Session 407: Low Level Laser Therapy: The Nuts & Bolts of Clinical Application

Doug Johnson, LAT, ATC, EES, CLS

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Discussant

Douglas Johnson, ATC, EES, CLS, is a certified athletic trainer with over 20 years of clinical/industrial experience. He attended Wayne State University and The University of Detroit-Mercy where he earned a Summa Cum Laude Bachelors of Science degree in Sports Medicine in 1994.

He is the Senior Vice President, Clinical and Scientific Affairs at Multi Radiance Medical and is involved in numerous research studies involving photobiomodulation. Recently he was named a clinical advisor to Laser Therapy U, invited to speak at the Annual 2014 NATA Symposium, Euroscience 2015 London, and the NAALT/WALT 2014 conferences. He serves as a member of the NAALT Scientific Education Committee for the 2017 Program and currently serving as a member of the NAALT Board of Directors.

He studied the effect of PBM on non-specific knee pain (May 2014) and the thermal effects of multiple wavelengths on varying pigmented human skin, June, 2015. Currently, he is a reviewer for the Journal of Athletic Training and an advisor for EuroSciCon Organizational Committee for the 2017 London Conference and session chair for PBM at ASLMS in 2016.

His present area of research involves the preconditioning of athletes with photobiomodulation to improve athletic performance, accelerate recovery and reduce fatigue and injuries.

Disclosures:

Travel expenses paid by, received salary from, and hold ownership interest with Multi Radiance Medical.

Serves on Advisory Board for North American Association for Photobiomodulation Therapy and Laser Therapy.

“I have disclosed all potential conflicts of interest that may exist for myself and any member of my immediate household. I have also disclosed payments, past, present, or future, that I have received or expect to receive for participation in a speaker, lecture, webinar, symposium, manuscript, grant, or travel or accommodation expenses for a conference. These disclosures are based on the financial limits of commercial interests, organizations, or products.”
Abstract

Background: Low-level laser therapy (LLLT) has been proposed as a physical therapy for musculoskeletal disorders. Though widely used, its reported therapeutic outcomes are varied and conflicting. Results similarly conflict regarding its usage in patients with nonspecific chronic low back pain (NSCLBP). This study investigated the efficacy of LLLT for the treatment of NSCLBP by a systematic literature search with meta-analyses on selected studies.

Methods: MEDLINE, EMBASE, ISI Web of Science and Cochrane Library were systematically searched from January 2000 to November 2014. Included studies were randomized controlled trials (RCTs) written in English that compared LLLT with placebo treatment in NSCLBP patients. The efficacy effect size was calculated using mean difference (MD) or weighted mean difference (WMD) in visual analog scale (VAS) pain outcome score after treatment. Statistical analysis was performed using Review Manager (RevMan) software. Heterogeneity was assessed using the I² statistic.

Results: Of 221 studies, seven RCTs (one triple-blind, four double-blind, one single-blind, one not mentioning blinding) totaling 394 patients met the criteria for inclusion. Based on five studies, the WMD in VAS pain outcome after treatment was significantly lower in the LLLT group compared with placebo (WMD = -13.57 [95% CI = -17.42, -9.72], I² = 0%). No significant difference was found between groups for disability scores or spinal range of motion outcomes.

Conclusions: This review shows that optimal LLLT can offer clinically relevant pain relief and initiate a more rapid course of improvement, both alone and in combination with physiotherapy interventions. Our findings challenge the conclusions in previous multimodal shoulder reviews of physiotherapy and their lack of intervention quality assessments.

Method

A systematic review with meta-analysis and primary outcome measures pain relief on 100-mm visual analogue scale (VAS) and relative risk for global improvement. Two independent assessors rated the source of the literature search. After the literature search, 22 trials related to joint pain were included. Trials were sub-grouped by intervention quality and use of other physiotherapy interventions. CONCLUSION: This review shows that optimal LLLT can offer clinically relevant pain relief and initiate a more rapid course of improvement, both alone and in combination with physiotherapy interventions. Our findings challenge the conclusions in previous multimodal shoulder reviews of physiotherapy and their lack of intervention quality assessments.
Photobiomodulation

A form of light therapy that utilizes non-ionizing forms of light sources, including lasers, LEDs, and broadband light, in the visible and infrared spectrum. It is a non-thermal process involving endogenous chromophores eliciting photophysical (i.e., linear and nonlinear) and photochemical events at various biological scales. This process results in beneficial therapeutic outcomes including but not limited to the alleviation of pain or inflammation, immunomodulation, and promotion of wound healing and tissue regeneration.
Photobiomodulation

Photobimodulation

Decrease in Peroxidation of lipids

Influences Cutaneous Receptors

Activation of protein synthesis (RNA, DNA)

Improvement of cellular potential

Increase in adenosine triphosphate (ATP) formation

Increase in enzymatic formation and activation

Normalization of specific and non-specific immune factors

Normalization and synthesis of Prostaglandin

Improved Immune Response

Improved blood circulation

Anti-Inflammatory

Anti-Edematous

Improvement of Microcirculation

Regenerates Damaged Tissue

Enhances wound repair

Analgesic Effect

Low Level Laser Therapy

Monochromatic Lasers and General Uses

- Infrared
  - Musculoskeletal Disorder and Pain Relief
- Red
  - Wound healing and Pain Relief
- Green
  - Laser Puncture
- Blue
  - Dermatology and Anti-bacterial
- Violet
  - Anti-iral
Mechanisms

Inflammation
Increase in ATP synthesis
Enhancement of ATP synthesis
Dissociation of NO
Creation of ROS

Priority Principle™

Dose
Sequencing
Technique

Effects of Dose:

• Low level laser can perform two very different biological processes:
  • Tissue Repair
  • Pain Relief
Technique: Contact vs. Non-Contact

### Contact
- The most common technique is static contact mode with a mild overpressure.
- 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. (Bjordal et al)
- This ischemia will increase the penetration of laser into the tissue up to 40 times for 630 nm (red) and 3 times for 830 nm (infrared) as compared to non-contact. (Tuner and Hode)

### Non-Contact
- Scanning/Contact:
  - Used for large area treatment
  - Emitter is moved in the appropriate direction at a speed of 0.5 to 1.5 cm per second (forward - backwards, to the left – to the right, upward - downwards)
  - However, due to an increase of surface area, treatment times may need to be increased to deliver a uniform dose to the entire area

- Scanning/Non-Contact:
  - Used when surface pressure is contraindicated (i.e. infections, shingles, anti-coagulate therapy)
  - Or to treat the power or desperation of light (i.e. of pediatrics, wounds, elderly)
"Woodpecker" Technique for Edema / Swelling

- Must be performed in a gravity independent position (patient positioning)
- Must be done prior to start of other priorities
- Begin at the most proximal drainage site of the affected extremity and precede distally. Oshiro’s Principle
- Alternately compressed and released may assist with the mechanical increase of venous and lymphatic flow
  Note: there is no linear movement of the emitter.

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Trigger Points and Spasms

Technique Review

Review
- Contact
- Non-Contact
- Scanning
- Woodpecker
- Trigger Point
Injuries and Insults

• Tissue healing (or tissue repair) refers to the body’s replacement of destroyed tissue by living tissue and comprises two essential components: Regeneration and Repair.
• The differentiation between the two is based on the resultant tissue.
  • In Regeneration, specialized tissue is replaced by the proliferation of surrounding undamaged specialized cells.
  • In Repair, lost tissue is replaced by granulation tissue which matures to form scar tissue.

http://www.electrotherapy.org/modalities/tissuerepair.htm

Injuries and Insults

• A gross representation of the key phases of the tissue repair process.
• The phases identified are shown as separate entities, though in reality, they are interlinked in a very deliberate way.
• There are events associated with one phase that act as stimulants for the following phase.

11 Basic Methods

1. Minimizing Acute Injury
2. Chronic Injury
3. Reduce Swelling/Edema
4. Resolve Inflammation/Infecction
5. Spasm
6. Controlling Pain via Systemic Meds
7. Controlling Pain via Local Meds
8. Tissue Repair Local
9. Tissue Repair Systemic
10. Increase Range of Motion
11. Functional Strength: Prepare, Performance and Recovery
Acute Injury

The "First" Priority is to prevent the further progression of inflammation, edema, and swelling.

Smaller, more frequent, and localized doses are generally more advantageous than larger, systemic dose.
Oshiro's Chronic Pain Principle

- Used as a “primer” for the treatment of chronic pain
- Targets the blood supply to the brain to increase cerebral blood supply and oxygenation
- Stimulate the CNS to “wake” the “master” computer

Elimination of Swelling/Edema

Upper Extremity

<table>
<thead>
<tr>
<th>No.</th>
<th>Primary Treatment Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Axilla</td>
</tr>
<tr>
<td>2</td>
<td>Medial anterior forearm</td>
</tr>
<tr>
<td>3</td>
<td>Dorsal radial aspect of the wrist</td>
</tr>
</tbody>
</table>
Elimination of Swelling/Edema
Lower Extremity

<table>
<thead>
<tr>
<th>Area</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td></td>
</tr>
<tr>
<td>Popliteal fossa</td>
<td></td>
</tr>
<tr>
<td>Lower posterior</td>
<td></td>
</tr>
<tr>
<td>Malleolus</td>
<td></td>
</tr>
</tbody>
</table>

Inflammation

Stimulatory
Local treatment

Method | Dose | Notes
---|-----|-------
Low | Do NOT overstimulate |
Muscle Spasms and Trigger Points

Adapted Pöntinen’s Principle

Method | Dose | Notes
--- | --- | ---
High | Pöntinen’s Principle | Active and latent spasms in affected area, active and pain

Adapted Pöntinen Principle
(Multi Radiance Medical)

1) Select [1000], [3000] or [1000-3000 Hertz]
2) Identify trigger point (TP) 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) Laser the TP, static method, 2-5 minutes, with mild overpressure
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

Pöntinen’s Principle

- Method
- Dose
- Notes
Pain

Inhibitory

Systemic: NRT, Dermatomes, Myotomes

General Systemic Pain Relief

Roots and Trunks (NRT)

<table>
<thead>
<tr>
<th>Method</th>
<th>Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>~</td>
<td>Systemic, length (NRT), scanning, affected area, below, and above, keeping to no more than 3 levels or affecting a area on same side.</td>
</tr>
</tbody>
</table>
Tissue Repair (Systemic)

Photohemotherapy

Range of Motion
### Increasing Range of Motion

**Method**

1. High ROM
2. To all affected and limited joints
3. At 3-4 locations per joint (tender points or AHSHI points)

### Table: Increasing Range of Motion

<table>
<thead>
<tr>
<th>Method</th>
<th>Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>ROM</td>
<td>All affected and limited joints at 3-4 locations per joint (tender points or AHSHI points)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of AHSHI Points</th>
<th>Affected Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3 Fingers</td>
<td>Wrist</td>
</tr>
<tr>
<td>3-4 Wrist</td>
<td>Elbow</td>
</tr>
<tr>
<td>4-5 Shoulder</td>
<td>Cervical Spine</td>
</tr>
<tr>
<td>3-4 Thoracic Spine</td>
<td>Lumbar Spine</td>
</tr>
<tr>
<td>4-5 Hip</td>
<td>Knee</td>
</tr>
<tr>
<td>3-4 Ankle</td>
<td>2-3 Toes</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Theory into Practice

- **T**: Theory
- **I**: Into
- **P**: Practice

### Standard of Care

- **RICE**
  - Rest
  - Ice
  - Compression
  - Elevation
Photobiomodulation therapy (PBMT) and/or cryotherapy in skeletal muscle restitution, what is better? A randomized placebo-controlled clinical trial

Paulo Roberto Vicente de Paiva, Shaiane Silva Tomazoni, Douglas Scott Johnson, Adriane Aver Vanin, Gianna Móes Albuquerque-Pontes, Paulo de Tarso Camillo de Carvalho, Ernesto Cesar Pinto Leal-Júnior

- 50 Subjects
- Randomized, double blinded, placebo controlled study
- Interventions: Eccentric exercise of the quadriceps via Biodex
- Intervention:
  - Phototherapy 40 J to 6 points on the quad
  - Cryotherapy Ice 20 minutes to quad
  - PBMT + Cryotherapy
  - Cryotherapy + PBMT
  - Placebo

Data Collected:
- MVC (strength)
- DOMS (pain)
- CK (muscle damage)

Assessments:
- Baseline, 1, 24, 48, 72, and 96 hours

Results - MVC
Photobiomodulation therapy (PBMT) and/or cryotherapy in skeletal muscle restitution, what is better? A randomized placebo-controlled clinical trial

- PBMT alone was the best modality for post-exercise recovery (p<0.05) compared to all comparators
  - Improved MVC
  - Decreased DOMS
  - Reduced CK activity

- PBMT+Cryotherapy was also significantly better than placebo, cryotherapy and cryotherapy + PBMT (p<0.05).
  - Improved MVC
  - Decreased DOMS
  - Reduced CK activity

- Cryotherapy, cryotherapy+PBMT and placebo did not improve any measured variables

- We conclude that PBMT used as single treatment is the best modality for enhancement of post-exercise recovery.
Why ice inhibits inflammation:

- Nick DiNubile: “Seriously, do you honestly believe that your body’s natural inflammatory response is a mistake?”
- Inflammation is the first physiological process in the repair and remodeling of tissue. Without it, nothing after can happen.
- Macrophages release the hormone Insulin-like growth factor (IGF-1) into the damaged tissues, which helps muscles and other injured parts heal.
- Ice prevents the body from releasing IGF-1.
- It is IMPOSSIBLE to have tissue repair or remodeling without inflammation.

### Plantar Fasciitis

<table>
<thead>
<tr>
<th>Method</th>
<th>Tissue</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spasm</td>
<td>1000 Hz x 2</td>
<td>Pontinen's Principle: Medial Gastroc</td>
</tr>
<tr>
<td>Ice</td>
<td>1-2 min per spasm</td>
<td>Direct Contact</td>
</tr>
<tr>
<td>Tissue Repair</td>
<td>50 Hz x 1-2 min per location</td>
<td>PHT to 4) Femoral, 5) Popliteal, 6) Tibial, 7) Dorsalis Pedis</td>
</tr>
</tbody>
</table>

### Venous Insufficiency

<table>
<thead>
<tr>
<th>Method</th>
<th>Tissue</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling</td>
<td>High</td>
<td>Ohshiro's Proximal Priority</td>
</tr>
<tr>
<td>1) Groin, inguinal triangle of affected extremity</td>
<td>2) Popliteal Fossa of affected extremity</td>
<td>3) Lateral posterior malleolus of affected extremity</td>
</tr>
<tr>
<td>Tissue Repair</td>
<td>Low</td>
<td>PHT to 4) Femoral, 5) Popliteal, 6) Tibial, 7) Dorsalis Pedis</td>
</tr>
</tbody>
</table>

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• Methods are the combination of a dose or dose rate and one or more techniques
• Acute Injury = Rescue = Inhibitory + Local
• Swelling = Ohshiro’s Method = Inhibitory + Proximal Priority + Scanning Distal to Proximal
• Inflammation = Stimulatory + Static
• Muscle Spasm and Trigger Points = Pöntinen’s Principle = Inhibitory + Photoprobe + Reasons and Repeat
• Local Pain = Inhibitory + Static
• General Pain = Inhibitory + NRT (or Dermatomes, Myotomes) = Scanning
• Tissue Repair (Local) = Stimulatory + Static
• Tissue Repair (Systemic) = Photohemotherapy = Stimulatory + Proximal arterial pulsation
• ROM = Inhibitory + Static + Photoprobe
• Remember to adjust doses either by time or frequency

Dose Adjustment

• Be prepared to increase or decrease the dose in 1 minute or 2 J increments to achieve the desired response

+ / - 1 min Rule
+ / - 2 Joules

Yo-Yo Effect

• Typically, if a patient’s condition fluctuates between control (improvement) and exacerbation, this may indicate that the current area being treated or “stimulated” may not be the root cause of the issue
Closing Comments and Questions

• Adjunctive Modalities
• Clinical Pearls
• Contraindication/Indications
• Summary
• Contact Information
• Websites

Laser Therapy and Secondary Physical Agents

• Cryotherapy
  - Use laser therapy PRIOR to cryoprotection
• Heat therapies (US, EMS)
  - Use laser therapy PRIOR to increased blood flow causes increased absorption of light by hemoglobin resulting in decreased penetration
• Massage (Massage, STM, ASTM)
  - May do before or after
  - Reduce pain/spasm prior to laser treatment
  - After aggressive techniques
• Traction/Decompression
  - May do before or after, depending on the specific goals of laser therapy
  - Post/spasm prior
  - After aggressive traction after

Decade rule

• Take the patient’s age and divide by 10

• Determines probable number of treatments to get a strong, positive outcome
Clinical Notes on Systemic Treatments

- A patient may experience an exacerbation of symptoms (e.g., temporary pain) during systemic treatments.
- There is an increase in the blood supply to the tissue or system combined with a decrease in viscosity, improvement in the flow characteristics of the blood and the dilatation of the capillaries, precapillaries and arterioles.
- The venous system cannot improve its flow characteristics as fast as the arterial system.
- Creating stasis or congestion of the tissues causing the pain sensation and other effects.

Treatment Frequency

- “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 between sessions.
- “Inhibitory” treatments may be done as needed.

Contraindications:

**Absolute Contraindications:**

- Pregnancy
- Cancer
- Fever (body temperature higher than 100.4°F/38°C)
- During stages of acute infection (including localized infections)
- Over hemorrhages
- In the vicinity of pacemakers
Clinical Practice:

• Good: Technique
• Better: Dose
• Best: Methods

Laser Specific Resources:
Thank You
djohnson@multiradians.com
Email address for Douglas Johnson
www.lasertherapyu.org
Website for Low Level Laser Therapy