An Introduction to Low Intensity Laser Therapy for Pain & Musculoskeletal Injuries
Low Intensity Laser Therapy (LILT)

“the use of lasers and superluminous diodes for the treatment of a variety of medical conditions”
Different Terminology

- Laser Therapy
- Low Level Laser Therapy (LLLT)
- Cold Laser Therapy
- Phototheraphy
- Low Energy Laser Therapy (LELT)
- Laser Photobiostimulation
Lasers – What comes to mind?
Heliotherapy – Sunlight Therapy

University of Virginia Medical Center
Charlottesville, Virginia
Circa 1929

Samuel and Nettie Bowne Hospital
Poughkeepsie, New York.
Circa 1935
Seasonal Affective Disorder (SAD)

- Bright Light Phototherapy has been shown to effectively treat seasonal affective disorder (SAD).
- Non thermal and does not require specialized cells
Endre Mester published one of his first papers demonstrating the effects of ruby laser light on the stimulation of hair growth in 1968.
Endre Mester published another article demonstrating the effects of ruby laser light on the stimulation of wound healing.
**Historical Perspective**

1960’s
- Original laboratory research in Hungary, Russia and Japan

1970’s
- Early clinical application (He-Ne)

1980’s
- Initial applications in ‘West’
  - Slow evolution
  - Lack of English language publications
  - Availability of new light sources
    - Diode Lasers
  - Pharmaceutical culture
- Number of peer-reviewed journal articles and clinical trials has increased substantially over the past 10 years.

- Literature includes:
  - Cellular studies
  - Animal studies
  - Human case profiles
  - Placebo-controlled clinical trials
Laser Therapy Publications
Recent Developments in Laser Therapy

Improvements in the Technology
- More devices in the marketplace
- Availability of better engineered variable power diodes

Evidence Based Approach
- Increased volume of quality publications
- Better knowledge of what wavelengths and intensities produce optimal results for specific pathologies

Clinical Knowledge
- Understanding treatment parameters
- Keeping clinical records and documenting results
Advantages of Laser Therapy

• Non-toxic
• Non invasive
• Ease of application
• No ‘side effects’
• “Safe”
• Cost effective

• Superior alternative to:
  – analgesics
  – NSAID’s
  – other medications

• Obviate need for surgery
• Promotes rapid healing
An Introduction to the Science of Laser Therapy
The Electromagnetic Spectrum

Decrease in wavelength = Increase in energy in a smaller area
Biological Photoacceptor Molecules

Plants
- Chlorophyll
- Carotenoids

Humans
- Rhodopsin (vision)
- Hemoglobin (blood)
- Myoglobin (muscle)
- Cytochrome (all cells)
Cytochrome C Oxidase Absorption

Red light at 660nm and Infrared light at 830/840nm
Red light at 660nm and Infrared light at 830/840nm
Published Action Spectra

Karu and Afanasyeva, DAN 392(5):693, 1995

Red light at 660nm and Infrared light at 830/840nm
Biological Treatment Window

![Graph showing absorption coefficients for different substances across various wavelengths.]

- Water
- Deoxyhemoglobin
- Oxyhemoglobin
- Cytochrome C oxidized
- Cytochrome C reduced

M. Cope thesis data modified by M. Patterson
Energy Production - Components

- NADH Dehydrogenase
- Cytochrome bc1 Complex
- Cytochrome c Oxidase
- ATP Synthase
Electron Transport Chain
Effect of Red and Infrared Light

\[ H^+ \quad H^+ \quad H^+ \quad H^+ \quad H^+ \quad H^+ \]

ADP

ATP
Laser Therapy Effects

Primary
- The light is absorbed by cytochrome c oxidase

Secondary
- Release of NO into endothelium of blood vessels
- Small increases in free radicals
- Increased proton gradient in mitochondria

Clinical
- Wound Healing, Acceleration of the Inflammatory Process and Pain Influence
Published Effects of Light on Cells

- Increased ATP production
- Circulation
  - Relaxation of smooth muscles surrounding blood vessels
  - Angiogenesis
- Increased production of:
  - Fibroblasts
  - Macrophage
  - Collagen
- Altered nerve conduction

- Increased metabolism of:
  - Endorphins
  - Acetylcholine
  - Serotonin
- Increased synthesis of:
  - DNA
  - Proteins
- Stimulation of immune response
A. No light gives no effect
B. Small amount of light also has no effect
C. Maximal effect at the apex of the curve
D. Inhibitory amount of light inhibits healing
Laser Therapy Dosage - Arndt-Shultz Law

This is a dose (energy density) response curve and there is a similar one for the power density.

Jan Tuner and Lars Hode, Cofounders and Magicians, Pg 3
Contact vs. Non-Contact

![Contact Laser Diagram](image1)

![Non-Contact Laser Diagram](image2)
BioFlex’s Leap into the 21st Century

- Scientifically developed & clinically tested protocols
- Ability to customize protocols
- Computerized function
- Large Surface Flexible Arrays
- New and elegant approach to healing
Conditions Treated

Acute Injuries/Trauma
- Muscle tears/ hematoma
- Tendon tears
- Ligament strains/sprains
- Fractures
- Sport injuries

Musculoskeletal
- Repetitive strain injuries
- Rotator cuff tears
- Carpal tunnel syndrome
- Fibromyalgia *
- Tempo mandibular joint pathologies

* Not a FDA Cleared Use
Conditions Treated

**Inflammatory Conditions**
- Tendonitis
- Bursitis
- Fascitis
- Rheumatoid arthritis

**Degenerative Disorders**
- Osteoarthritis

**Wound Management** *
- ulcers
- venous stasis
- diabetic
- contact
- atherosclerotic
- post-operative wounds/scars

* Not a FDA Cleared Use
Conditions Treated

Other Areas
- Dermatological *
- plastic surgery
- dental (e.g. gingivitis)
- podiatry

* Not a FDA Cleared Use

Veterinary
- equine
- companion animals
Musculo Skeletal Injuries
Chronic Left Achilles Tendonitis

10 treatments over 2 months

Tenderness, Edema and partial loss of flexion

Initial  1 Month after final treatment

09/20/2004  12/22/2004

100% function, asymptomatic
Inflammation – Achilles Tendonitis

- LLLT at a dose of 5.4 J per point can reduce inflammation and pain in activated Achilles tendinitis.


- Low-level laser therapy accelerates clinical recovery from chronic Achilles tendinopathy when added to an Eccentric Exercise regimen. For the LLLT group, the results at 4 weeks were similar to the placebo LLLT group results after 12 weeks.

Hamstring Tear/Hematoma

4 treatments over 7 days
Joint Disorders

6 treatments in 2 weeks

Age/Gender: 51/M
Diagnosis: Chronic Infrapatellar Tendinosis

Initial

Intermediate

Final

Taken on 02/17/2007

Taken on 02/24/2007

Taken on 03/02/2007
A systematic review on the effects of laser therapy in chronic joint disorders found “Low level laser therapy within the suggested dose range significantly reduces pain and improves health status in chronic joint disorders.”

Lateral Epicondylitis (tennis elbow)

- LLLT administered with optimal doses of 904 nm and possibly 632 nm wavelengths directly to the lateral elbow tendon insertions, seem to offer short-term pain relief and less disability in LET, both alone and in conjunction with an exercise regimen.

Bjordal et. al. *BMC Musculoskelet Disord*. 29(9): 75. 2008
Carpal Tunnel Syndrome
• A randomized placebo controlled double blind study carried out at General Motors in Detroit found that patients treated with laser had better functional recovery and a higher back to work percentage (72% active laser vs. 41% sham) (Anderson et al., 1995)

• A LILT study carried out in 2007 found that both the sensory and motor distal latency was improved compared with controls (Evcik et al., 2007)

• Another study carried out in 2007 found that LILT was effective in mild to moderate CTS, though not as effective in severe CTS (Elwakil et al., 2007)
Main Finding

The distal motor latency on the left is 5.29ms (moderate) and on the right is 4.45ms (mild)
After 4 weeks and 7 treatments

Main Finding

The distal motor latency on the left is 4.77ms (moderate) and on the right is 4.30ms (normal)
After 11 weeks and 15 treatments

Main Finding

The distal motor latency on the left is 4.40ms (normal) and on the right is 3.98ms (normal)
Pilot CTS Study Results

- Completed 12 carpal tunnel syndrome cases in 8 patients
- There was an average of 0.49 ms improvement in the distal motor latency (DML) after an average of 13 treatments over an average of 50 days
- This positive increase in the DML corresponded to a decrease in the patients' CTS symptoms
- The patients with mild and moderate CTS noted a larger benefit when compared with severe CTS
Other
Neurological Injury – Spinal Cord Shock / Brachial Plexus Tear

Initial
Peripheral Nerve Injury

• A randomized-placebo controlled, double blind study on the incomplete peripheral nerve injury. Peripheral nerve injury occurred 6 months prior to trial, severe motor deficit and slow neurological improvement.

• 18 patients suffering from incomplete peripheral nerve or brachial plexus injuries.

• Carried out clinical and electrophysiological assessments at 21 days, 3 and 6 months

• Demonstrated that laser phototherapy enhances the recovery of patients with long term incomplete peripheral nerve and brachial plexus injuries.

Muscle Fatigue

“We conclude that LLLT appears to delay the onset of muscle fatigue and exhaustion by a local mechanism in spite of increased blood lactate levels.”


![Graphs showing total number of repetitions and total time of contractions for Placebo and Laser groups.](attachment:graphs.png)
Olecranon Bursitis (Recurrent Effusion)

6 treatments over 2 weeks
Post-Traumatic Fracture in the R-Humerus
Age: 66/M

Initial

10/29/2006

Intermediate

11/04/2006

Final

11/29/2006

10/25/2006

11/01/2006

12/06/2006
Bone Healing

- A study performed in human osteoblast cells found “low-level laser therapy has a biostimulatory effect on human osteoblast-like cells during the first 72 h after irradiation.”

- The results of a study carried out in laboratory mice indicates “that the use of low-intensity laser promotes better repair of bone injury”.

- A more recent study in rabbits found that LILT “may accelerate the process of fracture repair or cause increases in callus volume and BMD, especially in the early stages of absorbing the hematoma and bone remodeling”
Post-Traumatic Hematoma

74M

Initial

After 4 Treatments over 10 days

After 5 Treatments over 13 days
Post Surgical Healing

5 Treatments over 2 weeks
Wounds
*Not FDA Cleared for this indication

...but a few visual comments related to Athletic Trainers
Puncture Wound

August 19, 2006

October 4, 2006

October 10, 2006
Diabetes Mellitus
Pre-Gangrenous Right Foot

Initial
Intermediate
Intermediate
Hemochromatosis
Dermal Ulcers – 2 Years

Initial
After 1 Treatment
After 5 Treatment
After 36 Treatment
1-Year Follow-up
Imaging Supported Case Profiles
Main Finding

A large L-5/S-1 Central and Left Paracentral Disc Herniation which has a maximal AP depth of 1cm and a base of 1.6cm.
Disc Herniation - Case Follow Up

After 16 Treatments

Main Finding

In comparison to the CT scan dated 02/12/06, there has been a considerable interval decrease in size in the disc herniation, and whereas there was lateral recess stenosis on the basis of the CT, I don’t see any on today’s MRI.

DATE OF EXAM: 13/03/07
JONLO
SPINE LTD. WITHOUT 4 SERIES

MRI OF LUMBAR SPINE

At the L-5-S-1 level, there is a moderate-sized central disc herniation present. It is not producing any significant central canal stenosis and I don’t identify a critical lateral recess stenosis. The intervertebral foramina appear widely patent.

In comparison to the CT scan dated 02/12/06, there has been a considerable interval decrease in size in the disc herniation, and whereas there was lateral recess stenosis on the basis of the CT, I don’t see any on today’s MR.

IAN C. BALL MD
AUTHENTICATED BY ELECTRONIC MEANS/PDG
14/03/07
Rep. # 1403-0188
Knee Injury

Main Finding

- There is a nondisplaced vertical longitudinal tear of the posterior horn of the medial meniscus
- ...I believe the ACL is partially torn although there may be some intact fibers.
Main Finding

- There appears to have been healing of the vertical longitudinal tear previously noted in the periphery of the posterior horn of the medial meniscus.
- There is no evidence of an acute ACL tear.
Rotator Cuff Injury

8 treatments over 3 weeks
Rotator Cuff Injury

**Initial**

ULTRASOUND: RIGHT SHOULDER

The biceps, subscapularis, infraspinatus, and teres minor tendons are normal.

There is a full thickness tear of the anterior and mid fibers at the insertion of the supraspinatus tendon with a tear measuring 24 x 15 x 9mm.

A large amount of bursal fluid is noted.

**OPINION:**

FULL THICKNESS TEAR ANTERIOR AND MID FIBERS SUPRASPINATUS TENDON.
LARGE AMOUNT OF BURSAL FLUID.

RIGHT SHOULDER:

Mild OA present at the ac joint with minor OA at the glenohumeral joint.

There is no rotator cuff tendon calcification, fracture or dislocation.

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**Main Finding**

There is a full thickness tear of the anterior and mid fibers at the insertion of the supraspinatus tendon with a tear measuring 24 x 15 x 9 mm.
After 13 Treatments

StL DIAGNOSTIC IMAGING
3155 Harvester Road, Suite 310
Burlington, Ontario L7N 3V2
Phone: (905) 637-8608 / 1-800-263-4275
Fax: (905) 637-3144

Case #: BL31758

D.O.B : 09-May-44  63y 6m  Sex: M

ULTRASOUND – RIGHT SHOULDER:

Comparison: 2/07/07

The biceps tendon is intact but there is fluid within the biceps tendon sheath.

The subscapularis and infraspinatus tendons are intact.

The humeral head, greater tuberosity and deltoid muscles show no abnormality. There is a small amount of fluid in the subdeltoid bursa.

The tear involving the supraspinatus tendon noted previously is not as extensive on this occasion and an intra-substance tear only is identified at this time measuring approximately 10 x 4mm.

OPINION:

Fluid within biceps tendon sheath and subdeltoid bursa.

Supraspinatus tear not as extensive on this occasion as demonstrated previously with intrasubstance tear shown measuring 10 x 4mm.

Main Finding

The tear involving the supraspinatus tendon noted previously is not as extensive and an intra-substance tear only is identified at this time measuring approximately 10 x 4mm.
After 18 Treatments

Main Finding

No rotator cuff tear is seen.
BioFlex Therapist Laser System

$12,950

OR

Lease-to-own approx. $265/month for 60 months