Chapter

1

Priority Principle Method

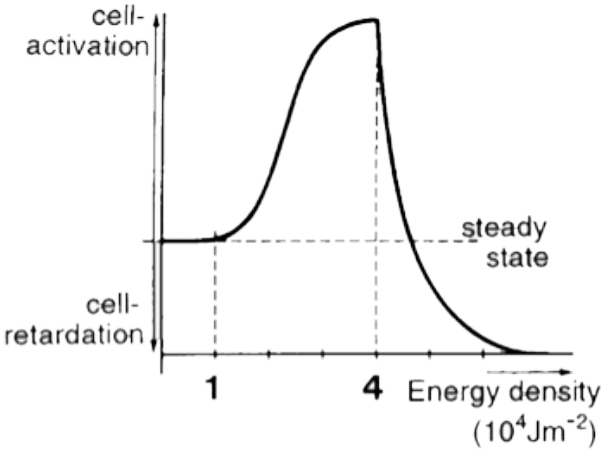
Successful laser therapy outcomes are continually attributed to correct dose, application proper target selection, and technique. However, the relationship between these highly important variables has never been explained or established. The Priority Principle Methodology developed by the Multi Radiance Medical Team has been created to bridge the link between technique, target and dose as they relate to clinical outcomes.

The **Priority Principle** is defined as a dynamic methodology used for integrating laser therapy and other methods/modalities into clinical practice. By prioritizing the current physiological and functional needs of the patient, the phototherapeutic responses and patient outcomes will be maximized by the application of the most appropriate dose and technique to the target tissue.

Before exploring how the Priority Principle Method works, let's spend a moment or two understanding the impact of these three parameters on laser therapy.

Dose:

Dose may be the single most important to consider, and yet it is the most complicated and elusive to grasp. Dose has certainly earned its moniker "impossible" for many reasons. A times, a dose can be stimulatory, have a biphasic response, showing stimulation at a variety of doses and densities, and other times, the exact same dose can be inhibitory, creating excessive amounts of oxidative stress within tissue. While it is easy to say laser therapy doses follow the Arndt Schultz curve, the values of the curve, what threshold, minimum and maximum, are far from being understood. There is no "one size fits all" laser dose, as the required dose can be as unique and individual as the person receiving the treatment.



Both NAALT and WALT[i] have identified some general dose guidelines based on the available literature; but these remain just "probable" suggestions. The appropriate dose appears to be between 0.3 and 19 joules per square centimeter.[ii]

Meta-Analysis of Pain Relief Effects by Laser Irradiation on Joint Areas

Ho Jang and Hyunju Lee.

Photomedicine and Laser Surgery. doi:10.1089/pho.2012.3240.

Abstract

Background: Laser therapy has been proposed as a physical therapy for musculoskeletal disorders and has attained popularity because no side effects have been reported after treatment. However, its true effectiveness is still controversial because several clinical trials have reported the ineffectiveness of lasers in treating pain. Methods: In this systematic review, we investigate the clinical effectiveness of low-level laser therapy (LLLT) on joint pain. Clinical trials on joint pain satisfying the following conditions are included: the laser is irradiated on the joint area, the PEDro scale score is at least 5, and the effectiveness of the trial is measured using a visual analogue scale (VAS). To estimate the overall effectiveness of all included clinical trials, a mean weighted difference in change of pain on VAS was used. Results: MEDLINE is the main source of the literature search. After the literature search, 22 trials related to joint pain were selected. The average methodological quality score of the 22 trials consisting of 1014 patients was 7.96 on the PEDro scale; 11 trials reported positive effects and 11 trials reported negative effects. The mean weighted difference in change of pain on VAS was 13.96mm (95% CI, 7.24–20.69) in favor of the active LLLT groups. When we only considered the clinical trials in which the energy dose was within the dose range suggested in the review by Bjordal et al. in 2003 and in World Association for Laser Therapy (WALT) dose recommendation, the mean effect sizes were 19.88 and 21.05mm in favor of the true LLLT groups, respectively. Conclusions: The review shows that laser therapy on the joint reduces pain in patients. Moreover, when we restrict the energy doses of the laser therapy into the dose window suggested in the previous study, we can expect more reliable pain relief treatments.http://online.liebertpub.com/doi/abs/10.1089/pho.2012.3240

As other parameters can affect how the dose is accepted by the target tissues. Peak and average power, wavelength, whether the laser is super pulsed, continuous or duty cycled, and more importantly the rate of energy deliver to the tissue can all affect the applicable dose. Failure to address these other critical aspects can lead to improper dosing and lack of phototherapeutic response. While these topics are beyond the simple confines of this introduction, time should be spent understanding these concepts and how they impact dose and dose rate.

However, what is critical is the basic understanding of how the Multi Radiance Medical laser therapy systems generate energy and how the pulse repetition (super pulse laser impulse frequency) affects the overall dose and dose rate.

The Gallium Arsenide (GaAs) super-pulsed laser is the second best documented therapeutic laser in the world. The GaAs semiconductor laser creates infrared light and as the name implies, produce a high power level impulse of light for a very brief duration. It is the high power level during each pulse that creates the energy density necessary to deliver light energy to the target tissue.

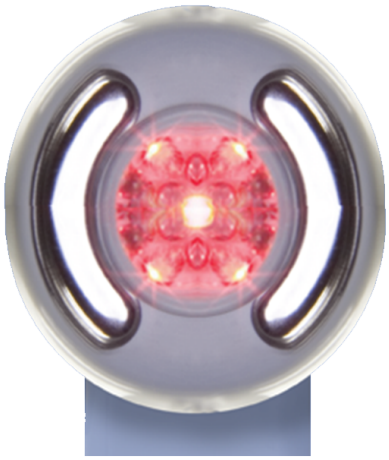
Even though the power is in several watts, the pulses have an extremely short duration (pulse width) resulting in very low thermal effects being transferred to the surrounding tissue.[iii] [iv] Therefore, the peak power of a super-pulsed laser is high compared to its average output power (or heat generation). Since the primary effects of the phototherapy are based on photochemical changes not the result of thermal changes in tissue[v], the super-pulsed laser can effectively deliver higher densities of light energy irradiation with a greater depth of penetration but at a low thermal influence.

The biological responses of cells to super pulsed laser therapy can be different from responses to continuous wave, and there is a strong dependence on pulse repetition rate, pulse duration and duty cycle, as well as dosage and wavelength.[vi] The Super Pulsed laser utilized in the Multi Radiance Technology has a "constant pulse width", usually measured in nanoseconds. This ensures that each impulse of the laser is identical in time, intensity and structure, and independent of a "set dose". Therefore, by changing the laser pulse repetition, there is a change in the mean output of power of the laser. A 5 Hz pulse repetition has 5 "exact" impulses in that second duration; a 50 Hz pulse will have 50 exact impulses in the same time and 10 times more power than the 5 Hz pulse. This allows for an adjustable dose rate.

In vivo trials with 904 nm pulse lasers have demonstrated that Super Pulsed lasers achieve similar effects on collagen production with far lower doses on the animals' skin than lasers with continuous output.[vii] Bjordal et al conducted a review of literature and concluded that "Super Pulsed" lasers (904 nm) were not significantly more effective than CW lasers (810–830 nm); both types of laser achieved similar results, but half the energy was needed to be used for superpulsed lasers.[viii] It was noted for Multi Radiance Medical lasers this "conversion" factor can be between 1/8 and 1/10 of the continuous wave dose.[ix]

Target Selection:

Many papers validate the fact that photonic absorption is dependent on the moment of irradiation.[x] That is, the ability to absorb the photonic energy is dependent on the redox state of the target tissue[xi] and the cellular secondary response upon the cell's sensitivity[xii]. Therefore, even when all dose parameters are optimal, the proper selection of primary and secondary targets is a critical consideration. Failure to identify the injured or affected tissue can result in no response at all, since healthy tissue does not respond nearly the same way as ill or injured tissue.[xiii] [xiv]



While palpation during the physical examination is the most

common method of target identification, the LaserStim™ emitter is a novel method of objectively identifying and locating primary "targets" via the inbuilt impedance meter. The Treatment Area Recognition and Guidance Enhanced Technology (TARGET™) will register any decreases in resistance to the flow of electrical current. These active points can be considered the primary target site for the laser therapy application.[xv]

Once the primary laser therapy targets are properly recognized, the injured tissues type are identified and appropriate laser dose parameters can now be selected. The computed optimal dose is selected to produce either photobiostimulative or photobioinhibitive effects during various stages of healing. Simply, the injured tissue type and desired tissue response dictate the most appropriate application method and dose.[xvi]

Randomly assigning doses, not understanding the effects those doses may have on the tissue and how it affects the stages of healing is foolish and rarely deliver the "promised" laser therapy outcomes. This concept is crucial to the Priority Principle as the marriage of tissue type, phototherapeutic response and technique are the basis for the methodology.

Techniques:

The most common technique is static contact mode with a mild over pressure. This results in a higher local pressure, creating an ischemic area under the laser aperture and photobleaching phenomenon, where the first strong pulse bleaches the opaque barrier of tissue, letting the second pulse pass through the tissue barrier with less loss of energy.[xvii] This ischemia will increase the penetration of laser into the tissue[xviii] up to 40 times for 630 nm (red) and 3 times for 830 nm (infrared) as compared to non-contact.

The Multi Radiance Medical laser probes, LaserStim™ and SE25, have threaded apertures to attach optional "photoprobes" or light guides. The use of the Photoprobe attachments can assist with palpating and an ideal way of facilitating better delivery of the laser to the target tissues as well as collimating the Super Pulsed laser for greater energy density.

When patient contact or over pressure is not possible (ie: acute injury, wounds and hypersensitivity and patient on anti-coagulate drug therapy), the emitter can be held approximately .5 to 3 cm from the skin surface. This will impact the delivered dose and decrease the depth of penetration of non-coherent and coherent light compared to contact methods. Not only has the spot size increased (resulting in a decreased energy density) but the amount of available photons for absorption will be decreased due to reflection from the skin surface. Therefore a dose adjustment may be necessary. Usually an increase in energy is needed to mimic a dose similar to one delivered by contact method. (However, this is dependent on the desired tissue response, at times a "lower" dose may be indicated as in case of pediatric or geriatric populations.)

A scanning technique can also be employed. It is a way to cover a larger volume of skin surface. The emitter is held in contact with the skin and moved approximately 0.5 to 1.5 cm per second (forward - backwards, to the left – to the right, upward - downward) in an area no larger than 50 cm^2. This increase in target area will decrease the delivered dose per unit area. As with the non-contact method, a dose adjustment may be necessary to compensate for losses. This technique may be suited better for pain abatement and increase systemic effects of laser therapy relating to the increased of target area. When a more "uniform" dose is necessary, it is advisable to use the static contact method.

> "Adapt what is useful, reject what is useless, and add what is specifically your own." — Bruce Lee

Scanning and non-contact methods may also be combined. However, as noted previously, the combination of methods will greatly decrease the delivered dose. This is not just due to the reflection of the light sources from the skin, but also the increased treatment area. This is not to say this method does not have applicable uses, however, quantifying the delivered dose will not be possible.

Lastly, there is an ideal technique used for lymphatic drainage and swelling; this is called the "Woodpecker Technique". Treatment is done over major lymph nodes and the emitter is held in place and instead of constant over pressure, there are repeated light percussive strokes. This may well help in the mechanical increase of venous and lymphatic flow as the vessels are alternately compressed and released. Treatment must always begin at the most proximal drainage site of the affected extremity and proceed distally.

In addition to the above techniques, many pioneers[xix],[xx],[xxi] in the laser therapy field have written extensively on additional methods that can positively impact clinical outcomes. Some of these include: laserpuncture, photohemotherapy, trigger points and muscle spasms, swelling and edema, chronic pain, etc. Descriptions of the various techniques will be referenced later in this article but detailed instructions of proper application will follow in subsequent articles.

Priority Principle Methodology:

Since no two patients are ever alike, no two approaches or protocols should be either. The standard cook book treatments may not always taken into account the current stage of healing, or amount of swelling found locally, or the intensity of any associated pain. The Priority Principle allows the clinician to set the "priorities" for the "moment" of treatment, allowing for a more tailored and specific approach.

With the various methods of treatment, it may appear that any clinical decision making in regards to laser therapy is as "impossible" as the dose. However, Priority Principle provides a systematic approach by integrating stages of healing, tissue priority, and laser dose into a simple flow chart based on the clinician selected Principle.

1st	Swelling/edema
2nd	Inflammation
3rd	Spasms
4th	Pain (a),(b)
5th	Tissue Repair (a),(b)
6th	ROM
7th	Functional Strength

There are seven core Principles to the main part of the method. These correlate to the status of the tissue at the moment of treatment, correlating to the histological and clinical status of the patient's injury. The main Principles triage acute and chronic injuries while addressing inflammation, swelling, pain, spasm, quality tissue repair, range of motion improvement, and improvement of function. Explanation and details of each of the Principles, including technique and dosimetry, will be discussed in future articles.

As a note, not all Principles have the same "weight' or importance as others. There is a saying, "90% of the work is done by 10% of the people". This is true in the Priority Principles as well. In many instances, a condition or illness may respond or resolve with utilization of only a few Principle(s) that address the main symptoms of that condition. These Principles should be called "**Prime Principles**", as they can be accredited for the majority of the success of the laser therapy treatment program. For example, a tendinitis is characterized by the presence of inflammation, therefore the 2nd Principle – Inflammation may resolve nearly all cases of tendinitis, however the method is dynamic enough to take into consideration the other small percentage that may require additional treatments or techniques.

-2	<48 Hours (Acute Injury)
-1	General Stimulation

There are two supplementary Principles. These additional "**Negative**" Principles address specific states or conditions of the body. Since the state of the body varies in times of duress, acute injuries (less than 48 hours) and chronic conditions may need preliminary or "priming" treatments to enhance phototherapeutic outcomes.

The [-2 Principle] focuses on treatment during the acute injury phase. The desired effect is to minimizing any swelling, eliminate inflammation and ease pain. This is accomplished by general stimulation of the traumatized tissues with small, frequent doses of laser therapy.

General stimulation [-1 Principle] is utilized in both chronic injuries and illnesses that may have systemic origins (such as osteoarthritis, diabetes, and hypertension. There is not just a single method of stimulation, but a place marker that designates when general systemic effects of laser therapy could be a potential benefit to the patient. Several of the methods include URP (Universal Rehabilitation Program), GSB (General Somatic Biostimulation), PHT (Photohemotherapy), POD (Prophylaxis of Occupational Diseases), POL (Prolongation of Life), Oshiro Proximal Priority Treatment (OPPT). Explanation and details of each of these methods will be discussed in future articles.

0 Pain

While there are physically only 9 Principles, a tenth does exist: the [0 Principle]. This is not by definition a proper Principle but instead it acts as a way of "adjusting" the order of the methodology as needed (PRN). In an ideal world, treatment would always focus only on tissue repair and functional outcomes; however, the presence of pain can negatively impact or derail even the best rehabilitation plans. Therefore, when pain becomes the main Priority, the Priority Principle Method can be made to "jump the track" (bypassing Priorities 1-3) and allow the treatment of symptomatic pain to take center focus in the treatment program. When pain has come under control, or subsided, the "normal" track can either be initiated or continued.

The second part of the Priority Principle is the merging of laser therapy and other methods/ modalities. While laser therapy can be utilized as a monotherapy, it is primarily utilized clinically as an adjunct to other methods and modalities. Therefore, understanding how laser therapy can impact other modalities should be considered. Adaption of the laser therapy parameters, adjustments in the dosage, dose rate or treatment technique may be necessary.

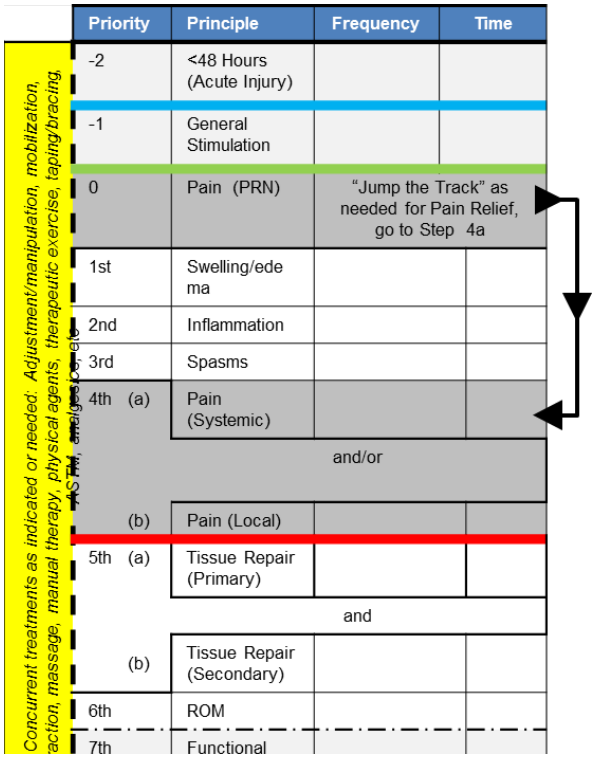
In general, laser therapy is done prior to any thermal modality (this includes hot pack, ultrasounds), and performed after cold applications (such as cold pack or ice massage). When considering massage, adjustment, tractions, or mobilization, laser therapy can be performed either before (to reduce muscle guarding or pain) or after to sate pain or discomfort occasionally felt following some procedures.[xxii]

Concurrent methods other than laser therapy are contained in the Priority Principle in the far left most box. This union is represented in the Priority Principle as a dotted line separating the two modalities, illustrating how both may be utilized in single sessions. Future articles will address how other modalities and methods such as taping, topical analgesics and exercise impact laser treatment parameters.

Using the Priority Principle:

The key to understanding the method is less complicated than it first may appear. After diagnosis or evaluation, the desired objective and subjective outcomes are identified. It is the "priority" of these anticipated goals that will help to determine the first (and most appropriate) course of action.

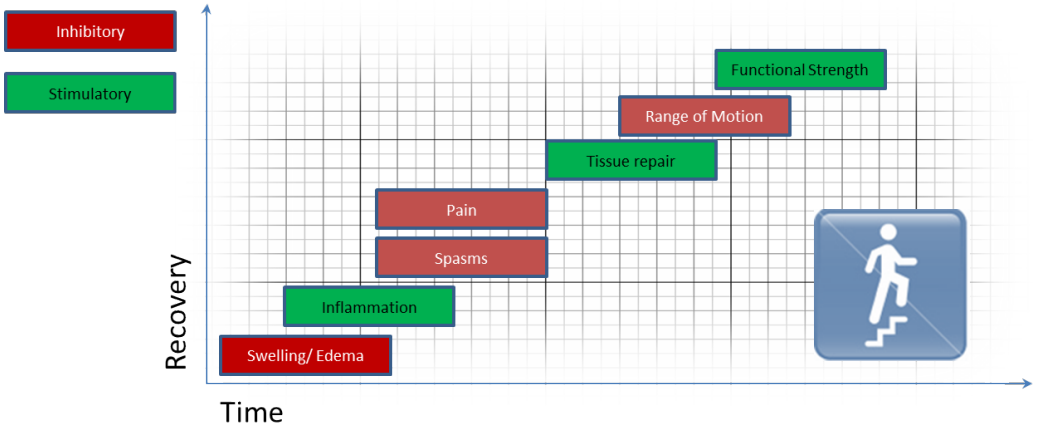
A treatment session is always initiated at the [-2 Principle] and will move sequentially down the list toward the last [7th Principle]. The Priorities can be found in the column labeled "Priority'"; this numbering system is also utilized in other ways to categorize the Priorities. Each Principle is identified by its



corresponding number (-2 to 7, as well as a and b) on many of the anatomical charts found in this manual, but it serves as the proper sequence of Principles in regards to treatment applications.

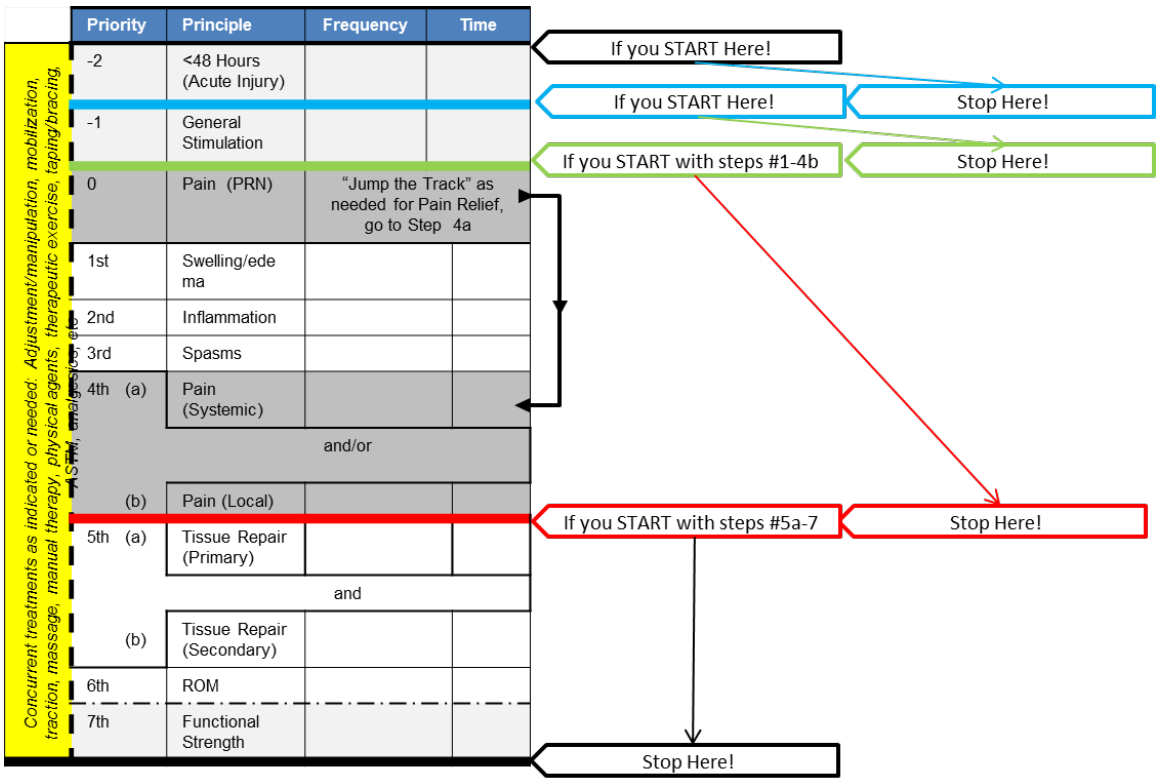
The clinician determines which, if any, Principles are selected. This is done only “if” the “Principle” applies to the condition of the patient or injury. Any “selected” Principles now become part of the Priority Principle Protocol and those not selected are “skipped” from the treatment plan that session. This will allow the "current" state of the patient to be addressed as the "highest" priority of the day. As stated earlier, not every patient (or condition/illness, for that fact) will utilize every one of the 9 Principles. All Principles are listed in “Principle” column (located to the right of the “Prioirty” column) of all Priority Principle Protocol Methods.

Once all selected Principles are identified, the Principle with the greatest Priority (smaller the number, the greater the priority) is the starting point for that treatment session. The highest Principle identified and deemed necessary will determine the treatment course, by providing the “starting” Principle but also, it will dictate the “conclusion” Principle.



In order to maximize the outcomes of each Principle, the associated doses (and methods) are developed to either stimulate the tissue (healing) or inhibit biological activity (or provide pain relief). Principles 2, 5 and 7 are stimulatory, while 1, 3, 4, and 6 are inhibitory. Since a selected target cannot do both in a single session, it is necessary to make sure that targets are not repeatedly treated in the same session. Failure to do so can result in a dose that was initially stimulatory now being transformed into an inhibitory one due to the buildup of the cumulative laser therapy dose within the tissue.

To convey this in the Priority Principle Protocols, solids colored lines indicate when a treatment is to be concluded. Anytime you start with a Principle, you complete any following Principles until you would cross a solid colored line. So in essence, it would be impossible to complete ALL Principles in one session since there are three stops in the method. This will prevent you from treating the same area twice and provide proper dose to the targets at the session. If your starting Principle is [-2 Principle], treatment concludes at the solid blue line, [-1 Principle] on green, [0-4b Principles] on red, and [5a-7 Principle] end with black.



For example, if there is an acute injury less than 48 hours post, the first Priority would be [-2 Principle] and only this one. Since the treatment is typically done "locally" at the injury site, any further treatment will require treatment of that same target (ie: there may be localized pain [0 Principle] or swelling [1st Principle]. Therefore, treatment only uses [-2 Principle]. Follow the Frequency, Time, Target Selection and Technique recommendations provided.

Modifier columns are located to the far left of the Priority Principle, usually highlighted in yellow; there can be more than one modifier column. Regardless of the starting Priority, you should always start with the Modifier farthest to the left. Review how the Modifier may alter the action, function or outcome of the laser therapy before proceeding to initiate treatment with the identified first treatment Priority. If no Modifier is present or it does not apply to any of the selected "Priorities", the highest Priority is the starting location and no modification is necessary.

Rules of the Priority Principle:

To effectively utilize the Priority Principle, there are some basic rules to govern the method. Failure to follow can result in less than desired outcomes.

Priority Principle dictates that:

1. A selected "target" be treated only ONCE per session
2. A tissue can ONLY be stimulated OR inhibited – it cannot do both
3. You can continue "on track" until a "Principle" would require a duplicate treatment of the "same" target (crossing a solid colored line)
4. Review all Modifiers before initiating treatment

5. Follow “Tissue” priority, NOT “patient’s“

Clinicians should not lase the same "target" area more than once per session. Tissue should either be stimulated or inhibited...it cannot do both. This is based on the cumulative dose that can accumulate within the tissue. Fortunately, this is built into the Priority Principle Method (the solid colored lines).

Once you select a Principle, be sure to complete ALL Priorities (in order) until you would cross a solid colored line. This will identify all possible “targets” and “techniques” that should be considered.

Clinically, it is not uncommon for a “patient’s” goals to conflict with what may be the “best” clinical practice. This usually comes in the treatment of pain. While pain is a priority, it is NOT always the main Priority. Pain can be attributed to many factors, including swelling, spasm, inflammation, etc. Therefore, it would be prudent to treat the causation of the pain, rather than provide an inhibitory treatment at the “site” of pain. However, when pain becomes the main Priority, the clinician has the ability to “jump the track” and provide subjective pain treatments.

Chapter

2

Trigger Points, Muscle Spasms and Myofascial Pain

Understanding Trigger Points:

Trigger points, also known as trigger sites or muscle knots, are described as hyperirritable spots in skeletal muscle that are associated with palpable nodules in taut bands of muscle fibers.[xxiii] There are a few more than 620 potential trigger points possible in human muscles.[xxiv] Patients who have trigger points often report regional, persistent pain that usually results in a decreased range of motion of the muscle.

The term "trigger point" was coined in 1942 by Dr. Janet Travell to describe a clinical finding with the following characteristics: pain related to a discrete, irritable point in skeletal muscle or fascia, not caused by acute local trauma, inflammation, degeneration, neoplasm or infection. The painful point can be felt as a nodule or band in the muscle and a twitch response can be elicited on stimulation of the trigger point. Palpation of the trigger point reproduces the patient's complaint of pain, and the pain radiates in a distribution typical of the specific muscle harboring the trigger point. The pain cannot be explained by findings on neurological examination.[xxv]

Spasms may occur when a muscle is overused and tired, particularly if it is overstretched or if it has been held in the same position for a prolonged period of time. This spasm may involve part of a muscle, the whole muscle, or even adjacent muscles. There are a variety of causes of muscle spasms and each depends upon predisposing factors, the part of the body involved, and the environment the body is working in.

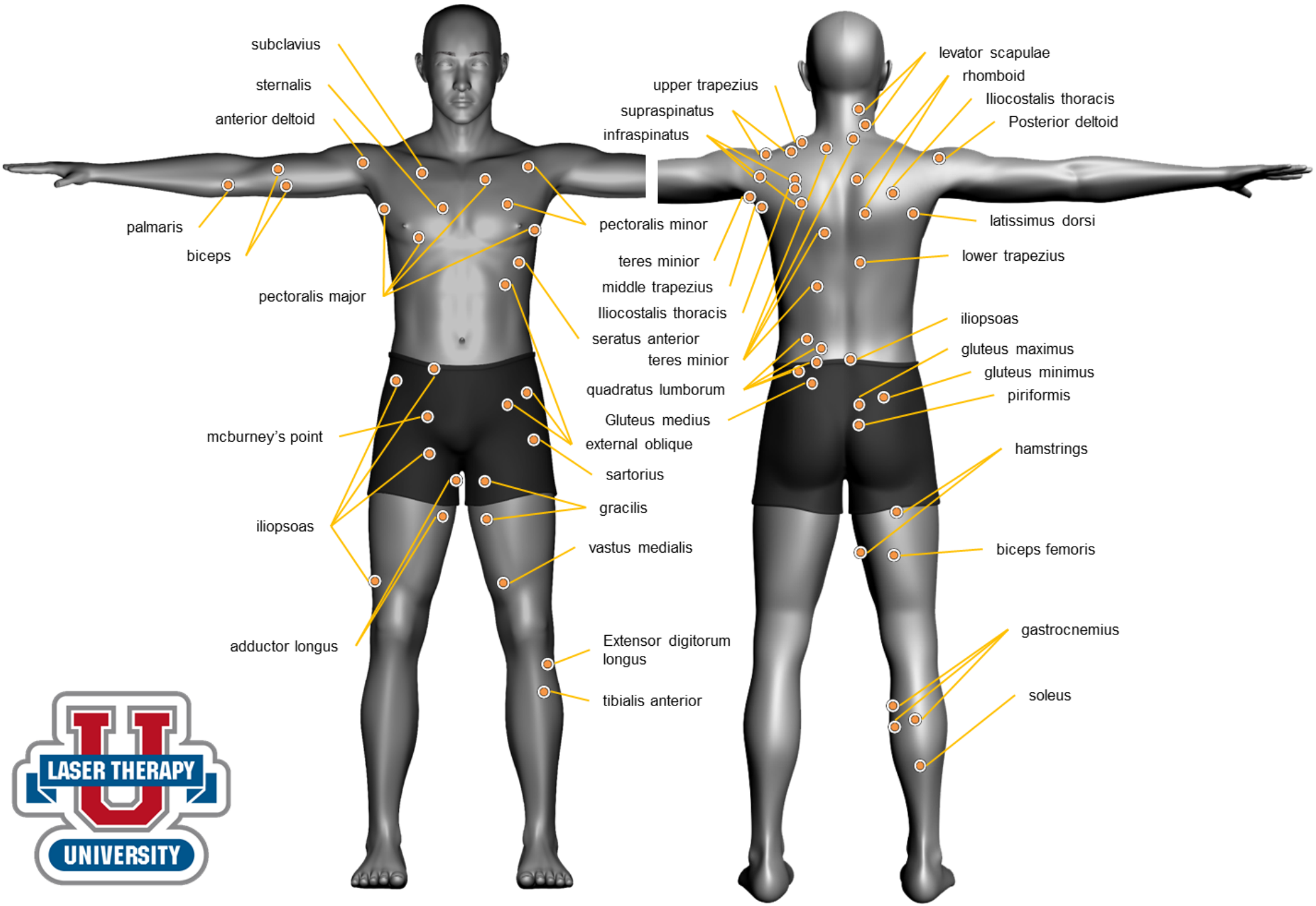
Laser therapy can increase pain thresholds, eliminate trigger points and reduce myofascial pain. The laser photobiostimulation reduces the duration of acute inflammation and accelerates tissue repair in tendon and muscle injuries. LLLT may promote changes in the cellular redox state, playing a pivotal role in sustaining cellular activities. Trigger points are classified as being active or latent, depending on their clinical characteristics.[xxvii]

Table 1: Trigger Points[xxvi]

Trigger Points
Local tenderness, taut band, local twitch response, jump sign
Single or multiple
May occur in any skeletal muscle
May cause a specific referred pain patter

An **active trigger point** causes pain at rest and is tender to palpation with a referred pain pattern that is similar to the patient's pain complaint. This referred pain is felt not at the site of the trigger-point origin, but remote from it. Referred pain is an important characteristic of a trigger point. It differentiates a trigger point from a tender point, which is associated with pain at the site of palpation only.[xxviii]

A **latent trigger point** does not cause spontaneous pain, but may restrict movement or cause muscle weakness.[xxix] The patient presenting with muscle restrictions or weakness may become aware of pain originating from a latent trigger point only when pressure is applied directly over the point.[xxx]



Supporting Research:

While scientific evidence is lacking for the development of trigger points, they have been attributed to disease, psychological distress (via systemic inflammation), homeostatic imbalances, acute trauma or repetitive micro trauma.[xxxi] Occupational, recreational and sporting activities that produce repetitive stress on a specific muscle or muscle group commonly cause chronic stress in muscle fibers, leading to trigger points.[xxxii]

There is, however, strong clinical evidence to support the use of laser therapy on myofasical trigger points. Decreases in muscle rigidity, spontaneous pain relief and improved range of motion and pain thresholds have all been demonstrated by laser therapy applications.[xxxiii]

Rizzi et al[xxxiv] utilized a Gallium Arsenide laser (904 nm, 45 mW, and 5 J/cm2 applied for 35 seconds duration) to reduce the inflammatory response induced by trauma and was able to block the effects of reactive oxygen species (ROS) release and the activation of NF-kappaB. The associated reduction of iNOS overexpression and collagen production suggest that the NF-kappaB pathway may be a signaling route involved in the pathogenesis of muscle trauma.[xxxv] Low level laser therapy improves local microcirculation, supplying hypoxic cells in the trigger point areas with improved oxygen supply and removing collected waste products. The normalization of the microcirculation, obtained due to laser applications, interrupts the "circulus vitiosus" of the origin of the pain and its development (Melzak: muscular tension > pain > increased tension > increased pain, etc.).[xxxvi]

Several meta-analyses suggested the use of LLLT on tender points or MTrPs of LE could effectively improve therapeutic effects. Vernon and Schneider[xxxvii] reviewed the most commonly used treatment procedures in chiropractic for myofascial pain syndrome (MPS) and myofascial trigger points (MTrPs). A Review of 112 articles resulted in strong evidence support for laser therapy. Chang et al[xxxviii] performed a systematic review and meta-analysis on the conservative treatment for lateral epicondylitis. Seven of the ten selected articles discussed the irradiation was conducted on tender points or MTrPs. The results revealed that applying LLLT on tender points or MTrPs is an effective means to improve the effect size (ES) of pain release after treatment.

The Super Pulsed laser has been demonstrated a high level efficacy in the literature and is recommended by Jan Tuner and Lars Hode, authors of essential guide on laser therapy, The New Laser

Applying Research Data to Improve Clinical Outcomes:

Acute pain can be diminished more than 70%, chronic pain more than 60% in on session

Clinical effectiveness (success or failure) depends on the correctly applied energy dose--over/underdosage produces opposite, negative effects on cellular metabolism

Laser treatment frequency of 1/day given for 5 consecutive days, followed by a 2-day rest interval with an average 12 applications was optimal

The effect on pain can be seen in less than fifteen minutes following the therapy

Therapy Handbook. They write, "The GaAs laser is the most effective in the treatment of pain, inflammations and functional disorders in muscles, tendons, and joints."[xxxix] This statement is further validated by the following research:

Gur et al[xl] studied the efficacy of 904 nm gallium arsenide low level laser therapy in the management of chronic myofascial pain in the neck. In double-blind, randomized, and controlled trial 60 MPS patients were randomly assigned to two treatment groups. Active treatments were conducted daily for 2 weeks (except for weekends). In active laser group, statistically significant improvements in pain at rest, pain at movement, number of trigger points (TP), the Neck Pain and Disability Visual Analog Scale (NPAD), Beck depression Inventory (BDI), and the Nottingham Health Profile (NHP).

Tam[xli] used a pulsed diode laser, GaAs 904 nm wavelength once per day for 5 consecutive days, followed by a 2-day interval with an average 12 applications. We irradiated the trigger points, and found laser has substantially reduced the pain and improved the quality of life of these patients.

Simunovic[xlii] measured the clinical treatment of more than 200 patients and the effect of 904 nm super pulsed LLLT had on trigger points. He notes in acute pain, diminished more than 70%; in chronic pain more than 60%. Clinical effectiveness (success or failure) depends on the correctly applied energy dose--over/underdosage produces opposite, negative effects on cellular metabolism.

Olavi et al[xliii] evaluated the effects of the 904 nm infrared laser therapy at treated and non-treated trigger points in the muscles of the infraspinatus, extensor carpi radialis, levator scapulae, trapezius and tibialis anterior. In the results there were observed highly significant changes in pain threshold between the laser and placebo groups immediately after the treatment, (p less than 0.001). The differences between these two treatments were greater after fifteen minutes of the therapy.

Treatment Technique:

Successful laser therapy outcomes, in particular with the treatment of muscle spasms, are technique driven. Poorly executed or improper methods can lead to less than desirable clinical outcomes. It begins with proper laser selection. An infrared (750 nm to 1000 nm wavelengths) therapeutic laser with a large peak power, or large energy density, without creating excessive tissue heating is ideal. An example of this type of laser is a Gallium Arsenide super pulsed laser. A super pulsed laser will have a very large peak power (greater than 15 W), but its average power output is very low. Alternatively, a low level or "cold" continuous wave laser may be utilized if the mean output of power is less than or

equal to 500 mW.

When trigger points are present in muscles there is often pain and weakness in the associated structures and follow specific nerve pathways. Many trigger points have pain patterns that overlap, and some create reciprocal cyclic relationships that need to be treated extensively to remove them. It then becomes of critical importance that all active and latent trigger points be cleared. Failure to address the root of problem and the outcomes will be less the desirable. This was found with Altan et al. who investigated the effect of Super Pulsed (GaAs) laser therapy on cervical myofascial pain syndrome without success.[xliv] The lack of clinical outcomes suggests that proper technique, identification of all active trigger points and dosage were inadequate.

No phototherapeutic effects are seen when low level laser therapy was applied to uninjured muscle.[xlv] Therefore, the first step is proper identification of the muscle spasm or trigger point.

There are several methods available to clinicians. Palpation is the most common method; however the LaserStim™ emitter is a novel method of objectively identifying and locating trigger or tender points via an impedance meter. Since trigger points will register a decreased resistance to the flow of electrical current, it will register as an active point and is considered a laser therapy target. Snyder-Mackler et al [xlvi] performed a double-blind study on twenty-four patients was to ascertain the effects of laser irradiation on skin resistance and pain in patients with trigger points in the neck or low back. Pre-treatment and post treatment skin resistance and pain measurements were taken during each session. Results indicated a statistically significant increase in skin resistance (p less than .001) and a decrease in pain (p less than .005) following laser treatment.

The Multi Radiance Medical laser probes, LaserStim™ and SE25, have threaded apertures to attach optional “photoprobes” or light guides. These attachments can assist with palpating and provide pain threshold ratings of trigger points as well as secondary soft tissue stimulation.

Once a trigger or tender point is identified, it is crucial that the laser aperture (where the laser light is emitted) be held perpendicular to the trigger point (target surface) with direct skin contact and “mild” overpressure. This facilitates deeper penetration of the laser and helps to prevent reflection of laser energy off the skin surface. Dr Pekka Pöntinen recommends the The Pöntinen Principle[xlvii], a set of treatment guidelines for the treatment of trigger and tender points. The method has been adjusted and simplified here for all Multi Radiance Medical laser therapy devices.

UPDATED!!!: Adapted Pöntinen’s Principle (Multi Radiance Medical)

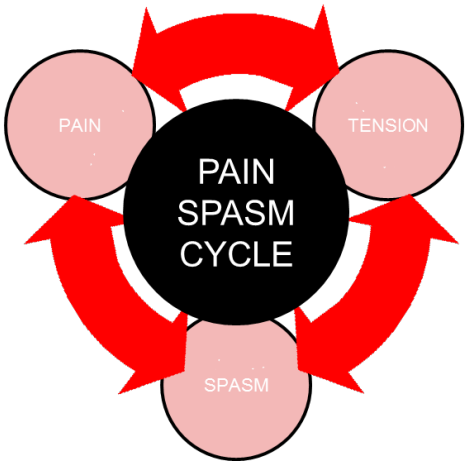
1. Select [1000], [3000], [5000] or [1000-3000 Hertz]
2. Identify trigger point utilizing the LaserStim TARGET feature or palpate suspected trigger points, be sure to document pain threshold, pain level (on a scale of 1 to 10, 10 being the worst) and texture of the TP
3. Attach PhotoProbes (corporal, auricular or utility) if desired

4. Lase the TP, static method, 2-5 minutes, with mild overpressure perpendicular to the target surface
5. Re-evaluate the TP and record any changes in pain threshold, pain level (on a scale of 1 to 10, 10 being the worst) and texture of the TP
6. If pain or spasm persists, reapply the entire treatment sequence, maximum of two additional times

Dr. Christopher Carraway, DC demonstrating Pöntinen's Principle

The effects of the laser application can be seen in one application and can have lasting effects. Functional outcomes can be easily and objectively monitored via dynameters, goniometers and dolorimeters to measure changes in strength, joint range of motion and pain thresholds following applications.

Once there is a reduction or elimination of the trigger points, other modalities or procedures may be performed in the treatment plan. These can include soft tissue mobilization, instrument assisted soft tissue mobilization, massage, traction, mobilization or therapeutic exercise.



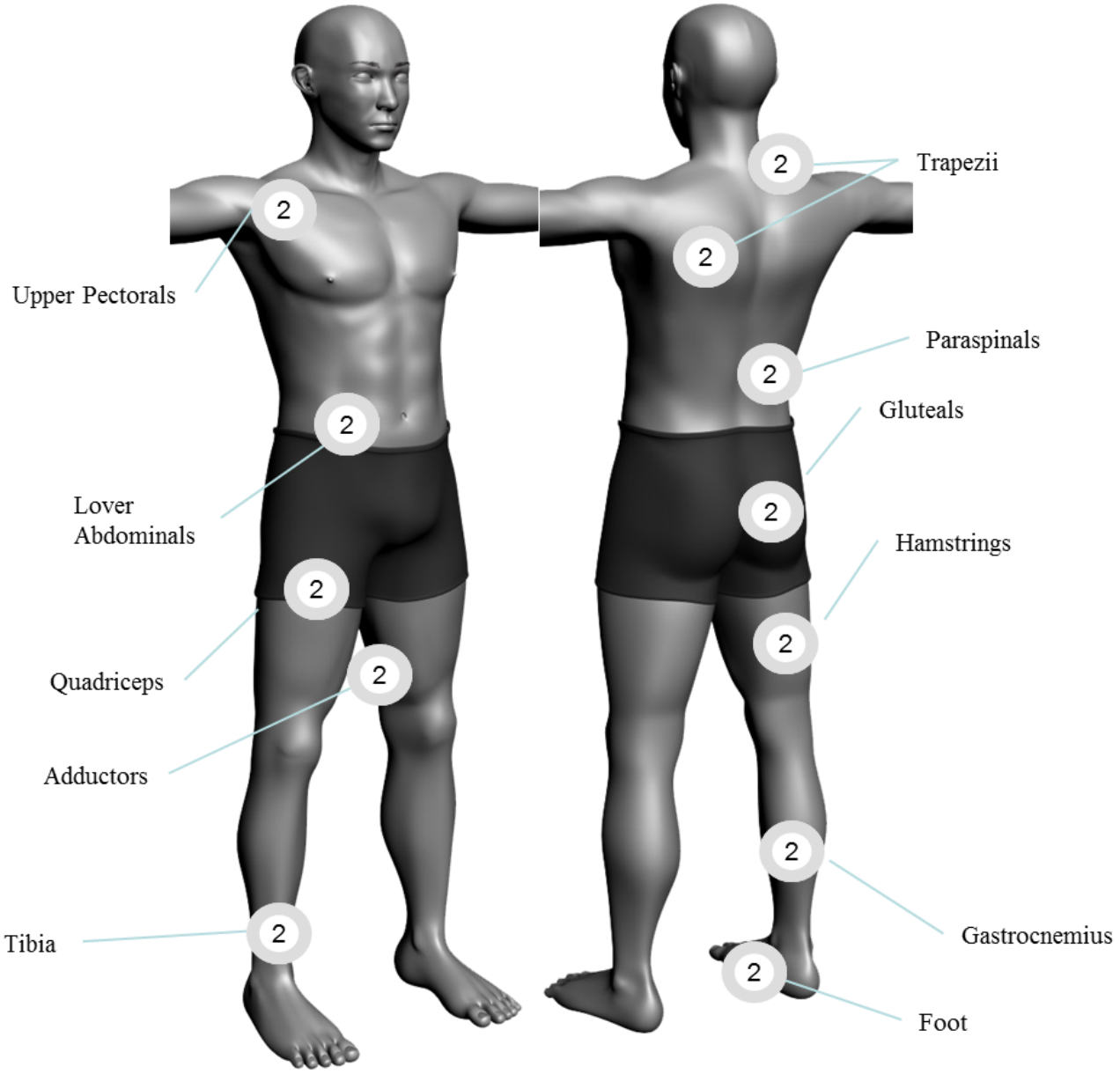
For acute muscle trauma, it is suggested that treatment also include early mobilization to induce more rapid and intensive capillary in growth into the injured area, better regeneration of muscle fibers, and more parallel orientation of the regenerating myofibers in comparison to immobilization.[xlviii]

Low level laser therapy improves local microcirculation, supplying hypoxic cells in the trigger point areas with improved oxygen supply while removing collected waste products.[xlix] The normalization of the microcirculation, obtained due to laser applications, interrupts the “pain/spams cycle”. Laser therapy is quickly administered, safe, easy and effective and should be considered a viable option for reducing trigger points, muscle spasm.

Priority Principle™: 3 Muscle Spasm

Post	3rd	Spasms: at palpable spasms in affected area, active and latent	1000 or 3000 Hz with Photoprobes	Pontinen's Principle

	Corporal Probe: Corporal acupuncture is done on points on the body. This probe can also be used for muscle trigger and mostor points.
	Utility Probe: This is an inter cavity probe designed for treatment of the mouth and ears. It may additionally be used as a point probe for patients that may find the corporal probe uncomfortable.



Chapter

3

Range of Motion

Understanding Trigger Points:

While, trigger points form only in muscles, **tender points**, or AHSHI points, are associated with pain at the site of palpation only, are not associated with referred pain, and occur in the insertion zone of muscles, not in taut bands in the muscle belly.[I] The pulling on tendons and ligaments associated with the spasm can cause pain deep within a joint where there are no muscles.

While, trigger points form only in muscles, tender points, or AH-SHI points, are associated with pain at the site of palpation only, are not associated with referred pain, and occur in the insertion zone of muscles, not in taut bands in the muscle belly. The pulling on tendons and ligaments associated with the spasm can cause pain deep within a joint where there are no muscles.

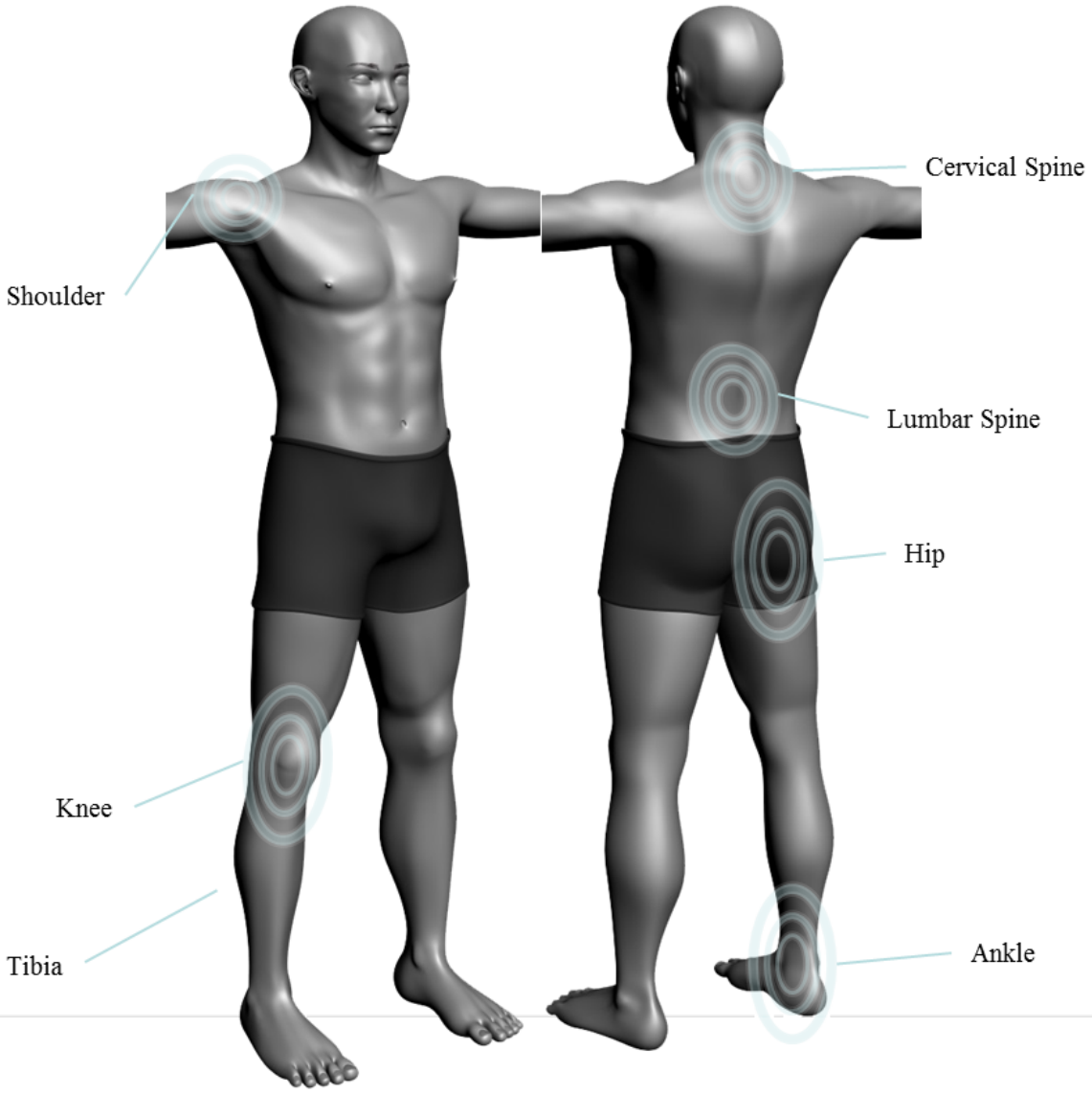
Table 2: Tender Points[li]

Tender Points
Local tenderness
Multiple
Occur in specific location are symmetrically located
Do not cause referred pain, but often cause a total body increase in pain sensitivity

Priority Principle™: 6 Range of Motion

6th	ROM: to all affected and limited joints at 3-4 location per joint line (Tender points or AHSHI points)	1000 Hz or greater	1-2 min with LaserStim or Photoprobe attachment

No of AHSHI Points	Affected joint
2-3	Fingers
3-4	Wrist
4	Elbow
4-5	Shoulder
3-4	Cervical Spine
3-4	Thoracic Spine
3-4	Lumbar Spine
4-5	Hip
3-4	Knee
3-4	Ankle
2-3	Toes



Chapter

4

Muscle Strains

Understanding Trigger Points:

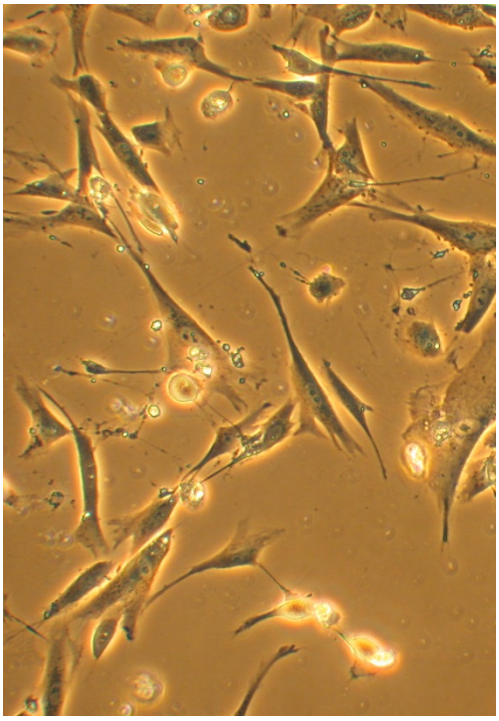
A strain is an injury to a muscle or tendon in which the muscle fibers tear as a result of overstretching. Typical symptoms of a strain include: localized pain, stiffness, discoloration and bruising around the strained muscle. Muscle strains are graded I, II, or III depending on the severity of the injury.

Grade I Muscle Strain:

- Muscle or tendon is overstretched
- Small tears to muscle fibers may or may not occur.
- Mild pain with or without swelling

Grade II Muscle Strain:

- Overstretched with torn fibers but not completely
- Marked pain with swelling
- Tenderness to palpation
- Bruising
- Painful movement



Grade III Muscle Strain:

- Most serious
- Most of the muscle fibers are torn or completely ruptured
- Pain, swelling, tenderness, and bruising are present
- Movement is usually difficult

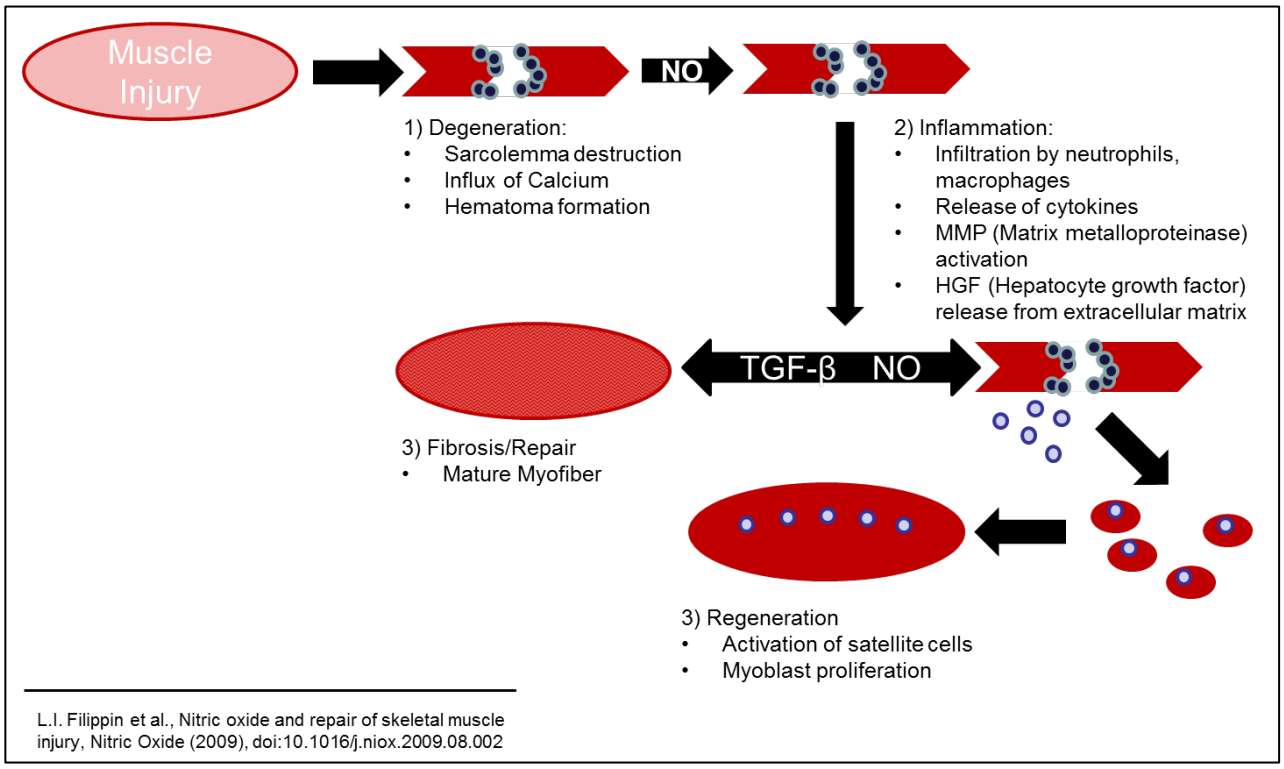
During skeletal muscle healing the predominant cell is the fibroblast and following trauma can be understood as a balance between fibrosis and regeneration.[lii] Factors influencing this balance consist of inflammation, the growth factors and cytokines present in site of injury, the interaction between infiltrating inflammatory cells and native myogenic cells.

The muscle fibrosis is an overproliferation of components of the extracellular matrix beginning approximately 2 weeks after injury and accelerating thereafter for as long as 4 weeks. The fibrotic scar tissue formation may lead to inadequate healing and a deficient muscle function.[liii]

Amaral et al evaluated the effect on mice skeletal muscle regeneration of different doses. 2.6, 8.4, and 25 J/cm2 of HeNe laser (λ 632.8 nm; power, 2.6 mW; spot size, 0.007 cm2) applied directly to intact skin of injured muscle. Muscle injury was induced in both right and left Tibialis anterior (TA) muscles by ACL myotoxin. Only the 2.6 J/cm2 dose resulted in changes such as increased mitochondrial density and muscle fiber in the TA muscles as compared to sham groups fiber area and mitochondrial density.[liv] This suggests smaller, more stimulatory doses are required to promote muscle repair.

Rizzi et al[lv] utilized a 904 nm, 45 mW, and 5 J/cm2 applied for 35 seconds duration to reduce the inflammatory response induced by trauma and was able to block the effects of reactive oxygen species (ROS) release and the activation of NF-kappaB.

LLLT application 24 h post-trauma by 7 or 14 days markedly inhibited the oxidative stress, followed by inhibition of iNOS expression, NF-kappaB activation and collagen deposition. The associated reduction of iNOS overexpression and collagen production suggest that the NF-kappaB pathway may be a signaling route involved in the pathogenesis of muscle trauma.[lvi] None of these effects could be seen when LLLT was applied to uninjured muscle.



Pulsed ultrasound has been suggested as well however, Rantanen et al concluded there were no significant effects on the overall morphological manifestations of muscle regeneration.[lvii]

Avni D, Levkovitz S, Maltz L, Oron; Protection of skeletal muscles from ischemic injury: low-level laser therapy increases antioxidant activity; Photomed Laser Surg. 2005 Jun;23(3):273-7

OBJECTIVE: The aim of this study was to investigate the effect of low-level laser therapy (LLLT) on ischemic-reperfusion (I-R) injury in the gastrocnemius muscle of the rat.

BACKGROUND DATA: Ischemic injury in skeletal muscle is initiated during hypoxia and is aggravated by reoxygenation during blood reperfusion and accumulation of cytotoxic reactive oxygen superoxides. LLLT has been found to biostimulate various biological processes, such as attenuation of ischemic injury in the heart.

MATERIALS AND METHODS: The injury was induced in the gastrocnemius muscles of 106 rats by complete occlusion of the blood supply for 3 h, followed by reperfusion. Another group of intact rats served to investigate the effect of LLLT on intact nonischemic muscles. Creatine phosphokinase, acid phosphatase, and heat shock protein were determined 7 days after I-R injury and antioxidant levels 2 h after reperfusion.

RESULTS: Laser irradiation (Ga-As, 810 nm) was applied to the muscles immediately and 1 h following blood supply occlusion. It was found that laser irradiation markedly protects skeletal muscles from degeneration following acute I-R injury. This was evident by significantly ($p < 0.05$) higher content of creatine phosphokinase activity and lower ($p < 0.05$) activity of acid

phosphatase in the LLLT-treated muscles relative to the injured non-irradiated ones. The content of antioxidants and heat shock proteins was also higher ($p < 0.05$) in the LLLT-treated muscles relative to that of injured non-irradiated muscles.

CONCLUSION: The present study describes for the first time the ability of LLLT to significantly prevent degeneration following ischemia/reperfusion injury in skeletal muscles, probably by induction of synthesis of antioxidants and other cytoprotective proteins, such as hsp-70i. The elevation of antioxidants was also evident in intact muscle following LLLT. The above phenomenon may also be of clinical relevance in scheduled surgery or microsurgery requiring extended tourniquet applications to skeletal muscle followed by reperfusion.

Shefer G, Partridge TA, Heslop L, Gross JG, Oron U, Halevy O.; Low-energy laser irradiation promotes the survival and cell cycle entry of skeletal muscle satellite cells; J Cell Sci. 2002 Apr 1;115(Pt 7):1461-9.

Low energy laser irradiation (LELI) has been shown to promote skeletal muscle cell activation and proliferation in primary cultures of satellite cells as well as in myogenic cell lines. Here, we have extended these studies to isolated myofibers. These constitute the minimum viable functional unit of the skeletal muscle, thus providing a close model of in vivo regeneration of muscle tissue. We show that LELI stimulates cell cycle entry and the accumulation of satellite cells around isolated single fibers grown under serum-free conditions and that these effects act synergistically with the addition of serum. Moreover, for the first time we show that LELI promotes the survival of fibers and their adjacent cells, as well as cultured myogenic cells, under serum-free conditions that normally lead to apoptosis. In both systems, expression of the anti-apoptotic protein Bcl-2 was markedly increased, whereas expression of the pro-apoptotic protein BAX was reduced. In culture, these changes were accompanied by a reduction in the expression of p53 and the cyclin-dependent kinase inhibitor p21, reflecting the small decrease in viable cells 24 hours after irradiation. These findings implicate regulation of these factors as part of the protective role of LELI against apoptosis. Taken together, our findings are of critical importance in attempts to improve muscle regeneration following injury. Anat Rec. 1995 Jan;241(1):123-8.

http://www.ncbi.nlm.nih.gov/pubmed/22538842?dopt=Citation

Priority Principle™: Muscle Strains

Mobilization, Elevation, Taping, ASTM

When	Priority	Principle	Muscle Spasm/Tenderness	Time
Pre	-2	<48 Hours (Acute Injury): At any acute spasm <48 Hours	5-1000 Hz	3 min scanning with LaserShower
Post	3rd	Spasms: at palpable spasms in affected area, active and latent	1000 or 3000 Hz with Photoprobes	Pontinen's Principle
Post	4th (a)	Pain (Systemic)	1000 Hz NRT	5 min scanning the entire spinal column with LaserShower
Post	5th (a)	Tissue Repair (Primary) at TARGET Identified Locations of spastic area including key and satellite points	5-250 Hz	DOSE with LaserStim
		and		
	(b)	Tissue Repair (Secondary/Improvement of blood circulation/removal of toxins)	50 Hz PHT to major artery of the body	5 min with LaserShower
Pre	6th	ROM: to all affected and limited joints at 3-4 location per joint line (Tender points or AHSHI points)	1000 Hz	1-2 min with LaserStim or Photoprobe attachment

# of Procedures/Bout	Frequency	Rest Period	# of Bouts per year
8-10 Treatments	Daily or Alternative Days	2 days	1-2 as needed

Chapter

4

Tendinitis

Lateral Epicondylitis (Tennis Elbow):

Tennis Elbow or Lateral Epicondylitis is an extremely common injury that originally got its name as it appeared in a high proportion of tennis players. Nevertheless, it commonly manifests in a vast proportion of people who do not play tennis at all. Tennis Elbow occurs most commonly in the tendon of the extensor carpi radialis brevis muscle at approximately 2 cm below the outer edge of the elbow joint or lateral epicondyle of the humerous. Abnormalities of the tendon occur to be an excess of fibroblasts and blood vessels in the area and actual deformity of the normal collagen that makes up a healthy tendon. Inflammation is rarely present and there is an increase in pain receptors in the area making the region extremely tender.

Lateral elbow pain in the elbow affects up to 3% of the population and symptoms may persist for over 1 year in up to 20% of people. Tendinopathies are one of the "Top 5 Conditions" seen clinically and most common in the wrist and hand. Overuse tendinitis comprises between 25% and 50% of all sports injuries (Rettig).

Tendons are very slow to heal and rarely regain their original strength. Partial tears heal by the rapid production of disorganized type-III collagen (which is weaker than normal tendon) which leads to a recurrence of injury.

The following protocol is based upon the findings of several studies. Oken et al[lviii] evaluate the effects of low-level laser therapy (LLLT) and to compare these with the effects of brace or ultrasound (US) treatment in tennis elbow. The results show that, in patients with lateral epicondylitis, a brace has a shorter beneficial effect than US and laser therapy in reducing pain and that laser therapy is more effective than the brace and US treatment in improving grip strength.

Simunovic et al[lix], Stergioulas[lx] and Lam and Cheing[lxi] studied the effectiveness of 904 Super Pulsed Ga-As laser for lateral epicondylitis; and low level laser therapy was shown to have an effect over placebo. Both Stergioulas and Lam and Cheing additionally studied a combination protocol of laser and plyometric exercises with controls in the treatment of tennis elbow. The results suggested that the combination of laser with exercises was more effective treatment than placebo laser in improving the grip strength and subjective rating of physical function of patients with lateral epicondylitis. The importance of the exercise program in lateral epicondylitis rehabilitation is confirmed by the work of Vasseljen et al[lxii] in that the effect of the Super Pulsed laser (GaAs) was shown to have an effect over placebo; however, as a sole treatment for lateral epicondylitis it is of limited value.

Tam[lxiii] notes long-term differences between injections and LLLT were significantly in favor of LLLT. Success rate at 52 weeks were 14 (70%) for injections, 19 (90.5%) for LLLT, and 16 (83%) for wait-and-

see policy. Bjordal[lxiv] states laser therapy is "as well documented as NSAIDs and steroid injections for shoulder tendinitis/bursitis and epicondylalgia. Adverse effects from LLLT are seldom seen and they appear less serious than for patients treated with NSAID and steroid injections."

The treatment plan should include manual therapy[lxv], [lxvi] and exercise. Simunovic[lxvii] observed that under and over irradiation dosage can result in the absence of positive therapy effects or even opposite, negative (e.g., inhibitory) effects so doses should be monitored.

Simunovic observed that under and over irradiation dosage can result in the absence of positive therapy effects or even opposite, negative (e.g., inhibitory) effects so doses should be monitored. Therefore, dosing should be determined by the LaserStim DOSE feature.

Be aware of the effects of oral anti-inflammatory medications and corticosteroid injections on laser therapy. Lopes-Martins et al[lxviii] have effectively shown that use of low level therapy in mice with induced (carrageenan injection) pleurisy decreased inflammation almost to pre-injection level after just four hour treatment. Pre-injection with NSAID blocked anti-inflammatory effect of low level laser therapy.

Chapter

5

Pain

Lateral Epicondylitis (Tennis Elbow):

Meta-Analysis of Pain Relief Effects by Laser Irradiation on Joint Areas

Ho Jang and Hyunju Lee.

Photomedicine and Laser Surgery. doi:10.1089/pho.2012.3240.

Abstract

Background: Laser therapy has been proposed as a physical therapy for musculoskeletal disorders and has attained popularity because no side effects have been reported after treatment. However, its true effectiveness is still controversial because several clinical trials have reported the ineffectiveness of lasers in treating pain. Methods: In this systematic review, we investigate the clinical effectiveness of low-level laser therapy (LLLT) on joint pain. Clinical trials on joint pain satisfying the following conditions are included: the laser is irradiated on the joint area, the PEDro scale score is at least 5, and the effectiveness of the trial is measured using a visual analogue scale (VAS). To estimate the overall effectiveness of all included clinical trials, a mean weighted difference in change of pain on VAS was used. Results: MEDLINE is the main source of the literature search. After the literature search, 22 trials related to joint pain were selected. The average methodological quality score of the 22 trials consisting of

1014 patients was 7.96 on the PEDro scale; 11 trials reported positive effects and 11 trials reported negative effects. The mean weighted difference in change of pain on VAS was 13.96mm (95% CI, 7.24–20.69) in favor of the active LLLT groups. When we only considered the clinical trials in which the energy dose was within the dose range suggested in the review by Bjordal et al. in 2003 and in World Association for Laser Therapy (WALT) dose recommendation, the mean effect sizes were 19.88 and 21.05mm in favor of the true LLLT groups, respectively. Conclusions: The review shows that laser therapy on the joint reduces pain in patients. Moreover, when we restrict the energy doses of the laser therapy into the dose window suggested in the previous study, we can expect more reliable pain relief treatments.http://online.liebertpub.com/doi/abs/10.1089/pho.2012.3240

Chapter

5

Sports Performance, Recovery, Prevention and Rehabilitation $(PR)^2$

Chapter Objectives:

The mechanisms of laser therapy performance enhancement and the latest peer reviewed evidence

The prevention of "overuse injuries" and over training utilizing Super Pulsed laser therapy

Learn Multi Radiance Medical's Priority PrincipleTM specific laser therapy protocols for performance and recovery that can be implemented immediately

Three Methods:

Mediation of pain

Increase in b-Endorphins

Decreased C fiber activity by blocking depolarization

Stimulated replenishment of Neurotransmitters at synaptic level

Increased nitric oxide production

Increased nerve cell action potential

Axonal sprouting and nerve cell regeneration

Decreased Bradykinin levels

Increased release of acetylcholine

Ion channel normalization

Release of serotonin and acetylcholine at site and higher centers in the brain

Attenuates effects of inflammation by acting on prostaglandin PG synthesis

Laser-Accelerated INFLAMMATION/PAIN REDUCTION AND HEALING by Richard Martin, BS, CLT ; Practical PAIN MANAGEMENT, Nov/Dec 2003, p. 20-25.

Release of Nitric Oxide (NO)

L.I. Filippin et al., Nitric oxide and repair of skeletal muscle injury, Nitric Oxide (2009), doi:10.1016/j.niox.2009.08.002

NO is:

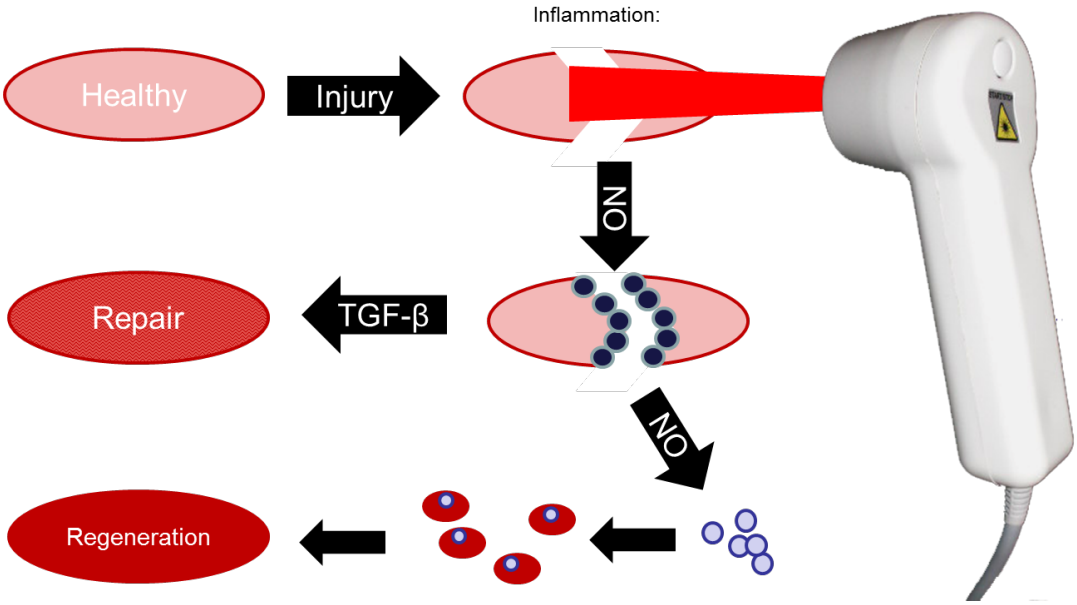
vascular smooth muscle relaxation, resulting in arterial vasodilation and increasing blood flow.

influences angiogenesis

neurotransmitter associated with neuronal activity

partially mediates macrophage cytotoxicity

NO reduces:



damage by inflammatory cells by increasing their apoptosis and inhibiting the expression of adhesion molecules

neutrophil-mediated lysis of muscle cells

superoxide concentration

L.I. Filippin et al., Nitric oxide and repair of skeletal muscle injury, Nitric Oxide (2009), doi:10.1016/j.niox.2009.08.002

Reduction or disappearance of ischemia in tissues

Anti-inflammatory effect through inhibition of the release of histamine and other inflammatory mediators from mast cells,

Inhibition of prostaglandin synthesis

Normalization of capillary permeability

Improvement of microcirculation

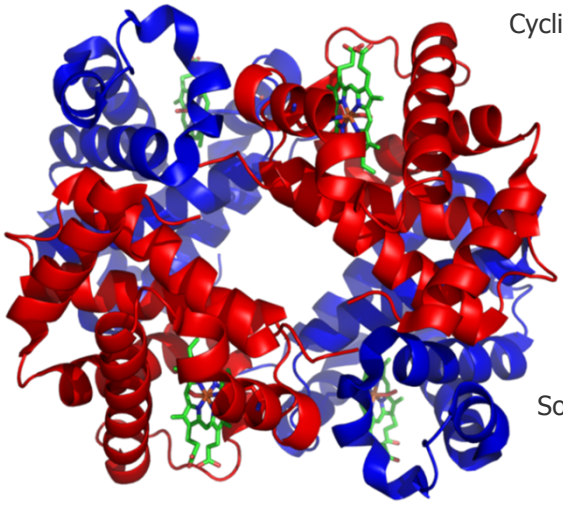
Asimov et al report that ONLY in low level laser therapy:

Molecular oxygen is generated due to laser-induced photodissociation of HbO2 in blood vessels

Quantum efficiency of the photodissociation of oxyhemoglobin is amazingly high and reaches 10 % in a wide visible spectral range

The Physics of Biomedical Effect of Blood Oxyhemoglobin Photodissociation. M. M. Asimov,R. M. Asimov,A. N. Rubinov,A. I. Gisbrecht

Hemoglobin



Cyclic nucleotides

Iron and copper containing ferments of cytochrome system

Almost all the ferments of Krebs's cycle

Some pigments

The Effect of GaAlAs Diode Laser On Pre-Sports Warming Up And Post-Sports Cooling Down. Yasushi Ishide, Toshio Ohshiro, Fumio Ueda, Mitsuyoshi Murayama, Takafumi Ohshiro, Shunji Fujii, Kiyofumi Takenouchi and Mitsuaki Kohzuma

- The use of the GaAlAs laser during warm up and cool down is beneficial.

Effects of low-level laser therapy (GaAs 904 nm) in skeletal muscle fatigue and biochemical markers of muscle damage in rats. Leal Junior EC, Lopes-Martins RA, de Almeida P, Ramos L, Iversen VV, Bjordal JM.

- Laser irradiation immediately **before** the first contraction for treated groups; blood samples were taken before the first and immediately after the sixth contraction.
- The relative peak forces for the sixth contraction were significantly better ($P < 0.05$) in the two laser groups irradiated with highest doses
- We conclude that pre-exercise irradiation with a laser dose of 1.0 J and 904 nm wavelength significantly delays muscle fatigue and decreases post-exercise blood lactate and CK in this rat model

Effect of 830 nm low-level laser therapy applied before high-intensity exercises on skeletal muscle recovery in athletes. Leal Junior EC, Lopes-Martins RA, Baroni BM, De Marchi T, Taufer D, Manfro DS, Rech M, Danna V, Grosselli D, Generosi RA, Marcos RL, Ramos L, Bjordal JM.

- LLLT irradiation before the Wingate test seemed to inhibit an expected post-exercise increase in CK level and to accelerate post-exercise lactate removal without affecting test performance
- These findings suggest that LLLT may be of benefit in accelerating post-exercise recovery

Delay of Onset Muscle Soreness

- Prior to activity!
- Can be done locally for individual muscle groups or globally for the entire body
- Form of Photohemotherapy

The results are all the training effects of regular exercise: increased muscular strength, endurance, bone density, and connective tissue toughness

Adequate hydration, nutrition and sufficient rest are needed to avoid overtraining

The body's reaction is to adapt and replete tissues at a higher level than that existing before exercising

More than just water

Consume about 20g of protein as soon as possible following training or competition, to enhance the muscle recovery process

Consume approximately 1/2 g of carbohydrate/pound of body weight (when the next workout is less than eight hours away)

Drink 16-24 ounces of fluid with sodium for each pound of body weight lost during exercise following a workout or game

Effects of low-level laser therapy (808 nm) on isokinetic muscle performance of young women submitted to endurance training: a randomized controlled clinical trial. de Brito Vieira WH, Ferraresi C, de Andrade Perez SE, Baldissera V, Parizotto NA

- LLLT was applied Immediately to the femoral quadriceps muscle of both lower limbs of the TLG subjects using an infrared laser device (808 nm) with six 60-mW diodes with an energy of 0.6 J per diode and a total energy applied to each limb of 18 J
- Endurance training program combined with LLLT leads to a greater reduction in fatigue than an endurance training program without

Effects of low level laser therapy (808 nm) on physical strength training in humans. Ferraresi C, de Brito Oliveira T, de Oliveira Zafalon L, de Menezes Reiff RB, Baldissera V, de Andrade Perez SE, Júnior EM, Parizotto NA.

- 808 nm LLLT with six diodes of 60 mW each a total energy of 50.4 J of LLLT was administered over 140 s was applied to the quadriceps muscle of both lower limbs of the immediately at the end of each training session.
- Strength training associated with LLLT can increase muscle performance compared with strength training only

Effects of low-level laser irradiation on rat skeletal muscle injury after eccentric exercise. Liu XG, Zhou YJ, Liu TC, Yuan JQ.

- Downhill running was used to induce muscle injury in the gastrocnemius muscle laser irradiations were administered to the injured muscles immediately and at 18 and 42 h after exercise.
- Laser irradiation at 43 J/cm2 inhibited muscle inflammation, significantly enhanced muscle SOD activity and significantly reduced serum CK activity and muscle MDA level at both 24 and 48 h after exercise

Effects of low-level laser therapy (808 nm) on isokinetic muscle performance of young women submitted to endurance training: a randomized controlled clinical trial. de Brito Vieira WH, Ferraresi C, de Andrade Perez SE, Baldissera V, Parizotto NA

- Immediately after each training session, LLLT was applied to the femoral quadriceps muscle of both lower limbs of the TLG subjects using an infrared laser device (808 nm) with six 60-mW diodes with an energy of 0.6 J per diode and a total energy applied to each limb of 18 J
- The results suggest that an endurance training program combined with LLLT leads to a greater reduction in fatigue than an endurance training program without LLLT

John P. Reid, BS; Nicolas G. Nelson, RN, MPH; Kristin J. Roberts, MS, MPH; Lara B. McKenzie, PhD, MA

Physician and Sports Medicine: Volume: 40 No.2

17-year study period, an estimated 159,663 patients were treated for track-related injuries in US emergency departments, an average of 8,870 cases per year

The overall number of cases increased 36.3%, from 7,702 injuries in 1991 to 10,496 injuries in 2008.

Boys were more likely to sustain pelvic injuries, while girls were more likely to sustain ankle injuries

Hurdling was found more likely to result in an injury to the upper extremities and the head

sprinting was more likely to result in an injury to the pelvis or upper leg.

The researchers conclude that there are several age, sex, and activity specific patterns of track-related injuries

They suggest performing more studies to determine how best to prevent these injuries.

Track-Related Injuries in Children and Adolescents Treated in US Emergency Departments From 1991 Through 2008

Low level laser therapy before eccentric exercise reduces muscle damage markers in humans. Bruno Manfredini Baroni, Ernesto Cesar Pinto Leal Junior, Thiago De Marchi, André Luiz Lopes, Mirian Salvador and Marco Aurélio Vaz

Thirty-six healthy men performed 75 maximal knee extensors eccentric contractions. Muscle soreness (VAS), lactate dehydrogenase (LDH) and creatine kinase (CK) levels were measured prior to exercise, and 24 and 48 h after exercise

Groups had no difference on kineanthropometric characteristics or eccentric exercise performance

LLLT treatment before eccentric exercise was effective in terms of attenuating the increase of muscle proteins in the blood serum and the decrease in muscle force

Low-energy laser irradiation promotes the survival and cell cycle entry of skeletal muscle satellite cells. Shefer G, Partridge TA, Heslop L, Gross JG, Oron U, Halevy O.

LELI promotes the survival of fibers and their adjacent cells that normally lead to apoptosis

These findings implicate the protective role of LELI against apoptosis

Protection of skeletal muscles from ischemic injury: low-level laser therapy increases antioxidant activity. Avni D, Levkovitz S, Maltz L, Oron U.

Laser irradiation (Ga-As, 810 nm) was applied to the muscles immediately and 1 h following blood supply occlusion

The present study describes for the first time the ability of LLLT to significantly prevent degeneration following ischemia/reperfusion injury in skeletal muscles, probably by induction of synthesis of antioxidants and other cytoprotective proteins

The elevation of antioxidants was also evident in intact muscle following LLLT

The Nature of the Game

Athletes from all levels of participation, from student, collegiate, professional and recreational will suffer from injuries or worse, over training

Some more severe than others

Researchers at the University of Alberta evaluated injury prevalence, time to injury and preseason fitness measures as predictors of time to injury

Fitness measures were Apley's range of motion, push-up, curl-ups, vertical jump, modified Illinois agility and sit-and-reach

The prediction of time to injury is influenced most heavily by gender and the sport played rather than an athlete's level of preseason fitness

women had a shorter time to injury than men — and that certain sports also had a significantly shorter time to injury than other sports.

More than two-thirds of the athletes in the study sustained injuries throughout the season, most common among them muscle or tendon strains in the legs or feet.

Although players missed practice time due to their injuries, with 55% missing at least one practice, most did not miss any games

Forty percent of injuries occurred during preseason practice

"Our data clearly show that time to first injury for athletes is more heavily influenced by gender and sport than pre-season fitness," Kennedy stated.

Study finds preseason fitness does not impact risk of injury

Common Athletic Injuries Treated with Laser TherapyMuscle Strains

Contusions

Joint Sprains

Tendonitis

Swelling/Edema

Bursitis

Pain

Arthritis

Fractures

Neuropathies

The genesis of many injures that occur later in athlete's career are do to improper training early in their career

After an injury occurs, damaged or injured cells produce a combination of:

Edema,

Inflammation,

Pain

Loss of function

An inflammatory reaction designed to:

Eliminate the cause of injury

Clean up the dead and the dying cells and tissues.

Injured cells and tissues emit enzymes that encourage the receipt of photons more readily than healthy cells and tissues.

Skeletal muscle healing following trauma can be understood as a balance between fibrosis and regeneration.

Factors influencing this balance:

consist of inflammation

the growth factors and cytokines present in site of injury

the interaction between infiltrating inflammatory cells and native myogenic cells

During this process the predominant cell is the fibroblast

L.I. Filippin et al., Nitric oxide and repair of skeletal muscle injury, Nitric Oxide (2009), doi:10.1016/j.niox.2009.08.002

Avoid or modify activities that aggravate pain

Relieve pain through complementary modalities: such as ice, heat, EMS

Maintain joint movement and muscle strength through rehabilitation

Decrease stress on the joints by using assistive devices: taping, bracing

Weak stimuli activate physiological processes

Very strong stimuli inhibit physiological responses

Stimulatory

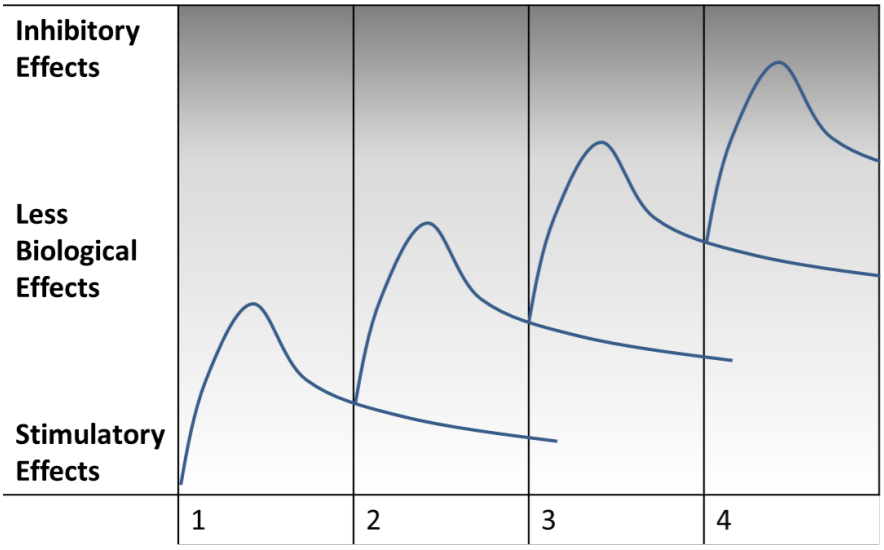
Inhibitory

“It is necessary to understand the delivered energy density (J/cm^2) and

number of exposures to prevent a cumulative inhibitory effect.”

Effect of multiple exposures of low-level laser therapy on the cellular responses of wounded human skin fibroblasts Hawkins D, Abrahamse H.

Photomed Laser Surg. 2006 Dec;24(6):705-14

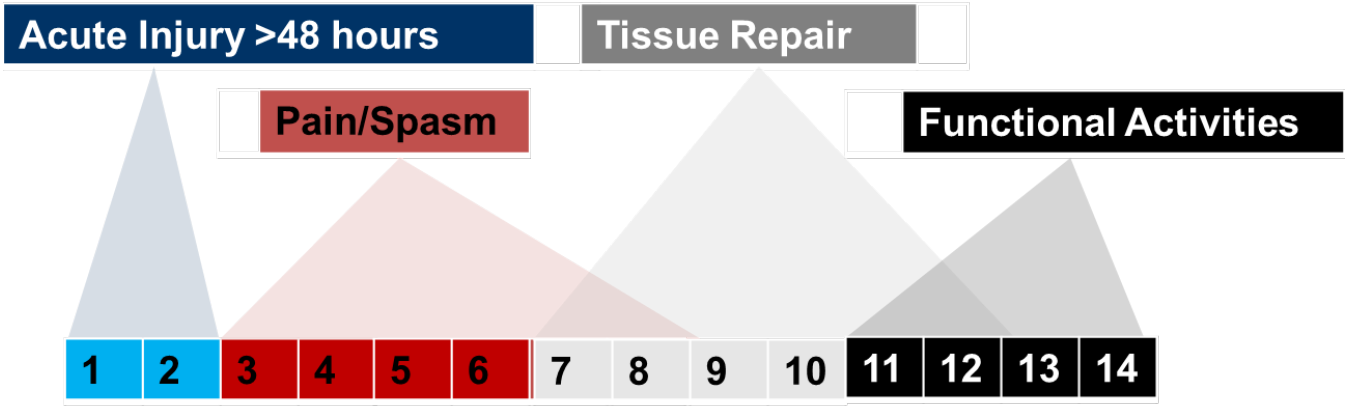


Photomed Laser Surg. 2006 Dec;24(6):705-14.; Effect of multiple exposures of low-level laser therapy on the cellular responses of wounded human skin fibroblasts.; Hawkins D, Abrahamse H.

Performance doses = stimulatory

Recovery > stimulatory

Muscle spasm = inhibitory



-2	Acute <48 Hours
1st	Swelling/edema
2nd	Inflammation
3rd	Spasms
4th	Pain (a),(b)
5th	Tissue Repair (a),(b)
6th	ROM
7th	Functional Strength

Prevent the further progression of inflammation, edema and swelling

Proceeds Priority Principle

< 48 hours

[5-1000 Hz] 3 min

[1000 Hz + 1-250 Hz] 1+1 min

Do NOT inhibit (pain relief) IE: NO Jumping the Track

Priority Principle™: Performance, Recovery, Prevention and Rehabilitation $(PR)^2$

	Priority	Principle	(PR)2	Time
Massage	-2	<48 Hours (Acute Injury): At any acute spasm <48 Hours	5-1000 Hz	3 min scanning with LaserShower
	3rd	Spasms: at palpable spasms in affected area, active and latent	1000 or 3000 Hz with Photoprobes	Pontinen's Principle
	4th (a)	Pain (Systemic)	1000 Hz NRT	5 min scanning the entire spinal column with LaserShower
	5th (a)	Tissue Repair (Primary) at TARGET Identified Locations of spastic area including key and satellite points	5-250 Hz	DOSE with LaserStim
		and		
	(b)	Tissue Repair (Secondary/Improvement of blood circulation/removal of toxins)	50 Hz PHT to major artery of the body	5 min with LaserShower
	6th	ROM: to all affected and limited joints at 3-4 location per joint line (Tender points or AHSHI points)	1000 Hz	1-2 min with LaserStim or Photoprobe attachment
	7th	Functional Strength: of affected muscle(s) <u>during</u> training/activity period	50 Hz (prior to activity) + 5 Hz (Apex Beat 5-250 (post activity)	2-3 min with LaserShower, 1 minute Apex Beat 2-3 min scanning with LaserShower

# of Procedures/Bout	Frequency	Rest Period	# of Bouts per year
8-10 Treatments	Daily or Alternative Days	2 days	1-2 as needed

Post Activity Recovery

designed for athletes engaged in training periods

Anaerobic activities

Pre-Performance Enhancement

utilized during the season, games, or events

Aerobic activities

The current research is performance is now just showing that "the moment" of laser irradiation is almost as important as the irradiation itself. Pre-performance laser therapy acts in a "semi protective" mode by reducing oxidative stress and inflammatory responses in muscle tissue that develop during activity. This is confirmed by blood draws with decreased postexercise levels of blood lactate, creatine kinase, and C-reactive protein.

The dose of 6J of is significant, as for continuous wave lasers, this is a stimulatory dose. Comparatively to a super pulsed dose, where the K(eff) is 1/2 to 1/10 the dose of CW lasers....this translates into .6 to 3J doses (which would tend to provide a stimulatory dose as well.)

In practical terms, the 25 W SPL of Multi Radiance technology can deliver that dose via any "frequency" setting. In stimulation, lower and slower tend to be better than higher and fast -- this has to do with tissue relaxation.

Dose / Power at 50 Hz + Power IRL + IRD = time
.6 J / .000125 W+ .09 W = t
6.7 s = time

3 J / .000125 W + .09 W = t
33.3 s = time

Therefore a stimulatory dose for prevention of muscle fatigue will be:
at 50 Hz, between 6.7 - 33.3s per point

This time is roughly about the same when utilizing the 5-250 Hz setting

But at 1000 Hz,
.6 J / .025 W + .09 W = 5.3 s
3 J / .025 W + .09 W = 27.3 s

or between 5.3 - 27.3 s per point.

J Orthop Sports Phys Ther. 2010 Aug;40(8):524-32.

Effects of low-level laser therapy (LLLT) in the development of exercise-induced skeletal muscle fatigue and changes in biochemical markers related to postexercise recovery.

Leal Junior EC, Lopes-Martins RA, Frigo L, De Marchi T, Rossi RP, de Godoi V, Tomazoni SS, Silva DP, Basso M, Filho PL, de Valls Corsetti F, Iversen VV, Bjordal JM.

Source

Center for Research and Innovation in Laser, Nove de Julho University (UNINOVE), São Paulo, SP, Brazil. ernesto.leal.junior@gmail.com

Abstract

STUDY DESIGN:

Randomized crossover double-blinded placebo-controlled trial.

OBJECTIVE:

To investigate if low-level laser therapy (LLLT) can affect biceps muscle performance, fatigue development, and biochemical markers of postexercise recovery.

BACKGROUND:

Cell and animal studies have suggested that LLLT can reduce oxidative stress and inflammatory responses in muscle tissue. But it remains uncertain whether these findings can translate into humans in sport and exercise situations.

METHODS:

Nine healthy male volleyball players participated in the study. They received either active LLLT (cluster probe with 5 laser diodes; lambda = 810 nm; 200 mW power output; 30 seconds of irradiation, applied in 2 locations over the biceps of the nondominant arm; 60 J of total energy) or placebo LLLT using an identical cluster probe. The intervention or placebo were applied 3 minutes before the performance of exercise. All subjects performed voluntary elbow flexion repetitions with a workload of 75% of their maximal voluntary contraction force until exhaustion.

RESULTS:

Active LLLT increased the number of repetitions by 14.5% (mean +/- SD, 39.6 +/- 4.3 versus 34.6 +/- 5.6; P = .037) and the elapsed time before exhaustion by 8.0% (P = .034), when compared to the placebo treatment. The biochemical markers also indicated that recovery may be positively affected by LLLT, as indicated by postexercise blood lactate levels (P<.01), creatine kinase activity (P = .017), and C-reactive protein levels (P = .047), showing a faster

recovery with LLLT application prior to the exercise.

CONCLUSION:

We conclude that pre-exercise irradiation of the biceps with an LLLT dose of 6 J per application location, applied in 2 locations, increased endurance for repeated elbow flexion against resistance and decreased postexercise levels of blood lactate, creatine kinase, and C-reactiveprotein.

LEVEL OF EVIDENCE:

Performance enhancement, level 1b.

PMID: 20436237 [PubMed - indexed for MEDLINE]

Priority Principle™: 7 Functional Strength Pre-Performance Enhancement

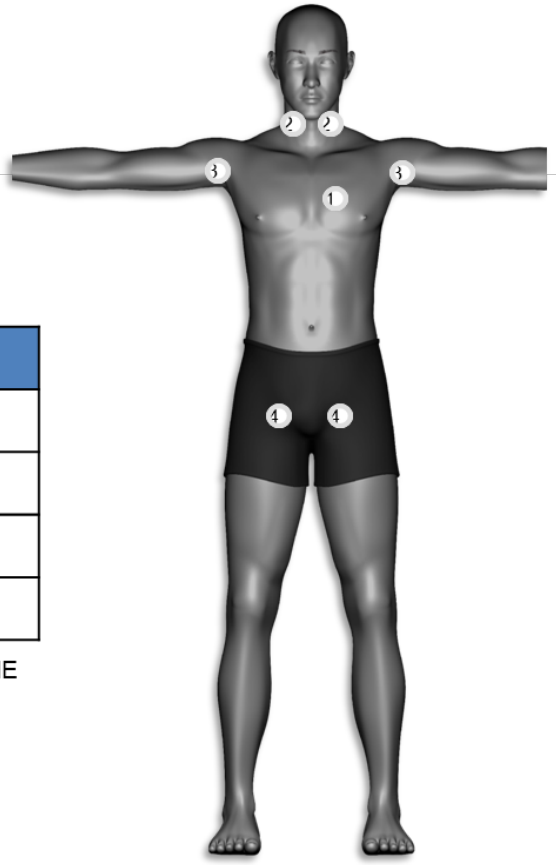
	Functional Strength: of affected muscle(s) <u>during</u> training/activity period	50 Hz (prior to activity) (Apex beat 5 Hz ONLY)	2-3 min with LaserShower*

* preferred for larger areas

eatment is performed
EFORE beginning the activity
o less than 15 minutes before
more than 2 hours prior

No	Primary Treatment area
1	Apex beat (5 Hz ONLY)
2†	Carotid Artery
3†	Axillary Artery
4†	Femoral Artery

† Choose only ONE

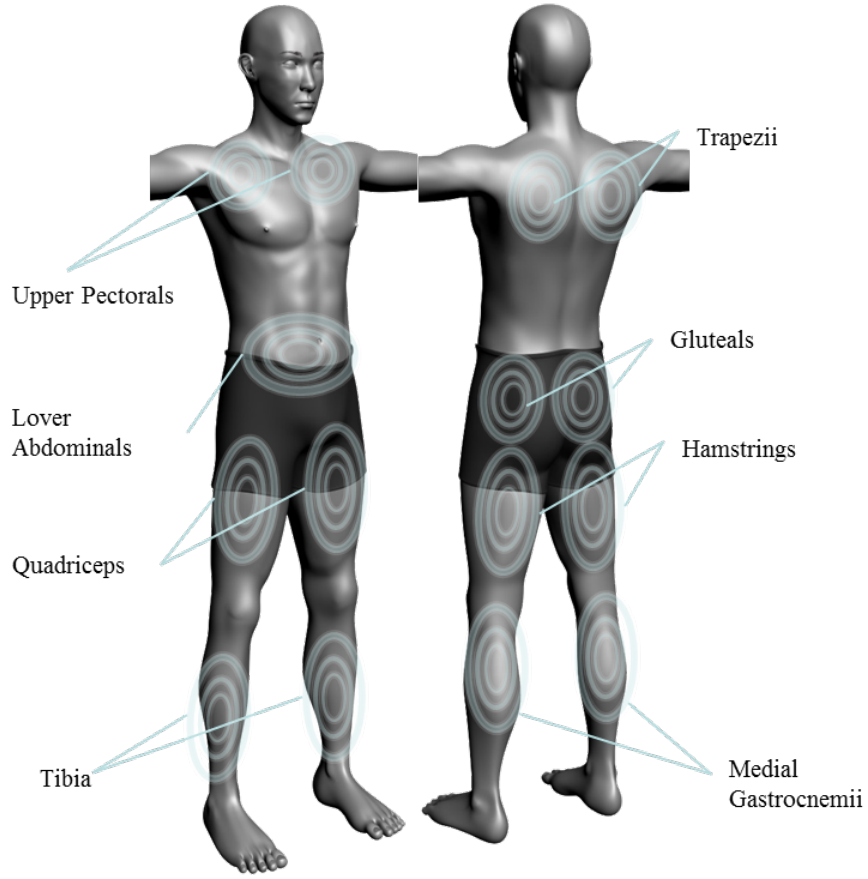


Post Activity Recovery

	Functional Strength: of affected muscle(s) <u>during</u> training/activity period	5-250 (post activity)	2-3 min scanning with LaserShower*

* preferred for larger areas

ess than 1 hour post activity

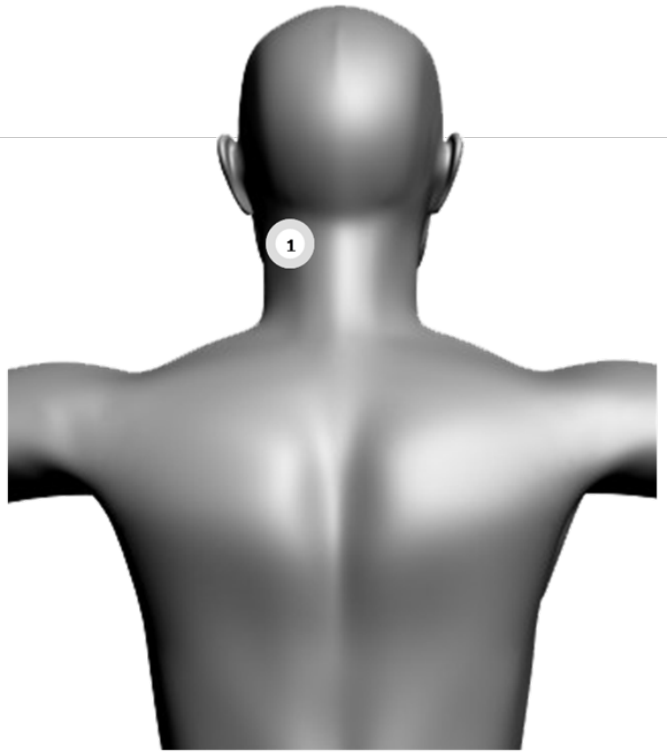


Priority Principle : Sedation/Relaxation

	To vertebral artery	5-1000 Hertz	5 min with LaserShower*

* preferred for larger areas

- Time Zone Adjustment
- Only one session per day is recommended
- Allow for ample recovery time
- Alternate between sides on consecutive day
- LaserShower emitter is optimal



IF a player has history of muscular fatigue, increase the time at that particular muscle “group” to 2 minutes.

If no specific muscle fatigue is noted, athletes may just perform “General Photohemotherapy Protocols” to help improve blood flow hemodynamics and eliminate waste products

Treat at close intervals in the beginning (e.g. every day or every other day for two weeks)

Then at longer and longer intervals (e.g. once/twice a week for a few weeks)

Experience shows that it is advantageous to temporarily suspend treatment after a number of introductory sessions

“Local” treatments may be given up to 3-4 times per day, using TARGET and DOSE

“Systemic” treatments should be kept to no more than 30 minutes per day

“Stimulatory” treatments should be done no sooner than 4 hours before competitive events

“Inhibitory” treatments may be done prior, during, or after events

Effects of Low-Level Laser Therapy (LLLT) in the Development of Exercise-Induced Skeletal Muscle Fatigue and Changes in Biochemical Markers Related to Post-Exercise Recovery.

Leal Junior EC, Lopes-Martins RA, Frigo L, De Marchi T, Rossi RP, de Godoi V, Tomazoni SS, da Silva DP, Basso M, Filho PL, de Valls Corsetti F, Iversen VV, Bjordal JM.

Effect of cluster multi-diode light emitting diode therapy (LEDT) on exercise-induced skeletal muscle fatigue and skeletal muscle recovery in humans.

Leal Junior EC, Lopes-Martins RA, Rossi RP, De Marchi T, Baroni BM, de Godoi V, Marcos RL, Ramos L, Bjordal JM.

Effect of phototherapy on delayed onset muscle soreness.

Douris P, Southard V, Ferrigi R, Grauer J, Katz D, Nascimento C, Podbielski P.

Effect of 655-nm low-level laser therapy on exercise-induced skeletal muscle fatigue in humans.

Leal Junior EC, Lopes-Martins RA, Dalan F, Ferrari M, Sbabo FM, Generosi RA, Baroni BM, Penna SC, Iversen VV, Bjordal JM.

MEDICINE

LASERS IN MEDICAL SCIENCE

Volume 27, Number 1 (2012), 231-236, DOI: 10.1007/s10103-011-0955-5

ORIGINAL ARTICLE

Low-level laser therapy (LLLT) in human progressive-intensity running: effects on exercise performance, skeletal muscle status, and oxidative stress

Thiago De Marchi, Ernesto Cesar Pinto Leal Junior, Celiana Bortoli, Shaiane Silva Tomazoni, Rodrigo Álvaro Brandão Lopes-Martins and Mirian Salvador

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Journal Article

Low-Level Laser Therapy in the Management of Neck PainMario F. P. Peres

Journal Article

Evaluation of the osteogenic effect of low-level laser therapy (808 nm and 660 nm) on bone defects induced in the femurs of female rats submitted to ovariectomyRodrigo Ré Poppi

Abstract

The aim of this work was to evaluate the effects of low-level laser therapy (LLLT) on exercise performance, oxidative stress, and muscle status in humans. A randomized double-blind placebo-controlled crossover trial was performed with 22 untrained male volunteers. LLLT (810 nm, 200 mW, 30 J in each site, 30 s of irradiation in each site) using a multi-diode cluster (with five spots - 6 J from each spot) at 12 sites of each lower limb (six in quadriceps, four in hamstrings, and two in gastrocnemius) was performed 5 min before a standardized progressive-intensity running protocol on a motor-drive treadmill until exhaustion. We analyzed exercise performance (VO2 max, time to exhaustion, aerobic threshold and anaerobic threshold), levels of oxidative damage to lipids and proteins, the activities of the antioxidant enzymes superoxide dismutase (SOD) and catalase (CAT), and the markers of muscle damage creatine kinase (CK) and lactate dehydrogenase (LDH). Compared to placebo, active LLLT significantly increased exercise performance (VO2 max $p = 0.01$; time to exhaustion, $p = 0.04$) without changing the aerobic and anaerobic thresholds. LLLT also decreased post-exercise lipid ($p = 0.0001$) and protein ($p = 0.0230$) damages, as well as the activities of SOD ($p = 0.0034$), CK ($p = 0.0001$) and LDH ($p = 0.0001$) enzymes. LLLT application was not able to modulate CAT activity. The use of LLLT before progressive-intensity running exercise increases exercise performance, decreases exercise-induced oxidative stress and muscle damage, suggesting that the modulation of the redox system by LLLT could be related to the delay in skeletal muscle fatigue observed after the use of LLLT.

Chapter

1

Multi Radiance Medical

Which the difference in the effectiveness of therapy with the continuous and super pulse emissions?

For understand the difference between the outcomes between the two devices, some values need to be introduced:

P- power of continuous radiation, W .

Ppeak - the power of super pulse radiation in pulse, W.

Pave - the average power of pulse radiation, in W, Pave = Ppeak • τ • F,

where: τ - pulse duration, F = frequency of emission

[k]eff - the coefficient of the biological effectiveness of pulse emission

Since the biological effectiveness of super pulsed emission is greater than for the continuous at the same power, i.e., therefore

R3 = [k]3 • R

The value of the coefficient of efficacy [k]eff for SPL depends on the status of the health of patient, current state of disease, target location (tissue type). On the basis of the survey of the scientific publications of Prof. carried out by it Korepanov determined the range of the coefficient of the biological effectiveness of the pulse emission of the laser, which according to the data of different researchers varies in the limits [k]eff from 1-10.

In this case, for the averaged value of the coefficient of efficacy, Korepanov accepted value [k]eff =8. This value is the basis for the calculations of the biological effectiveness of MILTA, RIKTA, "MR4" and "TerraQuant" products.

One of the possible theoretical explanations to the increased biological effectiveness of super pulsed emission is the fact that the cells absorb external (photo) energy which excites them and increases their internal energy. During the impulse, molecules and cells remain biologically

active, which is equivalent, as, to the a constant pulse of energy since the time for the resolution of the stimulus can be longer than the duration of the pulse. If the time to return to "homeostasis" or pre-lased state, time constants are greater than or equal to the pulse duration, the biological effectiveness grows several times, in this case the value [k]eff = 8.

Experimental measurements show that the primary laser emission in the investigated mouse tissue models showed it was weakened approximately 5-7 times for every 1 cm (i.e., approximately, 100 times at depth on the order of 3 cm). If such small intensities it is sufficient for biostimulating the cells, then direct radiation effect at the appropriate depths occurs .To speak about the depth of penetration without the indication of the permissible weakening does not make sense. However, it is possible to produce phototherapeutic effects at depths 10… 15 cm, but not due to the direct action of primary absorption. Since at such depths (it, practically, is absent), and can only be attributed to secondary radiation, which is the transfer of signals of excitation via chemical, electrical or mechanical means.

Photon density can improve depth of penetration (when not limited by wavelength, and other factors), so we are looking at an active depth of 3-5 cm and effective depth of 10-15 cm.

True "Super Pulsed" technology operates like a camera flash, a very large burst of light, delivered in a very short amount of time. Only the ultrashort impulses created by true "super pulsing" allow the tissue to "relax" between impulses, This minimizes the absorbed photons from being converted to heat or transferred to the surrounding tissue and the best way to maximize the phototheraputic effect.

Pulsed broad band infrared emitting Diodes (PBIREDs) (875 nm) penetrate shallower tissue depths than the super pulsed laser but provide a wider spectrum of wavelengths (colors). This bandwidth shift can be upwards of 100 nm!!! This varying stimulus provided by the (broadband) infrared emitting diodes aids in enhancing the phototherapeutic effect by preventing cellular adaption. The more unique the light, the more the organism is required to restore to adaptive mechanisms, to resolve the stimulus. A tissue cannot return to homeostasis when a an ever changing wavelength of the photons is being introduced to the target tissue

Exclusions to Multi Radiance Medical, LaserSweep settings can varying the pulse repetition of the laser impulses from 5-5000 Hz. These settings are used to not only control the desired depth of energy delivery into the tissue, but the rate as which that energy is delivered. No continuous wave or high powered Class 4 laser can even attempt this. Like the "PBIREDs" but with the super pulsed laser, the LaserSweep frequencies assist in preventing cellular adaption to the laser's photonic energy.

The static magnetic field (35 mT) assists in keeping photo-activated molecules in dissociated states, thereby enhancing their potential activity and energy levels at both molecular and cellular levels. An example of this is where nitric oxide is photodissociated from cytochrom c oxidase. With other laser therapy devices, NO will rebind shortly after dissociation, the SMF assists with maintaining laser enhances processes so the effects of the NO can be enhanced.

Dosing

A Joule is a unit of energy divided by area...however it is not a "definable" or reliable quantity.

Since the device does not measure in "real time" how much energy is being sent to the emitter, there is not a way of knowing what the wattage is. All diodes fluctuate and regardless of what the diode is "rated" by the manufacturer-that is NOT what is physically sent to the diode. This also does not take into account, what energy is actually being absorbed into the target tissue. We know that up to 40% of infrared light can be reflected when the diode is not placed in direct contact with the skin.

Secondly, since any type of semi-conductor diode emits light in a non-uniform matter (due to divergence), there is no way of actually knowing or measuring the "exact" spots size. Class IV complicates this because they do not use a uniform area of treatment, LiteCure "rolls" the emitter all around, while K-Laser has the emitter off the skin...and in an effort to not create a burn.

So now you have two non-reliable measurements...trying to create a reliable measurement. This is imprudent. However, with Multi Radiance Medical lasers, time is always constant, and our device measures the output continually via an inbuilt reflector that measures what is being reflected off the skin. If this fails to measure appropriately, the device will not work.

Since you cannot measure this amount of absorbed energy in the tissue or know the exact spot size, you must use a reliable measurement. Multi Radiance lasers' reliable measurement is time. Our outcomes are more predictable because the clinician can select the appropriate frequency and time to produce the desired effect in the tissue. Additionally, our lasers must register a minimum amount of deliverable energy (or it will not operate).

So a joule is not a quantifiable or a qualitative measurement.

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