heal with LASER

Low Level Laser Therapy Research - Podiatry

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A summary of Low Level Laser Therapy Research Podiatry

Contents

Introduction

Types of laser

Medical professionals will be familiar with the wide range of lasers that are used in modern medicine. These include Erbium:YAG, Argon and the Nd:YAG most often used in surgical situations. These lasers use or have the potential to use “high powers” ranging from fractions of a watt to 25 watts or more.

This document will help introduce evidence for the clinical use of a different type of medical laser – the low level laser.

Low level lasers terminology

Lasers that operate below about 3W are known as "low level lasers" (LLL) and are generally smaller and less expensive than those used in a surgical setting.

The therapy performed with such lasers is often called "Low Level Laser Therapy" (LLLT) or sometimes just “laser therapy” and the lasers are called "therapeutic lasers".

Other treatment terms used include “photobiomodulation”,”laser acupuncture” “biostimulation” and “biomodulation . At other times the equipment can be referred to as a "soft laser", "low intensity level laser", “cold laser”, and “low-power laser”.

These therapeutic lasers generally operate in the visible and the infrared spectrum, 600-900 nm wavelength. However, other wavelengths have been successfully used in laser therapy.

History

Not long after the invention of the laser in 1960, interest in its use in medicine started and reports appeared suggesting beneficial physiological effects of low level laser light. The use of lasers specifically designed for medical use began in 1967 but commercial LLL were very low powered and results were inconsistent. As models with higher powers have appeared the results have improved and the treatment times reduced.

Interpreting the scientific literature

The scientific literature contains thousands of published studies and reports in the domain of laser therapy in healthcare. These include double blind clinical trials. Even with the large range of modalities, experiment design, patient numbers and treatments investigated, 90% report a positive effect of laser therapy.

However, there are a large number of parameters that can be selected when designing these studies (time, intensity, wavelength, area, pulse or continuous, pulse frequency, number of applications). This can help explain a number of negative studies that have also been released. These should not necessarily be taken to mean that LLL therapy in ineffective but that the parameters chosen in those studies were not successful.

This document will highlight significant areas of treatment indications for modern podiatry practice. While some studies are hard to evaluate given the lack of standardisation of parameters in use and their reporting, an overall foundation for clinical use is presented.

In all cases, proper clinical assessment and judgment should be used no matter how impressive the results described – LLLT is not a universal remedy and has specific indications for use. Always use care to select the most appropriate treatment technique and interval with an appropriate dosage for a desirable result.

Podiatry

Clinical efficacy of low-level laser therapy in plantar fasciitis: A systematic review and meta-analysis.

BACKGROUND: Emerging evidence suggests that low-level laser therapy (LLLT) for plantar fasciitis (PF) may be beneficial. However, the convincing study investigating its effectiveness for treatment of PF was scarce. Therefore, a systematic review and meta-analysis was conducted to assess whether LLLT significantly relieve pain of patients with PF.

METHODS: PubMed, EMBASE, EBSCO, Web of Science, China Biological Medicine Database, China National Knowledge Infrastructure, Chinese Wan fang, and Cochrane CENTRAL were searched systematically up to March 2018.

RESULTS: A total of 6 randomized controlled trials were included. The meta-analysis indicated that compared with control group, visual analogue scale (VAS) score significantly decreased at the end point of the treatment in LLLT group. In addition, this improvement is continued for up to 3 months. However, no significant difference was observed according to the Foot Function Index-pain subscale (FFI-p).

CONCLUSION: This meta-analysis indicates that the LLLT in patients with PF significantly relieves the heel pain and the excellent efficacy lasts for 3 months after treatment.

Medicine (Baltimore). 2019 Jan;98(3):e14088. doi: 10.1097/MD.0000000000014088.
Wang W, Jiang W, Tang C, Zhang X, Xiang J.

Low Level Laser Therapy in patients with chronic foot and ankle joint pain.

The present study demonstrated that LLLT was an effective form of treatment for chronic foot and ankle joint pain, in conjunction with postural education during all activities of daily living.

Laser Ther. 2017 Mar 31;26(1):19-24. doi: 10.5978/islsm.17-OR-2.
Izukura H, Miyagi M, Harada T, Ohshiro T, Ebihara S.

Effect of low-level light therapy on diabetic foot ulcers: a near-infrared spectroscopy study.

Diabetic foot ulcer (DFU) is a diabetic complication due to peripheral vasculopathy and neuropathy. A promising technology for wound healing in DFU is low-level light therapy (LLLT).

Overall, our results demonstrate that LLLT improves blood flow and autonomic nervous system regulation in DFU and the importance of light intensity in therapeutic protocols.

J Biomed Opt. 2017 Mar 1;22(3):38001. doi: 10.1117/1.JBO.22.3.038001.
Salvi M, Rimini D, Molinari F, Bestente G, Bruno A.

A systematic review of low-level light therapy for treatment of diabetic foot ulcer.

Diabetes mellitus (DM) is a significant international health concern affecting more than 387 million individuals. A diabetic person has a 25% lifetime risk of developing a diabetic foot ulcer (DFU), leading to limb amputation in up to one in six DFU patients. Low-level light therapy (LLLT) uses low-power lasers or light-emitting diodes to alter cellular function and molecular pathways, and may be a promising treatment for DFU. The goal of this systematic review is to examine whether the clinical use of LLLT is effective in the healing of DFU at 12 and 20 weeks in comparison with the standard of care, and to provide evidence-based recommendation and future clinical guidelines for the treatment of DFU using LLLT.

The relevant articles that met the following criteria were selected for inclusion: randomized control trials (RCTs) that investigated the use of LLLT for treatment of DFU. Four RCTs involving 131 participants were suitable for inclusion based upon our criteria. The clinical trials used sham irriadiation, low dose, or nontherapeutic LLLT as placebo or control in comparison to LLLT.

However, all reviewed RCTs demonstrated therapeutic outcomes with no adverse events using LLLT for treatment of DFU. This systematic review reports that LLLT has significant potential to become a portable, minimally invasive, easy-to-use, and cost effective modality for treatment of DFU. To enthusiastically recommend LLLT for treatment of DFU, additional studies with comparable laser parameters, screening period to exclude rapid healers, larger sample sizes and longer follow-up periods are required. We envision future stringent RCTs may validate LLLT for treatment of DFU.

Tchanque-Fossuo CN, Ho D, Dahle SE, Koo E, Li CS, Isseroff RR, Jagdeo J.
Wound Repair Regen. 2016 Mar;24(2):418-26. doi: 10.1111/wrr.12399. Epub 2016 Mar 2. Review.

Effects of the Low-Level Laser Therapy (LLLT) in the process of healing diabetic foot ulcers.

The low-level laser treatment seems to be an efficient method, viable, painless and of low costs concerning the tissue repair ulcers in a diabetic foot.

Acta Cir Bras. 2015 Dec;30(12):852-7
Feitosa MC, Carvalho AF, Feitosa VC, Coelho IM, Oliveira RA, Arisawa EÂ.

Low-level laser therapy as an adjunct to conventional therapy in the treatment of diabetic foot ulcers.

Foot ulcers are serious complications of diabetes mellitus (DM) and are known to be resistant to conventional treatment. The results suggest that LLLT is beneficial as an adjunct to conventional therapy in the treatment of diabetic foot ulcers.

Lasers Med Sci. 2017 Feb;32(2):275-282. doi: 10.1007/s10103-016-2109-2. Epub 2016 Nov 29.
Mathur RK, Sahu K, Saraf S, Patheja P, Khan F, Gupta PK.

Low-level Light Therapy for Treatment of Diabetic Foot Ulcer: A Review of Clinical Experiences.

Diabetic foot ulcers (DFU) represent a significant complication of diabetes mellitus (DM). DFU affect one in four patients with DM and treatments of DFU are limited and challenging. The management of DFU remains a significant healthcare and socioeconomic burden ($245 billion). There is a wide range of advanced therapies for DFU, but these are costly and have demonstrated only minimal efficacy in

limited published studies. An emerging treatment modality to improve DFU and optimize wound healing is the use of low-level light therapy (LLLT).

LLLT is an emerging and promising treatment modality to current alternatives that are costly and have shown limited success. Based upon the published evidence, we envision additional research may allow for stronger recommendation with LLLT for treatment of DFU.

J Drugs Dermatol. 2016 Jul 1;15(7):843-8. Review.
Tchanque-Fossuo CN, Ho D, Dahle SE, Koo E, Isseroff RR, Jagdeo J.

Treatment of onychomycosis using the 1064 nm Nd:YAG laser: a clinical pilot study.

BACKGROUND: Nd:YAG lasers could be a safe and effective treatment modality for onychomycosis, without the side effects of drugs. Long and short-pulsed Nd:YAG lasers were used in this clinical study in a side-comparison manner without removal of onychomycotic nail material before treatment.

CONCLUSIONS: These results suggest that treatment of onychomycosis with the Nd:YAG laser without removing mycotic nail material can lead to a temporary clinical improvement, a reduction of positive fungal cultures and an improvement of the Onychomycosis Severity Index. The treatment regimen should be optimized to be used as an effective antimycotic monotherapy

Hees H, Jäger MW, Raulin C.
J Dtsch Dermatol Ges. 2014 Apr;12(4):322-9. doi: 10.1111/ddg.12292. Epub 2014 Mar 14.

Shedding light on a new treatment for diabetic wound healing: a review on phototherapy.

Impaired wound healing is a common complication associated with diabetes with complex pathophysiological underlying mechanisms and often necessitates amputation. With the advancement in laser technology, irradiation of these wounds with low-intensity laser irradiation (LILI) or phototherapy, has shown a vast improvement in wound healing. At the correct laser parameters, LILI has shown to increase migration, viability, and proliferation of diabetic cells in vitro; there is a stimulatory effect on the mitochondria with a resulting increase in adenosine triphosphate (ATP). In addition, LILI also has an anti-inflammatory and protective effect on these cells. In light of the ever present threat of diabetic foot ulcers, infection, and amputation, new improved therapies and the fortification of wound healing research deserves better prioritization. In this review we look at the complications associated with diabetic wound healing and the effect of laser irradiation both in vitro and in vivo in diabetic wound healing.

Houreld NN.
ScientificWorldJournal. 2014 Jan 6;2014:398412. doi: 10.1155/2014/398412. eCollection 2014.

Low-Level Laser Therapy for the Treatment of Chronic Plantar Fasciitis: A Prospective Study.

BACKGROUND: Plantar fasciitis affects nearly 1 million people annually in the United States. Traditional nonoperative management is successful in about 90% of patients, usually within 10 months. Chronic plantar fasciitis develops in about 10% of patients and is a difficult clinical problem to treat. A newly emerging technology, low-level laser therapy (LLLT), has demonstrated promising results for the treatment of acute and chronic pain.

CONCLUSION: Although further studies are warranted, this study shows that LLLT is a promising treatment of chronic plantar fasciitis.

Jastifer JR, Catena F, Doty JF, Stevens F, Coughlin MJ.
Foot Ankle Int. 2014 Feb 7;35(6):566-571.

Extracorporeal shock wave therapy versus low intensity laser therapy in the treatment of heel pain

Results: In the laser group pre-post treatment values showed a significant difference in favor of post treatment values in all measured parameters whereas in the ESWT group no difference was found in gait velocity or pain. Intergroup comparisons showed that LILT was more effective in reducing pain, increasing the speed of walking and in increasing perceived quality of life.

Conclusions: The results of this study suggest that LILT is more effective than ESWT in the treatment of heel pain.

Annual European Congress of Rheumatology; Madrid 12-15 June 2013
E. Cinar, F. Uygur

Efficacy of low level laser therapy on wound healing in patients with chronic diabetic foot ulcers-a randomised control trial.

BACKGROUND: Foot ulcers are serious complications of Diabetes Mellitus (DM) and are known to be resistant to conventional treatment. They may herald severe complications if not treated wisely. Electromagnetic radiations in the form of photons are delivered to the ulcers in laser form to stimulate healing. This study was conducted to evaluate the efficacy of Low Level Laser Therapy (LLLT) in diabetic ulcer healing dynamics. To determine mean percentage reduction of wound area in study and control groups.

STUDY DESIGN: Randomized-Control Study.

CONCLUSION: Low Level Laser Therapy is beneficial as an adjunct to conventional therapy in the treatment of diabetic foot ulcers (DFU).

Kajagar BM, Godhi AS, Pandit A, Khatri S.
Indian J Surg. 2012 Oct;74(5):359-63. doi: 10.1007/s12262-011-0393-4. Epub 2012 Apr 11.

Can Low-Level Laser Therapy Have An Impact For Small Fiber Neuropathy?

The data acquired from this prospective, non-randomized, non-controlled study demonstrates the potential utility of low-level laser therapy. These data show a clinically meaningful outcome for the treatment of neuropathic pain without an adverse event. However, a placebo-controlled, randomized, double-blind, multi-centered clinical investigation is warranted in order to elucidate the complete efficacy of this therapeutic approach. Furthermore, it would be important to enroll study participants who demonstrate similar baseline epidermal nerve fiber density of the legs and feet in order to appropriately quantify any improvement produced by low-level laser therapy.

We chose to present these findings as preliminary data because the patient response to the laser therapy was so promising. Given that low-level laser therapy is non-invasive and has no reported side effects, it is a very low-risk treatment option for patients with small fiber neuropathy. Patients are reporting a decrease in their neuropathy symptoms and, in some cases, are regenerating the small fiber nerves in the epidermis.

Kerry Zang, DPM, Janna Kroleski, DPM, Shahram Askari, DPM, and Sanford Kaner, DPM –
Podiatry Today Volume 24 - Issue 6 - June 2011

UVA-1 laser in the treatment of palmoplantar pustular psoriasis.

OBJECTIVE: The purpose of this study was to assess the efficacy of monochromatic UVA laser in the treatment of palmoplantar pustular psoriasis (PPP).

BACKGROUND DATA: UVA-1 laser (355 nm) has been reported to be safe and effective in the treatment of psoriasis, but the range of potential applications has not been fully explored.

CONCLUSIONS: We report for the first time that UVA-1 laser produces a therapeutic response in PPP.

Nisticò SP, Saraceno R, Chiricozzi A, Giunta A, Di Stefani A, Zerbinati N.
Photomed Laser Surg. 2013 Sep;31(9):434-8. doi: 10.1089/pho.2013.3545.

[Low-level laser therapy in the treatment of diabetic ulcers: an evidence problem].

INTRODUCTION: Diabetes Mellitus is the leading cause of lower limb amputation, representing a significant economic cost for health services. The development of diabetic ulcers is a main risk factor for amputations, which have a high mortality rate at five years. The ischemia caused by macrovascular disease is a key pathophysiological factor in the development of ischemic ulcers. Existing treatments are prolonged and associated with high rates of failure and relapse, requiring the combination of multiple therapeutic modalities. Lowlevel laser therapy has been used as an adjuvant therapy for diabetic foot ulcers, since the 1960's, due to its hypothetical stimulating effects over microcirculation and tissue repair.

CONCLUSIONS: Accordingly to the primum non nocere, laser therapy can and should be used as adjunctive therapy in the treatment of diabetic foot, because it isn't invasive, has low costs and is a fast therapy without significant adverse effects.

Camões Barbosa A, Simões H, Lorga S, Mendes M.
Acta Med Port. 2011 Dec;24 Suppl 4:875-80. Epub 2011 Dec 31.

Closure of non-healing chronic ulcer in Klippel-Trenaunay syndrome using low-level laser therapy.

A 69-year-old man diagnosed with Klippel-Trenaunay syndrome (KTS) reported to the physiotherapy outpatient clinic with the complaint of a non-healing ulcer over the right medial malleolus, for a 6-month duration, that was non-granulating and had moderate pus discharge with foul odour at initial assessment. There was a decrease in scores of the Pressure Ulcer Scale of Healing, a significant increase in granulation tissue, a decrease in the amount of discharge and foul odour along with complete closure of the chronic wound after irradiation with a light-emitting diode (LED). This is a novel case study analysing the possible effect of a helium-neon laser and LEDs on non-healing chronic ulcers associated with KTS, where the complete closure of the chronic ulcer that was initially not responsive to standard medical care was observed.

Dixit S, Maiya AG, Umakanth S, Shastry BA.
BMJ Case Rep. 2012 Jun 14;2012. pii: bcr2012006226. doi: 10.1136/bcr-2012-006226

Treatment of mild, moderate, and severe onychomycosis using 870- and 930-nm light exposure: some follow-up observations at 270 days.

We have previously reported the results of a clinical trial in which the Noveon laser was used to treat onychomycosis. In the 180-day follow-up therein it was noted that positive clinical impact was demonstrable by a clearly measurable decrease in positive fungal culture and a concomitant decrease

in positive microscopy with periodic acid-Schiff-stained nail scrapings. Review of 270-day mycological data, which are now available, confirmed that there was further decrease in both measures. Indeed, 38% of the treated population had negative culture and microscopy, qualifying as "mycological cures." These mycological cures occurred in cases categorized as mild, moderate, and even severe disease.

Landsman AS, Robbins AH.
J Am Podiatr Med Assoc. 2012 Mar-Apr;102(2):169-71

Laser irradiation effect on Staphylococcus aureus and Pseudomonas aeruginosa biofilms isolated from venous leg ulcer.

Chronic wounds, including diabetic foot ulcers, pressure ulcers and venous leg ulcers, represent a significant cause of morbidity in developed countries, predominantly in older patients. The aetiology of these wounds is probably multifactorial, but the role of bacteria in their pathogenesis is still unclear. Moreover, the presence of bacterial biofilms has been considered an important factor responsible for wounds chronicity. We aimed to investigate the laser action as a possible biofilm eradicating strategy, in order to attempt an additional treatment to antibiotic therapy to improve wound healing. In this work, the effect of near-infrared (NIR) laser was evaluated on mono and polymicrobial biofilms produced by two pathogenic bacterial strains, Staphylococcus aureus PECHA10 and Pseudomonas aeruginosa PECHA9, both isolated from a chronic venous leg ulcer. Laser effect was assessed by biomass measurement, colony forming unit count and cell viability assay. It was shown that the laser treatment has not affected the biofilms biomass neither the cell viability, although a small disruptive action was observed in the structure of all biofilms tested. A reduction on cell growth was observed in S. aureus and in polymicrobial biofilms. This work represents an initial in vitro approach to study the influence of NIR laser treatment on bacterial biofilms in order to explain its potentially advantageous effects in the healing process of chronic infected wounds.

Baffoni M, Bessa LJ, Grande R, Di Giulio M, Mongelli M, Ciarelli A, Cellini L.
Int Wound J. 2012 Oct;9(5):517-24. doi: 10.1111/j.1742-481X.2011.00910.x. Epub 2011 Dec 19.

The diabetic foot and leg: combined He-Ne and infrared low-intensity lasers improve skin blood perfusion and prevent potential complications. A prospective study on 30 Egyptian patients.

The objective of this study was to examine skin blood flow in diabetic patients having disease-related skin lesions, and to evaluate possible improvement imposed by low-intensity laser therapy (LILT) as a new treatment modality.

The study demonstrates that diabetes-linked skin lesions have a special pattern in Egyptians and are apparently caused by deranged skin blood flow .The deficit is measurable by laser flowmetry and can be partially reversed by LILT.

Saied GM, Kamel RM, Labib AM, Said MT, Mohamed AZ.
Lasers Med Sci. 2011 Sep;26(5):627-32. doi: 10.1007/s10103-011-0911-4. Epub 2011 Apr 1.

A randomized clinical trial on the effect of low-level laser therapy on chronic diabetic foot wound healing: a preliminary report.

BACKGROUND AND OBJECTIVES: Low-level laser therapy (LLLT) has been shown to promote chronic wound healing in conditions of reduced microcirculation. In this preliminary study, we report the results of using LLLT to heal foot ulcers in patients with diabetes mellitus.

CONCLUSIONS: The study provides evidence that LLLT can accelerate the healing process of chronic diabetic foot ulcers, and it can be presumed that LLLT may shorten the time period needed to achieve complete healing.

Kaviani A, Djavid GE, Ataie-Fashtami L, Fateh M, Ghodsi M, Salami M, Zand N, Kashef N, Larijani B. Photomed Laser Surg. 2011 Feb;29(2):109-14. doi: 10.1089/pho.2009.2680. Epub 2011 Jan 9.

Treatment of mild, moderate, and severe onychomycosis using 870- and 930-nm light exposure.

BACKGROUND: The Noveon is a unique dual-wavelength near-infrared diode laser used to treat onychomycosis. The device operates at physiologic temperatures that are thermally safe for human tissue. It uses only 870- and 930-nm near-infrared light, wavelengths that have unique photolethal effects on fungal pathogens. These wavelengths lack the teratogenic danger presented by ultraviolet light and the photoablation toxic plume associated with pulsed Nd:YAG lasers.

CONCLUSIONS: These results indicate a role for this laser in the treatment of onychomycosis, regardless of degree of severity. Ease of delivery and the lack of a need to monitor blood chemistry are attractive attributes.

Landsman AS, Robbins AH, Angelini PF, Wu CC, Cook J, Oster M, Bornstein ES. J Am Podiatr Med Assoc. 2010 May-Jun;100(3):166-77.

Ultrasonographic evaluation of plantar fasciitis after low-level laser therapy: results of a double-blind, randomized, placebo-controlled trial.

In summary, while ultrasound imaging is able to depict the morphologic changes related to plantar fasciitis, 904 nm gallium-arsenide (GaAs) infrared laser may contribute to healing and pain reduction in plantar fasciitis.

Lasers Med Sci. 2010 Mar;25(2):275-81. doi: 10.1007/s10103-009-0737-5. Kiritsi O[1], Tsitas K, Malliaropoulos N, Mikroulis G.

Phototherapy promotes healing of chronic diabetic leg ulcers that failed to respond to other therapies.

We tested the hypothesis that combined 660 and 890 nm LED phototherapy will promote healing of diabetic ulcers that failed to respond to other forms of treatment. Combined 660 and 890 nm light promotes rapid granulation and healing of diabetic ulcers that failed to respond to other forms of treatment.

Lasers Surg Med. 2009 Aug;41(6):433-41. doi: 10.1002/lsm.20789. Minatel DG[1], Frade MA, França SC, Enwemeka CS.

Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic achilles tendinopathy.

Low-level laser therapy, with the parameters used in this study, accelerates clinical recovery from chronic Achilles tendinopathy when added to an EE regimen. For the LLLT group, the results at 4 weeks were similar to the placebo LLLT group results after 12 weeks.

Am J Sports Med. 2008 May;36(5):881-7. doi: 10.1177/0363546507312165. Epub 2008 Feb 13. Stergioulas A[1], Stergioula M, Aarskog R, Lopes-Martins RA, Bjordal JM.

Light therapy and advanced wound care for a neuropathic plantar ulcer on a Charcot foot.

Light therapy is a relatively novel modality in wound care. I used a light-emitting diode (LED) and superluminous diode (SLD) to deliver low-intensity laser light as an adjunctive treatment to a patient with a chronic diabetic foot ulcer. Standard treatment of conservative sharp debridement, off-loading, bioburden management, and advanced dressings was delivered in a WOC clinic setting. This combination of therapies resulted in closure of the neuropathic plantar ulcer within 8 weeks.

Sutterfield R.
J Wound Ostomy Continence Nurs. 2008 Jan-Feb;35(1):113-5; discussion 116-7. doi: 10.1097/01.WON.0000308628.60958.d9

Anti-inflammatory effects of low-level laser therapy (LLLT) with two different red wavelengths (660 nm and 684 nm) in carrageenan-induced rat paw edema.

We conclude that both 660 nm and 684 nm red wavelengths of LLLT are effective in reducing edema formation and inflammatory cell migration when a dose of 7.5 J/cm(2) is used.

Albertini R, Villaverde AB, Aimbire F, Salgado MA, Bjordal JM, Alves LP, Munin E, Costa MS.
J Photochem Photobiol B. 2007 Nov 12;89(1):50-5. Epub 2007 Sep 6.

A randomised, placebo controlled trial of low level laser therapy for activated Achilles tendinitis with microdialysis measurement of peritendinous prostaglandin E2 concentrations.

LLLT at a dose of 5.4 J per point can reduce inflammation and pain in activated Achilles tendinitis. LLLT may therefore have potential in the management of diseases with an inflammatory component.

Br J Sports Med. 2006 Jan;40(1):76-80; discussion 76-80.
Bjordal JM[1], Lopes-Martins RA, Iversen VV.

Low-level laser treatment can reduce edema in second degree ankle sprains.

LLLT combined with RICE can reduce edema in second-degree ankle sprains.

J Clin Laser Med Surg. 2004 Apr;22(2):125-8.
Stergioulas A.

Wound healing and post-surgery

One of the more significant and widespread uses for LLL therapy is to enhance the healing process and promote better and faster wound repair for a spectrum of disorders requiring healing, regeneration and prevention of tissue death. The improved wound repair combines with the beneficial effects of reduced oedema as well as pain reduction.

In addition to iatrogenic wounds, improved healing has been shown for those that result from various injures e.g. sport or traffic accident and disease processes e.g. diabetic ulcer.

General surgical procedures are one of the main indications for the use of low level lasers in medicine with the therapy particularly useful when applied immediately after surgery to help reduce inflammation, swelling and pain.

Photobiomodulation therapy (PBMT) on acute pain and inflammation in patients who underwent total hip arthroplasty-a randomized, triple-blind, placebo-controlled clinical trial.

When conservative treatments fail, hip osteoarthritis (OA), a chronic degenerative disease characterized by cartilage wear, progressive joint deformity, and loss of function, can result in the need for a total hip arthroplasty (THA). Surgical procedures induced tissue trauma and incite an immune response. Photobiomodulation therapy (PBMt) using low-level laser therapy (LLLT) and/or light-emitting diode therapy (LEDT) has proven effective in tissue repair by modulating the inflammatory process and promoting pain relief. Therefore, the aim of this study was to analyze the immediate effect of PBMt on inflammation and pain of patients undergoing total hip arthroplasty.

We conclude that PBMt is effective in decreasing pain intensity and post-surgery inflammation in patients receiving total hip arthroplasty.

Lasers Med Sci. 2018 Dec;33(9):1933-1940. doi: 10.1007/s10103-018-2558-x. Epub 2018 Jun 16.
Langella LG, Casalechi HL, Tomazoni SS, Johnson DS, Albertini R, Pallotta RC, Marcos RL, de Carvalho PTC, Leal-Junior ECP.

Early Low-Level Laser Therapy Improves the Passive Range of Motion and Decreases Pain in Patients with Flexor Tendon Injury.

BACKGROUND:

To obtain the best result from flexor tendon repair surgery, proper surgical technique, appropriate materials, good rehabilitation, and patient satisfaction are essential to consider. Nevertheless, no general unique protocol still exists between researchers, for a suitable treatment plan.

OBJECTIVE:

The aim of the present random clinical trial (RCT) was to determine the adjuvant effect of low-level laser therapy (LLLT) on healing tendon injury in patients.

RESULTS:

In two groups, no rupture was observed during 4 weeks postsurgery. None of the patients in the control group was able to perform the full passive flexion. There was a significant increase in PROM ($t = 82.925$, $p = 0.000$) and a significant pain reduction ($t = -11.96$, $p = 0.000$) in the LLLT group, compared with the control group. All Patients in the LLLT group were satisfied.

CONCLUSIONS:

LLLT is a proper adjuvant therapy in flexor tendon repair. Evidently, LLLT promotes tendon healing, alleviates the pain, and assists flexibility of soft tissue and joints, leading to the tremendous improvement in patient cooperation and compliance.

Photomed Laser Surg. 2018 Oct;36(10):530-535. doi: 10.1089/pho.2018.4458.
Poorpezeshk N, Ghoreishi SK, Bayat M, Pouriran R, Yavari M.

Effect of low-level laser therapy on wound healing and patients' response after scalpel gingivectomy: A randomized clinical split-mouth study.

Results: LLLT-applied sites had significantly lower stained areas signifying improved wound healing compared with the controls on the postoperative 7th and 30th day.

Conclusion: Within the limitations of this study, the results indicated that LLLT might improve wound healing after gingivectomy.

J Indian Soc Periodontol. 2018 Sep-Oct;22(5):419-426. doi: 10.4103/jisp.jisp_239_18.
Kohale BR, Agrawal AA, Raut CP.

Combination of medicinal honey and 904 nm superpulsed laser-mediated photobiomodulation promotes healing and impedes inflammation, pain in full-thickness burn.

Burn wound is a complex multi-factorial pathophysiology producing excruciating pain and psychological discomfort among patients, which imposes a major burden on the healthcare system. Thus, the findings of present study signify that the combination of medicinal honey and PBMT accelerates the repair process of burn wounds. The study showed that therapeutic efficacy of 904 nm superpulsed laser-mediated PBM augments in the presence of medicinal honey by enhancing cellular proliferation and attenuation of inflammation and pain in burn wound healing.

J Photochem Photobiol B. 2018 Sep;186:152-159. doi: 10.1016/j.jphotobiol.2018.07.008. Epub 2018 Jul 18.
Yadav A, Verma S, Keshri GK, Gupta A.

Evaluation of the Effects of Low Level Laser Therapy on the Healing Process After Skin Graft Surgery in Burned Patients (A Randomized Clinical Trial).

Introduction: Skin graft is the standard therapeutic technique in patients with deep ulcers, but like every surgical procedure, it may present some complications. Although several modern dressings are available to enhance comfort of donor site, the use of techniques that accelerate wound healing may enhance patient's satisfaction. Low level laser therapy (LLLT) has been used in several medical fields, especially for wound healing, but it may take several months for large ulcers treated with laser to heal completely.

Results: The rate of wound dehiscence after skin graft surgery was significantly lower in laser treated group in comparison to control group which received only classic dressing (P=0.019). **Conclusion:** The results showed LLLT to be a safe effective method which improves graft survival and wound healing process and decreases the rate of wound dehiscence in patients with deep burn ulcers.

J Lasers Med Sci. 2018 Spring;9(2):139-143. doi: 10.15171/jlms.2018.26. Epub 2018 Mar 20.
Kazemikhoo N, Vaghardoost R, Dahmardehei M, Mokmeli S, Momeni M, Nilforoushzadeh MA, Ansari F, Razagi MR, Razagi Z, Amirkhani MA, Masjedi MR.

Should open excisions and sutured incisions be treated differently? A review and meta-analysis of animal wound models following low-level laser therapy.

Although low-level laser therapy (LLLT) was discovered already in the 1960s of the twentieth century, it took almost 40 years to be widely used in clinical dermatology/surgery. It has been demonstrated that LLLT is able to increase collagen production/wound stiffness and/or improve wound contraction. In this review, we investigated whether open and sutured wounds should be treated with different LLLT parameters. A PubMed search was performed to identify controlled studies with LLLT applied to wounded animals (sutured incisions-tensile strength measurement and open excisions-area measurement).

LLLT appears effective in the treatment of sutured and open wounds. Statistical heterogeneity indicates that the tensile strength development of sutured wounds is more dependent on laser power density compared to the contraction rate of open wounds.

Lasers Med Sci. 2018 Aug;33(6):1351-1362. doi: 10.1007/s10103-018-2496-7. Epub 2018 Mar 30. Review.
Gál P, Stausholm MB, Kováč I, Dosedla E, Luczy J, Sabol F, Bjordal JM.

Effects of Photobiomodulation on Degranulation and Number of Mast Cells and Wound Strength in Skin Wound Healing of Streptozotocin-Induced Diabetic Rats.

BACKGROUND: A lack of effective treatments still exists for patients suffering from diabetes mellitus. Photobiomodulation is proved as a beneficial therapeutic modality for wounds.

RESULTS: The administration of photobiomodulation and CM, alone or in combination, significantly increased the tensiometric properties within the healing wounds. Histologically, photobiomodulation+CM, CM, and photobiomodulation groups showed a significant decrease in the three types of mast cells and in the total number of mast cells compared with the control group on day 15.

CONCLUSIONS: We conclude that photobiomodulation and CM alone and or in combination significantly accelerated the healing process in a rat with a diabetic and ischemic wound, and significantly decreased the total number of mast cells and degranulation of mast cells. We suggest that the increased number of type 2 mast cells in the control group adversely affected the tensiometric properties of wounds in this group.

Photomed Laser Surg. 2018 Aug;36(8):415-423. doi: 10.1089/pho.2018.4453. Epub 2018 Jul 6.
Bagheri M, Amini A, Abdollahifar MA, Ghoreishi SK, Piryaei A, Pouriran R, Chien S, Dadras S, Rezaei F, Bayat M.

Photobiomodulation therapy promotes in vitro wound healing in nicastrin KO HaCaT cells.

Mutations in NCSTN gene (encoding for nicastrin protein) are associated with hidradenitis suppurativa (HS), a chronic inflammatory disease involving hair follicles. HS is clinically handled with drugs but the most severe cases are treated with surgery. Photobiomodulation (PBM) therapy, already used in the treatment of skin diseases such as acne, herpes virus lesions, ultraviolet damage, vitiligo, hypertrophic scar, keloid, burn, psoriasis and diabetic chronic wounds, could be beneficial as an adjuvant supportive treatment to promote and foster the healing process after skin excision in HS. The effects of PBM therapy in promoting the wound closure are evaluated in a HaCaT cells NCSTN-/-, assessing cell metabolism, migration rate, proliferation and cell cycle progression. In our experimental model, PBM exerts a potent action on metabolism of mutated keratinocytes, incrementing adenosine triphosphate (ATP) production at 2 hours, while after 24 hours an increase of metabolism with a decrement of intracellular ATP levels were recorded. Moreover, PBM speeds up the wound closure, inducing cells' migration without affecting their proliferation.Based on our findings, we suggest the use of PBM in HS patients, who undergo major surgery with large skin excision.

J Biophotonics. 2018 Dec;11(12):e201800174. doi: 10.1002/jbio.201800174. Epub 2018 Jul 24.
Tricarico PM, Zupin L, Ottaviani G, Pacor S, Jean-Louis F, Boniotto M, Crovella S.

Effects of Low-Power Light Therapy on the Tissue Repair Process of Chronic Wounds in Diabetic Feet.

OBJECTIVE: To analyze the efficacy of the therapeutic use of Low-Level Laser Therapy (LLLT) on the tissue repair process of chronic wounds in patients with diabetic feet through the analysis of Pressure Ulcer Scale for Healing (PUSH) scales, pain and the measurement done using the ImageJ© software.

RESULTS: The Laser Group presented a significant increase of the tissue repair index when compared with the Control Group, with a significant statistical difference ($p < 0.013$). There was no significant difference between the groups in all the weeks using the PUSH scale.

CONCLUSIONS: The use of LLLT on chronic wounds in a diabetic foot demonstrated efficacy on the progression of the tissue repair process in a short period.

Photomed Laser Surg. 2018 Jun;36(6):298-304. doi: 10.1089/pho.2018.4455.
de Alencar Fonseca Santos J, Campelo MBD, de Oliveira RA, Nicolau RA, Rezende VEA, Arisawa EÂL.

Effect of low-level laser therapy on the healing process of donor site in patients with grade 3 burn ulcer after skin graft surgery (a randomized clinical trial).

Skin graft is a standard therapeutic technique in patients with deep ulcers, but managing donor site after grafting is very important. Although several modern dressings are available to enhance the comfort of donor site, using techniques that accelerate wound healing may enhance patient satisfaction. Low-level laser therapy (LLLT) has been used in several medical fields, including healing of diabetic, surgical, and pressure ulcers, but there is not any report of using this method for healing of donor site in burn patients. The results showed that local irradiation of red laser accelerates wound healing process significantly.

Lasers Med Sci. 2018 Apr;33(3):603-607. doi: 10.1007/s10103-017-2430-4. Epub 2018 Jan 24.
Vaghardoost R, Momeni M, Kazemikhoo N, Mokmeli S, Dahmardehei M, Ansari F, Nilforoushzadeh MA, Sabr Joo P, Mey Abadi S, Naderi Gharagheshlagh S, Sassani S.

Photobiomodulation effect on children's scars.

The management of burn scars has become one of the major clinical challenges in the developing countries which involve enormous treatment cost; this needs new methods for better cost benefit relationship. The objective of the study is to analyze the effectiveness of low-level laser therapy on post-burn scar tissue in children.

Significant improvement was reported in the studied area compared to the control area for patients with P values ($P = 0.005$) and ($P = 0.0001$) for VSS and U/S scores, respectively. In addition, no adverse effect was reported. Photobiomodulation is an efficient and safe therapeutic modality for post-burn hypertrophic scars in children and should be considered a part of combination therapy for better results.

Lasers Med Sci. 2018 Apr;33(3):497-501. doi: 10.1007/s10103-017-2387-3. Epub 2017 Nov 24.
Alsharnoubi J, Mohamed O.

Effectiveness of Low-Intensity Laser Therapy on Tissue Repair Following Saphenectomy in Patients Who Underwent Coronary Artery Bypass Graft: A Randomized, Double-Blind Study.

OBJECTIVE: To verify the effectiveness of low-intensity laser therapy (LLLT) on tissue repair following saphenectomy during postoperative period in patients having undergone coronary artery bypass graft (CABG).

CONCLUSIONS: The proposed LLLT protocol improved the tissue repair following saphenectomy in CABG patients.

Photomed Laser Surg. 2018 Jan;36(1):18-23. doi: 10.1089/pho.2017.4329. Epub 2017 Oct 12.
Gonzaga ICA, Araújo RB Jr, Lima ACG, Fernandes GA, Cortellazi PS, Oliveira RA, Nicolau RA.

Photobiomodulation with Pulsed and Continuous Wave Near-Infrared Laser (810 nm, Al-Ga-As) Augments Dermal Wound Healing in Immunosuppressed Rats.

Chronic non-healing cutaneous wounds are often vulnerable in one or more repair phases that prevent normal healing and pose challenges to the use of conventional wound care modalities. In immunosuppressed subject, the sequential stages of healing get hampered, which may be the consequences of dysregulated or stagnant wound inflammation. Photobiomodulation (PBM) or low-level laser (light) therapy (LLLT) emerges as a promising drug-free, non-invasive biophysical approach for promoting wound healing, reduction of inflammation, pain and restoration of functions. The present study was therefore undertaken to evaluate the photobiomodulatory effects of 810 nm diode laser (40 mW/cm2; 22.6 J/cm2) with pulsed (10 and 100 Hz, 50% duty cycle) and continuous wave on full-thickness excision-type dermal wound healing in hydrocortisone-induced immunosuppressed rats. Results clearly delineated that 810 nm PBM at 10 Hz was more effective over continuous and 100 Hz frequency in accelerating wound healing by attenuating the pro-inflammatory markers (NF-kB, TNF-α), augmenting wound contraction (α-SM actin), enhancing cellular proliferation, ECM deposition, neovascularization (HIF-1α, VEGF), re-epithelialization along with up-regulated protein expression of FGFR-1, Fibronectin, HSP-90 and TGF-β2 as compared to the non-irradiated controls. Additionally, 810 nm laser irradiation significantly increased CCO activity and cellular ATP contents. Overall, the findings from this study might broaden the current biological mechanism that could be responsible for photobiomodulatory effect mediated through pulsed NIR 810 nm laser (10 Hz) for promoting dermal wound healing in immunosuppressed subjects.

Keshri GK, Gupta A, Yadav A, Sharma SK, Singh SB.
PLoS One. 2016 Nov 18;11(11):e0166705. doi: 10.1371/journal.pone.0166705. eCollection 2016.

Beneficial Effects of Applying Low-Level Laser Therapy to Surgical Wounds After Bariatric Surgery.

BACKGROUND: Bariatric surgery is a successful method for weight loss in cases of morbid obesity; however, as an invasive procedure, surgical complications may occur. Low-level laser therapy (LLLT) has been increasingly used due to its effectiveness in controlling the inflammatory response, accelerating tissue repair, and reducing pain. The objective of this study was to investigate photobiomodulation effects after bariatric surgery and determine the laser actions during the inflammatory process, wound healing (clinical observation), and analgesia.

RESULTS: Patients in the laser group demonstrated diminished wound temperature as erythrocyte sedimentation rate (ESR) compared with the placebo group, indicating better inflammatory process control as well as improved wound healing and reduced pain.

CONCLUSIONS: LLLT applied with the described protocol led to a decrease by biochemical markers and wound temperature compared with the placebo, which indicated that LLLT was able to control the inflammatory process; in addition, seroma and pain were reduced and cicatrization was improved by this preventive procedure.

Photomed Laser Surg. 2016 Nov;34(11):580-584.
Ojea AR, Madi O, Neto RM, Lima SE, de Carvalho BT, Ojea MJ, Marcos RL, da Silva FS, Zamuner SR, Chavantes MC.

Low-level laser therapy (904nm) can increase collagen and reduce oxidative and nitrosative stress in diabetic wounded mouse skin.

BACKGROUND AND OBJECTIVE: Over the last decade we have seen an increased interest in the use of Low-Level Laser Therapy (LLLT) in diseases that involve increased oxidative stress. It is well established that hyperglycemia in diabetes elicits a rise in reactive oxygen species (ROS) production but the effect of LLLT remains unclear. This study aimed to investigate whether LLLT was able to improve oxidative/nitrosative stress parameters in the wound healing process in diabetic mice.

CONCLUSIONS: Delayed wound healing in diabetes is still a challenge in clinical practice with high social costs. The increased production of collagen and decreased oxidative and nitrosative stress suggests that LLLT may be a viable therapeutic alternative in diabetic wound healing.

J Photochem Photobiol B. 2016 Nov;164:96-102. doi: 10.1016/j.jphotobiol.2016.09.017. Epub 2016 Sep 12.
Tatmatsu-Rocha JC, Ferraresi C, Hamblin MR, Damasceno Maia F, do Nascimento NR, Driusso P, Parizotto NA.

An in vitro method to test the safety and efficacy of low-level laser therapy (LLLT) in the healing of a canine skin model.

Low-level laser therapy (LLLT) has been used clinically as a treatment modality for a variety of medical conditions including wound-healing processes. It is an attractive and emerging method to enhance wound healing and improve clinical outcomes both in human and veterinary medicine. Despite the fact that the use of LLLT continues to gain in popularity, there is no universally accepted theory that defends all its cellular effects and beneficial biological processes in tissue repair. The present study was designed to evaluate the effect of LLLT on cellular migration and proliferation of cultured canine epidermal keratinocytes (CPEK) in an in vitro wound healing model.

In this in vitro wound-healing model, LLLT increased cellular migration and proliferation at doses of 0.1, 0.2, and 1.2 J/cm(2) while exposure to 10 J/cm(2) decreased cellular migration and proliferation. These data suggest that the beneficial effects of LLLT in vivo may be due, in part, to effects on keratinocyte behavior.

BMC Vet Res. 2016 Apr 8;12:73. doi: 10.1186/s12917-016-0689-5.
Gagnon D, Gibson TW, Singh A, zur Linden AR, Kazienko JE, LaMarre J.

Assessment of circular wound healing in rats after exposure to 808-nm laser pulses during specific healing phases.

Low-level laser therapy (LLLT), is an important application modality for the advancement of wound healing processes. In this study, histological and morphometric analyses have been made to understand and compare effects of high-power 808-nm pulses on circular skin wounds among groups irradiated immediately after wounding and groups irradiated at specific stages of the healing period.

Histological and morphometric results showed that high-power, low-energy application has the best effect when first applied 24 hours post-wounding (late inflammatory, early proliferative stage) as demonstrated by increases in granulation tissue, fibroblasts and collagen deposition, which lead to faster rates of wound contraction and thus accelerated healing.

Lasers Surg Med. 2016 Apr;48(4):409-15. doi: 10.1002/lsm.22462. Epub 2015 Dec 31.
Tabakoglu HO, Sani MM, Uba AI, Abdullahi UA.

Prevention of abdominal adhesions and healing skin after peritoniectomy using low level laser.

Adhesions commonly occur after abdominal surgery and can cause bowel obstruction, chronic abdominal pain, and infertility. Their prevention remains a challenge.

Low-level LASER is effective in preventing intra-abdominal adhesions in rabbits without compromising strength and healing of the abdominal wall.

Lasers Surg Med. 2015 Dec;47(10):817-23. doi: 10.1002/lsm.22423. Epub 2015 Sep 28.
Teixeira ML, Vasconcellos LS, Oliveira TG, Petroianu A, Alberti LR.

Improving the ability to eliminate wounds and pressure ulcers.

To investigate the morphological aspects of the healing of traumatic wounds in rats using low-power laser.

The healing of wounds in rats was improved with the use of the laser.

Wound Repair Regen. 2015 May-Jun;23(3):312-7. doi: 10.1111/wrr.12284. Review.
Kuffler DP.

Low power laser stimulation of the bone consolidation in tibial fractures of rats: a radiologic and histopathological analysis.

The objective of this study is to analyze the effectiveness of low power laser irradiation in the bone consolidation of tibial fractures in rats. An experimental, comparative, prospective study with control group was designed.

Radiologic data showed that the experimental group had a higher bone consolidation of Montoya scale after ten days of laser irradiation compared to control group ($P < 0.004$). Histopathologic data showed more fibroblasts and angiogenesis presence in the group receiving laser irradiation, compared to control group ($P < .002$). The low power laser radiation therapy may expedite the bone repair after tibial fractures in rats, according to radiologic and histopathologic analysis.

Lasers Med Sci. 2015 Jan;30(1):333-8. doi: 10.1007/s10103-014-1673-6. Epub 2014 Oct 2.
Briteño-Vázquez M, Santillán-Díaz G, González-Pérez M, Gallego-Izquierdo T, Pecos-Martín D, Plaza-Manzano G, Romero-Franco N.

Superpulsed (Ga-As, 904 nm) low-level laser therapy (LLLT) attenuates inflammatory response and enhances healing of burn wounds.

Low-level laser therapy (LLLT) using superpulsed near-infrared light can penetrate deeper in the injured tissue and could allow non-pharmacological treatment for chronic wound healing. This study investigated the effects of superpulsed laser (Ga-As 904 nm, 200 ns pulse width; 100 Hz; 0.7 mW mean output power; 0.4 mW/cm(2) average irradiance; 0.2 J/cm(2) total fluence) on the healing of burn

wounds in rats, and further explored the probable associated mechanisms of action. Irradiated group exhibited enhanced DNA, total protein, hydroxyproline and hexosamine contents compared to the control and silver sulfadiazine (reference care) treated groups. LLLT exhibited decreased TNF-α level and NF-kB, and up-regulated protein levels of VEGF, FGFR-1, HSP-60, HSP-90, HIF-1α and matrix metalloproteinases-2 and 9 compared to the controls. In conclusion, LLLT using superpulsed 904 nm laser reduced the inflammatory response and was able to enhance cellular proliferation, collagen deposition and wound contraction in the repair process of burn wounds. Photomicrographs showing no, absence inflammation and faster wound contraction in LLLT superpulsed (904 nm) laser treated burn wounds as compared to the non-irradiated control and silver sulfadiazine (SSD) ointment (reference care) treated wounds.

J Biophotonics. 2015 Jun;8(6):489-501. doi: 10.1002/jbio.201400058. Epub 2014 Sep 10.
Gupta A, Keshri GK, Yadav A, Gola S, Chauhan S, Salhan AK, Bala Singh S.

Effects of low-level laser therapy on skeletal muscle repair: a systematic review.

A review of the literature was performed to demonstrate the most current applicability of low-level laser therapy (LLLT) for the treatment of skeletal muscle injuries, addressing different lasers, irradiation parameters, and treatment results in animal models. Searches were performed in the PubMed/MEDLINE, SCOPUS, and SPIE Digital Library databases for studies published from January 2006 to August 2013 on the use of LLLT for the repair of skeletal muscle in any animal model. All selected articles were critically appraised by two independent raters. Seventeen of the 36 original articles on LLLT and muscle injuries met the inclusion criteria and were critically evaluated. The main effects of LLLT were a reduction in the inflammatory process, the modulation of growth factors and myogenic regulatory factors, and increased angiogenesis. The studies analyzed demonstrate the positive effects of LLLT on the muscle repair process, which are dependent on irradiation and treatment parameters. The findings suggest that LLLT is an excellent therapeutic resource for the treatment of skeletal muscle injuries in the short-term.

Am J Phys Med Rehabil. 2014 Dec;93(12):1073-85. doi: 10.1097/PHM.0000000000000158. Review.
Alves AN, Fernandes KP, Deana AM, Bussadori SK, Mesquita-Ferrari RA.

Effects of low-level laser therapy on wound healing.

OBJECTIVE: To gather and clarify the actual effects of low-level laser therapy on wound healing and its most effective ways of application in human and veterinary medicine.

METHODS: We searched original articles published in journals between the years 2000 and 2011, in Spanish, English, French and Portuguese languages, belonging to the following databases: Lilacs, Medline, PubMed and Bireme; Tey should contain the methodological description of the experimental design and parameters used.

RESULTS: doses ranging from 3 to 6 J/cm(2) appear to be more effective and doses 10 above J/cm(2) are associated with deleterious effects. The wavelengths ranging from 632.8 to 1000 nm remain as those that provide more satisfactory results in the wound healing process.

CONCLUSION: Low-level laser can be safely applied to accelerate the resolution of cutaneous wounds, although this fact is closely related to the election of parameters such as dose, time of exposure and wavelength.

Rev Col Bras Cir. 2014 Mar-Apr;41(2):129-33. Review. English, Portuguese.

Andrade Fdo S, Clark RM, Ferreira ML.

830 nm light-emitting diode low level light therapy (LED-LLLT) enhances wound healing: a preliminary study.

Background and aims: The application of light-emitting diodes in a number of clinical fields is expanding rapidly since the development in the late 1990s of the NASA LED. Wound healing is one field where low level light therapy with LEDs (LED-LLLT) has attracted attention for both accelerating wound healing and controlling sequelae. Conclusions: 830 nm LED-LLLT successfully brought about accelerated healing in wounds of different etiologies and at different stages, and successfully controlled secondary infection. LED-LLLT was easy and pain-free to apply, and was well-tolerated by all patients. The good results warrant the design of controlled studies with a larger patient population.

Laser Ther. 2013;22(1):43-9.
Min PK[1], Goo BL.

Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring.

Low-level laser (light) therapy (LLLT) is a fast-growing technology used to treat a multitude of conditions that require stimulation of healing, relief of pain and inflammation, and restoration of function. Although skin is naturally exposed to light more than any other organ, it still responds well to red and near-infrared wavelengths. The photons are absorbed by mitochondrial chromophores in skin cells. Consequently, electron transport, adenosine triphosphate nitric oxide release, blood flow, reactive oxygen species increase, and diverse signaling pathways are activated. Stem cells can be activated, allowing increased tissue repair and healing. In dermatology, LLLT has beneficial effects on wrinkles, acne scars, hypertrophic scars, and healing of burns. LLLT can reduce UV damage both as a treatment and as a prophylactic measure. In pigmentary disorders such as vitiligo, LLLT can increase pigmentation by stimulating melanocyte proliferation and reduce depigmentation by inhibiting autoimmunity. Inflammatory diseases such as psoriasis and acne can also be managed. The noninvasive nature and almost complete absence of side effects encourage further testing in dermatology.

Semin Cutan Med Surg. 2013 Mar;32(1):41-52.
Avci P[1], Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, Hamblin MR.

Advancement in the research of effect of low level laser therapy on wound healing.

Low level laser therapy (LLLT) is a therapeutic method which regulates the biological behavior of cells with light. The effects of LLLT consist of promotion of tissue repair, inhibition of inflammation, and relief of pain by promoting or inhibiting the cell proliferation, increasing or decreasing the release of some bioactive substances. Therefore, LLLT is also known as photomodulation. At present, there are many relevant experimental studies of LLLT abroad, and they are also used clinically. This article reviews the effect of LLLT on wound healing.

Zhonghua Shao Shang Za Zhi. 2012 Dec;28(6):462-5.
Mao HS[1], Yao M, Fang Y.

The influence of low-intensity laser therapy on bone healing.

Based on the results of the reviewed articles, low intensity laser therapy can accelerate bone healing in extraction sites, bone fracture defects and distraction osteogenesis, provided proper parameters were applied.

J Dent (Tehran). 2012 Fall;9(4):238-48. Epub 2012 Dec 31.
Ebrahimi T[1], Moslemi N, Rokn A, Heidari M, Nokhbatolfoghahaie H, Fekrazad R.

Biostimulation effects of low-power laser in the repair process.

Laser biostimulation appears to influence the behavior of the repair process. This paper aims at reviewing the most interesting aspects of the use of low-power laser in the tissue-repair process.

An Bras Dermatol. 2010 Nov-Dec;85(6):849-55. [Article in English, Portuguese]
Lins RD[1], Dantas EM, Lucena KC, Catão MH, Granville-Garcia AF, Carvalho Neto LG.

The role of laser biostimulation in early post-surgery rehabilitation and its effect on wound healing.

Low energy infrared laser radiation had a beneficial effect on the covering of the scar with stratified squamous cornifying epithelium and intensified wound healing. The gross and microscopic findings indicated a beneficial effect of laser stimulation on wound healing. These results underscore the utility of biostimulation lasers in the early post-operative period. Physicomechanical investigations did not reveal an effect of infrared laser biostimulation on the breaking strength of the cutaneous scar.

Ortop Traumatol Rehabil. 2010 Jan-Feb;12(1):67-79.
Krynicka I[1], Rutowski R, Staniszewska-Kuś J, Fugiel J, Zaleski A.

A meta-analysis of the efficacy of phototherapy in tissue repair.

The effect of phototherapy on tissue repair was determined by aggregating the literature and using statistical meta-analysis to analyze pertinent studies published between 2000 and 2007. These findings indicate that phototherapy is a highly effective form of treatment for tissue repair, with stronger supporting evidence resulting from experimental animal studies than human studies.

Photomed Laser Surg. 2009 Oct;27(5):695-702. doi: 10.1089/pho.2009.2550.
Fulop AM[1], Dhimmer S, Deluca JR, Johanson DD, Lenz RV, Patel KB, Douris PC, Enwemeka CS.

The role of laser fluence in cell viability, proliferation, and membrane integrity of wounded human skin fibroblasts following helium-neon laser irradiation.

Results show that 5 J/cm(2) stimulates mitochondrial activity, which leads to normalization of cell function and ultimately stimulates cell proliferation and migration of wounded fibroblasts to accelerate wound closure. Laser irradiation can modify cellular processes in a dose or fluence (J/cm(2)) dependent manner.

Lasers Surg Med. 2006 Jan;38(1):74-83.
Hawkins DH[1], Abrahamse H.

Low level laser therapy (LLLT) as an effective therapeutic modality for delayed wound healing.

Low level laser therapy (LLLT) is a form of phototherapy that involves the application of low power monochromatic and coherent light to injuries and lesions. It has been used successfully to induce wound healing in nonhealing defects. Other wounds treated with lasers include burns, amputation injuries, skin grafts, infected wounds, and trapping injuries. The unique properties of lasers create an enormous potential for specific therapy of skin diseases.

Ann N Y Acad Sci. 2005 Nov;1056:486-93.
Hawkins D[1], Houreld N, Abrahamse H.

Low-level laser irradiation promotes proliferation and differentiation of human osteoblasts in vitro.

The aim of the present study was to investigate the effect of low-level laser irradiation on proliferation and differentiation of a human osteoblast cell line. We conclude that LLLT promotes proliferation and maturation of human osteoblasts in vitro. These results may have clinical implications.

Photomed Laser Surg. 2005 Apr;23(2):161-6.
Stein A[1], Benayahu D, Maltz L, Oron U.

Low-level laser therapy (LLLT) efficacy in post-operative wounds.

LLLR with wavelength of 904 nm to stimulate postoperative aseptic wounds (early scar) is efficient in both cases of cutting plague.

Photomed Laser Surg. 2005 Feb;23(1):70-3.
Herascu N[1], Velciu B, Calin M, Savastru D, Talianu C.

Effect of low-level Er:YAG laser irradiation on cultured human gingival fibroblasts.

Low-level laser irradiation has been reported to enhance wound healing. Activation of gingival fibroblasts (GF) has a potential for early wound healing in periodontal treatment. Our results showed that the low-level Er:YAG laser irradiation stimulates the proliferation of cultured gingival fibroblasts. The optimal stimulative energy density was found to be 3.37 J/cm(2). This result suggests that Er:YAG laser irradiation may be of therapeutic benefit for wound healing.

J Periodontol. 2005 Feb;76(2):187-93.
Pourzarandian A[1], Watanabe H, Ruwanpura SM, Aoki A, Ishikawa I.

Low-Level Laser Therapy Facilitates Superficial Wound Healing in Humans: A Triple-Blind, Sham-Controlled Study.

The LLLT resulted in enhanced healing as measured by wound contraction. The untreated wounds in subjects treated with LLLT contracted more than the wounds in the sham group, so LLLT may produce an indirect healing effect on surrounding tissues. These data indicate that LLLT is an effective modality to facilitate wound contraction of partial-thickness wounds..

J Athl Train. 2004 Sep;39(3):223-229.
Hopkins JT[1], McLoda TA, Seegmiller JG, David Baxter G.

Low level laser irradiation and its effect on repair processes in the skin.

Effects of low level laser therapy on wound healing process is one of the most fully studied aspects of this type of therapy. It affects all phases of this very complex process. This paper offers a more detailed analysis of these aspects.

Med Pregl. 2003 Mar-Apr;56(3-4):137-41.
Matić M[1], Lazetić B, Poljacki M, Duran V, Ivkov-Simić M.

Increased fibroblast proliferation induced by light emitting diode and low power laser irradiation.

LED and LLL irradiation resulted in an increased fibroblast proliferation in vitro. This study therefore postulates possible stimulatory effects on wound healing in vivo at the applied dosimetric parameters.

Lasers Med Sci. 2003;18(2):95-9.
Vinck EM[1], Cagnie BJ, Cornelissen MJ, Declercq HA, Cambier DC.

Pain relief and tissue repair

One of the best documented uses for LLL therapy is to relieve pain. Many studies including meta analyses have shown the efficacy of the treatment and supported its place in contemporary pain management.

The additional benefits of reduced oedema and an improved tissue healing process amplify the specific pain modulation effects with the treatment often described as “highly effective”.

Optimal Laser Phototherapy Parameters for Pain Relief.

BACKGROUND AND OBJECTIVE: Studies on laser phototherapy for pain relief have used parameters that vary widely and have reported varying outcomes. The purpose of this study was to determine the optimal parameter ranges of laser phototherapy for pain relief by analyzing data aggregated from existing primary literature.

MATERIALS AND METHODS: Original studies were gathered from available sources and were screened to meet the pre-established inclusion criteria. The included articles were then subjected to meta-analysis using Cohen's d statistic for determining treatment effect size. From these studies, ranges of the reported parameters that always resulted into large effect sizes were determined. These optimal ranges were evaluated for their accuracy using leave-one-article-out cross-validation procedure.

RESULTS: A total of 96 articles met the inclusion criteria for meta-analysis and yielded 232 effect sizes. The average effect size was highly significant: d = +1.36 [confidence interval (95% CI) = 1.04-1.68]. Among all the parameters, total energy was found to have the greatest effect on pain relief and had the most prominent optimal ranges of 120-162 and 15.36-20.16 J, which always resulted in large effect sizes. The cross-validation accuracy of the optimal ranges for total energy was 68.57% (95% CI = 53.19-83.97). Fewer and less-prominent optimal ranges were obtained for the energy density and duration parameters. None of the remaining parameters was found to be independently related to pain relief outcomes.

CONCLUSIONS: The findings of meta-analysis indicate that laser phototherapy is highly effective for pain relief. Based on the analysis of parameters, total energy can be optimized to yield the largest effect on pain relief.

Photomed Laser Surg. 2018 Jul;36(7):354-362. doi: 10.1089/pho.2017.4399. Epub 2018 Mar 27.
Kate RJ, Rubatt S, Enwemeka CS, Huddleston WE.

Review of Literature on Low-level Laser Therapy Benefits for Nonpharmacological Pain Control in Chronic Pain and Osteoarthritis.

Introduction • Low-level laser therapy (LLLT) is a form of light therapy that triggers biochemical changes within cells. Photons are absorbed by cellular photoreceptors, triggering chemical alterations and potential biochemical benefits to the human body. LLLT has been used in pain management for years and is also known as cold laser therapy, which uses low-frequency continuous laser of typically 600 to 1000 nm wavelength for pain reduction and healing stimulation. Many studies have demonstrated analgesic and anti-inflammatory effects provided by photobiomodulation in both experimental and clinical trials. Objective • The purpose of this research article was to present a summary of the possible pain management benefits of LLLT.

Results • In cold laser therapy, coherent light of wavelength 600 to 1000 nm is applied to an area of concern with hope for photo-stimulating the tissues in a way that promotes and accelerates healing. This is evidenced by the similarity in absorption spectra between oxidized cytochrome c oxidase and action spectra from biological responses to light. LLLT, using the properties of coherent light, has been seen to produce pain relief and fibroblastic regeneration in clinical trials and laboratory experiments. LLLT has also been seen to significantly reduce pain in the acute setting; it is proposed that LLLT is able to reduce pain by lowering the level of biochemical markers and oxidative stress, and the formation of edema and hemorrhage. Many studies have demonstrated analgesic and anti-inflammatory effects provided by photobiomodulation in both experimental and clinical trials.

Conclusion • Based on current research, the utilization of LLLT for pain management and osteoarthritic conditions may be a complementary strategy used in clinical practice to provide symptom management for patients suffering from osteoarthritis and chronic pain.

Dima R, Tieppo Francio V, Towery C, Davani S.
Altern Ther Health Med. 2017 Oct 2. pii: AT5647

Effects of low-level laser therapy on pain in patients with musculoskeletal disorders: a systematic review and meta-analysis.

INTRODUCTION: This meta-analysis investigated the effectiveness of low-level laser therapy (LLLT) on pain in adult patients with musculoskeletal disorders.

CONCLUSIONS: This meta-analysis presents evidence that LLLT is an effective treatment modality to reduce pain in adult patients with musculoskeletal disorders. Adherence to WALT dosage recommendations seems to enhance treatment effectiveness.

Eur J Phys Rehabil Med. 2017 Aug;53(4):603-610. doi: 10.23736/S1973-9087.17.04432-X. Epub 2017 Jan 30. Review.
Clijsen R, Brunner A, Barbero M, Clarys P, Taeymans J.

Photobiomodulation: Implications for Anesthesia and Pain Relief.

OBJECTIVE: This review examines the evidence of neural inhibition as a mechanism underlying pain relief and anesthetic effect of photobiomodulation (PBM).

BACKGROUND: PBM for pain relief has also been used for more than 30 years; however, the mechanism of its effectiveness has not been well understood.

METHODS:

We review 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.

CONCLUSIONS: 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.

Photomed Laser Surg. 2016 Dec;34(12):599-609. doi: 10.1089/pho.2015.4048. Epub 2016 Jul 15. Review.
Chow RT, Armati PJ.

Low level laser therapy accelerates bone healing in spinal cord injured rats.

Bone loss occurs rapidly and consistently after the occurrence of a spinal cord injury (SCI), leading to a decrease in bone mineral density (BMD) and a higher risk of fractures. In this context, the stimulatory effects of low level laser therapy (LLLT) also known as photobiomodulation (PBM) have been highlighted, mainly due to its osteogenic potential. The aim of the present study was to evaluate the effects of LLLT on bone healing using an experimental model of tibial bone defect in SCI rats.

In conclusion, the results suggest that LLLT accelerated the process of bone repair in rats with complete SCI.

J Photochem Photobiol B. 2016 Jun;159:179-85. doi: 10.1016/j.jphotobiol.2016.03.041. Epub 2016 Mar 29.
Medalha CC, Santos AL, Veronez Sde O, Fernandes KR, Magri AM, Renno AC.

Therapeutic outcomes of low-level laser therapy for closed bone fracture in the human wrist and hand.

LLLT can relieve pain and improve the healing process of CBFs in the human wrist and hand.

Photomed Laser Surg. 2014 Apr;32(4):212-8. doi: 10.1089/pho.2012.3398. Epub 2014 Mar 20.
Chang WD[1], Wu JH, Wang HJ, Jiang JA.

Pain treatment with low reactive level laser therapy (LLLT).

[Article in Japanese]

Noninvasive and low reactive level laser (LLLT) is used as one of the light therapies without giving pain to the patient. Therefore, it is used often clinically in pain treatment, orthopedics, plastic surgery, dermatology, and dentistry. In the pain clinic field, it is one of the procedures indispensable to treatment of various pain including postherpetic neuralgia, diabetic neuropathy or myofascial pain. In recent years the mechanism has been gradually elucidated by basic study. The action is on sensory nerve, sympathetic nerve, blood vessel, immunity, inflammation and central nervous system, and is thought to contribute to analgesia. Also, many reports such as action to inhibit "itch", a promotor action of the bone metabolism, and the follicular maturation acceleration action have tested and

elucidated these mechanisms, and will add further adaptation that will be new in future. Furthermore, development and downsizing of the free electron laser will promote elucidation of the low response level laser therapy. We expect much in the future of the LLLT.

Masui. 2012 Jul;61(7):718-27.

Hosokawa T[1], Kawabata Y.

A meta-analysis of the efficacy of laser phototherapy on pain relief.

Laser phototherapy has been widely used to relieve pain for more than 30 years, but its efficacy remains controversial. To ascertain the overall effect of phototherapy on pain, we aggregated the literature and subjected the studies to statistical meta-analysis. These findings warrant the conclusion that laser phototherapy effectively relieves pain of various etiologies; making it a valuable addition to contemporary pain management armamentarium.

Clin J Pain. 2010 Oct;26(8):729-36. doi: 10.1097/AJP.0b013e3181f09713.
Fulop AM[1], Dhimmer S, Deluca JR, Johanson DD, Lenz RV, Patel KB, Douris PC, Enwemeka CS.

A meta-analysis of the efficacy of phototherapy in tissue repair.

The effect of phototherapy on tissue repair was determined by aggregating the literature and using statistical meta-analysis to analyze pertinent studies published between 2000 and 2007. These findings indicate that phototherapy is a highly effective form of treatment for tissue repair, with stronger supporting evidence resulting from experimental animal studies than human studies.

Photomed Laser Surg. 2009 Oct;27(5):695-702. doi: 10.1089/pho.2009.2550.
Fulop AM[1], Dhimmer S, Deluca JR, Johanson DD, Lenz RV, Patel KB, Douris PC, Enwemeka CS.

The efficacy of low-power lasers in tissue repair and pain control: a meta-analysis study.

We used statistical meta-analysis to determine the overall treatment effects of laser phototherapy on tissue repair and pain relief. These findings mandate the conclusion that laser phototherapy is a highly effective therapeutic armamentarium for tissue repair and pain relief.

Photomed Laser Surg. 2004 Aug;22(4):323-9.
Enwemeka CS[1], Parker JC, Dowdy DS, Harkness EE, Sanford LE, Woodruff LD.

Low level laser therapy with trigger points technique: a clinical study on 243 patients.

We did not observe any negative effects on the human body and the use of analgesic drugs could be reduced or completely excluded. LLLT suggests that the laser beam can be used as monotherapy or as a supplementary treatment to other therapeutic procedures for pain treatment.

J Clin Laser Med Surg. 1996 Aug;14(4):163-7.
Simunovic Z.

Relief from chronic pain by low power laser irradiation.

Neurosci Lett. 1983 Dec 30;43(2-3):339-44.
Walker J.

In a double blind study, repeated irradiation with a low-power (1 mW) helium-neon laser produced relief in subjects with chronic pain. Analgesia was observed after exposure of the skin overlying the

radial, medial and saphenous nerves and in some cases, irradiation of the appropriate painful nerve. Exposure of areas of skin not innervated by these nerves did not result in pain relief. Of the patients with trigeminal neuralgia, post-herpetic neuralgia, sciatica and ostearthritis, 19 of 26 experienced pain relief without the use of drugs. Patients who received sham stimulation reported no analgesia. Subjects who were exposed to laser irradiation had a large increase in the urinary excretion of 5-hydroxyindoleacetic acid, the degradation product of serotonin.

Back pain

LLLT has been shown in numerous studies to be an effective conservative measure that helps in the treatment of both acute and chronic back and especially lower back pain.

Clinical case series: the effect of MLS® treatment on 30 patients with lumbosacral sciatic pain

All the patients were treated with 12 sessions of MLS® therapy. Patients improved not only in terms of pain management, but also in function and therefore in every day activity comfort, i.e. better sleep and better walk ability. In terms of pain, before the treatment start, average VAS was 8, while at the end of the treatment cycle, average VAS was 1. The treatment was effective in keeping pain controlled between consecutive sessions. **In conclusion**, MLS® therapy resulted a useful approach for the treatment of lumbosacral sciatic pain.

L. Guzman, V. Mora Castillo, J. Olalde
Energy for Health [18] (2019)

Regression of cervical radiculopathy after laser therapy treatment - a case report.

At the end of the treatment, the patient was pain free and, remarkably, MRI conducted to evaluate the patient 2 months after the first radiographic assessment (Figure 2) revealed that spontaneous regression of the herniated disc had occurred, with 90% restitution of the spinal cord space. In the reported case, not only MLS® therapy provided an effective non-invasive approach to treat cervical pain, but the remarkable result observed in this case is the successful outcome on the spinal cord narrowing.

Energy for Health [17] (2018)
E. Perez, J.A. Natera, LD. Guzmán Hernández, J. Olalde

Safety and efficacy of Laserpuncture with MLS® laser – Mphi type – in spinal pain: additional clinical observations

The paper reports the results of a study which continues a previous clinical research about effectiveness and safety of laserpuncture with laser MLS® in patients with spinal pain. 41 outpatients with chronic spinal pain were enrolled and treated, twice a week, for 4-8 sessions. The points to treat were chosen following the rules of classical acupuncture. VAS/NRS before treatment was 7.5 ± 2, while at the end of treatment it was 3.4 ±1, and at 1 month follow-up remained at value 3.2±0. No side effect occurred. The PIGC score also showed good results on quality of life. The present data confirm our previous results about safety and efficacy of laserpuncture with MLS® laser.

Energy for Health [15] (2016)
T. Viliani

Application of MLS® therapy on a disc herniation with radiculopathy: a case study

In this case study, the M6-MLS® laser proved to be effective in decreasing the amount of pain associated with nerve root irritation caused by disc herniation. In addition to the analgesic effect, MLS® therapy may also have long term effects on this condition related to its ability to increase microcirculation and lymphatic drainage causing a decrease in chronic inflammation [7] and edema [8] associated with chronic symptoms of prior injuries. Furthermore, effects on cell energy metabolism leading to increased ATP production [9,10] and efficient ATP utilization [11], may aid in the body's natural ability to heal. Another advantage of the M6-MLS® laser is no side effects or heat generated during treatment, making it a more pleasant experience for the patient therefore increasing patient compliance.

M. Grennell
Energy for Health [14] (2015)

Low-level laser therapy (LLLT) for discogenic back pain

In summary, while MRI findings are able to depict the morphologic changes related to discogenic back pain, 905 nm gallium-arsenide infrared laser may contribute to healing and pain reduction in discogenic low back pain.

*Br J Sports Med 2011;**45**:e1 doi:10.1136/bjsm.2010.081554.56*
N Malliaropoulos[1,2], A Akritidou[2], I Tsifountoudis[3], K Tsitas[1]

Acute low back pain with radiculopathy: a double-blind, randomized, placebo-controlled study.

The aim of this study was to investigate the clinical effects of low-level laser therapy (LLLT) in patients with acute low back pain (LBP) with radiculopathy. The results of this study show better improvement in acute LBP treated with LLLT used as additional therapy.

Photomed Laser Surg. 2010 Aug;28(4):553-60. doi: 10.1089/pho.2009.2576.
Konstantinovic LM[1], Kanjuh ZM, Milovanovic AN, Cutovic MR, Djurovic AG, Savic VG, Dragin AS, Milovanovic ND.

Comparison of 3 physical therapy modalities for acute pain in lumbar disc herniation measured by clinical evaluation and magnetic resonance imaging.

This study showed that traction, ultrasound, and LPL therapies were all effective in the treatment of this group of patients with acute LDH. These results suggest that conservative measures such as traction, laser, and ultrasound treatments might have an important role in the treatment of acute LDH.

J Manipulative Physiol Ther. 2008 Mar;31(3):191-8. doi: 10.1016/j.jmpt.2008.02.001.
Unlu Z[1], Tasci S, Tarhan S, Pabuscu Y, Islak S.

In chronic low back pain, low level laser therapy combined with exercise is more beneficial than exercise alone in the long term: a randomised trial.

In chronic low back pain low level laser therapy combined with exercise is more beneficial than exercise alone in the long term.

Aust J Physiother. 2007;53(3):155-60.
Djavid GE[1], Mehrdad R, Ghasemi M, Hasan-Zadeh H, Sotoodeh-Manesh A, Pouryaghoub G.

The effect of laser irradiation for nucleus pulposus: an experimental study.

One of the mechanisms thought to be responsible for Percutaneous laser disc decompression's (PLDD) effectiveness is a decrease in the chemical factors through protein alteration in the intervertebral disc by laser irradiation.

Neurol Res. 2005 Apr;27(3):319-23.
Iwatsuki K[1], Yoshimine T, Sasaki M, Yasuda K, Akiyama C, Nakahira R.

Efficacy of low power laser therapy and exercise on pain and functions in chronic low back pain.

The aim of this study was to determine whether low power laser therapy (Gallium-Arsenide) is useful or not for the therapy of chronic low back pain (LBP). Low power laser therapy seemed to be an effective method in reducing pain and functional disability in the therapy of chronic LBP.

Lasers Surg Med. 2003;32(3):233-8.
Gur A[1], Karakoc M, Cevik R, Nas K, Sarac AJ, Karakoc M.

Tendinopathy

LLLT can be used alone or in combination with other treatment regimen to effectively treat tendinopathy both through relief of pain and improvement in mobility.

MLS® Laser Therapy in the treatment of patients affected by Tendinopathies

The results obtained in this study show that the treatment with a high power, dual wavelength NIR laser source is effective in inducing inhibition of pain referred by patients affected by tendinopathies.

Energy for Health [16] (2017)
L. Vignali, G. Caruso, S. Gervasi, F. Cialdai

The Efficacy of Low-Level Laser Therapy for Shoulder Tendinopathy: A Systematic Review and Meta-Analysis of Randomized Controlled Trials.

Haslerud S, Magnussen LH, Joensen J, Lopes-Martins RA, Bjordal JM.
Physiother Res Int. 2014 Dec 2. doi: 10.1002/pri.1606

Low-level laser therapy (LLLT) is proposed as a treatment for tendinopathies. This is the first systematic review focusing solely on LLLT treatment effects in shoulder tendinopathy.

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.

Low level laser treatment of tendinopathy: a systematic review with meta-analysis.

LLLT can potentially be effective in treating tendinopathy when recommended dosages are used. The 12 positive studies provide strong evidence that positive outcomes are associated with the use of current dosage recommendations for the treatment of tendinopathy.

Photomed Laser Surg. 2010 Feb;28(1):3-16. doi: 10.1089/pho.2008.2470.
Tumilty S[1], Munn J, McDonough S, Hurley DA, Basford JR, Baxter GD.

Comparing the effects of exercise program and low-level laser therapy with exercise program and polarized polychromatic non-coherent light (bioptron light) on the treatment of lateral elbow tendinopathy.

The results suggest that the combination of an exercise program with LLLT or polarized polychromatic non-coherent light is an adequate treatment for patients with LET. Further research to establish the relative and absolute effectiveness of such a treatment approach is needed.

Photomed Laser Surg. 2009 Jun;27(3):513-20. doi: 10.1089/pho.2008.2281.
Stasinopoulos D[1], Stasinopoulos I, Pantelis M, Stasinopoulou K.

Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic achilles tendinopathy.

Low-level laser therapy, with the parameters used in this study, accelerates clinical recovery from chronic Achilles tendinopathy when added to an EE regimen. For the LLLT group, the results at 4 weeks were similar to the placebo LLLT group results after 12 weeks.

Am J Sports Med. 2008 May;36(5):881-7. doi: 10.1177/0363546507312165. Epub 2008 Feb 13.
Stergioulas A[1], Stergioula M, Aarskog R, Lopes-Martins RA, Bjordal JM.

A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (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

BMC Musculoskelet Disord. 2008 May 29;9:75. doi: 10.1186/1471-2474-9-75.
Bjordal JM[1], Lopes-Martins RA, Joensen J, Couppe C, Ljunggren AE, Stergioulas A, Johnson MI.

A randomised, placebo controlled trial of low level laser therapy for activated Achilles tendinitis with microdialysis measurement of peritendinous prostaglandin E2 concentrations.

LLLT at a dose of 5.4 J per point can reduce inflammation and pain in activated Achilles tendinitis. LLLT may therefore have potential in the management of diseases with an inflammatory component.

Br J Sports Med. 2006 Jan;40(1):76-80; discussion 76-80.
Bjordal JM[1], Lopes-Martins RA, Iversen VV.

Low power laser therapy of shoulder tendonitis.

Scand J Rheumatol. 1989;18(6):427-31.
England S[1], Farrell AJ, Coppock JS, Struthers G, Bacon PA.

These results demonstrate the effectiveness of laser therapy in tendonitis of the shoulder.

Joint disorders (other)

Strong positive outcomes have been shown for the use of LLLT in the treatment of chronic disorders such as lateral and medial epicondylitis, plantar fasciitis, tendinopathy and various articular diseases. The treatment modality is effective in providing both immediate and long-term relief.

Assessment of the effectiveness of MLS laser therapy in the treatment of patients with knee osteoarthritis

A Dakowicz, A. Kuryliszyn-Moskal, M. Białowiezec, A. Gbur
Pol. J. Appl. Sci., 1 124-129, 2015

Knee osteoarthritis is the most frequent cause of pain. The article's main trust was to assess MLS laser therapy effectiveness in curing patients with gonarthrosis. The research was conducted on the group of 30 patients with bilateral gonarthrosis.

Clinical examinations included: visual analogue scale (VAS), estimating the scope of movability and the circumference of knee joints, the „Up & Go" test as well as the Laitinen questionnaire. After the treatment, it was determined that the pain intensity assessed according to the visual analogue scale (VAS) decreased, the scope of movability improved and the circumference of knee joints was reduced. Moreover, it was noted that the time for performing the „Up & Go" test was reduced. At the same time, it was proved that the implemented treatment improved the quality of patients' lives assessed according to the Laitinen questionnaire.

Effect of low-level laser therapy on muscle adaptation to knee extensor eccentric training.

Baroni BM1, Rodrigues R, Freire BB, Franke RD, Geremia JM, Vaz MA.
Eur J Appl Physiol. 2014 Nov 23.

Eccentric training has been popularized for physical conditioning and prevention/rehabilitation of musculoskeletal disorders, especially due to the expressive responses in terms of muscular strength gain. In view of evidence that low-level laser therapy (LLLT) is able to increase exercise performance and accelerate post-exercise recovery, the aim of this study was to verify the effect of LLLT on hypertrophy and strengthening of knee extensor muscles submitted to eccentric training.

LLLT applied before eccentric training sessions seems to improve the hypertrophic response and muscular strength gain in healthy subjects.

Musculoskeletal Atrophy in an Experimental Model of Knee Osteoarthritis: The Effects of Exercise Training and Low-Level Laser Therapy.

Assis L, Almeida T, Milares LP, Dos Passos N, Araújo B, Bublitz C, Veronez S, Renno AC.
Am J Phys Med Rehabil. 2014 Oct 8

The aim of this study was to evaluate the effects of an exercise training protocol and low-level laser therapy (and the association of both treatments) on musculoskeletal atrophy using an experimental model of knee osteoarthritis (OA).

These results suggest that exercise training and low-level laser therapy were effective in preventing musculoskeletal alterations related to atrophy caused by the degenerative process induced by knee OA.

Adjunctive use of combination of super-pulsed laser and light-emitting diodes phototherapy on nonspecific knee pain: double-blinded randomized placebo-controlled trial.

Leal-Junior EC, Johnson DS, Saltmarche A, Demchak T.
Lasers Med Sci. 2014 Nov;29(6):1839-47. doi: 10.1007/s10103-014-1592-6. Epub 2014 May 21.

Phototherapy with low-level laser therapy (LLLT) and light-emitting diode therapy (LEDT) has arisen as an interesting alternative to drugs in treatments of musculoskeletal disorders. However, there is a lack of studies investigating the effects of combined use of different wavelengths from different light sources like lasers and light-emitting diodes (LEDs) in skeletal muscle disorders.

Our results demonstrate that phototherapy significantly decreased pain ($p < 0.05$) from 10th treatment to follow-up assessments and significantly improved ($p < 0.05$) SF-36® physical component summary at posttreatments and follow-up assessments compared to placebo. We conclude that combination of super-pulsed laser, red and infrared LEDs is effective to decrease pain and improve quality of life in patients with knee pain.

Comparison of analgesic and anti-inflammatory effects of the classical low level laser therapy and multiwave locked system in inflammations of serous bursae

Introduction. Infrared thermography is a non-invasive physiological test that since 1990 was recognized as a diagnostic tool by the American Academy of Physical Medicine and Rehabilitation. The method is based on the identification and the quantification of coetaneous thermal asymmetry. Several studies were conducted in time, showing thermographic variations in some soft tissue conditions. **Objectives.** This study compares the anti-inflammatory and analgesic effect of classical laser therapy and multi-wave locked system (MLS) laser therapy by following the evolution of differences in temperature between the affected area and the unaffected controlateral area and the evolution of pain measured by visual analog scale (VAS). **Material and method.** I divided the patients in the study into two groups: a group of patients received classic laser therapy and a group of patients received MLS laser therapy. **Results.** In both group, the evolution of studied parameters (pain measured by visual analog scale and thermal gradient) demonstrate the efficiency of laser therapy in treating bursitis, yet the decrease of differences in temperature and of VAS score was steeper in the group under MLS therapy, the dissimilarity between the groups being relevant statistically. **Conclusions.** Laser therapy demonstrate both an analgesic (evidenced by the relieve pain) and anti-inflammatory effect (evidenced by reduction of the thermal gradient) for bursitis affecting superficial bursae and the difference between this two types of laser therapy are statistically significant (MLS therapy has a greater analgesic and anti-inflammatory effect compared with low level laser therapy).

Sports Medicine Journal / Medicina Sportiva; 9 (4):2234-2240 2013
Momanu A.v

The effectiveness of therapeutic class IV (10 W) laser treatment for epicondylitis.

These findings suggest that laser therapy using the 10 W class IV instrument is efficacious for the long-term relief of the symptoms associated with chronic epicondylitis. The potential for a rapidly administered, safe and effective treatment warrants further investigation.

Lasers Surg Med. 2013 Jul;45(5):311-7. doi: 10.1002/lsm.22140. Epub 2013 Jun 3.
Roberts DB[1], Kruse RJ, Stoll SF.

Low-level laser therapy in meniscal pathology: a double-blinded placebo-controlled trial.

Lasers Med Sci. 2013 Jul;28(4):1183-8. doi: 10.1007/s10103-012-1219-8. Epub 2012 Oct 24.
Malliaropoulos N[1], Kiritsi O, Tsitas K, Christodoulou D, Akritidou A, Del Buono A, Maffulli N.

Treatment with LLLT was associated with a significant decrease of symptoms compared to the placebo group: it should be considered in patients with meniscal tears who do not wish to undergo surgery.

Physical treatment of post traumatic gonalgia by NIR laser therapy: a case report

In this paper we present a case report that refers to a female patient, aged 54, who suffered from post-traumatic knee pain. The clinical case described was part of a clinical trial whose purpose was to investigate the therapeutic effects of NIR laser therapy on knee pain.

The laser source was a Multiwave Locked System (M6 device) provided by ASA s.r.l. (Arcugnano, Vicenza, Italy). The instrument consisted of two assembled laser diodes with synchronized emissions at 808 and 905 nm, respectively. The patient was treated 3 times weekly, for a total of 10 treatments. The patient's pain, both before and after each session, was measured by using VAS scale, in order to evaluate the effect of the laser therapy.

The data obtained show that, during the treatment, the patient had a progressive improvement in pain relief. At 60 days follow-up, it was observed that the effect of laser therapy persisted. The results we obtained in this study indicate that, with the chosen laser source (MLS) and treatment parameters, NIR laser therapy had beneficial effects on knee pain.

Energy for Health [9] (2012)
Caruso G., Gervasi S., Salvadori D.

Therapeutic effects of low-level laser on lateral epicondylitis from differential interventions of Chinese-Western medicine: systematic review.

We suggest that using LLLT on tender points or MTrPs of LE could effectively improve therapeutic effects.

Photomed Laser Surg. 2010 Jun;28(3):327-36. doi: 10.1089/pho.2009.2558.
Chang WD[1], Wu JH, Yang WJ, Jiang JA.

Low-power laser treatment in patients with frozen shoulder: preliminary results.

The results suggested that laser treatment was more effective in reducing pain and disability scores than placebo at the end of the treatment period, as well as at follow-up.

Photomed Laser Surg. 2008 Apr;26(2):99-105. doi: 10.1089/pho.2007.2138.
Stergioulas A.

Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis.

The results suggested that the combination of laser with plyometric exercises was more effective treatment than placebo laser with the same plyometric exercises at the end of the treatment as well as at the follow-up.

Photomed Laser Surg. 2007 Jun;25(3):205-13.
Stergioulas A.

Effects of 904-nm low-level laser therapy in the management of lateral epicondylitis: a randomized controlled trial.

This study revealed that LLLT in addition to exercise is effective in relieving pain, and in improving the grip strength and subjective rating of physical function of patients with lateral epicondylitis.

Photomed Laser Surg. 2007 Apr;25(2):65-71.
Lam LK[1], Cheing GL.

A systematic review of low level laser therapy with location-specific doses for pain from chronic joint disorders.

Low level laser therapy with the suggested dose range significantly reduces pain and improves health status in chronic joint disorders, but the heterogeneity in patient samples, treatment procedures and trial design calls for cautious interpretation of the results.

Aust J Physiother. 2003;49(2):107-16.
Bjordal JM[1], Couppé C, Chow RT, Tunér J, Ljunggren EA.

Treatment of medial and lateral epicondylitis--tennis and golfer's elbow--with low level laser therapy: a multicenter double blind, placebo-controlled clinical study on 324 patients.

The current clinical study provides further evidence of the efficacy of LLLT in the management of lateral and medial epicondylitis.

J Clin Laser Med Surg. 1998 Jun;16(3):145-51.
Simunovic Z[1], Trobonjaca T, Trobonjaca Z.

Low-level laser therapy in osteoarticular diseases in geriatric patients.

Low level laser therapy can be used to treat osteoarticular pain in geriatric patients. To optimize the results, the diagnostic picture must be correct and a treatment program defining the physical parameters used (wavelength, dose and irradiation technique) must also be designed.

Radiol Med. 1998 Apr;95(4):303-9.
Giavelli S[1], Fava G, Castronuovo G, Spinoglio L, Galanti A.

The effect of low-level Nd:YAG laser energy on adult articular cartilage in vitro.

These findings indicate that exposure to low-level noncontact Nd:YAG laser energy promotes a significant stimulation of cartilage matrix synthesis. However, a single exposure may not be sufficient to promote a sustained upregulation of cartilage metabolism.

Arthroscopy. 1992;8(1):36-43.
Spivak JM[1], Grande DA, Ben-Yishay A, Menche DS, Pitman MI.

Sports

Photobiomodulation therapy for the improvement of muscular performance and reduction of muscular fatigue associated with exercise in healthy people: a systematic review and meta-analysis.

Researches have been performed to investigate the effects of phototherapy on improving performance and reduction of muscular fatigue. However, a great variability in the light parameters and protocols of the trials are a concern to establish the efficacy of this therapy to be used in sports or clinic. The aim of this study is to investigate the effectiveness, moment of application of phototherapy within an exercise protocol, and which are the parameters optimally effective for the improvement of muscular performance and the reduction of muscular fatigue in healthy people.

Most of positive results were observed with an energy dose range from 20 to 60 J for small muscular groups and 60 to 300 J for large muscular groups and maximal power output of 200 mW per diode.

Lasers Med Sci. 2018 Jan;33(1):181-214. doi: 10.1007/s10103-017-2368-6. Epub 2017 Oct 31. Review.
Vanin AA, Verhagen E, Barboza SD, Costa LOP, Leal-Junior ECP.

Effects of Low-Level Laser Therapy Applied Before Treadmill Training on Recovery of Injured Skeletal Muscle in Wistar Rats.

OBJECTIVE: The aim of this study was to analyze the effects of low-level laser therapy (LLLT) when associated with treadmill training on the recovery of skeletal muscle, during two periods of rest after muscle injury in rats.

CONCLUSIONS: The LLLT applied before the physical exercise on the treadmill stimulated the angiogenesis and accelerated the process of muscle recovery.

Photomed Laser Surg. 2016 May;34(5):187-93. doi: 10.1089/pho.2015.4031. Epub 2016 Apr 8.
Adabbo M, Paolillo FR, Bossini PS, Rodrigues NC, Bagnato VS, Parizotto NA.

Five-day, low-level laser therapy for sports-related lower extremity periostitis in adult men: a randomized, controlled trial.

Periostitis in the lower leg caused by overexercise is a universal problem in athletes and runners. The purpose of this study was to observe the functional improvement of the lower limbs upon rehabilitation low-level laser therapy (LLLT). LLLT had a positive effect on proprioception in patients with lower limb periostitis. Larger, better controlled studies are needed to determine what specific effects LLLT has on the function of proprioception

Lasers Med Sci. 2014 Jul;29(4):1485-94. doi: 10.1007/s10103-014-1554-z. Epub 2014 Mar 13.
Chang CC[1], Ku CH, Hsu WC, Hu YA, Shyu JF, Chang ST.

830 nm light-emitting diode (led) phototherapy significantly reduced return-to-play in injured university athletes: a pilot study.

BACKGROUND AND AIMS: For any committed athlete, getting back to conditioning and participation post-injury (return to play [RTP]) needs to be as swift as possible. The effects of near-infrared light-emitting diode (LED) therapy on pain control, blood flow enhancement and relaxation of muscle

spasm (all aspects in the treatment of musculoskeletal injury) have attracted attention. The present pilot study was undertaken to assess the role of 830 nm LED phototherapy in safely accelerating RTP in injured university athletes.

SUBJECTS AND METHODS: Over a 15-month period, a total of 395 injuries including sprains, strains, ligament damage, tendonitis and contusions were treated with 1,669 sessions of 830 nm LED phototherapy (mean of 4.3 treatments per injury, range 2 - 6). Efficacy was measured with pain attenuation on a visual analog scale (VAS) and the RTP period compared with historically-based anticipated RTP with conventional therapeutic intervention.

RESULTS: A full set of treatment sessions and follow-up data was able to be recorded in 65 informed and consenting subjects who achieved pain relief on the VAS of up to 6 points in from 2-6 sessions. The average LED-mediated RTP in the 65 subjects was significantly shorter at 9.6 days, compared with the mean anticipated RTP of 19.23 days (p = 0.0066, paired two-tailed Student's t-test). A subjective satisfaction survey was carried out among the 112 students with injuries incurred from January to May, 2015. Eighty-eight (78.5%) were either very satisfied or satisfied, and only 8 (7.2%) were dissatisfied.

CONCLUSIONS: For any motivated athlete, RTP may be the most important factor postinjury based on the resolution of pain and inflammation and repair to tissue trauma. 830 nm LED phototherapy significantly and safely reduced the RTP in dedicated university athletes over a wide range of injuries with no adverse events. One limitation of the present study was the subjective nature of the assessments, and the lack of any control groups. However, further controlled studies are warranted to enable confirmation and generalization of the very good results in the present study.

Laser Ther. 2016 Mar 31;25(1):35-42. doi: 10.5978/islsm.16-OR-03.
Foley J, Vasily DB, Bradle J, Rudio C, Calderhead RG.

Immediate pain relief effect of low level laser therapy for sports injuries: Randomized, double-blind placebo clinical trial.

OBJECTIVES: To determine the immediate pain relief effect of low-level laser therapy on sports injuries in athletes and degree of pain relief by the therapy.

DESIGN: Double-blind, randomized, comparative clinical study.

METHODS: Participants were 32 college athletes with motion pain at a defined site. Participants were randomized into two groups in which the tested or placebo laser therapy was administered to determine pain intensity from painful action before and after laser irradiation, using the Modified Numerical Rating Scale. The post-therapeutic Modified Numerical Rating Scale score was subtracted from the pre-therapeutic Modified Numerical Rating Scale score to determine pain intensity difference, and the rate of pain intensity difference to pre-therapeutic Modified Numerical Rating Scale was calculated as pain relief rate.

RESULTS: Low-level laser therapy was effective in 75% of the laser group, whereas it was not effective in the placebo group, indicating a significant difference in favor of the laser group ($p<0.001$). Pain relief rate was significantly higher in the laser group than in the placebo group (36.94% vs. 8.20%, respectively, $p<0.001$), with the difference in pain relief rate being 28.74%.

CONCLUSIONS: Low-level laser therapy provided an immediate pain relief effect, reducing pain by 28.74%. It was effective for pain relief in 75% of participants.

J Sci Med Sport. 2016 Dec;19(12):980-983. doi: 10.1016/j.jsams.2016.03.006. Epub 2016 Mar 24.

Takenori A, Ikuhiro M, Shogo U, Hiroe K, Junji S, Yasutaka T, Hiroya K, Miki N.

Low level laser therapy for sports injuries.

Our hospital has used LLLT in the treatment of athletes since 1990. We had a good result about LLLT for sports injuries. However, few articles have attempted to evaluate the efficacy of LLLT for sports injuries. The aims of this study was to evaluate the efficacy of LLLT for sports injuries. RESULTS:

The rate of effectiveness (PRS of 5 or less) after LLLT was 65.9% (27/41 patients).

In this study, the resulting rate of effectiveness was 65.9% for all sports injuries. However, we have a high rate of effectiveness for Jumper's knee, tennis elbow and Achilles tendinitis and cases that were irradiated laser by a physician.

LLLT is an effective treatment for sports injuries, particularly jumper's knee, tennis elbow and Achilles tendinitis.

Laser Ther. 2013;22(1):17-20.
Morimoto Y[1], Saito A, Tokuhashi Y.

The effect of MLS Laser Therapy in élite football players affected by muscles injuries: a controlled clinical trial

Muscle injuries are frequent in élite football players, with a percentage of 30-40% of all injuries. The 22% of total injuries are muscular relapses. The focus of this study was to evaluate how the laser therapy could modify the recovery time in élite football player. The treatments have been performed with a Multiwave Locked System (MLS) laser. The sample group of football players was divided into two groups: the first group has been subjected to the standard rehabilitation program without MLS laser irradiation, the second group has been treated with the new rehabilitation program that included laser therapy.
We compared the average injury's duration in the two groups to establish the efficacy of the MLS laser treatment in accelerating rehabilitation. In spite of a positive trend observed in the laser-treated group, which showed a decrease of the recovery time on the basis of the lesions considered, the difference in comparison with the control group was not statistically significant, also due to the low number of patients considered.
Therefore, the results suggest that laser therapy could be useful to shorten the recovery time after muscle injury, but further studies with a larger number of cases are required to statistically demonstrate the efficacy of the MLS laser therapy.

Energy for Health [10] 2013
Galanti G., Stefani L., Iacchi A., Lonero L., Moretti A.

Effects of low-level laser therapy (808 nm) on isokinetic muscle performance of young women submitted to endurance training: a randomized controlled clinical trial.

Low-level laser therapy (LLLT) has shown efficacy in muscle bioenergetic activation and its effects could influence the mechanical performance of this tissue during physical exercise. This study tested whether endurance training associated with LLLT could increase human muscle performance in isokinetic dynamometry when compared to the same training without LLLT. The primary objective was to determine the fatigue index of the knee extensor muscles (FIext) and the secondary objective was to determine the total work of the knee extensor muscles (TWext).

The results suggest that an endurance training program combined with LLLT leads to a greater reduction in fatigue than an endurance training program without LLLT. This is relevant to everyone involved in sport and rehabilitation.

Vieira WH, Ferraresi C, Perez SE, Baldissera V, Parizotto NA.
Lasers Med Sci. 2012 Mar;27(2):497-504. doi: 10.1007/s10103-011-0984-0. Epub 2011 Aug 26.

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

The aim of this work was to evaluate the effects of low-level laser therapy (LLLT) on exercise performance, oxidative stress, and muscle status in humans. A randomized double-blind placebo-controlled crossover trial was performed with 22 untrained male volunteers. LLLT (810 nm, 200 mW, 30 J in each site, 30 s of irradiation in each site) using a multi-diode cluster (with five spots - 6 J from each spot) at 12 sites of each lower limb (six in quadriceps, four in hamstrings, and two in gastrocnemius) was performed 5 min before a standardized progressive-intensity running protocol on a motor-drive treadmill until exhaustion.

The use of LLLT before progressive-intensity running exercise increases exercise performance, decreases exercise-induced oxidative stress and muscle damage, suggesting that the modulation of the redox system by LLLT could be related to the delay in skeletal muscle fatigue observed after the use of LLLT.

De Marchi T, Leal Junior EC, Bortoli C, Tomazoni SS, Lopes-Martins RA, Salvador M.
Lasers Med Sci.2012 Jan;27(1):231-6. doi: 10.1007/s10103-011-0955-5. Epub 2011 Jul 8.

Application of MLS laser on muscular contracture caused by functional overload in a young athlete - case report

Myalgic fatigue (or muscular contracture caused by functional overload) is clinically detected as an unpleasant feeling of one or more muscles, that appears within 24 hours after exercise and disappears in 5-7 days.

Results: The athlete was available to work with the team after 3 days of treatment. We joined the athlete to the team according to subjective symptoms and to the clinical examination negative for pain and muscle contracture.

Discussion: The prognosis of a muscle contracture is 5-7 days as usually found in clinical experience. The athlete treated according to the new protocol was cured in just 3 days of therapies with no recurrence or new muscle injury. We should note that the injury occurred during the preseason, so the athlete was subjected to treatment twice a day rather than once, as often happens during the season. However, the result is very encouraging. Studies are in progress to confirm our findings increasing the number of cases and also evaluating the efficacy of MLS laser therapy on different the types of injury

G. Galanti, A. Moretti, L. Lo Nero
Energy For Health Vo 8 (2012)

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

STUDY DESIGN: Randomized crossover double-blinded placebo-controlled trial.

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

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

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

Leal Junior EC, Lopes-Martins RA, Frigo L, De Marchi T, Rossi RP, de Godoi V, Tomazoni SS, Silva DP, Basso M, Filho PL, de Valls Corsetti F, Iversen VV, Bjordal JM.
J Orthop Sports Phys Ther. 2010 Aug;40(8):524-32. doi: 10.2519/jospt.2010.3294.

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

BACKGROUND AND OBJECTIVES:

There are some indications that low-level laser therapy (LLLT) may delay the development of skeletal muscle fatigue during high-intensity exercise. There have also been claims that LED cluster probes may be effective for this application however there are differences between LED and laser sources like spot size, spectral width, power output, etc. In this study we wanted to test if light emitting diode therapy (LEDT) can alter muscle performance, fatigue development and biochemical markers for skeletal muscle recovery in an experimental model of biceps humeri muscle contractions.

CONCLUSION:

We conclude that this particular procedure and dose of LEDT immediately before exhaustive biceps humeri contractions, causes a slight delay in the development of skeletal muscle fatigue, decreases post-exercise blood lactate levels and inhibits the release of Creatine Kinase and C-Reative Protein.

Leal Junior EC, Lopes-Martins RA, Rossi RP, De Marchi T, Baroni BM, de Godoi V, Marcos RL, Ramos L, Bjordal JM. Lasers Surg Med. 2009 Oct;41(8):572-7. doi: 10.1002/lsm.20810.

Effect of 830 nm low-level laser therapy applied before high-intensity exercises on skeletal muscle recovery in athletes.

Our aim was to investigate the immediate effects of bilateral, 830 nm, low-level laser therapy (LLLT) on high-intensity exercise and biochemical markers of skeletal muscle recovery, in a randomised, double-blind, placebo-controlled, crossover trial set in a sports physiotherapy clinic. Twenty male athletes (nine professional volleyball players and eleven adolescent soccer players) participated. LLLT irradiation before the Wingate test seemed to inhibit an expected post-exercise increase in CK level and to accelerate post-exercise lactate removal without affecting test performance.

These findings suggest that LLLT may be of benefit in accelerating post-exercise recovery.

Leal Junior EC, Lopes-Martins RA, Baroni BM, De Marchi T, Taufer D, Manfro DS, Rech M, Danna V, Grosselli D, Generosi RA, Marcos RL, Ramos L, Bjordal JM.
Lasers Med Sci. 2009 Nov;24(6):857-63. doi: 10.1007/s10103-008-0633-4. Epub 2008 Dec 5

Effect of 830 nm low-level laser therapy in exercise-induced skeletal muscle fatigue in humans.

This study aimed to investigate the effect of 830 nm low-level laser therapy (LLLT) on skeletal muscle fatigue. Ten healthy male professional volleyball players entered a crossover randomized double-blinded placebo-controlled trial. Active LLLT (830 nm wavelength, 100 mW output, spot size 0.0028 cm(2), 200 s total irradiation time) or an identical placebo LLLT was delivered to four points on the biceps humeri muscle immediately before exercises. All subjects performed voluntary biceps humeri contractions with a load of 75% of the maximum voluntary contraction (MVC) force until exhaustion. After active LLLT the mean number of repetitions was significantly higher than after placebo irradiation [mean difference 4.5, standard deviation (SD) +/- 6.0, P = 0.042], the blood lactate levels increased after exercises, but there was no significant difference between the treatments.

We concluded that 830 nm LLLT can delay the onset of skeletal muscle fatigue in high-intensity exercises, in spite of increased blood lactate levels.

Leal Junior EC, Lopes-Martins RA, Vanin AA, Baroni BM, Grosselli D, De Marchi T, Iversen VV, Bjordal JM.
Lasers Med Sci. 2009 May;24(3):425-31. doi: 10.1007/s10103-008-0592-9. Epub 2008 Jul 23.

Low-level laser treatment can reduce edema in second degree ankle sprains.

OBJECTIVE: Low-level laser therapy (LLLT) has been used for the last few years to treat sports injuries. The purpose of this study was to compare three therapeutic protocols in treating edema in second degree ankle sprains that did not require immobilization with a splint, under placebo-controlled conditions.

CONCLUSIONS: LLLT combined with RICE can reduce edema in second-degree ankle sprains.

Stergioulas A.
*J Clin **Laser** Med Surg. 2004 Apr;22(2):125-8.*

Wound healing of animal and human body sport and traffic accident injuries using low-level laser therapy treatment: a randomized clinical study of seventy-four patients with control group.

In addition to accelerated wound healing, the main advantages of LLLT for postoperative sport- and traffic-related injuries include prevention of side effects of drugs, significantly accelerated functional recovery, earlier return to work, training and sport competition compared to the control group of patients, and cost benefit.

J Clin Laser Med Surg. 2000 Apr;18(2):67-73.
Simunovic Z[1], Ivankovich AD, Depolo A.

Nerve and sensory

LLLT has been used to reduce the incidence of post oral surgery paraesthesia. It has also be shown to provide a subjective and objective improvement in mechanical sensory perception where there is a long-standing neurosensory deficit.

Low-level laser effect in patients with neurosensory impairment of mandibular nerve after sagittal split ramus osteotomy. Randomized clinical trial, controlled by placebo.

Objective: Evaluate the effect on the application of low level laser therapy, in patients that have been previously intervened with a sagittal ramus split osteotomy and present neurosensory impairment due to this surgery, compared with placebo. Conclusion: Low-level laser therapy was beneficial for this group of patients on recovery of neurosensory impairment of mandibular nerve, compared to a placebo.

Med Oral Patol Oral Cir Bucal. 2014 Mar 8. [Epub ahead of print]
Führer-Valdivia A[1], Noguera-Pantoja A, Ramírez-Lobos V, Solé-Ventura P.

Phototherapy and nerve injury: focus on muscle response.

Preservation of biochemical processes in muscles is a major challenge in patients with severe peripheral nerve injury. This study showed that the laser phototherapy increases biochemical activity in intact muscle and thus could have direct therapeutic applications on muscle, especially during progressive atrophy resulting from peripheral nerve injury.

Int Rev Neurobiol. 2013;109:99-109. doi: 10.1016/B978-0-12-420045-6.00004-3.
Rochkind S[1], Geuna S, Shainberg A.

Assessment of functional recovery of sciatic nerve in rats submitted to low-level laser therapy with different fluences. An experimental study: laser in functional recovery in rats.

Peripheral nerve lesions caused sensory and motor deficits along the distribution of the injured nerve. Numerous researches have been carried out to enhance and/or accelerate the recovery of such lesions. It was possible to observe that the LLLT at fluency of 40 J/cm(2) and 80 J/cm(2) had a positive influence on the acceleration of the functional nerve recovery.

J Hand Microsurg. 2013 Dec;5(2):49-53. doi: 10.1007/s12593-013-0096-0. Epub 2013 Apr 25.
Marcolino AM[1], Barbosa RI[2], das Neves LM[2], Mazzer N[3], de Jesus Guirro RR[3], de Cássia Registro Fonseca M[3].

Lower-level laser therapy improves neurosensory disorders resulting from bilateral mandibular sagittal split osteotomy: A randomized crossover clinical trial.

Bilateral sagittal split osteotomy (BSSO) is a technique commonly used to correct mandibular disproportion but many patients experience hypoaesthesia of the inferior alveolar nerve (IAN). The purpose of this study was to verify the effectiveness of using a low-level laser therapy protocol after BSSO. On the treated side, recovery was faster and was almost complete at the time of the last evaluation. We suggest that this lower-level laser therapy protocol can improve tissue response and accelerate the recovery of neurosensory disorders following BSSO.

J Craniomaxillofac Surg. 2013 Sep 3. pii: S1010-5182(13)00204-7. doi: 10.1016/j.jcms.2013.07.009. [Epub ahead of print] Gasperini G[1], de Siqueira IC, Costa LR.

Low-level laser therapy in pediatric Bell's palsy: case report in a three-year-old child.

The objective of this study was to apply low-level laser therapy (LLLT) to accelerate the recovery process of a child patient with Bell's palsy (BP). The result of this study was the improvement of facial movement and facial symmetry, with complete reestablishment to normality. CONCLUSIONS: LLLT may be an alternative to speed up facial normality in pediatric BP.

J Altern Complement Med. 2013 Apr;19(4):376-82. doi: 10.1089/acm.2011.0531. Epub 2012 Nov 9.
Fontana CR[1], Bagnato VS.

Effect of low level laser therapy on neurovascular function of diabetic peripheral neuropathy

Low level laser therapy within the applied parameters and technique could be an effective therapeutic modality in reducing pain and improving neurovascular function in patients with diabetic polyneuropathy.

Journal of Advanced Research Volume 3, Issue 1, January 2012, Pages 21 -28
Abeer A. Yamanya, Hayam M. Sayedb

Role of low-level laser therapy in neurorehabilitation.

LLLT is steadily moving into mainstream medical practice. As the Western populations continue to age, the incidence of the degenerative diseases of old age will only continue to increase and produce an evermore severe financial and societal burden. Moreover, despite the best efforts of “big pharma,” distrust of pharmaceuticals is growing in general because of uncertain efficacy and troublesome adverse effects. LLLT has no reported adverse effects, and no reports of adverse events can be directly attributed to laser or light therapy. We believe that the high benefit: risk ratio of LLLT should be better appreciated by medical professionals in the rehabilitation and physical medicine specialties. The introduction of affordable LED devices powered by rechargeable batteries will lead to many home-use applications of LLLT. The concept of “wearable” light sources is not far off. Moreover, the particular benefits of LLLT to both the central and peripheral nervous systems suggest that much wider use of LLLT could or should be made in cases of both brain diseases and injuries.

PM R. 2010 Dec;2(12 Suppl 2):S292-305. doi: 10.1016/j.pmrj.2010.10.013.
Hashmi JT[1], Huang YY, Osmani BZ, Sharma SK, Naeser MA, Hamblin MR.

Comparative effects of wavelengths of low-power laser in regeneration of sciatic nerve in rats following crushing lesion.

Peripheral nerves are structures that, when damaged, can result in significant motor and sensory disabilities. Several studies have used therapeutic resources with the aim of promoting early nerve regeneration, such as the use of low-power laser. However, this laser therapy does not represent a consensus regarding the methodology, thus yielding controversial conclusions. One can observe that laser application at 660 nm with the parameters and methods utilised was effective in promoting early functional recovery, as indicated by the SFI, over the period evaluated.

Lasers Med Sci. 2010 May;25(3):423-30. doi: 10.1007/s10103-009-0750-8. Epub 2010 Feb 6.
Barbosa RI[1], Marcolino AM, de Jesus Guirro RR, Mazzer N, Barbieri CH, de Cássia Registro Fonseca M.

Laser phototherapy (780 nm), a new modality in treatment of long-term incomplete peripheral nerve injury: a randomized double-blind placebo-controlled study.

This pilot study suggests that in patients with long-term peripheral nerve injury noninvasive 780-nm laser phototherapy can progressively improve nerve function, which leads to significant functional recovery.

Photomed Laser Surg. 2007 Oct;25(5):436-42.
Rochkind S[1], Drory V, Alon M, Nissan M, Ouaknine GE.

Efficacy of 780-nm laser phototherapy on peripheral nerve regeneration after neurotube reconstruction procedure (double-blind randomized study).

The results of this study suggest that postoperative 780-nm laser phototherapy enhances the regenerative process of the peripheral nerve after reconnection of the nerve defect using a PGA neurotube.

Photomed Laser Surg. 2007 Jun;25(3):137-43.
Rochkind S[1], Leider-Trejo L, Nissan M, Shamir MH, Kharenko O, Alon M

Arthritis

LLLT has been shown to be effective in both osteoarthritis and rheumatoid arthritis in reducing pain and improving function.

Efficacy of class IV diode laser on pain and dysfunction in patients with knee osteoarthritis: a randomized placebo-control trial

Class IV diode laser combined with exercise was more effective than exercise alone in the treatment of patients with knee osteoarthritis. Multiwave locked system laser combined with exercise effectively decreased pain and WOMAC as compared with the placebo laser plus exercises group. Results: Reduction of pain was reported in the MLS laser therapy group, but not in the MF group. In both groups a decrease of swollen joints number (Ritchie Articular Index) was observed. Moreover, improvement of hand function, grip strength and quality of life (Health Assessment Questionnaire) were also observed, especially in MLS laser therapy group. Conclusion: MLS laser therapy appears to be more effective modality, than MF therapy in patients with RA with hand involvement.

Mohamed S Alayat Ph.D.P.T. , Mohamed M Ali
Bulletin of Faculty of Physical Therapy 2017, 22:40–45

The comparison of multi-waved locked system laser and low-frequency magnetic field therapy on hand function and quality of life in patients with rheumatoid arthritis - preliminary study

The progression of in!ammation in rheumatoid arthritis (RA) leads to destruction of synovial membrane, joint surface, loss of function and mobility. Comprehensive rehabilitation consists of exercises, modalities, orthoses and occupational therapy.

Annals of Physical and Rehabilitation Medicine 57:e191 · May 2014
Sylwia Chwieśko-Minarowska, Anna Kuryliszyn-Moskal, Marzena Pijanowska,

Monika Jabłońska

Efficiency of MLS therapy in abarticular rheumatism revealed by digital thermography and visual analog scale.

Conclusions: • MLS therapy leads to a faster reduction of pain symptoms. • In case of periarticular soft tissue diseases, the anti-inflammatory effect of MLS laser therapy may be confirmed through the reduction of temperature differences compared with the healthy contra lateral area. • The analgetic effect obtained with MLS therapy is long lasting.

A Momanu, A. Csapo
Energy For Heal Vol 8 (2011)

The effect of low-level laser in knee osteoarthritis: a double-blind, randomized, placebo-controlled trial.

Our results show that LLLT reduces pain in KOA and improves microcirculation in the irradiated area.

Photomed Laser Surg. 2009 Aug;27(4):577-84. doi: 10.1089/pho.2008.2297.
Hegedus B[1], Viharos L, Gervain M, Gálfi M.

Low level laser therapy (Classes I, II and III) for treating rheumatoid arthritis.

LLLT could be considered for short-term treatment for relief of pain and morning stiffness for RA patients, particularly since it has few side-effects.

Cochrane Database Syst Rev. 2005 Oct 19;(4):CD002049.
Brosseau L[1], Robinson V, Wells G, Debie R, Gam A, Harman K, Morin M, Shea B, Tugwell P.

Efficacy of different therapy regimes of low-power laser in painful osteoarthritis of the knee: a double-blind and randomized-controlled trial.

A prospective, double-blind, randomized, and controlled trial was conducted in patients with knee osteoarthritis (OA) to evaluate the efficacy of infrared low-power Gallium-Arsenide (Ga-As) laser therapy (LPLT) and compared two different laser therapy regimes. Our study demonstrated that applications of LPLT in different dose and duration have not affected results and both therapy regimes were a safe and effective method in treatment of knee OA.

Lasers Surg Med. 2003;33(5):330-8.
Gur A[1], Cosut A, Sarac AJ, Cevik R, Nas K, Uyar A.

The clinical efficacy of low-power laser therapy on pain and function in cervical osteoarthritis.

Ozdemir F[1], ***Birtane M***, ***Kokino S***.
Clin Rheumatol. 2001;20(3):181-4.

LPL seems to be successful in relieving pain and improving function in osteoarthritic diseases.

Improvement of pain and disability in elderly patients with degenerative osteoarthritis of the knee treated with narrow-band light therapy.

Stelian J[1], Gil I, Habot B, Rosenthal M, Abramovici I, Kutok N, Khahil A.

J Am Geriatr Soc. 1992 Jan;40(1):23-6.

Low-power light therapy is effective in relieving pain and disability in degenerative osteoarthritis of the knee.

Other

Comparative effectiveness of low-level laser therapy for adult androgenic alopecia: a system review and meta-analysis of randomized controlled trials.

The meta-analysis suggests that low treatment frequency by LLLT have a better hair growth effect than high treatment frequency. LLLT represents a potentially effective treatment for AGA in both male and female. The types of LLLT devices and LLLT treatment course duration did not affect the effectiveness in hair growth.

Lasers Med Sci. 2019 Jan 31. doi: 10.1007/s10103-019-02723-6. [Epub ahead of print]
Liu KH, Liu D, Chen YT, Chin SY.

In vivo and in vitro analysis of low level light therapy: a useful therapeutic approach for sensitive skin.

Our results suggest that LLLT could be a useful and safe treatment modality for sensitive skin, and modification of inflammatory cytokines released from irritated keratinocytes may be considered as one of plausible mechanisms in sensitive skin treated with LLLT.

Lasers Med Sci. 2013 Nov;28(6):1573-9. doi: 10.1007/s10103-013-1281-x. Epub 2013 Feb 10. Choi M1, Kim JE, Cho KH, Lee JH.

The influence of Multiwave Locked System (MLS) laser therapy on clinical features, microcirculatory abnormalities and selected modulators of angiogenesis in patients with Raynaud's phenomenon.

Clin Rheumatol. 2015 Mar;34(3):489-96. doi: 10.1007/s10067-014-2637-8. Epub 2014 May 13.
Kuryliszyn-Moskal A, Kita J, Dakowicz A, Chwieśko-Minarowska S, Moskal D, Kosztyła-Hojna B, Jabłońska E, Klimiuk PA.

The aim of this study was to investigate the influence of the Multiwave Locked System (MLS) laser therapy on clinical features, microvascular changes in nailfold videocapillaroscopy (NVC) and circulating modulators releasing as a consequence of vascular endothelium injury such as vascular endothelial growth factor (VEGF) and angiopoietin 2 (Ang-2) in patients with primary and secondary Raynaud's phenomenon. Seventy-eight RP patients and 30 healthy volunteers were recruited into the study. All patients with RP received MLS laser irradiation for 3 weeks. Clinical, NVC and laboratory investigations were performed before and after the MLS laser therapy. The serum concentration of VEGF and Ang-2 were determined by an enzyme-linked immunosorbent assay (ELISA). After 3 weeks of MLS laser therapy, the clinical improvement manifested by decreasing of the number of RP attacks, mean duration of Raynaud's attack and pain intensity in RP patients was observed. After MLS laser therapy in 65% of patients with primary and in 35% with secondary RP, an increase in the loop number and/or a reduction in avascular areas in NVC were observed. In comparison with a control group, higher serum concentration of VEGF and Ang-2 in RP patients was demonstrated. After MLS

laser therapy, a reduction of Ang-2 in both groups of RP patients was found. Our results suggest that NVC may reflect microvascular changes associated with clinical improvement after MLS laser therapy in patients with primary and secondary RP. Ang-2 serum levels may be a useful marker of microvascular abnormalities in RP patients treated with MLS laser therapy.

Effect of 635nm Low-level Laser Therapy on Upper Arm Circumference Reduction: A Double-blind, Randomized, Sham-controlled Trial.

Noninvasive low-level laser therapy is safe, painless, and effective in reducing upper arm circumference and is associated with a high degree of subject satisfaction.

J Clin Aesthet Dermatol. 2012 Feb;5(2):42-8. Nestor MS, Zarraga MB, Park H.

Low-level laser therapy for the treatment of epidermolysis bullosa: a case report.

J Cosmet Laser Ther. 2010 Aug;12(4):203-5. doi: 10.3109/14764172.2010.502460.
Minicucci EM1, Barraviera SR, Miot H, Almeida-Lopes L.

Epidermolysis bullosa (EB) is a rare group of diseases characterized by skin fragility. There is no specific treatment, short of protection from trauma, currently available for these patients. Low-level laser therapy (LLLT) was effective as an analgesic and in accelerating cutaneous wound healing after six sessions of therapy in a child with dystrophic EB with cutaneous scarring and blisters on the limbs and trunk.

Multiwavelength laser treatment of venous lakes.

Roncero M1, Cañueto J, Blanco S, Unamuno P, Boixeda P
Dermatol Surg. 2009 Dec;35(12):1942-6. doi: 10.1111/j.1524-4725.2009.01357.x.

Multiwavelentgh laser (595 nm; 1,064 nm) provides a safe, fast, and effective option in the treatment of VLs

Low level laser therapy in primary Raynaud's phenomenon - results of a placebo controlled, double blind intervention study.

Low level laser therapy reduces frequency and severity of Raynaud attacks. The effect is most pronounced in patients with signs of decreased threshold for vasospasm and less effective in patients with delayed hyperemia.

J Rheumatol. 2004 Dec;31(12):2408-12.
Hirschl M1, Katzenschlager R, Francesconi C, Kundi M.

Low-intensity laser irradiation improves skin circulation in patients with diabetic microangiopathy.

The data from this first randomized double-blind placebo-controlled clinical trial demonstrate an increase in skin microcirculation due to athermic laser irradiation in patients with diabetic microangiopathy.

Schindl A1, Schindl M, Schön H, Knobler R, Havelec L, Schindl L. Diabetes Care. 1998 Apr;21(4):580-4.

Treatment of Postherpetic Neuralgia With Low Level Laser Therapy

LLLT is a noninvasive, pain-free, light-based therapy that uses red and infrared light to resolve the inflammatory process and eliminate pain in patients with PHN. We present a number of PHN cases that have responded favorably to LLLT and review the mechanisms of action of the technology. All patients saw an improvement of at least 40%, which is comparable to the most successful pharmacological treatment, but without the harmful side effects.

Laser Therapy. 1988; 1: 7 Merrick RV, Saraga F.

MLS therapy research

Clinical case series: the effect of MLS® treatment on 30 patients with lumbosacral sciatic pain

L. Guzman, V. Mora Castillo, J. Olalde
Energy for Health [18] (2019)

Lumbosacral sciatic pain is a condition associated to spine degeneration which is affecting people daily life and activities. In fact, often pain is not only affecting the lumbar zone, but it is also irradiating down to the lower limb and can influence movement flexibility and general physical function.
Conservative treatment involves the use of anti-inflammatory drugs and different physical therapy approaches. Nevertheless, most severe cases need to be treated with surgical intervention.
This case collection reports on the use of MLS® therapy in 30 cases of lumbosacral sciatic pain, where the goal was not only the management of the pain, but also the improvement in physical function with the aim of reaching a better quality of life for the treated patient.
All the patients were treated with 12 sessions of MLS® therapy.
Patients improved not only in terms of pain management, but also in function and therefore in every day activity comfort, i.e. better sleep and better walk ability. In terms of pain, before the treatment start, average VAS was 8, while at the end of the treatment cycle, average VAS was 1. The treatment was effective in keeping pain controlled between consecutive sessions.
In conclusion, MLS® therapy resulted a useful approach for the treatment of lumbosacral sciatic pain.

Regression of cervical radiculopathy after laser therapy treatment - a case report.

Energy for Health [17] (2018)

E. Perez, J.A. Natera, LD. Guzmán Hernández, J. Olalde
At the end of the treatment, the patient was pain free and, remarkably, MRI conducted to evaluate the patient 2 months after the first radiographic assessment (Figure 2) revealed that spontaneous regression of the herniated disc had occurred, with 90% restitution of the spinal cord space. In the reported case, not only MLS® therapy provided an effective non-invasive approach to treat cervical pain, but the remarkable result observed in this case is the successful outcome on the spinal cord narrowing.

MLS® Laser Therapy in the treatment of patients affected by Tendinopathies

Energy for Health [16] (2017)
L. Vignali, G. Caruso, S. Gervasi, F. Cialdai

The results obtained in this study show that the treatment with a high power, dual wavelength NIR laser source is effective in inducing inhibition of pain referred by patients affected by tendinopathies.

Efficacy of class IV diode laser on pain and dysfunction in patients with knee osteoarthritis: a randomized placebo-control trial

Bulletin of Faculty of Physical Therapy 2017, 22:40–45
Mohamed S Alayat Ph.D.P.T. , Mohamed M Ali

Class IV diode laser combined with exercise was more effective than exercise alone in the treatment of patients with knee osteoarthritis. Multiwave locked system laser combined with exercise effectively decreased pain and WOMAC as compared with the placebo laser plus exercises group

A comparison of effects of therapy with the NIR laser diode and MLS® laser system

Energy for Health [15] (2016)
M. Kimlickova, Y. Efremova, E. Blaskova, V. Navratil, L. Navratil

The target of the present study was an assessment of therapeutic effects achieved applying laser therapy to treat three different musculoskeletal disorders: arthrosis, vertebrogenic algesic syndrome (VAS) and enthesopathy. Two different sources were compared: a single wavelength (830 nm), pulsed NIR laser (BLT2000) and a dual wavelength (808nm, continuous emission, and 905 nm, pulsed emission) NIR laser (Multiwave Locked System - MLS®). In the study presented here, we demonstrated important benefits due to laser therapy in rehabilitation care, particularly due to its analgesic effects. Technically different types of laser sources were tested (MLS® and BTL). The results demonstrated benefits from both types of laser, but there was a very significant difference in the number of applications needed. MLS® system induced significant therapeutic effects with only 4 sessions against 12 with BLT. This difference enhances the patient comfort and speeds up rehabilitation.

Safety and efficacy of Laserpuncture with MLS® laser – Mphi type – in spinal pain: additional clinical observations

Energy for Health [15] (2016)
T. Viliani

The paper reports the results of a study which continues a previous clinical research about effectiveness and safety of laserpuncture with laser MLS® in patients with spinal pain. 41 outpatients with chronic spinal pain were enrolled and treated, twice a week, for 4-8 sessions. The points to treat were chosen following the rules of classical acupuncture. VAS/NRS before treatment was 7.5 ± 2, while at the end of treatment it was 3.4 ±1, and at 1 month follow-up remained at value 3.2±0. No side

effect occurred. The PIGC score also showed good results on quality of life. The present data confirm our previous results about safety and efficacy of laserpuncture with MLS® laser.

Effectiveness of Multiwave Locked System Laser therapy in treatment of Carpal Tunnel Syndrome Patients

Kanuengnid Wongwanna, Nitsara Pattapong, Pensuda Iamlaoor, Pimolporn Jaion*
Naresuan University Journal Vol 24 No 1 (2559): January-April 2016

The effectiveness of Multiwave Locked System (MLS) laser therapy was evaluated in a total of 30 patients, aged more than 20 years old with mild to moderate carpal tunnel syndrome (CTS) with a single-blinded randomized controlled study.

The improvements were significantly more pronounced in the intervention group than control group ($p<0.05$) especially for VAS and Compound muscle action potential (CMAP) amplitude of the median nerve at 12 weeks follow-up. MLS laser therapy coupled with conventional rehabilitation treatments is an effective treatment option in mild to moderate degree CTS before proceeding to surgery. It can clinically improve especially for VAS and electrophysiological parameter with a carry-over effect up to 3 months.

Application of MLS® therapy on a disc herniation with radiculopathy: a case study

In this case study, the M6-MLS® laser proved to be effective in decreasing the amount of pain associated with nerve root irritation caused by disc herniation. In addition to the analgesic effect, MLS® therapy may also have long term effects on this condition related to its ability to increase microcirculation and lymphatic drainage causing a decrease in chronic inflammation [7] and edema [8] associated with chronic symptoms of prior injuries. Furthermore, effects on cell energy metabolism leading to increased ATP production [9,10] and efficient ATP utilization [11], may aid in the body's natural ability to heal. Another advantage of the M6-MLS® laser is no side effects or heat generated during treatment, making it a more pleasant experience for the patient therefore increasing patient compliance.

M. Grennell
Energy for Health [14] (2015)

The influence of Multiwave Locked System (MLS) laser therapy on clinical features, microcirculatory abnormalities and selected modulators of angiogenesis in patients with Raynaud's phenomenon.

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The aim of this study was to investigate the influence of the Multiwave Locked System (MLS) laser therapy on clinical features, microvascular changes in nailfold videocapillaroscopy (NVC) and circulating modulators releasing as a consequence of vascular endothelium injury such as vascular endothelial growth factor (VEGF) and angiopoietin 2 (Ang-2) in patients with primary and secondary Raynaud's phenomenon. Seventy-eight RP patients and 30 healthy volunteers were recruited into the

study. All patients with RP received MLS laser irradiation for 3 weeks. Clinical, NVC and laboratory investigations were performed before and after the MLS laser therapy. The serum concentration of VEGF and Ang-2 were determined by an enzyme-linked immunosorbent assay (ELISA). After 3 weeks of MLS laser therapy, the clinical improvement manifested by decreasing of the number of RP attacks, mean duration of Raynaud's attack and pain intensity in RP patients was observed. After MLS laser therapy in 65% of patients with primary and in 35% with secondary RP, an increase in the loop number and/or a reduction in avascular areas in NVC were observed. In comparison with a control group, higher serum concentration of VEGF and Ang-2 in RP patients was demonstrated. After MLS laser therapy, a reduction of Ang-2 in both groups of RP patients was found. Our results suggest that NVC may reflect microvascular changes associated with clinical improvement after MLS laser therapy in patients with primary and secondary RP. Ang-2 serum levels may be a useful marker of microvascular abnormalities in RP patients treated with MLS laser therapy.

Kuryliszyn-Moskal A, Kita J, Dakowicz A, Chwieśko-Minarowska S, Moskal D, Kosztyła-Hojna B, Jabłońska E, Klimiuk PA
Clin Rheumatol. 2015 Mar;34(3):489-96. doi: 10.1007/s10067-014-2637-8. Epub 2014 May 13.

Assessment of the effectiveness of MLS laser therapy in the treatment of patients with knee osteoarthritis

Knee osteoarthritis is the most frequent cause of pain. The article's main trust was to assess MLS laser therapy effectiveness in curing patients with gonarthrosis. The research was conducted on the group of 30 patients with bilateral gonarthrosis.

Clinical examinations included: visual analogue scale (VAS), estimating the scope of movability and the circumference of knee joints, the „Up & Go" test as well as the Laitinen questionnaire. After the treatment, it was determined that the pain intensity assessed according to the visual analogue scale (VAS) decreased, the scope of movability improved and the circumference of knee joints was reduced. Moreover, it was noted that the time for performing the „Up & Go" test was reduced. At the same time, it was proved that the implemented treatment improved the quality of patients' lives assessed according to the Laitinen questionnaire.

Pol. J. Appl. Sci., 1 124-129, 2015
A Dakowicz, A. Kuryliszyn-Moskal, M. Białowiezec, A. Gbur

The influence of Multiwave Locked System (MLS) laser therapy on clinical features, microcirculatory abnormalities and selected modulators of angiogenesis in patients with Raynaud's phenomenon

Kuryliszyn-Moskal A., Kita J., Dakowicz A., Chwieśko-Minarowska S., Moskal D., Kosztyła-Hojna B., Jabłońska E., Klimiuk P.A.
Clin Rheumatol; DOI 10.1007/s10067-014-2637-8 2014
The aim of this study was to investigate the influence of the Multiwave Locked System(MLS) laser therapy on clinical features, microvascular changes in nailfold videocapillaroscopy (NVC) and

circulating modulators releasing as a consequence of vascular endothelium injury such as vascular endothelial growth factor (VEGF) and angiopoietin 2 (Ang-2) in patients with primary and secondary Raynaud's phenomenon. Seventy-eight RP patients and 30 healthy volunteers were recruited into the study. All patients with RP received MLS laser irradiation for 3 weeks. Clinical, NVC and laboratory investigations were performed before and after the MLS laser therapy. The serum concentration of VEGF and Ang-2 were determined by an enzyme-linked immunosorbent assay (ELISA). After 3 weeks of MLS laser therapy, the clinical improvement manifested by decreasing of the number of RP attacks, mean duration of Raynaud's attack and pain intensity in RP patients was observed. After MLS laser therapy in 65 % of patients with primary and in 35% with secondary RP, an increase in the loop number and/or a reduction in avascular areas in NVC were observed. In comparison with a control group, higher serum concentration of VEGF and Ang-2 in RP patients was demonstrated. After MLS laser therapy, a reduction of Ang-2 in both groups of RP patients was found. Our results suggest that NVC may reflect microvascular changes associated with clinical improvement after MLS laser therapy in patients with primary and secondary RP. Ang-2 serumlevels may be a useful marker of microvascular abnormalities in RP patients treated with MLS laser therapy.

The effect of MLS Laser Therapy in élite football players affected by muscles injuries: a controlled clinical trial

Galanti G., Stefani L., Iacchi A., Lonero L., Moretti A.
Energy for Health [10] 2013

Muscle injuries are frequent in élite football players, with a percentage of 30-40% of all injuries. The 22% of total injuries are muscular relapses. The focus of this study was to evaluate how the laser therapy could modify the recovery time in élite football player. The treatments have been performed with a Multiwave Locked System (MLS) laser. The sample group of football players was divided into two groups: the first group has been subjected to the standard rehabilitation program without MLS laser irradiation, the second group has been treated with the new rehabilitation program that included laser therapy.

We compared the average injury's duration in the two groups to establish the efficacy of the MLS laser treatment in accelerating rehabilitation. In spite of a positive trend observed in the laser-treated group, which showed a decrease of the recovery time on the basis of the lesions considered, the difference in comparison with the control group was not statistically significant, also due to the low number of patients considered.

Therefore, the results suggest that laser therapy could be useful to shorten the recovery time after muscle injury, but further studies with a larger number of cases are required to statistically demonstrate the efficacy of the MLS laser therapy.

Comparison of analgesic and anti-inflammatory effects of the classical low level laser therapy and multiwave locked system in inflammations of serous bursae

Momanu A.
Sports Medicine Journal / Medicina Sportiva; 9 (4):2234-2240 2013

Introduction. Infrared thermography is a non-invasive physiological test that since 1990 was recognized as a diagnostic tool by the American Academy of Physical Medicine and Rehabilitation.

The method is based on the identification and the quantification of coetaneous thermal asymmetry. Several studies were conducted in time, showing thermographic variations in some soft tissue conditions. **Objectives.** This study compares the anti-inflammatory and analgesic effect of classical laser therapy and multi-wave locked system (MLS) laser therapy by following the evolution of differences in temperature between the affected area and the unaffected controlateral area and the evolution of pain measured by visual analog scale (VAS). **Material and method.** I divided the patients in the study into two groups: a group of patients received classic laser therapy and a group of patients received MLS laser therapy. **Results.** In both group, the evolution of studied parameters (pain measured by visual analog scale and thermal gradient) demonstrate the efficiency of laser therapy in treating bursitis, yet the decrease of differences in temperature and of VAS score was steeper in the group under MLS therapy, the dissimilarity between the groups being relevant statistically. **Conclusions.** Laser therapy demonstrate both an analgesic (evidenced by the relieve pain) and anti-inflammatory effect (evidenced by reduction of the thermal gradient) for bursitis affecting superficial bursae and the difference between this two types of laser therapy are statistically significant (MLS therapy has a greater analgesic and anti-inflammatory effect compared with low level laser therapy).

Physical treatment of post traumatic gonalgia by NIR laser therapy: a case report

Caruso G., Gervasi S., Salvadori D.
Energy for Health [9] (2012)

In this paper we present a case report that refers to a female patient, aged 54, who suffered from post-traumatic knee pain. The clinical case described was part of a clinical trial whose purpose was to investigate the therapeutic effects of NIR laser therapy on knee pain.

The laser source was a Multiwave Locked System (M6 device) provided by ASA s.r.l. (Arcugnano, Vicenza, Italy). The instrument consisted of two assembled laser diodes with synchronized emissions at 808 and 905 nm, respectively. The patient was treated 3 times weekly, for a total of 10 treatments. The patient's pain, both before and after each session, was measured by using VAS scale, in order to evaluate the effect of the laser therapy.

The data obtained show that, during the treatment, the patient had a progressive improvement in pain relief. At 60 days follow-up, it was observed that the effect of laser therapy persisted. The results we obtained in this study indicate that, with the chosen laser source (MLS) and treatment parameters, NIR laser therapy had beneficial effects on knee pain.

The role of physical factors in cells differentiation, tissue repair and regeneration.

Cialdai F., Monici M.
Tissue Regeneration – From Basic Biology to Clinical Application. Jamie Davies Ed., Intech - Open Access Publisher, ISBN 978-953-307-876-2. March, 2012

Physical factors may induce significant biological effects, therefore they can be applied in biomedical and biotechnological fields in order to drive and modulate biological processes. It is well known that both humoral and physical factors (in particular, but not limited to the mechanical ones) are necessary for maintaining tissue homeostasis. Both biochemical and physical factors can induce the cells to

reprogram their functions to adapt dynamically to the environmental conditions. It is evident, therefore, that the only way to approach functional tissue regeneration and repair is to supply combined humoral and physical stimuli in a dose- and time-dependent manner. For example, in vitro studies have shown that a biomimetic environment simulating pulsatile flow is an indispensable condition for the tissue engineering of functional trileaflet heart valves from human marrow stromal cells. Static controls show morphological alterations and weaker mechanical properties (Hoerstrup et al., 2002). Studies on the role of physical factors in tissue repair and regeneration cover a very broad field that extends from investigations aimed at deepening our understanding of the physiological mechanisms of tissue repair and regeneration to biotech advances in tissue engineering, such as development of biocompatible scaffolds, 3D cell culture systems and bioreactors, which in the future must integrate the delivery of biochemical factors with the provision of physical stimuli that are equally necessary. In this chapter, far from providing a comprehensive overview of this field of studies, we introduce some issues concerning the application of physical factors in biomedicine and biotechnology and report the results of our research on the application of various physical stimuli (gravitational and mechanical stresses, laser radiation, electromagnetic fields (EMF)) for modulating cell commitment and differentiation, cell adhesion/migration, production and assembly of extracellular matrix (ECM) components, with the final aim of understanding when and how physical stimuli can be useful for promoting tissue repair and formation of functional tissue constructs. We also briefly mention how, in past centuries, the role of physical factors in biological processes has been understood and physical stimuli have been applied for therapeutic purposes.

The affect of MLS therapy on nerve conduction parameters in developing diabetic sensory peripheral neuropathy

Rader A.
Energy for Health 09, 2012

The MLS laser is composed of an 808nm continuous emission laser and a 905nm pulsed emission laser that are synchronized. The purpose of this study was to determine the effect of the MLS laser on the injured tibial and peroneal nerves in diabetic sensory neuropathy. The sural nerve was chosen as an untreated control nerve. A controlled prospective study was performed on ten patients with documented type 2 diabetes and peripheral sensory neuropathy. Nerve conduction parameters were determined prior to therapy and reevaluated post therapy. The course of therapy was three weeks. F-wave chronodispersion (Fc) measurements at the completion of the study showed significant improvement with this therapy. Peroneal Fc went from 8.99ms to 6-19ms (p=.O15). Tibial Fc went from 10.30ms to 6-97ms (p=.OO1). The MLS laser therapy produced objective improvement in nerve function for persons with developing diabetic sensory neuropathy.

Comparative Evaluation of the Direct Analgesic Efficacy of Selected Physiotherapeutic Methods in Subjects with Knee Osteoarthritis. Preliminary Report

Kędzierski T., Stańczak K., Gworys K., Gasztych J., Sibiński M., Kujawa J.
Ortop Traumatol Rehabil.;14 (6):537-44 2012

Background. The goals of the study were to evaluate the efficacy of two physiotherapeutic

procedures: low energy laser therapy and low frequency transcutaneous electric nerve stimulation (TENS) and to compare these modalities with regard to their therapeutic effects in patients with knee osteoarthritis. **Material and methods.** Fifty subjects were enrolled into the study and divided into two groups of 25 subjects. Group A received 10 MLS laser therapy sessions with a synchronised laser beam at doses of 12 J per treated site. Group B received ten sessions of low frequency TENS. The procedures were carried out every day for two weeks (5 times a week). All patients completed a personal data questionnaire and underwent an examination of knee joint motion range and circumference. Subjective pain intensity was assessed using the VAS pain scale and the modified Laitinen questionnaire. **Results.** An analysis of the results of the treatment demonstrated statistically significant pain reduction in both groups. This improvement was significantly higher in the two-phase laser therapy group vs. the LF-TENS group. No statistically significant improvement was noted in either of the groups regarding the knee joint range of motion. **Conclusions.** 1. Synchronised laser beam (MLS) therapy and low-frequency TENS contribute to direct pain relief effects in subjects with knee osteoarthritis. 2. The study confirmed better analgesic effects of two-phase laser therapy vs. LF-TENS.

Influence of Various Laser Therapy Methods on Knee Joint Pain and Function in Patients with Knee Osteoarthritis

Gworys K., Gasztych J., Puzder A., Gworys P., Kujawa J.
Ortop Traumatol Rehabil.;14 (3): 269-77 2012
Background. The aim of the study was to estimate the influence of various laser therapy methods on knee joint pain and function in patients with knee osteoarthritis. **Material and methods.** 125 patients were randomly assigned to 4 groups: Group I received one-wave laser irradiation (wave length 810 nm, dose 8 J/point), Group II received two-wave MLS laser irradiation (power 1100 mW, frequency 2000 Hz, dose 12.4 J/point), Group III received a similar regimen of two-wave MLS laser irradiation, but at a dose of 6.6 J per point, Group IV was a placebo group where laser therapy procedures were simulated without actual irradiation. The effectiveness of the therapy was evaluated by means of Lequesne's scale, a modified Laitinen questionnaire and a visual analogue scale (VAS). Statistical analysis utilised non-parametric Wilcoxon's and Mann-Whitney's tests. Calculations were carried out with MedCalc v. 11.6.1.0. **Results.** Statistically significant improvements in knee joint function and pain relief were seen in all Groups (I, II and III). When Groups I, II and III were compared, the largest improvement was found in Group II (MLS laser, dose 12.4 J/point). The degrees of improvement in Groups I and III were similar. **Conclusions.** One-wave laser irradiation at a dose of 8 J per point and two-wave laser irradiation with doses of 12.4 J and 6.6 J per point significantly improved knee joint function and relieved knee pain in patients with osteoarthritis.

Application of MLS® laser on muscular contracture caused by functional overload in a young athlete - case report

Galanti G., Moretti A., Lo Nero L.
Energy for Health [9] 2012
Myalgic fatigue (or muscular contracture caused by functional overload) is clinically detected as an

unpleasant feeling of one or more muscles, that appears within 24 hours after exercise and disappears in 5-7 days. In athletes, often the muscular contracture is not due to pathological alterations of muscle metabolism, but rather to a condition of lack of training, as typically happens at the beginning of the training season or after a period of enforced rest due to trauma or injury. Laser therapy has long been widely used to treat muscle pain and contracture, and recently it has also been proposed to prevent injuries from overwork in athletes. The aim of this study was to evaluate the efficacy of an advanced IR laser system, the MLS laser, in combination with the other components of standard therapy for the treatment of muscular contracture. MLS system is a laser device with special characteristics: it is equipped with synchronized combination of continuous and pulsed emissions. The first one (that may emit also in pulsed mode) with λ=808 nm and maximum power of 1W, the other one with λ=905 nm and peak power of 25W. Here we report the case of a 16 years old athlete in good health state and with no previous muscle injury. The athlete reported a rectus femoris pain after a work of multiple running on 200 meters. After 3 days of MLS treatment, associated with mobilization of the muscle, stretching and eccentric contraction exercise, the athlete reported negative clinical examination for pain and muscle contracture and was available to work with the team. Studies are in progress to confirm our findings increasing the number of cases and also evaluating the efficacy of MLS laser therapy on different types of injury.

Efficiency of MLS® therapy in abarticular rheumatism revealed by digital thermography and visual analog scale

Momanu A., Csapo A.
Energy for Health [08] 2011
A lot of 22 patients with acute pathology soft-tissue injuries (shoulder periarthritis, tendinitis, epicondylitis, bursitis), which was divided into two groups. The first group (G1) received treatment with conventional electrotherapy (interferential or diadynamics current, ultrasound) and 100 mW laser. The second group (G2), received conventional therapy electrotherapy and MLS therapy. The aim of this study was to compare the anthalgic and anti-inflammatory effect of the MLS laser therapy and the mono-channel laser treatment in abarticular rheumatism, by digital thermography (outlining the local anti-inflammatory effect by the decrease in the cutaneous temperature), soft tissue echography (visualization of tissular modifications) and by clinical methods (the visual analogue pain scale). The decrease of VAS values to 5 or 10 days of treatment is more important for MLS therapy. It is also apparent decrease in the temperature difference between the affected and the healthy area. Conclusions: • MLS therapy leads to a faster reduction of pain symptoms. • In case of periarticular soft tissue diseases, the anti-inflammatory effect of MLS laser therapy may be confirmed through the reduction of temperature differences compared with the healthy contra lateral area. • The analgetic effect obtained with MLS therapy is long lasting.

Comparison of the effects of low energy laser and ultrasound in treatment of shoulder myofascial pain syndrome: a randomized single blinded clinical trial

Rayegani S.M., Bahrami M.H., Samadi B., Sedighpour L., Mokhtarirad M.R., Eliaspoor D.
47:391-90 2011

Background: Myofascial pain syndrome (MPS) is one of the most prevalent musculoskeletal diseases. MPS impaired quality of life in the patients. There is a lot of controversy about different treatment options which include medical treatments, physical therapy, injections, ultrasound and laser. The effects of laser in MPS are challenging. **Aim:** To assess the effects of laser and ultrasound in treatment of MPS. **Design:** Randomized single blinded clinical trial. **Setting:** Outpatient physical therapy clinic at university hospital. **Population:** Sixty three subjects (females: 46, males: 17), (age range: 17-55 year old) who had a diagnosis of definite MPS were entered in the study. **Methods:** We measured the pain intensity at rest, during activity and at night using Visual Analogue Scale (VAS) questionnaire. The patients also filled the Neck Disability Index (NDI) form and the pain threshold provoked by pressure was determined using algometric assessment. Then, the patients were categorized randomly in groups A, B and C (receiving laser therapy, ultrasound and sham laser therapy, respectively). Six weeks after the initial visit, they were visited again and filled the forms again. **Results:** Ultrasound was effective in VAS improvement during activity (46%), at rest (39%) and at night (35%). It also improved NDI scores (34%) and algometric assessment (37%). Laser was effective in VAS improving during activity (54%), at night (51%) and at rest (51%) and also improved NDI scores (73%). It was also found effective in algometric assessment improvement (105%). Laser resulted in more NDI score and algometric assessment improvements comparing to ultrasound ($p<0.05$). **Conclusion:** This study introduces laser as one of the preferred treatments of myofascial pain syndrome in shoulder.

Diabetic distal symmetric polyneuropathy: Effect of low-intensity laser therapy

Khamseh M. E., Kazemikho N., Aghili R., Forough B., Lajevardi M., Dabaghian F. H., Goushegir A., Malek M.
Lasers in Medical Science; 26 (6): 831-835 2011

Low-intensity laser therapy (LILT) has been considered as a treatment modality in diabetic distal symmetric polyneuropathy (DSP). The aim of this study is to determine the effectiveness of LILT on DSP. We examined 107 subjects with type 2 diabetes for detection of DSP using the Michigan Neuropathy Screening Instrument (MNSI). Seventeen subjects were eligible to be enrolled in the study. Nerve conduction studies (NCS) were performed in all eligible subjects as an objective method to confirm neuropathy. The participants received LILT three times a week for ten sessions. NCSs were reevaluated after completion of the treatment. The absolute changes in NCS parameters were considered to establish the effectiveness of the treatment. Baseline demographics were similar in all participants. The mean differences of NCV parameters were considered for comparison. At the end of the study, the subjects showed a significant increase in neural potential amplitudes ($p < 0.05$). This study clearly demonstrated a significant positive effect of LILT on improvement of nerve conduction velocity on diabetic distal symmetric polyneuropathy (DSP). This finding supports the therapeutic potential of LILT in DSP.

Clinical results in the treatment of ankle and knee distortion pathologies with MLS® therapy

Corti L., Rosa E., Norbiato V., Pedrini L.
Scientific Report MLS® - 2004

The aim of this study is to evaluate the effectiveness of MLS (Multiwave Locked System) Therapy on osteo-musculotendinous pathologies previously not considered, such as trauma to the knee and ankle. The knee is a complex joint, extremely exposed to trauma and degenerative lesions; while the ankle bears the body weight and is thus very vulnerable and subject to sprains. Of the 28 patients

included in this study, 11 had knee trauma, 18 had ankle trauma. A 10-day treatment with the M6 system (ASA, Arcugnano, Vicenza) was scheduled, making automatic execution of the therapy possible. The VAS scores before MLS Therapy, those before therapy but after palpation, and those right after treatment are compared through t-test. The results confirm the effectiveness of MLS Therapy in the remission of painful symptoms and in recovery of functionality in a short time, so as to allow, in many cases, for the suspension of therapy before completing the 10 sessions foreseen by protocol.

MLS® therapy treatment of acute shoulder pain in inflammatory processes of the rotator cuff

Smiderle C., Scapin M.
Scientific Report MLS® - 2004
Shoulder pain is a complex pathology due to pathological processes involving the glenohumeral joint, the acromioclavicular joint, the ligaments or the supporting tendons. In this paper we illustrate the efficacy of MLS (Multiwave Locked System) Therapy in the treatment of acute shoulder pain in inflammatory processes involving the rotator cuff. Twenty patients underwent monotherapy treatment with MLS Therapy using the MIX5 system (ASA, Arcugnano, Vicenza). After an initial clinical-anamnestic examination, subjective and objective evaluations of the pain symptomatology are made right before treatment, after 10 days of application and after 30 days. At the end of MLS Therapy treatment the data are compared with each other using t-test: the results relative to the VAS ($p<0.0001$) and to the SRQ and SSRS parameters show a statistically significant improvement and, as already demonstrated previously, confirm MLS Therapy as one of the best solutions for rapidly reducing pain symptoms in many muscle-tendon diseases, guaranteeing longlasting benefits from the results.

MLS® laser therapy treatment of shoulder pain: a controlled comparative study

Corti L.
Scientific Report MLS® - 2004
The term “periarthritis” is commonly used to describe a range of painful situations in the shoulder region, including the impingement syndrome, acute and chronic calcific tendonitis, subacromial bursitis and adhesive capsulitis. These are complex and multifactorial clinical scenarios, which cause pain and reduced mobility. These pathologies are most commonly found in classic cases where the limb is subjected to excessive strain, either during work or following intense physical activity. Periarthritis is a strain-related pathology that affects the extra rotary muscles of the upper limb (supraspinatus, infraspinatus, teres minor) or the synovial bursae (subacromial, subcoracoid and subscapular). In some athletes, the shoulder is put through considerable strain and may be subject to repeated micro traumas. In the long term, these may determine a painful syndrome that is often the cause of a suspension of sports or work activity. The pain is frequently localized on the anterior/lateral face of the shoulder, tending to spread along the front face of the arm. Following the application of pressure, a strong pain in correspondence to the bicipital groove may arise. The painful symptoms

also worsen when the joint is moved. In order to understand how the different clinical scenarios develop, we need to bear in mind some important anatomical/functional aspects.

MLS® therapy treatment of various osteo/muscolar/tendinous pathologies

Tasca A.
Scientific Report MLS® - 2004
Some osteo/muscular/tendinous pathologies are a source of considerable social costs due to their incidence amongst the population and their debilitating symptoms. The extent of the phenomenon and its consequent economic impact increase with the prevalence of the pathology, especially in the workplace. In order to provide a clear picture of the extent of the problem, we have provided some information regarding the incidence of some of the pathologies covered by this study.