

November 2022



RESEARCH OVERVIEW PHOTOBIO-MODULATION THERAPY

This interactive presentation gives an overview of published research on PBMT

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BASIC SCIENCE
(How) does photobiomodulation work?

CLINICAL EVIDENCE
High Power Laser Therapy in multiple indications



(How) Does Photobiomodulation Work?

Mitochondria & ATP

Karu, 2010

Karu, 1989

Analgesia mechanisms

Ketz, 2017

Chow, 2016

Chow, 2011

Anti-inflammatory

Pallotta, 2012

Bjordal, 2010

Tissue repair - Cell proliferation

Gao, 2009

Chen, 2009

Tissue repair - Muscle

Alves, 2014

Luo, 2013

Tissue repair - Cartilage

Torricelli, 2001

Morrone, 2000

Clinical Evidence



High Power Laser Treatment

Temporomandibular Joint Disorder (TMD)	Ekici, 2021			
Neck Pain	Alayat, 2022	Alayat, 2019	Alayat, 2016	Dundar, 2015
Shoulder Pain	Yilmaz, 2022	Atan, 2021	Elsodany, 2018	
Fibromyalgia	Panton, 2013			
Low Back Pain	Chen, 2018	Alayat, 2019	Alayat, 2014	
Epicondylitis	Roberts, 2013			
Carpal Tunnel	Ezzati, 2020			
Hand Arthropathy	Abdel-Aal, 2020			
Hamstring Tendinopathy	Verma, 2022		Borsa, 2019	
Knee OA	Ahmad, 2022	Akaltum, 2021	Song, 2020	Nazari, 2019
Achilles Tendinopathy	Mårdh, 2016	Tumilty, 2016		
Diabetic Neuropathy	Chatterjee, 2020			
Plantar Fasciitis	Ordahan, 2018			

Qceps Muscle Recovery





Karu T. Mitochondrial mechanisms of photobiomodulation in context of new data about multiple roles of ATP. *Photomed Laser Surg.* 2010 Apr;28(2):159-60.

Photomedicine and Laser Surgery
Volume 28, Number 2, 2010
© Mary Ann Liebert, Inc.
Pp. 159–160
DOI: 10.1089/pho.2010.2789

Guest Editorial

Mitochondrial Mechanisms of Photobiomodulation in Context of New Data About Multiple Roles of ATP

Tiina Karu, Dr. Sci., Ph.D.

This article summarizes the literature that investigated the cellular responses to laser irradiation. It highlights the importance of

- Mitochondria and Cytochrome C
- ATP

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- **Mitochondria** are the initial site of light action in cells, and cytochrome c oxidase (the terminal enzyme of the mitochondrial respiratory chain) is the responsible molecule.
- Mixed-valence copper components of **cytochrome c oxidase**, CuA and CuB, are believed to be the photo-acceptors.
- The excitation of the photo-acceptor molecule sets in motion cellular metabolism through cascades of reactions called cellular signalling or retrograde mitochondrial signalling.
- At least two reactions are starting points for monitoring cellular-signalling reactions after light action on the cytochrome c oxidase molecule.
 - One of them is dissociation of **NO** from the catalytic center of cytochrome c oxidase.
 - Another signalling pathway starting from the mitochondria is connected with **ATP**.

Karu T. *Photobiology of low-power laser effects. Health Phys.* 1989 May;56(5):691-704.

Health Physics Vol. 56.No. 5(May) ,pp. 691-704,1989
Printed in the U.S.A.

0017-9078/89 \$3.00+0.0
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PHOTOBIOLOGY OF LOW-POWER LASER EFFECTS

Tiina Karu

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Abstract—Quantitative studies have been performed to determine the action of low-intensity visible monochromatic light on various cells (*E. coli*, yeasts, HeLa, Chinese hamster fibroblasts and human lymphocytes); also irradiation conditions (wavelength, dose and intensity) conducive to vital activity stimulation have been examined. Respiratory chain components are discussed as primary photoacceptors. The possible ways for photosignal transduction and amplification are discussed. It is proposed that enhanced wound healing due to irradiation with low-intensity visible laser light (He-Cd, He-Ne and semiconductor lasers) is due to the increasing proliferation of cells.

This article discusses the biological processes of photobiomodulation.

- Respiratory chain components are discussed as primary photo-acceptors.
- The possible ways for photo-signal transduction and amplification are discussed.
- It is proposed that enhanced wound healing due to irradiation with low-intensity visible laser light is due to increasing proliferation of cells.

- Laser biostimulation is a photobiological phenomenon
- Primary photo-acceptors are components of the respiratory chain. This explains the universality of low-power laser effects.
- The respiratory chain components can be the photoacceptors in the case of cellular metabolism stimulation, as well as inhibition depending on the dose of light. At low doses, irradiation causes redox regulation of cellular metabolism; at high doses photodynamic damage prevails.
- Light quantum is only a trigger for cellular metabolism regulation. This explains the low doses and intensities needed.
- The magnitude of the biostimulation effect depends on the physiological state of the cell before irradiation. This explains why biostimulation effect is not always possible.
- The therapeutic effects of low-power laser irradiation can be explained by an increase of proliferation of G₀ and G₁ cells or by changes in the physiological activity of excitable cells.

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Kobiela Ketz A, Byrnes KR, Grunberg NE, Kasper CE, Osborne L, Pryor B, Tosini NL, Wu X, Anders JJ. Characterization of Macrophage/Microglial Activation and Effect of Photobiomodulation in the Spared Nerve Injury Model of Neuropathic Pain. *Pain Med.* 2017 May 1;18(5):932-946.

Pain Medicine 2017; 18: 932-946
doi: 10.1093/pm/pnw144

OXFORD

NEUROPATHIC PAIN SECTION

Original Research Article

Characterization of Macrophage/Microglial Activation and Effect of Photobiomodulation in the Spared Nerve Injury Model of Neuropathic Pain

Ann Kobiela Ketz, PhD,* Kimberly R. Byrnes, PhD,^{||} Neil E. Grunberg, PhD,^{†+§} Christine E. Kasper, PhD,^{||} Lisa Osborne, PhD,^{||} Brian Pryor, PhD,^{||} Nicholas L. Tosini,^{**} Xingjia Wu, BS,^{||} and Juanita J. Anders, PhD^{||}

and Lite Cure, LLC; received equipment from B&W Tek, Irradia, Lite Cure, Nitto Denko, PhotoThera; holds intellectual property rights with Henry M. Jackson Foundation; serves on Advisory Board for Companion Animal LLC, Lite Cure LLC, Lumithera Inc; and served

CONCLUSION:

Photobiomodulation effectively reduced mechanical hypersensitivity, potentially through modulating macrophage/microglial activation to an anti-inflammatory phenotype

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- **Design:** Animal study
- **Subjects:** 33 Sprague-Dawley rats
 - Sham surgery (n=13)
 - SNI surgery (n=13)
 - SNI surgery + PBM treatment (n=7)
- **PBM (980 nm) protocol:**
 - Affected hind paw: 1 W, 20 s, 41cm above skin, dose 20 J
 - Dorsal root ganglia: 4.5W, 19s, skin contact, dose 85.5 J
 - Spinal cord regions 1.5 W, 19s, skin contact, dose 28.5 J
 - Every other day from day 7-30 post-operatively.
- **Results:**
 - Injured groups demonstrated mechanical hypersensitivity 1-30 days post-operatively.
 - Photobiomodulation-treated animals began to recover after two treatments; at day 26, mechanical sensitivity reached baseline.
 - Peripheral nerve injury caused region-specific macrophages/ microglia activation along spinothalamic and dorsal-column medial lemniscus pathways.
 - A pro-inflammatory microglial marker was expressed in the spinal cord of injured rats compared to photobiomodulation-treated and sham group.
 - Photobiomodulation-treated dorsal root ganglion macrophages expressed anti-inflammatory markers.

Chow RT, Armati PJ. Photobiomodulation: Implications for Anesthesia and Pain Relief. *Photomed Laser Surg.* 2016 Dec;34(12):599-609.

Photomedicine and Laser Surgery
Volume 34, Number 12, 2016
© Mary Ann Liebert, Inc.
Pp. 599–609
DOI: 10.1089/pho.2015.4048

Photobiomodulation: Implications for Anesthesia and Pain Relief

Roberta T. Chow, MB, BS (Hons), FRACGP, PhD,¹ and Patricia J. Armati, PhD²

CONCLUSION

This review provides strong evidence in neuroscience identifying inhibition of neural function as a mechanism for the clinical application of PBM in pain and anesthesia.

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Design & purpose: Review of electrophysiological studies in humans and animal models and cell culture studies to examine neural responses to PBM.

Results:

- Evidence shows that PBM can inhibit nerve function in vivo, in situ, ex vivo, and in culture.
- Animal studies using noxious stimuli indicate nociceptor-specific inhibition with other studies providing direct evidence of local conduction block, leading to inhibited translation of pain centrally.
- Evidence of PBM disrupted neuronal physiology affecting axonal flow, cytoskeleton organization, and decreased ATP is also presented.
- PBM changes are reversible with no side effects or nerve damage.

Chow R, Armati P, Laakso EL, Bjordal JM, Baxter GD. Inhibitory effects of laser irradiation on peripheral mammalian nerves and relevance to analgesic effects: a systematic review. *Photomed Laser Surg.* 2011 Jun;29(6):365-81.

Photomedicine and Laser Surgery
Volume 29, Number 6, 2011
© Mary Ann Liebert, Inc.
Pp. 365–381
DOI: 10.1089/pho.2010.2928

Review Article

Inhibitory Effects of Laser Irradiation on Peripheral Mammalian Nerves and Relevance to Analgesic Effects: A Systematic Review

Roberta Chow, M.B., BS(Hons), FRACGP, MAppSci, (Med Acu), Ph.D.,¹ Patricia Armati, B.Sc., M.Sc., Ph.D.,¹ E-Liisa Laakso, B Phty(Hons1), Ph.D., GCMgmt(QH),² Jan M. Bjordal, B.Sc., Physiotherapy, M.Sc., DPhil,³ and G. David Baxter, TD BSc(Hons), DPhil, M.B.A.⁴

CONCLUSION:

The evidence supports the view that neural inhibition is a plausible mechanism for the relief of acute and chronic pain with LLLT.

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Design: Systematic review.

- 44 studies were suitable for inclusion, 18 human and 26 animal studies.

Results:

- In 13 of 18 human studies, pulsed or continuous wave visible and continuous wave infrared (IR) laser irradiation slowed conduction velocity (CV) and/or reduced the amplitude of compound action potentials (CAPs).
- In 26 animal experiments, IR laser irradiation suppressed electrically and noxiously evoked action potentials including pro-inflammatory mediators.

Pallotta RC, Bjordal JM, Frigo L, Leal Junior EC, Teixeira S, Marcos RL, Ramos L, Messias Fde M, Lopes-Martins RA. Infrared (810-nm) low-level laser therapy on rat experimental knee inflammation. Lasers Med Sci. 2012 Jan;27(1):71-8.

Lasers Med Sci (2012) 27:71–78
DOI 10.1007/s10103-011-0906-1

ORIGINAL ARTICLE

Infrared (810-nm) low-level laser therapy on rat experimental knee inflammation

Rodney Capp Pallotta · Jan Magnus Bjordal · Lúcio Frigo · Ernesto Cesar Pinto Leal Junior · Simone Teixeira · Rodrigo Labat Marcos · Luciano Ramos · Felipe de Moura Messias · Rodrigo Álvaro Brandão Lopes-Martins

CONCLUSION:

The results suggest that laser radiation could be acting to modulate the inflammatory process and possibly to stimulate the production of anti-inflammatory mediators.

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- Design: animal study (30 Whistar rats)
- Methods: knee joint inflammation was induced with
- Results:
 - Significant reduction of the number of leucocytes and neutrophils in the joint cavity
 - Significant reduction of pro-inflammatory mediators (IL-1, IL-6) implicated in cartilage degeneration

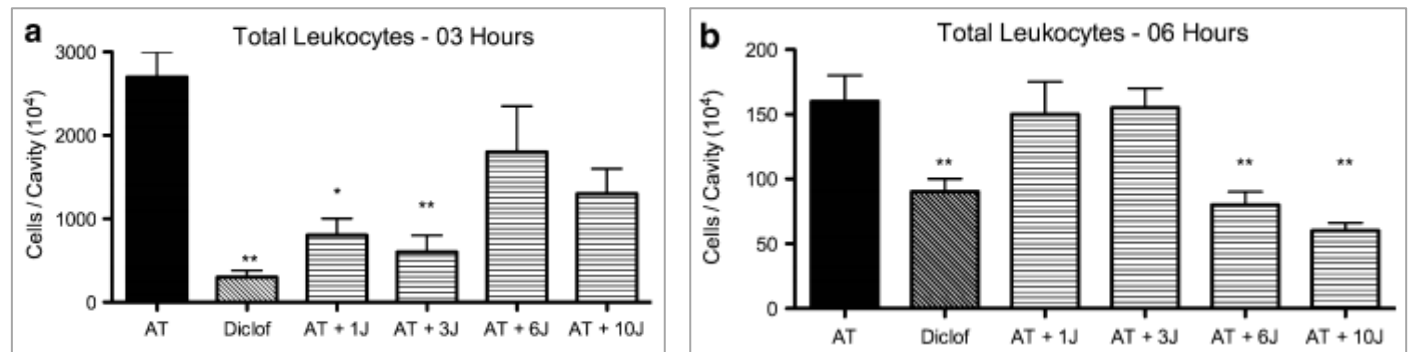


Fig. 1 Analysis of articular wash 3 and 6 h after induced inflammation. a Total number of leukocytes in articular lavage fluid after 3 h in the control group and after LLLT (n=6 animals per group (*p<0.05) (**p<0.001). b Total number of leukocytes in articular lavage fluid after 6 h in the control group and after LLLT (n=6 animals per group arthritis group (AT); the arthritis group treated with diclofenac (Diclof); the arthritis group treated with 1 J LLLT (AT+ 1 J); the arthritis group treated with 3 J LLLT (AT+3 J); the arthritis group treated with 6 J LLLT (AT+6 J); the arthritis group treated with 10 J LLLT (AT+10 J). Results are expressed as mean (±SEM)

Bjordal JM, Lopes-Martins RA, Joensen J, Iversen VV. The anti-inflammatory mechanism of low level laser therapy and its relevance for clinical use in physiotherapy. *Physical Therapy Reviews* 2010;15(4):286-293.



CONCLUSION:

There is strong evidence that red and infrared LLLT has a dose-dependent anti-inflammatory effect in animals, and scant evidence that the anti-inflammatory effect also occurs after LLLT in humans. The magnitude of the effect is not significantly different from NSAIDs

iEnovis

Journal link


Design: Systematic review

Studies: 11 cell studies and 27 animals studies met all inclusion criteria, and another 6 animal studies met the inclusion criteria for drug comparisons and LLLT interactions.

Results:

- There is strong evidence of an anti-inflammatory effect from LLLT, which is consistent across all 12 tested laboratory models and phases of inflammation and wavelengths between 633 and 904 nm.
- The magnitude of the anti-inflammatory effect is not significantly different from that of non-steroidal anti-inflammatory drugs (NSAIDs), but it is slightly less than glucocorticoid steroids.
- There is moderate evidence that concomitant use of glucocorticoid steroid has a negative effect on LLLT mechanisms and should be avoided.

Gao X, Xing D. Molecular mechanisms of cell proliferation induced by low power laser irradiation. *J Biomed Sci.* 2009; 16(1): 4.

Journal of Biomedical Science 

Review Open Access

Molecular mechanisms of cell proliferation induced by low power laser irradiation

Xuejuan Gao and Da Xing*

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* Corresponding author

Published: 12 January 2009 Received: 15 October 2008
Journal of Biomedical Science 2009, 16:4 Accepted: 12 January 2009
doi:10.1186/1423-0127-16-4

Molecular mechanisms of LPLI induced cell proliferation involve a number of signalling proteins, cell cycle-specific proteins and other molecules such as growth factors, interleukins, inflammatory cytokines and other small molecules.

This study discusses the discovered mitochondrial photoacceptors and nonmitochondrial photoacceptors, and then reviews the studies on the molecular mechanisms of LPLI-induced proliferation since January 1999, which will serve as a reference for the researchers in this field

- A number of signalling proteins are involved with laser-induced cell proliferation.
- Laser irradiation can regulate cell cycle progression by the activation or elevated expressions of cell cycle-specific proteins.
- Laser irradiation reduces signal molecules involved in inflammatory response and enhances immunomodulatory effects.
- Laser irradiation induces expression and secretion of growth factors, interleukins, inflammatory cytokines and small molecules (such as ATP, ROS, intracellular Ca²⁺).

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Chen CH, Tsai JL, Wang YH, Lee CL, Chen JK, Huang MH. Low-level laser irradiation promotes cell proliferation and mRNA expression of type I collagen and decorin in porcine Achilles tendon fibroblasts in vitro. *J Orthop Res.* 2009 May;27(5):646-50.

Low-Level Laser Irradiation Promotes Cell Proliferation and mRNA Expression of Type I Collagen and Decorin in Porcine Achilles Tendon Fibroblasts *In Vitro*

Chia-Hsin Chen,^{1,2} Jin-Lian Tsai,³ Yan-Hsiung Wang,^{2,4} Chia-Ling Lee,¹ June-Kai Chen,¹ Mao-Hsiung Huang¹

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Received 7 April 2008; accepted 25 September 2008

Published online 7 November 2008 in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/jor.20800

Low level laser irradiation promotes cell proliferation and production of mRNA for type I collagen and decorin synthesis.

Design: Laboratory study

Methods: 4 groups of identically cultured fibroblasts were exposed to LLLI and harvested after 24 h.

- Group 1 (control group) received no LLLI.
- Group 2 received 1 J/cm² LLLI
- Group 3 received 2 J/cm² LLLI
- Group 4 received 3 J/cm² LLLI

Results:

- When compared to the control group, the cell proliferation of irradiated AT fibroblasts in the other 3 groups increased significantly by 13% (Group 2), 30% (Group 3), and 12% (Group 4) respectively.
- The mRNA expressions of decorin and type I collagen in fibroblasts with LLLI were significantly higher than in the control condition ($p < 0.05$).

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Alves AN, Fernandes KP, Deana AM, Bussadori SK, Mesquita-Ferrari RA. Effects of low-level laser therapy on skeletal muscle repair: a systematic review. Am J Phys Med Rehabil. 2014 Dec;93(12):1073-85.

<p>Authors: Agnelo Neves Alves, MsC Kristianne Porta Santos Fernandes, PhD Alessandro Melo Deana, PhD Sandra Kalil Bussadori, PhD Raquel Agnelli Mesquita-Ferrari, PhD</p> <p>Affiliations: From the Postgraduate Program in Rehabilitation Sciences (ANA, KPSF, SKB, RAM-F) and Postgraduate Program in Biophotonics Applied to Health Sciences (KPSF, AMD, RAM-F), Universidade Nove de Julho, São Paulo, Brazil.</p> <p>Correspondence:</p>	<p>Muscle Repair</p> <p>LITERATURE REVIEW</p> <p>Effects of Low-Level Laser Therapy on Skeletal Muscle Repair A Systematic Review</p>
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The main effects of LLLT in muscle injuries were a reduction in the inflammatory process, the modulation of growth factors and myogenic regulatory factors, remodelling of extracellular matrix, and increased angiogenesis.

Design: Systematic review of 17 studies on the use of LLLT for the repair of skeletal muscle in any animal model.

Results:

- LLLT has been shown to be an extremely efficient therapeutic resource for the **modulation of the inflammatory process** and the attenuation of oxidative damage after muscle injury.
- LLLT has shown promise in **modulating MRFs** (myogenic regulatory factors).
- LLLT has been shown to be effective in **modulating the formation of fibrotic tissue** during the repair of injured muscle tissue. It has been shown to be effective in reducing the gene expression of TGF- β which plays a key role in the initiation of fibrotic cascades and the differentiation of satellite cells into myofibroblasts in injured muscle.
- LLLT is extremely effective in **modulating the expression of VEGF mRNA** and the consequent formation of **new blood vessels** during the repair of injured skeletal muscle.



Luo L, Sun Z, Zhang L, Li X, Dong Y, Liu TC. Effects of low-level laser therapy on ROS homeostasis and expression of IGF-1 and TGF- β 1 in skeletal muscle during the repair process. *Lasers Med Sci.* 2013 May;28(3):725-34.



Original Article | Published: 20 June 2012

Effects of low-level laser therapy on ROS homeostasis and expression of IGF-1 and TGF- β 1 in skeletal muscle during the repair process

[Li Luo](#), [Zhongwen Sun](#), [Lin Zhang](#), [Xiaoning Li](#), [Yu Dong](#) & [Timon Cheng-Yi Liu](#) 

Lasers in Medical Science 28, 725–734 (2013) | [Cite this article](#)

This study showed that LLLT could modulate the homeostasis of ROS (reactive oxygen species) and of the growth factors IGF-1 and TGF- β 1, which are known to play important roles in the repair process. This may constitute a new preventive approach to muscular fibrosis.

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Design: Laboratory study

Methods: Adult male Sprague-Dawley rats (n=96) were randomly divided into three groups: control group (no lesion, untreated, n=6), contusion group (n=48), and contusion-plus-LLLT group (n=42).

Muscle remodelling was evaluated at 0 h and 1, 2, 3, 7, 14, 21, and 28 days after injury.

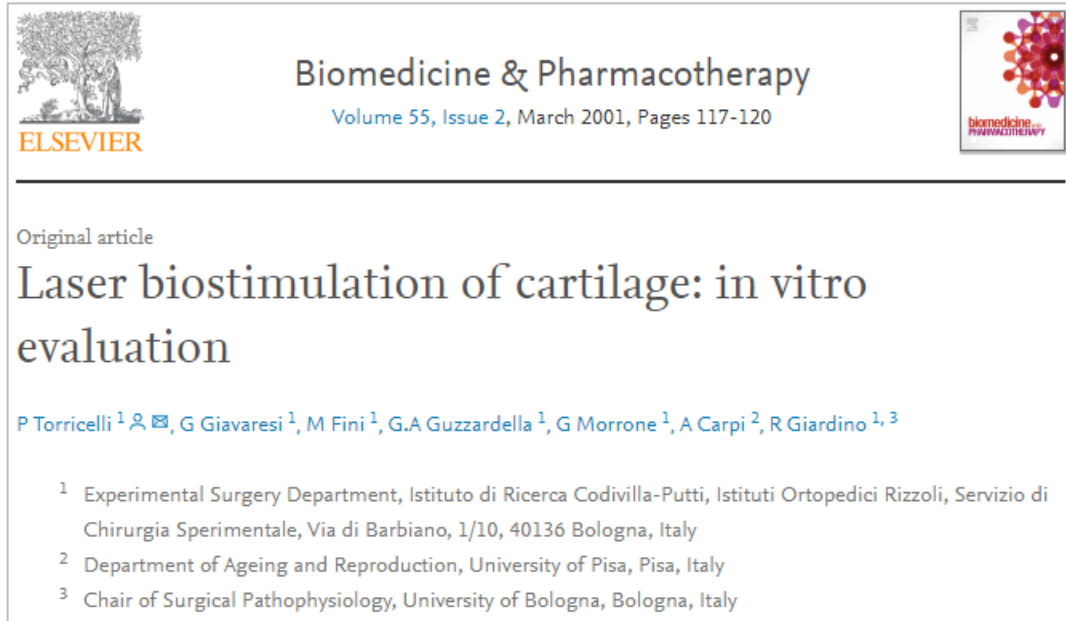
Results:

- LLLT markedly promoted the regeneration of muscle and reduced scar formation.
- LLLT also significantly enhanced muscle SOD (muscle superoxide dismutase) activity and significantly decreased muscle MDA (malondialdehyde) levels 1, 2, and 3 days after injury.
- LLLT increased the expression of IGF-1 2, 3, and 7 days after injury and decreased the expression of IGF-1 21 and 28 days after injury.
- LLLT decreased the expression of TGF- β 1 3 and 28 days after injury but increased expression at 7 and 14 days after injury.

Torricelli et al. 2001 | Cartilage repair



Torricelli P, Giavaresi G, Fini M, Guzzardella GA, Morrone G, Carpi A, Giardino R. Laser biostimulation of cartilage: in vitro evaluation. *Biomed Pharmacother.* 2001 Mar;55(2):117-20.



Laser irradiation had a positive biostimulation effect on chondrocyte cell proliferation which was maintained for five days following the laser treatment.

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Pubmed

Design: In vitro study.

Methods: Chondrocyte cultures were derived from rabbit and human cartilage.

- These cells were exposed to laser treatment for 5 days, using the following parameters: 300 joules, 1 watt, 100 (treatment A) or 300 (treatment B) hertz, pulsating emission for 10 minutes, under a sterile laminar flow.
- Control cultures (no treatment) received the same treatment with the laser device off.

Outcome: Cell viability was measured by MTT assay at the end of the laser treatment and then after 5 days.

Results:

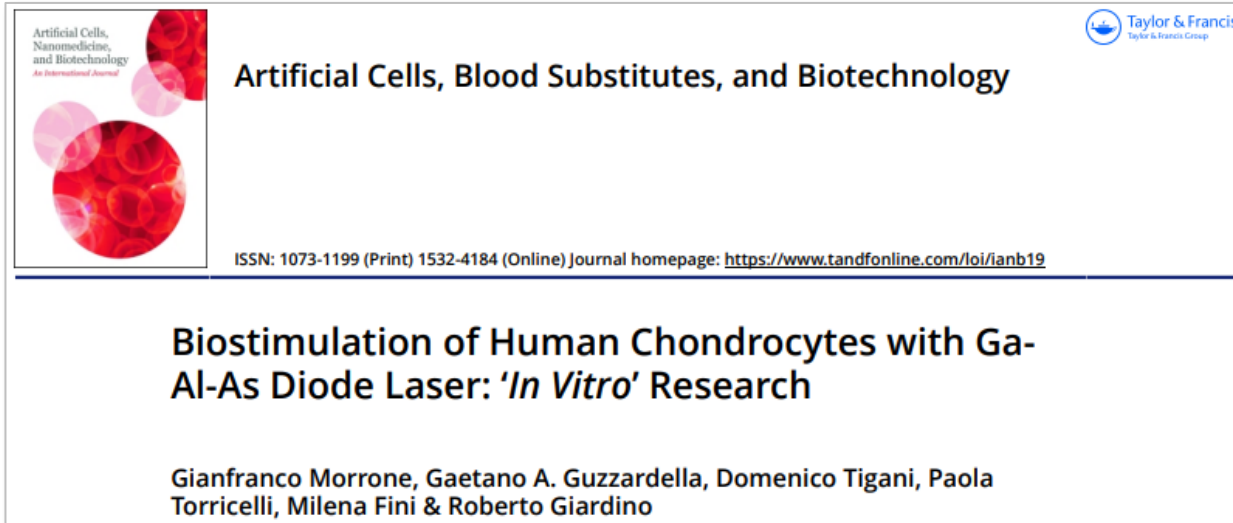
- Neither rabbit nor human cultured chondrocytes showed any damage under a light microscope and immunostaining control following laser treatment.
- The MTT test results indicated a positive biostimulation effect on cell proliferation with respect to the control group.
- The increase in viability of irradiated chondrocytes was maintained for five days following the end of the laser treatment.

Morrone et al. 2000 | Cartilage repair



Back to overview

Morrone G, Guzzardella GA, Tigani D, Torricelli P, Fini M, Giardino R. Biostimulation of human chondrocytes with Ga-Al-As diode laser: 'in vitro' research. *Artif Cells Blood Substit Immobil Biotechnol.* 2000 Mar;28(2):193-201.



Laser irradiation provides biostimulation to chondrocytes without cell damage

iEnovis

Pubmed

Design: In vitro study.

Methods: The cartilage sample used for the biostimulation treatment was taken from the right knee of a 19-year-old patient. After the chondrocytes were isolated and suspended for cultivation, the cultures were incubated for 10 days. The cultures were divided into four groups.

- Groups I, II, III were subject to biostimulation with the following laser parameters: 300 J, 1 W, 100 Hz, 10 min. exposure, pulsating emission; 300 J, 1 W, 300 Hz, 10 min. exposure, pulsating emission; and 300 J, 1 W, 500 Hz, 10 min. exposure, pulsating emission, respectively.
- Group IV did not receive any treatment. The laser biostimulation was conducted for five consecutive days.

Outcomes: At the end of the treatment, the Calcium, Alkaline Phosphate, MTT tests and proteoglycan were performed to assess cell metabolism and toxicity level.

Results

The data showed good results in terms of cell viability and levels of Ca and Alkaline Phosphate in the groups treated with laser biostimulation compared to the untreated group.



Ekici Ö, Dündar Ü, Büyükbosna M. Effectiveness of high-intensity laser therapy in patients with myogenic temporomandibular joint disorder: A double-blind, placebo-controlled study. *J Stomatol Oral Maxillofac Surg.* 2022 Jun;123(3):e90-e96.

J Stomatol Oral Maxillofac Surg 123 (2022) e90–e96

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ScienceDirect
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EM|consulte
www.em-consulte.com

Original Article

Effectiveness of high-intensity laser therapy in patients with myogenic temporomandibular joint disorder: A double-blind, placebo-controlled study

Ömer Ekici^{a,*}, Ümit Dündar^b, Murat Büyükbosna^c

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^b Prof. Dr. Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, Turkey
^c Physical therapist, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, Turkey

- **Design:** Prospective, double-blind, placebo controlled clinical study
- **Subjects:** 70 patients with myogenic TMD
- **Device:** ASA Hiro 3
- **HILT Protocol:**
 - mean power 10.5W
 - total dose per session: 1029 J
 - 1 session per day, 5 days / week for 3 weeks (15 sessions in total)

CONCLUSION:

HILT is a highly effective, non-invasive therapeutic method for patients with myogenic TMD. It provides significantly better results than placebo for improvement of pain, function and quality of life.

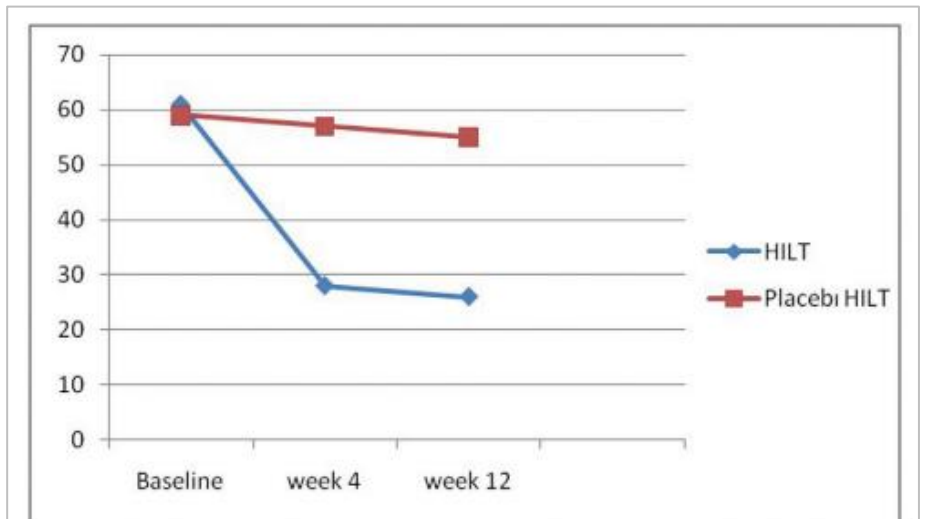


Fig. 2. Mean VAS scores in the HILT and placebo HILT groups.

[iEnovis](#)

[Pubmed](#)


Yilmaz M, Eroglu S, Dundar U, Toktas H. The effectiveness of high-intensity laser therapy on pain, range of motion, functional capacity, quality of life, and muscle strength in subacromial impingement syndrome: a 3-month follow-up, double-blinded, randomized, placebo-controlled trial. *Lasers Med Sci.* 2022 Feb;37(1):241-250.

Lasers in Medical Science
<https://doi.org/10.1007/s10103-020-03224-7>

ORIGINAL ARTICLE



The effectiveness of high-intensity laser therapy on pain, range of motion, functional capacity, quality of life, and muscle strength in subacromial impingement syndrome: a 3-month follow-up, double-blinded, randomized, placebo-controlled trial

Muhammed Yilmaz¹  • Selma Eroglu²  • Umit Dundar²  • Hasan Toktas² 

Received: 10 September 2020 / Accepted: 16 December 2020
© The Author(s), under exclusive licence to Springer-Verlag London Ltd. part of Springer Nature 2021

- **Design:** Double-blind randomised placebo controlled trial
- **Subjects:** 63 patients who were diagnosed with SAIS
 - HILT + exercise group (n=32)
 - Sham HILT + exercise group (n=31)
- **Device:** ASA Hiro 3
- **HILT Protocol:**
 - total dose per session: 2781 J
 - 5 sessions / week for 3 weeks (15 sessions in total)
- **Results:**

Both groups improved significantly, but the HILT group had a statistically significant greater improvement compared with the placebo group in

- the active shoulder flexion,
- IR and ER ROM measurements
- all VAS scores;
- CMS activities of daily living,
- all the sub-parameters of SF-36
- IR 120,180, 210 and ER 120,180 degrees peak torque values of isokinetic measurement

CONCLUSION:

HILT combined with exercise appears to provide significantly better outcomes than exercise alone for improving pain and increasing ROM, function, quality of life, and muscular strength.



Atan et al. 2021 | Shoulder pain



Atan T, Bahar-Ozdemir Y. Efficacy of high-intensity laser therapy in patients with adhesive capsulitis: a sham-controlled randomized controlled trial. *Lasers Med Sci.* 2021 Feb;36(1):207-217.

Lasers in Medical Science
https://doi.org/10.1007/s10103-020-03121-z

ORIGINAL ARTICLE

Efficacy of high-intensity laser therapy in patients with adhesive capsulitis: a sham-controlled randomized controlled trial

Tuğba Atan¹ · Yeliz Bahar-Ozdemir²

Received: 7 May 2020 / Accepted: 10 August 2020
© Springer-Verlag London Ltd., part of Springer Nature 2020

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CONCLUSION:

Pain and quality of life significantly improved when HPL is combined with exercises, compared to placebo laser treatment or exercises only.

- **Design:** Double-blind randomised placebo controlled trial
- **Subjects:** 36 patients diagnosed with adhesive capsulitis
 - HILT plus therapeutic exercises
 - Sham-laser plus therapeutic exercises
 - Control: therapeutic exercises only
- **Device:** Mectronic iLux
- **HILT Protocol:**
 - 100J/cm², 8-12 W in stochastic and burst mode
 - Scanning over anterior & posterior joint line
 - 5 sessions / week for 3 weeks (15 sessions in total)
- **Results:**
 - Only HILT plus therapeutic exercises group showed significant decrease with time of the VAS-pain score and significant improvement of all SF-36 subscores over time, except for subscore emotional well-being.
 - At the end of the study, there was a significant ($p < 0.05$) difference in VAS-pain, SPADI-pain, and SF-36 (subgroups of energy/fatigue, pain, and general health) scores in favour of the HILT plus ex. group compared to the other groups.
 - All groups provided comparable improvements in SPADI-disability and ROM of shoulder joint after the interventions and during the follow-up (all $P < 0.05$).

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Pubmed

Elsodany AM, Alayat MSM, Ali MME, Khaprani HM. Long-Term Effect of Pulsed Nd:YAG Laser in the Treatment of Patients with Rotator Cuff Tendinopathy: A Randomized Controlled Trial. *Photomed Laser Surg.* 2018 Sep;36(9):506-513.

Photomedicine and Laser Surgery
Volume 36, Number 9, 2018
© Mary Ann Liebert, Inc.
Pp. 506–513
DOI: 10.1089/pho.2018.4476

Long-Term Effect of Pulsed Nd:YAG Laser in the Treatment of Patients with Rotator Cuff Tendinopathy: A Randomized Controlled Trial

Ahmed Mohamed Elsodany, PhDPT,¹ Mohamed Salaheldien Mohamed Alayat, PhDPT,¹
Mohamed Mohamed Ebrahim Ali, PhDPT,² and Hussien Mosa Khaprani, MscPT³

CONCLUSION:

Adding HILT to active exercise therapy is of clinical significance for improving symptoms associated with rotator cuff tendinopathy and this positive impact lasts for 6 months.

- **Design:** Randomised placebo controlled trial
- **Subjects:** 60 patients with rotator cuff tendinopathy
 - HILT + exercise group (n=30)
 - Sham HILT + exercise group (n=30)
- **Device:** ASA Hiro 3
- **HILT Protocol:**
 - total dose per session: 2050 J
 - 3 sessions / week for 4 weeks (12 sessions in total)
 - Average power: 10.5 W
- **Results:**
 - Pain, ROM and shoulder function improved significantly in both groups after treatment and at follow-up intervals ($p < 0.001$).
 - The improvements were significantly higher in the HILT group compared to the control group.
 - There was a significant difference between HILT group and control group for all outcome variables at all time points (post-treatment, 3m, 6m) in favour of the HILT group ($p < 0.001$).

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Figures

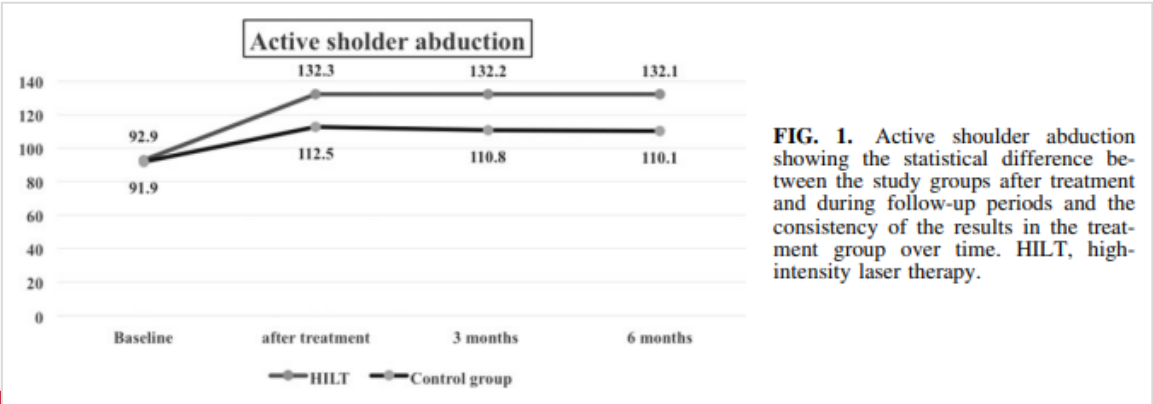
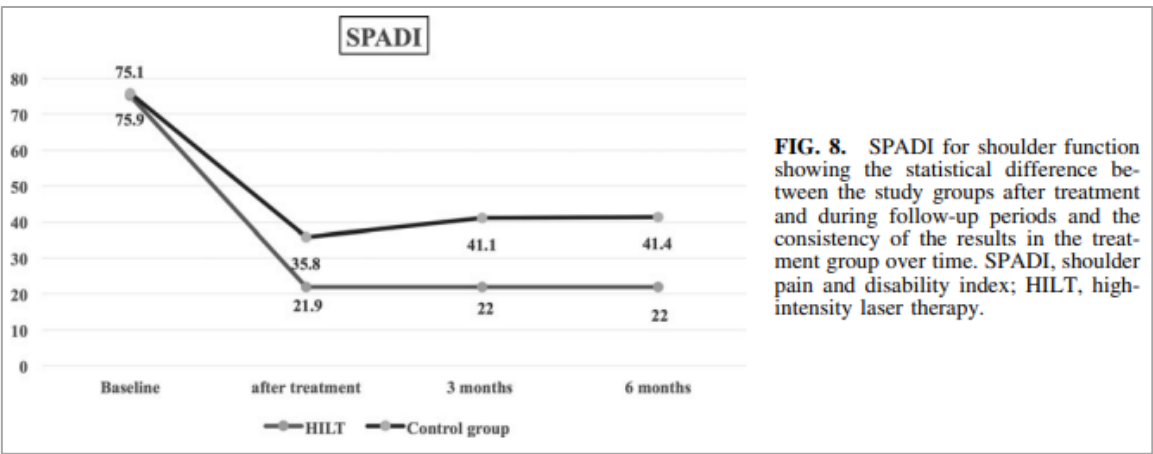
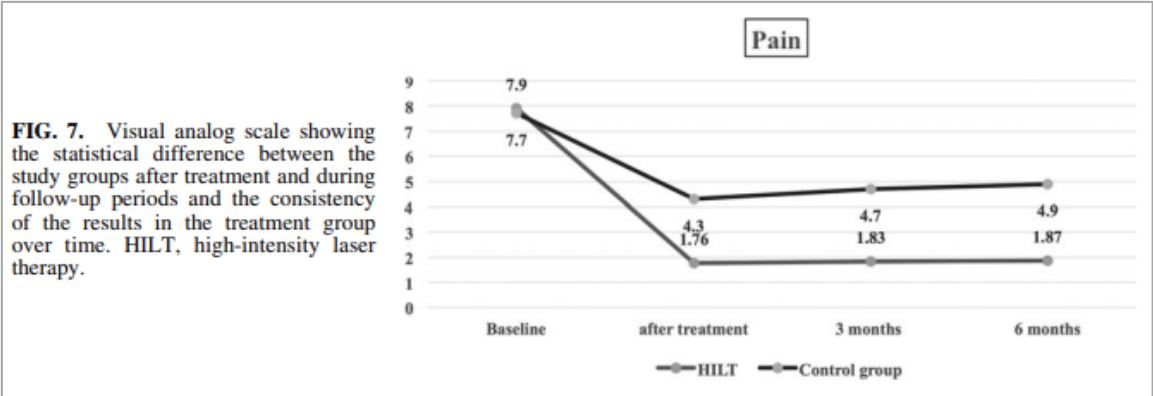


FIG. 8. SPADI for shoulder function showing the statistical difference between the study groups after treatment and during follow-up periods and the consistency of the results in the treatment group over time. SPADI, shoulder pain and disability index; HILT, high-intensity laser therapy.

FIG. 1. Active shoulder abduction showing the statistical difference between the study groups after treatment and during follow-up periods and the consistency of the results in the treatment group over time. HILT, high-intensity laser therapy.

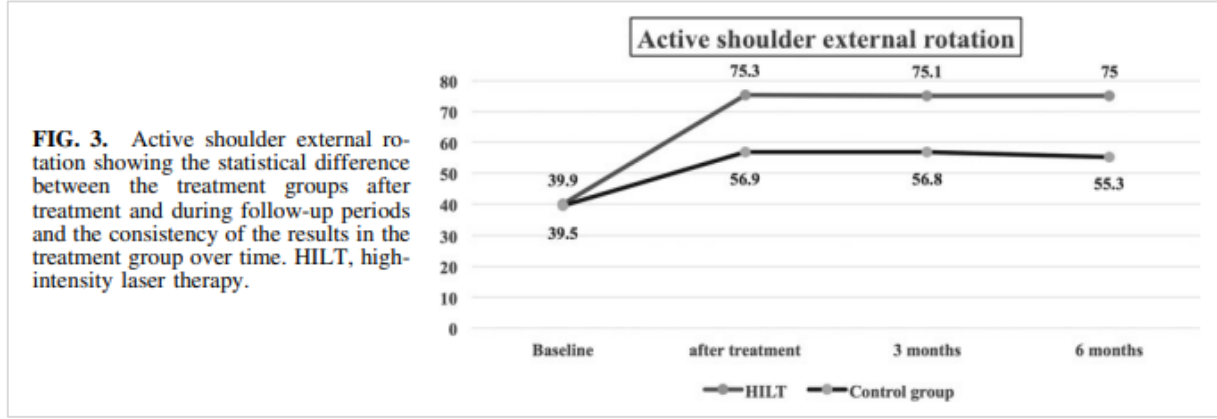


FIG. 3. Active shoulder external rotation showing the statistical difference between the treatment groups after treatment and during follow-up periods and the consistency of the results in the treatment group over time. HILT, high-intensity laser therapy.

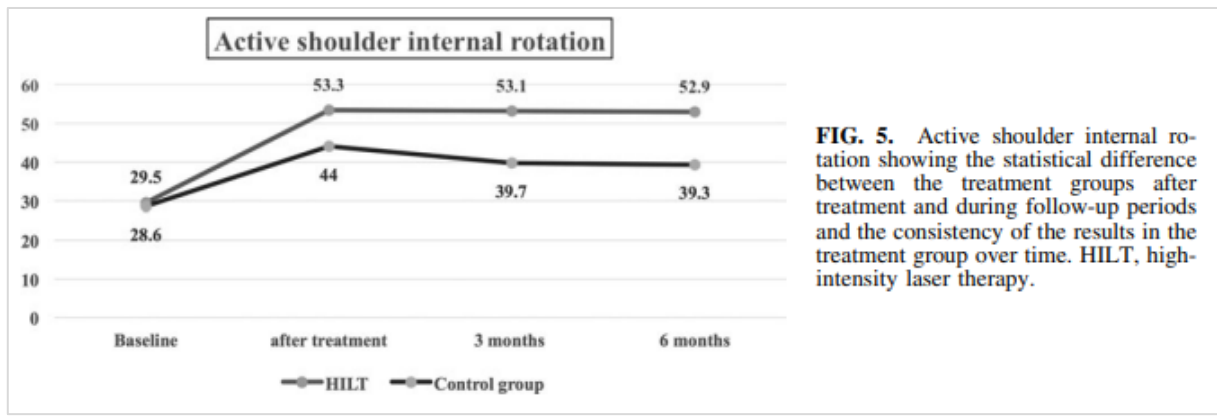


FIG. 5. Active shoulder internal rotation showing the statistical difference between the treatment groups after treatment and during follow-up periods and the consistency of the results in the treatment group over time. HILT, high-intensity laser therapy.


Elsodany AM, Alayat MSM, Ali MME, Khaprani HM. Long-Term Effect of Pulsed Nd:YAG Laser in the Treatment of Patients with Rotator Cuff Tendinopathy: A Randomized Controlled Trial. *Photomed Laser Surg.* 2018 Sep;36(9):506-513.

Alayat MSM, Battecha KH, Elsodany AM, Alzahrani OA, Alqurashi AKA, Jawa AT, Alharthi YS. Effectiveness of Photobiomodulation Therapy in the Treatment of Myofascial Pain Syndrome of the Upper Trapezius Muscle: A Systematic Review and Meta-Analysis. *Photobiomodul Photomed Laser Surg.* 2022 Oct;40(10):661-674.

Photobiomodulation, Photomedicine, and Laser Surgery
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© Mary Ann Liebert, Inc.
Pp. 661–674
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Photobiomodulation—Review

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Effectiveness of Photobiomodulation Therapy in the Treatment of Myofascial Pain Syndrome of the Upper Trapezius Muscle: A Systematic Review and Meta-Analysis

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Ahmed Mohamed Elsodany, PhD PT,² Omer Abdulaziz Alzahrani, BSc,¹
Abdulmajeed Khalaf Allah Alqurashi, BSc,¹ AbdulAziz Talal Jawa, BSc,¹ and Yazan Saleh Alharthi, BSc¹

Conclusion:
PBMT is an effective treatment modality for myofascial pain syndrome with significant effects compared to controls.

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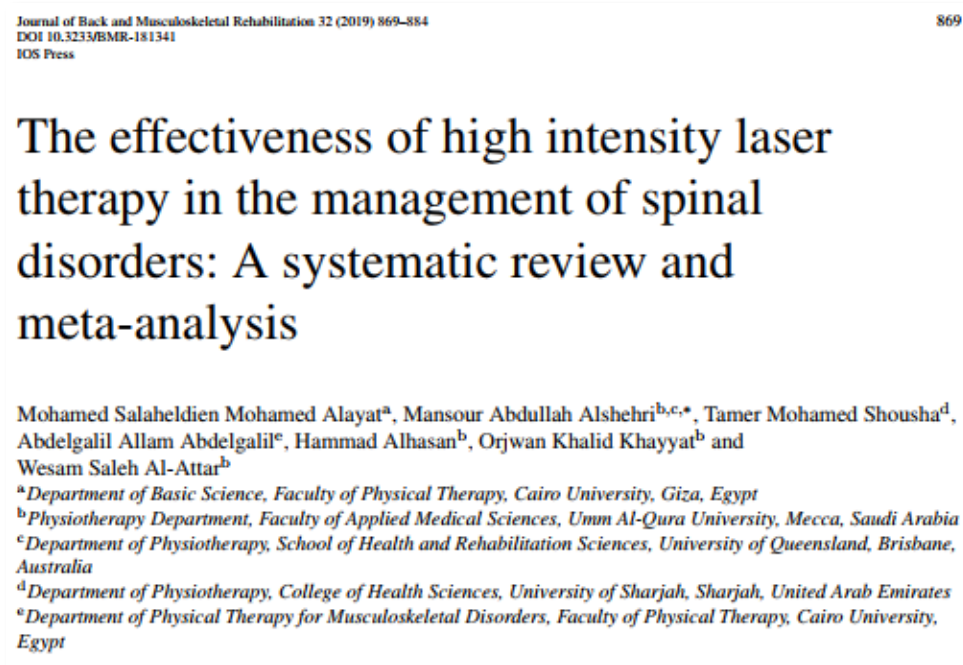
Design: systematic review with meta-analysis

- 17 studies included in the review
 - 16 included in the meta-analysis
 - 3 HILT studies
 - 12 high quality studies (PEDRO)
 - 8 studies (441 patients) compared ‘PBMT alone’ with control treatment (placebo /medication /other PT / manual therapy).
 - 7 studies (421 patients) compared ‘PBMT + Exercise’ with control treatment.

Results:

- PBMT and PBMT+Ex were significantly more effective than control or comparator groups post-treatment and at follow-up for pain reduction and increase of PPT (pain pressure threshold)
- PBMT: medium effect size
- PBMT+Ex: large effect size

Alayat MSM, Alshehri MA, Shousha TM, Abdelgalil AA, Alhasan H, Khayyat OK, Al-Attar WS. The effectiveness of high intensity laser therapy in the management of spinal disorders: A systematic review and meta-analysis. J Back Musculoskelet Rehabil. 2019;32(6):869-884.



CONCLUSION:

HILT as a complementary modality to exercise or conventional physical therapy may offer significant additional pain relief and functional improvement.

- Design: Systematic review with Meta-analysis
- Studies: 10 RCTs met the inclusion criteria
 - 4 studies on neck pain
 - 6 studies on low back pain
- Results: Forest plots showed that
 - HILT with exercise was significantly more effective than placebo HILT with exercise in terms of pain reduction and functional improvement.
 - HILT alone or HILT with conventional physiotherapy (CPT) provided significantly better outcomes than CPT alone.

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Figures

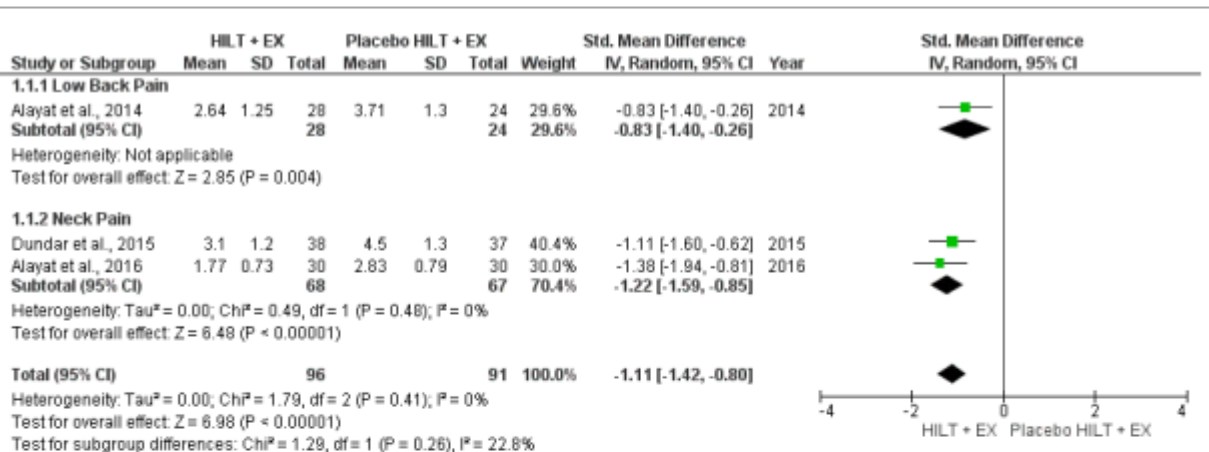
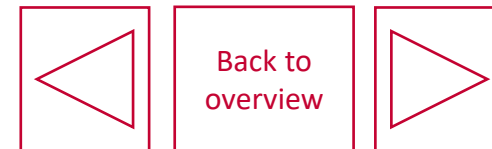


Fig. 2. Meta-analyses of the VAS pain score after HILT + EX compared to placebo HILT + EX.

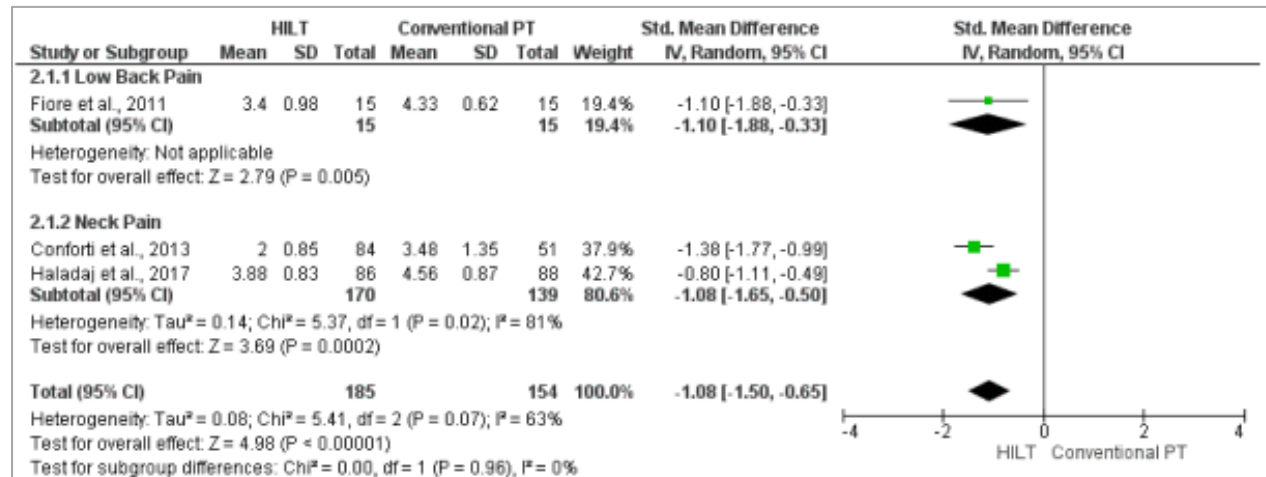


Fig. 4. Meta-analysis of the VAS pain score after HILT compared to CPT.

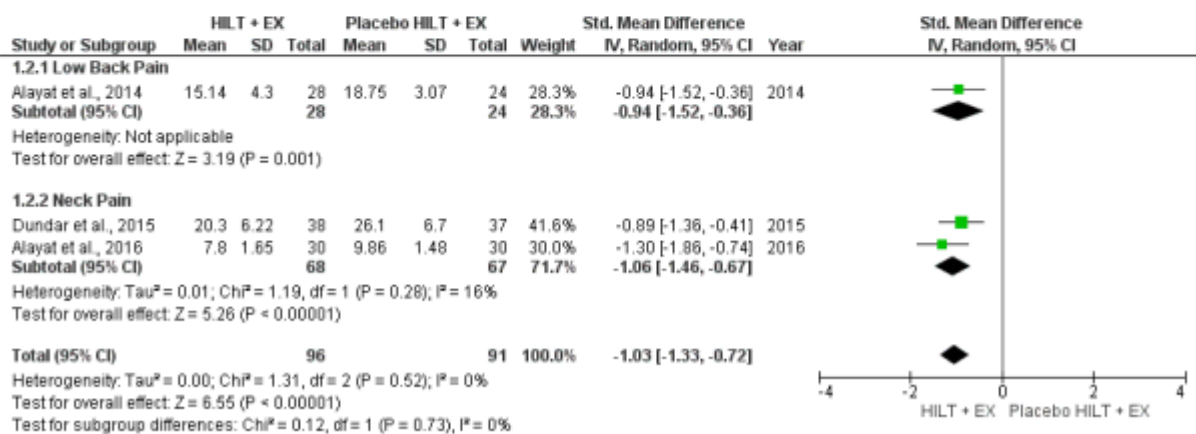


Fig. 3. Meta-analysis of functional scales score after HILT + EX compared to placebo HILT + EX.

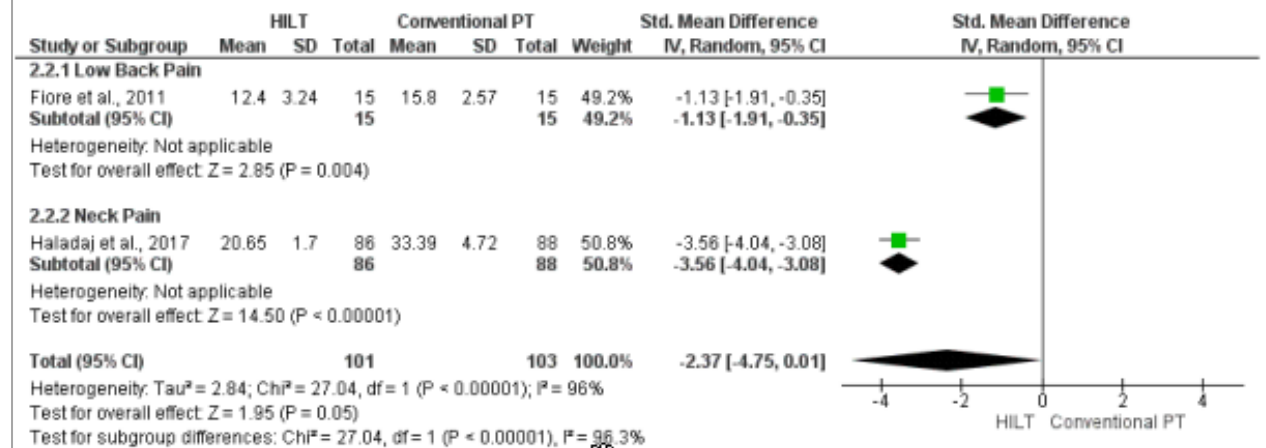


Fig. 5. Meta-analysis of functional scales score after HILT compared to CPT.

Alayat MS, Mohamed AA, Helal OF, Khaled OA. Efficacy of high-intensity laser therapy in the treatment of chronic neck pain: a randomized double-blind placebo-control trial. *Lasers Med Sci.* 2016 May;31(4):687-94.

Lasers Med Sci (2016) 31:687–694
DOI 10.1007/s10103-016-1910-2

ORIGINAL ARTICLE

Efficacy of high-intensity laser therapy in the treatment of chronic neck pain: a randomized double-blind placebo-control trial

Mohamed Salaheldien Mohamed Alayat¹ · Ashraf Abdelaal Mohamed¹ · Omar Farouk Helal¹ · Osama Ahmed Khaled²

- **Design:** Double-blind randomised placebo controlled trial
- **Subjects:** 60 male patients with chronic neck pain (>3m)
 - HILT + Exercise group (n=30)
 - Sham laser + Exercise group (n=30)
- **Device:** ASA Hiro 3
- **HILT Protocol:**
 - total dose per session: 2250 J
 - 2 sessions / week for 6 weeks (12 sessions in total)

CONCLUSION:

HILT was significantly more effective than placebo laser treatment for improving pain, function and cervical ROM in patients with chronic neck pain.

Table 2 Changes in the VAS and NDI between treatment groups

	VAS (Pain)				NDI (Neck Disability Index)			
	Pre	Post	t value	p value	Pre	Post	t value	p value
HILT+EX	8.00±0.79	1.77±0.73	-50.288	0.0009 ^a	45.87±5.12	7.80±1.65	-50.4222	0.0008 ^a
PL+EX	7.83±0.80	2.83±0.79	-42.573	0.0001 ^a	47.97±3.29	9.86±1.48	-78.546	0.0002 ^a
t value	0.817	-5.4331			-1.891	-5.1106		
p value	0.4170 ^c	0.0001 ^b			0.063 ^c	0.0003 ^b		

VAS visual analogue scale, NDI neck disability index

^a Significant difference in the same treatment group (Wilcoxon signed ranks test; $p < 0.05$)

^b Significant difference between two treatment groups (Mann-Whitney U test; $p < 0.05$)

^c Nonsignificant difference in pre-treatment mean values



Dundar U, Turkmen U, Toktas H, Solak O, Ulasli AM. Effect of high-intensity laser therapy in the management of myofascial pain syndrome of the trapezius: a double-blind, placebo-controlled study. *Lasers Med Sci.* 2015 Jan;30(1):325-32.

Lasers Med Sci (2015) 30:325–332
DOI 10.1007/s10103-014-1671-8

ORIGINAL ARTICLE

Effect of high-intensity laser therapy in the management of myofascial pain syndrome of the trapezius: a double-blind, placebo-controlled study

Umit Dundar · Utku Turkmen · Hasan Toktas · Ozlem Solak · Alper Murat Ulasli

- **Design:** Double-blind randomised placebo controlled trial
- **Subjects:** 76 female patients with myofascial pain syndrome of the trapezius
 - HILT + Exercise group (n=38)
 - Sham laser + Exercise group (n=37, 1 drop-out)
- **Device:** ASA Hiro 3
- **HILT Protocol:**
 - total dose per session: 1060 J
 - 1 session per day, 5 days / week for 3 weeks (15 sessions in total)

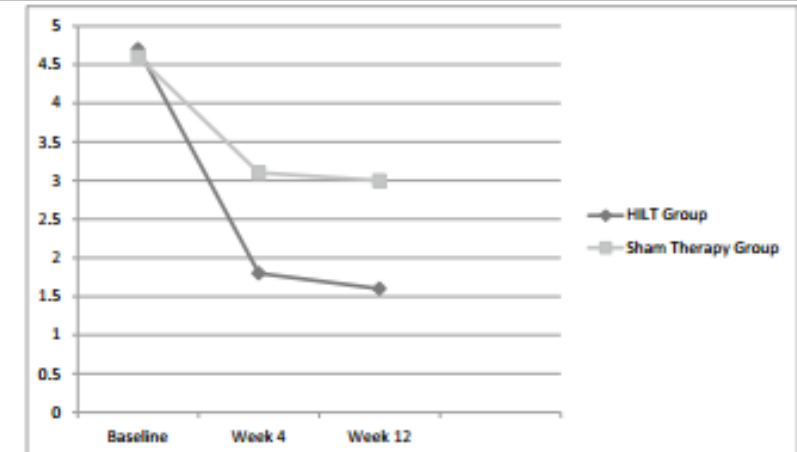
CONCLUSION:

HILT produced significantly greater improvements in pain (at rest, during movement and at night), disability and quality of life than sham laser in patients with MPS.

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Fig. 3 Mean VAS (pain at night) scores in the HILT and sham therapy groups at three different time points (baseline (1), week 4 (2), and week 12 (3)) [time (x-axis), VAS scores (y-axis)]. HILT high-intensity laser therapy, VAS visual analog scale



Panton L, Simonavice E, Williams K, Mojock C, Kim JS, Kingsley JD, McMillan V, Mathis R. Effects of Class IV laser therapy on fibromyalgia impact and function in women with fibromyalgia. *J Altern Complement Med.* 2013 May;19(5):445-52.

THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 19, Number 5, 2013, pp. 445–452
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DOI: 10.1089/acm.2011.0398

Effects of Class IV Laser Therapy on Fibromyalgia Impact and Function in Women with Fibromyalgia

Lynn Panton, PhD, FACSM,¹ Emily Simonavice, PhD,² Kristen Williams, MS,¹ Christopher Mojock, MS,¹ Jeong-Su Kim, PhD,¹ J. Derek Kingsley, PhD,³ Victor McMillan, MD,⁴ and Reed Mathis, DC⁵

CONCLUSION:

HILT may be a beneficial modality for women with fibromyalgia. It produced significantly greater improvements in pain and upper-body flexibility than placebo treatment, ultimately reducing the impact of fibromyalgia.

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- **Design:** Double-blind randomised placebo controlled trial
- **Subjects:** 38 women with fibromyalgia
 - Laser heat therapy: HILT + warm air (n=20)
 - Placebo: warm air only (n=18)
- **Device:** Litecure LCT-1000
- **HILT Protocol:**
 - 10.63 J/cm² , total dose per session 4200J
 - Grid scanning technique over 7 tender points located across the neck, shoulders and back
 - 2 sessions/week for 4 weeks (total 8 sessions)
- **Results:**
 - Pain decreased with 12.7% in the HILT group (signif.) versus 5.1% in the control group (not signif.)
 - Fibromyalgia Impact score improved with 9.5% in the HILT group (signif.) versus no change in the control group.
 - Function scores improved with 19.5% in the HILT group (signif.) versus 8.2% in the control group (signif.)
 - Upper body flexibility improved with 9.9% in the HILT group (signif.) versus no change in the control group.

Chen L, Liu D, Zou L, Huang J, Chen J, Zou Y, Lai J, Chen J, Li H, Liu G. Efficacy of high intensity laser therapy in treatment of patients with lumbar disc protrusion: A randomized controlled trial. *J Back Musculoskelet Rehabil.* 2018 Feb 6;31(1):191-196.

Journal of Back and Musculoskeletal Rehabilitation 31 (2018) 191–196
DOI 10.3233/BMR-170793
IOS Press

191

Efficacy of high intensity laser therapy in treatment of patients with lumbar disc protrusion: A randomized controlled trial

Lianghua Chen^{a,1}, Dandan Liu^{a,1}, Liping Zou^a, Ju Huang^a, Junqi Chen^a, Yucong Zou^a, Jienuan Lai^a, Jingjie Chen^a, Haihong Li^a and Gang Liu^{a,*}
^aDepartment of Rehabilitation Medicine, The Third Affiliated Hospital of Southern Medical University, Guangzhou, Guangdong, China

- **Design:** Randomised controlled trial
- **Subjects:** 63 patients suffering from protrusion of lumbar intervertebral disc
 - Group 1 was treated with HILT and spinal decompression system (SDS).
 - Group 2 received SDS alone.
- **Device:** BTL-6000
- **HILT Protocol:**
 - 12 W, 150 J/cm², total dose per session 7500 J
 - Scanning plus pain points
 - 5 sessions/week for 2 weeks (total 10 sessions)
- **Results:**
 - Both groups improved significantly after 2 weeks treatment.
 - At 1 month follow-up, Group 1 had significantly better scores for ODI, lumbosacral portion pain, and lower limb radiation pain.

CONCLUSION:

HP laser therapy added to traction therapy provides better improvement of symptoms in patients with lumbar disk protrusion



Table 3
Comparison of results for lower limb radiation pain with VAS in two patient groups before treatment, after treatment, and during follow-up visit ($\bar{x} \pm s$)

Item	Time	Group 1 (n = 11) ($\bar{x} \pm s$)	Group 2 (n = 13) ($\bar{x} \pm s$)	P value
Lower limb radiation pain VAS (score)	Before treatment	7.59 ± 0.92	7.69 ± 0.75	0.77
	Two weeks after treatment	3.15 ± 1.24	3.69 ± 1.03	0.14
	One month after follow-up visit	1.45 ± 1.13	3.40 ± 1.05	< 0.001
P value		< 0.001	< 0.001	

Alayat MS, Atya AM, Ali MM, Shosha TM. Long-term effect of high-intensity laser therapy in the treatment of patients with chronic low back pain: a randomized blinded placebo-controlled trial. *Lasers Med Sci.* 2014 May;29(3):1065-73.

Lasers Med Sci (2014) 29:1065–1073
DOI 10.1007/s10103-013-1472-5

ORIGINAL ARTICLE

Long-term effect of high-intensity laser therapy in the treatment of patients with chronic low back pain: a randomized blinded placebo-controlled trial

Mohamed Salaheldien Mohamed Alayat · Azza Mohamed Atya · Mohamed Mohamed Ebrahim Ali · Tamer Mohamed Shosha

CONCLUSION:

HILT combined with exercise is more effective and has a more prolonged effect than sham laser + exercise or laser alone in increasing lumbar ROM and in decreasing pain and functional disability, with effects lasting up to 3 months.

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- **Design:** Randomised single-blinded placebo-controlled trial
- **Subjects:** 72 male patients with CLBP
 - Group 1: HILT plus exercise (HILT + EX)
 - Group 2: Placebo laser plus exercise (PL + EX)
 - Group 3: HILT alone
- **Device:** ASA Hiro-3
- **HILT Protocol:**
 - Total dose per session 3000 J
 - 3 sessions/week for 4 weeks (total 12 sessions)

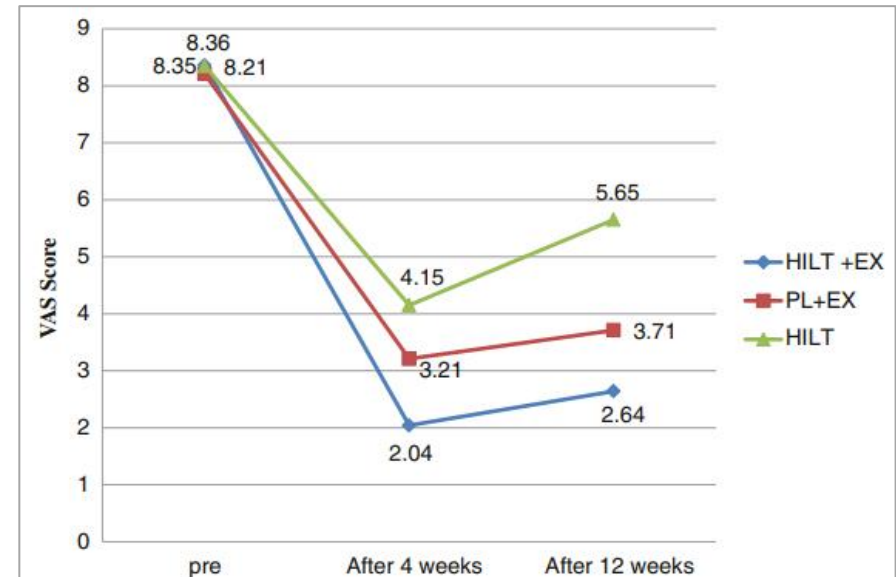


Fig. 2 VAS changes among treatment groups

Roberts DB, Kruse RJ, Stoll SF. The effectiveness of therapeutic class IV (10 W) laser treatment for epicondylitis. *Lasers Surg Med.* 2013 Jul;45(5):311-7.

Lasers in Surgery and Medicine 45:311–317 (2013)

The Effectiveness of Therapeutic Class IV (10 W) Laser Treatment for Epicondylitis

Delia B. Roberts, PhD, FACSM,*¹ Roger J. Kruse, MD, FACSM,² and Stephen F. Stoll, MD³

¹Selkirk College, Castlegar, British Columbia, Canada, V1N 4L3

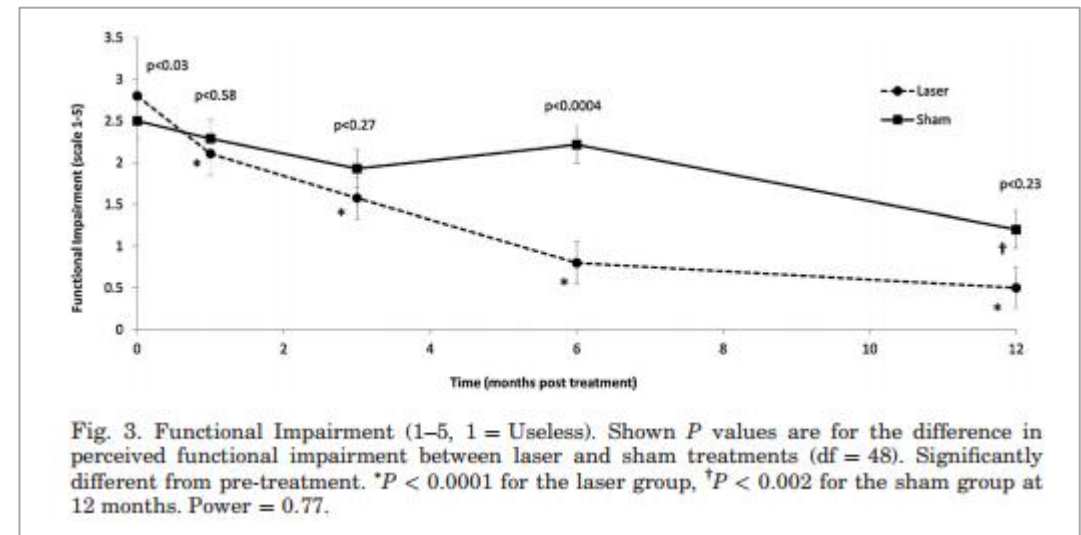
²Sports Care, ProMedica Health System, Toledo, Ohio, 43615

³Diagnostic Radiologist, Toledo Radiological Associates, Toledo, Ohio, 43606

- **Design:** Randomized placebo-controlled double-blinded clinical trial.
- **Subjects:** 16 patients with epicondylitis
 - Group 1: HILT
 - Group 2: Placebo laser
- **Device:** LiteCure 10W HPL device
- **HILT Protocol:**
 - 6.6 J/cm², total dose per session 3000 J
 - 8 sessions over 18 days

CONCLUSION:

Faster reductions in pain and return of strength and function in the HP laser treatment group than in the sham group, with improvement continuing up to 1 year post-treatment.



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Back to overview



Ezzati K, Laakso EL, Saberi A, Yousefzadeh Chabok S, Nasiri E, Bakhshayesh Eghbali B. A comparative study of the dose-dependent effects of low level and high intensity photobiomodulation (laser) therapy on pain and electrophysiological parameters in patients with carpal tunnel syndrome. *Eur J Phys Rehabil Med.* 2020 Dec;56(6):733-740.

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European Journal of Physical and Rehabilitation Medicine 2020 December;56(6):733-40
DOI: 10.23736/S1973-9087.19.05835-0

ORIGINAL ARTICLE

A comparative study of the dose-dependent effects of low level and high intensity photobiomodulation (laser) therapy on pain and electrophysiological parameters in patients with carpal tunnel syndrome

Kamran EZZATI ¹, E-Liisa LAAKSO ², Alia SABERI ³ *, Shahrokh YOUSEFZADEH CHABOK ⁴, Ebrahim NASIRI ⁵, Babak BAKHSHAYESH EGHBALI ³

CONCLUSION:

LLLT and HILT in conjunction with exercise program are effective in reducing pain and improving median motor nerve conduction studies of the patients with CTS. High power laser (1.6W) with 8J/cm² fluence produced the best results.

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- **Design:** Double-blind randomized controlled trial.
- **Subjects:** 98 patients with CTS; 5 groups:
 - LLLT 50 mW low fluence 8J/cm² + home exercises
 - LLLT 50 mW high fluence 20J/cm² + home exercises
 - HILT 1.6 W low fluence 8J/cm² + home exercises
 - HILT 1.6 W high fluence 20J/cm² + exercises
 - Control group: home exercise program only
- **Device:** Pagani HPL device
- 5 laser therapy sessions over 2 weeks

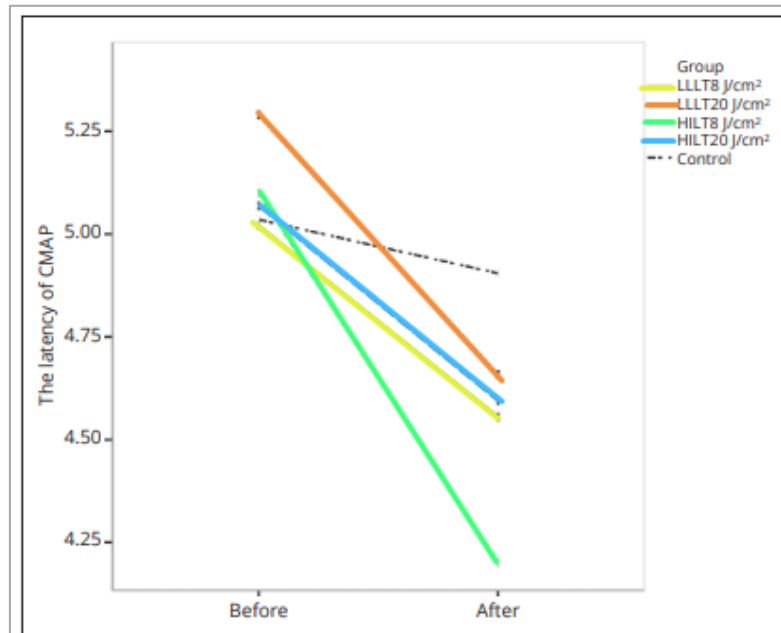


Figure 2.—The initial and final value of the latency of CMAP.


Abdel-Aal et al. 2020 | Hand arthropathy



Abdel-Aal NM, Ali KM, Eladl HM. Efficacy of high-intensity laser therapy on arthropathy of the hands in patients with systemic lupus erythematosus: a double-blinded, randomized controlled trial. *Clin Rehabil.* 2020 Oct;34(10):1303-1312.


Original Article

Efficacy of high-intensity laser therapy on arthropathy of the hands in patients with systemic lupus erythematosus: a double-blinded, randomized controlled trial

Nabil Mahmoud Abdel-Aal¹ , Khadra Mohamed Ali² and Hadaya Mosaad Eladl²

CLINICAL REHABILITATION

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- **Design:** Double-blind randomized controlled trial.
- **Subjects:** 50 patients with arthropathy of the hands
 - Experimental group received HILT plus the routine physical therapy program. Total energy delivered per session was 2100 J.
 - The control group received sham HILT plus the same routine physical therapy program.
- **Device:** ASA Hiro-3
- 3 sessions/week for 8 weeks
- **Results**
 - Handgrip strength, joint swelling count, joint tenderness count and pain VAS improved significantly more in the HILT group compared to the sham-control group.

CONCLUSION:

Adding HILT to the routine physical therapy program might be more effective than routine PT program alone for improving handgrip strength, decreasing joint swelling counts, joint tenderness counts, and pain in patients with arthropathy of the hands.

Table 2. Outcome data for handgrip, joint swelling, joint tenderness and VAS at baseline and after eight-weeks of intervention (N=50)*.

Outcomes	HILT Group (n=25)			Sham HILT Group (n=25)			MD (95%CI) between groups after eight weeks	Group X time interaction P value	Effect size (η ²)
	Baseline	After eight weeks	MD (95%CI)	Baseline	After eight weeks	MD (95%CI)			
Handgrip (kg)	20.84 ± 9.02	28.34 ± 8.3	-7.5 (-8.54, -6.55)	19.36 ± 8.31	22.96 ± 8.76	-3.6 (-4.55, -2.65)	5.38 (0.53, 10.23)	P=0.031	0.1
Joint swelling (n)	9.84 ± 2.23	4.4 ± 2.18	5.44 (4.92, 5.96)	10.32 ± 2.24	7.36 ± 2.14	2.96 (2.44, 3.48)	-2.96 (-4.19, -1.73)	P<0.001	0.48
Joint tenderness (n)	11 ± 2.29	5 ± 2.1	6 (5.59, 6.41)	11.52 ± 1.94	9.08 ± 1.63	2.44 (2.03, 2.85)	-4.08 (-5.15, -3.01)	P<0.001	0.33
VAS (mm)	84.4 ± 7.12	35.6 ± 13.87	48.8 (44.97, 52.63)	88.4 ± 8.51	58.8 ± 10.54	29.6 (25.77, 33.43)	-23.2 (-30.2, -16.2)	P<0.001	0.55

HILT: High-Intensity Laser Therapy; CI: Confidence Interval; VAS: visual analog scale (based on 100-mm scale); MD: Mean Difference; η²: partial eta square

*Data are mean ± SD, P-value <0.05 indicate statistical significance. Negative mean difference scores (95% CI) on visual analog scale, number of joint swelling and tenderness are indicative of improvement, whereas positive change scores (95% CI) for handgrip strength indicates improvement.





Back to overview






Verma S, Esht V, Chahal A, Kapoor G, Sharma S, Alghadir AH, Khan M, Kashoo FZ, Shaphe MA. Effectiveness of High Power Laser Therapy on Pain and Isokinetic Peak Torque in Athletes with Proximal Hamstring Tendinopathy: A Randomized Trial. *Biomed Res Int.* 2022 May 20;2022:4133883.

Hindawi
BioMed Research International
Volume 2022, Article ID 4133883, 8 pages
<https://doi.org/10.1155/2022/4133883>



Research Article

Effectiveness of High Power Laser Therapy on Pain and Isokinetic Peak Torque in Athletes with Proximal Hamstring Tendinopathy: A Randomized Trial

Sachin Verma,¹ Vandana Esht,¹ Aksh Chahal,¹ Gaurav Kapoor,² Sorabh Sharma,³
Ahmad H. Alghadir,⁴ Masood Khan ,⁴ Faizan Z. Kashoo ,⁵ and Mohammad A. Shaphe ⁶

CONCLUSION:

HPLT was effective for significantly improving pain and increasing hamstring muscle strength in athletes with PHT. Pain relief was significantly greater than with conventional PT.

- **Design:** Randomized comparative study.
- **Subjects:** 36 athletes with proximal hamstring tendinopathy
 - Experimental group received HILT as monotherapy.
 - 50J/cm² - total energy per session was 1800 J.
 - Conventional group received conventional PT.
 - US, moist heat pack, home exercises
 - Both groups were treated 3 days / week for 3 weeks
- **Device:** Litecure LCT-1000 (810/980 nm)
- **Results**
 - Significant decrease of pain (by 61%) and increase of hamstring isokin. strength (by 13%) in HILT group
 - In conventional group, only pain decreased significantly (by 41%) while strength increase was only 1.5% and n.s.
 - Difference in pain decrease between groups (61% vs. 41%) was significant: significantly greater pain relief with HILT.

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Ahmad MA, A Hamid MS, Yusof A. Effects of low-level and high-intensity laser therapy as adjunctive to rehabilitation exercise on pain, stiffness and function in knee osteoarthritis: a systematic review and meta-analysis. *Physiotherapy*. 2022 Mar;114:85-95.

Physiotherapy

Systematic review

Effects of low-level and high-intensity laser therapy as adjunctive to rehabilitation exercise on pain, stiffness and function in knee osteoarthritis: a systematic review and meta-analysis

Mohd Azzuan Ahmad^{a,b}, Mohamad Shariff A. Hamid^c, Ashril Yusof^{a,*}

^a Centre for Sport and Exercise Sciences, University of Malaya, 50603, Kuala Lumpur, Malaysia
^b Physiotherapy Programme, Centre for Rehabilitation and Special Needs Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, 50300, Kuala Lumpur, Malaysia
^c Sports Medicine Unit, Faculty of Medicine, University of Malaya Medical Centre, 59100 Kuala Lumpur, Malaysia

CONCLUSION:

Photobiomodulation therapy, compared to control, is an effective adjunct treatment modality for improving pain, stiffness and function in knee OA, with HILT producing larger effects than LLLT.

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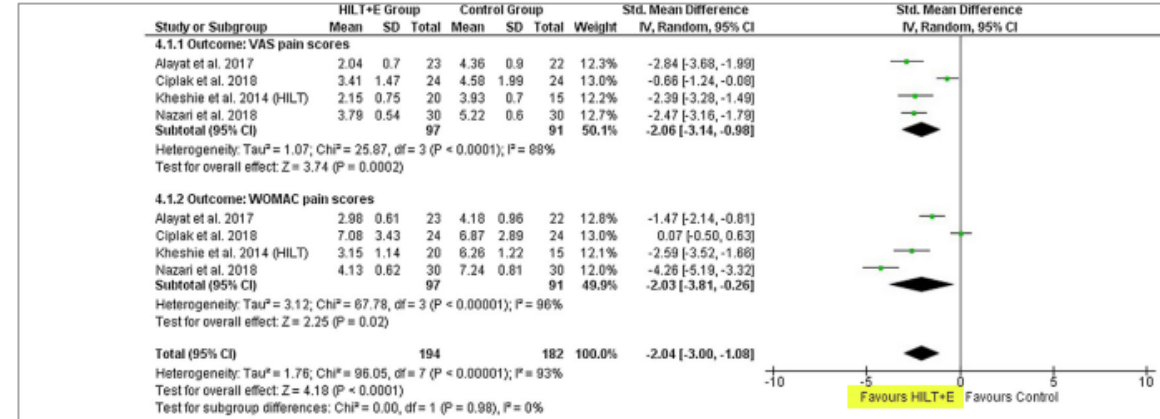


Fig. 6. Forest plot of knee pain scores for HILT + E vs control.

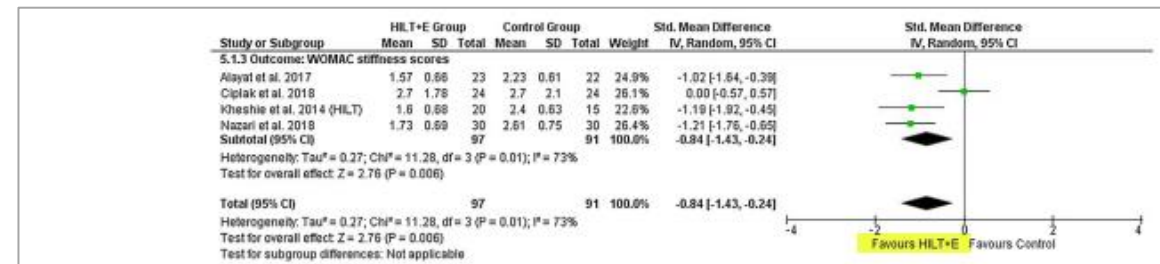


Fig. 7. Forest plot of knee stiffness scores for HILT + E vs control.

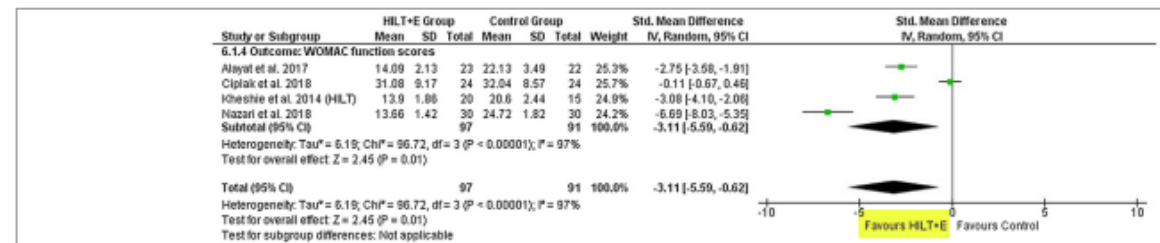


Fig. 8. Forest plot of knee function scores for HILT + E vs control.

Akaltun MS, Altindag O, Turan N, GURSOY S, Gur A. Efficacy of high intensity laser therapy in knee osteoarthritis: a double-blind controlled randomized study. Clin Rheumatol. 2021 May;40(5):1989-1995

Clinical Rheumatology
<https://doi.org/10.1007/s10067-020-05469-7>

ORIGINAL ARTICLE

Check for updates

Efficacy of high intensity laser therapy in knee osteoarthritis: a double-blind controlled randomized study

Mazlum Serdar Akaltun¹ · Ozlem Altindag¹ · Neytullah Turan¹ · Savas GURSOY¹ · Ali Gur¹

CONCLUSION:

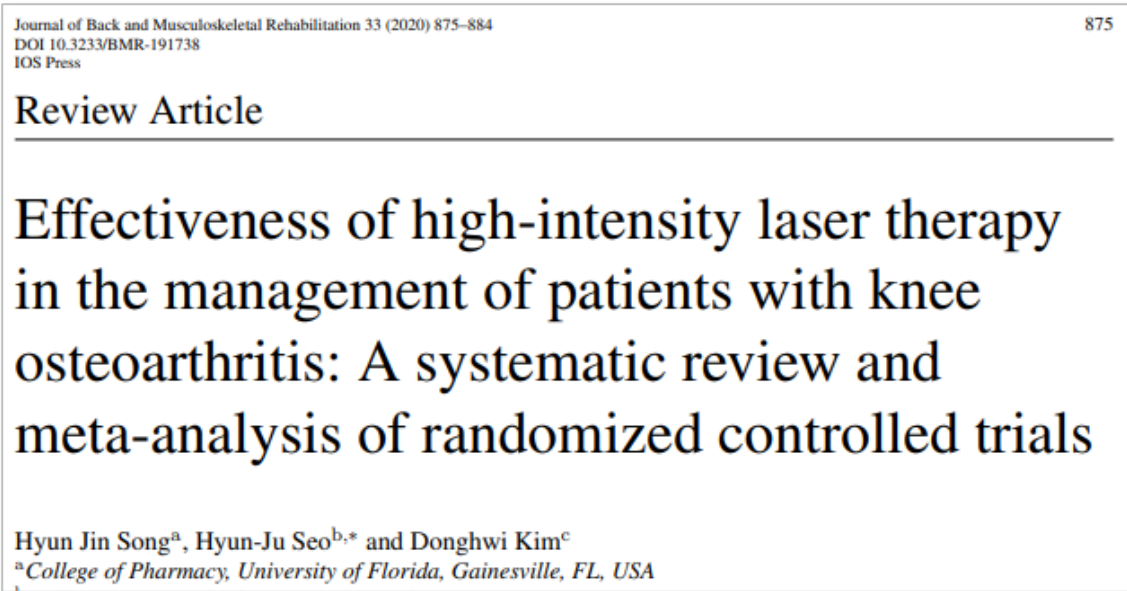
HILT plus exercise can significantly improve pain and function and increase the thickness of the hyaline cartilage.

- **Design:** Double-blind randomized controlled trial.
- **Subjects:** 40 patients with knee OA, 2 groups:
 - HILT + exercise therapy
 - Sham (placebo) laser + exercise therapy
- **Device:** BTL-6000
- **HILT protocol:**
 - 120J/cm² - total 3000 J / session
 - 5 sessions / week for 2 weeks (total 10 sessions)
- **Results:**
 - Both groups significantly improved post-treatment
 - At 4-week follow-up, Pain VAS, WOMAC, Functional ROM and femur cartilage thickness were significantly more improved in the HILT + ex. group compared to the sham laser + ex. group.

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Song HJ, Seo HJ, Kim D. Effectiveness of high-intensity laser therapy in the management of patients with knee osteoarthritis: A systematic review and meta-analysis of randomized controlled trials. *J Back Musculoskelet Rehabil.* 2020;33(6):875-884.



Design: Systematic review and Meta-analysis

Results:

- 6 randomized controlled trials (RCTs) were included in this meta-analysis.
- For **VAS pain**, 334 patients from 4 studies showed that HILT significantly decreased pain compared to the control (MD, -1.18; 95% CI, -1.68 to -0.69).
- For **stiffness**, 168 patients from 4 studies showed that HILT significantly improved WOMAC stiffness compared to the control (SMD -1.00; 95% CI -1.32, -0.68)
- For **function**, 87 patients from 4 studies showed that HILT significantly improved function compared to the control(SMD, -5.36; 95% CI -7.39 to -3.34).

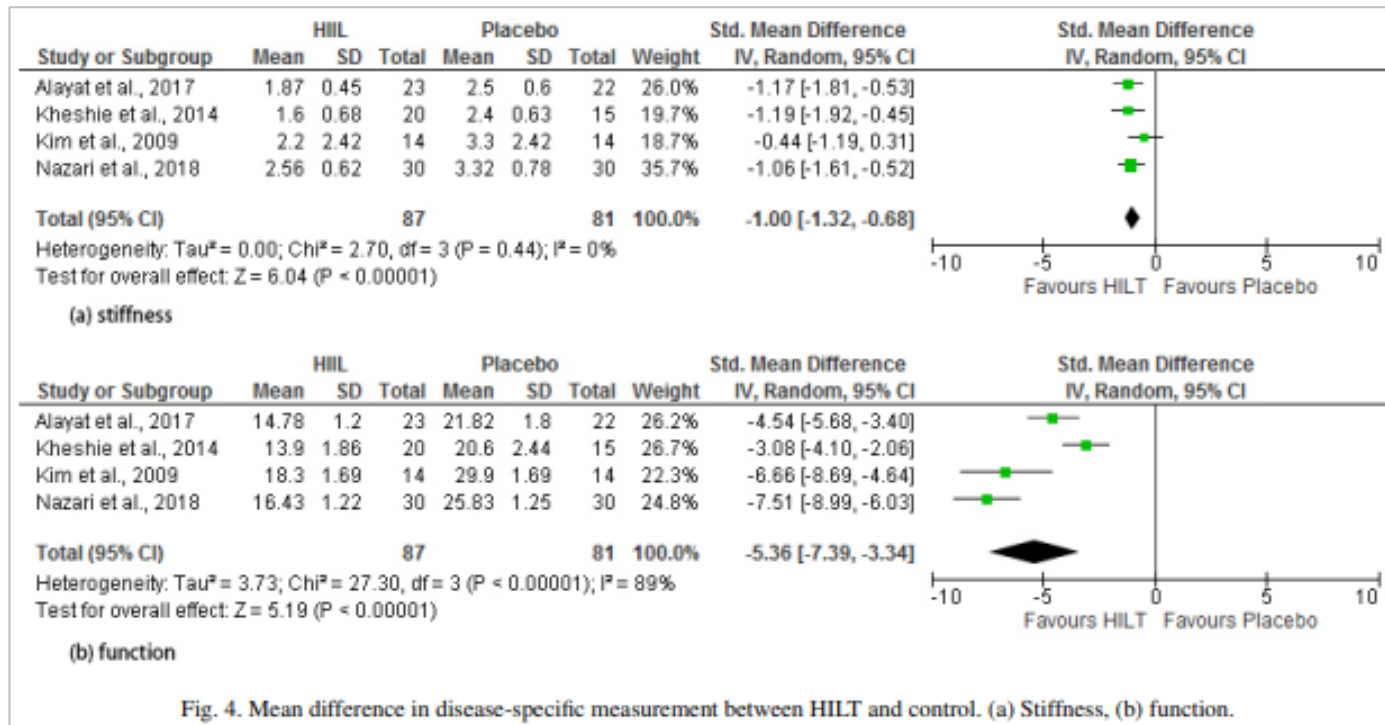
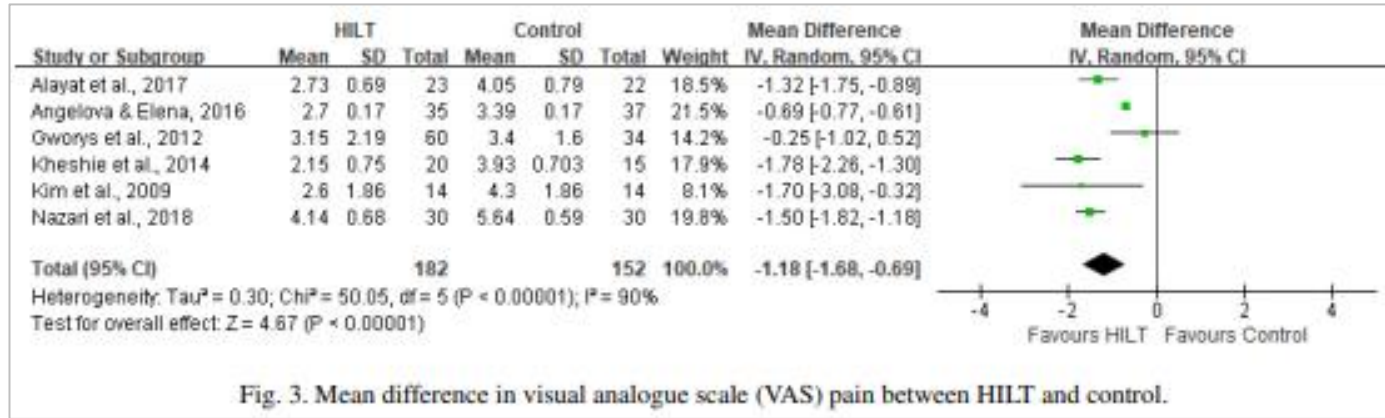
Conclusion:

HILT can significantly improve pain, stiffness and function in Knee Osteoarthritis compared to placebo or other control interventions.

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Figures



Nazari A, Moezy A, Nejati P, Mazaherinezhad A. Efficacy of high-intensity laser therapy in comparison with conventional physiotherapy and exercise therapy on pain and function of patients with knee osteoarthritis: a randomized controlled trial with 12-week follow up. *Lasers Med Sci.* 2019 Apr;34(3):505-516.

Lasers in Medical Science (2019) 34:505–516
<https://doi.org/10.1007/s10103-018-2624-4>

ORIGINAL ARTICLE

 CrossMark

Efficacy of high-intensity laser therapy in comparison with conventional physiotherapy and exercise therapy on pain and function of patients with knee osteoarthritis: a randomized controlled trial with 12-week follow up

Ahmad Nazari¹ · Azar Moezy¹  · Parisa Nejati¹ · Ali Mazaherinezhad¹

CONCLUSION:

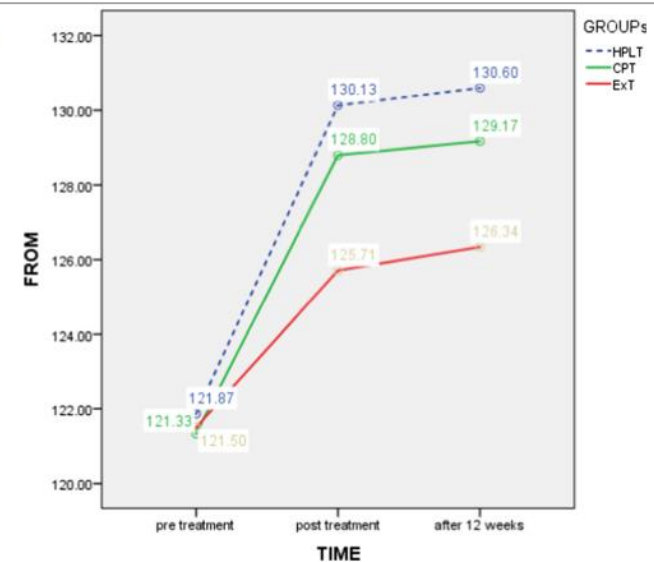
HILT provided better improvement of pain, ROM and function than conventional PT and exercise therapy in patients with knee OA.

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- **Design:** Randomized controlled trial.
- **Subjects:** 93 Knee OA patients, 3 groups:
 - HILT / Conventional PT / Exercise Therapy
- **Device:** Nd:YAG laser device 1064 nm
- **HILT protocol:**
 - 60 J/cm², total energy of 2400 J per session
 - 3x / week for 4 weeks (total 12 sessions)
- **Results:**
 - Significantly greater improvement of VAS pain score, functional ROM and scores of WOMAC (total and function subscale) in the HILT group compared to the other groups, both after treatment and after 12 weeks.

Fig. 3 Mean flexion range of motion (FROM) changes among treatment groups over time ($p < 0.001$)



Mårdh et al. 2016 | Achilles Tendinopathy



Mårdh A, Lund I. High Power Laser for Treatment of Achilles Tendinosis - a Single Blind Randomized Placebo Controlled Clinical Study. *J Lasers Med Sci.* 2016 Spring;7(2):92-8.

Journal of **Lasers** in Medical Sciences
J Lasers Med Sci 2016 Spring;7(2):92-98
Original Article
doi 10.15171/jlms.2016.16
http://www.journals.sbmu.ac.ir/jlms

High Power Laser for Treatment of Achilles Tendinosis – a Single Blind Randomized Placebo Controlled Clinical Study

Anders Mårdh^{1*}, Iréne Lund²

¹Fysioterapiteamet, Drottningatan 88 F, SE-111 36 Stockholm, Sweden
²Department of Physiology and Pharmacology, Karolinska Institutet, SE-17177 Stockholm, Sweden

- **Design:** Randomized, single blind, placebo controlled trial.
- **Subjects:** 40 patients with long-term (≥ 2 m) Achilles tendinosis
 - HILT group
 - Placebo HILT group
- **Device:** Swiss DynaLaser 980 nm
- **HILT Protocol:**
 - Total energy per session: 520 J
 - 6 sessions over 3-4 weeks

CONCLUSION:

HILT produced significantly greater decrease of pain and increase of pain threshold than placebo laser.

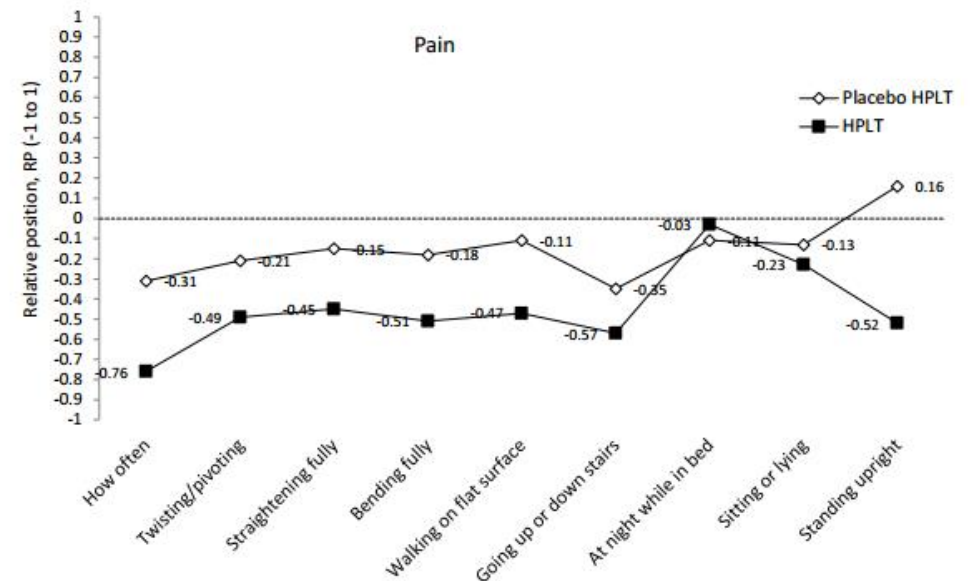


Figure 1. Relative Position (RP) Profiles of Self-rated Pain Items of the Foot and Ankle Outcome Score (FAOS).

Lasers Med Sci (2016) 31:127–135
DOI 10.1007/s10103-015-1840-4



ORIGINAL ARTICLE

Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial

Steve Tumilty¹ · Ramikrishnan Mani¹ · George D. Baxter¹

Conclusion:

In this study the best results were obtained with a combined protocol of twice a week eccentric exercise plus high power PMB therapy.

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Design: Double-blind randomised controlled trial

Methods: 80 subjects were randomly assigned to

- Group 1: Placebo laser + Ex Regime 1
- Group 2: Laser + Ex Regime 1
- Group 3: Placebo laser + Ex Regime 2
- Group 4: Laser + Ex Regime 2

Protocols:

- Laser: ED 6.66J/cm², total dose: 450J per session, 2X/week for 4 weeks
 - LightForce EX device
- Exercise Regime 1: 14 sessions/week (2x/day)
- Exercise Regime 2: 2 sessions/week (2x/week)

Results:

- Significantly greater improvement of VISA-A score at 12 weeks in Group 4 compared to other groups.
- **Clinical relevance:**
 - Twice-daily exercise sessions are not necessary as equivalent results can be obtained with two exercise sessions per week.
 - The addition of photobiomodulation as adjunct to exercise can bring added benefit.



Back to overview



Chatterjee P, Srivastava AK, Kumar DA, Chakrawarty A, Khan MA, Ambashtha AK, Kumar V, De Taboada L, Dey AB. Effect of deep tissue laser therapy treatment on peripheral neuropathic pain in older adults with type 2 diabetes: a pilot randomized clinical trial. *BMC Geriatr.* 2019 Aug 12;19(1):218.

Chatterjee et al. *BMC Geriatrics* (2019) 19:218
<https://doi.org/10.1186/s12877-019-1237-5>

BMC Geriatrics

RESEARCH ARTICLE Open Access

Effect of deep tissue laser therapy treatment on peripheral neuropathic pain in older adults with type 2 diabetes: a pilot randomized clinical trial

Prasun Chatterjee^{1*}, Achal K. Srivastava², Deepa A. Kumar¹, Avinash Chakrawarty¹, Maroof A. Khan³, Akash K. Ambashtha⁴, Vijay Kumar¹, Luis De Taboada⁵ and Aparajit B. Dey¹

CONCLUSION:

HILT is a safe, nonpharmacological addition to the standard of care for the management of pain in older adults with painful diabetic peripheral neuropathy, offering significant improvement of their quality of life.

- **Design:** Randomized double-blind sham-controlled trial.
- **Subjects:** 40 patients with type 2 diabetes with painful diabetic peripheral neuropathy
 - HILT group: HILT + standard care
 - Control group: sham laser + standard care
 - 2x/wk for 4 weeks + 1x/wk for 8 weeks (12 weeks in total)
- **Device:** LightForce HPL device (810/980 nm)
- **HILT protocol:**
 - Treatment area: plantar foot and lumbar region (DRG L4-S2)
 - Power: plantar 2W; lumbar 8W
 - Energy density: plantar 1.8-3.0 J/cm²; lumbar 13 J/cm²
 - Total dose: plantar 300-1800 J; lumbar 1920 J
 - Application technique: on contact scanning technique
- **Results**
 - Signif. more **pain** relief in HILT group
 - Greater improvements of **function** HILT group
 - Signif. improvement of **QoL** in HILT group vs. no improvement in control group
 - Serum levels of **inflammatory** biomarkers improved more in the HILT group

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Pubmed


Ordahan et al. 2018 | Plantar Fasciitis



Ordahan B, Karahan AY, Kaydok E. The effect of high-intensity versus low-level laser therapy in the management of plantar fasciitis: a randomized clinical trial. *Lasers Med Sci.* 2018 Aug;33(6):1363-1369.

Lasers in Medical Science
<https://doi.org/10.1007/s10103-018-2497-6>

ORIGINAL ARTICLE



The effect of high-intensity versus low-level laser therapy in the management of plantar fasciitis: a randomized clinical trial

Banu Ordahan^{1,2} · Ali Yavuz Karahan³ · Ercan Kaydok⁴

- **Design:** Randomized comparative study.
- **Subjects:** 70 patients with unilateral plantar heel pain
 - LLLT group: 0.24W, 6J/cm², total 37.8J/session
 - HILT group: 6-8W, 6-150J/cm², total 330J/session
- **HILT Device:** BTL-6000
- **Results**
 - Pain VAS, Heel Tenderness index and FAOS improved significantly in both groups (p<0.05)
 - The improvements were significantly greater in the HILT group (p<0.05)

CONCLUSION:

HILT provided significantly more improvement of pain and function than LLLT




Table 2 Assessment of functional parameters

	HILT (n:35) Mean ± SD	LLLT (n:35) Mean ± SD	HILT vs. LLLT p
VAS			
Baseline	8.87 ± 1.54	8.35 ± 1.78	0.660
After treatment	2.75 ± 1.84	5.56 ± 2.11	0.048
p	0.017 †	0.036 †	significant
HTI			
Baseline	2.05 ± 0.89	2.11 ± 1.21	0.731
After treatment	0.37 ± 0.48	0.98 ± 0.51	0.043
p	0.021 †	0.038 †	significant

† Baseline versus after treatment. Samples t test, paired-samples t test; p < 0.05
 VAS Visual Analogue Scale, HTI Heel Tenderness Index; HILT high-intensity laser therapy, LLLT low-level laser therapy

Borsa PA, Dale RB, Levine D and Crow JA. Muscular Preconditioning using Phototherapy Improves the Physical Work Capacity of the Quadriceps when applied between Repeated bouts of resistance Exercise. J Athl Enhanc 2019, Vol: 8 Issue: 1

Borsa et al., J Athl Enhanc 2019, 8:1
DOI: 10.4172/2324-9080.1000310



Journal of Athletic Enhancement
A SCITECHNOL JOURNAL

Research Article

Muscular Preconditioning Using Phototherapy Improves the Physical Work Capacity of the Quadriceps when Applied between Repeated Bouts of Resistance Exercise

Borsa PA^{1*}, Dale RB², Levine D³ and Crow JA⁴

Introduction

Exercise and sports scientists are constantly searching for ways to optimize the body's response to strenuous physical activity by prolonging the ability of skeletal muscle to perform work while resisting exertional fatigue. Skeletal muscle fatigue is a rate-limiting factor for athletes who participate and compete in sports that require muscular endurance and sustained levels of strength [1]. Fatigue impairs the ability of skeletal muscle to generate force, and reduces a muscle's capacity to perform work over an extended time period [2,3]. The decrease in muscle function associated with fatigue is believed to be a result of metabolic alterations such as substrate depletion (lack of ATP and glycogen), oxidative stress, tissue ischemia/hypoxia and blood acidification [2, 4]. One ergogenic aid that has garnered interest

CONCLUSION:

HILT appears to reduce Quadriceps muscle fatigue for athletes requiring high levels of endurance.

Preconditioning skeletal muscle with phototherapy intermittently during recovery intervals may be a beneficial, non-invasive and safe ergogenic aid for athletes that require high levels of muscular endurance.

- **Design:** Triple-blind, repeated measures, placebo controlled, cross-over study
- **Subjects:** 20 healthy individuals, 2 conditions
 - HILT during recovery
 - Sham-laser during recovery
- **Procedure:**
 - Subjects performed quadriceps fatiguing protocol consisting of 4 high intensity exercise bouts
 - HILT or sham laser was applied during the recovery in between exercise bouts
- **HILT Device:** LiteCure LT-1000 810/980 nm HPL device
- HILT protocol: 10 J/cm²; total dose per session 1600-2400 J
- **Result**
 - HILT group was able to produce higher quadriceps torque and showed less decline of muscle performance throughout the bouts.

Figures

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Journal link

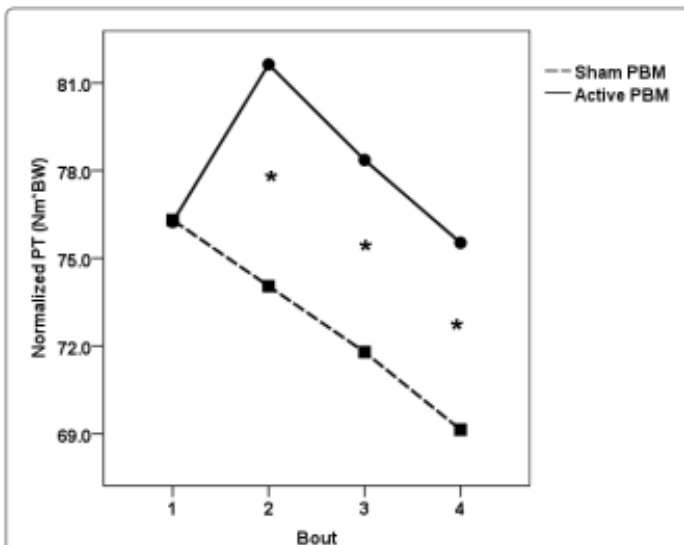


Figure 3: Normalized Peak Torque for the four exercise bouts (Marginal means). Participants produced higher peak torque (PT) during bouts 2, 3 and 4 after receiving active phototherapy compared to sham phototherapy. Asterisk denotes statistically significant difference of $p \leq 0.013$.

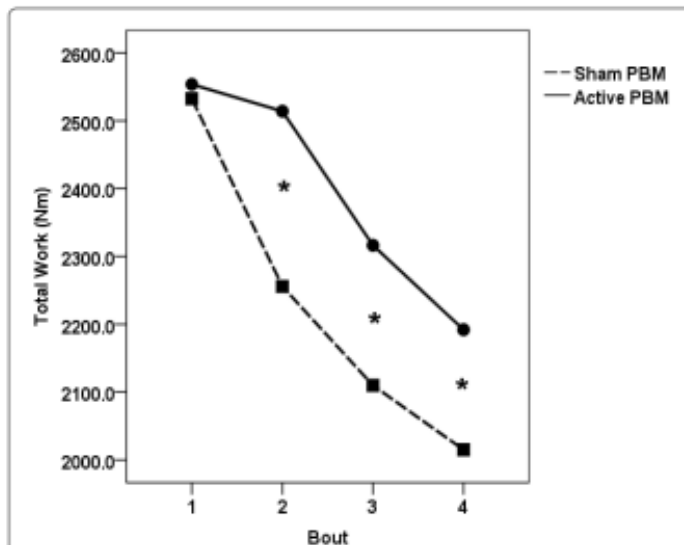


Figure 5: Total Work for the four exercise bouts (Marginal means). Participants produced more work during bouts 2, 3 and 4 after receiving active phototherapy compared to sham phototherapy. Asterisk denotes statistically significant difference of $p \leq 0.013$.

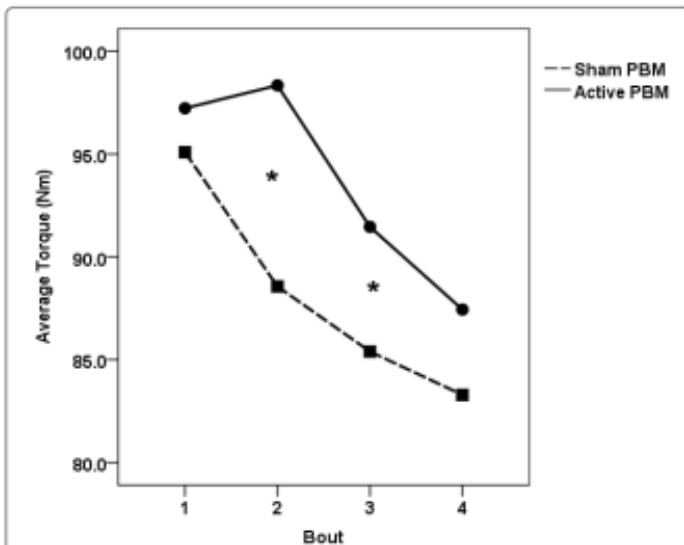


Figure 4: Average Torque for the four exercise bouts (Marginal means). Participants produced more average torque during bouts 2 and 3 after receiving active phototherapy compared to sham phototherapy. Asterisk denotes statistically significant difference of $p \leq 0.013$.

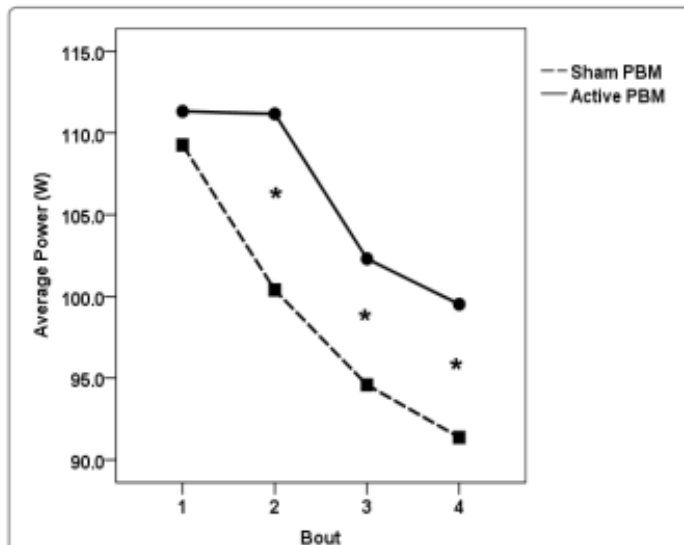
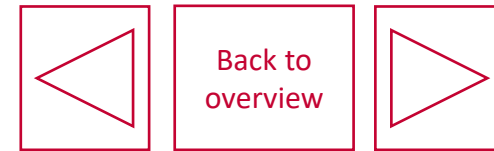


Figure 6: Average power for the four exercise bouts (Marginal means). Participants produced more power during bouts 2, 3 and 4 after receiving active phototherapy compared to sham phototherapy. Asterisk denotes statistically significant difference of $p \leq 0.013$.



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