

## Effects of low-level laser therapy (LLLT) on bone repair in rats: optical densitometry analysis.

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### ABSTRACT

The aim of this study was to evaluate the process of bone repair in rats submitted to low-level laser therapy using optical densitometry. A total of 45 rats which underwent femoral osteotomy were randomly distributed into three groups: control (group I) and laser-treated groups using wavelengths in the red ( $\lambda$ , 660-690 nm) and in the infrared ( $\lambda$ , 790-830 nm) spectra (group II and group III, respectively). The animals (five per group) were killed after 7, 14, and 21 days and the femurs were removed for optical densitometry analysis. Optical density showed a significant increase in the degree of mineralization (gray level) in both groups treated with the laser after 7 days. After 14 days, only the group treated with laser therapy in the infrared spectrum showed higher bone density. No differences were observed between groups after 21 days. Such results suggest the positive effect of low-level laser therapy in bone repair is time- and wavelength-dependent. In addition, our results have confirmed that optical densitometry technique can measure bone mineralization status.

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## Effect of Low-level laser therapy and autogenous bone graft on bone regeneration in the treatment of two wall and three wall intrabony periodontal defects: a clinical study

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### ABSTRACT

**Background:** Intrabony lesions caused by periodontal disease are of particular importance in terms of treatment. Such lesions have been treated with different methods including the use of autogenous bone harvested or allogeneic grafts, guided tissue regeneration (GTR) and enamel matrix proteins use (EMP) or a combination of these methods. Recently, the use of low power laser or Low-level lasertherapy (LLLT) as one of the new methods to improve bone repair has been of great interest. The purpose of this study was to compare the use of autogenous bone alone and in combination with Low-level laser therapy (LLLT) in the treatment of two and three wall periodontal intrabony defects in vivo.

**Material and Methods:** A number of 14 patients with moderate to severe chronic periodontitis were with bilateral intrabony defect( probing pocket depth of at least 5 mm and intrabony component of at least 3 mm) were included. In a split mouth study, 14 defects were treated in one side by OFD and autogenous bone while in the contralateral side Low-level laser therapy was done as an adjunct treatment to the OFD and autogenous bone grafting. A GaAlAs diode laser (830 nm) (continuous wave 40 Mw and fluence 4 J/cm<sup>2</sup> with total energy density of 16 J/cm<sup>2</sup>) was used. Laser therapy was repeated at days 3, 5 and 7 with the same parameters. Re-entry surgeries were done after 3 months. Clinical probing pocket depth, clinical attachment level, gingival margin level, alveolar crest level and the deepest part of the defect all were recorded relative to an acrylic stent at baseline and after 3 months. intrabony defect depth was also recorded at baseline and after 3 months.

**Results:** Application of a low level laser with the parameters listed reduced probing depth ( $3.78 \pm 0.72$  mm vs.  $2.39 \pm 1.02$  mm), improved the clinical attachment level ( $3.42 \pm 0.93$  mm vs.  $2.25 \pm 1.12$  mm), reduced the distance between deepest part of the defect to stent ( $3.21 \pm 1.03$  mm vs.  $1.44 \pm 0.20$  mm) and also reduced defect depth ( $1.33 \pm 0.18$  mm versus  $2.50 \pm 0.91$  mm ) significantly when compared to control group, while it had no significant effect on gingival margin level and alveolar crest level.

**Conclusion:** The results of this study suggest the use of low level laser therapy in combination with autogenous bone can improve the periodontal treatment outcome in terms of probing depth reduction, clinical attachment level improvement and reduction of the defect depth.

## Effect of Low-Level Laser Therapy on Incorporation of Block Allografts

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### Abstract

**Objective:** To assess the effect of low-level laser therapy (LLLT) on the incorporation of deep-frozen block allografts in a rabbit model.

**Background Data:** Studies have shown that LLLT has beneficial effects on tissue repair and new bone formation.

**Methods:** Bone tissue was harvested from two rabbits, processed by deep-freezing and grafted into the calvaria of 12 animals, which were then randomly allocated into two groups: experimental (L) and control (C). Rabbits in group L were irradiated with an aluminum gallium arsenide diode laser (AlGaAs; wavelength 830 nm, 4 J/cm<sup>2</sup>), applied to four sites on the calvaria, for a total dose of 16 J/cm<sup>2</sup> per session. The total treatment dose after eight sessions was 128 J/cm<sup>2</sup>. Animals were euthanized at 35 (n = 6) or 70 days (n = 6) postoperatively.

**Results:** Deep-freeze-processed block allografts followed by LLLT showed incorporation at the graft-host interface, moderate bone remodeling, partial filling of osteocyte lacunae, less inflammatory infiltrate in the early postoperative period, and higher collagen deposition than the control group.

**Conclusion:** Optical microscopy and scanning electron microscopy showed that allograft bone processed by deep-freezing plus LLLT is suitable as an alternative for the treatment of bone defects. Use of the deep-freezing method for processing of bone grafts preserves the structural and osteoconductive characteristics of bone tissue.

## Effect of low-level laser on guided tissue regeneration performed with equine bone and membrane in the treatment of intrabony defects: a clinical study

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### Abstract

**Abstract Objective:** The purpose of the present study was to evaluate the clinical results of guided tissue regeneration (GTR) after the application of equine bone and membrane alone or combined with low-level laser therapy (LLLT) for the treatment of periodontal defects.

**Materials and methods:** This study was an intra-individual longitudinal study of 6 months' duration conducted using a split-mouth and randomized design. In 13 periodontitis patients with bilateral intrabony periodontal defects, while one defect site was treated with GTR plus LLLT (1064nm, 100mW, with energy density of 4J/cm<sup>2</sup>), the contralateral defect site was treated with guided GTR alone. GTR was performed with a combination of equine bone and membrane. LLLT was used both intra- and postoperatively. Clinical probing depth (PPD), clinical attachment level (CAL), clinical gingival recession level (REC), plaque index (PI) score, and sulcus bleeding index (SBI) score were recorded at the time of surgery, and at the 3rd and 6th months after operation.

**Results:** The treatment of periodontal intrabony defects with equine bone and membrane in the operation of GTR alone or GTR plus LLLT in combination led to statistically significant PPD reduction, CAL gain, and lower SBI score at the end of the study (p<0.05). In addition, between the two groups, GTR plus LLLT resulted in statistically significant lower REC (p=0.025), lower SBI (p=0.008) score, more reduction of PPD (p=0.009) and CAL gain (p=0.002) compared with GTR alone at 6th month control.

**Conclusions:** This study showed that GTR is an effective treatment for periodontal regeneration, and that LLLT may improve the effects of GTR in the treatment of periodontal defects.

## Adjunctive use of diode lasers in the treatment of peri-implantitis: A case series

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### Abstract

Peri-implantitis is defined as an inflammatory process which affects the tissues around an osseointegrated implant in function, resulting in bleeding, suppuration, increased probing depth, mobility and radiographic bone loss. This case report is on two cases of peri-implantitis and their treatment by using lasers. The aim of the article is to describe the added clinical benefits of laser as an adjunct in the treatment of peri-implantitis. This case series showed that the irradiation with a diode soft laser had positive biostimulating effects, which might be used in treatment of peri-implantitis and osseointegration of dental implants.

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## Effect of laser therapy on attachment, proliferation and differentiation of human osteoblast-like cells cultured on titanium implant material

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### Abstract

The aim of this in vitro study was to investigate the effect of low-level laser therapy (LLLT) on the attachment, proliferation, differentiation and production of transforming growth factor- $\beta_1$  (TGF- $\beta_1$ ) by human osteoblast-like cells (HOB). Cells derived from human mandibular bone were exposed to GaAlAs diode laser at dosages of 1.5 or 3 J/cm<sup>2</sup> and then seeded onto titanium discs. Nonirradiated cultures served as controls. After 1, 3 and 24 h, cells were stained and the attached cells were counted under a light microscope. In order to investigate the effect of LLLT on cell proliferation after 48, 72 and 96 h, cells were cultured on titanium specimens for 24 h and then exposed to laser irradiation for three consecutive days. Specific alkaline phosphatase activity and the ability of the cells to synthesize osteocalcin after 10 days were investigated using p-nitrophenylphosphate as a substrate and the ELSA-OST-NAT immunoradiometric kit, respectively. Cellular production of TGF- $\beta_1$  was measured by an enzyme-linked immunosorbent assay (ELISA), using commercially available kits. LLLT significantly enhanced cellular attachment (Po0:05). Greater cell proliferation in the irradiated groups was observed first after 96 h. Osteocalcin synthesis and TGF- $\beta_1$  production were significantly greater (Po0:05) on the samples exposed to 3 J/cm<sup>2</sup>. However, alkaline phosphatase activity did not differ significantly among the three groups. These results showed that in response to LLLT, HOB cultured on titanium implant material had a tendency towards increased cellular attachment, proliferation, differentiation and production of TGF- $\beta_1$ , indicating that in vitro LLLT can modulate the activity of cells and tissues surrounding implant material.

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## Low-level laser therapy stimulates bone–implant interaction: an experimental study in rabbits

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### Abstract

The aim of the present study was to investigate the effect of low-level laser therapy (LLLT) with a gallium-aluminium-arsenide (GaAlAs) diode laser device on titanium implant healing and attachment in bone. This study was performed as an animal trial of 8 weeks duration with a blinded, placebo-controlled design. Two coin-shaped titanium implants with a diameter of 6.25mm and a height of 1.95mm were implanted into cortical bone in each proximal tibia of twelve New Zealand white female rabbits (n¼48). The animals were randomly divided into irradiated and control groups. The LLLT was used immediately after surgery and carried out daily for 10 consecutive days. The animals were killed after 8 weeks of healing. The mechanical strength of the attachment between the bone and 44 titanium implants was evaluated using a tensile pullout test. Histomorphometrical analysis of the four implants left in place from four rabbits was then performed. Energy-dispersive X-ray microanalysis was applied for analyses of calcium and phosphorus on the implant test surface after the tensile test. The mean tensile forces, measured in Newton, of the irradiated implants and controls were 14.35 (SD74.98) and 10.27 (SD74.38), respectively, suggesting a gain in functional attachment at 8 weeks following LLLT (P¼0.013). The histomorphometrical evaluation suggested that the irradiated group had more bone-to-implant contact than the controls. The weight percentages of calcium and phosphorus were significantly higher in the irradiated group when compared to the controls (P¼0.037) and (P¼0.034), respectively, suggesting that bone maturation processed faster in irradiated bone. These findings suggest that LLLT might have a favourable effect on healing and attachment of titanium implants.

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## USE OF LOW-INTENSITY LASER IRRADIATION IN IMPLANT DENTISTRY

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### ABSTRACT

The stability of dental implants is of great significance for successful osseointegration. The long-term retention of implants, however, depends on how strongly the epithelial and connective tissues adhere to its titanium surface, that is, on how efficiently the soft tissues seal the bone protecting it from the oral bacterial flora. The aim of the present study was to develop a technique that uses low-intensity laser irradiation to stimulate the growth of healthy peri-implant mucosa. The study yielded very good results.

# Periodontitis, gum inflammation

General Dentistry September • October 2012

## Five-year retrospective study of laser-assisted periodontal therapy

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The use of dental lasers for the treatment of periodontal disease is accepted in some areas of dentistry, while in others it is thought to be antidotal therapy.<sup>1</sup> This article seeks to show that laser-assisted periodontal therapy is a viable, noninvasive method for treating periodontal disease. Periodontal disease is a chronic inflammatory disease caused by a bacterial infection. For this reason, the bactericidal and detoxifying effects of laser treatment are advantageous in periodontal therapy.<sup>2</sup> The effectiveness of this therapy involves suppressing certain bacteria such as *Aggregatibacter actinomycetemcomitans*, an invasive bacterium associated with aggressive forms of periodontal disease that cannot be treated readily with conventional scaling and root planing (SRP). This bacterium is present on diseased root surfaces; as a result, it can invade the adjacent soft tissues as well, making removal by mechanical instrumentation difficult.<sup>3</sup> It is impossible to achieve success with traditional periodontal methods of treatment due to the great difficulty in terms of completely removing bacterial deposits and their endotoxins from deep areas of periodontal pockets.<sup>4</sup> In addition, antibiotics that are used to prevent bacterial colonization after periodontal treatment help to increase the resistance of the microorganism.<sup>5</sup> According to the literature, using diode lasers in conjunction with SRP accelerates and enhances wound healing, making it more comfortable, while decreasing gingival bleeding, inflammation, and pocket depths.<sup>6</sup> A 2002 position paper from the American Academy of Periodontology stated that gingival curettage consistently fails to provide any advantage in treating chronic periodontitis compared to SRP alone.<sup>7</sup> The current article challenges this assertion by describing a five-year retrospective study that shows how laser technology made a consistent difference in the health of chronic periodontal patients. It is the authors' opinion that the biofilm attaches to the inner lining of the epithelium and bony walls exposed to the bacteria. That biofilm will continue to destroy sulcular and junctional epithelium if it is not eliminated.

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## The Effect of Low-Level Laser Therapy as an Adjunct to Non-Surgical Periodontal Treatment

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**Background:** The aim of this study is to evaluate the effect of low-level laser therapy (LLLT) as an adjunct to non-surgical periodontal therapy of smoking and non-smoking patients with moderate to advanced chronic periodontitis.

**Methods:** All 36 systemically healthy patients who were included in the study initially received non-surgical periodontal therapy. The LLLT group (n = 18) received GaAlAs diode laser therapy as an adjunct to non-surgical periodontal therapy. A diode laser with a wavelength of 808 nm was used for the LLLT. Energy density of 4 J/cm<sup>2</sup> was applied to the gingival surface after periodontal treatment on the first, second, and seventh days. Each of the LLLT and control groups was divided into two groups as smoking and non-smoking patients to investigate the effect of smoking on treatment. Gingival crevicular fluid samples were collected from all patients and clinical parameters were recorded on baseline, the first, third, and sixth months after treatment. Matrix metalloproteinase-1, tissue inhibitor matrix metalloproteinase-1, transforming growth factor-b1, and basic-fibroblast growth factor levels in the collected gingival crevicular fluid were measured.

**Results:** The primary outcome variable in this study was change in gingival bleeding and inflammation. At all time points, the LLLT group showed significantly more improvement in sulcus bleeding index (SBI), clinical attachment level, and probing depth (PD) levels compared to the control group (P < 0.001). There were clinically significant improvements in the laser-applied smokers' PD and SBI levels compared to smokers to whom a laser was not applied, between the baseline and all time points (P < 0.001) (SBI score: control group 1.12, LLLT group 1.49; PD: control group 1.21 mm, LLLT group 1.46 mm, between baseline and 6 months). Transforming growth factor-b1 levels and the ratio of matrix metalloproteinase-1 to tissue inhibitor matrix metalloproteinase-1 decreased significantly in both groups at 1, 3, and 6 months after periodontal therapy (P < 0.001). Basic-fibroblast growth factor levels significantly decreased in both groups in the first month after the treatment, then increased in the third and sixth months (P < 0.005). No marker level change showed significant differences between the groups (P < 0.05).

**Conclusion:** LLLT as an adjunctive therapy to non-surgical periodontal treatment improves periodontal healing.

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## Low-Level Lasers as an Adjunct in Periodontal Therapy in Patients with Diabetes Mellitus

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### Abstract

**Background:** Diabetes mellitus (DM) increases the risk of periodontitis, and severe periodontitis often coexists with severe DM. The proposed dual pathway of tissue destruction suggests that control of chronic periodontal infection and gingival inflammation is essential for achieving long-term control of DM. The purpose this study is to evaluate the effects of low-level laser therapy (LLLT) by exfoliative cytology in patients with DM and gingival inflammation.

**Subjects and Methods:** Three hundred patients were divided in three equal groups: Group 1 consisted of patients with periodontitis and type 1 DM, Group 2 of patients with periodontitis and type 2 DM, and Group 3 of patients with periodontitis (control group). After oral examination, smears were taken from gingival tissue, and afterward all of the patients received oral hygiene instructions, removal of dental plaque, and full-mouth scaling and root planing. A split-mouth design was applied; on the right side of jaws GaAIIAs LLLT (670 nm, 5mW, 14 min/day) (model Mils 94; Optica Laser, Sofia, Bulgaria) was applied for five consecutive days. After the therapy was completed, smears from both sides of jaws were taken. The morphometric analysis was done using the National Institutes of Health Image software program and a model NU2 microscope (Carl Zeiss, Jena, Germany).

**Results:** Investigated parameters were significantly lower after therapy compared with values before therapy. After therapy on the side subjected to LLLT, there was no significantly difference between patients with DM and the control group.

**Conclusions:** It can be concluded that LLLT as an adjunct in periodontal therapy reduces gingival inflammation in patients with DM and periodontitis.

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## Effect of low power diode laser 810 nm on TGF- $\beta$ 1 level in GCF in aggressive periodontitis

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### Abstract

**Objective:** To evaluate the effect of low power diode laser (LPDL) 810 nm as an adjunct to nonsurgical treatment of mild to moderate aggressive periodontitis (AgP). Background: AgP is a rapidly progressive severe form of periodontitis; conventional treatment depends on the concept of plaque control and bacterial eradication. Scaling and root planning (SRP) is the basic periodontal treatment, has its limitations, so new treatment modalities are needed.

**Materials and Methods:** The use of low power laser was suggested as an adjunct to periodontal treatment, as it was proven earlier to have a positive biomodulatory effect on biological tissues if suitable parameters were used for the condition in hand. A split-mouth design clinical trial was performed. The laser group received both SRP plus laser, and the control group only received SRP. The clinical evaluation included periodontal pocket depth (PPD), clinical attachment loss (CAL), plaque index (PI), modified gingival index (MGI), and gingival recession (GR), were taken at baseline and at 3 months. Transforming growth factor beta 1 (TGF- $\beta$ 1) was screened by sampling gingival crevicular fluid (GCF) at baseline and at 1, 2, 3, and 4 weeks after treatment.

**Results:** Showed a significant decrease of PPD and CAL in favor of laser group. PI, MGI, and GR showed no significant difference between both groups. TGF- $\beta$ 1 mean percentage showed a significant steady decrease in the laser group.

**Conclusion:** Low power laser parameters in this clinical trial can be used as an adjunct to SRP in treatment of mild to moderate AgP.

## Clinical Study of the Gingiva Healing after Gingivectomy and Low-Level Laser Therapy

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### ABSTRACT

**Objective:** The purpose of this study was to investigate gingival healing after gingivectomy and adjunctive use of low-level laser therapy (LLLT).

**Background Data:** LLLT has been used in animal experiments to examine the influence of laser radiation on the wound healing process since the 1960s. However, clinical trials in dentistry are scarce, and most of them refer to treatment after extraction of the third molars, with only a few reports in the area of periodontics.

**Methods:** Twenty patients with periodontal disease were selected, and treatment was planned for gingivectomy to bilateral maxillary and mandibular premolar teeth. After surgery, one side was submitted to LLLT using a 685-nm wavelength, output power of 50 mW, and energy density of 4 J/cm<sup>2</sup>. The other side was used as the control and did not receive laser irradiation. Healing was evaluated, clinically and biometrically, immediately post-surgery and at days 3, 7, 14, 21, 28, and 35. Results were submitted to statistical analysis.

**Results:** Biometrical evaluation indicated a significant improvement in healing for the laser group at 21 and 28 days. Clinical evaluation showed better repair for the laser group, mainly after the third day.

**Conclusion:** LLLT was an effective adjunctive treatment that appeared to promote healing following gingivectomy.

## Extractions

Macedonian Journal of Medical Sciences. 2010 Sep 15; 3(3):303-306

### A Randomized Double Blind Clinical Study on the Efficacy of Low Level Laser Therapy in Reducing Pain After Simple Third Molar Extraction

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#### Abstract

**Aim:** The aim of this clinical study was to test the efficacy of Low level laser therapy (LLLT) in controlling post-operative pain after simple third molar extraction in a double blind, randomized placebo control study.

**Material and Methods:** Sixty healthy adults undergoing simple third molar extraction under local anesthesia (2% lidocaine with epinephrine 1:80.000) were selected in the study. 30 patients received a soft laser with an 870 nm wave length applied intra-orally from a distance of 1 cm for 10 minutes after extraction procedure. The energy output was 4 J/cm<sup>2</sup>, with constant power density of 50 mW. Laser treatment was simulated in the other 30 patients. Patients were instructed to evaluate their postoperative pain through out 7 days after extraction using a visual analogue scale (VAS).

**Results:** Results showed that the pain level in the laser group was lower than in the placebo group throughout the 7 day follow up period. The differences were significant starting from second postoperative day and continue all through the 7 day follow up period (Mann-Whitney U – test, p<0.05).

**Conclusion:** We suggest that the use of low power laser irradiation is a promising therapy in reducing the post-operative pain after third molars extraction.

## Pain Reduction Using Low Level Laser Irradiation in Single-Visit Endodontic Treatment

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### Abstract:

**Introduction:** Post-endodontic treatment pain is a relatively common condition which needs analgesics for patient's pain relief. Low-level laser therapy (LLLT) is suggested as a non-pharmacological and non-invasive treatment for dealing with painful conditions. The purpose of this study was to evaluate the pain relief effect of LLLT after endodontic treatment.

**Methods:** Eighty patients randomly received either LLLT (n=40), or placebo laser (n=40) after the completion of endodontic treatment for their first permanent upper or lower molars. In the laser group, the patients received a single course of low level laser therapy (Whitening Lase II- Laser DMC, Samsung, Korea) for 80 second (a dose = 70 j/cm<sup>2</sup>) per tooth. Intensity of post treatment pain was recorded using a questionnaire (The McGill Pain Questionnaire) and a numeric rating scale (Visual Analogue Scale {VAS}) at 4, 8, 12, 24, and 48 hours. VAS is a 10 cm line with "no pain" at one end, and "worst pain imaginable" at the other end. This method makes it possible to quantify pain levels. T-test and Chi-square test were used for data statistical analyses.

**Results:** Compared to the placebo group, post-endodontic pain was significantly reduced in LLLT group at 4, 8, 12, and 48 hours (P<0.05). But the difference between the two groups was not significant at 24 hours after endodontic treatment (P>0.05).

**Conclusion:** Regarding the significant pain reduction in LLLT group at 4, 8, 12, and 48 hours after endodontic treatment, LLLT seems to be an effective and nonpharmacological approach for the reduction of post-endodontic treatment pain.

Int. J. Oral Maxillofac. Surg. 2004; 33: 38–41

## Efficacy of low level laser therapy in reducing postoperative pain after endodontic surgery—A randomized double blind clinical study

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### Abstract

The aim of the study was to evaluate the effect of low level laser application on postoperative pain after endodontic surgery in a double blind, randomized clinical study. Fifty-two healthy adults undergoing endodontic surgery were included into the study. Subsequently to suturing, 26 patients had the operation site treated with an 809 nm-GaAlAs-laser (oralaser voxx, Oralia GmbH, Konstanz, Germany) at a power output of 50 mW and an irradiation time of 150 s. Laser treatment was simulated in further 26 patients. Patients were instructed to evaluate their postoperative pain on 7 days after surgery by means of a visual analogue scale (VAS). The results revealed that the pain level in the laser group was lower than in the placebo group throughout the 7 day follow-up period. The differences, however, were significant only on the first postoperative day (Mann–Whitney U-test, P<0.05). Low level laser therapy can be beneficial for the reduction of postoperative pain. Its clinical efficiency and applicability with regard to endodontic surgery, however, require further investigation. This is in particular true for the optimal energy dosage and the number of laser treatments needed after surgery.



# Dentin hypersensitivity

J Clin Periodontol. 2013 Jan;40(1):53-64. doi: 10.1111/jcpe.12011. Epub 2012 Oct 11.

## In-office treatment for dentin hypersensitivity: a systematic review and network meta-analysis.

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### Abstract

**AIM:** Dentin hypersensitivity, caused by the exposure and patency of dentinal tubules, can affect patients' quality of life. The aim of this study was to undertake a systematic review and a network meta-analysis, comparing the effectiveness in resolving dentin hypersensitivity among different in-office desensitizing treatments.

**MATERIALS AND METHODS:** A literature search was performed with electronic databases and by hand until December 2011. The included trials were divided into six treatment groups as placebo, physical occlusion, chemical occlusion, nerve desensitization, laser therapy and combined treatments. The treatment effects between groups were estimated with standardized mean differences by using a Bayesian network meta-analysis.

**RESULTS:** Forty studies were included. The standardized mean difference between placebo and physical occlusion was -2.57 [95% credible interval (CI): -4.24 to -0.94]; placebo versus chemical occlusion was -2.33 (95% CI: -3.65 to -1.04); placebo versus nerve desensitization was -1.72 (95% CI: -4.00 to 0.52); placebo versus laser therapy was -2.81 (95% CI: -4.41 to -1.24); placebo versus combined treatment was -3.47 (95% CI: -5.99 to -0.96). The comparisons of the five active treatments showed no significant differences.

**CONCLUSIONS:** The results from network meta-analysis showed that most active treatment options had significantly better treatment outcome than placebo.

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## In-office treatment for dentin hypersensitivity: a systematic review and network meta-analysis

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<sup>3</sup>Department of Dentistry, Shin Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan

### Abstract

**Aim:** Dentin hypersensitivity, caused by the exposure and patency of dentinal tubules, can affect patients' quality of life. The aim of this study was to undertake a systematic review and a network meta-analysis, comparing the effectiveness in resolving dentin hypersensitivity among different in-office desensitizing treatments.

**Materials and Methods:** A literature search was performed with electronic databases and by hand until December 2011. The included trials were divided into six treatment groups as placebo, physical occlusion, chemical occlusion, nerve desensitization, laser therapy and combined treatments. The treatment effects between groups were estimated with standardized mean differences by using a Bayesian network meta-analysis.

**Results:** Forty studies were included. The standardized mean difference between placebo and physical occlusion was 2.57 [95% credible interval (CI): 4.24 to 0.94]; placebo versus chemical occlusion was 2.33 (95% CI: 3.65 to 1.04); placebo versus nerve desensitization was 1.72 (95% CI: 4.00 to 0.52); placebo versus laser therapy was 2.81 (95% CI: 4.41 to 1.24); placebo versus combined treatment was 3.47 (95% CI: 5.99 to 0.96). The comparisons of the five active treatments showed no significant differences.

**Conclusions:** The results from network meta-analysis showed that most active treatment options had significantly better treatment outcome than placebo.

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## Clinical evaluation of Er,Cr:YSGG and GaAlAs laser therapy for treating dentine hypersensitivity: A randomized controlled clinical trial

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### Abstract

**Objective:** The advent of dental lasers has raised another possible treatment option for dentine hypersensitivity (DH) and has become a research interest in the last decades. The aim of this randomized, controlled, double-blind, split mouth, clinical study was to evaluate and compare the desensitizing effects of erbium, chromium-doped:yttrium, scandium, gallium and garnet (Er,Cr:YSGG) to gallium–aluminium–arsenide (GaAlAs) laser on DH.

**Methods:** Fifty-one patients participated in this study for a total of 174 teeth. DH was assessed for all groups with a visual analog scale. For each patient, the teeth were randomized to three groups. In the diode laser group, sensitive teeth were irradiated with the GaAlAs laser at 8.5 J/cm<sup>2</sup> energy density. In the Er,Cr:YSGG laser group, sensitive teeth were irradiated with Er,Cr:YSGG laser in the hard tissue mode using a none-contact probe at an energy level of 0.25W and repetition rate of 20 Hz, 0% water and 10% air. In the control group no treatment was performed. Treatment time was 60 s for GaAlAs laser and 30 s for Er,Cr:YSGG laser.

**Results:** When compared with the control group and baseline data, in both laser groups, laser irradiation provided a desensitizing effect immediately after treatment and this effect was maintained throughout the study ( $p < 0.05$ ). No significant differences between Er,Cr:YSGG and GaAlAs laser groups were found at any follow-up examination ( $p > 0.05$ ).

**Conclusion:** Based on these findings, it may be concluded that both Er,Cr:YSGG and GaAlAs lasers were effective in the treatment of DH following a single application.

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## Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation

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### Abstract

**INTRODUCTION:** The long duration of orthodontic treatment is a major concern for patients. A noninvasive method of accelerating tooth movement in a physiologic manner is needed. The aim of this study was to evaluate of the efficacy of low-intensity laser therapy in reducing orthodontic treatment duration and pain.

**METHODS:** Twenty patients requiring extraction of first premolars were selected for this study. We used a randomly assigned incomplete block split-mouth design. Individual canine retraction by a nickel-titanium closed-coil spring was studied. The experimental side received infrared radiation from a semiconductor (aluminium gallium arsenide) diode laser with a wavelength of 810 nm. The laser regimen was applied on days 0, 3, 7, and 14 in the first month, and thereafter on every 15th day until complete canine retraction was achieved on the experimental side. Tooth movement was measured on progress models. Each patient's pain response was ranked according to a visual analog scale.

**RESULTS:** An average increase of 30% in the rate of tooth movement was observed with the low-intensity laser therapy. Pain scores on the experimental sides were significantly lower compared with the control sides.

**CONCLUSIONS:** Low-intensity laser therapy is a good option to reduce treatment duration and pain.

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## Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: A clinical investigation

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<sup>a</sup>Postgraduate student. <sup>b</sup>Assistant professor and head.

**Introduction:** The long duration of orthodontic treatment is a major concern for patients. A noninvasive method of accelerating tooth movement in a physiologic manner is needed. The aim of this study was to evaluate of the efficacy of low-intensity laser therapy in reducing orthodontic treatment duration and pain.

**Methods:** Twenty patients requiring extraction of first premolars were selected for this study. We used a randomly assigned incomplete block split-mouth design. Individual canine retraction by a nickel-titanium closed-coil spring was studied. The experimental side received infrared radiation from a semiconductor (aluminium gallium arsenide) diode laser with a wavelength of 810 nm. The laser regimen was applied on days 0, 3, 7, and 14 in the first month, and thereafter on every 15th day until complete canine retraction was achieved on the experimental side. Tooth movement was measured on progress models. Each patient's pain response was ranked according to a visual analog scale.

**Results:** An average increase of 30% in the rate of tooth movement was observed with the low-intensity laser therapy. Pain scores on the experimental sides were significantly lower compared with the control sides.

**Conclusions:** Low-intensity laser therapy is a good option to reduce treatment duration and pain. (Am J Orthod Dentofacial Orthop 2012;141:289-97)

## COMPARING THE 810NM DIODE LASER WITH CONVENTIONAL SURGERY IN ORTHODONTIC SOFT TISSUE PROCEDURES

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### SUMMARY

**Aim:** To compare the use of the 810nm diode laser with conventional surgery in the management of soft tissue mucogingival problems associated with orthodontic treatment.

**Methods:** Orthodontic patients requiring different soft tissue surgical procedures were randomly assigned to receive conventional surgery or soft tissue diode laser, (wavelength 810 nm).

**Main outcome measures:** Parameters documented include the type of anaesthesia used, intra and post operative pain, bleeding, the use of scalpel and sutures. The chi-squared test was used to test for significance at 95% confidence level. Probability values (p-values) less than 0.05 were regarded as significant.

**Results:** Only 2(16.7%) of the procedures carried out with the soft tissue laser required infiltration anaesthesia compared to 10 (90.9%) with conventional surgery and this was significant ( $P<0.001$ ). Post operative pain was significantly reduced in all cases treated with the diode laser ( $P<0.001$ ). There was also a significant difference ( $P<0.05$ ) in post operative bleeding in all cases treated with the diode laser. No sutures were used in all soft tissue cases managed with the diode laser and this was significant ( $P<0.001$ ). There was no statistically significant difference in treatment time in the use of the laser compared with conventional surgery.

**Conclusion:** Orthodontic patients treated with the diode laser required less infiltration anaesthesia, had reduced bleeding during and after surgery, rapid postoperative haemostasis, elimination of the need for sutures and an improved postoperative comfort and healing.

## Efficacy of Low-Level Laser Therapy in Treatment of Recurrent Aphthous Ulcers – A Sham Controlled, Split Mouth Follow Up Study

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### ABSTRACT

**Introduction:** Aphthous ulcers, commonly referred to as canker sores, are the most common ulcerative lesions of the oral mucosa. These are usually painful and are associated with redness, and occasional bleeding from the affected area(s). The aims of treatment are to reduce pain and healing time.

**Aims:** To assess clinically the efficacy of Low-level laser therapy (LLLT) on recurrent aphthous ulcers for reduction of pain, lesion size, and healing time and to compare the results with those of a sham control group.

**Settings and Design:** A total of 30 patients who presented with two separate aphthous ulcers were included in the study. Each lesion was randomly allotted to either the active treatment group or the sham control group.

**Materials and Methods:** Lesions which were included in the active group were treated with LLLT in a single sitting, which was divided into four sessions. Lesions in the sham control group were subjected to similar treatment without activating the LASER unit. Each patient was evaluated for pain, lesion size, and complete healing at the following intervals; immediately post LLLT and one day, two days, and three days follow up.

**Statistical Analysis :** The Student's t-test was used for statistical evaluation of the data.

**Results:** Complete resolution of the ulcers in the active group was  $3.05 \pm 1.10$  days as compared to  $8.90 \pm 2.45$  days in the sham control group. Immediately, post the LLLT application, complete pain relief was observed in 28 of the 30 patients of the active group.

**Conclusion:** LLLT was effective in relieving pain and reducing the healing time during the treatment of aphthous ulcers.

Int J Immunopathol Pharmacol. 2010 Oct-Dec;23(4):1167-76.

## Inhibition of HSV-1 replication by laser diode-irradiation: possible mechanism of action

Donnarumma G, De Gregorio V, Fusco A, Farina E, Baroni A, Esposito V, Contaldo M, Petruzzi M, Pannone G, Serpico R.

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### Abstract

Herpes labialis are the most frequent clinical manifestations of HSV-1 infection. Epithelial cells are able to respond to HSV-1 presence inducing the expression of IL-6, IL-1, TNF- $\alpha$  and IL-8. These proinflammatory cytokines have a function in the acute phase response mediation, chemotaxis, inflammatory cell activation and antigen presenting cells. In the human epithelial cell models, it has been demonstrated that, after an early induction of proinflammatory host response, HSV-1 down-modulates the proinflammatory cytokine production through the accumulation of two viral proteins, ICP4 and ICP27, whose transcription is induced by tegument protein VP16. These viral proteins, through the decreasing of stabilizing the mRNAs of proinflammatory genes, delay cytokine production to an extent that allows the virus to replicate. Moreover, viral transactivating proteins, ICP-0 and VP-16 induce IL-10 expression. The conventional treatment of herpes labialis involves the topical and systemic use of antiviral drugs but it is necessary to find new therapies that can act in a selective and non-cytotoxic manner in viral infection. Laser diode therapy has been considered as a non-invasive alternative treatment to the conventional treatment of herpes labialis in pain therapy, in modulation of inflammation and in wound healing. This study aims to report a possible mechanism of action of laser diode irradiation in prevention and reduction of severity of labial manifestations of herpes labialis virus. We investigated, in an in vitro model of epithelial cells HaCat, the laser-effect on HSV-1 replication and we evaluated the

modulation of expression of certain proinflammatory cytokines (TNF- $\alpha$ , IL-1 $\beta$  and IL-6), antimicrobial peptide HBD2, chemokine IL-8 and the immunosuppressive cytokine, IL-10. Our results lead us to hypothesize that LD-irradiation acts in the final stage of HSV-1 replication by limiting viral spread from cell to cell and that laser therapy acts also on the host immune response unblocking the suppression of proinflammatory mediators induced by accumulation of progeny virus in infected epithelial cells.

Support Care Cancer (2011) 19:1069–1077. DOI 10.1007/s00520-011-1202-0. Received: 26 August 2010 / Accepted: 30 May 2011 / Published online: 10 June 2011. © Springer-Verlag 2011

## A systematic review with meta-analysis of the effect of low-level laser therapy (LLLT) in cancer therapy-induced oral mucositis

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### Abstract

**Purpose:** The purpose of this study is to review the effects of low-level laser therapy (LLLT) in the prevention and treatment of cancer therapy-induced oral mucositis (OM).

**Methods:** A systematic review and meta-analysis of randomised placebo-controlled trials of LLLT performed during chemotherapy or radiation therapy in head and neck cancer patients.

**Results:** We found 11 randomised placebo-controlled trials with a total of 415 patients; methodological quality was acceptable at 4.10 (SD $\pm$ 0.74) on the 5-point Jadad scale. The relative risk (RR) for developing OM was significantly ( $p=0.02$ ) reduced after LLLT compared with placebo LLLT (RR= 2.03 (95% CI, 1.11 to 3.69)). This preventive effect of LLLT improved to RR=2.72 (95% CI, 1.98 to 3.74) when only trials with adequate doses above 1 J were included. For treatment of OM ulcers, the number of days with OM grade 2 or worse was significantly reduced after LLLT to 4.38 (95% CI, 3.35 to 5.40) days less than placebo LLLT. Oral mucositis severity was also reduced after LLLT with a standardised mean difference of 1.33 (95% CI, 0.68 to 1.98) over placebo LLLT. All studies registered possible side-effects, but they were not significantly different from placebo LLLT.

**Conclusions:** There is consistent evidence from small highquality studies that red and infrared LLLT can partly prevent development of cancer therapy-induced OM. LLLT also significantly reduced pain, severity and duration of symptoms in patients with cancer therapy-induced OM.

Photomed Laser Surg. 2011 Oct;29(10):707-10.

## Treatment of persistent idiopathic facial pain (PIFP) with a low-level energy diode laser

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### Abstract

**OBJECTIVE:** The purpose of this study was to test the therapeutic efficacy of low-level energy diode laser on persistent idiopathic facial pain (PIFP).

**BACKGROUND DATA:** PIFP has presented a diagnosis and management challenge to clinicians. Many patients were misdiagnosed, which resulted in unnecessary dental procedures. Low-level energy diode laser therapy has been applied to different chronic and acute pain disorders, including neck, back, and myofascial pain; degenerative osteoarthritis; and headache, and it may be an effective alternative treatment for PIFP.

**METHODS:** A total of 16 patients, who were diagnosed with PIFP, were treated with an 800-nm wavelength diode laser. A straight handpiece having an end size of 0.8 cm in diameter, or an angled handpiece with an end size of 0.5 cm in diameter was used. When laser was applied, the handpiece directly contacted the involved symptomatic region with an energy density of 105 J/cm<sup>2</sup>. Overall pain and discomfort was analyzed with a 10-cm visual analogue scale (VAS) before and after treatment.

**RESULTS:** All patients received diode laser therapy between 1 and 10 times. The average pain score was 7.4 before the treatment (ranging from 2.9 to 9.8), and 4.1 after the treatment. An average pain reduction of 43.87% (ranging from 9.3% to 91.8%) was achieved. The pain remained unchanged at a lower level for up to 12 months.

**CONCLUSIONS:** Low-level energy diode laser may be an effective treatment for PIFP.

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## Evaluation of orofacial function in temporomandibular disorder patients after low-level laser therapy

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<sup>1</sup>Department of Prosthodontics, Faculty of Dentistry, Istanbul University, Istanbul, Turkey, and <sup>2</sup>Department of Oral and Maxillofacial Surgery, School of Dentistry, Thoku University, Sendai, Japan

### Abstract

**Objective:** To evaluate the effect of low-level laser therapy on occlusal contact area, occlusal pressure and bite force in temporomandibular disorder patients.

**Patients and method:** Twenty patients (14 women, six men, mean age 33.1 ± 3.8 years) diagnosed with myofascial pain according to the Research Diagnostic Criteria for Temporomandibular Disorder (RDC/TMD) participated in the study. Twenty healthy individuals, matched in age and gender, served as a control group. Low-level laser was applied to the mastication muscles three times per week, for a total of 10 sessions. The mandibular mobility range was evaluated. The maximum bite force, occlusal contact area and occlusal pressure were measured bilaterally with a dental pre-scale before and after treatment. All variables were analyzed descriptively. Changes in the masticatory muscle tenderness, mandibular movements, maximum bite force, occlusal contact area and occlusal pressure were compared by paired-sample Student's t-tests.

**Results:** There was a significant increase in the pressure pain threshold of the examined muscles. Mandibular movements were significantly improved in all patients. There was also a significant decrease in pain by palpation after laser exposure. However, no significant change was found in the maximum bite force, occlusal contact area or occlusal pressure after the treatment and also the values after the treatment were still significantly lower than those of the healthy individuals.

**Conclusion:** This particular type of LLLT is effective at relieving pain but does not provide physical improvement.

## Evaluation of Low-Level Laser Therapy in the Treatment of Temporomandibular Disorders

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### Abstract

**Objective:** The purpose of this study was to assess the effectiveness of low-level laser therapy (LLLT) in the treatment of myogenic originated temporomandibular disorders (TMD).

**Background Data:** Limited studies have demonstrated that LLLT may have a therapeutic effect on the treatment of TMD.

**Methods:** Thirty-nine patients with myogenic TMD-associated orofacial pain, limited mandibular movements, chewing difficulties, and tender points were included in this study. Twenty-four of them were treated with LLLT for 10 sessions per day excluding weekends as test group, and 15 patients with the same protocol received placebo laser treatment as a control group. These parameters were assessed just before, just after, and 1 month after the treatment.

**Results:** Maximal mouth-opening improvement, and reductions in pain and chewing difficulty were statistically significant in the test group when compared with the control group. Statistically significant improvements were also detected between two groups regarding reduction in the number of tender points.

**Conclusion:** Based on the results of this placebo-controlled report, LLLT is an appropriate treatment for TMD and should be considered as an alternative to other methods.

Clin J Pain. 2010 Sep;26(7):611-6. doi: 10.1097/AJP.0b013e3181e0190d.

## Effects of superpulsed low-level laser therapy on temporomandibular joint pain

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### Abstract

**OBJECTIVES:** A randomized double-blind study was conducted to compare the efficacy of superpulsed low-level laser therapy (SLLLT) with nonsteroidal anti-inflammatory drugs in the treatment of pain caused by temporomandibular joint disorders.

**METHODS:** A total of 99 patients with temporomandibular joint disorders, secondary to disc displacement without reduction or osteoarthritis were randomly divided into 3 groups. Thirty-nine patients received SLLLT in 10 sessions over 2 weeks, 30 patients received ibuprofen 800 mg twice a day for 10 days, and 30 patients received sham laser as placebo in 10 sessions over 2 weeks. Pain intensity was measured by visual analog scale at baseline, 2, 5, 10, and 15 days of treatment. Mandibular function was evaluated by monitoring active and passive mouth openings and right and left lateral motions at baseline, 15 days, and 1 month of treatment. Magnetic resonance imaging was performed at baseline and the end of therapy.

**RESULTS:** Mean visual analog scale pain scores in SLLLT group was significantly lower than in nonsteroidal anti-inflammatory drug group and control group ( $P=0.0001$ ) from fifth day up to the end of the observation period. As for active and passive mouth openings and right and left lateral motions, superiority of SLLLT was evident 1 month after treatment (interaction time treatment,  $P=0.0001$ ).

**DISCUSSION:** Mandibular function improved in all SLLLT patients proving the effectiveness in the treatment of pain, as demonstrated by a significant improvement in clinical signs and symptoms of temporomandibular joint disc displacement without reduction and osteoarthritis at the end of treatment and stability over a period of 1 month.



## Effectiveness of low-level laser therapy in temporomandibular disorder

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**Objective:** To investigate the effectiveness of low-level laser therapy in the treatment of temporomandibular disorder and to compare treatment effects in myogenic and arthrogenic cases.

**Methods:** Thirty-five patients were evaluated by magnetic resonance imaging and randomly allocated to active treatment (n~20) and placebo treatment (n~15) groups. In addition to a daily exercise program, all patients were treated with fifteen sessions of low-level laser therapy. Pain, joint motion, number of joint sounds and tender points were assessed.

**Results:** Significant reduction in pain was observed in both active and placebo treatment groups. Active and passive maximum mouth opening, lateral motion, number of tender points were significantly improved only in the active treatment group. Treatment effects in myogenic and arthrogenic cases were similar.

**Conclusion:** Low-level laser therapy can be considered as an alternative physical modality in the management of temporomandibular disorder.

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## Use of low level laser therapy in the treatment of persistent idiopathic orofacial pain and traumatic trigeminal neuropathy- a pilot study

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### Abstract

**Background:** Nerve recovery in the orofacial region is not completely satisfactory. Nowadays, low level laser therapy (LLLT) has been recognized and accepted as a possible therapeutic option in various states of nerve damage throughout the body. LLLT is noninvasive and there are only few contraindications for its use. Therefore, the effect of LLLT on patients with idiopathic orofacial pain and traumatic trigeminal neuropathy was assessed.

**Methods:** Twenty one patient was enrolled in this pilot study, there were 10 patients with persistent idiopathic facial pain (PIFP) and 11 patients with traumatic trigeminal neuropathy (TTN). Each patient was treated once daily in 10 sessions using a GaAlAs laser (830 nm, 3 W, 50 ms, 50 Hz which is equivalent to an energy density of 1.5 J/cm<sup>2</sup>). The outcome of LLLT was evaluated by means of a patient survey on the relief of symptoms (0=no improvement, 1=partial improvement, 2=complete improvement). Statistical analysis was performed by use of descriptive statistics and when needed by use of chi-square test. Values lower than 0.05 were considered as significant.

**Results:** Complete improvement of symptoms was seen in 70% of the patients with PIFP and in 36.4% of patients with TTN. LLLT showed no improvement in 10% with PIFP and 45.4% of patients with TTN.

**Conclusion:** It might be concluded that LLLT is beneficial in patients with persistent idiopathic orofacial pain and traumatic trigeminal neuropathy.

## Acute Low Back Pain with Radiculopathy: A Double-Blind, Randomized, Placebo-Controlled Study

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<sup>4</sup>Department for Physical Medicine, Institute for Rheumatology, Belgrade, Serbia.

### Abstract

**Objective:** 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.

**Background Data:** Acute LBP with radiculopathy is associated with pain and disability and the important pathogenic role of inflammation. LLLT has shown significant antiinflammatory effects in many studies.

**Materials and Methods:** A randomized, double-blind, placebo-controlled trial was performed on 546 patients. Group A (182 patients) was treated with nimesulide 200mg/day and additionally with active LLLT; group B (182 patients) was treated only with nimesulide; and group C (182 patients) was treated with nimesulide and placebo LLLT. LLLT was applied behind the involved spine segment using a stationary skin-contact method. Patients were treated 5 times weekly, for a total of 15 treatments, with the following parameters: wavelength 904 nm; frequency 5000 Hz; 100-mW average diode power; power density of 20mW/cm<sup>2</sup> and dose of 3 J/cm<sup>2</sup>; treatment time 150 sec at whole doses of 12 J/cm<sup>2</sup>. The outcomes were pain intensity measured with a visual analog scale (VAS); lumbar movement, with a modified Schober test; pain disability, with Oswestry disability score; and quality of life, with a 12-item short-form health survey questionnaire (SF-12). Subjects were evaluated before and after treatment. Statistical analyses were done with SPSS 11.5.

**Results:** Statistically significant differences were found in all outcomes measured ( $p < 0.001$ ), but were larger in group A than in B ( $p < 0.0005$ ) and C ( $p < 0.0005$ ). The results in group C were better than in group B ( $p < 0.0005$ ).

**Conclusions:** The results of this study show better improvement in acute LBP treated with LLLT used as additional therapy.

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## Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis of randomised placebo or active-treatment controlled trials

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### Summary

**Background:** Neck pain is a common and costly condition for which pharmacological management has limited evidence of efficacy and side-effects. Low-level laser therapy (LLLT) is a relatively uncommon, non-invasive treatment for neck pain, in which non-thermal laser irradiation is applied to sites of pain. We did a systematic review and meta-analysis of randomised controlled trials to assess the efficacy of LLLT in neck pain.

**Methods:** We searched computerised databases comparing efficacy of LLLT using any wavelength with placebo or with active control in acute or chronic neck pain. Effect size for the primary outcome, pain intensity, was defined as a pooled estimate of mean difference in change in mm on 100 mm visual analogue scale.

**Findings:** We identified 16 randomised controlled trials including a total of 820 patients. In acute neck pain, results of two trials showed a relative risk (RR) of 1.69 (95% CI 1.22–2.33) for pain improvement of LLLT versus placebo. Five trials of chronic neck pain reporting categorical data showed an RR for pain improvement of 4.05 (2.74–5.98) of LLLT. Patients in 11 trials reporting changes in visual analogue scale had pain intensity reduced by 19.86 mm (10.04–29.68). Seven trials provided follow-up data for 1–22 weeks after completion of treatment, with short-term pain relief persisting in the medium term with a reduction of 22.07 mm (17.42–26.72). Side-effects from LLLT were mild and not different from those of placebo.

**Interpretation:** We show that LLLT reduces pain immediately after treatment in acute neck pain and up to 22 weeks after completion of treatment in patients with chronic neck pain.