

Pain Management; A modern evidence based, none pharmaceutical approach using 635nm low level laser device

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Abstract

Low level lasers have been used in pain and rehabilitation management for many years, as a modality they are often overlooked, misunderstood and used in concert with other devices. Generally, LLLT is used in physiotherapy practice along with exercise for muscular rehabilitation, primarily of the shoulder. These case notes are taken as a random sample of over 1000 patients, treated over a number of years, to demonstrate the efficacy of LLLT in a Rehabilitation/Pain Management Setting.

Methods used with all these laser patients was the same, that is, direct application of the laser to the nerve root of the affected area with active movement and or resistance of that movement. All nerve root stimulation was for 3 minutes, followed by treatment of the area.

The three patients present here show a consistent approach to management in a methodical way utilising a 635nm laser to achieve to an 89% success rate using this modality alone. The findings of these case presentations may serve to help inform decision makers and support systematic guidelines in pain and rehabilitation management in the application of laser.

1. Keywords: Low level laser, Rehabilitation, Pain, Active movement, nerve route

2. Introduction

The science behind the method of action of Low level laser therapy is not fully understood and research is ongoing to answer this outstanding question.

According to Farivar et al (2014) [1], Low level laser therapy is the application of light to a biological

system to promote tissue regeneration, reduce inflammation and relieve pain. LLLT does not have an ablative or thermal mechanism, rather it has a photochemical effect which means the light is absorbed and causes a chemical systemic change [2].

For low power visible light to have an effect on living cells, the photons must be absorbed by electronic absorption band that are part of a molecular photo-acceptor or chromophores (particular to red laser light) [3]. Water strongly absorbs red laser light, therefore, the use of LLLT for

pain and rehabilitation management almost exclusively uses red and near-infrared light between 600-1100 nm [4]. What we do know, through research about the function of laser, in brief, is as follows.

Water is important in the application of red laser; indeed, it is important for any LLLT application. A review of the research agrees that the involvement of mitochondria is key, Huang et al (2009) is there for still current, cytochrome c is a multi component water-soluble protein that contains a binuclear copper centre along with a heme binuclear centre, which in response to photonic energy through photo reception, becomes cytochrome c oxidase (Cox). Cytochrome c is a terminal enzyme of the electron transport chain and is vital in the bioenergetics of the cell [5].

The photons are absorbed by Cox creating an electronic excited state; this increase leads to acceleration in electron transfer and thus greater electron transport and ATP synthesis [6]. Photo activation of terminal enzymes, like Cox, plays an essential role in the activation of the diverse biological cascade that is seen in LLL application [7]. Cytochrome c oxidase is inhibited by nitric oxide (NO) [8,9]. The easiest way to understand this inhibition is to view it like a competition between the NO and the O₂ for the now reduced binuclear centre Cu₂/a₃ of Cox and is resolvable. Propose that irradiation with LLL could reverse this inhibition through a process of photo dissociation of the NO from its binding sites. This dissociation of NO from Cox increases the respiration rate. Light can reverse inhibition caused by NO binding to Cox, both in isolated mitochondria and in whole cells [10], as a result, LLL protects cells against NO induced cell death [7].

There is a good body of research on reactive oxygen species and gene transcription which talks about redox potential and cellular signalling pathways that control gene expression and modulate the redox state through activation or inhibition of signalling pathways such as nucleic acid, protein, and enzyme synthesis [7, 11-15].

Gene expression profiles show that irradiation of human fibroblasts affects the expression of many genes that belong to many different function categories including those responsible for inflammation and pain mitigation [15]. Irradiation using LLL red light stimulates growth directly through regulation of the expression of genes related to cell proliferation and indirectly through regulation

of the expression of genes related to cell migration and remodelling, DNA synthesis and repair, ion channel and membrane potential, cell metabolism and enhanced proliferation by suppression of cell apoptosis [15]. LLLT has been researched in temporomandibular disorders and shown to have an anti-inflammatory and analgesic effect, this therapy is quick and non-pharmacological.

We know from research carried out by Shen et al 2013 that red laser accelerated nerve regeneration over a large area of neural tissue (sciatic nerve), resulting in axons of greater diameter and myelin sheath of greater thickness. In the authors clinics, red lasers (635 nm) have been extensively used in pain management and research into nerve regeneration in diabetic patients with peripheral neuropath to great results (awaiting publication). Laser is a modality that warrants further study and clinical exploration. The following clinical cases present three possible uses for laser in this environment.

3. Clinical case study 1

3.1. The Case

28 year old male recreational athlete presented with recurrent Plantar Fasciitis to the right foot. The patient has a good minor ketogenic diet. When injury free he runs up to 40kms a week for exercise.

3.2. The Condition

Plantar fasciitis is one of the most common causes of heel pain and affect both sedentary and active people. It is believed to be the result of chronic repetitive overload (Dyck and O'Neill 2004). More current literature suggests that plantar fasciitis in more degeneration rather than just inflammation (Thomas et al 2010). Many patients may have had a sudden increase in their activity level prior to the onset of symptoms.

3.3. The Presentation

On presentation the patient was on no medication other than a topical anti-inflammatory gel, and had been icing the foot for comfort. He had also been doing some plantar stretches before getting out of bed in the morning. He had a steroidal injection from his local hospital 10 weeks before. He also had some shockwave therapy which causes more pain. This was the first time we had seen him; to date nothing had worked.

3.4. The Evaluation: Upon examination there was tightness to the Achilles tendon and tenderness to the anterior medial heel. There was limited dorsiflexion and the patient had a limp and presented with a preference for toe walking. Subjectively pain was worse when barefoot on hard surfaces and with stair climbing. It was also noted that the patient was using an orthotical device. His VAS was 9/10.

3.5. Treatment Rational:

As laser is the only treatment offered for the purposes of these case studies; the base protocol is the same for all, that is, the base dermatome or nerve root is the primary site for laser intervention in all instances in this paper (**Figure 1**).

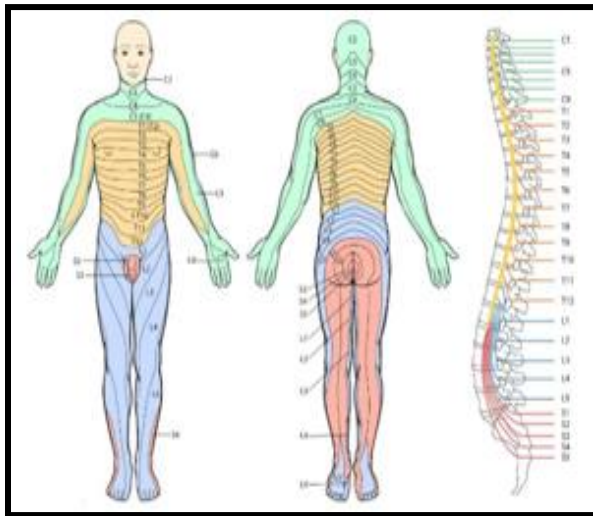


Figure 1: Diagram www.midletonfootclinic.ie with permission.

The above chart demonstrates the dermatomes and their field of action, the nerve root is where the nerve/s for and dermatome exits the spinal column. The above chart demonstrates the dermatomes and their field of action, the nerve root is where the nerve/s for and dermatome exits the spinal column.

Plantar fasciitis is an L5 S1-2 dermatome therefore the primary treatment with the Erchonia's PL Touch 635 nm laser (this has been found to be the most effective by the authors team) (**Figure 2**), was the above area for 3 minutes. The origin of the plantar ligament for 10 mins and the mid gastrocnemius for 3 minutes.



Figure 2: The PL Touch is a dual head 4 diode true laser.

3.6. Treatment procedure:

- Both the patient and the operator wear protective glasses. Have the patient sit on the therapy bench with legs dangling. Apply the laser heads directly to the skin over L5 for approx. 20 seconds, placed medial and lateral, repeat this for S1-2 then scan the area at a distance of about 5cm for a further 2 minutes; the light should be uninterrupted by clothing. While this is being done have the patient plantar and dorsiflex both feet slowly. You and they should notice a change in the quality of the movement.
- With the patient now sitting up on the bench; move both heads of the laser heads to the origin of the plantar ligament and place them directly to the skin for approx.30 seconds then scan the foot at a distance of about 5cm from the origin to the incursions of the tendon for 9 to 10 minutes, have the patient slowly move the toes during this process and after 5 mins stop and manually, with resistance, flex the plantar apronus. Resume the laser.
- Have the patient place the foot flat on the bench. Place the laser heads agents the skin to the mid belly of the gastrocnemius for approx. 30 seconds and the pull back to about 5cm and scan the area for about 3 minutes.
- Have the patient do some stretches and recommend 5 further sessions. Also review footwear and advise them not to go barefoot. A morning stretch prior to getting out of bed is

recommended using a belt or towel not a resistance band.

3.7. Outcome: this patient completed 6 sessions as advised and returned to normal function post week three. 12 months later, the pain has not returned.

4. Clinical case study 2

4.1. The Case

52 year old female diagnosed with complex regional pain syndrome affecting her left arm and hand for the past 12 years plus. She takes amitriptyline 20mg at night and a Tylenol paracetamol combination (Tramacet) and lidocaine patch. The patient considered amputation but was advised by her GP that this would not necessarily end the pain. In the past she has had Botox, arcoxia, and nerve blocks, all with little or no relief. Medical cannabis has given some rest bite from the condition.

4.2. The Condition

Complex regional pain syndrome (CRPS) is characterized by prolonged or excessive pain and changes in skin colour, temperature, and/or swelling in the affected area. CRPS is a chronic (lasting greater than six months) pain condition that most often affects one limb (arm, leg, hand, or foot) usually after an injury. CRPS is believed to be caused by damage to, or malfunction of, the peripheral and central nervous systems. Currently there is no specific test that can confirm CRPS. Its diagnosis is based on a person's medical history and signs and symptoms that match the definition. Since other conditions can cause similar symptoms, careful examination is important. As most people improve gradually over time, the diagnosis may be more difficult later in the course of the disorder. (<https://www.ninds.nih.gov>).

4.3. The Presentation

Subjectively the patient was in a lot of discomfort and appeared generally tired and aggregated. Her general demeanour was one of desperation.

5. On Evaluation

There were visual changes in skin texture on the hand and lower arm and it appeared shiny and thin.

The associated muscles lacked any bulk and her hand and wrist joints were stiff. There was abnormal sweating pattern to the hand and surrounding areas. The nails were brittle and there was no hair growth to the ringers or lower part of the limb. There were further problems coordinating muscle movement, with decreased ability to move the fingers and wrist. There was an abnormal twitch movement in the thumb and palm of the hand, limb, and the wrist had an abnormal posture compounded by involuntary jerking. Her VAS was 10/10. Complex regional pain syndrome occasionally may spread from its source to elsewhere in the body, such as the opposite limb. In some people, signs and symptoms of complex regional pain syndrome go away on their own. In others, signs and symptoms may persist for months to years. Treatment is likely to be most effective when started early in the course of the condition.

This patient presented a particular challenge given the time elapsed since first presentation many years ago. This case is an exception to the norm and a more direct approach is called for. In consultation with the patient, colleagues and some experts in the field, it was agreed that we would take a direct brain approach as we do in other complex cases. The approach involves targeting the whole brain with the laser with both movement of the limb and the reciting do something very familiar to the patient.

Direct brain treatments can be very quick and the response instant. The Erchonia FX 635 laser (**Figure 3**) is used for this type of treatment as it is a three diode true laser.



Figure 3: The Erchonia FX635 nm laser.

5.1. Treatment Procedure

- The procedure is explained to the patient alone with what she is expected to do. The laser was placed over her head with the central diode placed over the central sulcus about 5cm above the scalp. The second was placed focused on the brain stem and cerebellum, again 5 cm away. The final diode was placed to the frontal lobe, again 5 cm away so that an imaginary line drawn from the 2nd to 3rd laser would have them directly facing each other this coupled with the 1st positioned laser means that the total brain is targeted by the laser. The patient and the operator both wear protective glasses.
- As soon as the laser is activated the patient is asked to start reciting something that they know well, such as a nursery rhyme or song and also to begin to slowly move the hand and wrist of the affected limb at the same time. The clinician watches for changes in respiration, involuntary facial movements, pauses or discrepancies in the rhyme or song. When this happens, the laser is switched off and the patient is then asked to continue to move the limb, but more actively. When treating this way, the author or team members have never needed to treat for more than 2 minutes in and one cycle.
- The above cycle was repeated a further 2 times during this visit.

It is very difficult to quantify the number of treatments need in a case such as this. Clinically patients have resolved in as few as 1 treatment and as many as 8. Maintenance is always recommended on the short term, but this is often only at the behest of the patient (Figure 4).

5.2. The Conclusion: this client had 3 treatments in three weeks and had 4 maintenance sessions at 6 weekly intervals. She has now been pain and medication free for 18 months.



Figure 4: Photo from file with kind permission

6. Clinical case study 3

6.1. The Case

44 year old female road traffic accident victim who sustained a whiplash and shoulder injury in 2005 whilst on holiday in Spain when her car was hit from behind. She now suffers with paraesthesia of the digits to the right hand. She has limited mobility to her neck and suffers headaches and anxiety. She was taking tramadol as and when required, arcoxia and ibuprofen. She had acupuncture, a nerve block and Botox for muscle spasms.

6.2. The Condition

A search of the literature shows little research on whiplash since 1997, this paper suggests that whiplash injury may occur as a result of hyperextension of the lower cervical vertebrae in relation to a relative flexion of the upper cervical vertebrae, which produces an S-shape of the cervical spine at the time of impact [16]. This differs from the normal physiology where motion of the cervical spine begins with the upper vertebrae. This theory suggests an abnormal physiologic basis for the development of whiplash injuries.

6.3. The Presentation

On presentation, the patient was lethargic, and the head was too inclined to the right. She was complaining of pins and needles in her arm and hand

that was present for over two weeks and only disappeared with the use of tramadol.

6.4. On Evaluation

The patient had neck pain and stiffness. The other symptoms included headaches, she complained of, mainly occipital, upper back and shoulder pain, and upper limb pain. She had intermittent and sometimes constant paraesthesias, numbness, and/or weakness of the upper limbs and occasionally suffers from dizziness, blurred vision, vertigo, dysphagia, and tiredness.

There are two laser treatment options for this patient, the 1st being laser to the effected nerve root, as already discussed, also laser could also be used directly to the brain as in the previous case, or a combination of both. In this instance we decided to take the nerve root approach.

6.5. Treatment Procedure

- The patient was put sitting on a clinical treatment bench with their legs dangling and the laser was placed for 30 seconds on each of the C vertebra from the occiput to the 7th. This was done with the patient looking forward and slowly moving the fingers of both hands as if playing the piano.
- The steps above were repeated a further three times, but with the patient slowly looking from left to right and increasing the range of movement as the area became more mobile.
- The brachial nerve plexus was then followed down the arm with slow movements being performed by the patient.

At subsequent visits the neck was manually rotated, with and without resistance while the laser was used.

After the 4th session the patient reported nosymptoms but elected to continue treatment for a further 2 sessions. The patient was seen a further three time in the course of a year and has now returned to normal function. Follow up at 18 with the patient was positive and she had no pain.

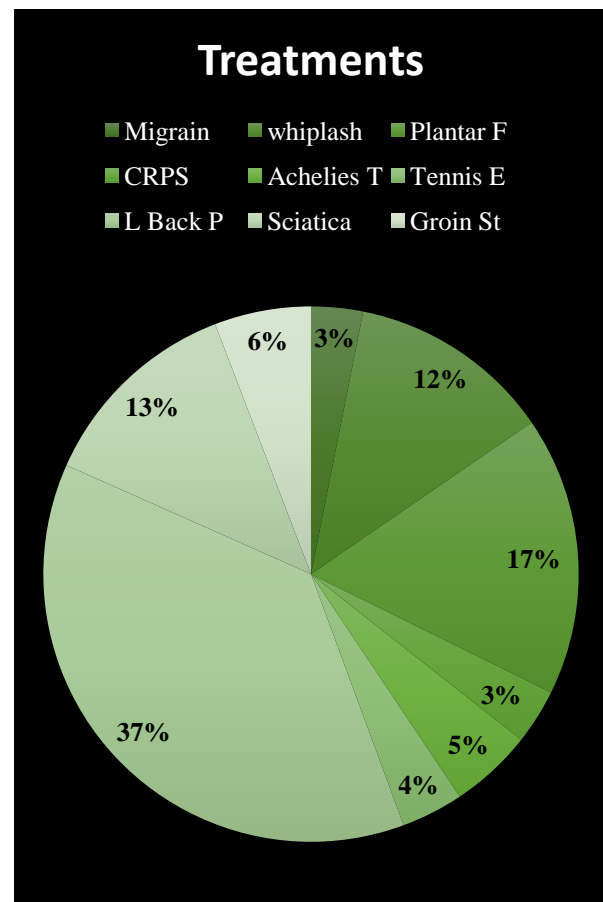
6.6. The Conclusion

This patient had initially 6 treatments with the Erchonia PL-Touch and a further 3 sessions in the year. At her 18 months follow up she was pain free

and returned to normal function. Her pain had not returned.

7. The Argument for Laser

Over the past 6 years many lasers have come on line, some with LED and some without. True laser is colimated light that in unidirectional, of a single wavelength and in phase. Having reviewed many such devices, the Erchonia FX635 and PL-TOUCH was chosen for its versatility, reliability and its support and service. In 5 years the FX and PL combined have treated 4800 patients (**Figure 5**). An audit of these patients shows the following [17,18].



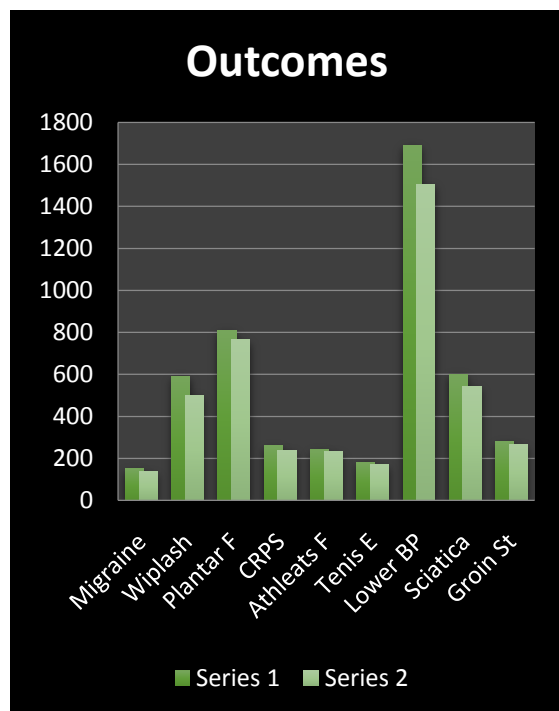


Figure 5: The above chart represents the treatment outcomes and shows the pain free stats at 18 months per treatment group. Series 1 are the numbers treated per category and Series 2 those that remain pain free 18 month post. This shows an 89% efficacy using the Erchonia lasers in these conditions.

8. Conclusion

Prior to using laser more manual treatments were undertaken using various modalities with different levels of success. Laser has changed the way the author and his team think. More challenging cases have been taken and research has been embarked upon culminating in the publication of a study in the regeneration of nerve tissue in diabetic patients suffering with neuropathy. The results of this study were amazing.

Laser has enormous potential in the healthcare market and has the potential to help people in many ways. There is current research being done into Alzheimer's, Parkinson's, ADD and other rehabilitation conditions. We need more good quality research with LLLT to see just where we can take it for the good of all. Laser is not a miracle cure all. A review of the science and mode of action shows the potential of these devices. Initiate the physiological photodynamic changes cause by the Erchonia lasers and think outside of the box. We are scientists and

clinicians, devices such as these allow us to open the windows of possibility.

9. Further Reading

<https://www.sciencedirect.com/topics/medicine-and-dentistry/low-level-laser-therapy>
<https://www.erchonia.com/research-articles/>
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