

Low-level Laser Therapy and Chiropractic Conditions

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Abstract

Low-level laser therapy got its recognition in the 1960's. Not until the past 20 years has it been used as a therapeutic remedy. This literature review will review the reported effects of low-level laser therapy on different conditions affecting the body. Further, research concerning the therapeutic effects it has to reduce pain and the effects it has when combined with modern medicine is reviewed. A number of studies have been performed comparing the difference between laser and their use on different chiropractic conditions. The studies show conflicting results, possibly due to poor research design, relative to the effects of low-level laser therapy and the treatment of these conditions.

Introduction

Low-level laser light is compressed light of a wavelength from the red portion of the light spectrum of electromagnetic radiation. It is different from natural light in that: it is one precise color, it is capable of parallelism (travelling in a straight line) but has been modified to diverge slightly for safety purposes, has a single wavelength and it concentrates its beam in a defined location or spot [19]. All this allows laser light to penetrate the surface of the skin with minimal heating effect (0.1-0.5°C), no damage to the skin and no known side effects. Rather, laser light directs biostimulative light energy to the body's cells, which the cells then convert into chemical energy to promote natural healing and pain relief.

Low-level laser therapy is the application of red and near infrared light (approximately 500 milliwatts) over injuries or wounds improving soft tissue healing and relieving both acute and chronic pain. Low-level therapy uses cold laser light energy to the body's cells without injuring or damaging them and without producing any visible skin reactions or sensations during the treatment. This contrasts with the surgical use of lasers that work at 3-50 Watts which generate significant heat and cellular changes. The low-level laser therapy is precise, accurate and offers safe and effective treatment for a wide variety of conditions without heat and significant cellular changes.

Low-level lasers supply energy to the body in the form of non-thermal photons of light [7]. Light is transmitted through the skin's layers (the dermis, epidermis and the subcutaneous tissue or tissue fat under the skin) at all wavelengths in the visible range. However, light waves in the near infrared ranges (600-900nm) penetrate the deepest of all light waves in the visible spectrum.

The energy used is indicated in Joules, which is the number of milliwatts x the number of seconds of irradiation. Normal therapeutic energies range from 1-10 Joules per point. The dose is indicated in J/cm² so the irradiated area must be known.

When low-level laser light waves penetrate deeply into the skin, they stimulate the immune responses of the blood, which has wound healing, anti-inflammatory, analgesic, immunoregulatory, and regenerative effects according to published laser research [20].

Wound healing effects and examples

- Increase collagen synthesis
- Stimulate the enzyme superoxide-dismutase, which inhibits the peroxidation of unsaturated fatty acids (Burns)

Anti-inflammatory effects and examples

- Enhances proliferation of immune cells (Herpes simplex and zoster)
- Enhances lymphatic activity (Decubitus)
- Improves microcirculation (Diabetic foot)
- Reduces swelling (Lymphadenopathy)

Regenerative effects and examples

- Regulation of muscle tissue (Wound healing)

- Increased activity of osteoblasts promoting the formation of callus (Bone repair)
- Neovascularization of lymphatic and blood vessels as well as vasodilation, improve microcirculation and lymphatic drainage (Inner ear problems)
- Prevention of central nerve degeneration and regeneration of peripheral axons after injury (Stroke rehabilitation)
- Stimulates fibroblast development and collagen synthesis in damaged tissue (Post operative)

Analgesic and examples

- Reduction in pain sensing nerves (Fractures)
- Improved release reaction of endorphins (OA, tendonitis)
- Relaxation of muscle induced by the neuromuscular unit (Lumbago)
- Reduction of trigger activity (Fibromyalgia)
- Increases ATP production (Soft tissue injuries)

Immunoregulatory

- Activation of proliferation of immune cells including macrophages
- Reduction of antigen perception of the T-lymphocytes
- Activation of immunoglobines

These effects can be seen in dermatology, neurology, surgery, rheumatology, traumatology, orthopedics, gynecology, urology, dental medicine and veterinary medicine.

Contraindications

There are no absolute contraindications for low-level laser therapy but there are some high-risk patients that need to be mentioned.

- Patients with pacemakers: pacemakers are protected inside a cover, insensitive to light and is an approved medical device
- Patients with a history of unexplained chest pain: when lasers are applied to the mid-thoracic area paraspinally they may induce coronary spasms or arrhythmia's-rarely
- Patients who are pregnant: laser should not be applied over a fetus
- Patients with epilepsy: pulsating lights can induce an epileptic attack
- Endocrine glands: the thyroid gland is sensitive to light therefore laser should be avoided over this area
- Patients with tumors: laser has not induced tumor growth but should not be used directly over a tumor
- Patients with prostheses: laser does not increase the temperature of deeper tissues but some sensitive patients may feel temporary increase in pain
- Risk of eye injury: protective goggles should be worn
- Patients with hypersensitivity to light: a reaction may occur with high photon densities are used

Conditions

Rheumatoid Arthritis

Rheumatoid Arthritis is a chronic, systemic, inflammatory disease that chiefly affects the synovial membranes of multiple joints in the body. Since Rheumatoid Arthritis is a systematic disease extra-articular conditions may occur. Such conditions may include neuropathy, pericarditis, rheumatoid nodules, lymphadenopathy, splenomegaly, arteritis and scleritis.

In most cases of rheumatoid arthritis, the patient has remissions and exacerbations of the symptoms. This means that there are periods of time when the patient "feels good" and times when the patient "feels worse". There will likely be times that a patient will "feel cured". It is

important to understand that there are very few patients that have complete remission of the disease and it is critical that the patient does not stop the treatment program established by their health care practitioner. Rarely does the disease "go away"; although at times the symptoms might temporarily remit [21].

The prevalence of the disease is one to two percent of the general population and is found worldwide. Females with RA outnumber males by a three to one margin. Onset of the disease in adults is usually between the ages of 40 to 60 years, although it can occur at any age.

Rheumatoid arthritis can attack any synovial joint in the body, with the exception of the distal interphalangeal joints and it has a preference for the small joints of the hand, wrist, and foot. In many cases the joint involvement in the limbs becomes relatively symmetrical and bilateral. If the superior aspect of the cervical spine becomes affected, patients must be watched carefully for disruption of the transverse ligament, which can lead to death.

Early in the course of the disease several changes in joint structures occur. Joint effusion and inflammation of the synovium occur causing soft tissue swelling that is easily seen during evaluation of the patient. Additionally, osteoporosis in the ends of the bones forming the joint may be present early in the disease process. The attack on a joint by the disease usually begins with the synovium. Early in the disease, edema begins to be seen in cells in the synovium and multiplication of synovial lining cells occur. As the disease progresses, the synovium may grow larger forming tissue called pannus, which may be considered the most destructive element affecting the joints. Pannus can attack articular cartilage and destroy it. The synovial fluid secreted by the synovium is thought to serve two main purposes, lubrication of the joint and provision of nutrients to the avascular articular cartilage. In this disease process, an interaction between antibodies and antigens occurs, and causes alterations in the composition of the synovial fluid. Once the composition of this fluid is altered, it is less able to perform the normal functions noted above, and more likely to become destructive.

The changes in the synovium and synovial fluid briefly described above are responsible for a large amount of joint and soft tissue destruction. The destruction of bone eventually leads to laxity in tendons and ligaments. Under the strain of daily activities and other forces, these alterations in bone and joint structure result in the deformities frequently seen in patients with rheumatoid arthritis. Considerable destruction of the joint can occur with pannus invading the subchondral bone.

Bone destruction occurs at areas where the hyaline cartilage and the synovial lining do not adequately cover the bone. If the disease progresses to a more advanced stage, the articular cartilage may lose its structure and density resulting in an inability to withstand the normal forces placed on the joint. In these advanced cases, muscle activity causes the involved ends of the bones to be compressed together causing further bone destruction. Further, the disease can irreversibly change the structure and function of a joint to the degree that other degenerative changes may occur, especially in the weight bearing joints of the body. Thus, joint destruction can progress to the degree that joint motion is significantly limited and joints can become markedly unstable.

Rheumatoid Arthritis and Low-level Laser Therapy

Low-level laser therapy was introduced as an alternate and non-invasive treatment for rheumatoid arthritis about 15 years ago but is still controversial. Thirteen trials were completed by Brosseau [22] with 212 patients randomized to laser or placebo. 174 to placebo laser and 68 to active laser. These treatments lasted from four to ten weeks and with follow up of only two of the thirteen trials for three months. The results showed that in the patients with active laser therapy, the pain was reduced by 70% relative to the placebo laser and morning stiffness was reduced by 27.5 minutes. Other outcomes such as range of motion and local swelling were not different between groups. Another trial done in 1994 by Hall [23] did a double blind and placebo-controlled study to determine the efficacy of laser therapy on chronic Rheumatoid arthritis patients with

finger joint synovitis. Active or placebo laser was given three times a week for four weeks with measurements taken prior, just after, one month after and three months following. Few differences were noted in grip strength, range of motion, duration of morning stiffness, joint tenderness and temperature between groups. Since there was a significant amount of time between trials and the advancement of modern medicine it is safe to say that low-level laser therapy can be used on patient with rheumatoid arthritis for reduction of morning stiffness time and decrease in pain.

Osteoarthritis

Osteoarthritis is the oldest and most common form of arthritis. In osteoarthritis, changes occur in both the cartilage and bone of joints that can lead to joint pain, stiffness and swelling.

Osteoarthritis also is known by many other names, such as degenerative joint disease, arthrosis or osteoarthrosis. Risk factors for OA include being overweight, joint injury/trauma, muscle weakness, having other forms of arthritis, age and heredity.

Osteoarthritis can affect any joint, but it occurs most often in weight bearing joints such as the knees and hips and other joints such as the spine, small joints of the fingers, and the base of the thumb and big toe. It affects other joints as a result of previous injury to the joint or unusual stress on the joint. It is usually symmetrical and unilateral.

In normal joints cartilage covers the end of each bone, which allows for a smooth, gliding surface for joint motion and acts as a cushion between the bones. As stated above, in osteoarthritis the cartilage between the joints breaks down leading to symptoms such as pain, swelling and problems using the joint.

Osteoarthritis has several phases. During the first phase, cartilage loses its elasticity and is more easily damaged by injury or excessive use. In the second phase, cartilage is breaking down causing changes in the underlying bone that becomes thickened with bony growths called spurs.

During the third phase, fluid-filled cysts form in the bone near the joints, which may have bits of bone or cartilage floating loosely in the joint space. Finally, the synovium becomes inflamed and produces inflammatory proteins and enzymes that damage the cartilage further.

Usually joints affected by osteoarthritis hurt most after they've been overused or after periods of inactivity. It is difficult to move the joint after first getting up in the morning, or following more-than-usual use of the joint.

Also, if the joint isn't moved or exercised, the muscles surrounding the affected joint will become weaker. They then may not be able to support the joint as well, which can lead to increased joint pain. Coordination, walking and posture may become affected.

The cause of osteoarthritis is not known, but researchers have shown that there are several factors that increase the risk of developing osteoarthritis. These factors include heredity, obesity, and injury to the joint, repeated overuse of certain joints, muscle weakness, nerve injury and aging.

Osteoarthritis and Low-level Laser Therapy

As mentioned earlier, low-level laser therapy was introduced ten years ago as a non-invasive treatment for osteoarthritis. A trial was performed by Brosseau [24] to study the effectiveness of low-level laser therapy in the treatment of osteoarthritis. 112 patients received laser and 85 patients received placebo laser. The treatment duration ranged from four to ten weeks. The results were conflicting which may have been due to the method of application. Some of the trials showed a decrease in pain whereas some trials had no significant difference in pain. Joint tenderness, joint mobility and strength were not measured. Another trial done by Brosseau [22] showed the same results. In this trial, 212 patients were randomized to laser, 174 patients to active laser and 68 patients received placebo laser on the other. Treatment duration ranged from four to ten weeks with follow up on only two trials for three months. For osteoarthritis, 197

patients were randomized with pain being assessed for three trials. Once again, the results showed no significant difference in pain and may depend on the method of application.

A trial performed by Giavelli [2] in 1998 showed different results than the ones just mentioned due to different methods of application. A trial on knee osteoarthritis was performed on 228 elderly patients; 36 patients received CO₂ laser with a sweeping technique, 31 patients received HeNe laser with a sweeping technique and 82 patients received GaAs laser with either a sweeping or point technique. In the sweeping method, the area to be treated was the knee articulation. In the point technique the application was applied to the condyles of the femur, the articulation of the femur and the tibia, the condyles of the tibia, the peroneal head, the kneecap and the vastus medius and lateralis muscles. The CO₂ trial lasted ten minutes and was carried out 20 times and had a sweeping distance of 10x15 cm. The HeNe trial the treatment time was 30 minutes and had a sweeping distance of 2.5 to 2.8 cm/sec. In the GaAs trial, the time of application was one minute per point within a range of ten to 15 points per knee. Good results were shown on 67.5% of CO₂ patients, 72.3% of point technique GaAs patients, 61.3% of sweeping technique GaAs patients and 42.6% of HeNe patients. There was no significant difference between CO₂ and GaAs therapy but difference was noted between CO₂ and HeNe.

Giavelli [2] performed another trial on lumbar spine osteoarthritis. In this trial, 117 patients were suffering from spinal pain due to lumbar osteoarthritis. Either a GaAs diode or HeNe laser carried out treatment, by sweeping, by points or a combination of the two. The treatment was performed daily with the sweeping method range of tenx15 cm and points on the lumbar nerve roots. 46% of patients receiving GaAs laser showed very good results, an increase in range of motion and a decrease in pain, whereas only 31.8% of the patients receiving HeNe laser had the same results. The results indicated that GaAs was more effective than HeNe in the treatment of lumbar spine osteoarthritis. These trials showed that different laser apparatuses present different efficacy when treating osteoarthritis. It was noted that GaAs lasers are more effective than HeNe laser, which may be due to the fact that GaAs lasers penetrate deeper into the tissue.

Tempromandibular Disorders

Tempromandibular disorders fall into three main categories [1]. The first is myofascial pain; this is the most common form of Tempromandibular disorders and is a discomfort or pain in the muscles that control jaw function and the neck and shoulder muscles. The second is internal derangement of the jaw; this is a dislocated jaw or a displaced disc. Last is degenerative joint disease such as osteoarthritis or rheumatoid arthritis in the jaw joint.

The causes of tempromandibular disorders are not clearly understood. Injury to the tempromandiublar joint or the jaw due to a fracture is the most common cause. Arthritis, a bad bite, orthodontic treatment, work habits/posture, genders (most likely women) and aging may be some other causes. Some experts believe that mental or physical stress may aggravate this disorder. There is no evidence that gum chewing can cause tempromandibular disorder but it should be avoided for people who have symptoms. Pain in the muscles and/or joint is the most common symptom. Other symptoms may include limited movement or locking of the jaw, radiating pain in the face, neck or shoulders, painful clicking, popping or grating sounds in the jaw when opening or closing of the mouth and sudden change in the way the upper and lower teeth fit together. Headaches, earaches, dizziness and hearing problems may also be associated with tempromandibular disorders.

Tempromandiublar Disorders and Low-level Laser Therapy

A trial was done by Kulekicoglu [25] done in 2003 to determine the effectiveness of low level laser therapy in the treatment of tempromandibular disorders. In this trial, 35 patients were given either active treatment (20) or placebo treatment (15). Each patient was treated with fifteen sessions of low-level laser therapy in addition to a daily exercise program. Pain, joint motion, number of joint sounds and tender points were assessed. There was a significant decrease in pain in both the active and placebo groups. Active and passive mouth opening and the number of tender points were significantly improved only in the active group by 48.2%. The placebo group did not show the same results due to the myogenic involvement not treated. The results showed

that low-level laser therapy could be used as an alternative modality on patients with temporomandibular disorders.

In 1998, Pinheiro et al. [4, 5] wanted to determine the effects of low-level laser therapy in the treatment of maxillofacial disorders. Two hundred and forty one patients were treated with 632.8, 670 and 830 nm diode lasers for a period of two applications per week with an average dose of $1.8\text{J}/\text{cm}^2$. The results showed that 154 patients were asymptomatic at the end of the treatment. Half of these patients were still asymptomatic three months following the trial. This trial shows that low-level laser therapy is beneficial for the treatment of maxillofacial disorders.

Bezuur and Hansson [27] treated 27 patients suffering from long-term joint and muscular temporomandibular disorders with a GaAs laser. The treatment was given over a period of five days. 80% of the patients with joint pain were totally relieved of pain and the jaw opening ability increased. The patients who were also experiencing muscle pain did not have such significant results due to the fact that the muscles were not treated. Conti [1] came up with similar results. This trial was done on 20 patients with a chief complaint being divided into joint pain and muscle pain groups. It was also divided into active versus placebo treatment. An 830 nm GaAlAs laser was used for three sessions. A Visual Analog Scale was used for pain and active range of motion was used to measure changes in mandibular function. After the active laser treatment was performed, only pain was decreased in those with joint pain not those with muscle pain.

Eckerdal [28] found that of different types of perioral neuropathies (trigeminal neuralgia, paresthias, temporomandibular disorders, etc.) Temporomandibular disorders had the greatest results when being treated with four to eight sessions of low-level laser therapy.

Kim [29] divided 36 patients into three groups; one group used a bite splint, one group received GaAlAs laser treatment and the other group received laser acupuncture. The treatments lasted two to four weeks. The results showed that the bite splint group and the laser treatment group

both had a decrease in pain (76%) and EMG activity but the laser treatment group had faster results showing that the pain was decreased after the first treatment. The laser acupuncture group had the poorest results.

Lopez [30] treated 168 patients using a combination of bite splints and HeNe laser. There was an improvement in 52 of the patients after a single treatment. After ten treatments, 90% had improved. The laser treatment was given directly over the maxillary joint for about five minutes. The extent of healing was inspected on a tomographic x-ray before and after six months. At the six month point, the extent of healing was advanced to a stage usually seen after 12 to 18 months when only a bite splint is used. Of the patients with pain in the jaw muscles, pain decreased for up to six hours but without lasting results.

These results showed that low level laser therapy is beneficial for tempromandibular disorders. It should be aimed at treating joint pain but not muscle pain. Low-level laser therapy can also be combined with a bite splint or a bite splint may be used alone.

Tinnitus

Tinnitus is either objective or subjective ringing in the ears with or without any external noise being produced. Most tinnitus comes from damage to the microscopic endings of the hearing nerve in the ear. Objective tinnitus the less common of the two, and is described as ringing in the ears usually heard by other people (a physician's stethoscope). These sounds are usually tempromandibular problems or open of the eustachian tubes. Subjective tinnitus ringing in the ear heard only by the sufferer. This may be caused from a plug of wax in the ear to stiffening of the bones in the ear (otosclerosis). The sounds produced by subjective tinnitus range from metallic ringing, buzzing, blowing, roaring or popping [31]. In older individuals, advancing age is generally accompanied by hearing nerve impairment and tinnitus.

Tinnitus may be caused by a number of different factors. Some of these possibilities include allergies, high blood pressure, a tumor, diabetes, thyroid problems, injury to the head or neck and a variety of medications [31]. Food allergies such as red wine, cheese, chocolate, aspartame and foods rich in salicylates are usually the main allergic reaction concerns with tinnitus. Arteries may press too closely to the inner ear nerves. Tumors such as benign acoustic neuromas can put pressure on the auditory nerves. Many over-the-counter drugs may cause tinnitus and may be permanent. Repeated exposure to loud noises such as movie theaters, amplified music, heavy construction and lawn movers can cause permanent hearing damage. High tech machines such as MRI and CAT scanning machines are very loud and earplugs should be worn.

Tinnitus and Low-level Laser Therapy

Shiomi's [10] and Tauber [31] trials of transmetal cochlear laser and tinnitus were applied to 35 patients with chronic tinnitus. The patients were randomized and received five single-diode laser treatments. These patients were observed closely to make sure there was no damage to the external, middle or inner ear. After a six month follow up, tinnitus was decreased in 13 of the 35 patients and two of the patients were completely free of tinnitus. Shiomi found that 26% of the patients had increased duration, 58% had decreased loudness and 55% had a reduction in annoyance.

Many low-level laser therapy treatments are combined with ginkgo biloba infusions in order to treat tinnitus. Tejncka [11] treated 40 patients with 50 mg of Ginkgo biloba, 20 patients received placebo laser treatment and 20 patients received real laser treatment. Fifty percent of the patients stated that they had a reduction in tinnitus of more than 10dB compared to five percent the control group.

Beyer [32] treated 30 patients five times within two weeks. One group received treatment with 635 nm diode laser and the other group received treatment with 830 nm diode laser. Forty percent of the patients reported a slight to significant decrease of tinnitus.

Prochazka [8] did a trial on 200 patients experiencing diagnosed subjective tinnitus. The average was 64 years of age. There were three scales used to measure the subjective complaints. The percentage scale begins with 100% at the beginning of the trial and goes to 0% for no tinnitus. The five-grade scale was another form of measurement with I = no tinnitus and V = tinnitus limiting all activities. Last is the graphic scale that measures the patient based on facial grimaces. To simplify the effect of the therapy, patients were put into four groups based on the relief of tinnitus (group one no relief, group two less than 50% relief, group three more than 50% relief and group four free of tinnitus). Low-level laser therapy was used on the external acoustic meatus and on the mastoid process. Laser therapy was used on all patients, 31 of which received a placebo treatment. There were eight to ten procedures, twice a week with a four to six week break. Three month follow up treatment consisting of five to six treatments once a week. The placebo group received laser treatment, medication and manipulation of the cervical spine. It was noticed that there was an increase of tinnitus after the first few low-level laser treatments in some of the patients who ended up with greater than 50% relief or no tinnitus remaining at all. The conclusion after three years of monitoring showed 16% had no effects, 15% had less than 50% relief, 43% had greater than 50% relief and 26% were totally free of tinnitus.

Conclusion

Although just a few chiropractic conditions were discussed in this paper, low-level laser therapy may have many uses elsewhere (surgical, veterinary procedures, wound healing, etc.). In many of the studies done for rheumatoid arthritis, low-level laser therapy may be effective for reduction of pain and to decrease the time of morning stiffness. In osteoarthritis, low-level laser therapy resulted in a decrease in pain depending on the type of modality used. Temporomandibular disorders seemed to have gotten the best results. In many cases, the joint pain had decreased whereas the muscle pain had not due to the fact that the muscles were not treated. Tinnitus was reduced in many patients once again depending on the treatment used. As shown from above, some of the research designs were poor which may have led to poor outcome. Further research of good design may show low-level laser therapy is very useful in the conservative management of several conditions.

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