion and webbing of skin between neck and scapula is seen. Treatment is by surgically repositioning the scapula.

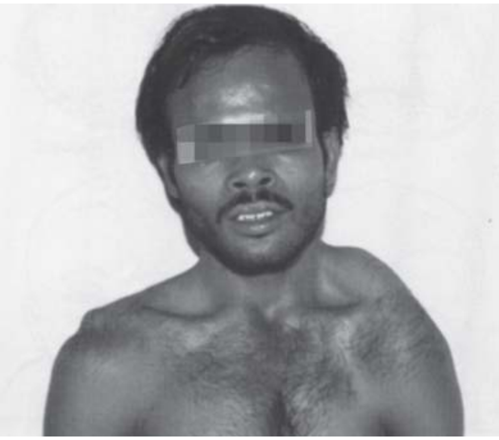


Figure 14.9: Sprengel's shoulder deformity

Congenital Vertical Talus

The talus lies in a vertical plane than in the normal horizontal plane. The foot has a characteristic look, with a loss of concavity on the sole and a prominence of head of talus medially – "Rocker Bottom Foot". There is equinovalgus of the heel.

Treatment: Serial casting after manipulation of the feet. In severe cases, soft tissue release is performed.

Congenital Radio-ulnar Synstosis

In this condition there is a unilateral or sometimes bilateral fusion of radius and ulna at the superior radio-ulnar joint. The person is unable to supinate the forearm, and there is fibrosis of the pronator teres and pronator quadratus.

Congenital Torticollis

Congenital torticollis is an asymmetric deformity of the neck resulting from unilateral contracture of sternocleidomastoid muscle.

The chin is tilted to the opposite side and the occiput rotated towards the ipsilateral shoulder. The face becomes asymmetrical, smaller and eyes become slanting. The sternocleidomastoid is short and prominently seen.

Management

Conservative

- Passive stretching of sternocleidomastoid.
- Ultrasound
- Massage

Surgical: It is indicated when torticollis does not respond to conservative measures up to one year. The surgeon does a partial excision of sternocleidomastoid muscle and immobilizes the head in the corrected position in a plaster cast for a period of 6-8 weeks. Active and passive physiotherapy exercises are carried out to prevent any recurrence of the deformity.

CONGENITAL SCOLIOSIS

Congenital scoliosis is the lateral curvature of the spine occurring at birth. This is a deformity of the spine associated with a primary malformation of the vertebral elements. Although secondary changes in vertebral shape may occur, the primary lesion is often due to failure of segmentation or of formation of the spinal column, and as such is often associated with anomalies of the spinal nerves and spinal cord.

The primary bony deformities can be divided into failures of formation, as in wedged or hemivertebrae, and failures of segmentation, as in a block vertebra. In addition to the rib fusions, there is a higher prevalence of genital, urinary and cardiac anomalies.

Management (Ref Chap 20)

In order to assess the need for intervention, the individual features of the deformity must be considered. Posterior spinal fusion is usually used with a simple convex stabilization, in infants. When there is severe deformity, an anterior procedure to allow some correction and shortening of the column is essential. In more severe and rigid deformities, the recommended technique is an anteroposterior, staged, closing wedged osteotomy.

CONGENITAL DISLOCATION OF HIP

This is a spontaneous dislocation of hip occurring before or after birth.

When the child begins to stand on its feet and walk the diagnosis of congenital dislocation of the hip becomes easier. Delay in walking is one of the first symptoms to suspect congenital dislocation of the hip. The gait is characteristic; some unsteadiness of a limb is observed in unilateral affliction and a waddling gait in bilateral affliction.

Etiology

- Genetically determined joint laxity
- Laxity due to hormonal changes
- Genetically determined dysplasia of the hip
- Breech malposition.

Clinical Manifestation

- Limitation of abduction
- Asymmetrical thigh folds

- Shortening of affected limb
- Trendelenberg gait.

In bilateral dislocation the features are:
- Waddling gait
- Widening of perineum
- Marked lumbar lordosis.

Treatment

This varies according to the age of the child.
0-6 months closed reduction is successful.
Plaster cast is applied in frog leg position
6-18 months
- Application of traction to the limbs either on a frame or in a Gallow's suspension and to maintain abduction of hips.
- If it fails, adductor tenotomy can be performed.

18 months - 3 years: In this age group of infants, closed reduction fails and open reduction is possible.

Surgery
- Salter's osteotomy
- Pemberton's osteotomy
- Wain Wright's shelf operation

CONGENITAL TALIPES EQUINOVARUS (CTEV) (FIG. 14.10)

Clubfoot is a congenital contracture of the joints of the foot. The main clinical signs of congenital talipes equinovarus are:
- Equinus (plantar flexion of the foot in the ankle joint),
- Supination (the plantar surface of the foot is turned inward)
- Forefoot adduction (the anterior part of the foot is displaced medially).

Congenital clubfoot presents in two clinical forms, namely Typical (75 per cent) and Atypical (25 percent).

In addition to the deformity of the foot children with congenital clubfoot have a leg rotated inward and restricted movement of the ankle joint. The degree of deformity is aggravated as soon as the child begins to walk, and skin on the outer border of the foot becomes rough, and callosities develop with bursae.

Adults with neglected CTEV walk on the outer borders of their feet.

Causes

- Mechanical theory—due to abnormal intrauterine position of the fetus.
- Ischaemic theory— this theory suggests that lack of blood supply to the calf muscles during intrauterine life results in these foot deformities.

Figure 14.10: Congenital talipes equinovarus

- Genetic theory—some genetically related disturbances in the development of foot leads to deformity
- Neuromuscular deficit.

Secondary Clubfoot

- Paralytic disorders – polio
- UMN disorders—rare
- Post-trauma.

Conservative Treatment of Clubfoot (Fig. 14.11)

Passive movements to the ankle and foot joints, followed by gentle passive stretching to the posteromedial tight structures are given. Active movements of the foot should be encouraged during therapy which is given three or four times a day for a few minutes each time. Between the active and passive movements the foot and leg are stroked and massaged. After each procedure the foot is immobilized by means of a soft bandage in the corrected position attained.

- In the newborn, the mother is taught to manipulate the foot.
- When the child attains the age of three months, manipulation of the foot is done once in two weeks and the foot is held in the corrected position by strapping with a plaster cast extending till above the knee. The order of correction of deformity is adduction, varus deformity and then the equinus. This is done for the milder versions of the problem.

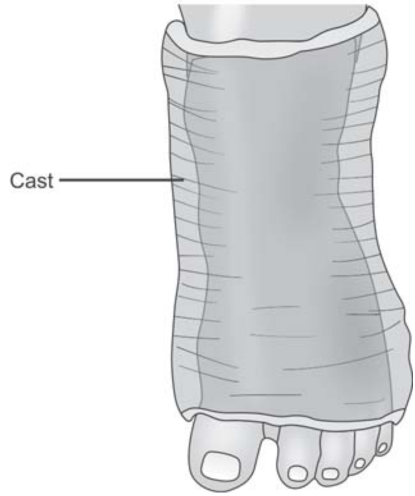


Figure 14.11: Cast for congenital talipes equinovarus

Children up to two years of age who are brought late to a doctor should be immediately put in plaster casts which make the subsequent operation on the tendo-ligamentous structures much easier. Massage, baths, and corrective exercises are also prescribed and, in cases with weakened muscles, rhythmic faradic stimulation of the anterior peroneal muscles may be given. When conservative treatment proves ineffective an operation on the tendo-ligamentous tissues is indicated at the age of two or two-and-a-half years.

Surgery

Surgery should be resorted to only in cases where conservative treatment has failed.

- ***Tendo-Achilles lengthening and posterior capsulotomy.***
- ***Posteromedial soft tissue release***—in this operation the tibialis posterior, flexor hallucis longus and flexor digitorum longus tendons are also lengthened in addition to the tendo-Achilles. In an effort to correct the varus component of the deformity all the ligaments and soft tissues on the plantar and medial surfaces of the calcaneus, talus and navicular bones are divided.
- ***Complete subtalar release***—currently the surgical treatment followed is a complete release of all tight structures in the posterior, medial and lateral aspects of the subtalar and ankle joint.
- ***Bone Operations***—a lateral wedge resection and calcaneocuboid fusion by stapling will be necessary to get full correction.

Maintenance of Correction

Clubfoot boot: The corrected foot is maintained by means of clubfoot boot. It consists of

- No heel—to prevent equinus,

- Elevation of lateral border
- Medial border straight—to prevent forefoot adduction
- An anterior strap—to prevent inversion. It is also applied as a conservative form in case of mobile clubfoot.

CONGENITAL DEFORMITIES OF SKULL

Microcephaly

Microcephaly is defined as a head circumference that measures less than three standard deviations below the measure for age and sex. It is very common amidst the mentally retarded. There are two types described: the primary (genetic) Microcephaly and secondary (non-genetic) type.

Clinical Manifestation: It is important to measure the patient's head circumference at birth. A very small head circumference implies a process that began early in embryonic or foetal development. Serial head circumference measurements are more meaningful than a single determination particularly when the abnormality is minimal.

Treatment: Once the cause of the microcephaly has been established the physician must provide accurate and supportive genetic and family counseling, because many children with microcephaly will also be mentally retarded. Intelligence quotient is reduced compared with the general population. (Ref Chapter 6).

MONGOLISM (DOWN'S SYNDROME) (FIG. 14.12)

Down's syndrome, described by Dr John Langdon Down in 1866, is one of the common causes of mental sub normality in children; occurring in 1.3 out

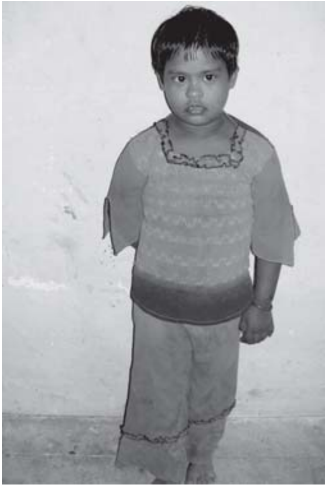


Figure 14.12: Down's syndrome

of every thousand live births. The cause for Down's syndrome is a chromosomal abnormality called Trisomy 21. In the patient with this problem, there are 47 chromosomes with an extra chromosome for number 21 resulting from non-dysjunction.

Clinical Features

- Skull is small and round with small ears
- The face is flat, with a small nose and short neck.
- Delayed closure of fontanelles may be present.
- The eyes are set in slanting position [Mongolian features] where epicanthic folds, the small folds of skin between the inner corner of the eye and the bridge of the nose, are prominent.
- Small white spots are present on the iris (Brushfield's spots); there may be a squint or cataract
- Congenital malformations in the heart (atrial or ventricular septal defect) or alimentary tract (duodenal stenosis) may be present
- Speech and social development are markedly delayed
- the hands are broad with fingers like spoons.
- The 5th finger is short and curved inward.
- The gap between the great and second toe is increased.
- There may be a single deep plantar crease while there is only one transverse palmar crease
- The child is well behaved, but there is mental sub normality.
- Tongue is usually protruded with prominent fissures.
- Congenital malformations in the alimentary tract (duodenal stenosis) may be present.
- Muscles are hypotonic and motor milestones tend to be delayed because of this. Deep tendon jerks are diminished.
- The ligaments are lax and hyper mobility in the joints is also seen.
- Deformities like scoliosis, pes planus and subluxation of joints, may be present.

Management—Positioning

Child prefers supine lying and sitting to avoid energy expenditure. Some milestones like crawling may be substituted during development. Balance reactions should be trained.

Sensory and Proprioceptive Re-education

- Strengthening towards achievement of motor milestones, and later individual muscular activities.
- ADL training, IQ assessment and special education, behavior modification. (Ref Chap 6)

Genetic Counseling

Genetic counseling is the communication of information about disorders with a genetic component.

Features of genetic counseling:
- Take history
- Construct pedigree
- Establish diagnosis
- Counseling to parents
- Risk estimation
- Follow-up

The initial response may be one of shock and denial. Some irresponsible parents even think of abandoning the child. Anxiety and even depression follow, and make collecting information difficult.

Others resort to a blame game in which the mother or father are made to feel guilty as if it is their fault. Relatives chip in with ill directed and inaccurate information. In some communities the child is treated like some curious phenomenon, and yet in others visits to temples or god men are recommended. A good counselor will have to give whatever he or she knows about the condition to the parents, and recommend that they seek proper medical help.

CONCLUSION

Newer technologies today involve diagnosis of congenital deformities in utero, and intrauterine surgery of the foetus is gaining success today. It is thus a distinct possibility that several severe malformations can either be corrected in the future or provoke the decision to terminate pregnancy.

CHAPTER 15

Rehabilitation of Cerebral Palsy

DEFINITION

Cerebral palsy is the commonly used term for a group of conditions characterized by motor dysfunction due to non-progressive brain damage to the developing brain.

ETIOLOGY

The causes of cerebral palsy are many and they are grouped under three headings: prenatal, perinatal and postnatal. There are innumerable causes some of which are:

Prenatal Causes (From conception until setting in of labor pains)

- Maternal viral infections such as TORCH infections (Toxoplasmosis, Rubella, Cytomegalovirus varicella, or Herpes simplex)
- Metabolic disorders in the mother such as diabetes, heart ailments, hyperthyroidism or severe asthma or anemia
- Poor prenatal care
- Rh incompatibility between partners
- Abdominal injury, smoking or drinking during pregnancy
- Early or late primi mothers

Perinatal Causes (Shortly before birth and up to a month after birth)

- Asphyxia due to a mechanical respiratory obstruction
- Drugs causing anoxia administered during labor
- Trauma to the head during labor, big head babies
- Uterine hemorrhage
- Forceps application

- Poor position of the infant like breech delivery
- Prematurity and complications at birth, respiratory distress, very low birth weight
- Anatomical abnormality in the uterus or vaginal canal
- Eclampsia
- Anoxia due to various problems like umbilical cord round the neck or placenta previa

Developmental Causes

- Macrocephaly
- Microcephaly

Acquired Postnatal

- Trauma to the head with injury to the brain.
- Infections of the central nervous system such as meningitis, encephalitis, tuberculosis and brain abscess.
- Thrombosis or hemorrhage which causes vascular insufficiency
- Anoxia due to drowning, murder attempt, like strangulation, suffocation by pillows or plastic covers, or carbon monoxide poisoning.
- Malignancy or space occupying lesions like cysts, or tumors
- Hydrocephalus.

CLASSIFICATION

The topographical classifications frequently used are as follows:

Quadriplegia	Involvement of four limbs.
Diplegia	Involvement of four limbs with the legs more affected than the arms.
	Double hemiplegia same as above but with arms affected more than legs
Paraplegia	Involvement of both legs.
Triplegia	Involvement of three limbs.
Hemiplegia	One side of the body is affected.
Monoplegia	One limb is affected.

The types of involvement are ***spastic, ataxic, athetoid or hypotonic***. Floppy babies usually become spastic, athetoid or ataxic. Some exhibit mixed features and are termed '***mixed cerebral palsy***.'

CLINICAL CLASSIFICATION

Spastic Cerebral Palsy

The characteristics of spastic CP are hypertonicity of the clasp-knife variety, with increased tendon jerks and occasional clonus.

Abnormal Postures (Figs 15.1 and 15.2)

Changes in posture may occur with excitement, emotional outbursts, fear or anxiety, which increase muscle tension. The position of the head and neck can influence the tone of the body wherever there are tonic neck reflexes like ATNR or STNR.

Voluntary Movement

Spasticity does not mean paralysis. There may be some amount of voluntary control, but this is not enough to overcome the spasticity. If spasticity is

Figure 15.1: Backward arching in a child with cerebral palsy

Figure 15.2: Universal flexed posture in a child with cerebral palsy

controlled by drugs, botulinum toxin injection or physiotherapy, the muscles may also be stronger as they no longer have to overcome the resistance of tight spastic antagonists.

Athetoid Cerebral Palsy

This form is characterized by bizarre and uncontrolled involuntary movements, called athetoid movements, which are purposeless, writhing or jerky, tremor like, swiping or describing rotary patterns around the body. There may be some volition over the muscles but involuntary movement may mask it and there may be an initial delay before the voluntary movement is begun. Superadded on this is fluctuation in tone, hypertonia or hypotonia making the activity seem uncoordinated.

Athetoid Dance

The involuntary movements of some athetoid patients prevent them from maintaining weight on their feet. They continuously withdraw their feet upward almost as if they were dancing. Intelligence is frequently good and the children perform well academically.

Ataxic Cerebral Palsy

Disturbance of balance and coordination are the hallmarks of the ataxic type. The child reaches out to objects but is unable to achieve its objective due to over shooting or under reaching. Stability of the head on the trunk and the body on the pelvis is poor. This results in the child appearing clumsy. There may also be an intention tremor which prevents fine motor movements. Like every other cerebellar problem, nystagmus may also be present. Mental, visual and perceptual problems, too, are also often present.

Mixed type: In this type, there will be a mixed presentation in the same child, with spasticity, athetosis and ataxia or any two of these coexisting.

Flaccid type: This is relatively rare and presents with a flaccid weakness. The child develops deformities like kyphosis, or genu recurvatum easier than the other types.

Multiple Disabilities

It is being increasingly recognized that cerebral palsy is not just an umbrella term or a diagnosis, but that children or adults present with multiple problems in the same person. This is challenging as there is a need for a team member to attend to each distinct problem. What is more, each disability is interdependent, and milestones achieved are composite in nature. For example, if a child is visually impaired, his motor milestones also tend to get delayed. In India the National Institute for Empowerment of Persons with Multiple Disability (NIEPMD) has been set up for patients of this nature.

Common Features in All Types of Cerebral Palsy

All cerebral palsied children are slow in motor development because of retarded or abnormal development of the postural balance mechanisms or reflexes. Another common feature is the possible appearance of certain abnormal reflexes, which are seen in the more profound cases.

The inability to maintain balance and posture is quite obvious in the athetoid and ataxic children, but is as much a cause of the physical handicap in the child with spasticity. The child would still be physically disabled even if the spasticity were removed.

- Children with athetoid cerebral palsy are generally more intelligent.
- Perception of space is affected more in the spastic type of cerebral palsy.
- There may be visual field loss and lack of sensation in one side of the body in the child with hemiplegia.
- Spinal deformities together with rib-cage abnormalities can lead to poor respiration.
- Epilepsies are more common in the spastic type than in other types of cerebral palsy.

Neonatal Reflexes

Patients with cerebral palsy often exhibit neonatal reflexes as listed below.

- Tonic neck reflexes
  - Asymmetric tonic neck reflex
  - Symmetric tonic neck reflex.
- Crossed extensor response
- Moro reflex
- Galant reflex
- Labyrinthine – righting reactions
- Parachute reaction
- Placing reaction
- Neonatal standing and stepping

There are reflexes, like the positive supporting reaction [PSR] which is a modification of the spinal extensor thrust response, converting the leg in contact with the ground in to a spastic rigid column offering support to the rest of the body. The stimulus for developing the PSR could be the impulses from the touch receptors of the heel in contact with the ground or proprioceptive, that is stimulation from the intrinsic foot muscle stretch. The PSR or NSR, the Landau response and the parachute reflex are not abnormal; indeed the parachute reflex is protective and persists throughout life.

Landau response: This response is elicited with the child prone, supported in air. Ordinarily the head will extend and the back and hips will extend in sequence, the so called 'superman appearance'. Appearing around the 4th month, it is seen to reinforce the spinal extensor pattern and break the flexion pattern seen at birth.

Tilting Reaction in Prone: This reaction, appearing in 6 months, persists through life. The child is placed prone on a tilt board, and examined while the board is tilted. If the child curves his trunk against the displacement and the upper arm and leg abduct away it is a normal response.

ABNORMAL REFLEXES

The abnormal reflexes are pathological reflexes which have been described in children with different types of cerebral palsy. These are reflexes, which are present in the normal newborn, and which become integrated as it grows or disappear as it matures. In some patients these infantile reflexes are still present later, when they should have become integrated within the nervous system, for example, the Moro reflex, the palmar and plantar grasp reflexes, automatic stepping, extensor thrust and feeding reflexes.

There are also the tonic reflexes, which are the tonic labyrinthine reflexes (TLR), the asymmetrical tonic neck reflex (ATNR) and the symmetrical tonic neck reflexes (STNR), which are an impediment to the child's development and need to be factored during the treatment program.

Asymmetric tonic neck reflex (ATNR): When the face is turned to one side, the arm and leg on that side extend and the arm and leg on the opposite side flex. This resembles the initial stance in the sport called fencing.

Symmetric tonic neck reflex (STNR): With the child in prone if the head is lifted or extended, the arms symmetrically and automatically straighten, and the hips and knees bend. The reverse happens if the head and neck flex; the arms bend and the hips and knees extend. This is believed to be a prelude to crawling. An easy way to remember the reflex is to think of a cat trying to crawl under a fence.

Galant reflex: This is elicited by holding the child face down and stimulating one side of the spine. A positive response is denoted by the newborn flexing the body towards the stimulated side.

Moro reflex: This is a response when the child is startled by a loud sound, sudden tilt of the head back on the examiners hands or a jerk of the bed in which it is lying. It is present in all newborns and consists of symmetrically spreading out of the arms in abduction, bringing them back to the midline in adduction after the startling stimulus.

Parachute reflex: Though this reflex appears later, at about 8th or 9th month, just before the child walks, it persists throughout life. The child is held face down at the trunk and suddenly brought down towards the ground. It extends its arms toward the ground as if in a protective response to cushion the fall.

Opisthotonus: This is an abnormal reflex pattern when there is predominant extensor spasticity. The child goes for complete extension of head, trunk and limbs, resulting in arching. The reflex is elicited by stimulating the spinal and paraspinal areas by touch.

Reflex walking or stepping: When the dorsum of the child's foot is placed against the under surface of a table the child takes the foot up and places it on the surface of the table. The child may also try to bring the other foot forward as if attempting to walk.

AIMS OF REHABILITATION

- To develop forms of communication (gesture, speech, typing and with signs or electronic aids).
- To play and develop leisure and recreational activities.
- To develop independence in the daily activities of eating, drinking, bathing, dressing, washing, toileting and general self-care.
- To develop some form of locomotion and independent mobility that may include wheelchairs, electronic wheelchairs scooting boards or motor vehicles.

PRINCIPLES OF TREATMENT

- The child should be seen as being not only physically but multiply handicapped, in other words, a holistic approach is needed.
- Treatment should be aimed at the neurological mechanisms of posture, balance and movement, supplemented by procedures for muscles and joints when necessary.
- There should not be a rigid adherence to particular diagnostic classifications in treatment programs, as aetiology may not influence the treatment in cerebral palsy.
- Treatment should also provide for features of the motor disorder such as spasticity, involuntary movements, weakness, abnormal movements and primitive reflexes.
- Developmental schedules should only be used as guidelines and adaptations made to each child in a customized manner.
- Earlier the intervention, the sooner are the results
- Treatment plans should be reviewed periodically to take account of changes in the clinical picture, as the child grows older.
- Developmental and not chronological age should be taken into consideration.
- Duration of treatment need not be restricted to a few hours; it may be chronic continuous and merged with day to day activities.
- Since professionals may not be present throughout the day with the patient it is better for the parents, or siblings to learn some principles of therapy, since the parent spends more time with the child.

- All members of the team are involved in the program, simultaneously.
- Alternate forms of treatment like creative movement therapy or dance therapy can be introduced.

THERAPEUTIC TECHNIQUES

Medical management: The role of medicines in cerebral palsy is primarily to control epilepsy and hypertonicity.

Treatment Approaches

WM Phelps was one of the pioneers, who diagnosed five types of cerebral palsy. Specific combinations of muscle education and bracing were prescribed for different types of cerebral palsy. These combinations encompassed fifteen modalities of treatment. Muscles were assessed, classified as spastic, weak, normal or atonic and reeducation was given based on their condition. In this system muscles antagonistic to spastic ones are activated.

Progressive Movement Pattern

Temple Fay opined that development of children was similar to development of life itself in evolution and cerebral palsied children could be taught movement according to their motor milestones in a progressive movement pattern. The earliest living creatures, namely the fish, the reptiles and amphibians, had their own unique movements, from swimming to crawling to hopping. This mimics the initial motor milestones of the child. So, from sinuous creeping to reciprocal crawling on all fours, the therapy program can be initialized and maintained till the final gait pattern is achieved, namely erect walking like primates.

Synergistic Movement Patterns

Signe Brunnstrom (1970), induced movement in synergistic patterns mimicking those seen in the foetus. Initially the child is trained in reflex responses and later these responses are brought under voluntary control. For example the ATNR and STNR if present can be stimulated or modified to achieve head and trunk control. Associated reactions (like hyperextension of the thumb producing relaxation of the finger flexors) are used to achieve the desired effect.

Proprioceptive Neuromuscular Facilitation

Herman Kabat, with ***Margaret Knott*** and ***Dorothy* Voss** developed a system of movement facilitation techniques and methods for inhibition of hypertonicity. They observed the areas of function such as walking, running, playing games or self care activities. Those muscle groups working in synergy with spiral, rotational and diagonal patterns were identified and with a combination of touch and pressure, traction and compression, they were stimulated to contract against resistance. Proprioception, auditory and visual stimuli were also given in this technique.

Special Techniques

- ***Irradiation***—this is the predictable overflow of action from one muscle group to another within a synergy or movement pattern or by reinforcement of action of one part of the body stimulating action in another part of the body. For example when we ask a person to fold his elbow against manual resistance we observe his wrist and fingers also flexing in the same direction.
- ***Rhythmic stabilization*** which use stimuli alternating from the agonist to its antagonist while contracting isometrically.
- ***Stimulation*** of reflexes such as the mass flexion or extension.
- ***Repeated contractions*** of one pattern using any joint as a pivot.
- ***Relaxation techniques*** such as contract relax and hold.

Functional work or mat work involves the use of various methods mentioned above in training rolling, creeping, crawling, walking and various balance positions of sitting, kneeling and standing.

Neuro Developmental Treatment with Reflex Inhibition and Facilitation

This technique, developed by **Berta Bobath**, is based on the inhibition of tonic reflexes, such as the tonic labyrinthine reflex, symmetrical tonic neck reflexes and asymmetrical tonic neck reflexes. The child moves once these reflex patterns are curbed.

Sensory Stimulation for Activation and Inhibition

Margaret Rood developed this technique. It is a sensory approach named after her called Rood's technique. Muscles are classified according to their function and the appropriate stimuli for their actions are given. These stimuli are quite varied and involve slow and quick muscle stretch, stroking, proprioceptive stimulation, icing, applying warmth, pounding, brushing, joint retraction and approximation.

Reflex Creeping and Other Reflex Reactions

This is a technique developed by **Vojta**. Trigger points are points on the body which facilitate movement patterns involving the head, trunk and limbs. These points or reflex zones (nine in number) are activated with sensory stimuli and creeping is seen as a response to this triggering. Reflex rolling is also used with special methods of triggering.

Conductive Education

Andreas Peto is the one who paved the way for conductive education. The main feature is the integration of therapy and education by having a trainer who may play different roles of nurse, teacher and therapist, all in one. The children work as a group of about fifteen to twenty.

Furniture is modified so that children can develop milestones such as crawling, sitting and coming to stand. A typical session consists of movements that take place beside furniture which are slotted plinths (table/beds) and with ladder backed chairs, to help children climb up them. The tasks are based on the ADLs, hand function, balance and locomotion. The purpose of each movement is explained to the children. Speech training, reading, writing and other school work are also integrated in to these sessions.

Rhythmic Intention

Rhythm is a natural and innate character of a person. In this technique, movements are trained in a rhythmic fashion. For example, the trainer tells the children an intended motion: "I touch my nose with my finger." The children repeat after him and then the whole group does the action in slow, rhythmic counts of one to five. Motion is also carried out to the rhythmic chanting of a word such as up, or down repeated in a rhythm slow enough for the children's active movement ability.

Normal Development Stages

Stage	*Developed by*
Postural fixation of the head	3 months
Head righting	3 months
Postural fixation of the head and the trunk	3-6 months and independent by 9 months
Head and trunk righting	3-12 months
Sitting counterpoising head arms trunk and leg movements	6-12 months
Tilt reactions	9-12 months
Antigravity support or weight bearing on feet	Present at birth and modified at 6 months
Postural fixation of the pelvic girdle	9-12 months
Counterpoising in the standing position when holding	9-12 months
Counter poising in standing without holding on	12-18 months
Saving from falling	12-24 months

TREATMENT SUGGESTIONS AND DAILY CARE FOR ALL LEVELS OF DEVELOPMENT

PHYSIOTHERAPY MANAGEMENT

Lifting and Carrying

The therapist needs to instruct the parents or caregivers to carry the child in a special way in order to prevent worsening of deformities.

Positioning

Lying: Supine—a pillow placed under the head, or a pillow on both sides of the head and shoulders often promotes symmetry.

In prone: Children are often more symmetrical in this position, but a prone wedge board is used to raise the upper torso off the floor so that they use their hands to stabilize and heads to extend.

W-sitting: This position is to be avoided because of the reinforcement of the flexed, adducted and internally rotated position of hips.

Standing: Standing prevents the equinus deformity at the ankle. While standing the hips and knees should be extended hips slightly externally rotated and abducted knees should be straight and feet should be plantigrade.

Floor Sitting—Types

- ***Corner sitting:*** The child sits supporting the back in a corner of the wall, chair or sofa with legs supported by gaiters. In India, where there is little furniture in many houses, and all activities are on the floor, the child is given a corner floor seat with legs extended.
- Side sitting
- Long-leg sitting.
- W-sitting (rarely prescribed in some patients as it promotes backward pelvic tilt but may lead to flexion contractures of the lower limbs).

Chair Sitting

The correct posture in chair sitting is; head upright, the spinal curves supported, the person's weight distributed evenly through the buttocks and thighs, the knees at 90° and the foot planti-grade.

Stages in Prone Development

- Prone position placement
- Head control— raising the head in prone, with postural fixation (holding it steady)
- Turning the head from side to side (counterpoising).
- Raising the upper torso with the head and taking weight on forearms. This is a prelude to crawling.

Supine Development

- The head is stabilized with respect to the shoulder girdle.
- Next follows the shoulder girdle which is posturally fixed with relation to the head and pelvis
- Postural fixation of the pelvis with respect to the shoulder girdle and lower limbs
- Rising to sit and rising to stand.

Development of Sitting

Supine rise to sitting

- First 0-6 months normal development level: Help the child to develop head control.

- From 6 – 10 months' normal development level: Help the child come to sit on his own after it has attained fair head control, and developed balance and saving reactions. Of course the developmental age is more important than the chronological age.

Sitting is trained once the child has attained fair head control, and developing balance and saving reactions. The child is given exercises like

- Pull to sit.
- Sitting with counterpoising.
- Side lying to sit.
- Spinal extension exercises.

Development of Gait

If the child has not developed proper stability or fixation the training can be delayed. All the abnormal gaits will be treated in a program concentrating on:

- Correction of abnormal postures during standing and walking
- Head, trunk and pelvic postural fixation and counterpoising in sitting. Support on hands in upright kneeling, half-kneeling as well as in standing.
- Building up of the child's stability by decreasing support.
- Weight shift and development of stepping [taking weight on legs alternately]
- Equal distribution of weight on each foot during stance
- Training lateral sway
- Training to stop while walking, turn and walk on uneven ground
- Train in climbing stairs and inclines.

Occupational Therapy

The main goal of the occupational therapist is to making the child independent in his activities of daily living. Some of the adaptive devices are as follows: (Refer Chapter 11).

Toileting:

- Special toilet chairs that are either attached to the lavatory pan or slide over it are suitable for more severely affected people.
- Handrails are provided.
- For cleaning a hand held faucet can be used.
- Disposable nappies for the young incontinent child.

Bathing: A bath mat is kept in the tub to prevent a child from slipping. The floor of the bath room is kept dry and grab rails are placed on the walls. As the child grows in to a severely handicapped adult, a hoist may be necessary.

Feeding: Ideally, the feeding person should be directly in front in order to maintain the person's position. The table should be positioned at axilla height and close to the chest so that the distance from the plate to mouth is reduced. A non-slip mat on the table can stabilize dishes or special suction-based dishes can be used.

Special cutlery, such as combined fork and knife may be devised. Using a straw or a cup with a lid will prevent liquids dribbling back out of the mouth.

Sleeping: Frequent play activities are provided to discourage unwanted sleep, for some children who are on antiepileptic or anti spastic drugs and who may sleep for long periods during the day. Pillows are placed and splints are used to support limbs or whole body in a more satisfactory and comfortable position.

Dressing: Clothing should be loose, free from unnecessary fastening and limited to a few layers. Techniques to inhibit spastic postures will facilitate the movements of the limbs into and out of clothing.

Furniture: On account of their instability children with cerebral palsy tend to fall frequently and injure themselves. Furniture in the house must be suitably padded and help develop the respective milestones, like Peto chairs or corner chairs. Attention must be given to activities to be done within the position, even if it were a standing frame.

COMMON DEFORMITIES IN CP (FIG. 15.3) (REF CHAP 20)

In Lower limb

- Hip—flexion, adduction and internal rotation.
- Knee—flexion or hyperextension.
- Ankle and foot—plantar flexion inversion and forefoot adduction, valgus and collapsed arches.

In Upper limb

- Shoulder—flexion, adduction and internal rotation.
- Elbow—flexion, pronation
- Wrist and fingers—flexion.

SURGICAL OPTIONS IN CEREBRAL PALSY

Surgical options in spastic CP include stereotactic thalamotomy, intrathecal Baclofen pumps, and selective dorsal rhizotomy. Spasticity is limited by

Figure 15.3: Multiple deformities like scissoring in cerebral palsy

surgery which selectively divides the multiarticular spastic muscles and preserves the antigravity muscles. Management of soft tissue contractures has been discussed in Chap. 20.

Asymmetric tonic neck reflex (ATNR): Release of hypertonic extensors such as the longissimus capitis and cervicis to control asymmetric position of the head and neck is sometimes done.

ATTENTION DEFICIT DISORDERS

This requires careful establishment of tasks that provide challenge but are well within the capacity of the child. Distracting influences must be reduced so that the child can identify the significant stimulus as clearly differentiated from the background. The required response is clearly stated. This is done by moving the child through the required response, making the child solve problems or challenges as it goes, all the time giving words of guidance or encouragement. The special educator sits with the child whenever the visual cues are not effective and give verbal cues for the puzzle or building block game that is taken up for the activity.

Emotional and Motivational Factors

The brain injured child experiences emotional stress during treatment when surrounded by unfamiliar personnel. The care giver who may be the parent or a grandparent is involved in the whole exercise and sometimes does the program under instructions from the professional. In the beginning this helps to get over the fear of strangers and once the child accepts the presence of the professional, gradual take over by the professional can be done. In the long term, the parents have to be trained in the care and handling, as they are the ones who are with the child most of the time. The program is given with some recreational activity, so that the child perceives it all as fun.

Emotional problems derived from interpersonal relationships, familial disruptions, disturbances of attitudes and perspectives with the parents following out of past experience need to be identified. Some women are ostracized from the family when they give birth to such children. In some families the parents are both working out of office and cannot spend time with the kid. The arrival of another kid on the scene results in neglect to the affected child. If the problem is hereditary, there is a possibility of two or more kids with delayed development at home. In India, the small family norm is not often the case, and there are families with five or more children. Because of the status afforded to the male child in some societies, there are one or more female children in the family with delayed milestones. Counseling of parents psychologically helps in the overall rehabilitation program. Alteration of behavior of family members is essential, and they need to be empathetic to the problem.

Cognitive Function

In assessing cognitive function in children with brain damage, it is important to define the cognitive processes (perception, processing, analysis and organized response) in order to learn which intellectual systems are intact and which are disrupted.

The clinical psychologist is also consulted in this regard. Measurement of the IQ of the child with brain damage may be useful to place it in a school program.

With the results of multiple test procedures, it is possible to develop a customized educational program in consultation with the special educators.

Autism and ADHD

Children with autism hyperactivity or learning disorders tend to get included under cerebral palsy, though the approach to each child is quite different. Some of these children need sensory integration. Often these children get admitted in to special schools and are attended to by special educators with training in management of these disorders (ref Chap 6)

Special Education (Ref Chap 6)

The role of the special educator in cerebral palsy is all pervasive, since it is an area of multiple disability, and often associated with learning disability, deaf blindness and autism, which place an awesome responsibility on the special skills of the educator.

Vocational Rehabilitation

The child with cerebral palsy grows up to be an adult with cerebral palsy, and the question that arises in the minds of the parents is 'after me what ?'. The parent is often left wondering how the adult with CP is going to fend for himself or herself after their lifetime. It is here that sociovocational rehabilitation steps in, and children with cerebral palsy are trained in some skill that could be mental or physical depending on their abilities. They may be placed in skill training units or homes and based on the vocational model available, encouraged to live as independently as possible. Obviously several of them are dependent, and society needs to be educated on approaching this problem with empathy.

CONCLUSION

Among all the techniques explained above, no single technique if done alone is satisfactory or sufficient for a particular type of cerebral palsy. So, it is very important that an integrated individualized approach is followed and those techniques which are appropriate to the characteristic features are carried out.

CHAPTER 16

Rehabilitation of Poliomyelitis

INTRODUCTION

Poliomyelitis is a viral infection affecting the anterior horn cells in the spinal cord and brainstem producing a flaccid motor paralysis.

ETIOLOGY

The causative organism of poliomyelitis is an enterovirus, which is specific in its action, and primarily attacks and destroys the anterior horn cells. The predominant age group affected is children between the ages of 1-4 years, but theoretically no age is immune. The disease is highly infectious. The virus spreads rapidly in a community by 'carriers' as well as by those who are in the incubation period or early stages of the disease, by droplet infection or more commonly feco-oral route [the gastrointestinal tract]; the incubation period is 4-14 days.

The disease process may be staged as,

Stage I	Acute stage (of Paralysis)
Stage II	Recovery
Stage III	Residual paralysis.

Clinical Manifestation

Depending on the host immunity, the virus may produce no infection, sub clinical infection, and symptoms with or without paralysis. The paralysis itself may be transient, mild or severe. Sometimes there are no symptoms even if the virus is present in the body.

Management of minor illness or non paralytic poliomyelitis is outside the scope of this book.

Paralytic Poliomyelitis

Involvement of motor nerve cells in the spinal cord, resulting in paresis or paralysis of various muscles. Paralytic poliomyelitis may be subdivided into the following types:

- Spinal
- Bulbar
- Bulbospinal
- Polio encephalitis.

Spinal Paralytic Poliomyelitis

In the early stages of spinal paralytic poliomyelitis there is severe cramping pain in the muscles with hyperaesthesia of the overlying skin. In children less than 5 years old, paresis of one leg is most common. In patients between 5 and 15 years of age weakness of one arm or both lower extremities is more frequent. Paralysis of the muscles of respiration is often present in those over 16 years of age getting infected.

Bulbar Poliomyelitis

Damage to the medulla, pons, and midbrain with dysfunction of the cranial nerve nuclei and the respiratory and vasomotor regulating centres in the medulla.

Bulbospinal Poliomyelitis

Also known as respiratory poliomyelitis this form has symptoms both of spinal and bulbar manifestations. It affects the upper part of the spinal cord C3 to C5 segments and causes paralysis of the diaphragm, which is why there is respiratory difficulty. Swallowing is affected and respiration is impossible without ventilator support since the phrenic nerve is paralysed. Sometimes heart functions are also affected.

Polio Encephalitis

There is inflammation of motor neurons within the brain stem, motor cortex and the spinal cord. Initially this causes swelling and redness of the grey matter of the spinal cord, and presents **as stiffness** of the back and neck, muscle cramps, dysphagia, loss of reflexes, headache and paraesthesias. Paralysis occurs within ten days after symptoms develop, progresses in two or three days, and is complete by the time the fever subsides.

EXAMINATION

Muscle Charting

The muscle power is graded from 0 to 5. It is sometimes useful to have fractional muscle power, especially if the power has improved from one figure and yet has not quite reached the next one.

It is important to assess all the muscle groups as soon as the tenderness in the muscles will allow, approximately three weeks after the onset of paralysis.

The degree of recovery should then be assessed at regular intervals, and an estimate as to the final degree of recovery and the necessity for calipers can be made.

Approximate Assessment of Final Recovery

- Add 2 to the assessment of initial power (three weeks), i.e. a muscle power of 2 could finally have a power of 4
- Add 1 to the power assessed at three months
- After six months all recovery is due to hypertrophy of residual muscles.

DEFORMITIES IN POLIO (FIGS 16.1 AND 16.2)

Muscle spasm is followed by interstitial fibrosis and collagen deposits. Contractures set in even within a month, and spasms are thought to be due to incoordination and involuntary contraction of the weak muscle, and to avoid pain. The growth of the limb is almost always retarded. All residual deformities are measured by a goniometer.

Contractures will usually occur if there is imbalance of opposing groups of muscles which are not held in check, gravity, flexed joints in bed, or results of bearing weight on a weak leg. Long-standing contractures, especially of a major joint may be corrected by major operations. Operative correction is required if knee and ankle contractures prevent the fitting of orthoses. (Ref Chap 20).

Figure 16.1: Flexion deformity in both knees with equinus

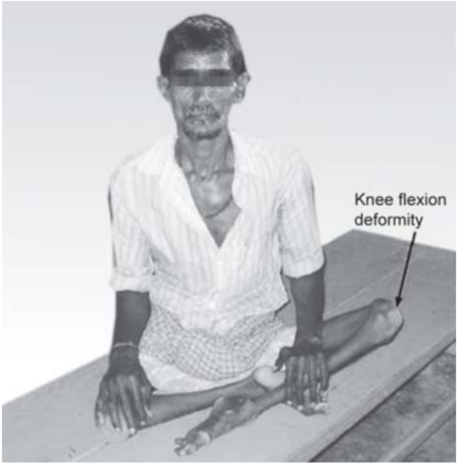


Figure 16.2: Severe knee flexion deformity in adult poliomyelitis (residual stage)

Lower Limb

Hip:

- Flexion/abduction and external rotation
- Subluxation.

Knee: Flexion deformity measured with the hip extended as much as possible to avoid error due to tight hamstrings. External rotation of the tibia is measured with knee extended. The common deformities at the knee include ***subluxation, genu recurvatum, and rotation of the tibia***. The lower end of the femur may be more globular than normal and the posterior articular surface of the femoral condyles may be flattened on long standing. The patella is often much smaller than normal, and the tibial plateau may be deformed and sloped either backwards or forwards.

Spinal Deformity

Scoliosis of the spine in polio is usually due to an imbalance of the lateral flexors of the trunk. There are usually compensatory curves above and below the main curve in the opposite direction except when the spine is completely flail. Deformities may also be due to a much lesser extent to a tilt of the pelvis or to abduction contracture. Lordosis is usually an attempt by the patient to balance a weak spine on a weak pelvis.

Treatment: Supporting corsets made out of polyethylene or polypropylene only give partial support and hardly prevent a worsening of the deformity. Milwaukee brace, in which distracting pressure is exerted between the skull and chin above requires accurate adjustment and regular supervision (Ref Chaps 7 and 20).

Ankle

Equinus, varus, valgus, cavus, pes planus (Ref Chap 20).

Pelvic Tilt

A limb length discrepancy can cause a pelvic tilt leading to compensatory changes in the spine.

Upper Extremity

The elbow may be out of shape with dislocation of the head of the radius. Rotation of the forearm may be present, with deformities of the wrist metacarpals and phalanges. X-rays show narrow shafts and globular heads in relation to the shaft. Common upper limb deformities are:
- Adduction and subluxation of shoulder
- Flexor deformity of elbow

Lower Extremity

Isolated knee contractures of less than 30 degrees: In a child these are best treated by fortnightly manipulations under anesthesia. An HKAFO is then fitted. A supracondylar osteotomy or hamstring release may be done if the foot is stable, and if the limb cannot be fitted at all with the caliper.

If the child with deformity has a reasonable chance of being able to walk even with calipers on both legs, then the deformity should be corrected.

Contraindications to operation in children: When both legs are severely involved, or flail with one or both arms, weak particularly at the triceps, which is needed to bear weight on the axillary crutches, then surgery is avoided. The motivation of the child and relatives towards post operative care and physiotherapy also is important before taking the decision to operate. Surgery to release the soft tissues without caring to take a proper muscle power assessment or communicating to the patient about the outcome of the operation is of no use and in fact detrimental because the patient does not cooperate with any rehabilitation initiatives after that.

Indications for Surgery

Hip and knee contractures of over 30 degrees: In a young child with fairly recent contractures the commonest cause for the deformity is a tight tensor fascia lata and ilio-tibial band.

Ankle and foot deformities: A tight tendo-Achilles is the major cause for an equinus deformity of the foot when there is no associated varus and this is corrected by subcutaneous elongation of the tendon (Ref Chap 20).

TREATMENT

The treatment of paralytic poliomyelitis involves

- The use of all measures to save the life of the patient.
- Maintenance of weak muscles in as good a condition as possible
- Immediate recognition and treatment of medical complications
- Prophylaxis and therapy of emotional disorders
- Surgical treatment of correctable defects and
- Social, economic occupational and physical rehabilitation
- Physiotherapy and occupational therapy

Acute Stage

The emphasis is primarily on the relief of the headache, pain in the back, and spasm of the legs.

- The child is rested in bed with a firm mattress. The back is supported at the lumbar region by a board and so are the paralyzed limbs.
- Sister Kenny hot moist towels to the affected muscles produce considerable relief from the pain. Analgesics like paracetamol may be used to relieve pain.
- Feet are supported by rigid boards in padded KAFO with 90^0 FDS. Early spinal bracing is indicated if the back is weak.
- Knees and hips are mildly flexed and arms are positioned in abduction with mild support.
- The therapist puts joints through a full range of motion once a day.
- Nurses are instructed to make the severely paralyzed patient lie face down with extended hips every 2 hours to prevent pressure sores and deformities.

Every patient thought to have non-paralytic poliomyelitis should have careful assessment of muscle function after recovery. Weak muscles must be maintained in as good condition as possible until neural function returns; the time, degree, and extent of resumption of function are unpredictable, but treatment should be continued for at least 2 years.

Convalescent Stage (Stage II)

Modes of treatment

- Sitting up can be encouraged in early stages if paralysis is not very severe.
- Supported sitting in padded chair.
- Parallel bar, wheelchairs and orthosis.
- Faradic stimulation
- Passive, active assisted to active resisted (strengthening) exercises, sitting balance training standing balance, walking training. (Refer: Therapeutic exercises).
- Hydrotherapy.

REHABILITATION (STAGE III)

Duties of Rehabilitation Professionals

Every aspect of rehabilitation of the patient as a wage-earning member of the community should be planned as early as possible in the treatment. A patient can be very severely disabled and yet can still be fully rehabilitated into the community, especially if relatives and friends are prepared to help.

The severely disabled patient should be taught to be as independent as possible and take care of washing, dressing, feeding and attending to his toilet needs. This may need modifications to his clothes, cooking and bathroom appliances, a simple change that is not very expensive but that can make a shift from dependence to independence. The ability to ambulate, at least on a fairly level surface, is an additional attribute, which will help to make him independent.

Orthotic Prescription

Before prescribing orthosis it is necessary to assess

- The power of hip abductors and extensors and knee-quadriceps
- Hip, knee and ankle stability
- Limb length measurement and gait pattern
- Contractures and deformities

Orthosis cannot be given when there is a deformity. In case of minor deformity, the orthoses may be fit with the limb in the corrected position. Bilateral KAFO or HKAFO should not be prescribed without testing the power of upper limbs and grip (Ref Chap 7).

ADL's Training and Occupational therapy

Washing and toilet: Supporting rails, bath or shower seats, and adjustments to the height of washing bowl, basin or bath. A rubber mat in the bath and on the floor can often save a fall.

Dressing: This may mean experimenting with special clothes, zip fasteners, Velcro fastenings and similar attachments to clothes and appliances.

Housing, domestic aids and furniture have to be modified for the severely disabled patients (Ref Chap 10).

Transport: Wheelchairs must be strong enough for rough roads and be patient propelled whenever possible. Tricycles are very commonly used in rural India. Motorized wheelchairs, and cars with special controls, are available for the more wealthy patients.

Education is in short supply in India where families are large and money is scanty. It is not surprising that so many disabled children are left uneducated.

In the cases of a physically disabled child, who may have to earn a wage more by brain power, education is even more important than in the physically normal child.

School for Severely Disabled Children

The very severely disabled require a polio clinic with extra staff to look after them, and extra care with both their education and their daily needs. The school building must be housed in the ground floor, and no discrimination should be meted out to the person with disability. Education can also be given in normal schools with mild changes to the toilets, seating arrangements and ramps.

REHABILITATION OF THE ADULT

Rehabilitation Centers (Ref Chap 12)

The chronic residents become permanent fixtures in a sheltered workshop. The optimum method is to train patients, where possible, in skills that will enable them to earn their own living in their own community. Once independence is achieved, the disabled person can regain self-respect for both himself and his family.

Selection of Patients for Training

Patients placed in an industrial job must be able to do as well as the able bodied, provided adjustments are made to machines or workbenches. It is important that the disabled should hold their jobs by their ability rather than by sympathy. Many disabled people are capable of working more conscientiously than the able bodied, and can sometimes do even better work.

Agricultural Rehabilitation

The emphasis is on teaching a number of agricultural skills, which may be useful to him and his family and also how to grow the vegetables, which will not only feed him and his family, but also provide cash.

Patients with Good Academic Education

Training can be given for office jobs such as filing clerks, office machine operators, receptionists, office messengers and telephonic operators.

Other skills which are encouraged are small animal farming, home tailoring, shoemaking, home repairing, and rural crafts with local material. It is also important that the sheltered workshops should employ the disabled at standard rates of pay, under normal working conditions, without giving a ‘dole’. This goes a long way to help regain their self-respect.

Mobile rehabilitation centers for rural disabled women: Instructors travel around the country in a van, to teach these patients how to overcome their disabilities and to operate their savings to the best advantage in their own homes.

Training of these disabled women also includes childcare, home management, hygiene, nutrition, literacy and citizenship.

Rehabilitation of disabled beggars: These patients will resist, with understandable justification, any attempt to straighten their deformed legs if, at the same time, no attempt is made to rehabilitate them and give them employment. Professional counseling is to be done if we have to make any headway in eradicating beggary.

Orthopedic Workshop

A nice place in which to employ polio victims is obviously an orthopaedic workshop. It is also of help to patients requiring appliances to see these being made by workers with disabilities similar to their own. Disabled patients are supervised for at least two years after returning to their own communities.

Recreation for the Disabled

Few people realize that the disabled require recreation or sport. In view of their disability it is considered that a radio or television set will cater for all their recreational needs outside their work, and that they will be content just to sit and watch. This is not true.

The Stoke Mandeville games in Britain have demonstrated that paraplegic patients including those with paralysis due to poliomyelitis can participate in competitive sport. These annual games have shown that many patients even more severely disabled than those with poliomyelitis, can do surprisingly well in a wide range of sports, played with other disabled competitors.

Archery, swimming, tennis, and table tennis are a few of the more popular games for these patients. Painting and photography can be made into lucrative hobbies for those who are even more severely disabled and have the necessary skill.

CHAPTER 17

Rehabilitation of Brain Injury

INTRODUCTION

Traumatic brain injury (TBI) is damage to the brain as a result of an external force to the brain and it is associated with changes in consciousness that can cause cognitive, physical and psychosocial functional disorders. This is a typical example of multiple disability in the adult and poses a challenge to the rehabilitation team because of the myriad problems the patient presents with. This chapter gives a brief overview about the condition without delving into much detail.

The temporary or permanent damage to the internal structures of the brain presents as:

- Motor disturbances
- Sensory disturbances and
- Cranial nerve involvement

TBI may be classified as ***mild moderate or severe***

Mild head injury is manifested by any one or more of the following:

Any focal neurologic deficits, which may or may not be persistent.

Any period of loss of consciousness

Any alteration in mental state immediately after the accident

Any loss of memory for events immediately before or after the accident

Glasgow Coma Scale (GCS) score greater than 12

Admission in a hospital for less than 48 hours

Moderate traumatic brain injury:

GCS score of 9-12 or higher

Intracranial lesion that needs surgery

CT abnormality

Admission and stay for more than 2 days in the hospital

Severe Trauma is suspected when GCS score below 9 within 48 hours of the injury.

Motor Disturbances

The usual abnormalities include monoplegia, hemiplegia, and quadriplegia. Great variations exist initially and presentation of the patient can fluctuate from flaccidity to spasticity with abnormal reflexes. In some cases decorticate or decerebrate rigidity is found. Examples of typical motor disturbances are:

- Abnormal flexor responses in upper limb and abnormal extensor responses in lower limb
- Abnormal extensor responses in upper and lower extremities
- Absence of motor responses (flaccid)

Sensory Disturbances

- Hemisensory loss involving ipsilateral face
- Hemisensory loss on the contralateral side

CLINICAL PRESENTATION (FIG. 17.1)

Primary Disability

Frontal lobe

- Expressive dysphasia (dominant hemisphere)
- Personality change-antisocial behavior
- Loss of inhibitions
- Loss of initiative
- Intellectual impairment
- Profound dementia (especially if corpus callosum is involved)

Figure 17.1: Multiple deformities in an adult with brain injury

Temporal lobe

Receptive dysphasia (dominant hemisphere)
Visual field defect
Upper homonymous quadrantanopia

Parietal Lobe

Loss of sensation
Loss of localization of touch
Loss of two point discrimination
Astereognosis
Sensory inattention
Visual field defect
Lower homonymous quadrantanopia

Occipital lobe

Visual field defect-homonymous hemianopia

Hypothalamus/Pituitary Damage

Endocrine Dysfunction

Supratentorial injuries may directly damage the I and II cranial nerves. Cavernous sinus compression or invasion may involve the III and IV cranial nerves.

Infratentorial:

Deterioration of consciousness level
Tremor (red nucleus)
Impaired eye movements
Pupillary abnormalities
Vomiting, hiccough (medulla)

Cerebellum:

Ataxic gait
Intention tremor
Dysmetria
Dysarthria
Nystagmus

Movement Disorders:

Tremors
Myoclonic jerks
Chorea athetosis
Ballismus
Focal and general dystonia
Tics

Eye:

Paralysis
Infection
Diplopia
Orbital fractures
Field deficits
Blindness

Nose:

Traumatic anosmia

Mouth and Throat:

Dental and gingival problems
Jaw fractures
Dental injuries
Dysphagia

Larynx:

Vocal cord trauma, paralysis

Cranial Neuropathies

Paralysis of cranial nerves 1-12 resulting in varying symptoms like diplopia, vertigo, dysarthria or dysphagia.

Secondary Disability (other organ failure due to prolonged immobilization)

The person with traumatic brain injury could have suffered from multiple injuries as in a road traffic accident, and a complete assessment of all organs is needed. Multiple system failure may be primary in this case, but also may be secondary due to the patient being confined to bed for a long time, in an unconscious or semi-conscious state. The other organs affected are:

Skin:

- Decubitus ulcers
- Sweat disorders
- Infections
- Oedema

Ear:

- Hearing deficits, deafness
- Infection
- Trauma

Lungs:

- Emboli
- Recurrent pneumothorax
- Pneumonia
- Atelectasis
- Pulmonary oedema
- Restrictive defects
- Broncho-pleural cutaneous fistula
- Adult respiratory distress syndrome

Gastrointestinal Tract:

- Gastroparesis-sluggish gut
- Esophagitis-acid reflux
- Peptic ulcer

Hepatitis:

Elevated liver function tests

Heart:

- Direct Trauma
- Heart failure
- Pericardial effusion
- Arrhythmia

Peripheral vascular system:

- Thrombophlebitis
- Hypotension
- Hypertension

Genitourinary System:

- Infection calculi formation
- Trauma of bladder or kidney
- Incontinence
- Sexual dysfunction

Metabolic and endocrine system:

- Hypothalamic-pituitary failure
- Syndrome of inappropriate antidiuretic hormone (SIADH)
- Salt wasting syndrome
- Uraemia
- Electrolyte and fluid disorders
- Malignant hyperthermia

Musculoskeletal system:

- Fractures
- Osteoporosis
- Contractures
- Heterotopic ossification
- Spasticity
- Occult spinal cord injury
- Radiculopathy - Pain syndromes
- Cutaneous neuroma

Peripheral nervous system:

- Neuropathies
- Drug reactions
- Local Injury (peroneal, sciatic and ulnar nerves)
- Nerve compression syndrome
- Reflex sympathetic dystrophy

REHABILITATION ASSESSMENT

Assessment in the Acute Phase

Once a patient with TBI has regained consciousness, it is essential to decipher what structures have suffered damage, in order to determine the need of post acute rehabilitation services. The patient may have:

- Impairment of higher functions: memory, concentration and orientation.
- Cognitive communication disorder: Language problems, particularly aphasia.
- Emotional, psychological and behavioral problems
- Motor impairments such as weakness, altered tone and lack of co-ordination in the limbs
- Oromotor problems with speech and swallowing difficulty.
- Sensory impairments like visual problems, hearing loss.
- Bowel and bladder incontinence

Assessment in Later Phases

In addition to the above the following will be assessed for rehabilitation:
Self care (Functional assessment): for washing, feeding and other ADL's

Movement:

- In bed
- Sitting to standing
- Bed to chair

Ambulation on flat surfaces, uneven ground, stairs and in crowded environments

Social aspects like
- family
- housing
- occupation
- hobbies
- lifestyle

ASSESSMENT SCALES

Assessment is generally done clinically at the bedside on the guidelines given above but when these parameters have to be quantified, for example, the level of coma, the independence level or the disability levels, it is advisable to use standardized scales.

Rancho Los Amigos Scale

The patient may be in coma and he is assessed according to ***the Rancho Los Amigos Scale*** (given below concisely). This universally recognized scale was developed for use in the planning of treatment, monitoring the recovery, and classifying outcome levels in brain injury. It is an easy and simple test to perform for evaluating cognition of the patients and is a validated test. Not only does it give a status on the patient but it can also follow-up and compare between patients. There are 8 classification levels, ranging from no response (level I) to "confused and agitated" (level IV) to purposeful and appropriate (level VIII)

I. ***No Response:*** The patient does not respond to environmental stimuli such as sounds, sights, touch or movement.

II. ***Generalized Response:*** There will be a delayed response to environment, which may be non specific, like chewing, sucking, breathing faster, moaning or moving some part of the body. Sweating or increased blood pressure may occur as part of an overall systemic response.

III. ***Localized Response:*** The patient is awake on and off during the day, moves body more and recognizes people around him. He may follow simple instructions like 'open your mouth' but responds inconsistently or incoherently to simple questions.

IV. ***Confused-Agitated:*** The patient becomes very confused or agitated, reacting to what he sees hears or feels by lashing out, shouting, using abusive language, or tossing about. He cannot follow directions, cooperate with the care giver, or concentrate even for a few seconds.

V. ***Confused-Inappropriate, Non-Agitated:*** This confused patient is less agitated than stage 4, and is not oriented to time or place. His memory and concentration are poor. He follows commands slowly and is still fully dependent for his ADLs. He may get obsessed on an idea or activity (perseveration) and needs help to switch to the next part of the activity. Past memory may be better than recent memory.

VI. ***Confused-Appropriate:*** This patient is still confused in memory and thought processes but can remember some snatches from a conversation.

He can be persuaded to follow a certain routine, but will get confused and upset if it is changed. He is more oriented to time and place but cannot do multitasking, that is many tasks at a time.

VII. ***Automatic-Appropriate:*** This person can follow his routine, take care of himself and is independent in most self care activities. However he is still confined to a routine and any change might irritate him. Long range planning or strategies still elude him, and he gets flustered in crowded surroundings. He is incapable of handling an emergency.

VIII. ***Purposeful-Appropriate:*** In this stage the person is more adaptable, and is more aware of his loss of memory. He starts to compensate for his deficits and does not flounder in stressful situations. However when a new challenge presents itself he may show poor judgement.

OTHER SCALES

AGITATED BEHAVIOR SCALE FUNCTIONAL INDEPENDENCE MEASURE

Disability rating scale DRS: This scale though developed for brain injury, is used for other assessment programs. There are 8 items in 4 categories; arousal and awareness; cognitive ability to handle self-care functions; physical dependence and psychosocial adaptability. ***DRS*** scores range from 0 to 30; a lower score indicates a lower level of disability, and a higher score obviously means more independence.

Neuro-behavioral scale: The neuro-behavioral rating scale has 27 variables.

DISABILITY SCALE (DRS)

Category	*Item*	*Instructions*	*Score*
Arousability, Awareness and Responsivity	*Eye Opening*	0 = spontaneous 1 = to speech 2 = to pain 3 = none	
	Communication Ability	0 = oriented 1 = confused 2 = inappropriate 3 = incomprehensible 4 = none	
	Motor Response	0 = obeying 1 = localizing 2 = withdrawing 3 = flexing 4 = extending 5 = none	
Cognitive Ability for Self Care Activities	*Feeding*	0 = complete 1 = partial 2 = minimal 3 = none	
	Toileting	0 = complete 1 = partial	

(Contd...)

(Contd...)

Category	*Item*	*Instructions*	*Score*
		2 = minimal 3 = none	
	Grooming	0 = complete 1 = partial 2 = minimal 3 = none	
Dependence on Others	*Level of Functioning*	0 = completely independent 1 = independent in special environment 2 = mildly dependent 3 = moderately dependent 4 = markedly dependent 5 = totally dependent	
Psychosocial Adaptability	*Employability*	0 = not restricted 1 = selected jobs 2 = sheltered workshop (non-competitive) 3 = not employable	
Total DR Score			

Treatment

The treatment has been dealt with as:
- Medical treatment
- Surgical treatment
- Rehabilitation.

Medical treatment: **The ABC -**airway, breathing and circulation and vital signs need to be monitored during the acute phase.

Surgical treatment: The neurosurgeon may be called on to perform the following on brain injured patients:
- Burr-holes
- Craniotomy
- Craniectomy
- Ventriculo-peritoneal shunt (Hydrocephalus).

REHABILITATION—PHYSIOTHERAPY AND OCCUPATIONAL THERAPY

Acute Stage

Aims
- To clear the chest and to enhance breathing
  - Postural drainage within any limitations imposed by raised intracranial pressure and additional trauma.
  - Vibration/Percussion (if there is injury to chest—contraindicated).
  - Mechanical suction

- To prevent joint stiffness and deformity from muscle contracture. Maintain joint length and muscle length by passive movement
- To enhance functional activities confined to the bed
- To prevent pressure sores
- Bladder-care if necessary.
- Inhibit development of reflexes and abnormal muscle tone by proper positioning.

Principles of Physiotherapy for the Conscious Patient

The aim of physical therapy once the patient regains consciousness is to aid the recovery of normal functioning, to provide compensatory strategies for the symptoms that persist, and to increase independence through facilitation of motor control and skills. The therapist does the following:

- Encourage active coughing and huffing
- Assisted active exercise to facilitate voluntary movement
- Establish communication both verbally and non-verbally
- Increase sensory awareness by the use of touch and pressure
- Re-education of righting and equilibrium reactions
- Re-educate functional activities by choosing the right activities and adaptive aids for them.

Physiotherapy in Later Stages (Fig. 17.2)

1. ***Supportive seating and standing:*** If a patient lies down continuously he is prone to secondary problems like osteopenia and reduction in muscle bulk. He is mobilized to sitting [even with support] which promotes normal proprioception, postural tone and joint alignment. Appropriate wheel chairs and supportive systems help to maintain the head and trunk in good position and free the upper limbs for functional use in

Figure 17.2: An adult with brain injury being made to stand in a tilt-standing frame

the early stages. People with complex postural needs should be referred to a movement disorder clinic.

2. ***Aids and Orthoses:*** Orthoses like AFO help to maintain stability during walking and prevent deformity. Care must be taken while fitting the orthosis to avoid pressure areas, especially where deformity exists and sensation is impaired. Hand splints are given to prevent deformity.
3. ***Rehabilitation of motor control:*** The patient is suspended from a harness and made to walk with its support on a treadmill. Strength training, gait re-education, and aerobic exercises are given to improve cardio-respiratory function and promote activities.
4. ***Continence:*** Bladder and bowel incontinence is a major hassle not only for the patient but also for the care giver. Toilet programs are based on bladder retraining and reinforcement for cognitive impairments, intermittent catheterization where there is post-micturition residual volume of >150 ml, and supra-pubic catheters in place of long term catheters. In case of constipation- a diet with roughage and sufficient fluid intake, bulk laxatives will help evacuate bowels easily. Mobilizing the patient to standing also helps the constipated patient.
5. ***Visual and hearing impairments:*** Use of hearing aids, prosthesis and planning of adaptive strategies or augmentative communication (Ref Chap 5)
6. ***Pain:*** Pain is sometimes under-diagnosed in traumatic brain injury because of poor communication and cognitive deficits in patients who are unable to describe their sensory experiences. The causes of pain may be diverse: heterotopic ossification, shoulder pains due to subluxation, spasticity, or malalignment, and secondary damage to soft-tissues like the impingement of the rotator-cuff. Neuropathic pain may be due to local hypersensitivity to touch.
7. ***Cognition:*** Cognitive rehabilitation has proven to be effective but the effectiveness of specific intervention is not known. Rehabilitation starts with using one of the assessment tools. The patient is kept in his home amongst relatives without distractions and unpleasant associations. A goal oriented program that needs some planning sequencing and problem solving is given.
8. ***Aids to improve memory***
   - External
     - Reminders by others
     - Tape recorders
     - Written notes
     - Personal organizer, diary
     - Time reminders-Alarm clocks/phone calls
     - Orientation board with lists written out
   - Internal
     - Mental retracing of events; rehearsal

- Visual imaging
- Alphabet searching; mnemonics
- Association with items already recalled

9. ***Management of Agitation:*** Reduce the level of stimulation in the environment by placing patient in a quiet private place
Remove painful stimuli if possible, e.g. tubes, catheters, restraints, traction
Limit number and length of therapy sessions if patient is highly resistant
Provide therapy in the patient's room and not make him or her undergo unnecessary transportation
Protect patient from harming self or others
Communicate to patient briefly and simply: Let one person speak to the patient at a time
Reorient patient to place and time repeatedly
10. ***Sexuality:*** Advice about sexuality should cover both the physical aspects (positioning, erectile dysfunction, and sensory deficits) and psychological aspects (communication, fears, poor self image and lack of interest by the patient or partner). If sexually inappropriate behavior like exhibitionism or masturbation is severe or inappropriate then it should be referred to the psychiatrist or psychologist.
11. ***Electro-encephalographic biofeedback/ neuro-feedback*** (Ref Chap 13)
12. ***Training balance:*** The patient often exhibits difficulty in maintaining his center of gravity within his base of support due to visual, vestibular and sensorimotor disturbances. Individuals may not perform body movements that challenge their balance.
Actions may need to be modified initially so that the postural adjustments are initially small, which are:

- Looking up at the ceiling (the proprioception of the feet is activated to ensure that the centre of body mass does not move back)
- Changing the shape of the base of support
- Reaching the arm forward towards an object and increasing its distance from the body
- Varying the object size and weight to make use of both the hands
- Turning to look behind without moving the feet
- Reaching sideways, backwards and towards the floor

Speech Therapy

Speech is often affected by symptoms like jaw thrust, clenching, and retraction, which can affect jaw closure and repetitive mandibular movement needed for chewing. This has a snowballing effect as lack of proper chewing can lead to poor digestion, and thereby to poor nutrition. The food given to such patients should be initially liquid, then semi liquid introduced through naso-gastric or gastrostomy tubes. The speech therapist gives exercises to control tongue thrust and to develop tongue coordination and strength. The face, neck and lip muscles are also strengthened.

Role of the Physiatrist

The Physiatrist is called in as a consultant even when the patient is still in the intensive care unit.

The post acute rehabilitation phase depends on the expressed and perceived needs of the patient and the family. If comprehensive rehabilitation is required, even at a slow rate of progression, the patient may be referred to an inpatient facility. Where the patient can be managed at home, a 'day treatment program' can be given which provides

- Extensive cognitive rehabilitation
- Behavior management
- Daily life skills training
- Community activities and
- Pre-vocational activities

When a brain-injured person has regained the ability to learn and interact appropriately with others, community based treatment alternative may be considered. In the inpatient or step down care models, the brain-injured person lives in a supervised group home setting and is given progressively increasing responsibility in the skills needed to live independently.

Vocational Rehabilitation

A final step in social reintegration is return to work. This is done through the vocational evaluator and the placement officer

- Vocational assessment and training
- Placement into a job in the community or sheltered work setting after job trial.

During the long recovery process, the social worker can coordinate and provide social support. The case manager acts as a liaison between the patient, family and service providers, maintains medical records, and arranges for medical visits, screen programs and facilities. This person also facilitates financial and insurance matters, which are of critical importance in sustaining the patient.

CONCLUSION

The rehabilitation of a brain injured patient is extremely challenging and demands the involvement of almost all members of the rehabilitation team. It is a tedious and time consuming process which can frustrate the patient, his relatives and even the staff. This is because, unlike cerebral palsy, the patient and those around him remember how he was prior to the accident, and find it difficult to reconcile themselves to the present condition. With advanced technology and surgical procedures it is possible to envisage a near normal lifestyle in the future even for the severely brain injured.

CHAPTER 18

Stroke Rehabilitation

INTRODUCTION

Stroke is a focal neurological disorder lasting more than 24 hours of sudden development due to a defect in cerebral blood vessels. It remains one of the top four causes of death in the civilized world. Prevention has produced a significant reduction in its occurrence in the United States and the United Kingdom; the death rate from stroke has now decreased in the last decade. It is paradoxical, but as mortality due to stroke has decreased due to better medical care, impairment and disability due to it has actually increased, since there are more survivors. Generally, the majority of stroke patients regain ability to walk (with or without assistive device) and up to half regain independence with their self-care skills.

Cerebrovascular accident (CVA) is a broad term which includes all types of occlusion or stenosing disease of cerebral blood vessels as well as hemorrhagic disease of brain. It is the name given to the clinical manifestation of brain infarction causing weakness of one side of the body or hemiparesis. There may be disturbances of voluntary movement, sensation, language, emotional and intellectual functioning. The description of a patient with stroke must be precise, and include mention of these disturbances.

Etiopathogenesis

The cerebrovascular event causing stroke may be ischaemia or hemorrhage. Ischemia, which deprives the tissue of O_2 and nutrients, may be caused by ***thrombosis*** or ***embolism***. Thrombotic and embolic phenomena account for most of all strokes.

Rehabilitation Assessment

Assessment is also an important and integral part of treatment. The physiatrist constantly assesses to see if his treatment has reduced hypertonicity, stimulated activity and improved the general abilities of the patient.

He notes how the patient enters the examination room; whether he is escorted, and if so whether held or supported. If the patient is in a wheelchair, he notes how he is propelled, whether both hands are used or whether it is a one arm propelled wheelchair. The general appearance of the patient - how he is sitting and whether he looks alert or less interested is noted and compared with each subsequent visit for prognosis.

Conscious Level Assessment

Hemiplegia must not be viewed as simply paralysis of one side of the body; a stroke victim must be rehabilitated holistically. During the acute stage the consciousness must be evaluated.

- ***Eye opening:*** whether spontaneous to speech or to pain.
- ***Verbal response:*** whether oriented, confused, speaks words or only makes sounds.
- ***Motor response:*** Obeys commands like lifting up arms. Does the patient localize, flex or extend limb in response to pain
- ***Cognitive skills:*** Orientation to time, place and person.

Higher Cortical Functions

There are basic differences in cognition between patients with right sided hemiplegia and those with left hemiplegia. The left hemiplegic patient lacks insight and judgment. Learning is impaired and neglect is more common, hence cognitive retraining is difficult. The right hemiplegic patient may be aphasic but retains the ability to learn from mistakes and from observing others. The right hemiplegic exhibits more unilateral neglect. Cognitive retraining may need the help of occupational therapists, speech therapist and psychologists and testing includes:

Memory: Test for immediate, recent and remote memory. Also look for verbal and visual memory

Reasoning and problem solving: Test if patient can solve simple problems.

Emotional status: The patient may be anxious depressed or uninhibited.

Cranial Nerve Examination

Motor Examination

- General build of the patient
- Posture

- Gait—if present
- Wasting of muscles
- Balance
- Righting and saving reactions
- Handedness
- Associated medical conditions and complications like cardiovascular co-morbidity or venous thromboembolism
- Attitude of limbs in sitting and standing
- Onset of motor power
- Deformities, contractures, tightness
- Involuntary movements, if present.

Negative Prognostic Indicators

The prognosis for the patient with severe spasticity or prolonged flaccid paralysis and late onset of motor function is poor. Associated dementia, incontinence, deformed hand or gross cognitive and visuo-spatial deficits are also poor prognosticators. Prolonged bed confinement also predisposes to several secondary disabilities. Patients with poor family support, illiteracy or depression definitely perform poorly during the rehab program. If there are cardiovascular, respiratory complications or bihemispherical involvement, therapeutic success is naturally limited.

Complications of Stroke (Fig. 18.1)

- Increased tone
- Decreased range of motion in joints, contractures, like the flexed cortical hand or toe clawing

Figure 18.1: An adult with left-sided hemiplegia showing flexed contracture of wrist and hand

- Pain in the joints or muscles, and Central post stroke pain
- Shoulder dysfunction, subluxation, brachial plexus injury or shoulder hand syndrome
- Gait – circumduction
- Spinal deformity
- Pedal edema
- Subluxation of the shoulder joint where the weight of the limb pulls the head of humerus down during the acute stage when there is complete flaccidity of all affected limbs.
- Deep vein thrombosis, pressure sores and wasting.

Other Associated Problems

- Seizures
- Heterotropic ossification
- Dysphagia
- Cardiac problems
- Bowel and bladder incontinence
- Musculoskeletal injuries due to falls
- Depression, suicide attempts
- Lack of proper nutrition.
- Sexual concerns
- Constipation.

Problems in ADL

Dressing	Apraxia
Language	Receptive aphasia
Recognizing objects	Agnosia
Naming objects	Nominal aphasia
Reading	Dyslexia
Writing	Dysgraphia
Calculating	Dyscalculia
Geometrical pattern	Construction apraxia

MANAGEMENT

It is quite difficult to predict recovery in stroke as it depends on several factors. However theories have been set forth that the denervated region develops neural plasticity and collateral sprouting. This ensures utilization of pathways that were originally not used but were later recruited when the dominant system failed. Neural plasticity can be altered by several external factors, including pharmacological agents, biofeedback, electrical and environmental stimulation

Medical Management

In the acute phase, efforts are undertaken to maintain airway, respiration, reduce edema, and maintain blood flow by fibrinolytic agents, or rheological agents.

Surgical Management

Neurosurgical procedures include occluding the neck of an aneurysm when there is a hemorrhage due to it, removal of a clot, or shunting of ventricular fluid.

PHYSIOTHERAPY MANAGEMENT

Techniques of Treatment: Approximately 48 hours after stroke, if patient is medically stable and alert, and there is no progression of the deficit, bedside physical and occupational therapy may be started. The program depends on the level of recovery of the patient.

Stages of Progression of the Disease

- ***Acute/initial flaccid stage:*** Lasts from a few days to several weeks and may be longer.
- ***Stage of spasticity:*** In nearly a month, the limbs move into a spastic stage, developing a flexor synergy pattern in the upper limb and extensor synergy pattern in the lower. While this synergy is detrimental to the hand, it is useful for the lower limb as the antigravity muscles which are spastic act as a pillar supporting the body, ensuring that a larger percentage of patients ultimately walk.
- ***Stage of relative recovery:*** As the patient gets voluntary control of movement synergies, he has to control some movements that are contrary to the synergic patterns. As normal tone returns, more intricate movements are achieved as the basic limb synergies give in to voluntary control. Later normal motor function is restored.

Many patients over a period perform daily ADL functions within the limitations of their physical impairments, despite poor recovery. Sometimes trick movements are used. Since most of the patients are senior citizens their prime motivation is to get back to self dependence.

Basic Limb Synergies

Synergy is a pattern of muscles contracting in a stereotyped predictable pattern in hemiplegics or cerebral palsy patients due to loss of inhibitory control normally exerted by higher centers in the brain. In the upper limb the ***flexor synergy*** and in the lower limb the ***extensor synergy*** patterns are commoner. The patterns are as follows:

Upper Limb Synergy Patterns: Flexor Synergy

- Scapular retraction/elevation
- Elbow flexion
- Wrist and fingers flexion

Lower Limb Synergy Pattern: Extensor Synergy

- Hip extension
- Hip adduction & internal rotation
- Knee extension
- Ankle plantar flexion and inversion, tending to equinovarus
- Toe plantar flexion

Bedside Management

Involvement of family members can assist in feeding and other ADLs, as well as in giving some simple exercises. Since bladder control recovers due to the bilateral innervation, indwelling catheters can be removed as soon as possible. High roughage diet and plenty of water avoids constipation.

- Passive range of movement to the involved extremities, active resisted (strengthening) exercises to the unaffected extremities
- Bed mobility - turning in bed on his own, with minimal assistance.
- Coming to sit - Development of head and trunk control, sitting balance.
- Transfers - The patient is taught transfers from bed to chair/ wheel-chair

Lower Extremity Management

The ultimate goal is to make the patient ambulant and as independent as possible. Due to the dominant extensor synergy in the lower limb, the patient "stands " on his spasticity and ultimately walks independently in most occasions.

- In order to be able to walk the patient must have a good sitting and standing balance and reasonable control of the affected lower limb.
- Weight bearing in the upright position is preceded by activity designed to promote good sitting balance and ability to transfer from sitting to standing without stimulating abnormal spastic reactions.
- The ankle dorsiflexors and evertors are usually the last to show improvement. Devices like leaf spring orthoses, quadripods with rubber ferrules will need to be used initially.
- Gait training should be provided on a variety of surfaces, and climbing stairs. Patients should be taught ways by which they can absorb the shock of a fall and get up from the floor. Walking too early may increase spasticity.
- Newer techniques like Biofeedback and FES may be tried for the right candidates.

POSITIONING OF THE PATIENT

Good positioning is needed to prevent contractures, pressure sores, circulatory problems, and other problems related to prolonged lying and to send inputs to the brain. It is advisable to position the bed, in such a way that the patient will look over his affected side. There may be anisognosia and lack of awareness of the affected side. Positioning for the shoulder is of utmost importance as they tend to develop synergic patterns. The shoulder should be externally rotated and the hip slightly internally rotated. Pillows may be placed below the shoulders, hips and on the outer aspects of the knees. The use of a foot board to prevent equinus is debated, because it increases the downward tone of the foot, but nevertheless one must not lose sight of the fact that an equinus contracture should be prevented. The arm and elbow are placed in supination and extension respectively. CIMT (Constraint induced movement therapy) can be started with positioning the items used daily on a side table on the affected side, enabling the person to reach out with his affected arm for his daily requirements. Once spasticity starts developing, the positioning will vary accordingly. It is recommended to change the position once in two hours from affected side to unaffected and to supine, and have a firm mattress with bed height adjustable to enable easy transfer.

Sitting in Bed

The patient should be made to sit as soon as possible to stimulate proprioception and balance reactions in sitting. He is made to sit erect with the head and trunk in vertical axis and his weight evenly distributed on both buttocks. The affected arm is protracted at the shoulder; both hands are clasped together and placed forward on a bed table. The weight is transferred from side to side, feet unsupported. He is also encouraged to come to standing from a chair.

ACTIVITIES FOR THE RECOVERING ARM—OCCUPATIONAL THERAPY

Upper Extremity Management

In most strokes the upper limb is the 'hardest hit'. Lack of movement especially if the dominant arm is affected, can be frightening and frustrating for the patient, since the hand performs so many more functions than the leg. If a dense hemiplegia is the result of lesions at the posterior limb of the internal capsule, the probability of recovery of isolated hand movement decreases progressively as the fibers descend downwards. The reason why the upper limb is affected more is:

- Cortical representation of the hand is high, and the lesion picks up more fibers supplying the hand than the rest of the body, especially the fine motor movements.

- The stage of spasticity develops as a flexor synergic pattern which prevents release of a grip
- The hand performs so many more functions than the lower limb.

Generally with complete arm paralysis at onset, there is a poor prognosis of recovery of useful hand function sometimes less than 10 percent. If some motor recovery of the hand is seen in a month, there is a good possibility of recovery. After that period, prognosis is quite poor if there is no recovery. Again, even if some movements are obtained in the shoulder that is not of much use, unless there is good hand function. So too, a good cylindrical grip would not be effective unless there is good release.

- Functional evaluation by the occupational therapist must be made as early as possible. Following this passive range of movement for the affected upper limb is given regularly. As motor function improves the patient is made to do active exercises which help him gain co-ordination, voluntary control, range of movement and dexterity. Muscle re-education techniques, including PNF, EMG Biofeedback and FES may be employed.
- Custom made devices are designed to assist in various activities.
- A resting hand splint may be used to prevent joint contractures secondary to abnormal posturing or to decrease tone in the spastic hand. However these are not needed in patients with significant hand function or in a flaccid hand.
- Specific problems related to the upper limb like shoulder subluxation, shoulder hand syndrome, frozen shoulder and central post stroke pain are treated.
- A recent hypothesis is that final recovery in the involved upper limb may be inhibited by substitution by the normal limb. 'Forced use' of the involved upper limb, is advocated thus retraining the involved arm and creating the need for function. This is called Constraint induced Movement Therapy (CIMT). As mentioned earlier, it is a technique that discourages the use of the normal or less affected upper limb of the person who has suffered a stroke or some other non progressive lesion like cerebral palsy or head injury [provided one side is affected more than the other]. This is done by constraining the normal side and encouraging the use of the affected hand in an effort to get back function, provided there is some minimal improvement. The patient's normal or unaffected arm is suspended in a sling and he is encouraged to use the affected arm repetitively and intensively, as much as possible. CIMT is based on the concept of "learned nonuse", when, during the period immediately after a stroke the brain needs to be plastic enough to use the affected side. Possibly this therapy explores new neural pathways and neuro-plasticity.

Treatment at the Spastic Stage

When spasticity has developed, the process of recovery is often slowed down, especially for the upper limb. It is at this stage that most chronic stroke patients come for rehabilitation.

The gradual development of spasticity occurs during the first stage, the predominantly flaccid stage. The treatment during the first and second stages, therefore, will have to be given observing this development and often there is an overlap. Some treatment done in supine, will have to be continued, but relaxation exercises may have to be started early in some patients. Spasticity increases with the patient's activities and use of effort throughout the first 18 months.

Icing to reduce spasticity: Crushed ice should be mixed with water and the affected hand is dipped in to it fully. Also, stroking the spastic hand or foot with a cube of ice helps.

Pressure tapping: This is a technique by which the therapist taps firmly with fingers pressed together over the dorsum and lateral aspect of the patient's foot to encourage dorsiflexion. Elbow and hip extension can also be facilitated by tapping.

Treatment for Standing up (Fig. 18.2)

Correct weight bearing at an early stage provides good inputs for ultimate walking and prevents deformities. Initially, weight bearing on the affected leg is taught followed by weight shift, releasing the knee and moving the hemiplegic leg in preparation for the swing phase of gait. The therapist puts his foot lightly on the patient's affected foot. The patient is then encouraged to lean well forward at the hips, so that he starts putting weight on both his legs before he actually stands up. Exercises on the balance board are useful when re-educating correct transference of weight.

Treatment for Walking

The therapist or attender should be on the affected side of the patient while walking to prevent a fall. The patient should be given a walking stick or tripod if more stability is needed. Bracing may be used, like an AFO or functional electrical stimulation.

Treatment to Improve the Patient's Gait

During heel strike, the ankle has to go in to full dorsiflexion to avoid dragging the foot. The patient is instructed to keep the heel of the affected leg forced down on the floor, to avoid equinus deformity. Circumduction, which is instinctively adopted by such patients with extensor synergy, should be discouraged right from the beginning before it becomes a habit. The patient should be made to walk backwards and forwards alternately.

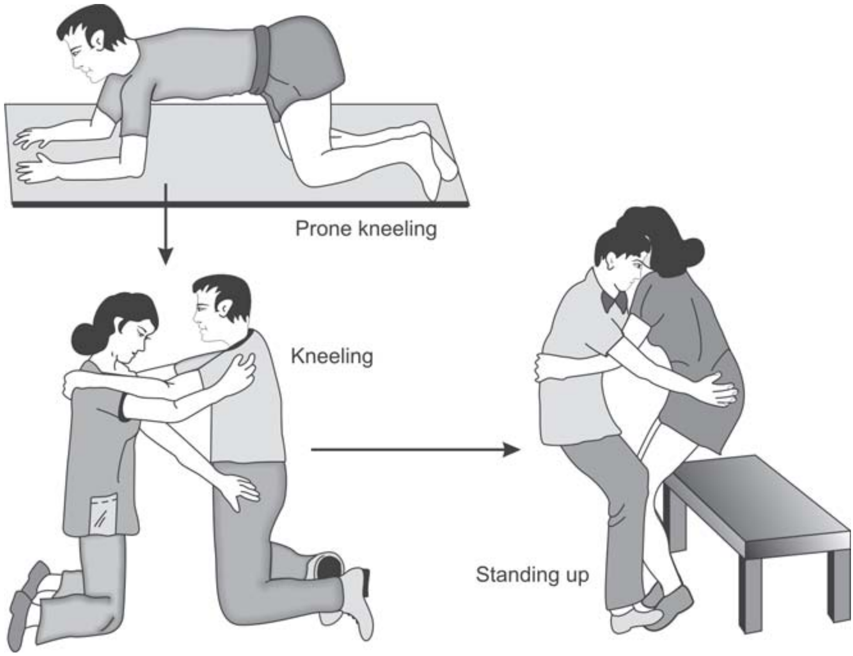


Figure 18.2: Training to come from prone kneeling to kneeling and standing up

Out of those patients who survive longer than one month after stroke, about ten to twenty percent experience almost complete spontaneous recovery. A similar percentage does not benefit from any form of treatment because of the severity of disability; it is the remaining with significant neurological deficits, and partial recovery who will benefit maximum from rehabilitation.

Support and Braces

The subluxation of the scapulohumeral joint, common in hemiplegia can be prevented by the use of an appropriate sling as soon as the patient begins to sit up, and proper positioning while lying.

1. A drop foot or unstable knee should be supported with suitable ankle foot orthosis.
2. In the case of a hemiplegic not walking, a one arm propelled wheelchair may be prescribed.

Speech

Spontaneous recovery is known to occur up to 2 weeks following the stroke. However, early and accurate diagnosis of the aphasia or dysarthria is essential. A speech pathologist should be consulted to evaluate the extent of the individual's speech problems and then recommend therapy. All persons in contact with the aphasic stroke patient should contribute to his language redevelopment by speaking to him frequently in slow, precise and quiet tones and in simple language and concept.

Home Modifications

The social worker may also make inquiries into the physical layout of the house, barriers and family members living at home. The patient is usually a senior citizen, and the dependence on family members may be much more. The psychosocial impact may be very high, since the patient may also have emotional lability or depression. Routine sexual counseling and professional advice regarding sexual activities must be included in the rehabilitation program. This depends on the age, inhibitions and mental makeup of patient.

Precautions during Bathing

- Non-slip rubber mat is a wise safety measure.
- Grab rail along the bath wall.
- Non-slip toweling mat on the floor.
- Items like soaps and shampoos should be within reach on the affected side initially as a form of CIMT but later on the unaffected side, depending on the improvement.

Toilet

The patient is taught grooming and self care activities using one hand if recovery on the affected side is negligible. The tap is placed within easy reach.

Undressing and Dressing

Ideally clothing should be loose fitting, easy to take off and put on but not so large that they hamper activity.

Vocational Rehabilitation

Stroke outcome studies vary on the reports of successful return to work. The role of the rehabilitation social worker is crucial and he should be involved as a resource and support person. Post-stroke depression and anxiety are very real problems and should be dealt with empathy.

CONCLUSION

The suddenness of a stroke and the dramatic change in motor, sensory, visual, and perceptual performance and feed back may leave the person confused, despondent and sometimes irritable. The psychosocial aspect of stroke recovery should receive significant attention in the rehabilitation setting. It is important for the team to recognize the patient as a person with hopes, dreams, and desires that are now altered by a disability.

CHAPTER 19

Peripheral Nerve Injuries

Peripheral nerves are bundles of axons conducting efferent (motor) impulses from cells in the anterior horn of the spinal cord to the muscles, and afferent (sensory) impulses from peripheral receptors via cells in the posterior root ganglia to the cord.

Peripheral nerves may be affected by

- Disease
- Compression
- Contusion
- Severance either partial or complete
- Inflammatory reaction

CLASSIFICATION

The most accepted classifications are that of Seddon and Sunderland. The terms given by Seddon are:

Neuropraxia (Fig. 19.1)

It is a physiological interruption of the nerve. The axons are intact, and the only pathology is degeneration of the myelin sheaths. Spontaneous recovery in 21 days is generally expected.

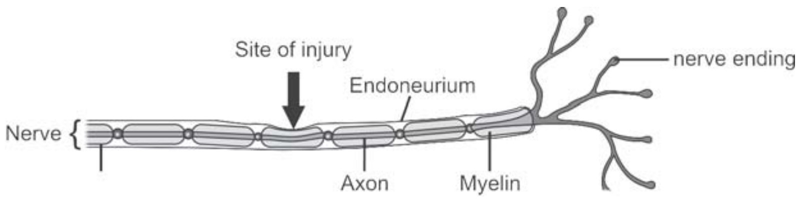


Figure 19.1: Neurapraxia

Axonotmesis (Incomplete Division) (Fig. 19.2)

Axonotmesis is complete interruption of the axon and the myelin sheath with preservation of surrounding mesenchymal structures like perineurium and epineurium. There is a sprouting of axons from the site of injury and recovery is generally good though the nervous tissue is damaged distally.

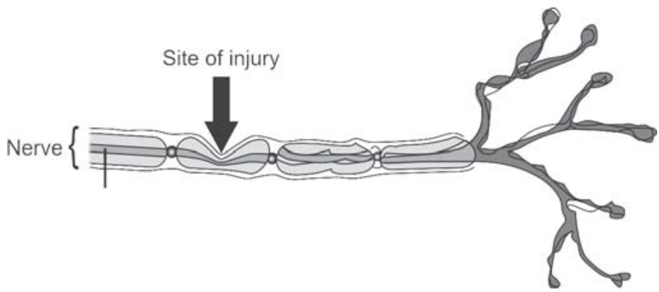


Figure 19.2: Axonotmesis

Neurotmesis (Complete Division) (Fig. 19.3)

Neurotmesis means 'nerve cutting', and refers to severe injury to the nerve which is not only cut but scarred preventing spontaneous regeneration. It is caused by open wounds, traction injuries, compression or intraneural injections. There is a chance of recovery after nerve suturing or nerve grafting.

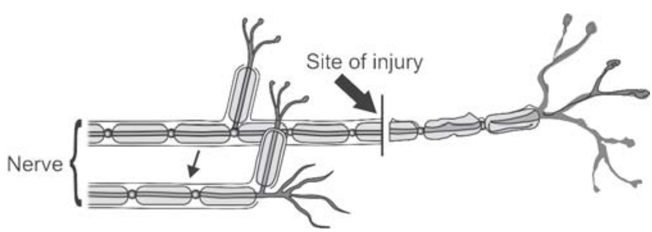


Figure 19.3: Neurotmesis

Clinical Features

The initial assessment is very important in determining management. The examiner needs to know the history, the likely prognosis, and explain this to the patient.

During the subjective examination the examiner can assess the reaction of the patient in relation to the injury and their motivation towards recovery. An assessment will be made of the problems as seen by the patient in relation to the activities of daily living, their occupation and leisure activities. Patients should be questioned about ***numbness***, any change of sensation or weakness without waiting for them to complain about it. This is because any nerve injury can be easily overlooked.

Muscle tone and power are lost, and wasting is apparent; the attitude of a paralyzed limb is often characteristic. If only some of the muscles in a group action are paralyzed then the movement may be produced but with reduced power. Some patients adapt quickly to a loss of movement and may perform trick movements, whilst others may have more disability than the loss of muscle power would indicate.

When an area of anaesthesia is present the test should start in this area and move towards the normal part otherwise once the patient has felt touch in a normal area they may imagine that they can feel it in the anaesthetized part. There may be areas of hyperaesthesia, particularly if the lesion is incomplete. A tap on the affected site of a nerve that has undergone Neuropraxia can be felt as a tingling sensation along the course of the nerve distally. This is called Tinel's sign

The examiner should note alterations in the color and texture of the skin, loss of muscle bulk and any deformities. Partial lesions sometimes cause pain or paresthesia. Late cases may present as joint stiffness, deformity or wasting. Anesthetic skin looks smooth and shiny, the affected fingers are thin and tapering and their nails abnormal. Trophic ulcers may be present, especially in the foot.

Special Investigations

Precise information about the nature, level and extent of recovery in nerve lesion can be obtained by

- The assessment of strength/duration curves
- Electromyographic study of voluntary action potentials
- Measurement of motor and sensory conduction velocities at various levels.
- Test for sweating
- Measurement of skin resistance.

Surgical Treatment

Normally nerve regeneration happens at the rate of 1 mm a day or about 25 mm a month. If there is a neuroma at the site of the nerve injury it has to be operated. If there is no sign of motor of sensory recovery in the expected time of recovery, then too surgery is indicated.

Neurolysis: The patient is admitted and under general anaesthesia and tourniquet control, the nerve is explored by a long incision and the site of injury exposed. The surgeon examines if there is continuity in the nerve and whether there is a neuroma. If not, then he needs to only release that portion of the injured segment from surrounding scar tissue.

Neuroraphe: This is also called nerve repair, where, if a space occupying lesion like a neuroma is found abutting the course of the nerve, it is removed and the cut ends sutured. Recently surgery has advanced with microscopic surgery, making it easier to suture the nerve ends.

Nerve grafting: Decision on whether a graft is needed is taken by the surgeon depending on the gap between the cut ends. If it is not very large, the cut ends can be approximated and sutured in a relaxed position by proper positioning of the limb. If however there is too large a gap, a nerve graft has to be used. Post operatively, it should be ensured that the sutured nerve is in a relaxed position and not unduly stretched. Efficient physiotherapy is required for muscle re-education during the recovery phase.

HANSEN'S DISEASE

Introduction

The problem of Leprosy is a cause of great concern in different parts of the world because it is communicable, and leads to significant disability in a proportion of the patients. The disability is both physical, and psychological, due to the social stigma attached to it.

Among the globally estimated cases, Asia has the largest share. Almost one billion people in the world live in highly endemic areas where the prevalence of leprosy is at least one per 1000.

The disease is caused by ***Mycobacterium leprae***, an acid-fast organism, which causes a diffuse inflammatory disorder of the skin, mucous membrane and peripheral nerves. The most severe neurological lesions are seen in tuberculoid type of leprosy.

Clinical Features

Anaesthetic hypo pigmented skin patches develop over the body. Thickened tender nerves can be felt as cords under the skin or where they cross the bones (e.g. ulnar nerve behind the medial epicondyle of the elbow.) With this disease, the most frequently involved nerves in the upper extremity are the ulnar nerve at the elbow and the median nerve at the wrist (carpal tunnel syndrome). This shows up as loss of motor and sensory function which predisposes to weakness and deformities of hand and feet. Trophic ulcers are common and may predispose to osteomyelitis. Lepromatous leprosy is associated with a symmetrical polyneuropathy, which occurs late in the disease.

Treatment of Neuritis

It is better to do a surgical decompression than to expose the patient to the risk of irreversible paralysis. Sometimes there is an unexpected sensory return, even after years of compression.

Unlike motor receptors, which degenerate rapidly, sensory receptors can survive for a relatively long time A deformed hand with intact sensitivity is more functional than one which is esthetically intact but lacks sensation.

Deformities in Leprosy

- Apethumb deformity.
- Button hole (boutonniere deformity).
- ***Clawing of toes and hands:*** The paralysis of ulnar nerve results in ***claw hand deformity***. This is characterized by hyperextension of the MCP joints and flexion of the IP joints. The features seen are wasting of the hypothenar and thumb web region, failure of finger closing and the ring and little fingers assume intrinsic minus position. If both median and ulnar nerves are paralyzed, the deformity is total claw hand.
- Hammer toe-flexion in IP joint and extension in MTP joint.

PLANTAR (TROPHIC) ULCERS (FIGS 19.4 AND 19.5)

When a person has no sensation on his foot he is not able to appreciate when it is damaged. The foot also suffers from strains and stresses because it is deprived of its intrinsic muscles, particularly in the region of the MTP joint, during walking. These muscles normally act during the push off stage of walking and help to counter the various strains in this region. When intrinsic muscles are paralyzed the pressures on the anesthetic foot build up.

The posterior tibial nerve is most often damaged in leprosy patients, giving rise to anaesthesia of the sole of the foot with plantar anaesthesia due to destruction of cutaneous nerves. The most important consequence of plantar anaesthesia is neuropathic plantar ulceration. About 10 to 15 percent of leprosy patients have this problem. The neuropathic plantar ulcer is relatively painless, develops spontaneously, persists for a long time and even after healing it has a tendency to recur. About 75 percent of these ulcers are seen in the ball of the foot (under the base of the V metatarsal) or in the heel.

Identical ulceration is seen in diseases such as diabetic neuropathy, spina bifida, neurosyphilis and peripheral nerve injuries. The majority of plantar ulcers result from the stresses and strains of walking but about 10 to 15 percent of ulcers arise from external injuries, cracks or fissures.

Figure 19.4: Common sites of trophic ulceration in the sole of the foot

Figure 19.5: Grade 4 ulcer exposing the bone *(For color version see Plate 5)*

These ulcers do not heal because they are insensitive and not treated properly. They recur because the original causes of ulceration persist and in addition, the scar tissue is more vulnerable to walking strain. The gait may be exaggerated by deformity or because of flare up of deep-seated latent infection. The basic principles of management are providing rest to the part, control of infection and promotion of healing by providing microcellular rubber footwear.

Amputations

Auto amputation (Fig. 19.6) is also a common phenomenon seen at the fingers or toes. Surgical amputation should not be thought of as the final solution to the problem of recurrent neuropathic ulceration since in most patients the stump is also likely to be insensitive. Therefore, one does an amputation only when it is absolutely necessary such as when the foot is gangrenous or when the severely deformed anaesthetic foot ulcerates frequently.

A fixed ankle brace is given for foot drop, a weight relieving orthosis is given to protect plantar ulcers and prosthesis is prescribed for amputations. The socket which receives the end-bearing stump should be lined with soft foam to minimize the impact. We must remember that the end-bearing stump is most likely to be anaesthetic and so the patient must be strictly warned not to walk with weight borne on the stump directly.

Physical Management in Leprosy

- ***Oil Massage:*** Any vegetable oil, preferably neem oil is used to massage hands to lubricate the skin and also to stretch out the contractures.
- ***Hydrotherapy:*** Immersion of the hand and foot in hot water and mobilization.
- ***Active exercises***

Figure 19.6: Autoamputation in a patient with Hansen's disease

- ***Wax bath:*** Immersion of the hand is done at a temperature of 120°F to 125°F (40°C to 42°C) for a period of 20 minutes (6-8 immersions) of course keeping in mind the hyposensitivity of the skin and the dangers of blisters.

Reconstructive Surgery in Leprosy

Tendon transfer is done generally when function needs to be restored after peripheral nerves are involved. One of these is temporalis transfer, done to correct Lagophthalmos and to get back eye closure. The operations commonly used in the correction of claw-fingers are mainly, Bunnell's operation and Brand's operation.

Flexor Superficialis Transfer (Bunnell's Operation)—Techniques: In this procedure the superficial finger flexor (flexor digitorum superficialis) is rerouted and made to act as the substitute for the paralyzed intrinsic muscles.

Brand's Operation: Also known as extensor many tailed graft operation, it is the lengthening of the extensor carpi radialis longus tendon by the addition of a free tendon graft after detaching it from its insertion. It is then split longitudinally into four tails or slips. This is the first stage.

In the second stage operation, the muscle used is extensor carpi radialis longus. The motor group is made to enter the palm, by bringing it forward to the front of the forearm and taking it through the carpal tunnel. The fixation of the 'tails' or slips of the motor tendon to the fingers are done the same way as in Brand's first operation to the lateral band of the extensor expansion.

Splints

Ulnar Splint: This is given to reduce ulnar neuritis to keep the hand in the optimal position. The elbow is semi flexed and midprone with wrist and hand in functional position.

Immobilization period—4 to 6 weeks. Every week, it should be reassessed.

Median Neuritic Splint: This extends from mid-forearm to finger anteriorly, with the wrist 15 degree extended. The fingers are in lumbrical position.

Radial Splint: The extent is from the upper arm to tip of fingers in same position as ulnar splint. The fingers and wrist are held in extension.

Footwear

Footwear is needed for the leprosy patient to prevent injury to the insensitive sole and to reduce the stresses and strains of walking. There is an apparatus to measure foot pressures, making the patient stand on a platform measuring forces acting on the pressure points which can be extremely useful in design of footwear to relieve pressure at the points where foot pressures are high. This is relevant not only in Hansen's disease but also in Diabetic neuropathy. The first objective is achieved by providing a tough outer sole (sometimes using old rubber tyre pieces in rural areas) and the second objective is achieved by providing a resilient insole (microcellular rubber). The footwear itself should not injure the foot.

Feet which have already ulcerated or scarred will need modifications in addition to MCR insole and tyre sole. When the ball of the foot is scarred, addition of a metatarsal bar is useful. If there is extensive scarring of this region, flexible footwear, a central cushioned heel, a rocker bottom or an arch support to distribute the weight of the body to a larger area of the sole is indicated.

WHO Approach to Rehabilitation in Leprosy: Last decade, that is in 1991 the World Health Assembly passed a resolution to eliminate leprosy by the year 2000. This meant achieving a target of a prevalence rate of less than one case per 10 000 persons which was done on schedule. Now the number of new cases detected globally has fallen appreciably and the WHO has a strategy of leprosy elimination and identifying patients in Brazil, Nepal, India and Congo where the disease is endemic in pockets.

- Early diagnosis and treatment
- Rehabilitation should take place in the environment of the community
- Prevention of disabilities by simple methods like advice to the patient on dangers to heat exposure, need for good footwear, care of the skin, splinting when there is nerve damage, and anti deformity positioning.
- Leprosy workers should receive adequate training in prevention of deformities
- Health education.
- Spreading information on disability.

Government Schemes for Hansen's Disease

- National Leprosy Eradication Program (NLEP).
- Self-employment scheme funded by nationalized government banks.
- Training with placement in jobs.
- Sheltered workshop.
- Disabled pension scheme.
- Leprosy home.

ERB'S PALSY

Causes

- Undue stretching of the head from the shoulder as in a maneuver to deliver the baby in breech presentation (birth injury).
- In an adult it may follow a blow or fall on the shoulder.

Muscles Paralyzed

- Supraspinatus
- Infraspinatus
- Subclavius
- Biceps
- Greater part of brachialis
- Coracobrachialis
- Deltoid
- Teres minor

Position of the Hand

Upper limb assumes the '*waiter's tip*' receiving position. The arm is adducted and internally rotated, the elbow is extended, forearm pronated. Movement of wrist and fingers are preserved. In addition there will be loss of sensation down the lateral side of arm.

Treatment

Recovery depends largely on the severity of the lesion but is usually rapid though not always complete. In order to prevent contracture the upper limb should be maintained in abduction and lateral rotation. The forearm is semi flexed at elbow and supinated.

Aeroplane Splint (Fig.19.7) this is maintained by a modified abductor frame but in the first few weeks or months the limb can be maintained as above by fastening the arm to the mattress with straps. The splint is not easy to wear, especially since the wearer is usually a child.

Physiotherapy Management

- Gentle passive stretching (affected segments).
- Faradic stimulation

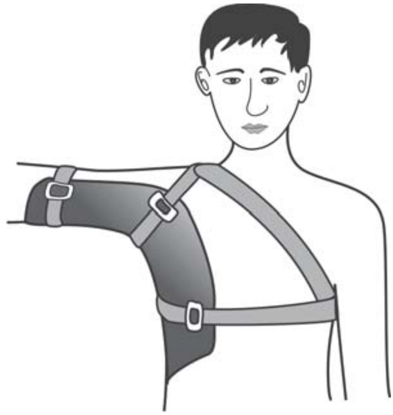


Figure 19.7: Axillary splint to prevent adductor contracture

- Active movements as voluntary power begins to return
- Surgery performed (nerve repair, or tendon transfer), depending on extent of recovery and deformity.

MONONEUROPATHY

Mononeuropathy is defined as a pathology that affects only a single nerve. Examples are cubital tunnel and Guyons canal syndrome (ulnar), tarsal tunnel syndrome (tibial), carpal tunnel syndrome (median), Meralgia paresthetica (lateral cutaneous nerve of thigh) and Saturday night palsy. Confirmation of the diagnosis is usually by doing electromyography, nerve conduction tests or nerve biopsy.

ULNAR NERVE PARALYSIS

The ulnar nerve may be injured at the elbow, where it may be torn or lacerated when a fracture or dislocation takes place. It may also be compressed by callus, bone growth or scar tissue, at the elbow or at the wrist, generally by direct injuries, such as cuts, or wounds. Tardy ulnar palsy, presenting insidiously and late in onset, is characterized by atrophy of the first dorsal interosseous muscle. There may be a history of injury of the ulnar nerve at the elbow but in the absence of injury those with a shallow ulnar groove or who persistently rest their weight on their elbows are more prone to this condition.

Signs and Symptoms

- Initially there is a tingling or pins and needles sensation or a pain from elbow to hand.
- ***Paralysis:*** While assessing the hand function, the power of the flexor carpi ulnaris and flexor digitorum profundus should be assessed. Intrinsic muscle function is tested by asking the patient to cross the long finger over the index finger, or hold a card between the fingers (card test). The power of the abductor digiti minimi and the first dorsal interosseous are also tested.

- The ulnar claw, that is clawing of the little and ringfingers, by hyper-extension at the MCP joints and flexion at the PIP and DIP joints is seen
- ***Anesthesia*** over the ulnar surface of the hand, the little finger, and the contiguous half of the proximal and middle phalanges of the ring finger, and partially the ulnar border of the hand

Management

The cause of the trouble, e.g. callus, scar tissue, or cervical rib if still persisting, must first be removed by surgical means.

Support: A knuckle bender splint may be given.

Position of the hand: If the nerve is injured just above the wrist, the hand should be placed on the splint with the metacarpophalangeal joints flexed, the fingers straight, and the thumb in adduction close to the hand. If it is injured above the point where its branches to the two forearm muscles are given off, the wrist should also be slightly flexed and the hand adducted.

The corrected position must be maintained throughout treatment which comprises exercises, massage and electrical stimulation.

Exercises
- Re-education
- Finger-parting and closing
- Grasping a sheet of paper between fingers
- Finger-stretching.

MEDIAN NERVE PARALYSIS

The median nerve may be injured:
- In the axilla, or above the elbow, although this is rare.
- At the elbow, where it may be involved in a fracture, though far less frequently than the ulnar nerve.
- Low down in the forearm, or at the wrist. This is most common site of injury, since the nerve is in a superficial position.

Symptoms and Signs

- ***In the forearm:*** The pronation of the fore arm, flexion of the wrist are affected and the wrist is in radial deviation.
- ***In the hand:*** There is loss of flexion or opposition of the thumb to the other fingers, with thenar atrophy and inability to oppose or flex the thumb. If injured below the point where the muscular branches are given off in the forearm, the only loss is that of the thenar muscles and lumbricals. The thumb lies back on the same plane as the fingers. The hand is supinated, and the wrist is slight extension.

- There is anaesthesia in the thumb, radial 2½ fingers, and corresponding portion of palm
- Loss of joint sense
- Trophic changes

The "hand of benediction" sign can happen when the median nerve is severed at the elbow. The index and middle fingers remain extended while attempting to make a fist because the ability to flex them is lost. This is because the extensors of these fingers are left unopposed.

Carpal Tunnel Syndrome

This is a syndrome when increased pressure on the median nerve and tendons within the Carpal tunnel causes tingling pain, numbness and sometimes weakness in the hand. Factors that contribute to the development of carpal tunnel syndrome include:

- Trauma or injury to the wrist
- Rheumatoid arthritis, hypothyroidism and diabetes
- Repetitive movements of the hand or wrist at work
- Cysts or tumors
- Pregnancy
- Frequent use of vibrating hand tools

Management

Conservative: Initially the hand is rested in an elevated position and immobilized in a splint with the elbow and wrist in mild flexion and forearm in mild pronation. Soft tissue stretching to the pronators and supinators and faradic stimulation can be given to stimulate the muscles innervated by the median nerve. Night splints are given to hold thumb in abduction, and simple finger splints to hold index and thumb in opposition can be given.

Tendon Transfer

Several attempts have been described to transfer tendons for full thumb opposition and strength. Transfers of FDS of the long and ring fingers or the wrist extensors (ECR or ECRL) best simulate the force and motion required and are preferred in combined median ulnar nerve palsy when both strength and motion are required. Reeducation of the muscles is started soon after.

Exercise Re-education—Occupational Therapy

- Picking up and putting down small objects like balls and coins.
- Grasping and squeezing a rubber ball.
- Keyboard playing movements of fingers
- Touching each finger at the second phalanx with tip of the thumb.
- Closing the hand; then opening it gently.

RADIAL NERVE PARALYSIS

The radial nerve passes below the humerus in the radial groove, which can get compressed, causing radial nerve palsy. Often called Saturday night palsy, or Monday morning palsy, this disorder occurs in people who drink heavily over the weekend and then sleep soundly with an arm draped over the back of a chair. In persons using axillary crutches it can happen because they fit incorrectly and press on the inner arm.

The position of the hand where the wrist hangs loosely in flexion and the metacarpophalangeal joints are also flexed is called ***wrist drop***.

Physical Treatment

Positioning: The hand is pronated and placed on a short cock-up splint, with the wrist in full, or almost full extension. The metacarpophalangeal joints may also be supported in extension as well, but the other finger joints should be left free; the thumb should be held in abduction and extension.

Electrical stimulation: The indifferent pad is best placed over the spiral groove, or where the nerve emerges through the interosseous membrane.

Passive movements: Full extension of the wrist and fingers together should be given.

Re-education
- Stretching movement for the wrist
- Simple activities with wrist in dorsiflexion like typing on the keyboard
- Hand pronated on table and picking up objects.
- Push away objects on the table by extending wrist and finger joints.

FACIAL PARALYSIS (VII NERVE PALSY) (FIG 19.8)

Facial palsy may be due to an upper or lower motor neuron lesion
- The cause of an upper motor neuron lesion may be hemorrhage, thrombosis or a tumor in the brain
- The lower motor neuron—the nucleus or its fibres within the pons can be affected in acute poliomyelitis, hemorrhage or tumors, but the commonest presentation however is Bells Palsy which is idiopathic. The patients report to the department after exposure to cold with facial palsy, thought to be due to compression at the stylomastoid foramen.

The peripheral fibres, after they have left the pons, may be injured or compressed either in the bony canal, or after they have emerged on the face, due to otitis media, accidental severance at operations on the ear, wounds, or fractures of the skull.

Upper motor neuron palsy usually recovers due to the bilateral innervation of the facial nerve, so the majority of patients with residual facial muscle weakness are in fact LMN palsy victims. The symptoms are:
- Eye can be opened but cannot be closed due to weakness of orbicularis oculi.
- Blinking is lost resulting in excessive tears.

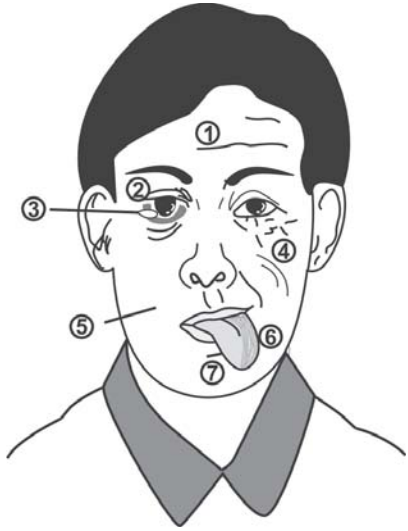


Figure 19.8: Common neurological signs associated with Bells palsy (1) Smoothening of the ipsilateral forehead, (2) Miosis, (3) Corneal ulcers, (4) Tears normal on unaffected side, (5) Diminished nasolabial fold (6) Tongue deviation if hypoglossal nerve also paralysed, (7) Loss of taste papillae on anterior 2/3rds of tongue

- Eye is not efficiently protected from dust and injurious substances.
- Bell's phenomenon: The eyeball tends to rotate upward and outward when closing.
- The corner of mouth droops.
- Patient cannot raise the corner of mouth on affected side while smiling.
- The face is asymmetrical.
- Food collects between teeth and cheek and the person finds a difference in taste.
- The patient cannot whistle or frown
- Facial expressions are affected.
- Articulation of the lips affected resulting in dysarthria. Pronunciation of labial/consonants (p,b) is affected.
- There is loss of sensation in the anterior part of the tongue, or in some cases hypersensitivity to certain sounds (hyperacusis) is present.

Physical Treatment

Electrical treatment: Muscle stimulation should only be by interrupted galvanism and nerve stimulation by faradism.

Massage: Stroking, effleurage, small circular fingering, kneading can be given all over the affected side of the face.

Tapotement: This is a form of massage by tapping quickly and lightly with the finger tips on the affected area

Vibration is performed with the tips of one or two fingers.

Exercises

- Widen the eyes, then frown.
- Close tightly eyes, and then open wide.
- Smile, grin, say 'O' and try to whistle
- Pronounce the vowels or their combinations aa ee ou
- Hold straw in mouth—suck and blow out air. Show as if blowing a balloon

The patient should practice these exercises in front of a mirror twice a day with about five repetitions.

Precautions

- Patient is always advised to wear spectacles and avoid seeing bright light
- To splash lukewarm water frequently to remove dust.
- to wear cotton plugs in ears to avoid exposure to cold.

FOOT DROP

Results from damage to the common peroneal nerve trunk and the consequent paralysis of the anterior and lateral group of leg muscles which dorsiflex and evert the foot respectively.

The patient is unable to lift the foot and the toes up voluntarily and the foot drops when the leg is lifted. In order to avoid the foot dragging on the ground during walking, the patient has to lift the leg higher than normal during the swing phase as if climbing steps. This gives rise to the characteristic 'stepping gait'. This makes the heel more vulnerable to plantar ulceration.

Drop-foot is corrected surgically by anterior transposition of the tibialis posterior tendon. When for some reason surgical correction cannot be done expeditiously, and AFO with foot drop stop, a leaf spring orthosis or a toe raising device has to be worn by the patient.

Causes of Foot Drop

At the spine: Spina bifida, Tumors, Disc prolapse

At the hip: Posterior dislocation of the hip, Fractures around the hip

At the thigh: Fracture shaft femur, Penetrating injury and gun shot injury

At the knee: Tight plaster casts around the knee, Poor padding during traction, Direct injuries to Tibialis anterior, and compression or fracture neck of fibula.

CONCLUSION

Management of peripheral nerve injury is a team approach with a good hand rehabilitation team consisting of a plastic surgeon, a physiatrist, an occupational therapist, a physiotherapist, an orthotist and a vocational counselor to enable the patient to get back to what he or she was doing.

CHAPTER 20

Common Deformities and the Role of Surgery in Rehabilitation

The word ‘deform’ means ‘out of shape.’ Deformation of body parts or segments is termed ***deformity***. The role of surgery in rehabilitation is usually to correct deformities.

TYPES OF DEFORMITIES

Many classifications of deformity exist. Some are seen at birth or congenital while others are acquired. Some are related to the soft tissue, e.g. tendo-Achilles contracture while others are bony, like CTEV. Also there are some deformities which are rigid and unyielding while there are others which yield and are only evident on weight bearing, called mobile deformities. Deformities become contractures when there is shortening of soft tissues or bony changes, and then they need to be corrected by surgery. Deformities may be primary, as in club foot, or secondary, and develop after the primary disability (Fig. 20.1).

CONGENITAL

Causes

- Malposition of the fetus in utero
- Decreased amniotic fluid thereby decreasing mobility of the fetus
- Genetic causes.
- Preterm delivery

Acquired

- Degenerative conditions, e.g. bow legs in osteoarthritis
- Bone diseases like TB or rickets
- Nerve involvement, e.g. neurotmesis.
- Trauma, e.g. fracture and malunion
- Muscular causes like imbalance among muscle groups, e.g. in cerebral palsy

Figure 20.1: Universal flexed position with poor positioning

- Shortening or contracture of muscle tendon or fascia, e.g. iliotibial band and flexion deformity of the hip
- Metabolic diseases like gout, causing Hallux valgus

Grading of Deformities

Deformities can be graded in three degrees.

First degree: The deformity can be corrected by active effort or passive force

Second degree: In this, there is a definite shortening of varying grade from tightness to early contracture. Passive effort to correct deformity elicits pain. Bony deformation may be minimal. Splints may be needed to maintain in corrected position.

Third degree: Bony deformation is seen with contracture.

Causes for Development of Secondary Deformity

- Immobility—Total or partial.
- Hypotonicity for example in muscular dystrophy.
- Hypertonicity—The spastic muscles pulling joints into abnormal positions, as in hemiplegia.
- Even lying down for prolonged periods can lead to decubitus contractures.
- Asymmetry, sometimes due to asymmetric tonic reflexes.
- Involuntary movements in one repetitive pattern, as in athetoid cerebral palsy
- Growth factor deficiencies.
- Effects of various forces, including gravity.
- Posture, for example the development of scoliosis on sitting.

PREVENTION

Deformities can be prevented, and indeed that is a primary goal of preventive rehabilitation. Many secondary deformities are preventable, but, alas, do occur sometimes even after corrective surgery. In a condition like cerebral palsy it is important to ensure:

- Frequent changes of child's posture.
- That the normal postural mechanism and locomotor reactions are trained as and when each milestone is achieved.
- That an asymmetrical posture is immediately corrected.
- Splints can be used to passively elongate hypertonic muscles and soft tissues and maintain correct positioning of each segment of a child's body.
- Control of involuntary movement in one pattern like asymmetric tonic neck reflex.

Since secondary deformities are often preventable, a very alert therapist may be able to anticipate the deformity before it really occurs and prevent it by various methods given above.

The following methods help in first and second degree deformities.

- Exercise to weak muscles
- Splints to prevent over action of opposing groups of muscles
- Relaxation exercises to spastic muscles, cryotherapy
- Stretching and its maintenance
- Serial casting (wedging)
- Orthosis

MANAGEMENT OF FIRST AND SECOND DEGREE OF DEFORMITIES

While it is important to treat the deformity it is imperative to know

- The diagnosis and prognosis of the condition
- The secondary cause of the deformity
- The extent of the deformity and whether it is likely to recur
- The functional loss due to it.
- Whether it is preventable, progressive or regressive.

Of course the physiatrist must treat the patient holistically and not just the problem. For example correction of an equinus deformity may not be a priority in a child with no head control or sitting balance. Surgery may be:

- Soft tissue release or lengthening
- Bony correction
- Bony fusion
- Tendon transfers
- Manipulation under general anesthesia.

COMMON DEFORMITIES OF LOWER LIMB

Hip Deformities

The hip gets adducted and interferes with gait, often called scissoring. The narrow base of support often causes the patient to fall frequently. Often adduction and internal rotation are accompanied by flexion. In the severely spastic patient who is bed ridden this can interfere with perineal hygiene. Flexion due to iliotibial band tightness and external rotation deformity also can occur.

Knee Deformities

- Knee flexion deformity.
- Knee hyperextension or genu recurvatum.
- Triple displacement. Often flexion deformity of hip is associated with flexion deformity of knee, with external rotation and posterior subluxation, the so called triple deformity at the knee.

FOOT DEFORMITIES

Equinus

Equinus (equine = horse) deformity of the foot is when the ankle dorsiflexion is not possible because the foot is pointing downward. It can occur in one foot when there is a difference in limb length and the person compensates by bringing down the forefoot. The heel does not touch the ground and the foot resembles the hoof of a horse, thence the name. In some patients it is present at birth, while in some, it is due to tightness of the tendo-Achilles. Conditions like poliomyelitis, cerebral palsy and hemiplegia predispose to an equinus deformity. Patients come with complaints of metatarsalgia or ankle pain. A non-invasive treatment is to stretch the tendo-Achilles and maintain it in a night splint.

Pes Planus—Flat Foot

This condition is characterized by the collapse or disappearance of the longitudinal arches, especially the medial arch of the foot. Flat foot is congenital or acquired.

Clinical Features

- Flat foot only evident on weight bearing.
- Hypermobility of subtalar and midtarsal joints.
- Limitation of dorsiflexion at the ankle joint
- A short tendo-Achilles

Pes Plano-valgus (Fig. 20.2)

This is manifested as flattening of the foot combined with eversion (valgus) of the foot.

It may be seen in the later stages of congenital flat foot or acquired as the result of a primary hind foot varus. Sometimes it follows neuro muscular disease, injury, arthritis or fractures of the ankle.

Figure 20.2: Bilateral dynamic valgus of foot

Pes Cavus (Fig. 20.3)

This is characterized by abnormally high longitudinal arches and is seen in some myopathies (e.g. muscular dystrophy).

It may also be seen in

- Postural deformity
- Muscle imbalance during the growth period
- Spina bifida occulta
- After direct trauma to foot
- Poliomyelitis

Clinical Features

- First metatarsal drop and pronation
- Tight plantar fascia
- Cock-up deformity of all toes at metacarpophalangeal joints
- Flexion deformity of all toes at interphalangeal joints.

Figure 20.3: Pes cavus

Hind Foot Varus (Calcaneo-varus)

Clinical Features

- Foot shows a moderate to high arched form.
- The forefoot is inverted and may also be adducted.
- The foot is hyper mobile and structurally unstable.
- Weight bearing is directed more medially than normal.

Congenital Talipes Equino Varus (Fig. 20.4) (Ref Chap 14)

Clubfoot is a congenital contracture of the joints of the foot. The main clinical signs of congenital talipes equinovarus are

- Equinus (plantar flexion of the foot in the ankle joint),
- Supination (the plantar surface of the foot is turned inward)
- Forefoot adduction (the anterior part of the foot is displaced medially).

Forefoot Varus: The forefoot is inverted in relation to the hind foot, with the hind foot in its neutral position.

Hallux Valgus: The big toe is abducted and axially rotated. Management of these deformities may be by surgery or orthotic modifications.

TREATMENT FOR PARTICULAR DEFORMITIES

Hip Flexion – Adduction – Internal Rotation

Positioning

- Prone lying, legs apart, in prone wedges or prone boards.
- The child sits with legs apart in an externally rotated position.
- The child is carried in a similar fashion by the parent with legs apart and turned out.

Splinting and Bracing

- Abductor splint is used during standing and walking.
- Long leg braces with pelvic band; de-rotation coil attached to pelvic band and shoe for external rotation for mild spastics.

Figure 20.4: Bilateral talipes equinovarus

Adductor Tenotomy (Figs 20.5 to 20.7)

When no fixed adductor contracture is present and only tightness is there, neurectomy of the anterior branches of the obturator nerve will denervate the adductors and release the tightness. On the other hand, if the obturator nerve block still does not correct the adductor contracture it would be advisable to go in for adductor tenotomy. A percutaneous release of the adductor tendon is done at the groin. Flexor contracture by the sartorius or rectus femoris is also released simultaneously.

Hip Flexion Abduction and External Rotation

The two common hip deformities are flexion and abduction. To test the flexion deformity at the hip we must eliminate lumbar lordosis by flexing the opposite hip fully and extend the affected hip (Thomas test) and check

Figure 20.5: Adductor tightness and equinus of foot

Figure 20.6: Postsurgical positioning of patient *(For color version see Plate 5)*

Figure 20.7: Gait after the surgery

all joint movements in supine and prone, eliminating trick movements. The ilio tibial band contracture also contributes to the flexion and abduction at the hip.

Soutter's operation: Flexion deformity hip requires extensive release, including the muscles in the anterior aspect of the thigh sartorius, rectus femoris, iliopsoas, anterior hip capsule and other tight structures. Tension in the femoral nerve and vessels may prevent correction of more than 45° fixed flexion deformities; any additional correction can be obtained by subtrochanteric extension osteotomy. Severe flexion deformity may be prevented by early tenotomy of the psoas.

Yount's operation: Abduction deformity hip while the hips are in extension is because of contracture of anterolateral structures. In this operation there is division of the tensor fascia lata at its origin together with release of any other tight structures on the anterolateral aspect of the hip. It may also be necessary to divide the ilio tibial band and lateral intramuscular septum.

Knee Flexion

Positioning: Prone lying with straight knees, long leg sitting with straight knees on the floor. Use knee gaiters in sitting and standing.

Splintage and bracing: Knee gaiters, long leg calipers, knee splints.

Surgical treatment: The subcutaneous method of division of the hamstrings is sufficient for the milder contractures. Care must be taken to avoid damaging the femoral or popliteal arteries and the lateral popliteal nerve, which could lead to severe haemorrhage or foot drop.

Posterior capsulotomy: The ilio tibial band is divided transversely and the peroneal nerve isolated. The biceps tendon is lengthened in a Z manner. The capsule is stripped upward from the posterior aspect of the femur after incising it. A medial incision is now made above the adductor tubercle to below the joint line. A similar stripping is carried out on this side.

A plaster of Paris cast is applied from ankle to groin with the knee fully extended. Weight bearing begins after 24 hours in the cast and intensive quadriceps exercises. The cast remains on for 2-3 weeks and then a posterior gutter splint is used and physiotherapy started.

Knee Hyperextension (Fig. 20.8)

Positioning: The child is given the position of sitting on chair and crook sitting. If the child is standing already, it should stand with posterior knee splint preventing hyperextension. Use shoes with high heel to throw child's weight into knee flexion posture if his plantar flexors are not shortened.

DEFORMITIES OF THE FEET

Equinus and Equinovarus

Positioning: Prone lying with feet over edge of wedge or pillows, sitting in chairs with heels flat on ground; standing feet held flat on the ground; bear walk positions. Child stands and leans forward to wall to stretch heel cords.

Splintage and bracing: Strap to keep the child's heel down on his boot. AFO with ninety degree foot drop stop ankle joint

Treatment of a short tendo-Achilles is by lengthening the tendon, dividing the fibres at its upper end of the tendon medially and at the lower end of the tendon anteriorly and correcting the ankle to just 90°. It must be lengthened in the right proportion, otherwise calcaneal deformity or gait will inevitably occur if the tendon is over lengthened with resultant poor stability and gait pattern. Following the operation the foot is protected in a below-knee walking

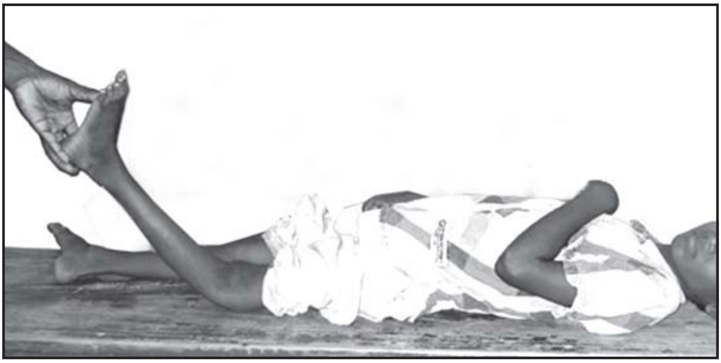


Figure 20.8: Hyperextension at the knee

cast for a period of 4 weeks. Another technique is the open sliding type or the 'Z' plasty where a Z shaped incision is made in the tendoachilles and the tendon is sutured in the lengthened position.

Valgus Deformity

Positioning: Have hips and knees turned out during sitting, cross-legged on the floor with feet in varus position, with hips externally rotated. Correct equinus if present.

Splintage and Bracing: Medial border elevation in the insole.

Orthopedic Surgery: Severely deformed feet may also be treated with Grice Green operation to the joints. (Triple arthrodesis).

Clenched Toes or Everted Toes: This disappears with correct weight bearing and balance training. Heel must be on the ground and equinus treated.

Arm Deformities

Shoulder: Flexion – Adduction – Internal rotation is common and should be positioned by elevating and resting the arms on a high table.

Elbow Flexion

Splintage: Well-padded elbow gaiters providing support to the forearm area.

Passive Stretch: Slow range of motion to maintain existing mobility.

Tendon Transfers: The substitution of a damaged tendon by another one is termed '***Tendon transfer***' Tendon transfers work better for upper than lower limb problems.

The application of certain fundamental principles is essential for successful transfer of muscle tendon units. These important concepts were established by such masters as Mayer, Steindler, Bunnell and Brand.

Principles

Range of movement: Maximum passive motion of all joints must be present before a tendon transfer is performed to have good active motion postoperatively. If a contracture is present it must be corrected.

Adequate strength of donor: The tendon chosen as a donor for transfer must be sufficiently strong to perform its new function. This is because the donor tendon will lose some of its power (usually by a factor of 1) after it has been rerouted.

Amplitude of motion: The surgeon must know the extent of tendon excursion for each muscle for purposes of determining the effectivity of the tendon in its new function. For example finger flexors have a longer excursion than wrist flexors.

Straight Line of Pull: The pioneers of tendon transfer surgery repeatedly emphasized that the most efficient transfer is one that passes in a direct line from its own origin to the insertion of the tendon being substituted.

One Tendon Function: The effectiveness of a tendon transfer is reduced when it is expected to produce two dissimilar functions. So a scenario where the tendon is expected to perform a single function is preferred.

Synergism: It is easier to retrain muscle function after synergistic muscle transfers, that is, if the function to be retrained after surgery is flexion, it is ideal to transfer a flexor tendon to perform the expected action.

Tissue Equilibrium: No tendon transfer should be done unless the local tissues are in optimal condition and conducive to the tendons passing between them.

Precautions During Tendon Transfers

- All deformities have first to be corrected.
- Muscle bellies and tendons should be handled gently, special care being taken not to damage the blood and nerve supply.
- The end of a transferred tendon is attached firmly to its new site under tension.
- The tendon is sutured to a firm fibrous structure like the periosteum. However, the most secure position is to a hole in the bone. A strong figure-of- 8 whip suture should be inserted into the end of the tendon.

Specific Transfers

Long Thoracic Nerve: Injury to the long thoracic nerve causes weakness of the serratus anterior with winging of the scapula. It can be treated by transferring the pectoralis minor into the inferomedial aspect of the scapula.

Musculocutaneous Nerve: Loss of function in this nerve causes weakness of elbow flexion. This may be overcome by 'Steindler Flexorplasty' where the brachioradialis is advanced proximally up the humerus to give better leverage.

Radial Nerve: In the modified Robert Jones operation which is commonly performed, the pronator teres tendon is transferred to the extensor carpi radialis longus and brevis to restore wrist extension, and the flexor carpi ulnaris tendon is transferred to the extensor digitorum tendons of the 4 fingers to retrain finger extension. The palmaris longus tendon is then transferred to the extensors of the thumb to restore thumb extension.

Median Nerve: For distal median nerve injury the motor losses are primarily abduction and opposition of thumb, whereas in proximal injury the radial wrist flexors, all the flexors to the thumb, index and middle finger and the flexor superficialis to the ring and the little finger are affected. Thumb opposition can partially be restored by routing the superficial tendon of the ring finger through a pulley in the ulnar border of the hand.

Ulnar Nerve: The ring and the little finger profundus tendons can be sutured with the functioning profundus muscles of the index and middle fingers. In the Bunnell's operation the flexor digitorum sublimis to the ring finger is removed from its insertion, split into two, rerouted and attached to the extensor expansion of the ring and little finger.

Lateral Popliteal Nerve: Transfer of tibialis posterior tendon to the tibialis anterior, through the interosseous membrane restores reasonable ankle dorsiflexion.

Preoperative Management in Tendon Transfer

- General condition of the patient is to be good
- Explain to the patient what exactly is going to be done.
- Maintain the muscle bulk by giving relaxed passive movements and active assisted exercises.
- Resisted exercises to the tendon to be transferred.
- Talk to him and boost his morale.

Postoperative Management and Muscle Re-education (Also Ref Chap 13)

Muscle re education is re establishing a new muscle contraction or strengthening it. This may be of the original muscle, or a donor muscle. In the case of the original muscle, it might have gone into disuse atrophy, or spasticity. It also might have been used in trick movements. Motor relearning programs and NDT are also in sense muscle reeducation. However many reeducation programs use stimulation or EMG biofeedback to aid the muscle retraining.

- Active finger movements of the limb in cast.
- Muscle re-education with the help of EMG Biofeedback.
- Electrical stimulation to train the new action of the tendon.
- Suspension therapy and hydrotherapy.

Surgery to the Bone and Joints

When severe deformities have been long-standing, they will need the following types of operations on the bone:

- Osteotomy – is a corrective surgery of the bone.
- Excision – removal of all or part of the bone
- Arthrodesis of joints
- Ilizarov technique used in the correction of deformities.

TORTICOLLIS (FIG. 20.9)

Definition

A deformity characterized by lateral inclination of the head towards the shoulder, accompanied by torsion of the neck and deviation of the face. It is caused by unilateral contracture of the sternomastoid, with secondary shortening of the fasciae and the other muscles of that side of the neck.

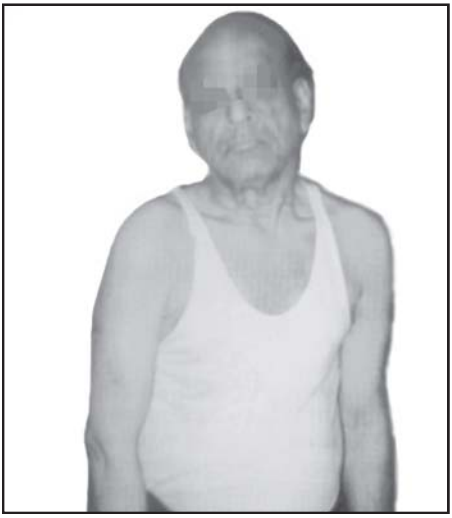


Figure 20.9: Torticollis

Classification

Congenital	*Acquired*
Idiopathic- sternocleidomastoid contracture	wry neck—fibrosis
Myodysplasia	traumatic sprain
Birth trauma—hematoma or ischemia	tumor of cervical spine

Another type of torticollis (Spasmodic torticollis) is characterized by repeated uncontrolled spasm of ipsilateral muscles, which responds to injection of Botulinum toxin.

Surgery—Open Operation

The muscular heads of the sternomastoid are defined and each head is divided. During the operation the head is gradually manipulated into the correct position, in order to bring any shortened structure into prominence. Active and passive movements to prevent any recurrence of the deformity are given.

SCOLIOSIS (FIG. 20.10)

It is defined as a pathological lateral curving of the spine from the midline. It is inevitably accompanied by lateral rotation of vertebral bodies, towards the

Figure 20.10: Scoliosis

convex side of the curve. At first the curve is functional (reversible) and later becomes structural (fixed). At the thoracic level, the ribs too undergo rotation. This could lead to cardiopulmonary problems secondary to rib deformity.

A potentially deforming orthopedic problem which is very often progressive, scoliosis is specified according to the site—cervical, thoracic, and lumbar. Curves may be primary (congenital) or secondary to some other pathological conditions, like injury of the spine, polio, syrinx, infections or cerebral palsy and dystrophy.

The problems it poses are:

- Cosmetically unsightly
- It changes the load and force transmission mechanism through the spine, causing pain
- Jeopardizes the functions of vital organs like lungs, by over crowding.
- It is a potential source of pain due to
  - Muscle fatigue and ligamentous strain
  - Nerve root irritation.

Measuring Severity of the Scoliosis (Fig. 20.11)

Cobb's angle is the index, which determines the severity of scoliosis and type of therapeutic intervention. Clinically it can be detected early by sighting down the spine. In children if rotation starts even with a mild lateral curve, Milwaukee brace has to be prescribed (ref Chap 7). Curves less than 20° need counseling and frequent check up. Curves > 20 degree to < 40 degree need to be controlled by the brace and exercises for at least two years.

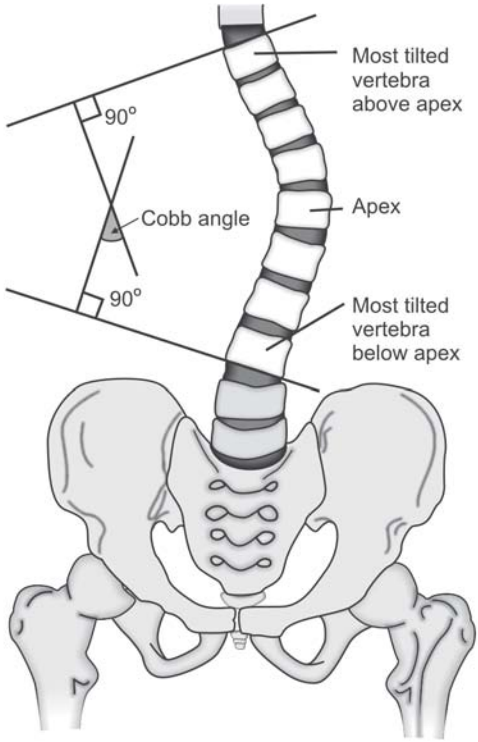


Figure 20.11: Cobb's angle

Exercises prescribed are:

- Strengthening the lateral flexors of the convex side.
- Stretching the lateral flexors of concave side.
- Spinal stabilization exercises
- Breathing exercises—deep diaphragmatic breathing exercises/chest expansion exercises.

Curves > 40° require surgical correction.

Scoliosis can be progressive, therefore frequent check up and X-ray reports of spine periodically would help in handling the condition effectively.

Surgical Treatment

Harrington Rod: This consists of a longitudinal rod surgically fixed by hooks to the spine above and below the deformity. The rod can extend and elongate the spine. A compression metalwork system is placed on the convex side of the spine, pulling on the vertebral elements above and below, so that the convexity is shortened. Using the two systems it is generally possible to achieve an appreciable correction of the Cobb angle for mobile or flexible curves.

Spinal Surgery in Paraplegia: Surgery is performed as an emergency method to prevent secondary damage to the cord and for spinal stabilization. It is a passport to early rehabilitation in paraplegia. Usually decompression of the cord and laminectomy is done. Internal fixation using instrumentation such as Harrington rods, (compression or distraction), Luque rods, and Weiss compression springs is done selectively by spinal surgeons. Post-operatively the patient is advised to wear a spinal orthosis, like Taylor's brace for 3–6 months.

Hip Replacement

Hip replacement has been around for several decades' more than total knee replacement (ever since the pioneering metallic implant surgery in 1940). It consists of a metal femoral component, implanted in a teflon acetabular component and both fixed by bone cement or screws. The indications are many, and include, among others, certain hip fractures, osteoarthritis, bone tumors and avascular necrosis. With proper rehab and gait training, it is possible to retrain a near normal gait with most patients, who would otherwise have been confined to bed.

Total Knee Replacement

The knee is generally divided into three "compartments": medial, lateral, and patellofemoral, and when more than two are affected, a Total knee replacement (TKR) can be considered.

Ideally TKR should be called knee arthroplasty as it consists of replacing the diseased or damaged joint surfaces of the knee in chronic degenerative arthritis (Osteoarthritis) with metal and plastic components. It consists of implants replacing the lower end of the femur and upper end of the tibia, with removal of the cruciate ligaments but retention of the collateral ligaments. Partial knee replacement which is a term given to unicompartmental arthroplasty is done when only one of the compartments is affected.

Post operatively, weight bearing on crutches or a walker is required until the quadriceps muscle has got back its strength (since part of it has been detached from the patella during the surgery. Continuous Passive Motion may be given during the hospitalization which varies up to one week. A good range of motion is expected with diligent physiotherapy, but most Indian patients find it difficult to sit cross legged on the floor, a habit they are used to. By two months patients have usually progressed to full weight bearing with a cane and satisfactory functional recovery in about three months.

CHAPTER 21

Rehabilitation of Muscular Dystrophy

Myopathies are primary afflictions of muscles that are genetically determined and may have hereditary transmission. No definite cause has been attributed to these diseases.

MUSCULAR DYSTROPHY

In this group of conditions muscles undergo progressive degeneration and the patient who has inherited this condition gets progressively weaker without involvement of the nervous system. Muscular dystrophy is distinguished from other muscular diseases by four obligatory criteria:

- It is a primary myopathy
- There is a genetic basis for the disorder
- The course is progressive
- Degeneration and death of muscle fibers occur at some stage of the disease.

In myopathies, there are pathological, biochemical or electrical changes characterized by involvement of proximal and larger muscle groups, with wasting and absence of deep tendon reflexes. Muscles show fibrillation, are symmetrically involved, with usually no involvement of the central and peripheral nervous system. The disease takes a down hill course and there is usually no remission.

In muscular dystrophy, muscle wasting and weakness are symmetrical, but there is no fasciculation, tendon reflexes are preserved until a late stage and there is no sensory loss. Some muscular dystrophies are severe at birth and progress rapidly even unto death. There are others which are very slow in their course lasting sometimes several decades. In some the disease does not manifest until late adult life and may be compatible with normal longevity. The differences between various muscular dystrophies are made out genetically rather than by clinical and histopathology features.

Classification

X-linked recessive	*Autosomal recessive*	*Autosomal dominant*
Duchenne	Limb-girdle type	Facioscapulohumeral
Becker	Childhood type	Emery-Dreifuss
McLeod's type	Congenital muscular dystrophy	Oculopharyngeal

DUCHENNE MUSCULAR DYSTROPHY (DMD)

It is the most common, most studied and one of the most severe of muscular dystrophies. Males are affected more than females who are carriers.

Pathology

It is caused by deletion of a large gene in the p21 region of the short arm of the X-chromosome, resulting in the deficiency of a muscle protein called ***dystrophin***.

Dystrophin is distributed widely in the body. It is concentrated in skeletal and cardiac muscle and found in small quantities in smooth muscle, brain, lungs and skin.

Deficiency of dystrophin impairs fast muscle fiber function. These fibers are the first to degenerate, followed by degeneration of other muscle fibers, until the entire muscle is replaced by fatty and fibrous tissue.

Clinical Features

Children with DMD classically present with muscle weakness by about 5 years of age. They find it difficult to climb stairs, get up from squatting and their parents usually complain that they fall too often. Motor milestones are occasionally delayed, especially walking. The child may never ever run.

- Poor head control in infancy is noticed. Weakness of neck flexors is an early sign.
- The extensors of the hip are weak and to compensate for this the child may assume lordotic posture and gait.
- *Gowers' sign:* This is a clinical assessment of pelvic muscle weakness in Duchenne muscular dystrophy. It is performed by asking the child to get up from the floor. Due to pelvic muscle weakness while attempting to get up the child will 'climb up himself', i.e. with the support of upper limbs on the ground and gradually on the knees and coming to stand. Pharyngeal weakness may lead to episodes of aspiration and regurgitation of liquids and the voice may have a nasal or airy quality.

Muscle weakness is proximal, symmetrical and progressive in a fairly predictable pattern (Figs 21.1 to 21.5). Shoulder girdle weakness appears later making it progressively difficult to lift the arm above the shoulder, and interfering with ADL. There is pseudohypertrophy of the calves and

Figure 21.1: Gowers' sign

Figure 21.2: Gowers' sign—leaning forward and taking weight on hands

Figure 21.3: Gowers' sign—reducing the distance between arms and legs by 'walking the arms towards the body'

Figure 21.4: Gowers' sign—climbing upon ones body

Figure 21.5: Gowers' sign—coming to stand

sometimes quadriceps, glutei, tongue and deltoid. Other systemic manifestations are short stature, growth retardation, and increased head circumference, impairment in locomotor and language areas. The course of Duchenne muscular dystrophy can be divided into 3 stages depending on the mobility and functional ability of the patient. The stages are: the ambulatory stage, wheelchair dependent stage and stage of confinement to bed. Some children become wheelchair- bound by 9-10 years. The progression often is:

up to 7 years	ambulatory stage.
up to 12 years	wheelchair bound
up to 19-20 years	bed bound

Death occurs around the 3rd decade, due to chest infection or cardio myopathy. It is pathetic to see the child deteriorate as his age advances, especially for the parents. Considering the limited longevity it is the quality of life that matters most. The child is fully aware of his deterioration and often longs to play with his friends.

The disease is staged as follows:

Stage I ambulatory
Stage II ambulates but climbs stairs with support
Stage III can come to stand from sitting
Stage IV needs to be lifted to come to stand, but can walk with support
Stage V is wheelchair independent
Stage VI is wheelchair dependent
Stage VII confined to bed (independent)
Stage VIII is confined to bed and dependent for all ADL's.

Complications

Respiratory: Respiratory complications are the most frequent and the most common cause of death in DMD. These include recurrent respiratory tract infections, restrictive pulmonary disease and chronic alveolar hypoventilation. Cor pulmonale and ventricular failure may eventually develop.

Cardiomyopathy can occur in patients with DMD as well as in carriers.

Scoliosis begins during the ambulatory stage and progresses rapidly once the child is wheelchair bound. Spinal deformity is present in almost 90% of children with DMD and continues to progress throughout life. Scoliosis adds to the respiratory complications by reducing vital capacity.

Contractures appear early in DMD, especially in the lower limbs. Hip flexion deformity, iliotibial band tightness, knee flexion deformity, equinus contracture, all diminish the ability to walk.

In the upper limbs, the habitual flexed position of the elbows in patients using wheelchairs may lead to elbow flexion contractures.

Investigations

- ***Serum muscle enzyme estimations:*** Creatine phosphokinase (CPK) levels are greater than 10 times normal in children with DMD, 2-5 times normal in carriers. Measurement of post-exercise CPK levels increases the sensitivity of the test. Other muscle enzymes like carbonic anhydrase III, pyruvate kinase and lactate dehydrogenase are also elevated.

- ***EMG studies:*** Supports the diagnosis and forms an important investigation to detect early cases with no specific family history. It shows denervated potentials in the skeletal muscles in DMD. It records spontaneous mutation states but not carrier states.
- ***Muscle biopsy*** is diagnostic: Shows areas of degeneration and regeneration in the muscle.
- ***ECG, and echocardiogram*** to assess cardiac status.
- ***Genetic counseling:*** This obviously applies to having the next child or marriage counseling for carriers of the gene.

REHABILITATION

Ambulatory Stage

- Early detection and management of contractures is the single most important step to keep the child walking and mobile
  - Positions which encourage contracture formation are avoided. Long leg sitting and prone lying are encouraged to stretch the hamstrings and hip flexors
  - Passive stretching daily. Standing and walking are functional stretching exercises
  - Splinting, especially at night, to avoid contractures.
- Supportive physical therapy, e.g. endurance exercises, respiratory muscle strengthening exercise (chest physiotherapy) and occupational therapy
- Monitoring and prevention of cardiac complications
- Psychological support to patient and his family.

Wheelchair Dependent Stage

- Respiratory management and training [chest physiotherapy
  - Management of acute episodes of respiratory insufficiency, e.g. infections
  - Breathing exercises and endurance training
  - Assisted ventilation.
- Upper limb weakness becomes incapacitating at this stage. Weakness is most severe proximally, and the child is taught various methods to use his upper limb. Mobile arm support, a forearm orthosis or an overhead sling suspension system can be used.
- Training in ADL independence. Assistive devices like long-handled combs, reachers and spoons can be used. Toilet modifications are required.
- Prevention of scoliosis is critical to sitting balance and comfort in the wheelchair, and respiratory function. Early bracing [spinal orthosis] has been reported to be useful, but patient compliance is poor, especially in hot weather. Wheelchair modifications like lateral trunk supports, and custom-made spinal support systems may have to be used.
- Cardiac function monitoring.

Stage of Prolonged Survival

- The use of non-invasive respiratory muscle aids to assist ventilation and clear airway secretions is recommended.
- Facilitation of ADL independence as far as possible
- Communication aids wherever possible, e.g. personal computer with voice synthesizer, eye switch control.

LIMB-GIRDLE MUSCULAR DYSTROPHY

It represents a group of progressive hereditary myopathies that mainly affect muscles of the hip and shoulder girdles. Most cases of limb-girdle muscular dystrophy are of autosomal recessive inheritance, but some families express an autosomal dominant trait. It rarely appears before middle or late childhood and may be deferred until early adult life.

Clinical Features

- It is an autosomal recessive disease.
- Muscle involvement may be asymmetrical
- Onset is usually in the pelvic or shoulder girdle muscles.
- The disease usually progresses slowly except in some cases. Proximal muscle weakness occurs and later involves distal groups too. The ECG may be normal.
- The patient adopts a lordotic posture which may ultimately lead to low back pain.
- Tendon reflexes become diminished.
- There is weakness of neck flexors and extensors and hypertrophy of the calves
- Ankle contractures develop in some forms.

FACIOSCAPULOHUMERAL MUSCULAR DYSTROPHY

Facioscapulohumeral muscular dystrophy, also known as Landouzy-Dejerine disease is a group of diseases with similar clinical manifestations and autosomal dominance.

Clinical Features

- Severe weakness in facial and shoulder girdle muscles.
- Scapular winging is prominent.
- There may be flattening or even concavity of the deltoid contour.
- Muscles of the arm are weak.
- The eye remains open during sleep.
- The extra ocular muscles become weak.
- Foot drop may be present because of weakness of dorsiflexors
- Involvement of chest and upper back muscles.

- Pelvic muscles and quadriceps may eventually become involved.
- Protrusion of buttocks is observed.
- Life expectancy may be normal since the cardiac muscle is not involved.

Complications

The spine becomes deformed because of weakness of the paraspinal muscles and lumbar lordosis and kyphoscoliosis are common complications. EMG reveals nonspecific myopathic muscle potentials. Muscle biopsy and EMG distinguishes the primary myopathy from other neurologic diseases.

Treatment: (*Common to all dystrophies*)

As of now no drugs have been proven to be effective.

Tonics, cod liver oil, vitamin C can be used as supplementary foods. Surgery is not usually performed, and if at all, it is done in the later stages to release contractures and deformities if present, and if the release promises to offer functional improvement.

REHABILITATION (COMMON TO ALL DYSTROPHIES)

Exercise: Endurance exercises are performed with many repetitions and minimal resistance to the point of muscle fatigue. When signs of fatigue occur do not push to the point of straining the supporting tissue (Ref Chap 3).

Splints and Braces

- Spinal brace is given to prevent scoliosis.
- A lumbar corset may be given for treating lumbar lordosis.
- Foot drop splint.

Breathing Exercises: Breathing exercises are taught to the patient, as in the later stage the respiratory muscles might get involved and lead to chest infections. This also increases vital capacity and oxygenation.

Wheelchair: It is essential that a correct fitting wheelchair is ordered so that a good sitting position may be maintained, with minimal room on either side of the chair to prevent the patient leaning or slanting to one side. The feet should be supported at a right angle position in a footrest

A self-propelled wheelchair may be used, the child being encouraged to do as much for himself as he can, thus helping to maintain cardiorespiratory status and muscle endurance for as long as possible. Later on a motorized wheelchair with puff or joystick propulsion and steering systems can be prescribed.

Counseling: This is crucial in the care of a muscular dystrophy patient and his family. Grief in the family will increase with disease exacerbation and changes in the patient's functional ability. Later there is social withdrawal, frustration and anxiety secondary to a fear of dying. The child grows into a young adult fully aware of what he is unable to do, especially of things that he was able to.

Sociovocational activities and occupational therapy: Since the child is mentally and emotionally normal, he or she needs to find new interests like collecting stamps, playing computer games or other recreational activities to pass the time. The Internet is a huge resource for education and leisure activities for patients who would otherwise have been greatly deprived of these.

CONCLUSION

It is important to communicate to the parents of the affected child about the condition of their child and the prognosis. It is quite traumatic for the parents to see their child deteriorate physically and not be able to treat it medically or surgically. Genetic and sociovocational counseling are paramount in the rehabilitation of families of individuals with muscular dystrophy.

CHAPTER 22

Rehabilitation of Spinal Cord Injury

INTRODUCTION

Paraplegia refers to partial or complete paralysis of all or part of the trunk and both lower extremities, resulting from lesions of the thoracic or lumbar spinal cord.

Quadriplegia is partial or complete paralysis of all four limbs and trunk including respiratory muscles, as a result of damage to the spinal cord in the cervical region.

Spinal cord injury is a disabling condition that has its roots in the several wars that have been fought since time immemorial. The survival rate has always been poor and 90% of soldiers who suffered spinal cord injury during the first World War died within one year and only 1% survived more than 20 years.

Spinal cord injury was first described as "an ailment not to be treated". Scientists like Hippocrates and Galen have studied this condition and have identified that traumatic lesions lead to motor functional loss and reduction can be achieved through traction. Over the ages decompressive laminectomy, surgical treatment for spinal cord injuries have been described by Paulus and Sommering while Donald Munro described bladder management social and vocational rehabilitation.

Etiology

- Traumatic
  - *Road traffic accidents* (whiplash injuries can cause quadriparesis)
  - *Subluxation of vertebrae:* producing quadriparesis in rheumatoid arthritis.
  - *Suicidal attempts*, like jumping down a well, hangman's fracture
  - *Criminal assault:* gunshot or stab injury.
  - *Falls from a height:* In certain districts of South India, climbing coconut and palmyra trees to tap for juice is a common occupation, and a fall

from these trees is a very common occupational injury, quite often resulting in paralysis below the neck. Building construction workers are also very prone to this sort of injury.

- *Sports injuries:* like diving into a shallow swimming pool or taking a toss during a game of rugby, horse riding (Christopher Reeve, the movie star of Superman fame, became quadriplegic after a fall from a horse), gymnastics or parachuting.
- *Industrial accidents:* Common in mining industry, and harbors, among loading and unloading workers.
- The catastrophe that was the Gujarat earthquake in 2002, flattened several buildings trapping several survivors under great beams resulting in spinal cord injury of an unprecedented nature (Fig. 22.1).

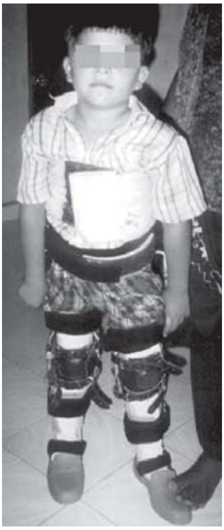


Figure 22.1: A young paraplegic victim of the earthquake

- ***Infections:*** Guillain-Barre syndrome, Transverse myelitis, Tuberculosis of spine.
- ***Vascular:*** Hemorrhage in to the cord, arteriovenous malformation.
- ***Congenital:*** Meningomyelocele.
- ***Diseases affecting the spinal cord:*** Multiple sclerosis, syringomyelia.
- ***Tumors***

Mechanism of Injury

The most common mechanism of spinal cord injury is a fall from a height. Others may be a head on collision with a surface, a blow to the back or trunk or gunshot wounds. These injuries may result in anterior wedge compression fracture of the vertebrae or fracture of posterior structures of the spine. The common levels of injury are from T12-L2.

STAGING

Stage of Spinal Shock

Immediately after injury the patient enters the stage of spinal shock that lasts from 24 hours to six weeks. During this stage there is no reflex activity below the level of lesion. The muscles are flaccid and hypotonic, the bladder and bowel are atonic and there is sympathetic dysfunction and diminished systemic activity below the level of injury. If the bulbocavernous reflex can be elicited once again, it indicates that the stage of spinal shock is over.

Stage of Reflex Activity

During this stage those muscles below the level of injury become activated. There is good chance of recovery in this stage. Reflexes can be elicited during this stage.

- ***Paraplegia-in-extension:*** Here the spinal cord lesion is incomplete and affects principally the pyramidal tracts. The tone of the spastic lower limbs, as indicated in the name is increased in the extensor muscles.
- ***Paraplegia-in-flexion:*** This can occur due to a complete lesion in both the pyramidal tracts with lesions of other descending spinal pathways. The legs become progressively more flexed at the knees and hips and stimulation will provoke painful flexor spasms and mass reflexes which are not under the patient's volition.

Stage of Failure of Reflex Activity

During this stage the muscles tend to become spastic, reflexes become hyperactive and ankle clonus may be elicited. Usually after a few weeks the reflex responses to stimulation, which are initially minimal, become stronger. The bladder retains less amounts of urine due to active contractions of the detrusor at regular intervals. Reflex defecation also happens.

The picture in quadriparesis is also quite similar. In addition there is involvement of the muscles of respiration in higher level lesions, upper limb paralysis, and affliction of abdominals and spinals. The impact of the above has a far reaching effect on the patient's activities of daily living, largely controlled by hand function, sitting balance and respiratory efficiency.

Syndromes Associated with Cord Injury

Conus Syndrome: This is more commonly seen in thoraco-lumbar fractures or dislocations, where there is partial to complete loss of sensation around the perineum with varying degrees of dysfunction of the anal sphincter.

Brown-Sequard Syndrome: This happens when there is a hemisection of the cord with ipsilateral pyramidal and posterior column impairment and hemisensory loss on the opposite side.

Central Cord Syndrome: Damage to the central areas of the cervical cord, occurring in whiplash injuries can lead to weakness more in the upper limbs than the lower with or without sensory loss.

General Examination of the Patient

Attention is given to:
- Previous medical history and current medical conditions
- Occupation
- Family history
- The patient's injury, site and condition of the fracture, if any
- Bladder and bowel status
- Sensory function
- Presence or absence of reflexes
- Level of the lesion.
- The strength of innervated muscles and their antagonists.
- The degree of spasticity, if present
- The presence of pressure sores and edema.
- Respiratory status
- The presence of associated fractures or injuries
- Deep vein thrombosis
- Independence in ADL.
- The passive range of motion (ROM) of all joints involved and the presence of contractures.

In case of quadriplegia, attention is given to respiratory insufficiency, which may be due to intercostal paralysis, partial phrenic nerve palsy or difficulty to expectorate

IDENTIFICATION OF THE LEVEL OF THE LESION

Segmental spinal cord level and function

Level	*Function*
Cl-C6	Neck flexors
Cl-T1	Neck extensors
C3, C4, C5	Diaphragm
C5, C6	Shoulder movement (deltoid); flexion of elbow (biceps); C6 externally rotates the arm (supinates)
C6, C7, C8	Extends elbow and wrist (triceps and wrist extensors); pronates wrist
C7, C8, Tl	Flexes wrist
C8, Tl	Small muscles of the hand
Tl -T6	lntercostals and trunk above the waist

Segmental level	*Muscle group paralyzed*	*Reflexes served*

(Contd...)

(Contd...)

Segmental level	*Muscle group paralyzed*	*Reflexes served*
T6-12	Abdominal muscles	Abdominal
L1	Hip flexors	
L2-3	Hip adductors	
L3-4	Knee extensors	Knee-jerk
L4-5	Ankle dorsiflexors	
L5	Toe extensors	
L4,5 S1	Knee flexors	
S1-2	Plantar flexors and toe flexors	Ankle-jerk
S2-4		Plantar Bulbocavernous Anal reflex

Specific Assessment

Impairment scale of the American Spinal Injury Association (ASIA scale)

A = Complete, no motor or sensory function is present in the segments

B = Incomplete sensory function is preserved below neurological level, and extends through sacral segments

C = Incomplete motor function is preserved below neurological level and majority of key muscles have muscles grading less than 3.

D = Incomplete; key muscles have a power of more than 3.

E = Normal motor and sensory function

Psychological Evaluation

The patient becomes increasingly aware of his disability. This knowledge gradually deepens and the patient begins to realize what the loss of mobility and bladder, bowel and sexual function will mean in daily life. Uncertainty fear and anxiety give rise to questions:

'Am I going to be permanently disabled?"

'Will I ever walk or work again?'

He may go through the stages of adjustment including shock and disbelief, denial, depression, grief and acceptance. A period of depression follows as the patient experiences a loss of self esteem in areas of self identity, sexual functioning and social and emotional roles.

Patients acutely depressed may develop various kinds of physical complaints. It is important that the patient becomes aware of his potential (or the lack of it) in physical achievements also the limitations imposed by his disability. All members of the rehabilitation team have to be actively involved in the psychological readjustment of the patient. The patient must have confidence and feel free to discuss his problems and thus dispel his anxiety and frustration.

Nursing Assessment

Nurses must be aware of potential problems in the lifelong management of spinal injured. Assessment focuses on the patient's general condition, secondary deformities and complications and determining how the patient is managing his activities of daily living.

A major goal of nursing management is to help these patients overcome their sense of 'giving up' and to encourage them to venture into, and adjust to the outside world. It must be realized that an excessively sympathetic attitude by the staff and relatives may cause patients to develop an over dependence that defeats the purpose of the entire rehabilitation program.

The patient is taught and assisted when necessary but activities that patients can do for themselves with a little effort are not carried out for them.

MANAGEMENT OF ACUTE SPINAL CORD INJURY

Safe Transportation

Safe transportation of an acutely injured spinal cord patient is essential to prevent secondary damage to the cord. The patient is well-supported by two to three persons by means of stretchers and transported by emergency vehicles to the nearest spinal care unit/hospital, care being taken not to mobilize or move the spine. When there is a high level injury, cardiopulmonary resuscitation is to be started. If the diaphragm is suspected to be paralyzed, artificial respiration is given by mouth, till the patient is admitted in hospital where mechanical ventilation is available.

Traction

In injuries of the cervical spine, if skull traction is given it is normally maintained for 6 weeks initially. The spine may be positioned in flexion, extension or neutral depending on the nature of injury, by altering pillow placement. The patient is treated in a turning frame (Stryker frame).

X-rays are taken regularly for determining position of the spine and for evidence of bony union at six weeks. Immobilization is continued for further two to three weeks if there are signs of instability. The pressure points are checked frequently for development of induration which could later turn into pressure sores. Once the patient is medically stable, he is given a collar and made to sit up in bed gradually. Pressure stockings are given to prevent deep vein thrombosis.

The muscles at the level of the lesion are flaccid or weak and have to be facilitated to contract.

Surgical Stabilization

Basically, spine surgery to treat SCI involves decompressing the spine to relieve pressure effects caused on the spinal cord by a haematoma or a chip from a fractured vertebra, infection, or a tumor.

Stabilizing the spine: *Spinal Fusion* uses the time honored technique of taking a bone graft from the patient's pelvis to cause two opposing bony surfaces to fuse and unite together. If the graft is harvested from someone else it is called allograft. Bone Morphogenetic Protein (BMP) is the protein that stimulates the body to synthesize bone.

The surgeon first decides where he needs bony fusion, strips the tissue away from the area, chipping away the surface of the bone, which gives the surface for the bone graft to fuse.

A piece of bone graft is removed from the hip and approximated with the area to be fused.

Metal instrumentation made of stainless steel, titanium, or its alloy is engaged to form a stable, rigid column that encourages the bones to fuse. Typically, they come in many shapes and sizes that include rods, hooks, braided cable, plates, screws, and more recently, threaded interbody cages. The Harrington rod, one of the earliest, required a long period of brace wearing after the operation, and did not allow segmental adjustment of correction. The Luque rod, developed later, prevented long postoperative bracing. However, though it avoids a cast or brace, it is a complex surgery. Many operations today are performed with a mixture of techniques, such as fixing Luque rods in the lower back and stabilizing with hooks and screws up higher. Another technique, called Steffi fixation, which does not resect much tissue and offers good stability and safety is widely used.

Modern techniques use screws embedded into the pedicles in the vertebra saving the need for threaded wires, but there is always the risk of impaction on the cord or the aorta by migration out of the bone.

REHABILITATION

- Inpatient care
- Outpatient care
- Extended care programs

Phases of Rehabilitation

Phase 1: The person in the immediate post acute phase of the injury is paralyzed due to trauma to the cord and immobilization. So the priority is to avoid complications of immobilization. During this phase lasting from a few days to several weeks and depending on the recovery the patient may even be started on activities outside the bed. However the focus still remains on the prevention of secondary disabilities, reduction of hypertonicity and psychological counseling.

Phase 2: This is the early rehabilitation phase, during which the patient is mobilized out of his bed for longer and he works towards long term goals like standing and walking. A minimum of three hours a day is spent on his rehabilitation, underscoring the need for inpatient rehabilitation.

Phase 3: It is the most rewarding phase, when the combined effort of the rehabilitation team and the patient bears fruit. The paraplegic learns to be more self reliant and begins to look forward to life after disability. He now is skilled in transferring, wheelchair mobility, self care and other ADLs. However for quadriplegics, special wheelchairs, hoists, or self help aids will be required.

Phase 4: Is aimed at a smooth change over to home environment. In some centers there is a half way home which replicates the surroundings of the patient's domestic environment. Members of the rehabilitation team especially the occupational therapist visit the home and make necessary self help devices and environmental changes.

Phase 5: Follow-up services with the rehabilitation center can be done on an out patient basis. The patient becomes integrated to the community and may go back to office or school and resume his family responsibilities.

Positioning

Postural reduction: Two pillows are usually sufficient to extend (maintain in hyperextension) and support fractures of the dorsolumbar spine. Soft supports are given under bony prominences to prevent pressure. Flexion and rotation of trunk and lower limbs must be particularly avoided.

Upper Limbs

Shoulders	–	Adducted and in mid-position or protracted. A pillow is placed between the arm and the chest wall.
Elbows	–	Kept in an extended position. Important when biceps innervated and triceps paralyzed.
Wrists	–	Dorsiflexed to approximately 45 degrees
Fingers	–	Slightly flexed.
Thumb	–	Opposed to prevent development of ape thumb.

Lower Limbs

Hips	extended and slightly abducted
Knees	extended but not hyper extended
Ankles	neutral or mild dorsiflexion
Toes	extended

One or two pillows are kept between the legs to maintain abduction and prevent pressure on the bony points, the medial condyles and malleoli.

Passive Movements

Passive movements of the paralyzed limbs are essential to stimulate circulation and preserve full range of movements in joints and soft tissues. Treatment is commenced usually on the first day after injury. During the period of spinal shock (approx. 6 weeks) treatment is given twice daily. When reflex activity returns the limb must be handled with extreme care so as not to elicit spasm and reinforce the spastic pattern. The therapist needs to be careful with vigorous passive movements against spastic groups of muscles that may even fracture a limb. In addition, he moves each joint from distal to proximal several times through its full range, to prevent muscle shortening. Movements are continued once or twice a day until there is return of power and the patient is capable of doing his own activities.

Precautions

Extreme ROM at the hip and knee must be avoided, as the damage of any periarticular structures may lead to heterotopic ossification. When there is a fracture of the lower thoracic or lumbar spine, movements are given very gently to the hip. The ROM is gradually increased as the pain at the fracture site diminishes.

The lower limb is abducted only to 45 degrees. The medial side of knee is always supported to prevent stretching the medial ligament. Deep vein thrombosis should be looked for in the presence of which passive movement should not be done.

Active Movements

All spared muscles need to be as strong as possible, to compensate for the affected ones. Any of the available techniques for strengthening these muscles can be given by the attending therapist.

Prone Activities in Quadriparesis (Fig 22.2A to F)

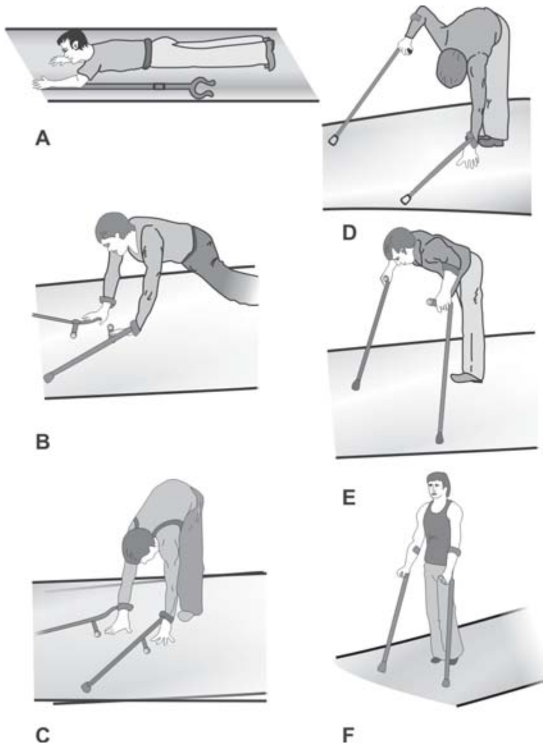
Patient is encouraged to create momentum in the upper torso and go to side lying and later prone. In prone patients hands are positioned near shoulders, elbows flexed and placed near trunk. Using the shoulder depressors and adductors, he comes to prone on elbow. He is taken through commando crawling from the above position, supine with support on flexed elbow, and supine sitting with extended elbows.

He is given push-ups; this technique strengthens muscles that will be used later to lift the pelvis in the long sitting position. He is then trained in long sitting and trunk balance initially with support of the ligaments of the hips. Other movements trained are:

- Move legs along mat in supine lying
- Cross one ankle over other and over opposite knee
- Flex leg in sitting and supine position. These exercises can be given passively and if there is any power in the lower limbs they may be done actively.

Middle Progression

Starting from supine and moving into lateral weight shifting on elbows, the patient is given challenges to his equilibrium in long sitting.



Figures 22.2A to F: Prone lying to standing with support of elbow crutches

The patient is progressed to transfers with minimal and later with no assistance. In the wheel chair he should be independent in mobility.

Chest Physiotherapy (Ref Chap 25)

The focus of all chest physiotherapy is obviously to improve air entry, oxygenation, increase lung volume, and to remove secretions from lungs. Chest physiotherapy is more relevant to quadriplegia, where there may be paralysis of the diaphragm.

Postural drainage can be given after ascertaining that there are no contra indications. The positioning during drainage has to be carefully done within limits imposed by the actual damage inflicted on the cord. For chest infections with expectoration, assisted coughing is given during drainage.

Inspiratory exercise, vibration, shaking and percussion are given for severe cases every hour, and for less severe cases, every 2 hours. Mechanical ventilation is required if it is a higher lesion involving C4, or at C5 with haemorrhage and oedema, and if severe chest injuries are present.

Mat Work

Activities on the mat include mobilization and strengthening of the trunk and limbs. Handling the trunk and mobilizing it should be done very carefully and slowly avoiding any form of forceful flexion. Preliminary training for functional activities involves ejecting the buttocks out of the seat by downward pressure of the arms in sitting since this is the basis of most of the activities of daily living. The patient is taught where to place the hands, shoulders and trunk and trained for an effective lift by improving balance and strength. This is taught to the patient and care givers.

Group Mat Activities

Group activity is very useful because patients can watch and copy others with similar lesions accomplishing the various maneuvers. Competitive exercise using balls, bean bags, or balloons improve sitting balance and co-ordination since it stimulates paraplegics to enjoy their training in a group.

Orthoses

Orthoses like spinal corsets, ASH brace, bilateral full length calipers, and crutches are used according to the level of lesion and recovery. Reciprocating gait orthosis or a hip guidance orthosis are prescribed once a patient develops good standing balance and can be trained for reciprocal movements and walk with more ease.

A well thought out, carefully designed and properly fitting orthosis often enhances mobility and effectiveness of the therapy program.

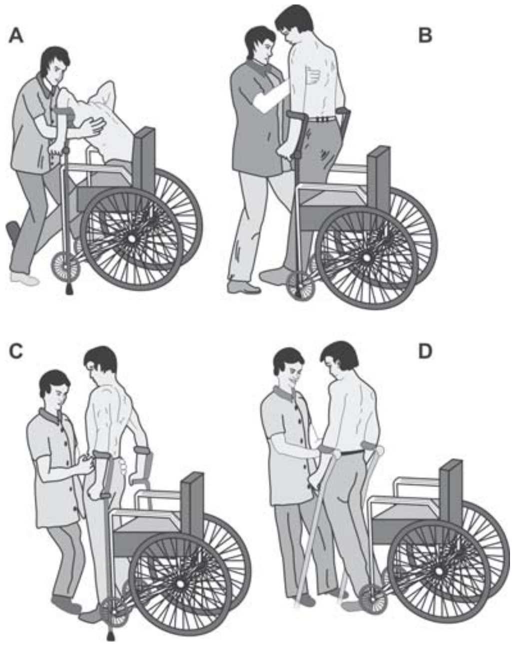
Gait Training (for Paraplegics) (Figs 22.3A to D)

All patients are encouraged to stand, and to walk where possible. Standing is important:

- To prevent contractures
- To avoid osteoporosis and thereby recurrent fractures
- To stimulate circulation
- To reduce spasticity
- To aid renal function.
- To improve gait expectations of patients with complete paraplegia.
- Boost the patient psychologically.

Functional Outcome

The ultimate goal of mobilizing patients with spinal cord injuries is to develop independence in all transfers and wheelchair maneuvers both indoors and outdoors. Patients with lesions at T6-T9 will probably walk with the aid of crutches and calipers, but higher lesions might be confined to the wheel chair. Of course a lot depends on the level of recovery, intensity of the rehabilitation program, motivation of the patient, his or her age, physique, general health, amount and control of spasticity. Ultimately, patients with lesions at T10 and below can achieve a better functional gait, and may also need locomotor aids.



Figures 22.3A to D: Training to stand and walk from the wheelchair

Descriptions of gait pattern possible

Level of injury	*Gait used*
D1-8	Swing to with calipers and rollator; may use crutches if spasticity is controlled
D8-D10	Swing through or swing to gait with HKAFO and crutches.
D10-L2	Swing through or 4 point gait with KAFO or HKAFO and axillary crutches.
L2-L4	KAFO or AFO with crutches or tripods with 4 point or 2 point gait pattern
L4-L5	May require sticks or other walking aids/may or may not require calipers

Mobility Training (for Quadriplegics)

Very few quadriplegics ultimately recover sufficiently to walk normally. Some have no recovery in the upper and lower limbs and the only mobility is neck upwards. Hence it is a major and often unrewarding task to train a quadriplegic to walk, indeed even attempt to do so. The safety of such patients is very important when attempts are made to make them stand or walk. However modern technology like multi channel FES or treadmill walking on a harness or voice activated wheel chairs has changed the outlook on the mobility for quadriplegics. Standing however is trained, depending on the motivation of the patient. Below the level of C6 there is return of independence in mobility on a wheel chair or driving a car with hand controls. Wheel chair modifications like powered wheel chairs or breath and joy stick controls may have to be given. This aspect of rehabilitation is more advanced in western countries.

- Patients with lesion at C2-C4: Stand on tilt table using multi-channel FES
- Patients with lesion at C5-C7: Stand in parallel bars.
- Patients with lesion at C6-T5: Walk in parallel bars (Swing to gait).

Level of Injury and Outcome

Complete lesion below C3	Dependent for self care. Tracheostomy with ventilatory support motorized wheelchair with chin or breath controls.
Complete lesion below C4	Dependent on others for all care Uses wheelchair as above Can breathe independently Will use a computer but with a stick in the mouth Can use an Environmental control system to turn on lights, open doors, and so on.
Complete lesion below C5	As above, but in addition, Can eat with a universal cuff Can wash face, write, comb hair, clean teeth using self help aid Can operate manual wheelchair on a flat surface for short distances May be able to transfer, using sliding board and a care giver's help on level surface. Upper half of body dressing partially independent
Complete lesion below C6	Independent propulsion of non motorized wheelchair Can extend wrists, may not need wrist support Can dress upper half of body unaided Can participate in wearing trousers or loose pyjamas Can be independent in transfers to and from wheel chair.
Complete lesion below C7	Full wrist movement and some hand function for ADL's Can do all transfers, eat and dress independently,
Complete lesion below C8	All hand muscles except intrinsics preserved more independent in ADL's Wheelchair independent,
Complete lesion below T1	The arm is completely innervated Wheel chair independent, Can drive a car with hand controls.

Do's

- Release the pressure on the buttocks by lifting the body with hand support in the chair every 15- 20 minutes
- Lift the paralysed legs over obstacles when transferring
- Regularly inspect buttocks, back of legs and malleoli, using a mirror to look for potential pressure sores (also over the penis, due to abrasions from a condom)
- Protect the body against extremes of temperature
  - inform all caregivers, your doctors and nurses that there is no sensation over the lower limbs.

Don'ts

- Do not ever use a hot water bottle or infrared lamp on the body to treat pain.
- Do not expose the body when going out in the hot sun.
- Do not carry hot food on the lap, especially if there is no hand control

Hand Rehabilitation Occupational Therapy in Quadriplegics

The role of the occupational therapist cannot be overstressed here, as various self help devices, vocational aids and the exercises to use them are imparted by the OT.

Lying down with the elbows extended will help to avoid elbow contractures. Placing a hand over rounded surface or cylindrical bar can maintain it in the functional position. When a patient cannot operate a splint with his own muscle power, external power may be selected. The external source of power may be gravity, electrical or solar power.

A rocker arm support is often prescribed for quadriplegics who have spasticity. Overhead slings, mouth sticks and other environmental controls can be used for better functioning of patient.

Adaptive devices are made by the occupational therapist to relearn eating, drinking, operating a keyboard or phone.

Wheelchair

The wheelchair is not a chair with wheels; it may be second home to the spinal injured. Many patients adapt their wheelchairs to their specific lifestyles, and it is much more effective to fabricate a wheelchair to their specifications, since it is they who are going to use it.

In quadriplegia

The quadriplegic is usually confined to a wheelchair for all his mobility needs, and the type [adult, child], requirement [sports, vocation], motorized propulsion, controls [puff, joystick, or voice activated] have to be decided upon in consultation with the patient.

Modification	*Indication*
Swivel back	To change position more easily in wheelchair.
Chest strap, knee strap,	For a high lesion especially in early treatment to prevent falling
Slightly reclined back	Patient whose trunk is inclined to fall forward.
Lateral supports or wedge cushions	Patient who has tendency to develop scoliosis due to spasticity
Pressure pads of 1 inch Foam rubber	Emaciated patient with tendency to develop pressure sores
Detachable arm troughs.	High lesion quadriplegic patient in order to aid in positioning and balance, protection of the shoulder joint, hand and wrist positioning.

(Contd...)

(Contd...)

Modification	*Indication*
Ankle strap	To restrain patients with gross extensor spasms from falling
Toe loops and foot rest in 90 degrees.	To correct various foot deformities like equinus
Wedge cushions	To relieve pressure on genitals and medial aspect of knee
Vertical grips to hand rim	If patient is unable to position his hand to propel
Environment control units	For ADL's and communication, use of computers, etc.
Alternative controls	Head control, chin control, breath control, heat sensitive, myoelectric, voice or optical head pointer

INNERVATION OF BLADDER (FIG. 22.4)

The nerve supply of the bladder is sympathetic and parasympathetic. Sympathetic innervation is from L1, 2 and parasympathetic from S2, 3, 4. A complex system controls the detrusor muscle in the bladder wall and bladder neck and monitors the filling and emptying of the bladder. Efferent fibres control the smooth muscle of the bladder, and afferent fibres signal distention and fullness of the bladder, and pain. The bladder fills through peristalsis. The smooth muscles in the ureters pass the urine wave by wave, down to the bladder but the entry of urine is not under nervous control since there is a functional valve is formed by the oblique passage of the ureters through the

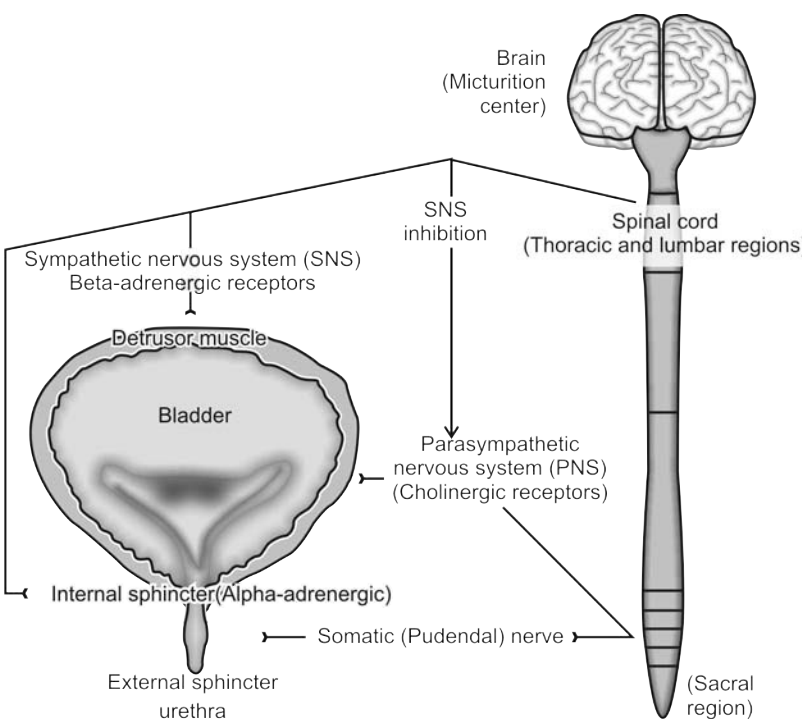


Figure 22.4: Innervation of the bladder

muscle of the bladder wall. As it is being filled, the bladder neck and sphincter urethrae muscles are continuously tightly shut under autonomic control. When the bladder volume reaches a critical level, and by central control (voluntary emptying), the detrusor muscle contracts, the nerve stimuli to the sphincter muscles are inhibited, the sphincter urethra opens and urine is ejected. The bladder neck muscle is not well-developed in females, and urine comes in a continuous stream.

Management of the Bladder

Disturbance of the bladder function produces many complications which constitute a lifelong threat to the patient. Bladder management would focus on the patient achieving fairly efficient method of emptying the bladder, preventing urinary infections and enabling the patient to remain continent.

Bladder Conditions

As spinal shock wears off which may take a few days to several weeks, there is a possibility of two main bladder conditions to develop:
- The automatic bladder.
- The autonomous bladder.

Automatic (or Reflex) Bladder

In most patients with the lesion above T10-11, it is noticed that as reflex tone returns to the detrusor muscle it contracts whenever filling pressure reaches a certain critical point. Reflex micturition happens when the power of the sphincter to retain urine is overcome. Manually this contractile action of the detrusor can be set off by kneading or stroking the abdominal wall, or by stroking the inner aspect of the thigh or pulling the pubic hair. In another method the patient taps the abdominal wall above the symphysis pubis with the ulnar border on one hand until the flow of urine ceases and there is no further contraction of the detrusor muscle.

This reflex action can be trained so that it occurs only on stimulation of the 'trigger' points and not otherwise. Over a period the patient learns to empty his bladder every 2 or 3 hours and remain dry in between.

Autonomous (or Non-Reflex) Bladder

The bladder has no tone and neither is there a reflex contraction of the detrusor muscle because there is a longitudinal lesion of the spinal cord at S2, 3, 4 or a lower motor neuron lesion. The bladder can be emptied by suprapubic manual pressure.

MANAGEMENT

Indwelling Catheter

If urine is already infected when patient is admitted to the spinal injuries unit, it is preferable to continue with an indwelling catheter until urine is cleared of infection and debris when intermittent urethral catheterization can be started. A Foley catheter with a 5-10 ml balloon should be used.

As these patients are prone to develop renal calculi, a weekly or twice weekly bladder wash out is done with sterile water. If present, the calculi should be crushed with an evacuator. Bladder retraining is done when signs of motor and sensory recovery are present. This is done by clamping the catheter and encouraging reflex emptying. When automatic bladder with reflex emptying is established, the catheter is removed.

Intermittent Self Catheterization

Intermittent clean self-catheterization (ICSC) can start as soon as patients begin to sit up. Patients catheterize themselves with the aim of remaining continent between catheterizations and therefore avoiding the need to wear urinary drainage apparatus. It may be the method of choice for long-term bladder management, and in these patients fluid restriction may not be appropriate. For quadriplegics this will be a problem due to poor hand function, and condom catheterization may be the only choice. There are some patients who prefer an indwelling catheter, but there are complications associated.

ICSC is particularly applicable to patients with an acontractile detrusor, usually associated with injury to the conus medullaris or cauda equina, for whom it is the most satisfactory method of bladder management. Even in reflex detrusor activity ICSC may be successful. Anti-cholinergic drugs such as propantheline may help to reduce detrusor activity. Injection of botulinum toxin into the bladder muscle is also being tried with some success. The patient can strain using his abdominal muscles but unfortunately this has the same effect on the rectum and evacuates it.

The Credes method is used to eject the urine from this type of bladder in bed or on the toilet. The patient places his clenched fist just above the symphysis pubis and pushes inwards and downwards leaning forward as he does so. Urine flows as long as the pressure is kept up. Initially the bladder may not be completely emptied and several attempts will probably be necessary. Gradually the bladder will become trained and the time between the visits to the toilet lengthened to 1, 2, 3 and in some cases even 4 hours.

Long-term Prevention of UTI

- High fluid intake
- Ensure effective bladder emptying
- Regular urine culture for bacteria, administration of antiseptics or antibiotics where required.

MANAGEMENT OF BOWELS (FIGS 22.5A TO C)

Immediately after the onset of paralysis, only fluids are given because of the danger of a paralytic ileus of neurogenic origin. The bowel regime is instituted once the patient is on a full diet. Regular adequate fluid intake of about 1500-2000 ml is recommended. Diet consists of increased fibre intake and adequate nutrients. Drugs to promote bowel movement may be bulk laxatives like husk, irritant cathartics like bisacodyl and stool softeners like liquid paraffin. Osmotic laxatives like milk of magnesia may also help.

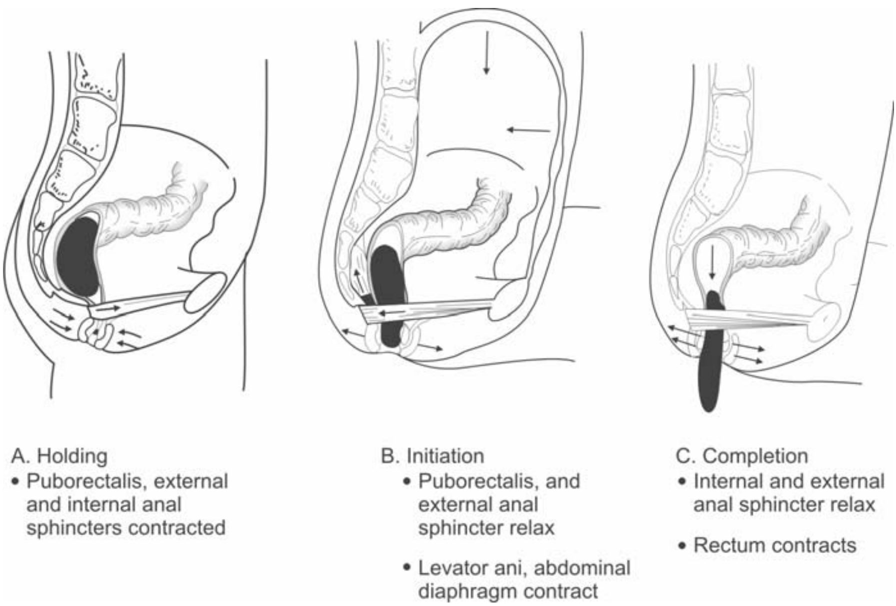
Toilet Training (Fig. 22.6)

Digital evacuation is often needed for such patients. Since the patient is continuously immobile there is always a chance for constipation. Hence the prescription of a good bowel program for all patients has to be done at the earliest**.** When the patient has sufficient sitting balance and is able to transfer with assistance, he is taught to evacuate himself. A hand rail is needed beside the toilet so that the patient can support himself whilst leaning forwards. When the patient is upright, digital stimulation may no longer be needed. Suppositories are continued as required.

Training Techniques

Patient must be toileted at the same time each day preferably in the evenings.

- Patient must be able to sit for at least half an hour.



Figures 22.5A to C: Control of defecation

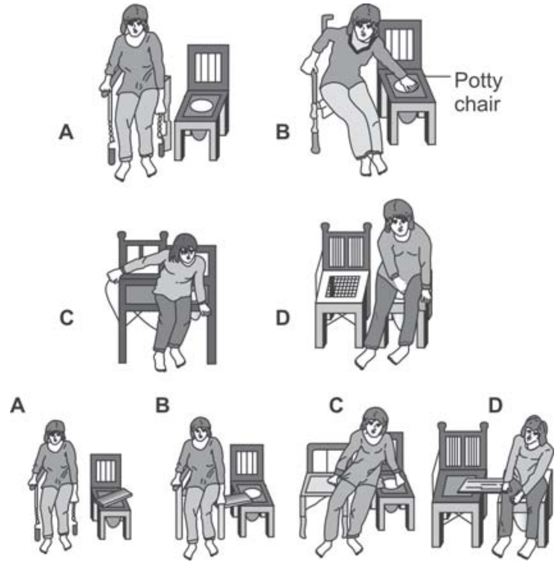


Figure 22.6: Transfer activities to and from the chair

- A mild laxative is given the evening before and a suppository may also be required half an hour before evacuation.
- Hoist the patient on to a commode.
- Patient presses down on abdomen, compressing abdominal muscles in a Valsalva maneuver holding a deep breath, and allowing trunk to flex.
- Gently massage around anus with a gloved finger.

Aids Used

- Digital stimulator.
- Dampened paper cloth for cleaning.

SEXUAL DYSFUNCTION

The brain is the source of psychogenic erections. Sexual thoughts or seeing or hearing something stimulating sends signals through the spinal cord down to the T10-L2 levels. The center of stimulation of the nerves that control reflex erection is in the spinal cord at the sacral region (S2-S4). The stimulation of arousal is then conveyed to the penis and triggers an erection. The erogenic areas can be reflexly stimulated with direct physical contact to the penis or the ears, nipples or neck without sexually stimulating thoughts.

Male sexual function varies widely in patients with incomplete lesions, according to the extent of cord damage sustained. Paralysis coupled with the loss of self image and bladder bowel incontinence rob the person of whatever pleasure he or she seeks in what is seen in an intensely personal relationship.

Even partial sensation on the penis may indicate some preservation of sexual performance. Nerve pathways that control sexual responses like lubrication, erection and ejaculation are affected. Autonomic problems can interfere with orgasm and lack of sensation interferes with sexual pleasure.

During the initial stages of spinal shock all sexual function is abolished and later return of function will depend on the extent of lesion. Patients with high spinal level lesions often have persistent erection for hours or several days after the injury. For patients with total lesions above the reflex center in the conus, automatic erections can occur in response to local stimuli, but there will be no pleasurable sensation during intercourse.

The impact of injury on sexual function can also differ with each paraplegic. Most men with SCI with intact sacral nerves (S2-S4) of the spinal cord are able to have a reflex erection with physical stimulation regardless of the extent of the injury.

Sexual dysfunction is not given as much importance as other parameters, but nevertheless, counseling with the patient and spouse is very important but rarely ever done in conservative households in India. A lot depends on the sexual partner. Adjustment in position during the sexual act, acts of intimacy and good communication go a long way in developing a good sexual relationship.

Erectile dysfunction (ED) is the inability of a man to achieve or maintain an erection that is able to satisfy his sexual needs or the needs of his partner. Recently there have been drugs like phosphodiesterase inhibitors such as sildenafil, which work by increasing blood flow to the penis to improve erectile function.

Penile injection therapy involves giving an injection of a drug [alprostadil] or a combination of drugs into the side of the penis not more than once a week, producing an erection that can last for one to two hours. Placed into the urethra, the same drug is absorbed into the surrounding tissues and causing the blood vessels to relax and allowing the penis to be filled. This form of treatment is called MUSE [Medicated Urethral System Erection] which is a form of transurethral therapy.

In another form of treatment, the penis is placed in a vacuum cylinder and air is pumped out of it. Blood rushes into the erectile tissues to fill the negative pressure, causing an erection. The erection is maintained by placing a constriction ring around the base of the penis, maintaining the blood in the erectile tissues and retaining turgidity. Surgical implants are the last option.

Complications of this treatment: Priapism which is persistent erection even after considerable time, and autonomic dysreflexia

Female Menstruation

There may be interruption of the menstrual cycle in women with complete or incomplete lesions, which can last from a few months to more than a year and eventually the menstrual cycle returns to normal.

Pregnancy

Many women feel they cannot conceive or deliver after spinal injury. Women must realize that they continue to ovulate and are capable of conception and have normal babies. These are delivered vaginally or by caesarian section if indicated. Patients with a complete lesion above T10 generally have painless delivery. Some patients with lower level lesions may sleep through labor because they are not aware that the labor has commenced. However, the woman will find it difficult to push during labor because of poor abdominal muscle control. Autonomic hyper-reflexia can be a complication during delivery. Therefore, patients are admitted to the nursing home well before the expected date of delivery and should be kept under observation.

Sports for the Disabled

The spinal cord damaged patients can indulge in a few sports activities like rowing, archery, wheelchair basketball, snooker and even tennis. The advantages of sports as a leisure activity for the disabled are many; there is

- Reduction of spasticity
- Improved coordination
- Increase of muscle strength
- Increased cardio respiratory function
- Correction of spinal deformities
- Reduction of contractures
- Improvement in general mood and cheerfulness, and better social interaction.

COMPLICATIONS

Pressure Sores—Effects and Prevention

Pressure sores are caused by prolonged pressure over any bony prominence, which prevents adequate circulation to the area.

Loss of sensation and voluntary movements: Due to his immobility the patient is not aware of the discomfort felt and is unable to shift his position. (Absence of shift reflex).

Loss of vasomotor control: The impairment of circulation produces lower tissue resistance to pressure. The most vulnerable areas are the bony prominences at the sacrum, trochanters, malleoli, knees, ischial tuberosities, fibulae, heels and fifth metatarsals. Ischemia due to local pressure occurs more readily at these areas and also at the ASIS, PSIS, spines, under splints, plaster, and the braces applied.

Pathology

First stage: (Fig. 22.7) There is transient circulatory disturbance producing erythema and slight edema. This inflammation disappears within two days after the pressure is relieved.

Second stage: (Fig. 22.8) Permanent damage to the superficial layers of the skin, vascular stasis, reddening, congestion of the area; later, blisters, superficial necrosis and ulcers develop.

Third stage: (Fig. 22.9) Extensive necrosis, destruction of subcutaneous tissue fascia muscles and bone occurs.

Fourth stage: Osteomyelitis and septicemia

Fifth stage: Amyloidosis.

Prevention

"Where there is no pressure, there will be no sore."

Patients are turned every two hours, throughout the day and night, using pillows and mattresses and moving from the supine to side lying position. Regular turning has other benefits. It prevents stagnation in the urinary tract and thereby stones in the ureters or bladder. All wrinkles and debris are removed from the bed, and daily inspection of the skin is done for redness, induration or swelling. For those who are incontinent, self-intermittent catheterization is taught early.

Figure 22.7: Stage of induration

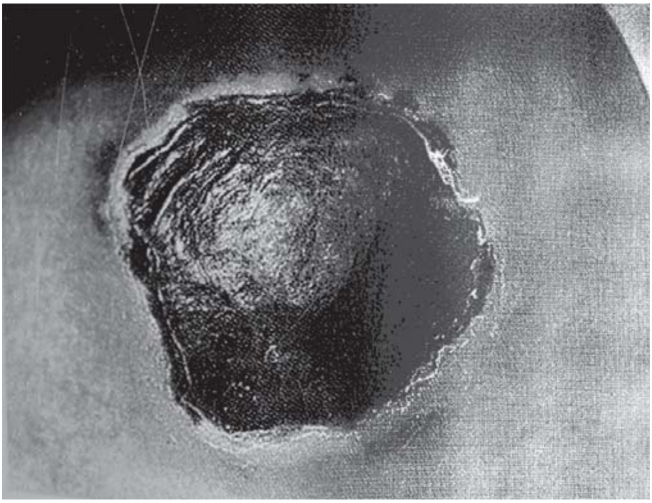


Figure 22.8: Stage of ulceration *(For color version see Plate 5)*

Figure 22.9: Stage of necrosis *(For color version see Plate 6)*

Observing Daily the Common Sites of Ulcer

Care of the Skin: Cleaning with soap and water and later applying body talc helps keep skin clean and dry.

Management of the Pressure Sore

In a spinal rehab unit, it is quite common to encounter pressure sores at various sites and at various stages of severity. In the earlier stages or with concomitant medical problems a conservative approach includes wound care, debridement, release of pressure, good nutrition, and control of spasticity. If a culture swab taken from the wound shows significant organisms growing, aggressive wound care is required. Debridement of excess necrotic tissue and moist saline dressings needs to be done. Release of pressure is possible by using a water bed or an alpha bed. The alpha bed has a motor that pumps in air which is distributed through compartments within the bed in an alternate fashion. This ensures that no specific of the body is in contact with the surface continuously. Clean wounds can be dressed with silver sulfadiazine or mupirocin, or a negative pressure dressing. Management of spasticity with baclofen and urinary tract infection helps in wound healing. With rapid skin breakdown and extension of the ulcer into deeper tissues, surgery by a plastic surgeon may be considered, of course, not when there is severe wound infection or septicemia. Flaps or grafts are done as follows:

Ischial wounds	Gluteal thigh rotation flap
Small sacral ulcers	Skin rotation flap with or without the superior gluteus maximus myocutaneous flap
Trochanteric pressure sores	The TFL flap (a myocutaneous flap based on the lateral femoral circumflex artery)

Post surgically the patient will be on the air bed for a month and later made to sit. It is important to continue physiotherapy for unaffected areas to prevent disuse atrophy (e.g. Crutch muscle strengthening)

Spasticity

Spasticity is a secondary complication in many of these individuals. Severe spasticity often causes pain, loss of ROM, pressure sores, and difficulty in performing ADLs.

AUTONOMIC DYSREFLEXIA

Autonomic dysreflexia is a vascular reflex, which can originate in any organ below the level of lesion in a patient with high lesion. It is an acute syndrome of massive sympathetic discharge. It occurs as a result of painful stimuli in a person with spinal cord lesions above the level of T6.

The signs and symptoms of autonomic hyper-reflexia are episodes of ***sweating, slow pulse, raised blood pressure and headache.*** Even if the bladder is overdistended due to a blocked catheter this can happen. This is one of the emergencies that can happen in a paraplegic and can potentially give rise to fits, CVA and even death. The treatment is to remove the cause, like removing the block in the bladder. The head can be tilted up temporarily during an acute episode to relieve the pressure until medical help arrives.

Triggers of Autonomic Dysreflexia

- Genitourinary: bladder distension, catheterization and urinary tract infections
- Rectal distension and flatulence
- Pressure sores
- Passive stretching
- Local causes: Tight clothing and shoes.
- Painful cutaneous stimuli
- Extremes heat or cold

Clinical Features

Symptoms

- Pounding headache
- Sweating of forehead
- Nasal block
- Goose flesh
- Blurred vision
- Tightness of chest

Signs

- Hypertension
- Bradycardia
- Arrhythmias
- Changes in temperature
- Visual field defects
- Faecal inhibition
- Bladder distention.
- Seizures
- Severe respiratory distress
- Hypertensive encephalopathy
- Bronchospasm
- Hemorrhage
- Retinal
- Cerebral

Management

Prevention

Give the patient an identity card, with an explanation of what has to be done in an emergency

- Education of patient and family
- Appropriate bladder and bowel programs
- Meticulous skin care

Treatment

- Place patient in upright position
- Remove precipitating stimulus
- Sublingual nifedipine (10 mg)
- For persistent increase in blood pressure, hydrallazine, nitroprusside may be given.

DEEP VEIN THROMBOSIS (REF CHAP 26)

Pulmonary Embolism

The patient presents with chest pain and dyspnea. Some of them have arrhythmias. It is prevented by changing the position frequently, regular deep breathing and assisted coughing. In high tetraplegia, glossopharyngeal breathing, phrenic nerve pacing would help.

Postural Hypotension

It is a decrease in blood pressure that occurs when a patient is moved from a horizontal position to a vertical position. This is more common in cervical and upper thoracic lesions, and is due to a loss of sympathetic vasoconstriction control. There is lack of muscle tone resulting in peripheral blood pooling with decreased venous return to heart and consequent depleted cerebral blood flow. Postural hypotension is avoided by putting the patient on a tilt table and increasing the verticality gradually.

Management

The patient is mobilized to a vertical position by elevating the head end of the bed, using a tilt table. Even in the wheel chair it is possible to use a design which enables the patient to stand up within the wheel chair. Elevation of the lower limb side of the bed can be useful. Use of compressive stockings and an abdominal binder is advocated.

Mild diuretics may be given to relieve persistent edema of legs ankles and feet. The patient may be referred to the physician for treating the fluctuating blood pressure. Careful monitoring of BP and symptoms of giddiness sweating or tremors should be done (Fig. 22.10).

Figure 22.10: Home visits to treat a paraplegic

Psychological Re-adjustment

The patient with spinal cord injury goes through tremendous mental agony. He is depressed and often refuses to cooperate with the team members, understandably so. He is totally dependent for most of his ADL's, and both patient and his family need counseling from rehabilitation professionals to make necessary mental adjustments to the life ahead of them.

Home adaptations with respect to architectural barriers and equipment are done, and arrangements can be made for the young student to continue his education. Financial assistance is also required for such patients when the bread winner is affected.

CONCLUSION

Every effort is made to make the patient psychologically readjusted, economically productive and functionally independent. The Physiatrist faces tremendous challenges when dealing with paraplegics and quadriplegics. Fortunately technological advancements come to his rescue, and the day is not very far when in the words of famous inventor Dean Kamen, as technology progresses "the line between technology and magic becomes so blurred, that one cannot make the difference."

CHAPTER 23

Sports Rehabilitation and Exercises for Positive Health

INTRODUCTION

The term "sportsman" here includes all, both male and female, who take part in games, adventure or athletics requiring physical activity as a hobby or as a career. During a promising career some sportsmen are affected with certain injuries typical to their sport. Of course any injury can occur with any sport but it is useful to be aware of which injuries are common in a specific sport for example, footballers are at risk of injuries to the ligaments or cartilages of the knee and the ankle. Fast bowlers in cricket and javelin throwers are susceptible to strain to the spine or in the shoulder. The knee is a joint that is particularly susceptible to twists and impacts and games like basket ball and kabaddi put the medial meniscus of the knee at risk (Fig. 23.1).

SPORTS INJURY REHABILITATION

This can be divided into three phases.

Phase One: This is the initial healing phase. During this phase the emphasis is on rest, reducing pain and swelling and promotion of tissue healing.

Figure 23.1: Knee injuries are common on the playing field

Phase two is the reinforced healing of the injured tissue.

Phase three represents functional integration, where it is retrained back to its original level of activity. During this phase the sports person and his team combine to integrate the injured body part to work perfectly with the rest of the body by building strength, endurance and coordination.

Diagnosis

It is important to take a detailed history from the patient: on what is the problem? Is it pain, instability of the joint, or a decline in performance? What is the duration is it progressive, what are the precipitating and relieving factors, and where is the problem? With regards to the injury, the details to be collected include: how did the injury occur? What caused it? When was it? What action was the sportsman doing then? Of course some sports are rougher in nature, like football or kabaddi, while some are gentler, like golf.

Sometimes there is a direct hit, as in a cricket ball struck at lightning speed and one must enquire where, how and in what direction. How forceful was the impact? Could the athlete hear any sound from his body part during the injury and was he or she able to continue the game? What was the first aid given after the accident?

Often the sportsperson is not a professional and does not train regularly hence one must check how often does he train, compete, and at what level. Sometimes the pain may be unrelated to the sport but to the training undergone. In many cases the training also is either inadequate or overdone, and is sporadic.

Examination

Shortly after an injury, it may not be possible to examine properly, especially if there is effusion or spasm or severe pain. Sometimes the cause may be elsewhere, like a hip problem presenting as a knee problem or vice versa. When examining the site of injury we must satisfy ourselves on these points:

- Look at the patient standing with both feet bare. Check the stance
- Examine for bleeding bruising or swelling
- Palpate the area affected and around it for local tenderness, swelling or effusion and muscle spasm
- Perform range of movements of the joints passively or actively in all directions if permitted; if not, rest the area till investigations are done.
- To detect instability of ligaments, check its response to a destabilizing force

Some Definitions

Contusion: A contusion (bruise) is an injury to soft tissue produced by a blunt force such as a hit, fall, or blow. Soon after the injury the area swells up, turns blue and aches severely.

Sprain: A sprain is a twisting injury to a ligament, causing micro tears, usually at the ankle, knee or wrist. A very common sprain is the lateral ligament sprain of the ankle.

Strain: A strain is an overuse injury to a muscle or tendon, often due to chronic and repetitive stretch as in repetitive strain injures that occur with prolonged computer use.

Investigations

- X-rays are mandatory for a suspected fracture or dislocation
- MRI scans or ultrasound scans are recommended for soft tissue injury. MRI scans tend to be more expensive
- Aspiration or arthroscopy of the joint is a useful diagnostic and therapeutic exercise. Very often blood is aspirated.
- Investigations are done to rule out metabolic or degenerative disease unrelated to the sport, like arthritis

Examples of Injuries in Sport

- Ligament sprains
- Rotator cuff injuries
- Lower back pain
- Stiff neck
- ACL injuries
- Muscle strains
- Achilles tendinitis
- Cramps
- Shoulder impingement
- Tennis elbow

Tennis elbow (lateral epicondylitis) is characterized by pain in the outer or lateral side of the elbow and forearm due to damage to the extensor tendons that dorsiflex the wrist. As the name suggests it is very often brought on by the backhand strokes in tennis. However, this condition is not unique to the game.

Golfer's elbow (medial epicondylitis) shows up as pain on the medial side of the forearm from the elbow to the wrist. As opposed to tennis elbow, it is damage to the flexor tendons of the wrist that causes golfer's elbow.

Lumbar strain is pain in the lower back precipitated in sport like weight lifting or shot put where the spine is subjected to sudden and heavy stresses. Sudden twisting of the lower back, such as badminton, and golf can also lead to this injury.

Jumper's knee characterized by inflammation of the patellar tendon, is caused by frequent jumping on hard surfaces as in basket ball and hence is also known as patellar tendonitis.

Runner's knee is characterized by the inner surface of the patella rubbing against the femur when running, causing pain.

Stress fractures are fractures in the bone caused by continuous overuse, like in football players, or hurdlers. The metatarsals in runners are especially vulnerable to stress fractures.

Dislocation: The most commonly dislocated joint is the shoulder, and this can happen in football or rugby when some one pulls on your shoulder while you are in motion.

Management

Drugs: Today international competition bans indiscriminate drug usage especially of the performance enhancing variety. Sportspersons taking part in major events like the Olympics, have to undergo tests, and if found positive are banned from the game and sometimes stripped of their medals. Painkillers like NSAIDS or paracetamol can be prescribed for sports injuries. In very acute pain the drugs are administered parenterally.

Acute Injury

If a part is injured it will need rest but often a sportsman does not heed this advice and plays on despite the pain. This increases the risk of further injury. However, in an acute injury the mnemonic **RICE** is well known and stands for:

Rest, Rehabilitation

Ice to reduce pain, promote vasoconstriction, and control hemorrhage and edema.

Compression by a bandage to reduce the amount of space available for swelling. Swelling retards healing and must be controlled in the acute stage of injury to hasten the rehabilitation process.

Elevate to eliminate gravitational blood pooling, and assist drainage back

Some Precautions

Heating or massaging must not be done to the injury early on, as it increases blood flow and pain

Alcohol must not be drunk as it leads to vasodilation

All sport related activity related to the affected part should be suspended pending results of the investigations and indeed, till the rehabilitation process is over. If the injured structure is not protected from further damage and rested appropriately, the healing process is not given a fair chance, and rehabilitation is prolonged.

Other factors that may impede healing are oedema, bleeding, muscle spasm, atrophy, or infection. Of course general factors like age, health and nutrition play a major role in healing.

Tissues take varying time to heal after injury, from 2-3 weeks for skin, one to two months for muscle, and up to three months for ligaments and tendons. Bone takes 12-16 weeks and nerves take 12-18 months to heal fully. This does not mean that at the end of this period the athlete can go back to his game. He still will have to undergo sports rehabilitation. Of course everything depends on the extent of the injury.

Returning to sport too soon after injury will delay the healing and repair process, and may result in a permanent functional disability (e.g. recurrent sprain in the ankle or knee) For every week an athlete has been away from activity as a result of injury, approximately the same duration of rehabilitation will be required, assuming that he or she is on a well designed program. The various stages of healing, and approximate time for each stage, like inflammation, fibroblastic and maturation is kept in mind. These phases overlap, and the rehabilitation would be different for each stage.

Preventive Rehabilitation

It has been estimated that at least one-half of sports injuries could have been prevented by the use of a good preventive rehabilitation exercise program. For professional sportspersons, where a lot of money is at stake, a personalized protocol that gives focused solutions is designed. As the body grows older within a sport, it adapts to the physical demands of training. A casual training program may predispose athletes to greater risk of injury, especially during peak competition.

Many programs focus on coordination and postural correction of the hips, stomach and back. Before designing one, a clinical measurement of range of motion and strength, past medical history, height and weight and fat content should be done. Again, since sports persons travel a great deal, they must plan ahead their travel schedules, to avoid jet lag in different time zones. At the highest level of competitive sport the players insist on good lodgings, food, places to work out and personal trainers to accompany them.

Injury Prevention (Figs 23.2 and 23.3)

The athlete must wear and use proper gear for the sport, including protective helmets, pads, gloves and layered clothing where needed. His training must be from a certified coach or instructor and follow the rules of the game, which may be quite rough. He must use proper body mechanics in sports and prevent repetitive stress to the upper extremities. Pain is a warning sign of injury and

Figure 23.2: Protective gear during a game

Figure 23.3: Protective gear for the shin of the leg during a game of cricket

one must not play through the pain. Cross training from one sport to another like professional cricketers playing football or volleyball allows specific muscles to rest and activates others. It will also alleviate boredom and monotony.

Factors to be considered when planning sports activities include the following:

- Proper maintenance of equipment used in the sport
- The temperature of the environment (a cooler environment is ideal)
- The playing surface (the more shock-absorbent the surface, the fewer injuries that may occur)
- The hindrance of traffic for sports activities such as bicycles or cars. In India many games are played on the streets and chances of injury are much higher.
- Proper medical evaluation prior to participation in organized sports

Generally it is children who start up in a sport. Hence it would be advisable to check if the child is fit for that sport by conducting a **"sports physical."** This assessment reveals the physical strengths and weaknesses of the child and helps determine which sports are appropriate for it. A physician measures height, weight, and vital signs, as well as checks eyes, nose, ears, chest, and abdomen and does an orthopedic examination. Anxious parents must know that starting a child in sports too young will not benefit the child; rather it would be detrimental. The American Academy of Pediatrics (AAP) recommends that children begin participating in team sports at age of six. Obviously the child must also be interested in the sport and willing to participate in team activities. There are some sports that are highly individual in nature like golf and some which rely on team spirit like volley ball.

Fluid Loss

Loss of fluids through sweat must be replaced with equal amounts of fluids, usually 1 to 1½ liters per hour of intense sports activity, before, during, and after each practice or game. Dehydration could present with symptoms like thirst, weakness, headache or dark-colored urine. Drinking water every quarter to half an hour can avoid abdominal cramps during a game.

Injury Prevention Tips

The sports person conditions himself by which he performs exercises designed to improve general as well as sports specific fitness. He needs to focus on areas of his body that are at high risk of injury. Many sportsmen undertake a good stretching program and proper warm up before and after a game and simultaneously, a program to develop flexibility, endurance and strength. They rest on two days of the week and do cross training. Strengthening exercises are done in limited sets of 3-5 sessions with 10-15 reps per set and alternated with stretches to avoid monotony.

Some tips:
- Do not over train either in frequency or duration or intensity.
- Relax and avoid tension in muscles.
- Adopt right postures through out the day.

Tailoring the Program to the Individual

The program has to be individualized according to age, body structure and nature of the sport. There are problems with flexibility, endurance, bone density and cardio vascular capacity as age advances. Returning to the sport after an injury needs special equipment or facilities like a swimming pool or practice on different surfaces. Special techniques like taping or strapping are used in addition to pain relief modalities like ice, diathermy or ultrasound. Some modalities of treatment include:

- Massage
- Joint mobilization
- Electrotherapy
- Taping
- Biofeedback
- Sports specific exercises

Biomechanics and Technique Correction

Strengthening and stretching exercises are combined in order to maintain full range of movement about the joints. A step up program would start with a gentle minimal stretch and proceed through isometric and later isotonic exercises with load.

Using many techniques including back stabilization, rotator cuff strengthening programs for adhesive capsulitis, and forearm flexibility and strengthening for tennis elbow, patients are given the route to avoid chronic pain in the future.

TRAINING FOR THE SPORT

Strength Training

Principles

A prospective sportsperson has to follow the principles of training: ***specificity, overload, recovery, adaptation and reversibility***.

Specificity: Specificity means that the exercise must be specific to the type of power or strength for the particular demands of the event. For example in the shot put event the trainer must know which muscles are involved, the pattern in which the weight is rested and released and the stance and posture required at the time of lifting and releasing the shot put.

Overload: When a muscle is made to contract beyond its usual load and intensity it recruits more fibres and becomes stronger. Overloading the muscle can be done by increasing the repetitions, sessions or the loads. High repetitions with low weights, where endurance and strengthening go hand in hand are more desirable to begin with. The protocol must be gradually increased over a period to prevent muscle strain and fatigue.

Recovery: We need to give time for damaged tissues to recover after trauma.

Adaptation: After a training session the body adapts to the new challenges by increasing its ability to cope with those loads.

Reversibility: The changes brought about by adaptation are reversible whenever the training is discontinued.

Taping and Strapping (Fig. 23.4)

After an injury there will be inflammation and swelling in the soft tissue. In the acute stage a stretching tape is applied with suitable padding after a complete assessment of the injury is made by an orthopedic surgeon. Protection and support of the capsule and affected ligaments in the shortened position is done using non stretch tape. The rehab program can start later after the requisite period of rest.

Multi-disciplinary Team Approach

Today sports is a big industry with crores of rupees being poured into mega events. Sports stars are besieged with sponsorships and endorsements. The performance therefore has to be optimized by a team consisting of

- Sports medicine specialist
- Physiatrist
- Exercise physiologist
- Athletic trainer
- Physical therapist
- Occupational therapist
- Orthopedist/orthopedic surgeon

The "whole" person and not just the injured part is managed by this team. Time and performance is crucial hence a careful assessment, correct diagnosis, and effective treatment is essential.

Figure 23.4: Taping for ankle injury *(For color version see Plate 6)*

Returning to Sport

The athlete must return to his sport only after an examination by his team of sports physician, physiatrist and physiotherapist. Obviously there must be a normal muscle power, joint range and flexibility. He or she is made to run, skip, pirouette, twist and land, take off and stop suddenly in mid stride before he can be certified fit to play. An examination on the couch will not suffice. Return to the game after an injury must be done only if the injury is fully healed. This role is taken by the sports therapist and personal trainer.

Warm-up Exercises

It is not advisable to start playing or training immediately on taking the field. A time lag exists between the onset of activity and the body's adjustment to exercise. It has been shown that muscle and tendon strains are reduced by a warm up before the sports activity. This prepares the body for activity and includes exercises that slowly prepare the heart for more strenuous activity, move the muscles through their full range and stretch joints to the maximum. Ten minute duration of total body movement would constitute warming. The benefits of a good warm up are lubrication, increased blood supply to the muscles, increase in muscle temperature and the efficiency of muscular contraction and general flexibility. There is dilatation of constricted capillaries and increase in circulation, augmenting oxygen delivery and minimizing oxygen deficit and formation of lactic acid. When forced into vigorous activity without adequate warm-up, the body remains stiff and prone for injuries.

Cool-down

After a good work out there is accumulation of waste products which must be flushed away. Tapering off the exercise allows the heart rate and breathing to come back to normalcy gradually. Muscles too respond better to stretching at this stage.

Preventing Stiffness

Warm up and cool down is the mantra to prevent stiffness. Many enthusiastic athletes over reach themselves or keep changing their training conditions or challenge themselves unduly. This leads to stiffness all over. One has to train regularly and scientifically for the sport and do specific warm ups and prevent freezing of the limbs. Some athletes are more prone to stiffness than others.

EXERCISES FOR POSITIVE HEALTH

Not all of those who exercise land up in the playing field. The focus of different people may be different. Some may take up a sport just to keep fit. Others take it up to keep their sugar levels and blood pressure under control. For some it is a great stress buster and for others it is a means of net working with friends. Some youngsters go to the gym to lose weight and others to put on weight and shape their body. Patients with arthritis look to exercise for pain relief and flexibility. This has resulted in mushrooming of health clinics, gyms and yoga coaching centers. There is how ever no two thoughts on the benefits that exercise and physical activity can give.

Physical Fitness (Fig. 23.5)

In common terms fitness is used either generally to indicate positive health and well-being and not just lack of disease. With increased automation and computerization people just do not get opportunities or time to pursue fitness related goals. There are few occupations however that still need specific fitness like porters or construction laborers. Physical fitness by and large is the body's ability to function efficiently in work and leisure activities, to feel healthy, to stay clear of life style diseases, and to meet emergency situations requiring high performance activity. The goals of fitness could be to develop aerobic capacity for the cardiovascular and respiratory systems, strength, endurance, flexibility, and a healthy internal milieu.

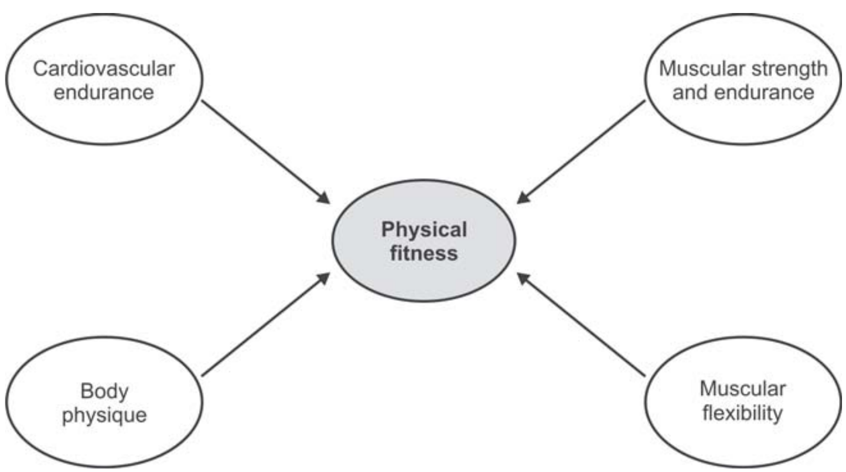


Figure 23.5: Components of fitness

The benefits are: A good program reduces the risk of developing diabetes, heart disease, high cholesterol, blood pressure, cancer, obesity and premature death. This reflects in the person's performance at work and studies.

Benefits of Aerobic Exercise (Fig. 23.6)

Aerobic exercise is one which consumes a lot of calories and increases oxygen consumption. The American College of Sports Medicine defines aerobic exercise as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." A standard measure of

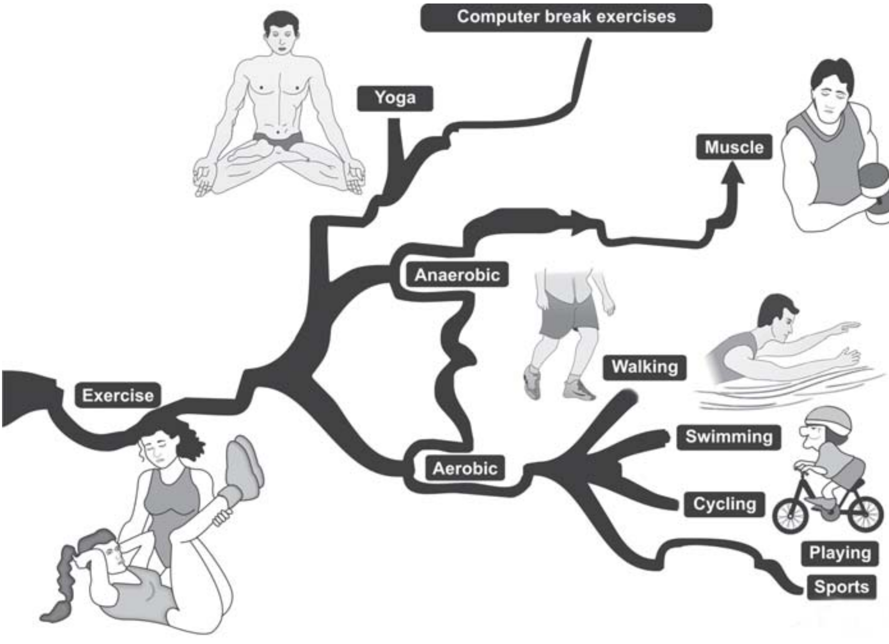


Figure 23.6: Types of exercise

cardiovascular fitness is Maximal Oxygen Uptake ($VO_{2\,max}$) which is the maximum amount of oxygen that a person can take in during the exercise. $VO_{2\,max}$ is a measure of the maximum volume of oxygen that a sports person can use. It is measured in milliliters per kilogram of body weight per minute (ml/kg/min).

During aerobic exercise, the heart and lungs are made to work harder and improve on their resting capacity. The overall benefits would be an improvement in cardio respiratory function, cardiac output, blood volume and ability to carry supply to muscles and use oxygen. For diabetics this means an increased glucose tolerance and reduced insulin resistance. For hypertensives it translates into lower resting systolic and diastolic blood pressure and for cardiac patients there is a reduced load on the heart.

The muscles too perform more efficiently due to enhanced number and size of mitochondria, myoglobin, diffusing capacity, and oxidizing capacity of fat and carbohydrates. There is increased blood flow and storage of muscle glycogen. There are many psychological benefits too. Anxiety and stress are reduced and there is perceptible improvement in mood, self esteem and self concept, especially in those who are depressed.

Benefits of Strength Training

The obvious benefit would be an increased muscular strength but the spin offs are improved flexibility, reduced body fat and increased lean body mass, changes in blood cholesterol, and better balance and functional ability.

Anaerobic exercise: When the person exercises in such a way that the muscle group is taxed 15 to 20 percent more than its maximum voluntary contraction, there is a shift to anaerobic metabolism leading to accumulation of lactic acid. This manifests as cramps, burning in the muscles and tremor. When anaerobic metabolism is triggered then that exercise is called anaerobic exercise. Typically bodybuilders, weightlifters and discus throwers build power and muscle mass by this mechanism. The muscles need to gear up to peak performance in a short duration, the lifter needs to yank huge weights in a high intensity activity, in up to about 2 minutes, and increases the oxygen demand due to which heart rate and stroke volume rises.

Anaerobic exercise burns up calories and uses oxygen more quickly than the body is able to replenish it. Muscle fibers therefore have to derive their contractile energy from stored carbohydrates (Glycogen). ATP (Adenosine Tri-Phosphate) and CP (Creatine Phosphate) are also used up. This can lead to severe muscle cramps, pain and fatigue if carried on ignoring the symptoms.

ENDURANCE TRAINING

Endurance: It is the ability of a muscle or a group of muscles to do sustained physical activity without undue fatigue. It depends on the strength of muscles involved, available energy stores and the aerobic capacity of the heart and lungs to deliver oxygen to the working muscles and to carry chemical wastes away from them.

Adaptations to an endurance training program occur centrally (heart) and peripherally (muscle), resulting in their increased efficiency. The degree of adaptation depends on the initial level of fitness of patient and the extent of training.

Principles of Endurance Training

The individual has to exercise longer at minimally higher work load. This improves aerobic capacity without taxing the system. The frequency of training is 3 to 5 days/week with an intensity of training up to 60-90 percent of maximum heart rate. The duration of training may be twenty to sixty minutes of continuous aerobic activity. If the intensity of activity is lower, then it should be conducted over a longer period of time.

Any exercise which uses larger muscle groups and that can be maintained continuously and is rhythmic in nature like running, cycling, or swimming is taken up. Older people prefer simpler exercises like walking, or at the most, jogging. The development of muscle endurance is closely linked with development of strength and power. Obviously a stronger muscle can do a given work for a longer duration without developing weakness.

The changes in response to endurance training are quite similar to those due to aerobic exercise. There is also the phenomenon of people getting "addicted" to exercise and the reason could be endorphins, released during strenuous exercise. These are endogenous compounds with the same structure like morphine, produced by the pituitary gland and the hypothalamus which produce analgesia and a sense of wellbeing.

Indications for Endurance Exercise

- Pregnant women before and after delivery
- Patients with coronary artery disease adequately treated
- Obese patients and older age group of people
- Patients with prolonged immobilization
- Muscular dystrophy

Equipment Used for Endurance: Treadmill, stationary bicycle, stair stepping, swimming pool, jogging track, multiexercise pulley unit.

Circuit and interval training: The exerciser moves through a series of weight training consecutively in a fast paced workout of 15 to 45 seconds per station with hardly any rest between stations. This is also known as "circuit weight training". More than aerobic stamina it can increase muscular strength and endurance.

Interval training: In this training the exercise is followed by a period of prescribed relief or rest interval. There is an alternate period of high intensity (called the work interval) with periods of lower intensity (called the rest or relief interval) in one cycle. There are usually eight to ten cycles in one workout session. It is less demanding than continuous training. High intensity work can be achieved with interval or intermittent work if there is appropriate spacing of work relief intervals. Interval training trains both the aerobic and anaerobic systems

The relief interval can be rest relief or work relief and its duration ranges from few seconds to few minutes. Work relief involves continuing exercises but at a reduced level from the work interval. During relief period, deposits of ATP are replenished in the muscles.

Circuit training: It employs a series of exercise activities, at the end of the last activity the individual starts from the beginning and again moves through the same series. Several exercise modes involving large and small muscle groups and a mix of static and dynamic effort can be used. Circuit training exercises both aerobic and anaerobic metabolism.

Obesity

This a condition in which excess body fat has accumulated in the body with a body mass index (BMI) of 30 kg/m^2 or higher. BMI is calculated by dividing the subject's mass in kg by the square of his or her height in meters. A person is said to be super obese with a BMI of above 50, morbidly obese between 40 and 50, severely obese between 30 and 40 and overweight if his BMI is less than 30 kg/m^2., but over 25 kg/m^2.

Men tend to put on weight around the abdomen while in women it is around the waist and hips. The absolute waist circumference (>102 cm in men and >88 cm in women) and the waist–hip ratio (the circumference of the waist divided by that of the hips of >0.9 for men and >0.85 for women) are both used as measures of central obesity. Body fat percentage is total body fat expressed as a percentage of total body weight. Men with more than 25% body fat and women with more than 33% body fat are said to be obese. Body fat percentage can be estimated from a person's BMI by the following formula:

Body fat% = (1.2 × BMI) + (0.23 × age) "5.4" (10.8 × gender) where gender is 0 if female and 1 if male

Obesity is associated with various diseases, particularly osteoarthritis, diabetes mellitus type 2, obstructive sleep apnea, certain types of cancer, and cardiovascular diseases. It has been found to reduce life expectancy. Excessive food consumption, lack of exercise, and genetic susceptibility combine to cause obesity, while medical disease or anorexia account for a smaller group of obese patients. Due to several articles in the media the awareness about obesity today is very high in the public and it wont be news to anyone that to control obesity one must go in for life style modifications like dieting and physical exercise. For the intractable cases drugs and bariatric surgery have been recommended.

Physical activity is recommended with various objectives; to prevent one from gaining weight, to lose weight, and to prevent weight regain after weight loss. Light-intensity activity is defined as 1.1 to 2.9 metabolic equivalents, moderate-intensity activity as 3.0 to 5.9 metabolic equivalents, and vigorous activity as 6 or more metabolic equivalents.

To prevent putting on weight, physical activity of 150 to 250 minutes per week, with an energy equivalent of 1200 to 2000 kcal/week, is recommended for most adults.

For weight loss of 5 to 7.5 kg physical activity of more than 225 to 420 minutes per week is recommended. At the other end of the spectrum physical activity of less than 150 minutes per week results in minimal weight loss.

Some recommend physical activity of approximately 200 to 300 minutes per week to maintain weight after a period of weight loss. Obviously all this is linked to dietary intake and such weight loss estimates have to be customized according to the quality and quantity of food consumed. Whether on a diet or not, resistance training is not the answer for weight loss programs. Continuous research is still being done in this field with no conclusive results.

YOGA

The word 'Yoga' itself means to 'unite' – uniting the individual energy with cosmic energy; or the various aspects of life to achieve a harmonious whole. The ultimate aim of the yogi (practitioner of yoga) is to realize the ***self*** and to achieve salvation by getting rid of distractions of the mind. In practice, yoga is an applied science of the mind and body. Patanjali, a sage around 300 to 400 BC was the first to compile texts into a treatise dealing with the basic principles of yogic philosophy. This book called the Patanjali Yoga Sutra deals with breathing exercises like pranayama. It starts on the premise that a healthy person is an integrated unit of body, mind and spirit. Yoga is not an exercise; it is a way of life. It does not ***create*** health; it creates an internal environment that allows the individual to come to his own state of dynamic balance of health. Yoga is thus a philosophy that offers an insight into the spiritual, the mental and the physical aspects of life and uplifts the practitioner to a higher plane of not just health but spirituality by a holistic approach. It includes proper exercise, breathing, diet, relaxation and meditation. Many rehabilitation centers employ yoga therapists to achieve optimum results. Certain aspects of yoga like Asanas (practice of postures) and Pranayama (breath control) can be used in therapy. Other aspects like Pratyahara (control of senses) and Dhyana (meditation) are not being used in active rehabilitative therapy.

Benefits of Yoga

- It is safe (if taught by a competent guru of the system) and conserves energy, except in conditions like hypertension it would be better to avoid certain asanas.
- There is no strain and it helps to become relaxed and more focused.
- It rejuvenates the muscles in a shorter period of time.

Yoga Asanas

Yoga Asanas or postures are body positions associated with the practice of Yoga. They maintain well-being, and improve the body's flexibility and vitality. Some times these postures are prescribed in therapy clinics to prevent back and neck pain from recurring and also to reduce stress and hypertension. However, they should be learnt under a trained yoga therapist. Many of these postures are akin to exercises prescribed in physiotherapy and there are physiotherapists trained in yogic asanas. The general health condition of the patient and contraindications also, are taken into consideration.

General Considerations

The place of yoga practice should be neat, clean and airy. The morning is always better to practice yoga as it frees the person for the rest of the day.

One must stick to the same place and time of practice every day and do so at least 15 minutes a day, for 5 days a week, which is gradually increased to an hour. One must practice singly, if possible on an empty stomach. Abstinence from hot food, coffee, tea, alcohol, tobacco and drugs or excessive spices is a prerequisite. A balanced vegetarian diet with a lot of fruits and vegetables and without onion and garlic is recommended. Women must not practice asanas during their menstrual periods, but meditation and pranayama may be practiced.

A period of relaxation between asanas is needed for approximately half a minute, during which the person takes 2 or 3 deep breaths. One should relax at the end of the yoga session for a quarter of the time of actual practice. For example if you practice asanas for an hour, relaxation is needed for 15 minutes.

The body should be neat and clean and one must wear clean and light clothes while practicing. Gradually with practice one becomes free from anxiety, tiredness, pain, worries or any strain.

The following asanas are relevant in preventing low back pain but are prescribed only if the patient is fit enough to do so, as back pain can increase or result from exertion to the para spinal muscles.

Ardha Halasana – The Half-Plough Pose (Fig. 23.7): "Ardha" means 'half' and 'Hala' means 'plough' in Sanskrit. This involves hip flexion with knees extended.

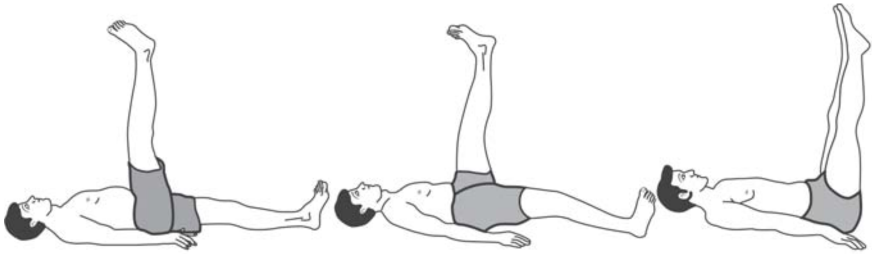


Figure 23.7: Ardha Halasana—half-plough pose

Ardha Shalabhasana – Half-Locust Pose (Fig. 23.8): "Shalabha" means "locust" in Sanskrit. The asana resembles a locust which lowers its head and raises its tail. 'Ardha' means 'half' in Sanskrit.

Bhujangasana – Cobra Pose (Fig. 23.9): This asana is called "Bhujangasana" as the raised trunk, neck and head while practicing it resemble a cobra ("Bhujanga" means "cobra" in Sanskrit) rearing its hood and about to strike.

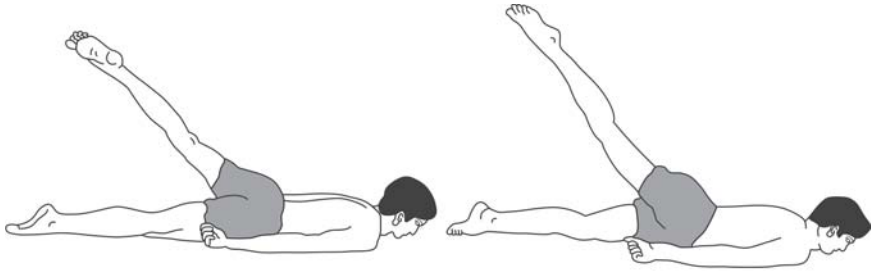


Figure 23.8: Ardha Shalabhasana—half-locust pose

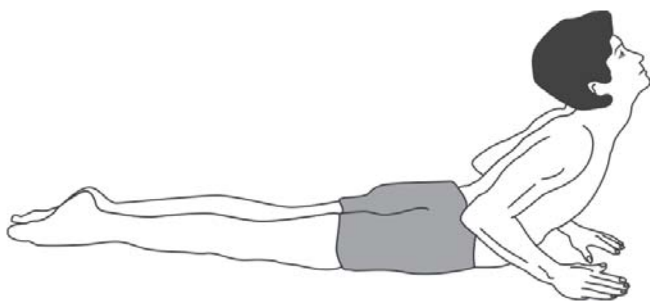


Figure 23.9: Bhujangasana—cobra pose

Chakrasana –Wheel Pose (Standing) (Fig. 23.10): "Chakra" means "wheel" in Sanskrit.

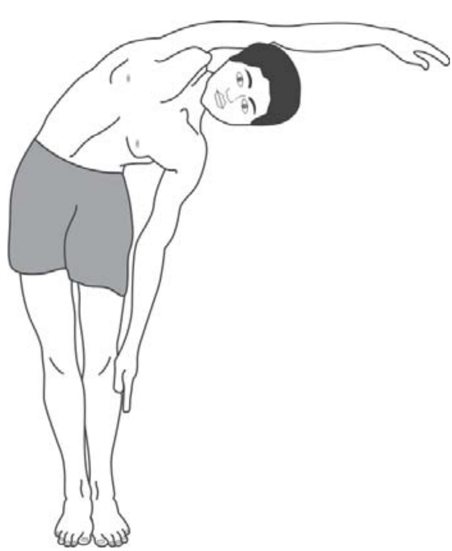


Figure 23.10: Chakrasana—wheel pose (Standing)

Naukasana – Boat Pose (Fig. 23.11): "Nauka" means "boat" in Sanskrit. The asana resembles a boat.

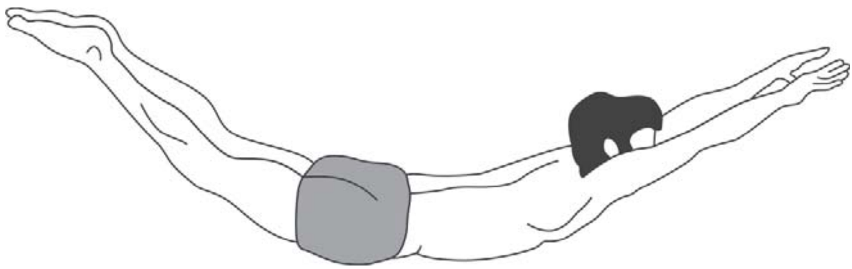


Figure 23.11: Naukasana—boat pose

Pavanamuktasana – Wind-releasing Pose (Fig. 23.12): "Pavana" means "wind" and "Mukta" means release in Sanskrit. The yogi brings his folded legs towards his stomach and as he does so, he breathes out as the name suggests. This asana massages the digestive organs and gives relief from excess flatulence in the stomach and intestines.

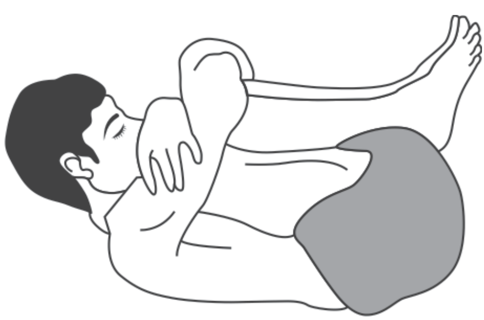


Figure 23.12: Pavanamuktasana—wind-releasing pose

Meruvakrasana – Lying Abdominal Twist (Fig. 23.13): The practitioner lies down face up and twists his spine and abdomen.

Suryanamaskar: It is a component of Hatha yoga and is the art of solar vitalization. Ideally it is done on an empty stomach with light and loose clothing early in the morning facing the rising sun. If done twice a day it is done in the evening facing west. Along with chanting of mantras in every posture it is a complete meditative technique and a physical exercise where almost all muscles are used and every joint is taken through almost the fullest range possible. It has got three aspects: form, vital energy and rhythm. It is the entry point for a person to get used to Yoga asanas. It is a combination

Figure 23.13: Lying abdominal twist

of 12 different postures, followed in a particular sequence with specific breathing patterns. The benefits of Surya Namaskar are seen at three levels: body, mind and intellect; and while performing Surya Namaskar the breathing delivers more oxygen to the lungs.

CHAPTER 24

Other Neurological Conditions

MULTIPLE SCLEROSIS

Multiple sclerosis (MS) is a disease of the central nervous system largely affecting young adults, predominately white populations; the cause of which is unknown. Major causative theories currently focus on an infectious origin, an immune mediated pathogenesis, or a combination of the two. The disease is characterized by demyelinating lesions known as plaques that are scattered throughout the white matter in the central nervous system. The myelin sheath is ultimately replaced by the fibrous scarring produced by glial cells (gliosis). ***The presence of scattered bright spots on an MRI of the CNS is highly diagnostic of MS.***

Symptoms

- Weakness in one or more limbs
- Optic neuritis
- Persistent paresthesiae are extremely common, occurring in 84% of patients.

The initial complaint is of fatigue or of weakness only on exertion. Abnormal sensations begin in one foot and soon spread to involve lower limbs, the buttocks and perineum and a variable area on the trunk. The sensations described are of paraesthesiae or tingling. Chronic respiratory weakness is common.

In established disease exaggerated tendon reflexes and extensor plantar reflexes are usually present. In the lower limbs increased extensor tone may be exaggerated as extensor spasms. As the disease progresses flexor tone begins to take over. Emotional changes keep happening irrelevantly and frequently. The hand muscles often are symmetrically wasted. Learning and short-term memory may be impaired early in the disease. There may be other symptoms like epilepsy, multiple personality disorder, dysarthria, loss of coordination and bladder control.

Course

The disease progresses very variably, from slow and benign, to rapidly progressive. In between there may exacerbations and remissions. Life expectancy is normal for more than three-fourths of MS patients from the onset.

Short-term Goals—Physiotherapy

- Improve sensory awareness
- Educate the patient with sensory loss and skin care
- Diminish spasticity and tonal influences on movement
- Improve muscle strength
- Improve gait pattern

Occupational Therapy

Improve functional mobility and independence in activities of daily living:

- Teach problem solving skills
- Teach compensatory training
- Teach energy conservation
- Provide appropriate mobility aids and adaptive equipment.
- Promote understanding of the disease, its symptoms and management
- Emphasize realistic expectations while maintaining hope.
- Focus on remaining abilities.
- Educate patient about support groups, like the MS society.

Long-term Goals

- Maximize independence in ADL.
- Prevent or retard the development of secondary impairments.
- Promote emotional, psychologic and social adjustment of patient and family.

The physiatrist is involved in preventive rehabilitation in most of these patients in coordination with the neurologist and psychologist.

Physiotherapy

The goal of the physiotherapist in long term care is in addition to the above,

- Improve or maintain range of motion
- Prevent skin and circulatory complications such as decubitus, thrombophlebitis, etc.
- Encourage functional wellbeing and activities of daily living.

Occupational Therapy

The role of the occupational therapist is to maintain the optimum level of personal independence of the patient by design of home modification and environment control systems.

Easy to wear clothes that are light in weight with Velcro fastenings, or zip pullers are stitched. Simple wraparound pants with elastic waist bands make dressing easier. In case of incoordination feeding can be made easy by forks and knives with built-up handgrips and straps, specially designed plates, and mugs with long and double handles.

Personal hygiene can be achieved with the modification of bathroom and toilet, providing barrier free environment to the individual.

PARKINSONISM

Parkinsonism (Fig. 24.1) is one of the disorders of the extra pyramidal system caused by damage to the basal ganglia, usually as a result of a deficiency of the neurotransmitter dopamine in old age. It is a name given to a clinical syndrome comprising of:

- Impairment of movement
- Rigidity
- Tremors

Clinical Features

Tremor: The tremor is coarse, regular, rhythmic (4-8 times/sec.) involuntary and alternates between the agonist and antagonist group of muscles. Pill-rolling movement is seen in the hand, when the thumb seems to 'roll over' the index and middle fingers in opposition.

Rigidity may be defined as an increased resistance to passive motion and affects all striated muscles (agonists and antagonists). Two variations are possible: Cogwheel type where the tremor is superimposed on the rigidity where there is a 'give in' after a stage during the movement.

Bradykinesia or Slowness of Movement

Other signs are an expressionless face, loss of blinking and swallowing resulting in drooling, small cramped handwriting (micrographia), low volume and slow speech, difficulty rising from a chair, turning in bed and in ambulation. The patient does not have automatic movements like swinging of arms while walking; instead he keeps his arms by the side stiffly. Sometimes the patient freezes when trying to initiate a movement like walking.

Posture: Typically the patient has a flexed, stooped posture due to dominance of the flexor muscles.

Festinant Gait: Ambulation is characterized by a small stepped, shuffling gait pattern with an absence of arm swing, with the patient leaning forward and taking increasingly faster steps to catch up with his center of gravity.

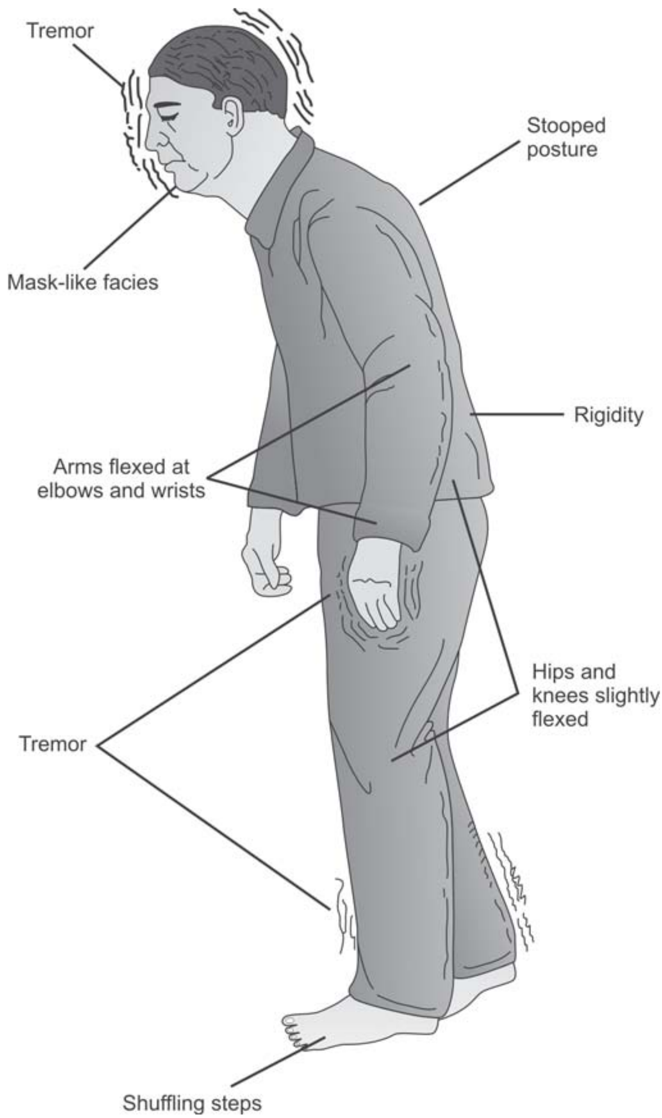


Figure 24.1: Typical posture of a person with Parkinsonism

Other Features

- Greasy, sweating, shiny skin
- Constipation, urinary difficulties
- Cognitive function is preserved but as the disease progresses there is mild impairment.
- Glabellar tap—tapping the forehead causes blinking which does not stop even after several repetitions.

- Patients may complain of coughing when eating, food sticking in their throat.
- Dementia occurs in later stages.

Treatment

The three methods of management include:
- Pharmacology
- Rehabilitation, and
- Neurosurgical procedures.

Pharmacologic Management

- Neurotransmitter replacement L-dopa, Carbidopa with L-dopa
- Anticholinergic drugs, like trihexyphenidyl, benztropine, procyclidine
- Receptor agonists like amantadine
- Bromocriptine

Rehabilitation

Medical and Nursing
- Firm bed to decrease contractures and improve bed mobility.
- Regular meals with low protein diet
- Incentive spirometry to prevent atelectasis and pneumonia
- Artificial tears for lack of blinking
- Anticholinergic medications for excessive drooling.

Physical Therapy
- Relaxation techniques to decrease rigidity
- PNF technique of rhythmic initiation (Ref. Chap 15), progresses from passive to active assisted exercise and progression from small range to maximum range. This overcomes the crippling effects of bradykinesia.
- ROM exercises, stretching and preventing contractures pectoralis stretching, isotonic and isometric exercise to quadriceps and hip extensors.
- Back flexion-extension exercises (especially extension) and pelvic tilt
- Proper sitting and postural control (static and dynamic)
- Mat activities
- Tilt table if needed
- Functional mobility training, including bed mobility, transfer training and learning to rise out of a chair by rocking the body forward and backward. The patient may require a chair lift. (Ref. Chap 9)
- Stationary cycling to help train reciprocal movements. Training to music or with auditory cues such as clapping may help in alternating movements.
- PNF, biofeedback, and NDT training to facilitate slow movement. Training in rhythmic pattern to music or with auditory cues such as clapping may help in alternating movements.

- Standing or balancing in parallel bars (static and dynamic) with weight shift.
- Progressive walking (large steps using blocks to have patient lift legs, teaching proper heel-toe gait patterns).
- Use of assistive devices (may need a weighted walker).
- General cardiovascular fitness exercises for aerobic conditioning (swimming, walking).
- Deep breathing exercises for the diaphragm
- Family training and home exercise program

Stereotaxic Surgery

These are surgical lesions in the basal ganglia or thalamus by cryosurgery or chemosurgery, to decrease or abolish tremor and to reduce rigidity. A recent development is the deep brain stimulator which is an implanted pacemaker of the brain, whose leads stimulate the globus pallidus or subthalamic nucleus with good therapeutic outcomes.

CEREBELLAR DISEASES

Hereditary Ataxias

The term Hereditary Ataxia applies to a group of closely related disorders, all genetically determined and characterized by degeneration of any or all of the cerebellum, the olives or the long ascending and descending tracts of the spinal cord.

Types

- Hereditary spastic paraplegia,
- Friedreich's ataxia
- The cerebellar degenerations, including the spastic ataxias
- Other miscellaneous hereditary ataxias.

Friedreich's Ataxia

The spinal cord is usually small; degeneration is seen in corticospinal tracts, posterior spinocerebellar tracts, and dorsal root fibers. The heart also shows diffuse changes leading to cardiac failure. The patient survives nearly two decades after onset of symptoms.

Symptoms

- Ataxic gait
- Incoordination of upper limbs with intentional tremor, and wasting
- Nystagmus
- Dysarthria
- Tendon jerks are diminished, with the ankle jerk preceding the knee jerk
- Scoliosis and deformities like pescavus develop

- Sphincters are atonic resulting in incontinence.
- Plantar reflex shows a Babinksi response.

Cerebellar Degeneration Including the Spastic Ataxias

The following are some of the varieties:
- Sanger-Brown's (spinocerebellar) ataxia
- Marie's spastic ataxia
- Primary parenchymatous degeneration of the cerebellum
- Olivopontocerebellar atrophy
- Olivorubrocerebellar atrophy
- Delayed cortical cerebellar atrophy.

Manifestations of Cerebellar Diseases

- Hypotonicity
- Asthenia
- Ataxia
- ***Dysmetria*** – People with cerebellar lesions have difficulty placing their limbs correctly during voluntary motion. When standing, they spread their feed apart and use their arms for balance. They typically over estimate (hypermetria) or under estimate (hypometria) distances.

Ataxic Gait

- Staggering gait
- Loss of arm swinging
- Inability to walk in a straight line
- Uneven step length

Movement decomposition: The client with a cerebellar lesion may perform a movement in a distinct sequence of steps rather than in one smooth pattern.

Dysdiadochokinesia: Clients with cerebellar lesions are unable to perform rapidly alternating movements (like tapping/waving the hands).

Speech: Words or syllables are pronounced slowly, accents are misplaced and pauses may be inappropriately short or long.

Gaze: Nystagmus is seen on prolonged gaze.

MOTOR NEURON DISEASE

Definition

It is defined as a selective degeneration of motor neurons in the anterior horn cells of the spinal cord.

Cause

Mostly it is idiopathic, sometimes it follows a viral infection, or after administration of steroids. It is beyond the purview of this book to go into the details of the condition. The disease is sometimes progressive and rehabilitation programs need to be constantly upgraded to accommodate the neurological manifestations of the patient.

This disease manifests itself clinically as:

- Progressive bulbar palsy
- Progressive muscular atrophy or true atrophic type of PMA.
- Amyotrophic lateral sclerosis.
- Primary lateral sclerosis.
- Pseudobulbar palsy.
- Progressive spinal muscular atrophy in children (Werdnig-Hoffmann paralysis).
- Neural form of peroneal muscular atrophy (Charcot-Marie Tooth disease).

PROGRESSIVE MUSCULAR ATROPHY

It is a progressive chronic degeneration of the motor neurons in the cerebral cortex, brainstem and spinal cord resulting in gradual atrophy, weakness and paralysis of muscles with fasciculation. The cause is unknown.

Clinical Features

Onset: The onset is insidious, around the fourth and sixth decades.

Sex: Males are commonly affected.
The lesion is chiefly located in the anterior horn calls. The interosseous spaces, thenar and hypothenar eminences are hollowed out and ultimately the hands assume an incomplete claw like deformity. There is non-symmetrical wasting of the small muscles of the hand. In course of time lower limbs may also be affected.

Amyotrophic Lateral Sclerosis: In this condition the lesion affects the pyramidal tracts. The deep tendon jerks are brisk and the plantar reflex may later become extensor. The rate of survival is often bleak with the patient living for about three years after onset.

Chronic Bulbar Palsy: Here the organ affected is the medulla around the bulbar nuclei of the 8th to 12th (last four) cranial nerves. Another term for this is Labio-glosso-pharyngo-laryngeal paralysis, which means there is progressive weakness and wasting of the tongue, palate, pharynx, lips and larynx giving rise to corresponding symptoms of dysarthria, dysphagia, and aphonia. The average life expectancy is, as in earlier diseases, quite short, about 1-½ years after onset.

Pseudobulbar Palsy: The areas involved are located in the upper motor neurons in the brainstem or above. Patients are psychologically unstable and signs of upper motor neuron lesion are present on both sides.

Rehabilitation of Motor Neuron Disease

The objectives would be to maintain the

- Range of movement
- Muscle power
- Functional independence especially in self care activities of the person.

It is important to do a vocational assessment and modify the environment and give self help aids so that the patient is able to perform his ADL's independently.

CONCLUSION

A variety of neurological disorders exists, the diagnosis of which would be the realm of the neurologist (or pediatric neurologist), but the long-term rehabilitation would complement the drugs given or surgeries performed, and, indeed would serve as the mainstay of the management of several of these patients.

CHAPTER 25

Cardiac and Pulmonary Rehabilitation

INTRODUCTION

The early concepts of Cardio Pulmonary rehabilitation may have been in the sanatoria dedicated to the treatment of tuberculosis and polio with respiratory muscle involvement in the earlier half of the last century and evolved in cardiac rehab centers where cardiac surgeries are performed. In the modern context the increasing incidence of chronic obstructive pulmonary disease, heart attacks, coronary blockage and air pollution makes cardiopulmonary rehabilitation a very important part of rehabilitation medicine.

CARDIAC REHABILITATION

Definition

It is a process of restoring the patient with heart disease to optimal functional status keeping in mind the physiological, psychological, and vocational requirements.

Features of Cardiac Rehabilitation

- It involves the active participation of patient and family members
- It is a sequence of medical and rehabilitation protocols which merge with each other
- It is personalized based on the patient's age and habits
- The patient has to be rehabilitated back to his original activity.

Components of Cardiac Rehabilitation

- Medical and surgical management.
- A dietician prescribes a customized diet; usually a low protein and high fiber diet.

- Psychosocial component: Any patient who has undergone a major surgery would naturally need counseling by a psychologist regarding issues like quality of life after surgery.

Candidates for Cardiac Rehabilitation

- Patients who undergo surgeries on the valves.
- Patients needing percutaneous transluminal coronary angioplasty (PTCA).
- Patients with milder form of myocardial infarction.
- Patients who undergo coronary active bypass grafting (CABG)

Contraindications

- Severe myocardial infarction
- Unstable angina
- Cardiac arrhythmias
- Systolic pressure > 220 mm Hg and diastolic pressure > 110 mm Hg.
- Impaired cognition
- Possible lack of compliance to therapy.

Cardiac Rehabilitation Team Members

- Cardiac rehabilitation specialist
- Cardiothoracic surgeon
- Cardiologist
- Cardiac rehabilitation nurse
- Psychologist
- Dietician
- Physical therapist
- Family members.

The prescription of the exercise program is done by a cardiac rehabilitation specialist according to the patients **Metabolic Equivalent of Task** (MET) levels and cardiopulmonary status. The **Metabolic Equivalent of Task** is a physiological concept giving a figurative value to the energy expenditure of physical activities. It is defined as the ratio of metabolic rate during a specific physical activity to a reference rate of metabolic rate at rest (Resting Metabolic Rate), which is 3.5 ml O_2 $kg^{-1} \cdot min^{-1}$. This is also a measure of the rate of energy consumption. One MET is considered by convention as the resting metabolic rate obtained during quiet sitting. The day to day MET values of physical activities are as low as 0.9 (sleeping) and can escalate above 15 (running). It is actually an index of the existing physical activity. Physical activity with a MET value of 3, uses up thrice the energy that person consumes at resting metabolic rate of 1.

An indication of MET s consumed is given below in this table.

Physical Activity	*MET*
Light Intensity Activities	<3
Sleeping	0.9
watching television	1.0
sexual intercourse	1.3
Writing on a desk, typing on a computer	1.8
Walking less than 2.0 mph on a level ground	2.0
Moderate Intensity Activities	3 to 6
Stationary bicycling	3.0
Home exercise with light or moderate effort	3.5
bicycling <10 mph to work or for pleasure	4.0
Vigorous Intensity Activities	>6
Jogging, swimming	7.0
Pushups, sit-ups, pull-ups - heavy, vigorous effort	8.0
Running, jogging on a treadmill	8.0

Exercise Testing

This is based on the standard **Bruce protocol** and involves walking on a treadmill with various electrodes attached to the body while the heart is monitored by an ECG machine. Perfusion and gaseous levels are also monitored, before, during and after exercise. The speed of walking on the treadmill and inclination can be adjusted to suit individual tolerance levels. The test is tolerated by most patients, and can detect signs of such conditions as angina, or a previous heart attack.

The protocol itself makes the patient run at speeds from 2.74 km/hr to 12.07 km/hr. The gradient is initially at horizontal and later increased up to 28% at intervals of 3 minutes. The patient is challenged to run on the treadmill till he or she is fatigued. For normal individuals the time is between 9 and 15 minutes. From the total walk/run time the patients $VO_{2\,max}$ can be calculated based on the total time taken for the test.

REHABILITATION PROGRAM

The rehabilitation program for patients after cardiac surgery is divided into three phases:

Phase One

This is an inpatient rehabilitation program lasting for ten to twelve days. There are many protocols followed by many centers with minor variations between them. However there are no two thoughts that the goals are to initiate early mobilization and early return to activities of daily living. The patient is given tips on living his life to the fullest after the surgical procedure.

Day of surgery: In the intensive care unit the patient would be connected to lines and monitors and ventilator support. He would not be fully conscious because of the effects of anaesthesia. The therapist visits three to four times during the day and gives relaxed diaphragmatic breathing and gentle toe and ankle movements

Day 1: As the patient is weaned off the ventilator, the therapist gives assisted coughing in sitting and active exercises to the upper limb within the pain free range, in addition to the therapy given above. It must be remembered that the operated site over the sternum can be painful and prevent movements of the shoulder girdle. It can be repeated three to four times a day depending on patient's cooperation.

During this period care is to be taken that electrocardiogram is monitored continuously and also through out the exercise program, and that the heart rate should not exceed 120/min.

Day 2: Patient's intravenous lines are removed. Repetition of the same exercises as the previous day.

Day 3: Patient is shifted out of the intensive care unit and to the ward if he is declared stable by the attending physician. The previous exercises are repeated and the patient is made to walk around the bed under supervision. Sitting in chair with the back support is encouraged.

Day 4: Shoulder girdle movements are performed within the pain free range. The patient is made to sit and stand in the right posture. Walking distance is increased within the ward under supervision of a physiotherapist.

Day 5 and 6: Stair climbing up to five steps is started under the supervision of physiotherapist.

Day 7: The patient is asked to cover a longer distance, with increase in stride length and cadence.

Day 8: Patient is counseled in the cardiac rehabilitation department by a team comprising of a psychologist, a physiotherapist, a dietician, a cardiologist and a cardiothoracic surgeon.

Day 9 and 10: Home exercise program is taught and patient is discharged after suture removal. Ideally by now the patient should have achieved a metabolic equivalent between two and three for progression to the second phase of rehabilitation.

Phase Two

This is an out patient program which means that the patient has to be brought to the department following his discharge until three months, thrice a week. Exercises are given for thirty to forty five minutes checking the vital signs periodically. A gradual warm up session for 5-10 minutes is given, followed by static cycling, treadmill walking and group therapy for up to half an hour. A cool down program for 5 minutes is also given at the end of this session, by which stage the patient is expected to attain 5 mets.

Phase Three

A detailed home exercise program is taught which is followed by the patient at home.

The rehabilitation program should monitor risk factors in post MI patients like hypertension, increased serum cholesterol levels, obesity and coronary atherosclerosis. Other habits like smoking and excessive drinking should be avoided.

Conclusion

It is increasingly being recognized that life after a bypass surgery is more effective only if delivered with proper rehabilitation back-up to enhance the speed of recovery and quality of life.

PULMONARY REHABILITATION

Definition: It is a customized multi disciplinary program in which the pathology of pulmonary disease is reversed through accurate diagnosis, therapy, emotional support and education. It thus improves prognosis and quality of life. Patients with obstructive/intrinsic lung disease benefit the most from pulmonary rehabilitation program, but they may also be of use in restrictive lung disease.

Assessment: Every patient with lung disease technically qualifies to be included in a pulmonary program, but it is essential to assess him holistically. Attention must be given to

- Respiratory muscle dysfunction
- Nutritional abnormalities
- Cardiac status
- Skeletal muscle weakness
- Metabolic disease
- Psychosocial factors

Patients with cognitive dysfunction, severe pulmonary hypertension, unstable angina, and recent myocardial infarction are excluded from the treatment.

Goals of Pulmonary Rehabilitation

- To improve ventilation
- To improve exercise tolerance.
- To provide education to the family members of patients
- To clear chest secretions.
- To promote self care.

Candidates for Rehabilitation

- Those with chronic pulmonary disease with symptoms
- Those who have undergone a recent change in pulmonary function for the worse within the last six months. Patients most likely to benefit from a pulmonary rehabilitation program are those with moderate to severe decrease in pulmonary capacity due to pulmonary disease, like COPD, cystic fibrosis, or bronchiectasis. Patients with severe neurological disability like brain injury and quadriplegia also benefit.

SURGICAL CONDITIONS

Thoracoplasty

The thoracic surgeon removes part of the ribs in certain conditions like thoracic empyema and allows inward retraction of the chest wall and collapse of the diseased lung. The removed portion of the chest wall sinks in toward the middle of the chest and reduces the size of the hemi thorax. There is poor cough reflex, and the vital capacity, FEV1, and total lung capacity are reduced.

Rehabilitation: After thoracoplasty the patient's complaints are pain in the chest or shoulder, and restriction of shoulder movements. Scoliosis may happen because of the collapse of the whole supportive mechanism on that side of the chest. There may be a constant feeling of tightness on the side of the surgery due to the contraction of the underlying fibrotic lung or thickened pleura. The patient must be given a period of rest for six months, during which breathing exercises are given. Full active range motion of the arm and shoulder is given regularly in the postoperative course to prevent the formation of adhesions.

Thoracotomy

Thoracotomy is surgical opening of the chest. When non invasive investigations do not reveal the nature of the disease and the cardio thoracic surgeon feels that surgery is needed for evaluation thoracotomy is done.

There are three basic approaches.

To approach anterior structures, a limited anterior or lateral thoracotomy can be done.

A posterolateral thoracotomy would be helpful to access the pleurae, hilum, mediastinum, and the entire lung.

When access to both lungs is needed a sternal splitting incision (median sternotomy) is indicated.

Rehabilitation after Thoracotomy

Aims: The idea is to increase endurance and overall health, maximize pulmonary function and clearance of secretions, and minimize morbidity associated with thoracic surgery. Another goal is to strengthen the shoulder, and avoid adhesive capsulitis and frozen shoulder.

The program can be started prior to surgery and will continue post-operatively. The physiatrist prescribes

I. Diaphragmatic breathing exercises
II. Shoulder ROM exercises
III. Shoulder strengthening exercises
IV. Customized program on the treadmill, rowing machine, or stationary bike.

The patient is assessed throughout for vital signs and given specialized advice from practitioners of pranayama, nutrition and fitness training. The Occupational therapist gives tips on energy conservation.

Assessment of a patient prior to undergoing rehabilitation

- Age, sex, occupation and family history, history of smoking, past medical history
- Complaints of present condition, medications taken (allergy to medication).
- Specific history of dyspnea, wheeze, cough, and nature of sputum.

General Observation

Vitals: Pulse, heart rate, BP and respiratory rate, clubbing, cyanosis, oedema and nutrition.

Specific assessment for examination of chest

- Use of accessory muscle activity
- Paradoxical breathing.
- Symmetry of expansion
- Pattern of breathing
- Rhythm of breathing
- Ratio of inspiratory to expiratory phases
- Abnormal configuration of chest

Palpation: Touch and palpate for

- Surgical emphysema
- Tracheal position
- Accessory muscle activity
- Expansion of the lobes
- Diaphragmatic excursion.

Measurement of Chest Expansion

Chest expansion is measured at:

- Axillary level (normal 2 cm)
- Nipple level (2 to 4 cm)
- Xiphisternal level (5 cm)

Auscultation: Look for

- Normal breath sounds

- Bilateral air entry
- Abnormal breath sounds (wheeze, crackles, rales).

Investigations:
- Chest X-ray
- Electrocardiograph tests
- Arterial blood gas analysis
- Spirometry.
- Pulmonary function
- Bronchoscopy, if essential
- Sputum analysis

These investigations and also the earlier mentioned exercise testing provide information about:
- Oxygenation of the tissues.
- Physical impairment of patients
- Changes in pulmonary functions during exercises.

Protocols in exercise testing: Some of the various protocols which are available to test the cardiopulmonary efficiency are:
- Stair climbing tests
- Six minutes distance test – the most commonly performed
- Twelve minutes distance test
- Cycle ergometry: **Ergometry** is the study of physical activity by the whole body and also specifically those performed by identified muscle groups. Equipment like treadmills, bicycles or rowing machines are used. A stationary cycle fitted with an ergometer measures the work done during exercise, the heart rate, blood pressure and VO_2 max.
- Treadmill test

Six Minutes Distance (SMD) Test

It is the distance covered by an individual in six minutes by walking briskly on a level enclosed corridor. First, a practice walk can be given at least twenty minutes before the actual testing. The patient may take a brief rest when they choose their level of intensity during the exercise. (rest period being excluded). SMD gives us the accurate condition of the patient, his response to treatment or prognosis and his sub maximal exercise tolerance.

Pulmonary Rehabilitation

Pulmonary rehabilitation falls under the following 3 heads.
- Medical management
- Exercise prescription
- Coping with a normal lifestyle

Medical Management

Medical management includes use of bronchodilators, antibiotics and inhalers and O_2 supplementation when indicated. Good hydration and nutrition must be maintained. Use of suction, nebulisers and ventilators is done during the acute episodes in the ICU. This is followed by prescription of exercises and lifestyle modification.

Exercise Prescription: Criteria

Exercise does not alter underlying pathology, but it does reduce breathlessness and improve other criteria· Endurance training is targeted at 60% of maximal workload for up to half an hour. It is repeated up to five times a week. Two to three minutes of high-intensity training alternating with sufficient periods of rest can be given for patients who cannot tolerate sustained activity. Some patients feel that it is enough to do the program for the duration that one is in hospital. It should be borne in mind that the benefits of training are only as long as exercise is continued. The patient should therefore adhere to the program in the long term.

Mode of exercise: Usually aerobic exercises are prescribed.

The intensity of exercise is varied according to each patient and depends on:
- Heart rate
- Rate of perceived exertion

Borg Scale: In exercise testing there are a few scales that can be used for evaluation. One of them is the Borg Scale that documents the patient's exertion during a test. Originally it was rated on a scale of 6-20 but later revised by the American college of Sports Medicine to 0-10.

The patient is introduced to the scale that asks him or her to rate the difficulty of breathing. Number 0 is where the breathing causes no difficulty at all and progresses through to number 10 where difficulty is maximal. After giving the exercise test the question is asked "Where in the numbers 0 to 10 would you rate your breathing difficulty?"

Chest Physical Therapy (Fig. 25.1): Standard chest therapy starting with postural drainage, cough, and the forced expiratory technique is the cornerstone of treatment for bronchiectasis and cystic fibrosis. The frequency and intensity must be individualized based on the severity of disease and on the quantity of airway secretions that must be cleared.

Breathing Techniques

The patients with COPD, bronchiectasis, and cystic fibrosis are taught controlled breathing and told to stop smoking. Getting oxygen rich air helps

Figure 25.1: Vibration *(For color version see Plate 6)*

those with COPD, and great benefit is obtained with chest physical therapy in chronic diseases like cystic fibrosis and bronchiectasis.

Pursed-lip Breathing

Patients purse their lips and breathe out slowly for 4-6 seconds as if they were whistling. This technique increases expiratory airway pressure, and relieves dyspnea. The work of inspiration is shifted from the diaphragm to the intercostals thus reducing breathlessness. Patients also shift their breathing pattern from a fast rate, to a slower, more controlled pattern under their own voluntary control.

Posture Techniques

When the patient leans forward, the abdominal contents are shifted and the diaphragm is elevated with consequent improved air entry. This relieves dyspnea in patients with COPD.

Diaphragmatic Breathing (Fig. 25.2)

During inspiration the patient brings the diaphragm down, protruding the abdomen. He breathes out by contracting the abdominal wall to displace the diaphragm upwards or superiorly. Patients with COPD benefit from this technique if they are medically monitored.

Active cycle of breathing: This is a technique which involves many exercises which are grouped together and performed in a sequential order, as follows:
- Thoracic expansion exercises
- Postural drainage with incentive spirometry
- Percussion (clapping) (Fig. 25.3)

Figure 25.2: Diaphragmatic breathing *(For color version see Plate 7)*

Figure 25.3: Clapping

- Vibrations
- Shaking—All these methods loosen secretions from the walls of the airways into the lumen.

Percussion

Percussion is also referred to as cupping, clapping, and Tapotement. The respiratory therapist rhythmically strikes the chest wall with cupped hand or mechanical device directly over the lung segment(s) being drained.

Vibration

Vibration involves the application of a fine rhythmic action over the draining area in the direction that the ribs and soft tissue of the chest move during expiration.

Forced expiratory techniques (coughing and huffing) is thought to milk secretions from the more distal airways.

Coughing is a deep inspiration is followed by forced expiration against a closed glottis. Where this technique is inadequate (e.g. in severe scoliosis, impaired glottis function), this is accompanied by anterior chest compression or abdominal thrust or both by the therapist.

Huffing is forced expiration is through an open glottis, producing the sound 'haa.'

POSTURAL DRAINAGE

Postural drainage is the drainage of secretions, from one or more lung segments to the bronchi and trachea where they can be removed naturally by coughing or artificially by mechanical aspiration. This includes positioning, turning and chest percussion and/or vibration. The aim is to mobilize secretions with other respiratory care procedures like aerosol administration. It works by the effect of gravity. The lung is divided into segments, which, are placed in a superior position, and held for a few minutes for the drainage to be effective so that the secretions drain out. Cough with expectoration or methods to clear the airway are indicated after postural drainage is done.

Goals

- To expel the bronchial secretions
- To facilitate ventilation and perfusion match
- Optimize functional residual capacity.

Turning

Turning is the rotation of the body around the longitudinal axis to promote lung expansion and improve arterial oxygenation. If the patient can do it himself it is ideal, otherwise, a caregiver is trained to do it. Patients are turned to midprone, prone or at an inclination midway.

Indications

- Bronchiectasis, cystic fibrosis, lung abscess
- Excessive sputum production and secretions in the airway
- Ineffective cough
- Abnormal chest X-ray indicative of atelectasis, mucus plugs or infiltrates.

Benefits

- Increase in sputum production in an optimally hydrated patient
- Improvement in breath sounds after secretions are drained
- Better lung compliance

- Reduction in spells of dyspnea
- Resolution of the lesion in chest X-ray, positive improvement in blood gas or ventilator values

Relaxed Positions for Postural Drainage

- Relaxed standing
- Forward lean standing
- Relaxed sitting
- Forward lean sitting
- High side lying

Augmentation to Chest Physiotherapy

- Visual imagery and biofeedback to reduce tension.
- Pollution control, work simplification and self-help aids at home and work.
- ***Smoking cessation:*** Counseling can be given to chronic smokers with pulmonary disease, to decrease the number of puffs and cigarettes.
- Energy conservation

Simplifying the work helps patients maintain ADL and do their jobs with less energy consumption. The methods include paced breathing, optimization of body usage, planning the activities in advance, their prioritization and use of assistive devices.

Contraindications

Chest percussion and postural drainage are not used much in cardiovascular failure, arrhythmia, severe hypertension, hemoptysis, raised intracranial and intraocular tensions, aortic aneurysm and facial edema.

Pranayama

Pranayama is the fourth part of Ashtanga Yoga of Patanjali, the major treatise on the subject. It deals with the breathing process or the control of inhalation, exhalation and the retention of vital energy. Good inspiration is practiced with complete and deep expiration along with relaxation and balance of the body. Pranayama is a synthesis of two words in Sanskrit - Prana and Ayama. The meaning of 'Prana' is life force, while 'Ayama' signifies control. Pranayama thus indicates an activity that develops and controls the life force. 'Prana' is the universal omnipresent life force or energy, a portion of which is also present in the human body. The goal of Pranayama is to increase the quantum of this life force (Prana) so that it can reach out to remote parts of the brain, and the rest of the body. The Prana or the vital life energy needs to be sustained by good oxygenation to the brain, in other words, by good breathing.

It may take months or even years before the practitioner experiences the full benefits of pranayama which is claimed to control almost any disease.

Pranayama is often done along with the asana or pose in Yoga. Practiced over the ages, pranayama and yogasana are considered to be the most purifying practices for the mind and the body, respectively. These practices induce heat in the body, called tapas, or the inner fire which purifies the self. This regulates the nerve channels of the body, or nadis, calming the mind, and making the body healthier.

Anuloma Viloma—Alternate Nostril Breathing: This form of breathing through the nostrils alternately, orients the energy flow in a balanced manner and simultaneously makes the person energetic and relaxed.

Bhastrika Breathing: "Bhastrika" in Sanskrit means "bellows" similar to that used by a blacksmith. This is a forceful breathing exercise both in inspiration and expiration where the air is drawn in and out of the lungs through the nose equally, deeply and slowly initially and later more rapidly like the pumping action of the bellows.

Bhramari Breathing: Bhramar means "bee". In this breathing practice a soft "humming-bee" sound is produced during exhalation, by closing the ears with the fingers.

Kapala Bhati: The Sanskrit work "Kapala" means "skull" (and by implication, the brain) and "Bhati" means "shining". Inhalation is slow and exhalation is prolonged and vigorous with a gap after each expiration.

All these techniques play varying roles in purifying the nasal passage and the lungs, helping the lungs throw out carbon dioxide and other impurities. They activate the spleen, pancreas and other abdominal organs.

CONCLUSION

The benefit of a successful pulmonary rehabilitation program includes improved exercise capacity, an enhanced sense of wellbeing and a reduced need for hospitalization. Good breathing techniques allow air entry and good oxygenation, promoting an all round improvement in the general condition of the patients with cardio respiratory problems.

CHAPTER 26

Vascular and Hematological Conditions

HEMOPHILIA

The hemophilias are a group of hereditary sex linked disorders, occurring predominantly in males through out life. Abnormalities in factors in the blood responsible for coagulation namely Factor VIII and Factor IX produce hemophilia A and B, respectively and a similar deficiency, in von Willebrand's factor produces von Willebrand's disease. The incidence is about 1:5,000 male births and all races and socioeconomic groups are affected. We discuss here only aspects related to hemophilia and its effect on the joints.

Clinical Features

The patient is prone to bleeding spontaneously or following minor trauma which can be very alarming. Even an innocuous injury can lead to continuous bleeds, sometimes unto death. The clinical features in patients coming to the rehabilitation center are the result of hemorrhages into joints, muscles and other tissues. Clotting factor is costly and not easily available and if not given when required, the joints develop deformity and arthritis and life expectancy is considerably reduced.

Management of the condition includes administration of safe, effective concentrates of the deficient clotting factor, a team approach to the total care of the person with hemophilia and counseling to prevent transmission of genes.

With a minor injury, bleeding occurs into the joint. This blood contains iron and other constituents which are destructive to the cartilage. The first reaction to the bleed is swelling and inflammation of the synovium which starts bleeding afresh. Treatment of the condition and the joint must be started on a war footing to break this vicious cycle.

Role of Physiotherapy

The role of the therapist is to increase function by maintaining range of motion, increasing muscle strength and avoiding joint deformity. These exercises should be done at home on a regular basis. The program of therapy should be individually tailored by the physical therapist to the patient's needs and lifestyle.

During an acute episode after haemorrhage, exercise to the involved joint would be dangerous to the patient since exercise might promote further bleeding. Further, the patient is experiencing pain and any motion would cause muscle guarding, spasm and increased pain. Hence the patient should receive concentrate of the factor prior to exercise so that he can work at his maximum capacity without fear of hemorrhage. The frequency and duration of the exercise should be brief initially and increase gradually. He should start with isometric exercises, and then progress to active assistive, and finally to resisted exercises as the pain diminishes and muscle tone and flexibility increase. Heat or cold applications and electrical stimulation are the most commonly used modalities for relief of pain and increasing range of movement. Hydrotherapy is very useful in management of hemophiliacs.

Arthritic Joint (Hemophilic Arthropathy)

Repeated episodes of bleeding lead to Arthropathy which is potentially disabling and the physiatrist is forced to take a difficult decision on whether to immobilize or not. The sequence of injury, from bleeding to synovitis to arthritis and total stiffness is a progressive one and it needs a good rehabilitation team to break and overcome this sequence.

The temporary use of braces and splints is useful provided physical therapy is used in conjunction with all forms of splinting. If a flexion contracture has minimally developed at the knee, serial casting and wedge casting with a lot of care have been successful in correcting it.

ARTERIOSCLEROSIS OBLITERANS (FIG. 26.1)

Arteriosclerosis obliterans is a disease of the large and medium sized arteries, particularly of the lower extremities. It is characterized by occlusive lesions in the blood vessels.

Predisposing Factors

- Cigarette smoking
- Diabetes mellitus.
- Hypertension
- Hyperlipidemia

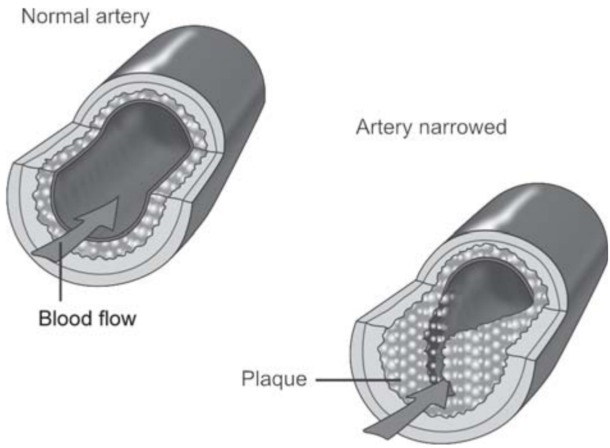


Figure 26.1: Artery narrowed by arteriosclerosis

Pathology

Accumulation of platelets, fibrin, and cholesterol
↓
Formation of thrombus with fibrosis
↓
Plaque formation and luminal encroachment
↓ ↓
Narrowing and occlusion of the lumen | Peripheral emboli

Symptoms

- Pain intermittent claudication, that is, the patient reports tightness in the calf muscle (claudication) after walking for a short distance. This distance varies according to the occlusion of the lumen and is called the claudication distance. This reduces as the disease advances, which means that the patient is unable to walk the distance he used to, earlier.
- Pallor—changes in skin color and temperature
- Paresthesiae—sensory disturbances
- Pulselessness
- Paralysis
- Ulceration
- Gangrene

Diagnosis

- Palpation of pulses of the upper limb, like the brachial, radial arteries, and the lower limb, the femoral, popliteal, posterior tibial, and the dorsalis pedis, which may be feeble or absent.

- Doppler
- Treadmill or bicycle ergo meter
- Arteriography
- Skin temperature
- Magnetic resonance imaging (MRI)

Medical Management

- Embolism – heparin
- Thrombosis – Fibrinolytic agents
- Antiplatelet drugs and blood thinners – Pentoxifylline, Ticlopidine, Clopidrogel

Physiotherapy Management

Buerger's Exercises: This is an exercise which consists of a sequence as follows:

- Patient is put in supine lying,
  His legs are elevated to 45°
- Observe time taken for blanching
- Patient is asked to remain in the same position for 2 more minutes.
- He then is made to sit in high sitting position.
- Pooling of blood is allowed in the superficial veins due to gravity.
- Patient continues in high sitting position for 3 more minutes
- He then lies flat for five minutes.

This sequence is repeated four to five times per session, for three sessions a day.

Effects and Uses

- Improvement in collateral circulation
- Better utilization of oxygen by muscle tissue
- Walking improves
- Improvement in cardio respiratory endurance
- Increased pain tolerance
- Psychological confidence of the patient can lead to a considerable increase in work performance.

Surgical Management

- Sympathectomy
- Percutaneous angioplasty
- Amputation (as a last resort).

THROMBOANGIITIS OBLITERANS (BUERGER'S DISEASE)

It usually occurs in young males who are heavy smokers and characteristically affects the peripheral arteries, giving rise to claudication in the feet or rest pain in the fingers or toes. The mapping of the blood vessels shows relatively healthy main vessels but narrowing or occlusion of small peripheral arteries. The presentation and treatment is quite similar to Arteriosclerosis. Amputation of the lower limb often has to be performed to save the life.

VARICOSE VEINS

Varicose veins are a common complaint of many people who need to stand for long hours, like surgeons, traffic policemen and security guards. It happens because the superficial veins are under severe pressure when standing or sitting due to incompetence of valves and reflux of blood from the deep venous system. The veins become elongated, dilated and tortuous, and the patient may present with chronic varicose ulcers. The symptoms of chronic venous insufficiency are pigmentation, induration, contact dermatitis and pain.

Management

- Reduction of oedema through:
  - Faradic current under pressure
  - Air compression
  - Exercises with the pressure support bandage or elastic support stockings
  - Elevation of lower limbs
  - Massage techniques like stroking and effleurage
- Bandaging
- Control of infection
- Mobilization of skin and connective tissue
- Treatment of the ulcer floor and edge through ultrasound or laser therapy
- Mobilization of joints and strengthening muscles.

DEEP VEIN THROMBOSIS

Clinical Features

DVT is very common in those who are confined to bed for a prolonged period
- Pain, swelling, redness and cyanotic discoloration of affected limbs
- Warm skin
- Homans sign—passive dorsiflexion of the ankle produces sharp pain in the calf
- Low grade fever

Complications

- Phlegmasia alba dolens—arterial spasm may accompany extensive DVT and cause a swollen white leg.
- Phlegmasia cerulea dolens—the limb is swollen and cyanosed
- Pulmonary embolism

PREVENTION (FIG. 26.2)

Elimination of stasis
- Early ambulation and leg exercises (not to be done if there is DVT).
- Graduated compression stockings
- External pneumatic compression (only as a precautionary measure to prevent DVT)
- Continuous rotation beds.

Medical Management

Counteracting blood coagulability (Heparin therapy)
- Aspirin
- Low molecular weight heparin

If thrombus is confined to the calf and the patient is fully mobile, elastic stockings and physical exercise, should be provided with utmost care.

LYMPHEDEMA

This is swelling of an extremity or other body part secondary to a malformation or obstruction of lymphatic channels. Lymph flow can be blocked by secondary causes like infections, filarial adenitis, tumors or surgical adhesions.

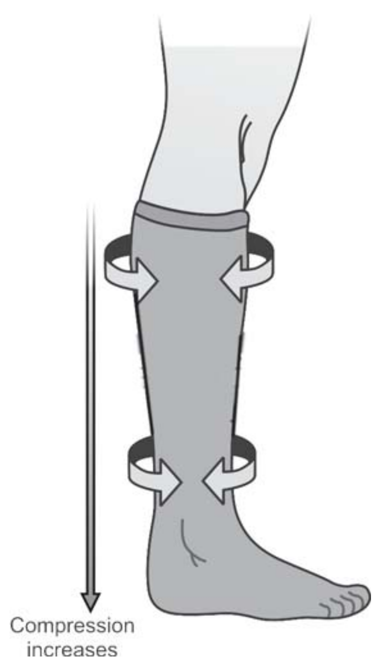


Figure 26.2: Compression bandaging for deep vein thrombosis

The primary causes are:

- Hereditary
- Lymphedema praecox
- Lymphedema tarda

Management

- Mobilization of fluid—massage effleurage
- Extremity compression—graded pressure pumps
- Gradient elastic stockings
- Exercises; to strengthen muscles and improve joint range in order to increase the effectiveness of the muscle pump.
- In recent times, mechanized sequential compression from distal to proximal segments (similar to effleurage) is done.

CHAPTER 27

Rehabilitation of Burns

INTRODUCTION

Humans have used fire since the dawn of history and burn injuries have presumably occurred ever since. Burns affect skin directly and all other organ systems indirectly, causing a chain of events with implications far beyond skin loss. Rehabilitation of the burn patient may be considered in 2 phases:

- Acute
- Postacute and longterm.

Assessment

Initially after eliciting a history, the rehabilitation team conducts a physical exam to document the type and extent of burns, neuromuscular and musculoskeletal damage, associated medical conditions, presence of other injuries and social problems.

The pediatric burns patient differs from an adult patient in many ways. Since the body surface area is different, dehydration is greater, temperature control is more difficult and hypertrophic scarring is more severe. In the pediatric patient, mortality is higher and rehabilitation more challenging. The assessment of burns in the acute phase is governed by the rule of 9 (given below) and in the rehabilitative phase the contractures and complications are assessed.

Classification

First-degree burns: shows up as an erythematous white plaque involving only the epidermis. In India, due to the severe heat in summer, people get sunburns and this can be included as first degree burns.

Second-degree burns: occur when there is blistering of the skin, involving mostly the superficial dermis and may also involve the deeper dermal layer it is a second degree burn.

Third-degree burns: This happens when the epidermis is lost with damage to the subcutaneous tissue there is charring with severe pain and even loss of hair. Grafting may be needed for these burns.

Fourth-degree burns: These burns damage deeper tissues like muscles, tendons, and ligaments, thus resulting in charring and later even contractures. These burns are usually fatal if not attended to immediately. Grafting and rehabilitation are required intensively.

Causes of Burns

Heat: including fire, radiation, or from steam, and hot liquids (scalds) and contact with hot objects. Household burns are very common, where contact with cooking utensils is unavoidable. A very unfortunate cause of burns is suicide, by dousing with kerosene and lighting with a match. The victim is often depressed or, as is common in India, uses this as a means of expressing solidarity with a cause or political protest. The rehab program is very tortuous and painful and several counseling sessions are needed.

Radiation: this is a rare but catastrophical cause of burns. Recent example is the disaster from the Chernobyl reactor. Ultraviolet light is also a source of radiation burns.

Light: burns caused by intense light sources. In the tropics, sunlight is also included.

Electrical: Common household and industrial sources of electricity are potential risks for electrical burns. It is also an occupational hazard for electricians and is a cause for bilateral amputation (Ref: Chap 8). Lightning is another cause, though rare.

Complications of Burns

- Bacterial contamination of the wound may occur even within a few hours. Burns are often fatal due to contamination leading to sepsis
- There is tremendous loss of body fluids through open wounds that can cause hypovolemia and shock; this is a major danger and could prove fatal
- The body's immunity is compromised
- The evaporation from open wounds results in heat loss
- Upper airway obstruction and lung infections occur
- Acute gastric dilatation and paralytic ileus.

Contractures (Figs 27.1 and 27.2) a contracture is a serious complication of a burn. It happens because elastic connective tissues are replaced with inelastic fibrous tissues. It presents as a permanent tightening of skin and underlying tissues resistant to stretching and preventing normal movement of the affected area. It occurs when the burn scar heals with fibrosis, thickens, and tightens

Figure 27.1: Burns contracture of the foot *(For color version see Plate 7)*

Figure 27.2: Burns contracture of the leg *(For color version see Plate 7)*

(which is normal in wound healing), reducing the range of movement. Sometimes there is hypertrophy of the scars producing keloids. During the healing stage, pressure dressings to burn wounds are generally advised to minimize hypertrophic scarring. Surgical excision and skin grafting may be done within three days after the burn, for nonscald full thickness burns in children and young adults. For older patients in the same category, it is better to wait before doing the surgery. When there is scalding a period of two weeks can pass before taking a decision for grafting. Hypertrophic scarring is more common when epithelialization takes longer than 2 weeks in children or three weeks in others. The burn wound may take up to a year to heal during which antiseptic, moisturizing cream and sun protection cream are used along with splints. Release of contractures, has to be decided based on the assessment of the surgeon and function planned.

Management in the Acute Phase

Rule of 9's is a quick way of estimating, the surface area that is affected by a burn. If the surface of the body is 100 percent, the areas can be divided as

- Face and scalp 9%
- Back 18%
- Perineum 1%
- Arm each 9%
- Front 18%
- Upper arm each 9%
- Lower leg each 9% (Fig. 27.3)

Goals

- To promote wound healing and prevent infection
- To control edema, lung infections, and electrolyte imbalance
- To maintain joint and skin mobility, with minimal disfigurement.

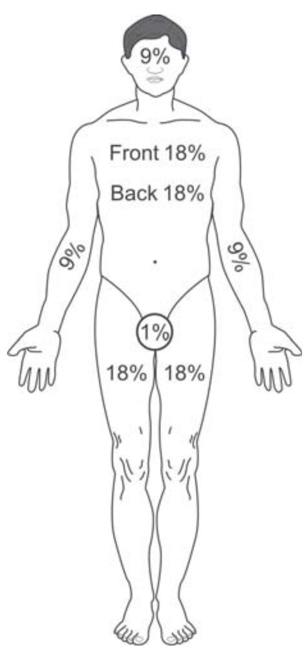


Figure 27.3: Rule of 9's in assessment of burns

REHABILITATION

Rehabilitation of the burns patient starts as soon as he or she is stabilized in the burns ward itself.

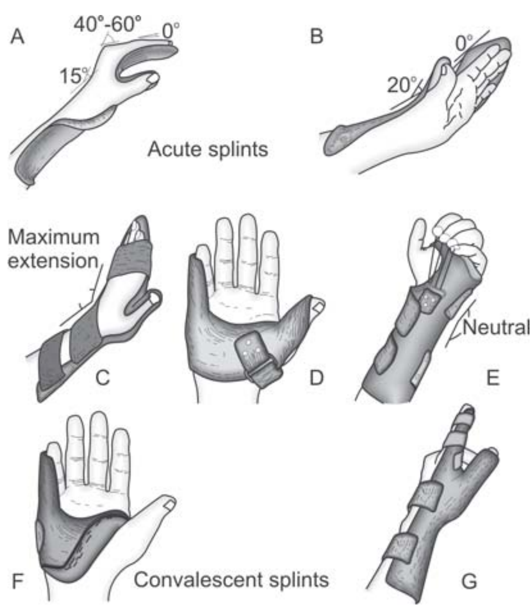
Positioning

Proper positioning of the patient in bed is fundamental to the rehabilitation program and this can be achieved using splints, foam wedges, pillows, and sandbags. This can be extremely difficult as the patient is in severe pain and seeks relief in a primarily flexed and adducted position which is the position of minimal pain but which unfortunately favors development of contractures rather rapidly.

Antideformity positioning should begin immediately in abduction and extension. Burnt tissues should be maintained in their elongated state, as far as possible. Alternating positions to prevent opposing deformities is important.

Splinting (Figs 27.4A to G)

Splints used in the acute phase in conjunction with gentle sustained stretching help maintain the desired anatomical position and prevent deformity. Splinting is performed at least 4 times a day in between therapy sessions.



Figures 27.4A to G: Common hand splints for burns

Indications for Splinting

A splint is given to prevent rupture of exposed tendons, to protect exposed joints or a graft and to prevent excessive scarring in areas where an important body contour would be lost, e.g. neck, face. This prevents too much disfigurement of the face and exposed areas.

Commonly used splints in the acute phase are

- Knee extension splints
- Dorsiflexion splints/posterior foot drop stop splints
- Resting hand splint
- Facial masks and cervical collars

Body Part	*Contracture/Predisposition*	*Preventive positioning*
Neck	Flexion	Extension/hyperextension
Anterior axilla	Shoulder adduction	Shoulder abduction
Posterior axilla	Shoulder extension	Shoulder flexion
Elbow	Flexion	Extension
Forearm	Pronation	Supination
Wrist	Flexion	Extension
MCP	hyperextension	MCP flexion
Fingers	IP flexion	IP extension
	Thumb adduction	Thumb palmar abduction
Hip	Flexion adduction ext.rotation	Extension/abduction/neutral
Knee	Flexion	Extension
Ankle	Plantar flexion	Dorsiflexion
Toes	Flexion	Extension

Special splints—splints painlessly maintain the gain in ROM and minimize hypertrophic scarring by applying constant pressure on scar tissue. They are applied as follows:

Mouth: Static or dynamic prevention of contractures around the mouth and microstomia is done using hooks made of acrylic or thermoplastic material and attached to a cervical collar.

Face and neck – Transparent PVC total contact masks, collars

Ears – A semi rigid mask may be taped around the ear to prevent folding of the helix

Axilla – Aeroplane splint/figure of eight clavicle brace

Elbows, knees – Gutter splints

Hip – Spica

Ankle and foot – Foot drop stop, reverse foot drop stop splints, extra depth shoes with soft inserts.

Electrotherapy

Decreases tendon adherence to scar tissue.

TENS	–	for pain from faulty positioning
US	–	for painful joints of the hand
Cryotherapy + Ultrasound	–	for hypertrophic scar pain
Biofeedback	–	for relaxation in insomnia

Exercise and Ambulation

Early limitation of motion is caused by pain and edema. The initial exercise program should focus on preserving the range of movement and maintaining strength. Passive range of movements 2 to 3 times a day for the critically ill patient in the ICU is indicated as long as they are unconscious or medicated, but for patients who can actively move a joint an active range of movement is better.

If the range is not full, active assisted exercises and passive stretching are instituted. Vigorous movements to the trunk like flexion-extension or rotation are done, though painful, to prevent the robot like posture that frequently develops. Gentle sustained stretch is more effective in stretching burnt tissue than multiple repetitive movements. Focus should be on those areas most prone to developing scar tissue contractures. Ambulation should start as soon as the patient is out of danger, his vital signs stabilize and pain is within tolerance limits. Patients with deep burns to the lower extremities should be fitted with extra depth shoes, moulded insoles or inserts. Early ambulation after grafting of the feet and legs is possible with total contact walking casts or Unna's boots. Unna's boot is a zinc oxide bandage that sets like plaster of Paris when dry and can be left in place for a week.

Care should be taken for patient with

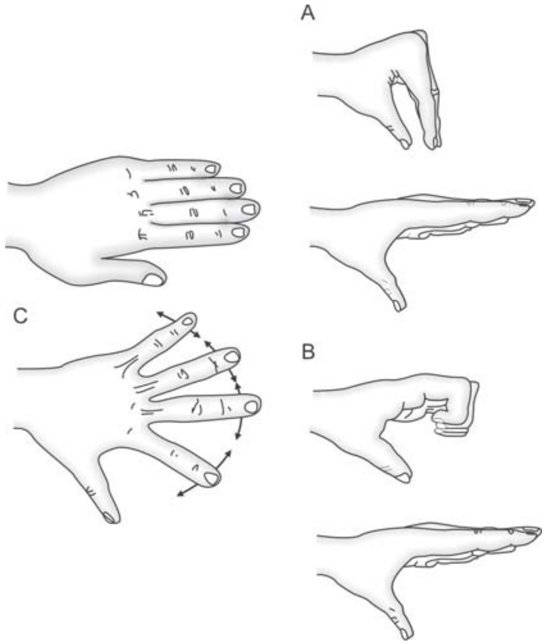
- Past medical history of cardiovascular or pulmonary disease
- Exposed tendons or bone
- Dystrophic calcification
- Patients on i.v. lines/ventilatory support.

Hand Management (Fig. 27.5)

The burnt hand needs static or dynamic splinting after the wounds have healed.

Burn injuries to the hands are all the more significant because the patient needs to return to normal function. Common deformities and problems of the burnt hand are:

- Clawing with hyperextension of the MCP joints, with flexion of the PIP and DIP joints. The thumb is in adduction and external rotation.
- Boutonniere deformities of the fingers.
- Edema which should be prevented by elevation of the whole arm immediately after injury.



Figures 27.5A to C: Exercises to prevent burns contracture; (A) MCP joint flexion and extension; (B) IP joint flexion and extension; (C) Adduction and Abduction to stretch web spaces

- Active gentle exercises to increase range of movement and stretch intrinsic muscles. Manual traction applied to the joints stretches the ligaments passively.

Contraindications to Exercise

- Thrombophlebitis, deep vein thrombosis and vascular complications
- Fresh unhealed skin graft
- Severe dehydration.
- Septicemia
- Exposed joints

Post-acute/Long-term Rehabilitation

Exercises can be in the form of play and recreational activities. The occupational therapist needs to innovate in order to fabricate splints for various sizes of hands.

Goals of Rehabilitation

- To improve independence in ADL
- To regain full active ROM of all joints, promote return of strength and endurance, and improve dexterity and co-ordination.
- To ensure wound healing and minimize scars

- To extend psychological support to the depressed patient and family
- To have the patient return to school or office.
- To improve looks and cosmesis; this can be very crucial to youngsters.

Management

- The newly formed skin is fragile and exercise, stretching, splints or vigorous movements can cause abrasions and sores.
- Healed burnt skin is different from normal skin and hardly ever regains its original durability, elasticity or color. It remains dry and often lacks normal suppleness, and can be massaged with moisturizers, like aloe vera, calamine lotion or tea tree oil
- Maintaining ROM is more challenging than in the acute phase because of contracting fibrous tissue. Once the scar is mature, stretching is of less benefit. The therapist must give a slow, sustained stretch along the burn length. It also helps to apply paraffin at mild heat before being mobilized. Allowing sustained stretch has been found to enhance patient comfort and gain in ROM, of course taking care of the skin over the wound.
- A regime of generalized strengthening exercises, endurance exercises, and mild aerobics to improve cardiovascular capacity is started.

Psychological Rehabilitation: Post-traumatic stress disorder is very common after burns. Sometimes the cause of the burn itself may be psychological; like a failed suicide attempt, often attempted in India. Stress and pain reduction mechanisms like relaxation techniques or hypnosis can be used. Individual and group counseling is done to support and educate patient groups on life after such a trauma.

Vocational Rehabilitation: The following are done to get the person back to his or her job, or train for a new one:

- Assessment of hand function
- Surgery/splinting to enhance function
- Self help aids
- Transfer of skill or retraining of skill
- Alternate job placement.

CONCLUSION

Even after the patient is totally rehabilitated from a medical point of view, there are residual defects that remain for the rest of his life. They range from sensory impairment, heat/cold intolerance and callused feet, to psychological and social problems. It is during this phase that the patient and family realize how devastating the damage has been to the body, and when rehabilitation rather than survival becomes the primary issue.

CHAPTER 28

Rehabilitation of Arthritis

INTRODUCTION

Arthritis is one of the major disabling conditions of the world, with several millions affected at any given time. It is simply defined as ***an inflammation of a joint***. There are several classifications but none too satisfactory, due to a bewildering spectrum of joint involvement. There are about 180 synovial joints in the body and almost as many afflictions as there are joints. Some of these are so crippling that the quality of life the sufferer is severely affected. Rehabilitation plays a major role in preventing deformities, correcting them, or helping the individual adapt to the environment.

CLASSIFICATION OF ARTHRITIS

- Degenerative arthritis, e.g. osteoarthritis
- Rheumatoid and related arthritides (inflammatory arthritis)
- Post-traumatic arthritis.
- Arthritis of infectious origin, e.g. bacterial, viral
- Metabolic arthritis, e.g. gout
- Seronegative spondylarthropathies
- Ankylosing spondylitis
- Ulcerative colitis
- Behcet's syndrome
- Psoriatic arthritis
- Reactive arthritis
- Whipple's disease
- Reiter's syndrome
- Crohn's disease

The classification may also be according to whether the affliction is symmetrical or otherwise, how many joints are involved and whether the underlying pathology is inflammatory or not.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis is a chronic destructive inflammatory process involving tissues in the joint which have originated from embryonic mesenchyme.

General Characteristics of Rheumatoid Arthritis

The onset and progression vary from mildly aching joints and tightness to severe swelling, stiffness and progressive deformity with periods of exacerbation and remission. There are early inflammatory changes in the synovial membrane (synovitis) and peripheral portions of articular cartilage. Later, granulation tissue (pannus) forms, covers and erodes the articular cartilage. Fibrosis or ossific ankylosis may result causing permanent deformity and disability. Inflammatory changes may also occur in tendon sheaths (tenosynovitis).

Extra-articular manifestations of rheumatoid arthritis:

Syndromes associated with RA (Fig. 28.1)

- ***Caplan's syndrome:*** This is an occupational lung disease with nodular lesions in the lung
- ***Sjögren's syndrome:*** The patient complains of drying up of lacrimal and salivary glands, consequently there is dryness in the mouth and eyes.
- ***Felty's syndrome:*** The components are hepatosplenomegaly, lymphadenopathy, and anemia.

Criteria for Classification of Rheumatoid Arthritis

The American Rheumatism Association has issued the following criteria for the diagnosis and classification of rheumatoid arthritis

Morning stiffness: Early morning stiffness in and around the joints, lasting at least one hour.

At least three joint areas affected having soft tissue swelling or fluid.

Arthritis of hand joints: At least one joint area swollen; from among the wrist, metacarpophalangeal MCP joints and proximal interphalangeal PIP joints (Fig. 28.2).

Symmetric and **s**imultaneous involvement of same small joint areas on both sides of body

Rheumatoid nodules: Subcutaneous nodules over bony prominences or extensor surfaces, typically at the elbow.

Serum rheumatoid factor positive: Demonstration of abnormal amounts of serum rheumatoid factor

Radiographic changes: Typical rheumatoid arthritic lesions at the hand and wrist must include erosions or decalcification localized in these involved joints.

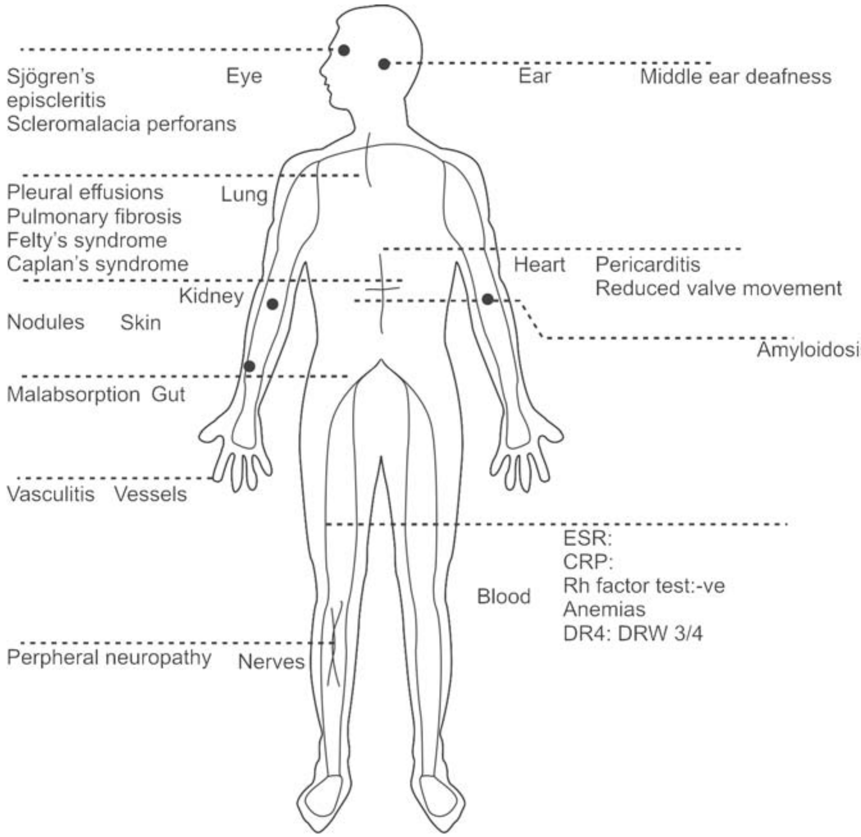


Figure 28.1: Extra-articular involvement in rheumatoid arthritis

Figure 28.2: Hands in rheumatoid arthritis

For criteria 1-5 to be satisfied symptoms must be present for 6 weeks. Based on the criteria the disease is classified as:

Classical – 7 criteria satisfied
Definitive – 5 criteria satisfied
Probable – 3 criteria satisfied.

COMMON DEFORMITIES (FIGS 28.3 AND 28.4)

Swan Neck Deformity: Flexion of distal interphalangeal joint with hyper-extension of proximal interphalangeal joint.

Boutonnière Deformity: This is the reverse of what happens in Swan neck deformity. There is flexion of the proximal interphalangeal joint and extension of the distal interphalangeal joint. This is because the extensor hood of the PIP joint is stretched, causing it to pop up in flexion pulling the DIP joint into hyperextension.

Thumb Deformity: Three types of deformity occur at the thumb.

Type 1 – Boutonniere deformity at the interphalangeal joint
Type 2 – Subluxation of carpometacarpal joint during adduction
Type 3 – Exaggerated adduction of first carpometacarpal joint, flexion at the metacarpophalangeal joint and hyperextension at distal interphalangeal joint.

Medical Management

Non-steroidal Anti-inflammatory Drugs (NSAIDs): These are drugs (which do not belong to the category of steroids) that control inflammation and relieve pain but do not influence the course of the disease. Examples are Aceclofenac, Ibuprofen, Diclofenac, Mefenamic acid, Piroxicam, Naproxen, Ketorolac and Indomethacin. Some NSAIDs are banned because of their toxic effects; others

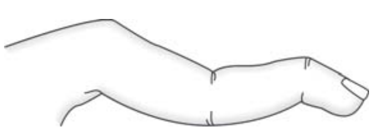


Figure 28.3: Swan neck deformity

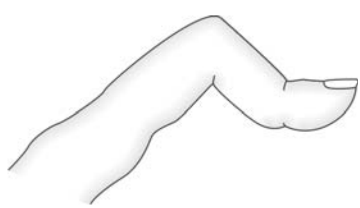


Figure 28.4: Boutonnière deformity

are contraindicated because of their adverse effects on the gastrointestinal tract and kidneys.

Disease modifying anti-Rheumatic drugs (DMARDS): These are drugs prescribed for rheumatoid arthritis patients, along with NSAIDs. These influence the course of the disease by modifying the disease activity.

- Methotrexate
- Azathioprine
- Penicillamine
- Salazopyrine
- Parenteral gold
- Leflunomide
- Chloroquine

Corticosteroids: The corticosteroids suppress inflammation and preserve joint structure. They are often used in the beginning of the disease or during exacerbations. They are, however not used continuously owing to their long term side effects, like osteoporosis or hypertension and are used in the lowest doses. They may be injected intra-articularly in pauciarticular arthritis, or used in life threatening complications like rheumatoid vasculitis or during pregnancy.

Surgical Management

- Joint replacements
- Osteotomy
- Soft tissue procedures
  - Synovectomy
  - Arthrodesis
  - Tendon transfer

REHABILITATION

Physiotherapy

Pain Relief Modalities (Ref Chap 13)

Mobilizing exercise to the joints involved: A thermal modality like diathermy or wax bath is given to enhance flexibility of soft tissue structures before mobilization, which has to be given intelligently keeping in mind the development of potential deformities. Pendular exercises, wall climbing exercises, toweling the back are prescribed for the patient as a home program. Isotonic and isometric exercises are given to the knee, ankle and foot.

Re-education of gait: The physiatrist should determine whether the patient would ambulate with aids or move around in a wheelchair. Therapists should ensure that acutely inflamed weight bearing joints are not unduly stressed.

Occupational Therapy

Exercises for the hand

- Hands are kept inside warm saline or a wax bathtub and vigorously moved in flexion and extension.
- Make shapes out of melted wax, putty or plastic.
- Keeping the IP joints extended, draw the tips of fingers and thumb together, then flatten hand and spread the fingers. This movement can be extended to practical activities like gathering in or spreading out some substance in a tray, such as sand, wheat flour, rice or beans.
- Fit hand round a soft ball, squeeze it repeatedly and then let go. Alternatively, squeeze and wring out the water from a sponge.
- In the sitting position grasp a rolling pin and roll it forwards and backwards on the thighs.
- Sit in front of a table—transfer matches from one box to another about 6 inches away, each match is picked up separately, the first being held between thumb and first finger, the second between thumb and second finger, and so on.

Splints are given to prevent deformities (Ref Chap 7).

Specific joint problems and positioning in prevention of potential deformities

Joint	*Position of Splinting*
Neck	Extension of cervical spine, chin forward
Dorsal spine	Full extension
Shoulder	90 degree abduction, neutral rotation
Elbow	90 degree flexion, and 10 degree supination
Wrist	30 degree and dorsiflexion
Thumb	Extension and opposition
Finger	Extension, without lateral deviation.
Hips	Extension in line with body, foot pointing upward.
Knee	Extension
Ankle	Neutral position
Foot	No varus or valgus
Toe	In line with plantar surface of foot

Problems with Specific Joints (Ref Chap 30)

Shoulder: Insertion of the rotator cuff tendon into the greater tuberosity makes it vulnerable to erosion by synovitis. Adhesive capsulitis or sub deltoid bursitis may be present.

Elbow: There is reduced range of movement. However preservation of maximum range is needed for activities for daily living like feeding or dressing (flexion) or reaching for over head activities (extension). Olecranon bursitis and lateral and medial epicondylitis (Tennis and golfers elbow) occur often, and are quite disabling.

Wrist and Hands: The deformities of the hands have been listed out earlier. Other than these there is ulnar deviation of the hand with weakness of the forearm intrinsic muscles, and a poor grip and pinch. Many patients find it difficult to open a tap or a vessel because of this. There is proliferation of the synovium at the wrist which increases pressure over the ligaments, tendons and cartilage. Sometimes the median nerve gets compressed in the wrist resulting in pain and paresthesiae over the hand – the classic carpal tunnel syndrome.

JUVENILE RHEUMATOID ARTHRITIS

It is a chronic connective tissue disorder (also called ***Stills disease***) affecting children. It may be classified as: pauci- articular, polyarticular and systemic.

Pauci-articular: Inflammation often begins in a single joint, and less than four joints are involved; The knee is involved very often. A major complication is inflammation of the anterior chamber of the eye (anterior uveitis).

Polyarticular: In about 40% of patients more than 4 joints are affected. There may be lymphadenopathy, hepatosplenomegaly, pericardial effusion and pleural effusion.

A small percentage of patients exhibit systemic symptoms like high spiking fever and a rash over the upper trunk.

Management of Juvenile Rheumatoid Arthritis

Objectives	*Management*
Increase child's and family's understanding of juvenile Rheumatoid arthritis	Education
Decrease inflammation	Drugs, thermal applications
Control or reduce pain	Drugs thermal applications, TENS
Increase and maintain range of motion and muscle strength	Exercise modalities, surgery Hydrotherapy
Encourage independence in daily activities	Adaptations for functional activities
Prevent depression and improve outlook on life	Psychological and psychosocial support
Maintain and optimize function	Rest, joint protection, splinting, positioning.

Therapeutic Exercises

Bedrest and immobilization are not required and should be avoided.

Hydrotherapy: Water play takes away the tedium of administering therapy to children. Group pool sessions also additionally develop team work and leadership skills.

Stretching of Soft Tissue Structures

There are two main types of stretching:
- Brief stretch
- Prolonged low load stretch for several hours (e.g. night splints)

Splints
- Resting splints for elbows, knees, wrists and hands.
- Dynamic splints for fingers.
- Serial splinting allows gradual correction of several contractures.

Systemic Lupus Erythematosus (SLE)

It is an inflammatory disease affecting many organs of the body characterized by the presence of auto antibodies in the serum.

Clinical Presentation

Many organ systems are involved in this and the presentation will vary depending on which system is involved first.

Skin: One of the characteristic finding is a butterfly rash on exposure to sunlight. It is seen on cheeks and across the bridge of the nose.

Musculoskeletal System: Patients with systemic lupus erythematosus complain of pain in the joints, which may be swollen, tender and inflamed. Joint involvement is fleeting and there is often remission without any deformity. Sometimes when joint involvement is chronic and persistent, deformities may set in, particularly occurring on the fingers producing a pattern known as ***Jaccoud's Arthropathy***. In most cases joint pain responds well to anti-inflammatory drugs.

Systemic Manifestations of SLE: The presence of skin ulcers may be due to Raynaud's syndrome and these respond to warmth. Patients with renal disease need medication for blood pressure control and management of edema. Other conditions are thrombocytopenia, pleurisy, vasculitis, peripheral neuropathy and pericarditis. Care must be taken to properly place the limbs in the functional position to limit contractures. Mild aerobic exercises are taught.

POLYMYOSITIS AND DERMATOMYOSITIS

These are conditions where muscles are weak and tender, with an onset over several weeks and sometimes after a systemic infection. Systemic symptoms like general weakness followed by muscle atrophy may be present.

Polymyositis

Muscles are painful and tender. Proximal muscles are first involved and initially weakness may be asymmetrical, e.g. gluteus maximus on one side only. Weakness of posterior neck muscles will result in head "lolling" forward. Occasionally weakness may spread into distal muscle groups. Pharyngeal and laryngeal involvement leads to difficulty in swallowing or dysphonia. There may be involvement of cardiac muscles. Eye muscles are usually not involved unless there is coexistent myasthenia gravis. Reflexes are retained.

Dermatomyositis

This condition is characterized by a violet discoloration of skin, and raised scaly erythematous rashes involving nose and cheeks, shoulders, or extensor surfaces of limbs and knuckles. Telangiectasis and tightening of skin are common and small ulcerated vascular lesions develop over bony prominences. There are two forms - child and adult. Muscle weakness is similar to polymyositis but may be more severe in children with difficulty in chewing, swallowing and breathing.

Rehabilitation

Since ambulation, mobility and self care will progressively decline, rehabilitation goals are aimed at maintaining these as long as possible. Weakness of pelvic girdle muscles lead to difficulty in rising from chair or climbing stairs.

Acute Phase
- Maintenance of range of motion.
- Avoiding joint contractures.

Recovery Phase
- To increase and maintain muscle strength
- To return to activities of daily living and restore previous lifestyle activities
- Collar may be given for support of neck to prevent lolling.

If respiratory muscle weakness is present
- Chest physiotherapy (breathing techniques)
- Postural drainage
- Suctioning
- Proper positioning

DEGENERATIVE ARTHROPATHIES

Osteoarthritis (Degenerative joint disease, osteoarthrosis) is characterized by thinning and destruction of the hyaline cartilage of joints, followed by remodeling of underlying bony surfaces. It is essentially non inflammatory. Stress on joints may be related to one's occupation. There are studies which show an increased prevalence of osteoarthritis of fingers, knees and elbows in dock workers. Some forms of osteoarthritis are genetically related.

Clinical Features

- Gradual onset with pain increasing over several years.
- Patients are usually past middle age.
- Joints affected early tend to be painful after sustained use.
- Movements become slowly restricted and rest will relieve pain.

OSTEOARTHRITIS KNEE

The medial compartment of the knee transmits a higher proportion of weight than the lateral compartment. As age advances, cartilage begins to wear out and as it degenerates, the stress of weight bearing frequently leads to narrowing of medial compartment. This may ultimately lead to genu varum, similar to bow legs where the knees curve outward.

Pathogenesis

Osteoarthritis may be due to abnormal stress to the aging joint with increased mechanical wear and tear (primary) and may also occur in post-traumatic mal alignment of joints (secondary).

Whatever the cause of osteoarthritis, ultimately the changes in articular cartilage are the same. Firstly the damage to the collagen fibres by mechanical stress results in decreased proteoglycans of the articular cartilage with reduced hydration or desiccation. Secondly, the repeated stress to the joint by walking results in micro trauma to the subchondral bone, eventually leading to eburnation, cartilage proliferation, proteoglycans synthesis, bony sclerosis and osteophyte formation. There is no bony ankylosis as in rheumatoid arthritis.

When articular cartilage has been damaged patients may complain of crepitus, or a grating sensation or audible crackling on movement of the patella over the joint. The joint between the patella and the femur, the patellofemoral joint undergoes compressive forces when rising from squatting position, climbing stairs, hills, which can aggravate pain. Thus, pain associated with osteoarthritis of knee will be worse on activities involving climbing, descending or prolonged standing. Most patients are female, elderly or fat. The prime muscle for stability in the knee, the quadriceps is wasted. OA is often associated with decreased bone density, osteoporosis, especially in women after menopause.

Management

Drugs: NSAIDs to reduce inflammation, glucosamine and chondroitin sulphate which are dietary supplements and diacerein, a more recent drug are said to be effective in treating the disease process, rather than just the pain. The ideal drug for treatment is yet to be invented.

Patient Education: Use of assistive devices, for example a knee brace, may reduce forces on damaged joints. Referral to a dietician may be important when there is obesity.

Surgery: Total knee replacement (Ref Chap 20) is gaining popularity amongst patients who have major damage in the joints, and expect an active lifestyle. It consists of replacing the diseased and painful joint surfaces of the knee with metal and a plastic component shaped to allow continued motion of the knee, and is proving to give a new lease of life to a lot of patients in India, where OA of the knee is commoner than other joints. Selection of the patients, who are inevitably old, will be determined by their immediate need, general condition to withstand the surgery and the ability to afford the operation.

Management of Specific Joints

Hip: Patient must maintain hip extension by lying in prone position for 30 to 40 minutes twice daily. An important goal is to maintain at least 20 degree flexion to assume normal gait.

Knee: Moderate to large effusions should be tapped and the fluid evacuated. Steroid or lignocaine can be instilled in some cases. Patient should avoid use of pillows under the knee because it encourages knee and hip flexion contracture.

Foot: The shoe needs to be a perfect fit and not too tight. A soft insert is added as an insole and if needed a metatarsal bar is given. Depending on the pressure relief required, a rocker bottom can be added to roll over in presence of a painful ankle.

Physiotherapy

- To control pain
- To prevent further strain or damage to affected joints
- To improve movements
- To improve muscle power
- To maintain and improve functional independence.
- To improve gait.

SERONEGATIVE SPONDYLARTHROPATHIES

ANKYLOSING SPONDYLITIS (FIGS 28.5 AND 28.6)

It is characterized by gradual development of inflammation of spine. It occurs in families containing the HLA B27 antigen.

Clinical Presentation

The onset of ankylosing spondylitis is insidious and is most frequently seen in males under 40. Symptoms usually start with pain and stiffness in the lower

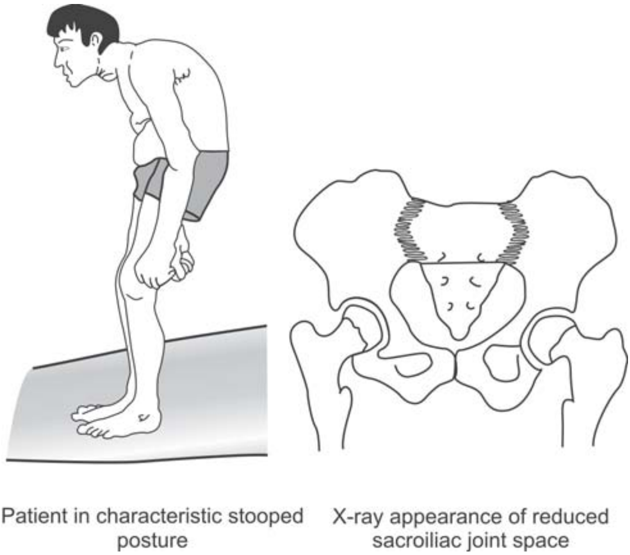


Figure 28.5: Ankylosing spondylosis

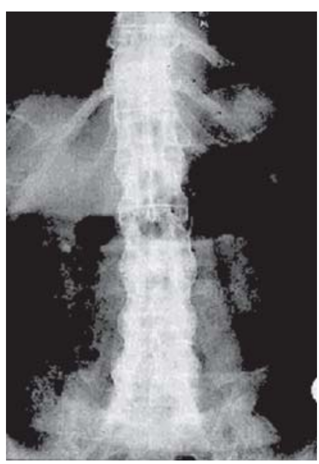


Figure 28.6: X-ray findings in ankylosing spondylosis showing bamboo spine

back, and are worse after a period of immobility and most severe in the morning.

Initially, stiffness is due to muscle spasm associated with underlying joint inflammation. Later, apophyseal joints develop fibrous or bony ankylosis and the spine looks like a bamboo on the x-ray. Finally, bony fusion between vertebrae may restrict all movements of spinal column. The spine takes the form of the number '7', with the sufferer adopting a rigid, stooped posture. A quarter of the patients developed enthesopathy and limitation of peripheral joint movement.

Aims of Management

- Inform the patient on the prognosis, and how it will affect his daily life
- Decrease pain and increase mobility
- Maintain and increase respiratory function
- Improve posture
- Increase strength and endurance
- Improve activities of daily living, by giving adaptations.

Pain Relief

Anti-inflammatory drugs: Oxyphenbutazone was once recommended as the drug of choice, now discontinued. Other analgesics and NSAIDs may be prescribed. Other electrotherapeutic modalities like IFT and ultrasound can reduce acute exacerbation of pain.

Mobility

Patients are taught to have at least 5 minutes of 'warm-up' prior to exercising, by applying a hot pack or preferably taking a warm shower followed by light arm movement or brisk walking. Swimming is excellent as an aerobic exercise as it moves almost all the joints. Target areas for stretching are short neck muscles, muscles around the pectoral girdle, hamstrings, hip flexors and spinal rotators.

Respiratory Function: Pain due to inflammation of costochondral joints or costovertebral joints may inhibit deep breathing. The sufferer should be encouraged to breathe deeply with resistance given by a towel or his hands with emphasis on full rib cage expansion.

Strength and Endurance: Muscle groups to be strengthened are spinal extensors shoulder retractors and hip extensors.

Posture: Postural awareness, correction and rhythmic stabilization are taught by telling the patient to touch the back of their heads to wall while standing against the wall. Prone lying, though difficult, is done for a period of 15 minutes or more every day.

Assistive Devices: Grabbers, dressing sticks and long handled shoe horns are given to patients who cannot reach their feet. For those car drivers with decreased neck movement, wide rear view mirrors are used.

DIFFUSE IDIOPATHIC SKELETAL HYPEROSTOSIS (DISH)

DISH (otherwise known as Forestier's disease) is a rarer type of degenerative arthritis where there is excessive bone growth along the sides of the vertebrae. There is inflammation and bony growth all over the body, especially where tendons and ligaments are attached to bone, such as at the heel or elbow.

Calcaneal spurs are commonly seen in the X rays of people with DISH. There is progressive reduction of the range in the neck and the patient finds it difficult to turn the neck and look to the side, or look down. This can go on till he is unable to turn in bed or bend and lift any objects. This stiffness and immobility spills into day to day activities like dressing and wearing shoes

PSORIATIC ARTHRITIS

Psoriasis is a relatively common skin condition presenting with erythematous lesions and silvery scales due to increased epidermal proliferation. Common areas are posterior aspect of elbows, anterior aspect of knees, low back and scalp.

Psoriatic arthritis is a common complication occurring in 5% of psoriasis cases. A number of HLA antigens are associated with psoriasis. When psoriatic patients carry the antigen HLA-B27, they are at high risk to develop psoriatic spondylitis. When they are positive for the antigen HA DR4 they are more liable to develop arthritis.

Patterns of Presentation

In the hands, the distal interphalangeal joints are prominently involved and associated with psoriatic nail involvement. There is progressive destruction of the joint surface with prominent bone destruction and resorption adjacent to the joint. The pattern of joint disease is variable and affects both sexes equally.

Group 1 – Classic psoriatic arthritis
Group 2 – Arthritis mutilans
Group 3 – Symmetric polyarthritis
Group 4 – Digoarticular arthritis
Group 5 – Psoriatic spondylitis

Management will be aimed at pain relief and mobility, and will include anti inflammatory drugs, analgesics and physiotherapy.

REITER'S SYNDROME

It is a seronegative arthritis consisting of a triad of

- ***Reactive arthritis:*** (Sometimes this is used as a synonym for Reiter's syndrome).
- Nonspecific urethritis and
- Conjunctivitis

Two types are recognized.

- Following a gastrointestinal infection (dysentery) with the bacterial organisms *Yersinia*, *Salmonella* or *Shigella*.
- After a an episode of nonspecific urethritis.

In both cases there is strong association with the presence of HLA-27 or closely related antigens. Joints of lower limb may be affected in asymmetrical patterns. Sometimes affliction may be monoarticular involving knee or hind foot. Plantar fascitis and tendinitis around ankle are common causes of pain. Dactylitis (sausage toe) with diffuse swelling, redness and pain may be present.

Other Manifestations

- Stomatitis
- Balanitis—ulcers and inflammation on the penis
- Keratoderma blennorrhagica—vesicles which fill in with caseous material found on the soles of the hands and feet
- Oral ulcers

Medical

- Acute severe stage—splinting and bed rest.
- Nonsteroidal anti-inflammatory drugs, intraarticular corticosteroids
- Urethritis—Tetracycline, Lincomycin.

Therapy: After achieving pain relief by conventional means, affected joints are treated by free exercise to maintain mobility and improve muscle power. Weight bearing walking aids can be used in the presence of severe pain.

CHAPTER 29

Rehabilitation of Fractures

In a world of increasing chaos and violence, accidents are becoming more common leading to injuries many of which cause fractures in the bone. ***Fractures*** are defined as a complete or incomplete interruption in the continuity of bone. An observation that the patient is unable to stand or walk after an injury or use the injured part, must always arouse suspicion of a fracture.

TYPES OF FRACTURE

Fractures may be subdivided, according to their aetiology, into three groups:

- ***Fractures caused by injury***—They may be due to:
  - *Direct violence:* With a direct force the bone breaks at the point of impact.
  - *Indirect violence:* The bone breaks at a distance from where the force is applied due to the force transmitted along the bone, e.g. fracture of clavicle after a fall on outstretched hand
- ***Fatigue fractures:*** Fatigue or stress fractures occur from repeated stress (e.g. March fracture).
- ***Pathological fractures:*** This is a fracture that occurs in a bone that is already weakened, or brittle due to a pathology like metastatic carcinoma, osteoporosis, Paget's disease of bone.

According to the Nature of Fracture

Closed Fracture: A fracture is closed or simple when there is no communication between the site of fracture and the exterior of the body.

Open Fracture: A fracture is open or compound when there is an external wound leading down to the site of fracture.

Fractures are often labeled by the pattern of the fracture surfaces.

- Spiral fractures
- Oblique fractures

- Transverse fractures
- Comminuted fractures (with more than two fragments)
- Compression fractures (common in the spine)
- Greenstick fractures (seen in children).

Common types of displacement are:
- Lateral displacement
- Over riding and shortening
- Rotation of one fragment over the other
- Angulation of one segment over the other

HEALING OF FRACTURES

- Stage of hematoma.
- Stage of subperiosteal and endosteal cellular proliferation.
- Stage of callus—the callus is a matrix of collagen and polysaccharide which soon becomes impregnated with calcium salts.
- Stage of consolidation
- The woven bone is gradually transformed into more mature bone.
- Remodeling stage.

Local Signs of Fracture

- Swelling and hemorrhage
- Deformity (e.g. dinner-fork deformity) (Fig. 29.1)
- Tenderness/muscle spasm
- Abnormal movement (It is advised not to elicit this finding clinically)
- Local warmth
- On movement of the fractured ends, there may be crepitation (It is advised not to elicit this finding clinically)

Investigations

An X-ray or CT/MRI scan needs to be taken to confirm the fracture. Sometimes the fracture is seen even at a different site from the site of impact. A high index of suspicion has to be maintained and it is better to rule out distant fractures, by taking a complete skeletal survey, because multiple fractures must not be missed when the patient may be unconscious.

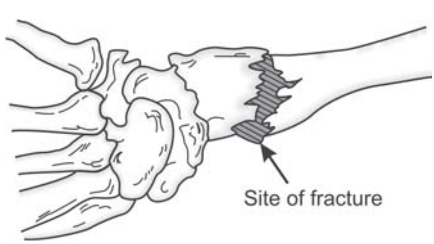


Figure 29.1: Dinner fork deformity in Colles' fracture

MANAGEMENT OF FRACTURES

The management of fractures is done by the team headed by the orthopedic surgeon. Recent advances in fracture management, like hip replacement, or shoulder replacement surgery has greatly reduced the morbidity associated with fractures. However the details of operative procedures are beyond the scope of this book.

Conservative Management

The surgeon achieves a closed reduction, and later maintains it in the reduced position. ***Reduction*** means aligning the fragments in fractures and maintaining them by immobilization with plaster of Paris casts or traction.

Duration of Immobilization

As a thumb rule, in children upper limb fractures unite in 3-4 weeks and lower limb fractures unite in 6-8 weeks. In adults, it takes a bit longer, with the upper limb fractures uniting in 6-8 weeks and lower limb fractures in 12-16 weeks.

Traction

Traction is simply longitudinal force applied to the body to achieve stability or change the position of the damaged part.

Skin traction: Provides generalized pull of the whole limb

Skeletal traction: The limb is placed within a splint like Thomas splint and a pull on the bone is exerted through a pin traversing it.

Gallow's traction: For treatment of fracture shaft femur in infants or reducing CHD, the child's body weight acts as counter traction.

Halo-pelvic traction: For the correction of spinal deformity.

Surgical Management

Open Reduction: Internal fixation immobilizes the bony fragments in a rigid matrix of screws and plates, which allows early mobilization, proper alignment and quicker restoration of function. In this operative procedure the orthopedic surgeon realigns the fragments, and fixes them with metallic implants. Screws alone are used to stabilize small fragments like medial malleolus of the ankle or the lateral condyle of humerus. Larger diaphyseal fractures like those of the radius and ulna of the forearm need plates and screws to fix them. Wires are used in the fixation of fractures of the patella and olecranon. Diaphyseal fractures in the lower limbs are stabilized with intramedullary nail fixation, e.g. fracture in the shaft of femur.

Of course the surgeon decides the procedure depending on several factors like weight bearing, stability extent of the fracture, age of the patient and osteoporosis.

Disadvantages: Internal fixation, involves open exploration surgically of the fracture site. This can lead to infection, if the environment is not sterile enough. Chronic osteomyelitis and non union can follow which makes the patient immobile and miserable. Delayed healing could be due to stripping of the periosteum during surgery that interferes with the blood supply to the fragments. Handling the soft tissues during the surgery also adds to the trauma and long term stiffness. However with advance of modern techniques of fixation, well equipped theatres, competent surgeons and more efficient anesthesia today, surgery is the first line of treatment today for most fractures. The benefits far outweigh the disadvantages.

External fixation: This is indicated when there is an open fracture, comminuted fracture, or when an implant is suspected to be infected. The fracture site is stabilized by several pins which are connected outside by rods. The most common among external fixators are AO fixators and Ilizarov fixator (Fig. 29.2). Precaution is to be taken to avoid infection of the pins.

Joint Replacement

Surgical techniques are improved to the extent that many joints like knee, shoulder can be replaced today. In certain cases the orthopedician decides to go in for a joint replacement using internal prosthesis, e.g. total replacement of the hip.

REHABILITATION

Principles

The patient is referred from the orthopedic department to the department of rehabilitation after surgery and after the surgeon determines that the patient is fit to be mobilized. The aims of rehabilitation after a fracture have to be explained to the patient to optimize the outcome.

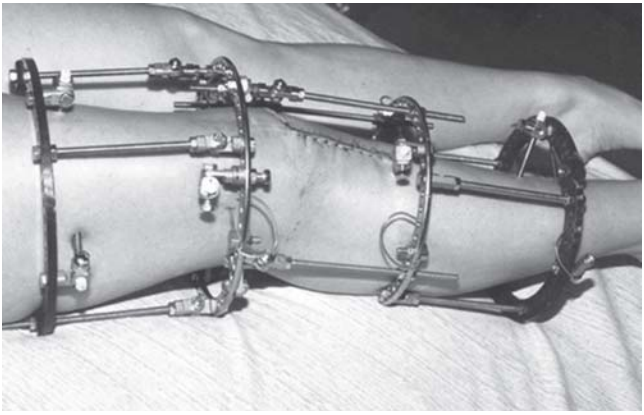


Figure 29.2: Ilizarov ring fixators

- The bone ends must be held in constant position together until healing occurs. To prevent further damage the patient is advised to maintain a position of rest during the healing phase for the affected part.
- To remove edema, extravasated blood and fluid must be removed by return flow. The soft tissues must be kept moving to prevent fibrosis and pain.
- Maintain normal movement, power and function of the rest of the body and to prevent complications due to prolonged immobilization.
- To maintain general health.
- To reduce pain, increase the arterial blood supply. Diathermy is not advisable in the early stages following fractures because it often causes increased pain by increasing blood flow.
- To enhance joint mobility.
- *Elevation:* Effective elevation is when the distal part of the extremity is above the proximal part and the proximal part above the level of the heart.

History

- Site, type of fracture
- Recording relevant information of cause of fracture, site, duration, any complications (like nerve paralysis, infection or contractures)
- Type of surgery done.

Assessment

An X-ray or scan is taken to confirm the union of the fracture properly
- Muscle power chart
- Joint range using goniometer (joints above and below the site of fracture.)
- Test sensations using pin prick or hot and cold test tubes.
- ADL chart.

Physiotherapy

General Aspects: Any of the following exercises singly or in combination can be used depending on the site, stage, duration or extent of the fracture and the age and goals of the patient.
- Free and progressive resisted exercises are given to the uninvolved joints and normal limbs using manual or mechanical resistance like pulleys, bands and weights.
- Passive mobilization.
- Proprioceptive neuromuscular facilitation PNF
- Continuous passive motion
- Suspension therapy
- Hydrotherapy.
- Grip strengthening by flexion and extension of fingers and thumb.

- Massage—the massage should be mild to relieve and certainly not aggravate pain and should be firm enough to reduce edema.
- Cryotherapy.
- Train in ADL's.
- Gait training.

Physiotherapy for Patients with Fractures of the Lower Limb

The incidence of hip fracture is increasing, since our aging population is on the rise. Inter-trochanteric fractures usually heal satisfactorily in about four months because the blood supply is adequate. In intracapsular fractures, nonunion is frequent because the major portion of the blood supply is cut off. The principles are to prevent flexion contracture of hip and knee and to maintain full movement of foot and ankle. In a hospital set up, there are machines that provide passive range of movement to the hip and knee (***continuous passive motion machine***) (Fig. 29.3). Other exercises given include:
- Hydrotherapy.
- Re-education, gravity eliminated and suspension exercises, abduction and adduction of hip.
- Isometric exercises for gluteal and quadriceps muscles
- Free and assisted movement in gravity eliminated positions and against gravity.
- Active ROM for foot/ankle

Occupational Therapy

Training in activities to develop independence, such as:
- Getting in and out of bed
- Standing to sitting in chair and vice versa
- Dressing
- Toilet training
- Gait training

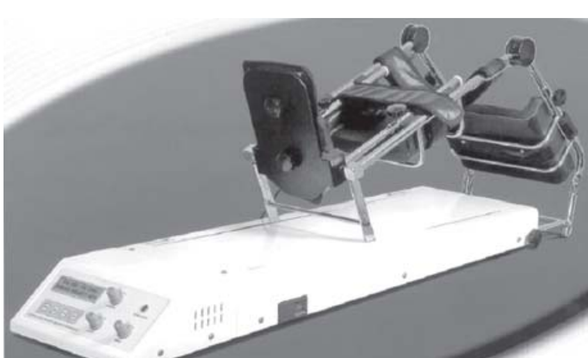


Figure 29.3: Continuous passive motion apparatus (*Courtesy:* Electrocare System and Services)

- Climbing steps/ramps
- Getting in and out of vehicles.

Gait Training

The walking aids are used are walkers, canes, axillary, elbow and gutter crutches.

- Initially, gait training is started by non weight bearing on axillary crutches or walker. Three point gait is taught with axillary crutches with gradual increase of weight on the affected side.
- Then partial weight bearing (PWB) is trained on axillary/elbow crutches.
- When the patient is in full weight bearing on his legs, gradually discard aids.

Functional Cast Braces

Bracing the fracture part in the closed method of reduction prevents the development of secondary joint stiffness, promotes osteogenesis and soft tissue healing. The functional cast brace allows movement of the joints and the load is transmitted through the muscles in the cast. On movement and weight bearing the muscle forces are driven inwards towards the fracture and not outwards; this keeps the fracture site firm. The muscle forces control the fracture fragments and resist any overriding or angulation until union occurs.

These are usually indicated in the middle or late phases of immobilization of fracture tibia and fracture femur.

Complications After a Fracture

Bone

- Avascular necrosis
- Non-union
- Mal-union
- Delayed union
- Osteomyelitis

Joints

- Adhesions
- Sudeck's atrophy
- Stiffness

Muscle and tendon

- Myositis ossificans
- Muscle wasting
- Post-traumatic tendinitis

Nerve

- Neuropraxia

- Axonotmesis
- Neurotmesis

Artery—impaired blood supply.

MYOSITIS OSSIFICANS

Myositis ossificans or heterotopic ossification is growth of new bone outside existing bone, but not related to cancer. This is very common around the elbow joint. It may appear after trauma, or as a rare, inherited disorder called progressive myositis where ossification of muscle, tendon and ligaments all over the body can happen that is very disabling. It is also seen in paraplegics as a complication.

It shows up as a swelling with pain one to two weeks after injury. The ESR and serum alkaline phosphatase are increased. On the X-ray the lesion begins to calcify at the periphery and works toward the center. The cause is thought to be an organizing hematoma, osteoblastic activity or metaplasia of connective tissues.

Treatment for myositis ossificans is conservative. Surgery in the beginning is contraindicated. Excision of the mass can be done when there is no evident bone activity.

Physiotherapy

The involved part is wrapped in insulating material to prevent heat loss. Mobilization is avoided. Two or more months of treatment are usually needed.

REFLEX SYMPATHETIC DYSTROPHY

RSD is a chronic neurological syndrome, of unknown cause characterized by:
- Hypersensitivity to touch
- Severe burning pain
- Swelling of the tissues
- Excessive sweating
- Pathological changes in bone and skin, like atrophy and pallor

There are two types. The type I RSD where nerve damage cannot be demonstrated is called ***Complex Regional pain syndrome***. Where a nerve is traumatized, it is Type II or Causalgia. It is thought to be a condition where healing does not take a normal course. The autonomic nervous system is believed to be involved. There is a decreased range of motion, increased redness and vasomotor instability, trophic skin changes, and localized osteoporosis. X-ray studies often show marked bone atrophy with a patchy distribution.

It is seen in the following stages:

Stage 1—acute: There is a burning pain, with ill defined edema, due to vasomotor changes in the hand and fingers. There is increased nail and hair growth and sweating. This phase lasts three to six months.

Stage 2—dystrophic: This pain intensifies and spreads proximally. There is atrophy of the skin and muscle with edema and atrophy of nails stiffness of the joints and mottled skin. This phase lasts from three to six months.

Stage 3—atrophic: in the final stage, the pain is not so much, but the hand looks pale and blue, the skin is smooth and shiny with wasting of muscles. Flexion contractures set in the shoulder elbow and wrist with demineralization of bone.

Etiology: Since it results from even minor trauma to the upper limb, hemiplegia, or myocardial infarction, there is no specific cause that can be ascertained. It is thought to be due to sympathomimetic transmitters causing nociceptive stimuli. Another theory is that an innocuous injury activates pain fibers through the central pain-signaling system. Over a period, efferent sympathetic fibers activate these pain fibers resulting in chronic pain.

Treatment: Systemic corticosteroids, nonsteroidal anti-inflammatory agents, local application of heat are given as a first line of treatment. The pain and disability due to RSD may be reduced by blocking the sympathetic ganglia supplying the area with local anesthetics, if there is no response. Active exercises lead to an increase in strength and range of movement. Exercising, manual mobilization, stellate ganglion block, or intrathecal pain drug delivery are the other physical or surgical means of management. Achieving complete remission is a challenging task.

VOLKMANN'S ISCHEMIC CONTRACTURE (VIC) (FIG. 29.4)

It is an ischemic necrosis of structures contained within the volar compartment of the forearm. VIC is due to the infarction produced by an arterial spasm with

Figure 29.4: Volkmann's ischemic contracture

reflex spasm of the collateral circulation. This produces ischemia of the muscle bellies which results in necrosis and is later replaced by fibrous tissue causing contractures. Fibrosis and contracture of the flexor compartment of the forearm causes finger flexion and the wrist into flexion and pronation. However, when the wrist is passively flexed, active extension of the fingers is possible; showing that the contracture is in the forearm. The reverse is also true: the Volkmann's sign consists of extending the wrist which exaggerates the flexion deformities of fingers and on flexion of the wrist the deformities appear less prominent.

Incidence and Etiology

Supracondylar fracture is the most common cause in children while crush injuries of the forearm are the most common causes in adults. Occasionally VIC can happen after fracture both bones forearm. A classical claw hand deformity results.

Management

The use of a whirlpool bath followed by massage to the paralyzed muscles should be started at once. Electrical stimulation can also be tried. A pancake splint with a malleable wrist section may be adjusted to maintain the length of the flexor muscles as it increases with intensive treatment.

In the mild type
- Dynamic splinting
- Physiotherapy – stretching to the flexors.
- Total excision if single muscle in involved.

In the moderate type
- Neurolysis
- Tendon transfers

In severe cases the following are performed
- Excision of the scar
  Seddon's carpectomy

PATHOLOGICAL FRACTURES

This is a fracture common in elderly persons occurring in a diseased bone and is usually spontaneous. The bone may be weakened due to a generalized disorder like Osteoporosis (ref Chap 30) or a localized lesion in it. Even a trivial incident, like sitting down heavily could result in pathological fracture.

Conditions where it can occur
- Generalized bone disease – steoporosis/osteopenia.
- Tumors of bone – Osteosarcoma.
- Infection of bone – Osteomyelitis
- Paget's disease

Common pathological fracture sites

- Fracture neck of femur
- Vertebral crush fracture
- Fractures around shoulder (Surgical neck of humerus)
- Colle's fracture
- Sub capital fracture of radius
- Fracture pelvis, etc.

Fracture Spine

Compression fractures of the spine usually result from falling from a chair in a sitting position on the floor, especially in old people. This combination of bending forward and upward pressure on the spine from the floor can cause compression fractures of the spine usually at the bottom part of the thoracic spine (T11 and T12) and the first vertebra of the lumbar spine (L1). This is because the head goes forward at the same time the lower part of the spine hits the floor. The spine bending forward puts pressure on the anterior part of the spine, resulting often in collapse of the front (anterior) part of the vertebral body forming a wedge shaped fracture. This can be maintained in hyperextension by an anterior hyperextension brace. Osteoporosis is one of the main risks for fractures of this kind.

Management

Patients are usually prevented from bearing weight, and are usually confined to bed. Spinal braces are given. Calcium supplements and drugs to increase calcium uptake are the mainstay of treatment while the bone heals.

CHAPTER 30

Common Pain Syndromes

LOW BACK PAIN

Low back pain is one of the most common ailments ever, accounting for about 80 percent of the population at some point in their lives. Backache is a work related problem more common than neck pain. The anatomical structure of the spinal curvature at the cervical and lumbar region where a mobile segment meets an immobile segment (sacrum), and where the lumbar lordosis merges into the sacral spine, makes it more susceptible to damage and, therefore pain.

Common Causes

- Postural – Most common
- Trauma – Lumbosacral strain, fracture of lumbar vertebrae
- Disc prolapse
- Degenerative disease – Lumbar spondylosis (Fig. 30.1)
- Structural lesions of spine – Spondylolisthesis, spondylolysis, spinal canal stenosis

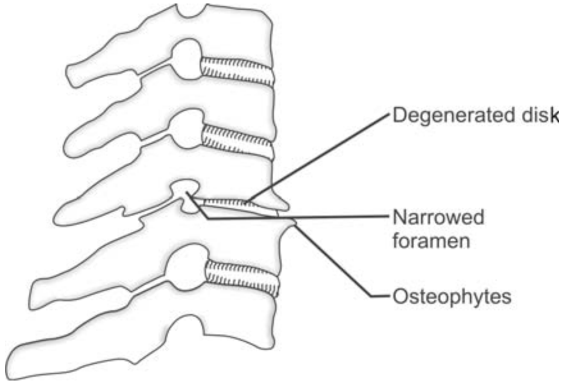


Figure 30.1: Spondylosis as a cause of low backache

- Tumors
- Inflammatory – Ankylosing spondylitis, Facetal joint arthritis
- Metabolic – Osteoporosis
- Others – Obesity, pregnancy occupational strain, etc.

Management

For acute back sprain, absolute bed rest is essential.

- ***Medical management:*** Non-steroidal anti-inflammatory drugs (NSAIDs)
- ***Surgical:*** Depending upon the cause of back pain surgical treatment can be planned. For example, in disc herniation percutaneous diskectomy can be performed.
- ***Physiotherapy:*** For acute back sprain, pain relieving modalities, such as interferential therapy, ultrasound or short wave diathermy can be given. Pelvic traction (Intermittent or continuous), depending on the cause of backache can be given. Some physiatrists prescribe a lumbosacral belt, and also abdominal supports in postoperative cases or postnatal cases. Later spinal muscle strengthening exercises are taught along with postural advice, such as not to bend forwards with hip and knee extended, while attempting to pick objects from the floor
- ***Postural advice*** to the patient on sitting at work, standing or lifting.

NECK PAIN (FIG. 30.2)

This is the second most common regional pain syndrome next to backache and is also an occupation related problem especially after the advent of computers. Cervical spine disorders usually interfere with the neurovascular structures of the upper limb producing referred pain and motor symptoms.

Causes

- Degenerative joint disease
- Cervical muscle strain
- Cervical spondylosis
- Cervical disc prolapse
- Cervical rib
- Cervical Spondylolisthesis
- ***Posture*** – This is assuming epidemic proportions because of the huge proportion of the working population sitting in front of the monitor for long duration.

Cervical kyphosis: Normally there is a (convex forward) curve in the cervical spine, which, by prolonged maintenance in forward position, straightens till the lordotic curve is obliterated. Cervical kyphosis can progress to the point where the curve in the neck actually reverses, going in the opposite direction

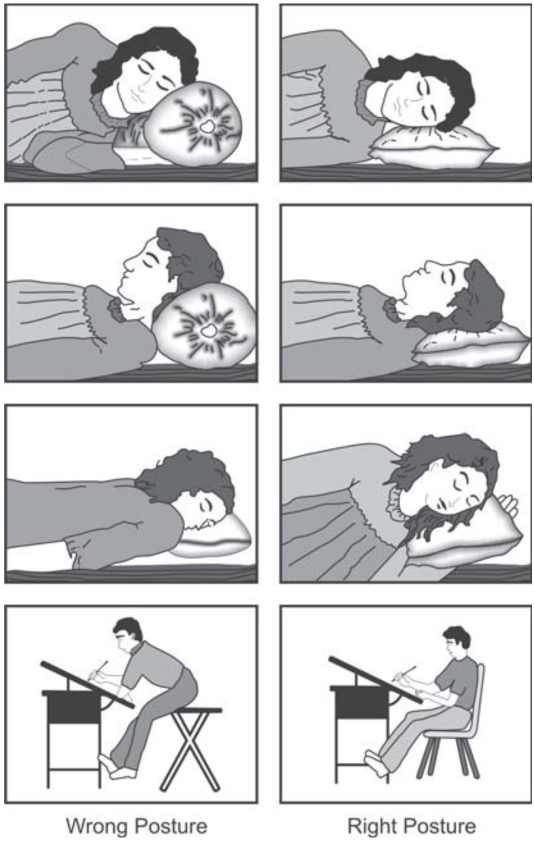


Figure 30.2: Correct and incorrect positioning to prevent back and neck pain

from its normal, so that the curve becomes actually concave forward causing neck pain. This is sometimes called the ***forward bent syndrome***.

Double crush syndrome: This is a new term to signify radiating pain or pain at different locations along the course of a nerve due to an entrapment or irritation at two or more anatomical sites. This means that a confusing clinical picture can present itself when nerves being irritated up in the neck or at some proximal location like the thoracic outlet (in the shoulder) can also be entrapped at a distal location like the carpal tunnel or ulnar entrapment at the elbow. Treatment of the carpal tunnel syndrome does not relieve the symptoms because of a lesion higher up.

Cervicobrachial neuralgia: Cervicobrachial neuralgia occurs in a large percentage of people in the 5th and 6th decades. The underlying pathology is often cervical spondylosis. The symptoms are neck stiffness, pain radiating from neck down to the upper limb and segmental paresthesia of the neck, arm and fingers; sometimes the pain may be referred to the occipital region or the shoulder. There may be numbness or pin and needle sensation in the finger tips and the deep tendon jerks slightly diminished. Some patients find relief by placing the affected hands on their own head in an adducted and internally rotated position.

Management

- Neck care and postural advice such as wearing a soft cervical collar or advising butterfly pillow for the neck. Work place modification (Fig. 30.3).
- Cervical diskectomy in cervical disk prolapse.
- Medical-non steroidal anti-inflammatory drugs.
- Physiotherapy (cervical traction, interferential therapy, ultrasound and diathermy).

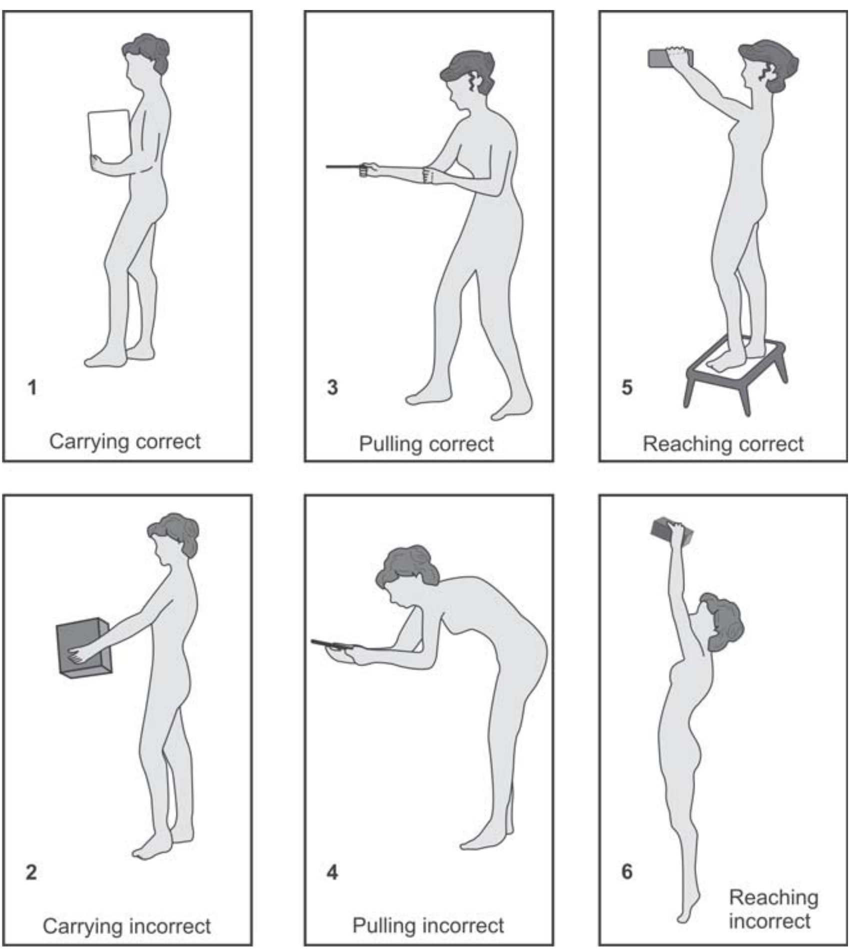


Figure 30.3: Correct and incorrect positioning to prevent back pain

TENNIS ELBOW

It is otherwise called ***lateral epicondylitis***; which is an inflammation of the common wrist extensor origin. It is common in tennis players and caused by micro tear of the common extensor origin due to repeated strain.

Clinical Findings

There is local tenderness at the common extensor origin from the lateral epicondyle with pain also at the back of forearm. Pain increases with resisted extension of the wrist in full elbow extension (Cozen Test)

Management

Conservative:

- Rest to the elbow (splinting may be used)
- Ultrasound to the common extensor origin.
- Local hydrocortisone infiltration.
- Stretching exercises to the wrist extensor at a later stage.

Surgical : In severe pain lasting more than 6 weeks and not responding to conservative treatment, release of the attachment of muscles to the epicondyle may be indicated.

GOLFER'S ELBOW

It is otherwise known as ***medial epicondylitis***. It is similar to tennis elbow but the pain originates from the medial epicondyle, i.e. common flexor origin. Pain increases on resisted wrist and finger flexion in pronation. Tenderness may be elicited at and around the medial epicondyle.

Treatment:

- Rest to elbow
- Ultrasonic massage to the common flexor origin
- Stretching exercises to wrist and flexors.

DE QUERVAIN'S DISEASE

It is the tenosynovitis of the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons. Pain usually is located at the base of thumb near the palmar side of the anatomical snuff box. There may be signs of inflammation at the base of thumb.

Causes

- Repeated stress injury to the wrist.
- Also seen in rheumatoid arthritis and other seronegative arthritides.

Finkelstein's Test: It is a test performed to diagnose de Quervain's tenosynovitis by asking the patient to touch the thumb to base of the little finger and fold other fingers around the thumb to make fist. Sudden ulnar deviation of the wrist elicits pain at the base of thumb.

Management

- NSAIDs
- Ultrasonic massage to the involved tendons.
- Splinting and rest to the wrist and thumb

PAIN IN THE SHOULDER

It is the pain due to inflammation of structures around the shoulder joint.

Causes

- Trauma around the shoulder, e.g. fracture and dislocation.
- Bicipital tendinitis
- Subacromial bursitis
- Frozen shoulder – (adhesive capsulitis, Periarthritis)
- Supraspinatus tendinitis

Clinical Findings

There is pain and restriction of shoulder movements such as abduction and lateral rotation and overhead activities. The structures involved may be the capsule, tendinous cuff, and muscles which undergo inflammation.

Painful arc syndrome: This is used to elicit supraspinatus syndrome, i.e. pain occurs in the impingement zone between 60° to 120° of abduction while the rest of movements are painless. The arm 'drops' when returning down after abduction above the head.

Adhesive Capsulitis (Frozen Shoulder, Periarthritis)

It is a condition of uncertain etiology that is characterized by progressive restriction of active and passive shoulder motion, usually without any demonstrable pathology. It is very often associated with diabetes. Shoulder pain because of adhesive capsulitis is felt mostly at night and at the extremes of range of motion of the shoulder. The movements of abduction and external rotation (e.g. combing one's hair] or extension and internal rotation (e.g. reaching for a purse behind] aggravate symptoms. Later the pain is constantly present. The pain precedes the contracture and often resolves before the contracture does. There is progressive loss of active and passive ROM more in external rotation than abduction or internal rotation. In India where the left hand is used for toileting purposes, the patients often come to the doctor when this important function cannot be performed. In some there is an associated autonomic sympathetic dysfunction in the upper extremities and shoulder hand syndrome may also be present. It is said that shoulder pain is the third most common cause of musculoskeletal disability after low back pain and neck pain. Nearly half of all type 1 diabetics are at risk of developing adhesive capsulitis. It may affect both shoulders, sometimes even simultaneously. Many cases of stroke develop painful stiffening of their shoulders.

Factors that increase pain: stress, exposure to cold or vibration. Risk factors are trauma, diabetes, thyroid disease, and dyslipidemia. Sometimes the trauma may be very minor, like throwing a small pebble in to the water.

Clinical Phases

Phase 1: The painful phase; the patient describes a slow onset of predominantly night pain, usually without a precipitating factor. Rest pain may be present at a later stage.

Phase 2: The frozen, or adhesive phase; the earlier pain may decrease but progressive reduction in ROM occurs in all movements.

Phase 3 is a recovery phase when, after about 9 months to a year there is reducing pain and return of ROM.

Management

Medical:
- NSAIDs
- Active shoulder mobilization exercises within the pain free range.
- Pain relieving modalities such as short wave diathermy, ultrasound therapy.
- Passive shoulder mobilization exercises when the pain has subsided.
- In frozen shoulder, exercises can be performed but manipulation under general anesthesia can be tried in resistant cases.

Surgical: When conservative treatment fails after 3 months, excision of adhesions, arthrodesis or arthroplasty may be indicated. Pain relief by local steroid injection is useful. For functional activities, shoulder must have 30-45 degree flexion, and 10 degree internal rotation. Strengthening exercises for deltoid are often prescribed.

Self-help: Patients are asked to avoid over reaching, like reaching behind to open a car door, repetitive overhead activities and movements such as mopping and sweeping. When these are unavoidable, long handled, light weight or power tools can be used.

Bicipital Tendinitis

It is an inflammation of the long head of biceps commonly presenting with anterior shoulder pain. The tendinitis is at the site anteriorly where the exposed tendon of the biceps passes through the bicipital groove and inserts onto the superior aspect of the glenohumeral joint. It is also associated with periarthritis or supraspinatus syndrome. Repeated shoulder strain or wear and tear such as carrying heavy objects or working on a lathe can predispose to bicipital tendinitis.

Clinical Finding: Bicipital tendinitis is suspected when athletes such as cricket bowlers, swimmers, or tennis enthusiasts complain of pain on the anterior joint line of shoulder after overhead overuse of the shoulder. Pain increases with active shoulder movement.

Yergason's Test for Bicipital Tendinitis: Resisted supination of forearm when the elbow is flexed to 90° and held at the side provokes pain in the long head of biceps tendon in the anterior compartment of the shoulder.

Management: Ultrasonic massage to the tender area, interferential therapy, or shortwave diathermy to shoulder. Local corticosteroid infiltration is often tried.

PLANTAR FASCIITIS

It is the inflammation of the plantar fascia of the foot with pain at its insertion, also seen in gout, rheumatoid arthritis, etc. It is one of the causes for heel pain. It is also common in persons who stand for long hours, like teachers or policemen.

Clinical Findings

Plantar fascitis presents as pain and tenderness at the insertion of plantar fascia [tubercles of calcaneum] which may also spread along the course of the plantar fascia. At times pain is felt at the balls of the toes while walking or standing. Pain is worst in the early morning while getting out of bed. Repeated attacks of plantar fascitis can lead to calcaneal spur, a calcified projection on the lower calcaneum.

Management

- NSAIDs
- Microcellular rubber slippers (MCR) or ones made of microcellular polymer
- Intrinsic foot muscle exercises.
- Ultrasonic therapy to the tender area and shortwave diathermy to the foot.
- Local corticosteroid infiltration is often tried

In severe/chronic plantar fasciitis which fails to respond to conservative treatment, surgical release of the plantar fascia through a proximal medial longitudinal arch incision can be planned.

OSTEOPOROSIS

Osteoporosis is reduction of bone tissue density that increases its susceptibility to fracture. A Bone Mineral Density exam or DEXA scan can indicate when osteoporosis is present. According to the WHO definition, a patient is osteoporotic if the patient's BMD is 2.5 standard deviations (SDs) below typical peak bone mass.

Osteoporosis can further be classified into primary secondary and rare forms of osteoporosis. (1) involutional, or primary, osteoporosis, in which no underlying cause can be identified; (2) secondary osteoporosis, in which the underlying cause (e.g., steroid use) is known; and (3) There are rare forms of the disease, such as pregnancy related, or juvenile osteoporosis. The common sites of fracture are the hip, spine, and wrist. Hip and spine fractures can make the patient bedridden for life. While women are four times more likely than men to develop the disease, men can also have osteoporosis. Estrogen which is protective to the bone is deficient in women above menopausal age and this deficiency induces increased generation and activity of osteoclasts. The osteoclasts which are bone destroying cells perforate bone trabeculae, reducing their strength and increasing fracture risk. For these reasons, accurate osteoporosis screening is crucial for preventing this disease. Very often people go through life without knowing that their bones are brittle and prone to fractures.

Clinical Presentation

The patient complains of back pain, or stooping, and the incidence of multiple fractures, especially with minor trauma usually of the vertebrae, wrists, and hips should arouse a suspicion of osteoporosis. Compression fractures are most commonly located between the end of the thoracic spine and the beginning of the lumbar spine (T8 – L3). The majority of hip fractures occur at home after a fall in the bathroom.

Prevention: Estrogens as a replacement therapy to females are also effective agents in the prevention of postmenopausal bone loss. Bone metabolism is dependent on regular exercise and activity which maintains structure and remodeling. Lack of exercise leads to bone loss.

Calcium: Calcium is an essential mineral in the control of several intracellular processes in the nerve and muscle, and a major component in bone mineralization. It is absorbed from the gut and Vitamin D is one of the trace vitamins essential for this process. Calcium is then carried by the blood to bone, where it is deposited in the bone matrix in the process of calcification. Calcium need is the most during adolescence, pregnancy, and old age, when the absorption becomes compromised. The recommended dietary allowances for calcium are up to 1200 mg/day for adolescents and for pregnant women, 1000 mg/day for children and 800 mg/day for adults. Foods rich in calcium include egg, milk and ragi. Alendronate acts by inhibiting osteoclast-mediated bone-resorption.

Secondary Osteoporosis: Causes of Secondary osteoporosis include Cushing's syndrome, hypergonadism, hyperthyroidism, and primary hyperparathyroidism. Corticosteroid induced osteoporosis is the most common form of secondary osteoporosis.

Complete immobilization of the whole body or of an extremity leads to osteoporosis. The bone loss accelerates at about 4 percent per month during the initial phase of bed rest. Patients with diffuse osteoporosis secondary to immobilization could lose up to 30 or 40 percent of their total bone over a relatively short period of time.

REPETITIVE STRAIN INJURY

In the last two decades, it has been observed that lakhs of healthy computer users have developed and are developing a ***painful debilitating*** and sometimes ***disabling*** condition known as ***RSI (Repetitive Strain injury)***. This condition has been described by The Occupational Safety and Health Administration (OSHA) as ***"the most important occupational safety and health problem in the United States today."*** RSI is not a diagnostic term or a disease. It is an umbrella term referring to work-related symptoms in computer users caused by continuous work in a ***static posture. Super imposed on this static posture are*** highly ***repetitive actions***, such as typing on a keyboard, which gives it the name repetitive strain injury or occupational over use syndrome or repetitive movement disorders. RSIs are not easy to diagnose owing to the multi factorial etiology and the lack of a single investigative procedure to confirm the diagnosis. It is a diffuse disorder of soft tissues muscle, fascia, tendons and neurovascular structures. Nearly a quarter of all computer users worldwide (vocational and leisure related) are estimated to have RSI. In India statistical surveys reveal that up to 75% of the population working in the IT, BPO and call center industry are at risk and exhibiting symptoms of RSI. RSI is not unique to computer users but also prevalent in manual workers.

Predisposing Ergonomic Factors

- Lack of appropriate breaks
- Poorly fitting furniture
- Mouse, keyboard or monitor too high (or too low)
- Direct mechanical pressure on tissues
- Resting the arm or wrist on a hard surface while typing
- Cold work environment
- Basic inadequacies of keyboard, monitor and workstation design
- Work organizational and psychosocial issues

Predisposing Postural Factors

- "Static loading" or holding a posture which promotes muscle tension for a long period

- Head forward position (this could be due to the monitor being far away, or the font size being too small, or just refractory errors of the eye not being corrected)
- Rounded back
- Protracted shoulders
- Prolonged repetitive, forceful, or awkward hand movements
- Bizarre leg positioning (behind and under the seat or sometimes on the workbench in front !)

Symptoms

When the computer user starts developing pain in the ***neck*** and ***upper limb*** (shoulder, arm, elbow, forearm, wrist, hand) he or she should be aware that it could be the beginning of RSI. It need not be pain but even burning, numbness, stiffness, tingling in the fingers, arms, shoulder, neck or back. Some patients complain of a constant need to stretch or massage one's arms, heaviness or weakness in hands or forearms.

RSI can be staged according to its severity. The initial stage is when the person develops pain during the day which vanishes whenever he takes a break. Stage two is when the pain comes on during the day and does not recede till he goes back home. If however he neglects these red flags he goes in to stage three which is constant pain, irrespective of the time of the day or the posture. This is because slow accumulation of injury occurs with gradual development of difficulty in day-to-day activities

Disorders Classified Under RSI

A whole lot of disorders of the musculoskeletal system are classified under RSI, and could be due to purely ergonomic factors; the list is growing and can never be complete.

- Tendinitis,
- Bursitis,
- Tenosynovitis,
- De Quervain's Syndrome
- Thoracic Outlet Syndrome
- Trigger Finger/Thumb,
- Myofascial Pain Syndrome
- Carpal tunnel syndrome
- Medial Epicondylitis
- Tremors
- Scalenus anterior tenderness stiffness
- Trapezius tenderness/stiffness
- Supraspinatus tendinitis
- Acromioclavicular degeneration

- Cubital Tunnel Syndrome
- Lateral Epicondylitis

ERGONOMICS

There is growing awareness of the scale of work-related ill health linked to musculoskeletal disorders and stress. Ergonomics is concerned with the 'fit' between people and their work, the branch of science that assesses human anthropometric measurements and abilities and then applies that knowledge to improve people's interaction with products, systems and environment. ***It is the science of fitting the job to the worker and vice versa.*** Of course more emphasis has to be given to modifying the work station and then training the person to use it or modify it. Unfortunately in India the awareness of RSI and its impact on health is very poor. Corporates too do not give the necessary importance to this condition unless it impacts their bottom line.

Management of RSI

Arrangement of the work station (Fig. 30.4): The position of the chair, the monitor, lighting and the contour of the desk are all taken into consideration. The Occupational Safety and Health Administration (OSHA) has put out guidelines, not only for office ergonomics but for various occupations such as load handling, mining and agriculture related occupations

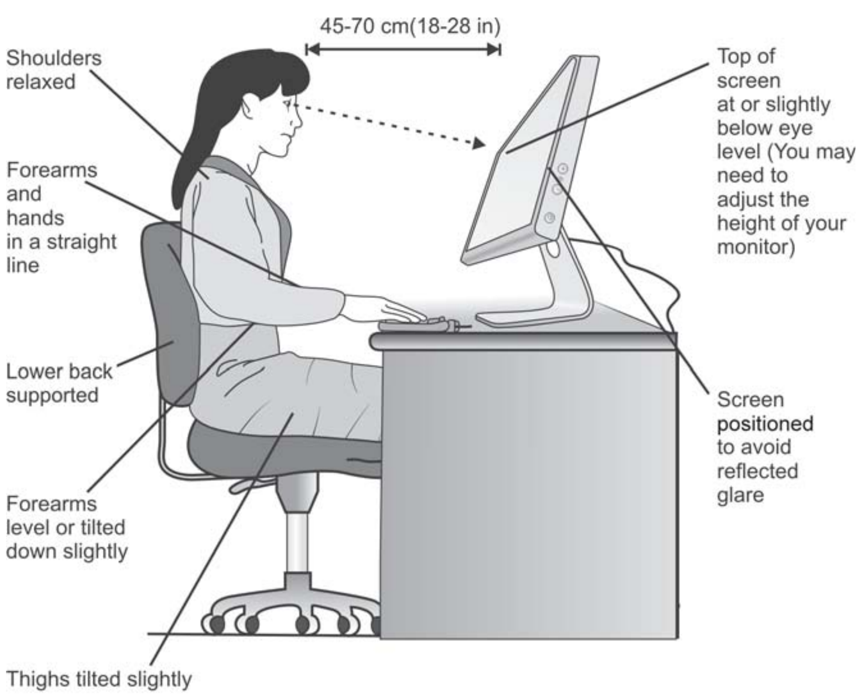


Figure 30.4: Posture at work on the computer

Relative rest: Relative rest really means avoiding pain-producing activities.

Occupational therapy and work hardening: The worker does not get back to full productivity or work load. Instead a graduated, incremental method for returning to full work and daily activities is implemented to avoid a recurrence. This concept is called ***work hardening*** in the field of occupational medicine. The worker starts working at a slower pace and intensity and later the time at work gradually increases while the rest periods gradually decrease. However, the work periods shouldn't increase beyond about 50 minutes, and the rest periods shouldn't fall below five or ten minutes

The World Health Organization has characterized "work-related" diseases as multifactorial to indicate that a number of risk factors contribute to causing these diseases (WHO 1985). One important reason for the difficulty in diagnosing work-related MSDs is their multifactorial nature.

Exercise: Exercise is one of the key elements in the successful outcome of an ergonomics program. It is recommended by OSHA that the computer user should move around about 5 minutes every hour during intensive computer use. He or she must stretch; use recommended stretching exercises called ***computer break exercises***, shift positions frequently and vary the work routines, for example, try to mix non-computer work with computer work.

Many companies provide facilities so that their employees participate in a regular fitness program away from work. There are Ergonomists who visit work site, suggest changes to the work station and training programs to the employees.

Computer break exercises are prescribed to prevent RSI. These are simple stretches to the neck, like neck nods or neck rotation, shoulder sway or shoulder shrug, and stretches to the elbow and hand that can be done even in the office in front of the computer

CONCLUSION

Ergonomics is not new. The first reference by the Father of Occupational Health, Bernardino Rammazzini, in his book DeMorbis Artificu, way back in 1700 AD, identified that occupation has a major impact on ones health. In his words " I assign certain violent and irregular motions and unnatural postures of the body, by reason of which the natural structure of the living machine is so impaired that serious diseases gradually develop there from", he has clearly assigned the causes of many diseases to posture and movement. During the industrial revolution when people were performing repetitive movements it was noticed that they were more susceptible to pain. Now it is the computer revolution and the impact is seen more and more in the younger generation.

With computers coming to stay it is vital to impart training to the employees at the induction level or at training sessions to maintain a healthy work force.

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