DYNAMIC NEUROMUSCULAR STABILIZATION

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Summary

Functional, dynamic and integrated postural stability is a prerequisite for optimal movement and performance whether during activities of daily living; in an elite athletic environment or in the recovery of neurology or orthopaedic patients.

Dynamic Neuromuscular Stabilization provides an assessment and treatment & rehabilitation approach to the neurology patient both integrates core stability prior to movement, optimal stability during movement and so improved overall functionality.

Key words

Dynamic Neuromuscular Stabilization, Posture, Postural-Locomotion Function, Postural-Respiration Function, Functional Postural Tests, Exercise in Developmental Positions, Functional Joint centration, Integrated Spinal Stabilisation System

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Introduction

Dynamic Neuromuscular Stabilization is a ground-breaking approach to rehabilitation being adopted by an increasing number of scientists and clinicians who believe it helps achieve superior results.

It aims to change global function, improve trunk stability essential for movement and balance, essential for daily tasks and independence but also long lasting improvement in function and pain relief.

Devised and developed by Professor Pavel Kolar a specialist in physiotherapy and greatly influenced by Czech neurologists Karel Lewit, Vaclav Vojta, Vladimir Janda and Frantisek Vele. This next-generation approach has been shown to activate the body's own integrated stabilising system. The process leads to faster and long-term improvement of function. Dynamic Neuromuscular Stabilization (DNS) – which is being used effectively alongside traditional methods – is based on developmental movement patterns and aims to restore function by mimicking the postures a child takes as it learns to roll over, crawl and stand upright.

Unlike many traditional approaches, DNS helps restore ideal muscle coordination of the integrated stabilisation system by prompting a full body – global – motor pattern, essential for the control of posture and spinal stability throughout life.

The DNS approach aims to exploit the plasticity of the brain and reactivate the patient's dormant natural motor pattern. Gentle pressure is applied to the body while the patient is situated in an ideal movement position. This stimulates a global motor reaction minimising muscle imbalances, relieving painful muscle spasms, improving spinal stability, and encouraging postural awareness. Repetition of DNS exercises is then prescribed to help spinal stability become habitual and automatic. DNS involves the entire musculoskeletal system and central nervous system which can be disturbed by pain, trauma, injury or repetitive overuse.

DNS can be used in the rehabilitation of both orthopaedic and neurology patients from infants to the elderly. When used correctly the technique activates inter-segmental spinal muscles, deep neck flexors, diaphragm, abdominal wall and pelvic floor, the integrated stabilising muscles of the spine and extremities known as the Integrated Spinal Stabilisation System. This in turn can reduce pain, spasm and spasticity, improve posture and facilitate efficient human motion.

The DNS assessment is a set of dynamic movement tests, conducted to recognise the most important dysfunctions in a compromised postural-locomotion system. The DNS assessment compares the healthy, developing stabilisation pattern of an infant with that of the neurologic compromised patient.

Corrective stabilisation training should always be the first step in any rehabilitation treatment. Balance and strengthening exercises or movement improvement will have limited effect and may promote abnormal patterns of movement and heighten the patient's pain or provide limited functional improvement in the neurology patient if implemented prior to stabilisation. DNS aims to prompt core stability, as this must be subconscious and correctly brace before movement.

DNS offers a set of postural exercises, based on ideal natural developmental patterns. Repeated performance of these movements activates the whole spinal stabilisation system, restoring ideal intra-abdominal pressure and thereby optimising efficient movement. In addition, patients perform better if there is focus on ideal trunk stability before limb movement is trained.

Developmental Stimulus

Human motor function is formed in the Central Nervous System (CNS). As the CNS matures, the infant controls first supine and prone posture; then achieves erect posture against gravity and finally develops precise purposeful muscular activity and isolated segmental movement (1). An infant is not taught how and when to lift its head, roll over or crawl. These movements manifest in sequence during the maturation of the CNS, at specific developmental ages (2) becoming more complex as the infant first develops proximal stability for moving a distal extremity for example moving the humerus in the glenoid cavity. This relationship between the fixed proximal and the moving distal part in the segment allows for an open kinetic chain motor stereotype. Simultaneously an infant develops closed chain motor patterns during which it stabilises a distal segment, for example weight bearing on the knee (femur), to move the acetabulum around the head of femur. Attainment of postural stability and movement depends equally on the integrity and coordination of the efferent and afferent motor systems (3).

There is a strong synchrony between CNS maturation and structural (or anatomical) development of bones, muscles and other soft tissues (4). Brain maturation influences development of motor patterns but so does brain injury and both influence structural development (5). In the presence of a CNS lesion, developmental synchrony and muscle coordination are adversely affected. With disturbed muscle coordination, soft tissue and joint development subsequently alters joint position, morphological development and ultimately the entire posture (6) (Fig. 1).

Fig. 1: Postural abnormality and structural deformities in individuals with cerebral palsy.

In a child with Cerebral Palsy, for example, anatomical deformities occur as a result of abnormal CNS drive (7,8). The deformities and abnormal function may be positively influenced by starting an early and targeted treatment (9-12). Despite both abnormal motor and sensory function, using the DNS approach and establishing optimal stabilisation prior to movement these children may show more favourable development and therefore movement long term.

Principles of Postural Stability and Respiration

Upright posture and postural stability are complex neuromotor processes. They involve the diaphragm as well as thoracic and abdominal pressures (13). The diaphragm, transversus abdominis, scalenes and intercostals, participate in respiration, stability and control of movement (14) of the trunk and indirectly movement of the upper and lower limbs (15, 16). When correct respiration and postural stability is provided by the diaphragm (17-19), the accessory muscles of respiration remain flexible and relaxed (20-22) allowing for effortless movement and minimal tension.

In the cervical and upper thoracic spine optimum stability and movement first require respiration to be ideal, then core and postural stability. Balanced activity between the deep neck flexors and (mainly deep) spinal extensors for the neck and upper thoracic spine (23-25) and diaphragm is required (26) supported by thoracic and abdominal pressure (13) and transversus abdominis (27). This will allow the upper thoracic spine to extend in cervical extension (28, 29) and rotate and extend in shoulder movement (30-32). Optimal functional activities of the neck and upper limbs require fixed proximal stability provided by the postural stability of the trunk (16).

For lower thoracic, lumbar spine and pelvic stability a similar intricate coordination exists between spinal extensors, all sections of the abdominal wall, diaphragm and pelvic floor. Well-balanced and congruent concentric activity of the diaphragm and pelvic floor is followed by eccentric activity of all sections of the abdominal wall. IAP increases, as the diaphragm descends, providing stability to the lumbar spine and pelvis from the front against the action of the spinal extensors (Fig. 2) (27, 33-40).

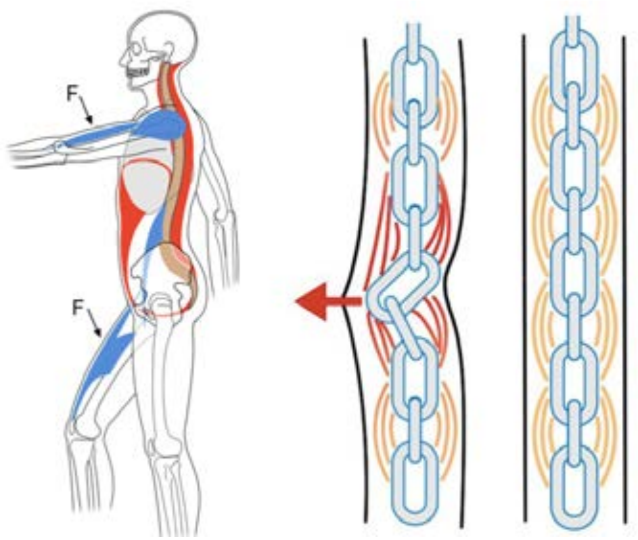


Fig. 2: Schematic illustration of muscles stabilising the shoulder and pelvic girdles and the spine.

Under normal conditions, the deep neck flexors and extensors stabilising the cervical and upper thoracic spine are in balance (red muscles along the cervical spine). The stabilisation of the lower thoracic and lumbar spine is ensured by coordination between the diaphragm, the pelvic floor and all the sections of the abdominal wall. These muscles (in red) regulate the intra-abdominal pressure by working in balance with the spinal extensors. The stabilising muscular contraction is automatically activated prior to any purposeful movement (e.g., hip flexion executed by the muscles in blue: the iliopsoas, rectus femoris, sartorius) to establish a stable base ("feed-forward mechanism"). In healthy subjects, the stabilising function of the trunk (ensured by all muscles pictured in red) ensures alignment and stability of the spinal segments during movement, e.g., lumbar segments during hip flexion. The spine can be viewed as a chain formed by links (spinal segments). A well-balanced activity of the stabilisers prevents decentration of any spinal segments during movement. The chain, i.e., the spine is stable. If any part of the stabilising pattern is weak, decentration (red arrow on the chain) occurs with every movement. Such repetitive strain (segmental decentration during every single movement) may finally result in a structural degeneration (osteosclerosis, disc degeneration, etc.).

No part of the stabilising system works alone, and Kolar et al (18) used the term integrated spinal stabilisation system (ISSS) to describe the inter-dependent relationship described above. When functioning optimally, the ISSS provides a fixed point, proximal stability or core from which to move (16). This task should be automatic and subconscious, though is easily compromised (12).

Every joint position depends on local and distal muscles to ensure optimal centration throughout the whole movement and for the entire kinetic chain to be optimally stabilised and simultaneously free to move. In the adult patient, who develops e.g. musculoskeletal pain and radiculopathy, assessing and treating the patient using DNS principles, the patient first learns to stabilise the core, and offload the damaged and inflamed tissues, then to move without aggravating the weakened disc. When working with a spastic or myopathy patient the same is true. Core stability is a prerequisite for extremity movement. Therefore in DNS, the initial focus is on proximal trunk stabilisation and only once this is established, train the phasic extremity movement with the aim, to reduce spasticity and increase muscles strength and movement accuracy.

Beyond its importance as part of the integrated spinal stabilising system, weakness of the diaphragm is a frequent cause of respiratory morbidity and recurrent respiratory tract infection in patients with neurological diseases (41).

The DNS Assessment

The DNS assessment compares the stabilisation pattern and movements of the neurologic compromised patient with that of a healthy developing stabilisation and movement pattern of an infant. The assertion, that coordination and activation of both global and local muscles is needed to establish a postural core or fixed point to move from. The assessment, is a set of functional tests, based on developmental positions, first to evaluate stabilisation and breathing and to recognise “key links”- i.e. the most important dysfunction(s). It is the optimal quality of this coordination that is critical and influence local as well as regional and global function (3, 42-46). The assessment comprise several postures that can challenge the patient but also give the clinician an initial picture of the patient's abilities and on repetition allows measurement of progress.

As stabilisation is closely related to the patient's respiration pattern (12, 18, 39, 40) the assessment should initially establish the patient's breathing pattern, followed by stabilisation, then stabilisation with movement.

Five commonly used tests are briefly described below (42, 47, 48).

Diaphragm test – postural stabilisation and respiration (Fig. 3)

In the seated diaphragm test, during the inspiration phase of tidal breathing the descent of the diaphragm increases Intra Abdominal Pressure (IAP), assuming the pelvic floor and abdominal wall maintain their respective tension. The chest and abdomen should be observed to move anteriorly and the posterior and lower ribs laterally during inhalation, with minimal superior elevation of the chest and no movement of the shoulders or neck. During exhalation, the ribcage returns to resting position.

The clinician places 2nd and 3rd fingers on the posterior/lateral lower intercostals spaces and the thumbs on the paraspinal muscles in the thoracolumbar (TL) junction, 4th and 5th fingers are placed gently on the lateral abdominal wall to monitor the intensity of the contraction against IAP changes during the respiratory cycle.

Common observable faults are typically:

1. Cranial elevation of the ribcage or shoulder elevation during inspiration
2. Contraction of the paraspinal muscles
3. Flexion in the thoracic spine (kyphosis on inhalation) or in the lumbar spine
4. Superior movement of the lower lateral ribs with a lack of lateral (bucket handle) movement in the lateral ribs. The deficiency may be either bi- or unilateral.

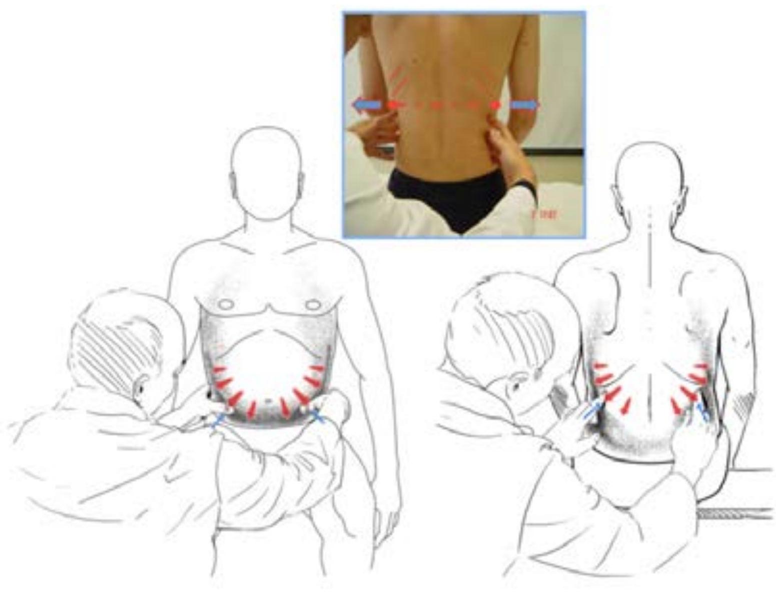


Fig. 3: Diaphragm Test

Respiratory-postural assessment. Assessment from behind: visually observe the patient's normal, relaxed breathing pattern. Manually palpate the lower intercostal spaces and abdominals from behind and observe typical breathing. Under normal conditions, the chest does not move superiorly with inhalation; instead, the lower ribcage and its intercostals spaces expand in all directions. To check the postural function of the diaphragm, ask the patient to push out against the examiner's fingers. Observe the quality and symmetry of firing. Assessment from the front: the sternum is rather stable, its lower part moves in an anterior direction with inhalation. Shoulder girdles remain relaxed, no protraction or elevation occurs. The patient is able to direct the inspiratory wave as far as the groin. To assess the postural function of the diaphragm, the examiner places their thumbs above the patient's groin and asks him to push against their fingers. A strong, symmetrical activation should occur.

Supine Neck and Trunk Flexion test (Fig. 4)

In the supine neck flexion test as the patient lifts the head there is a need for coordinated activation between the diaphragm, the scapula fixators and coordinated activation of neck flexors including the deep layers (Longus Coli, Longus Capitis, Rectus Capitis anterior and lateralis) and TL stability as well as flexion in the cervical and upper thoracic spine. The patient is asked to lift the head and look at their toes. In this assessment, the initial movement of lifting the head is the most important. The abdominal muscles should activate first and the chest kept in neutral position.

Typical faults are:

1. Excessive activity in the scalenes, sternocleidomastoids, and pectoralis muscles causing head (chin) protrusion
2. Cranial elevation of the chest
3. Convexity of the lateral abdominal wall or the ribs move sideways
4. The umbilicus move cranial
5. Concavity seen inside the anterior superior iliac crests
6. Rectus abdominis diastasis

Fig. 4: Supine Neck and Trunk Flexion Test

A-B: Ideal model of stabilisation in an infant and an adult – the chest in a neutral position, proportional activation of all sections of the abdominal wall.
C-E: Signs of pathological activation
C: Deep neck flexor insufficiency compensated for by an increased activity in the sternocleidomastoid muscles. The chin is jutting out.

D: Shoulder elevation and protraction during the test, rectus abdominis diastasis.
E: Jutting out of the chin, shoulder protraction, flaring of the lower ribs, diastasis recti with disproportional activation of the abdominal wall and over-activation of the rectus abdominis and an insufficient intra-abdominal and intra-pelvic pressure regulation (concavities above groin).

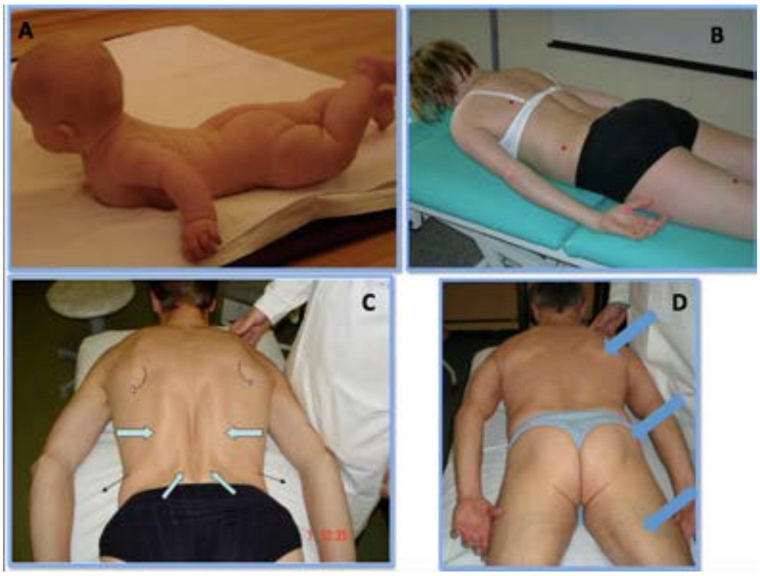
Prone Neck Extension test (Fig. 5-6)

During the neck extension test, it is important that there is coordination between the paravertebral muscles and the laterodorsal abdominal wall. During cervical extension the movement should initiate at T4-5 spinal level, indicating co-contraction between the deep neck flexors and cervical extensors. The patient is placed prone, the arms either along the trunk (Fig. 5) or in the 3 month developmental position with support on the medial epicondyles (Fig. 6). The patient is asked to lift the head off the table.

Failure is typically seen as:

1. Hyperactivity of neck extensors, with cranio-cervical extension
2. Upper angles of scapula pulled upward and medial and lower angles move toward abduction
3. Lack of segmental movement in the mid-thoracic segments, and increased thoracic kyphosis and lumbar lordosis
4. Anteversion in pelvis and bulging in lower abdominals

Fig. 5: Prone Neck Extension Test without Arm Support



A-B: An ideal model of stabilisation in an infant and an adult – chest in the neutral position, proportional uprighting of the upper thoracic and cervical segments. There is proportional activation of the abdominal wall with proper alignment between the chest and the pelvis. Proportional activation of the gluteal muscles, and legs relaxed.
C-D: Pathological stereotype with shoulder protraction, scapular elevation and external rotation, paraspinal muscle over-activation.
D: Also note the hyperactivity of gluteus maximus and the hamstrings (more on the right side).

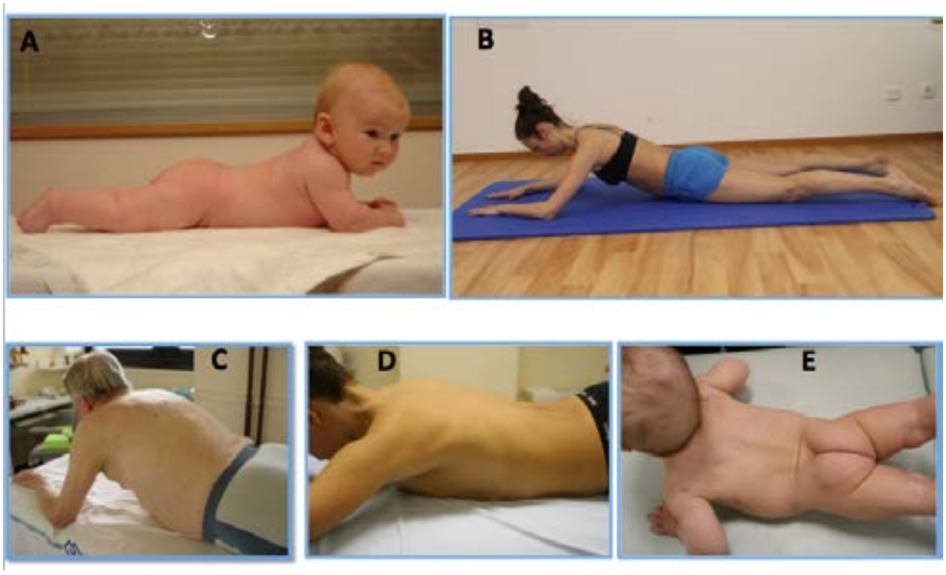


Fig. 6: Prone Neck Extension Test with Elbow Support

A-B: Ideal model of stabilisation in a 3-month-old infant and an adult – the medial epicondyles are weight-bearing, the neck extension initiated in the mid thoracic segments (T3/4/5). The cervical and upper thoracic spine elongate and upright, with ideal alignment between the chest and the pelvis.
C-D: Pathological pattern in an adults with rigid thoracic kyphosis substituted for by hyperextension at the cervico-cranial and cervico-thoracic junctions. Shoulder elevation and protraction.
E: Pathological pattern in an infant without elbow support: bulging of the latero-dorsal sections of the abdominal wall is compensated by hyperactivity of spinal extensors and an anterior pelvic tilt. Disproportional activation of the gluteals with overactivation of gluteus maximus, a lack of gluteus medius activation, and hamstring hyperactivity.

Arm Elevation Test (Fig. 7)

As the supine patient is asked to lift the arms off the table, the clinician looks for isolated shoulder movement. The patient should be able to keep the neck, torso and pelvis in neutral. The ribs should stay in neutral and any spinal uprighting should take place in the mid thoracic spine.

Common faults are:

1. The chest lifts cephalad as the arms are lifted
2. Increased lumbar lordosis
3. Increased cervical lordosis and chin lift

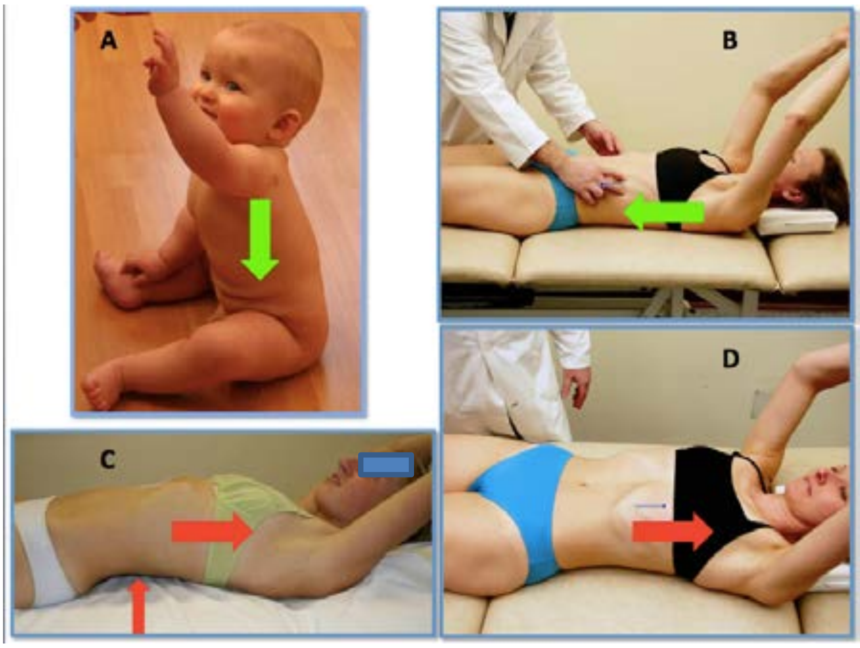


Fig. 7: Arm Elevation Test:

A-B: Optimal pattern of arm elevation in a 9-month-old infant and an adult. Chest is kept in a neutral caudal position (green arrows), balanced coordination between the anterior and posterior musculature.
C-D: Pathological pattern with the chest pulled in a cephalad direction (red horizontal arrows). Upper chest fixators (pectoralis, upper trapezius, levator scapulae, SCM, scalene) predominate over the lower fixators (diaphragm and abdominal muscles). Lumbar spine hyperlordosis (Pict. C: vertical red arrow).

Rock Forward Test (Fig. 8)

The patient is placed on all fours. The knees directly under the hips, and hand/palms directly under the shoulders. Firstly observe the posture in this position. Is the patient able to keep the spine elongated, intra-abdominal pressure maintained, ribcage remains in contact with the scapula? Then ask the patient to gently rock forward while keeping their hands/palms, knees and lower legs in place.

Typical faults are:

1. Winging of the scapula
2. Unable to hold pressure on the whole hand and palm, with most pressure on the ulnar/hypothenar side
3. Semiflexion at the elbow
4. Forward movement of the head and the torso moves forward
5. Increased lordosis in the lumbar spine
6. Feet lifting off

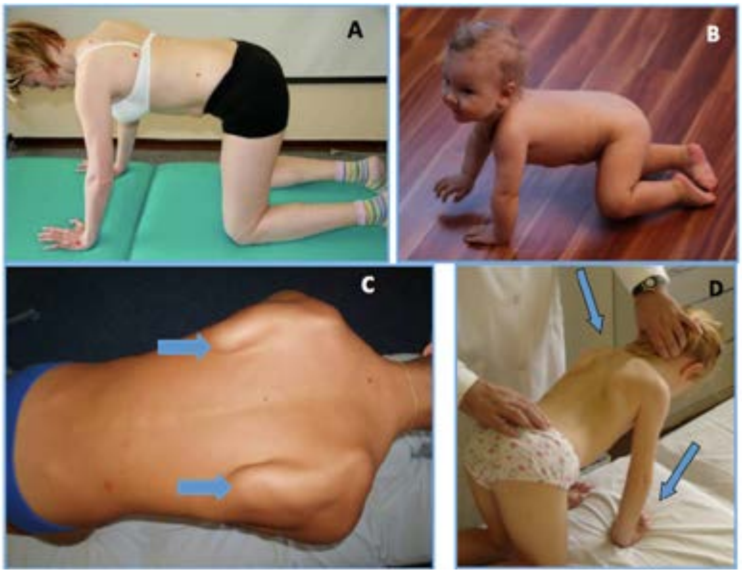


Fig. 8: Quadruped Rock Forward Test

A-B: Optimal pattern of quadruped posture in a 10-month-old infant and an adult: The scapulae are fixed, adhering to the trunk, its medial edge almost parallel to the spine. Balanced activation between anterior and posterior musculature, optimal alignment between the chest and the pelvis, spine upright, centration (proportional weight-bearing through the palms of both hands).
C-D: Pathological stereotype with “scapular winging” (C and D), hypothenar hand support dominate (ulnar side of the hand) and finger flexion (D), T/L junction instability & anterior pelvic tilt (D).

The DNS Treatment

Rehabilitation should initially address stabilisation of the trunk and integrated spinal stabilisation system (48, 16). Balance and strengthening exercises or movement restoration (improvement) will have limited effect and may promote abnormal patterns of movement and heighten the patient’s pain (18, 40) if initiated prior to corrective stabilisation and breathing. The core must be able to brace before movement (49-51) though stabilisation generally is subconscious and automatic and as a result easily compromised and difficult to retrain (12).

DNS treatment offers a set of postural exercises, ie. the patient is placed in various developmental positions with supporting joints optimally centrated allowing for coordinated and equal muscle support. Initial focus should be on retraining respiratory function, then integrate breathing and stabilisation followed by postures or positions where the patient is able to control breathing and stability with movement. Each posture or developmental stage provides the underpinning for every exercise and the next stage and exercise. The aim is to achieve optimal quality of both postural function and phasic movements. It activates the ISSS and restores ideal intra-abdominal pressure regulation to optimise efficient movement and prevent overload of joints, muscles and tendons.

First teach the patient to recognise the feeling of the right position verses the compromised stabilisation. This is followed by the ability to hold the optimal stabilisation posture in different positions and finally during movement. The end goal is to be able to integrate breathing and stabilisation with activities of daily living including sport activities.

Neutral Chest Position and Correct Breathing Stereotype

First establish neutral chest position (caudal expiratory position). This facilitates diaphragmatic breathing (Fig. 9) and thus IAP regulation and will aid in activating the ISSS. It is suggested that diaphragmatic breathing is essential and once established provides a solid base for further rehabilitation (52, 53).

Fig. 9: Diaphragmatic Breathing Education in Sitting

The patient is sitting upright, weight-bearing through bilateral ischial tuberosities, elongating the spine, avoiding shoulder elevation and protraction. Palpate between the patient's lower ribs and below the last ribs (latero-dorsal aspect of the abdominal wall). Instruct the patient to breathe into your fingers while keeping the chest in a caudal stable position. The patient's upper chest fixators (pectoralis, upper trapezius, scalenes, sternocleidomastoid) must remain silent during breathing. Ask the patient to practice such breathing at home in front of a mirror while watching the clavicles (there should be no movement during breathing). If the patient is unable to eliminate auxiliary respiratory muscles from breathing, ask him to push slightly with his (her) elbows into the armchair during inhalation. Thus, the patient will utilise the auxiliary muscles for arm activity thereby learning how to exclude them during normal breathing.

This may be achieved using mobilisation and manipulation to the ribs and thoracic spine, soft tissue techniques and release fascia of the thorax, teaching the patient how to achieve the neutral position of the chest, progress to breathing against resistance from a thera-band (Fig. 10).

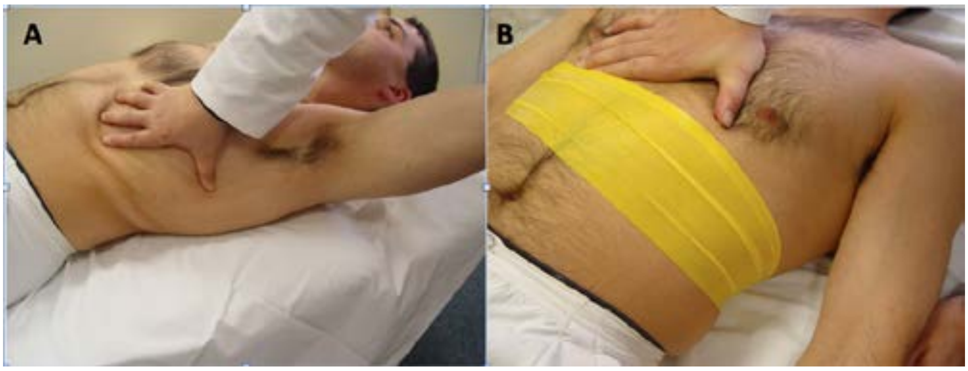


Fig. 10: Diaphragmatic breathing education with a client supine:

A: Thoracic fascia mobilisation – free soft tissue movement and full shoulder mobility is a prerequisite for normal breathing

pattern. Mobilise any joint restrictions in cervical and thoracic spine and ribs, and ensure free movement of all soft tissue layers.
B: Wrap a yellow thera-band around the patient's lower chest and give instruction to expand it with inhalation while maintaining caudal chest position and spinal uprighting.

Supine 3 month position (Fig. 11)

Place the patient supine, with 90º flexion in the hips, knees, and ankles, then bring the chest into neutral position. First the patient must feel this position and learn to bring the ribcage into this pose and hold it here. The goal is symmetrical distribution of IAP, support in the TL junction, balanced activity of the abdominal wall and uprighting/elongation of the whole spine and pelvis.

Mistakes to avoid are: cranial (lifted inspiratory) position of the chest (Fig. 4D, Fig. 7C,D) hyperactivity in rectus abdominus, especially the upper part or diastasis (Fig. 4D); posterior angles of ribs lifted ventrally; lumbar spine extension (Fig. 7C); head reclination, hyperextension in upper cervical spine; concavity above the groin (Fig. 7E), indicating insufficient IAP and/or pelvic floor activity and shoulders raised off the table.

Advancing the exercise and adding phasic movements can be done using first single arm or leg movements, progressing to include thera-bands (Fig. 11D) or small hand held weights.

Fig. 11: Stabilisation exercise in a 3-month-old supine position:

A: A 3-month-old infant demonstrating optimal core stabilisation. A 90-degree hip flexion, functional centration at the hips, spine upright, shoulder girdles relaxed, chest and pelvis properly aligned (chest and pelvic axis parallel, the diaphragm and pelvic floor can activate against each other and cooperate in both, stabilisation and respiratory function).
B: A 3-month-old exercise position for an adult
C: Patient education to produce and maintain proper core stabilisation with activation of the lower abdominal wall during both, breathing (the inspiratory wave reaches as far as the groin) and stabilisation (manifested by abdominal contraction and expansion above the groin).
D: Exercise progression: Instruct the patient to keep the core stabilised, breathing properly and activating extremities against resistance while lifting the feet slightly and performing

shoulder abduction & external rotation and supination of the forearm. The patient can only perform repetitions while able to maintain the correct stabilisation and breathing pattern. Stop the exercise as soon as any deviation from an ideal pattern occurs.

Prone 3 month position

In prone position, the upper arms are at a 90⁰ angle to the torso; support is on the elbows, anterior superior iliac spines and pubic symphysis (Fig. 12A); the wrist is in neutral avoiding ulnar deviation. First the patient learns to elongate / upright the spine (Fig. 12B), to keep the pelvis in neutral and avoid hyperextension in the cervical spine. Ensure well balanced activity of the scapula fixators (Fig 12A).

Common mistakes are: elevation, adduction and rotation of scapula; loss of contact between the ribcage and scapula; forward poking of chin, hyperextension in upper cervical and extension in TL junction.

Next, include a head raise, with the movement starting at the T4 level whilst keeping the spine long and pelvis neutral (Fig. 12B). Instruct the patient to maintain proper breathing during the exercise (Fig. 12C). Progress to isolated head movement – rotation, then add phasic movements of an arm, add thera-band, or place the patient on a less stable surface, or in a less stable position, e.g. low kneeling position (Fig. 12D).

Fig. 12: Stabilisation exercise in a 3-month-old prone position:

A: While in prone position adjust the position so support is on both medial epicondyles and the pubic symphysis. Guide the patient's shoulder blades to a neutral caudal position and request that this position is maintained actively.

B: Elongate the patient's spine and instruct the patient to extend the neck with focus on initiating the movement at the mid-thoracic spinal segments. Exercise segmental movement in C7/T1/T2/T3/T4/T5 segments into extension and rotation. Train the patient to focus on segmental movement in the upper thoracic segments (lack of segmental movement is quite common in this area and compensated for at C/T and T/L junctions, which then become overloaded).

C: Instruct the patient to expand the latero-dorsal abdominal section during inhalation while maintaining a neutral chest position.
D: Exercise progression – utilise the same instructions and principles as in the A-C pictures with the patient sitting on their heels.

Side lying 5 month position (Fig. 13)

The patient is lying with torso perpendicular to the table, the lower shoulder (support) and elbow are flexed to 90° each, the wrist in neutral. The down side leg (support) is semi flexed at the knee with the hip and heel in line with the ischial tuberosity. The spine is elongated and the pelvis in neutral. The patient should be conscious of the load on the supporting arm and leg.

Mistakes to avoid: collapse in the TL junction with top hip and shoulder angled towards each other; chin poking forward, upper cervical hyperextension.

Start the training by elongation of the spine with weight moving onto the supporting extremities, then rotating the torso and pelvis around the supporting extremities – slight back and forth movement as the elongation and IAP is held. Progression is achieved by adding movement of the top arm – as if to grasp an object in front, then adding resistance whilst holding the elongated posture (Fig. 13F-H).

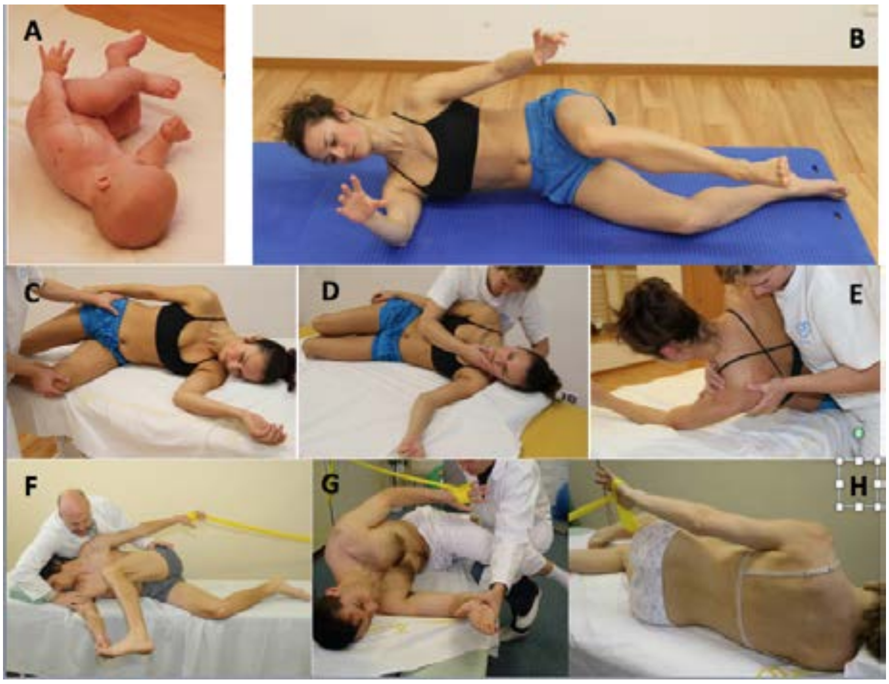


Fig. 13: Sidelying 5-month-old position

A: A 5-month-old infant demonstrating optimal core stabilisation in the sidelying position. Reciprocal position of the upper and lower limbs. Differentiated function with the bottom extremities being activated in support function (closed kinetic chain) and top extremities in reaching/stepping forward function (closed kinetic chain). Functional centration at all girdle joints, the spine upright, and the chest & pelvis properly aligned (the chest and pelvic axis parallel).
B: Corresponding sidelying position for an adult
C-E: Stabilisation activation may specifically target certain body segments

C: The therapist centrates (approximates) the bottom supporting hip joint guiding the patient with the top hand into pelvic rotation while maintaining ideal stabilisation pattern
D: Sidelying exercise with specific focus on neck stabilisation (cervical spine centration, elongation, chin tucked; the exercise focuses on coordination between the deep neck flexors and cervical spine extensors).
E: Exercise progression: Transitioning from sidelying into side-sitting with the bottom forearm (elbow) support. The therapist guides the patient and helps centrate the bottom shoulder blade (shoulder girdle).
F-H: Exercise progression while using resistance from exercise bands.

7 month oblique sitting position with forearm support (Fig. 14)

Place the patient on their side (Fig. 14B) , with support on the down side forearm and hand, hip, thigh, and ankle. Ensure the supporting shoulder is centrated with an active pressure onto the supporting forearm and hand as it helps centrate the shoulder and elongate the spine. The supporting leg should also actively press down and “out” to stabilise the pelvis in neutral.

Avoid (Fig. 14C): protraction and elevation in the shoulder, forward poke of chin (upper cervical hyperextension), flexion in the lumbo-pelvic area with weight-bearing toward the iliac crest and flexion in the thoracic spine.

Start the training (Fig. 14D-F)by teaching the patient the correct feeling of elongation and support, instruct that it should feel as if the support is moving toward the wrist and knee. Progress by teaching the patient to turn the torso around the head of humerus. Progress further by adding phasic movements, first without resistance then using a thera-band or hand held weight (Fig. 14G-I).

Fig. 14: Side-sitting position with forearm support corresponding to a 7-month-old developmental age

A: A 7-month-old infant demonstrating optimal core stabilisation in a side-sitting position with forearm support. Same principles can be observed as in Fig. 13A.

B: Corresponding side-sitting position in an adult with optimal stabilisation pattern
C: Side-sitting position in a child with abnormal posture: poor stabilisation of the bottom shoulder girdle, and instability at the T/L junction
D-F: The therapist may focus on specific partial patterns and assist the patient to achieve ideal muscle coordination in given a segment.
D: Centration and approximation of the bottom supporting leg
E: Assisting with pelvic rotation, keeping the pelvis in a neutral position, ensuring balanced coordination between the anterior (abdominal) and posterior (extensors) muscles with the spine upright and elongated
F: Centration of the supporting (bottom) shoulder girdle and the top (stepping forward) foot
G-I: Exercise progression using elastic bands or the clinician's resistance

8 month, all fours (quadruped) position (Fig. 15)

The patient is placed on all fours, knees directly under the hips and hands and wrists directly under the shoulders (Fig. 8A,15A). Ensure that the support on the hand is both on the thenar and hypothenar area and throughout the fingers – as if pushing down and forward at the same time. On the knees there should also be an active feeling of pressure down and out in the lower leg and foot. The spine is elongated and the pelvis in neutral.

Common mistakes (Fig. 8C,D): too much weight on the ulnar side of the hand – insufficient pressure through fingers and thumb; lower legs and feet passive, with weight only on knees; scapula adducted and elevated; chin poking forward and loss of contact between the ribcage and scapula.

First teach the patient to find the position and consciously hold it, then shift the weight slightly forward by moving the torso cephalad (Fig. 15B). Ensure the support is correct and active. Rock back and repeat. Progress by taking first one hand off the floor, or lift one knee off the floor, this may be followed by adding reaching and grasping with the non-supporting hand (Fig. 15C).

Fig. 15: Quadruped position

A,B: Training core stabilisation while supported on all fours. Instruct the patient to elongate the spine, tuck the chin, weight-bear on centrated hands (proportional loading on the hands) and both knees. The patient rocks forward and repeats the

movement as long as the proper stabilisation is maintained. Stop the exercise as soon as any deviation occurs.
C: Exercise progression: Ask the patient to lift one arm (and contralateral leg) and hold the position while correct joint centration and core stabilisation maintained.

Conclusion

Functional movement is achieved not just by training the lost or missing movement but by using a system that facilitates the correct use of the integrated stabilising muscles of the spine and extremities through precise coordination of the ISSS and IAP regulation. Evaluation, rehabilitation and training should initially address functional and dynamic stabilisation, then progress to isolated movements. DNS serves as an integrated approach to the neurology patient and integrates stability and movement from a physiologically ideal base utilising positions determined by developmental kinesiology.

In most neurology patients the ideal model of stabilisation is not possible to achieve because of spasticity, tremor, rigidity, balance problems, sensory disturbance, muscle weakness or other. The ultimate goal, however, is to get as close as possible to the ideal model of respiratory and postural-locomotion pattern as defined by developmental kinesiology. In every situation, it is imperative to respect each patient's capacities, their pain or discomfort. DNS offers great variability in treatment positions and practical approaches. Always choose a position and provide instructions appropriate to patient's abilities. When working with a neurology patient observe the postural-locomotion pattern at all times. As long as the pattern is on an acceptable level of quality or it is improving through the exercise, continue. Any observed deviation from optimal, which promote a poor movement pattern (joint decentration) or if the exercise evokes any pain stop the exercise and search for more adequate positions and instructions.

SUGGESTIONS FOR FURTHER READING

Kolar P et al. Clinical Rehabilitation. Alena Kobesová, Prague, 2014.

http://www.rehabps.com/REHABILITATION/Clinical_Rehabilitation_textbook.html

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