DENTAL MATERIALS XXX (2014) XXX–XXX

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Review

# Developments in low level light therapy (LLLT) for dentistry

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ARTICLE INFO

*Article history:*
Received 9 August 2013
Received in revised form
12 February 2014
Accepted 12 February 2014
Available online xxx

*Keywords:*
Oral disease
Dental therapy
Low-level laser therapy
Phototherapy
Photobiomodulation

ABSTRACT

*Objectives.* Low level light/laser therapy (LLLT) is the direct application of light to stimulate cell responses (photobiomodulation) in order to promote tissue healing, reduce inflammation and induce analgesia. There have been significant studies demonstrating its application and efficacy at many sites within the body and for treatment of a range of musculoskeletal injuries, degenerative diseases and dysfunction, however, its use on oral tissues has, to date, been limited. The purpose of this review is to consider the potential for LLLT in dental and oral applications by providing background information on its mechanism of action and delivery parameters and by drawing parallels with its treatment use in analogous cells and tissues from other sites of the body.

*Methods.* A literature search on Medline was performed on laser and light treatments in a range of dental/orofacial applications from 2010 to March 2013. The search results were filtered for LLLT relevance. The clinical papers were then arranged to eight broad dental/orofacial categories and reviewed.

*Results.* The initial search returned 2778 results, when filtered this was reduced to 153. 41 were review papers or editorials, 65 clinical and 47 laboratory studies. Of all the publications, 130 reported a positive effect in terms of pain relief, fast healing or other improvement in symptoms or appearance and 23 reported inconclusive or negative outcomes. Direct application of light as a therapeutic intervention within the oral cavity (rather than photodynamic therapies, which utilize photosensitizing solutions) has thus far received minimal attention. Data from the limited studies that have been performed which relate to the oral cavity indicate that LLLT may be a reliable, safe and novel approach to treating a range of oral and dental disorders and in particular for those which there is an unmet clinical need.

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http://dx.doi.org/10.1016/j.dental.2014.02.006


Please cite this article in press as: Carroll JD, et al. Developments in low level light therapy (LLLT) for dentistry. Dent Mater (2014), http://dx.doi.org/10.1016/j.dental.2014.02.006

*Significance.* The potential benefits of LLLT that have been demonstrated in many healthcare fields and include improved healing, reduced inflammation and pain control, which suggest considerable potential for its use in oral tissues.



## Contents



## 1. Introduction

Low level light/laser therapy (LLLT) is the application of light (usually delivered via a low power laser or light-emitting diode; LED) to promote tissue repair, reduce inflammation or induce analgesia. LLLT has been the subject of several systematic reviews for a range of musculoskeletal pathologies with favorable outcomes reported in The Lancet [1], British Medical Journal [2], International Association for the Study of Pain [3] and the World Health Organization [4]. Unlike many other laser treatments LLLT is not an ablating or heating based therapy but is more analogous to photosynthesis in its mode of action. LLLT also differs from photodynamic therapy (PDT), which utilizes light indirectly to trigger photosensitive dyes to produce bactericidal molecules that kill infecting microbes that cause disease. Indeed, current data indicates that PDT appears to be a useful adjunctive tool for treating oral infections in the dental specialties of oral surgery, endodontics and periodontitis (e.g. Periowave™) [5,6]. In contrast, LLLT or photobiomodulation uses the action of light and light alone to directly stimulate host cells in order to reduce inflammation, relieve pain and/or promote wound healing.

Dental applications for LLLT are not well documented in comparison with musculoskeletal applications; however, more studies are now being reported. Indeed, there is now encouraging data for LLLT application in a wide range of oral hard and soft tissues and covering a number of key dental specialties including endodontics, periodontics, orthodontics and maxillofacial surgery as described below. LLLT has also been shown to have efficacy in managing chronic pain and non-healing bone and soft tissue lesions in the maxillofacial region.

The laser or LED devices applied in LLLT typically emit in the 600–1000 nm spectrum range (red to near infrared), with typical irradiance of 5 mW/cm$^2$ to 5 W/cm$^2$ and generated by devices with as little power as 1 mW, and up to 10 W. Pulsed or sometimes continuous beams are delivered. Treatment time is typically for 30–60 s per treatment point (see Glossary of terms for an explanation of "per-point"; Table 4) and as little as one treatment point or a dozen or more may be treated at a given time. For acute and post-operative therapy one treatment is all that is usually required however for chronic pain

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and degenerative conditions as many as ten sessions may be necessary. Whilst other wavelengths outside the 650–850 nm spectrum can have similar effects they do not penetrate the tissues as well as those in the red and near-infrared range [7].

The following review provides an overview of LLLT, the background, our current mechanistic understanding, the clinical benefits and treatment parameters.

## 2. History and application of LLLT

In 1967, a few years after the first working laser was invented, Dr. Endre Mester at Semmelweis Medical University in Budapest, Hungary, attempted to identify if this newly developed 'ray of light' could induce cancer. In his experiment, hair was shaved from the backs of two groups of mice; one as the control, the other being exposed to treatment using a low-powered ruby laser. The treatment group did not develop cancer as had been predicted, however, the hair on the treated mice grew back at a faster rate than the untreated controls. Mester (1967) subsequently described this effect as "laser biostimulation" [8]. Forty-five years later, thousands of papers have been published with over 30 in-press every month related to LLLT and its mechanism of action, downstream physiological changes and the clinical benefits as demonstrated in both randomized clinical trials and in pooled data meta-analyzed in several systematic reviews [1–4,9].

To-date more than 300 randomized double blind placebo controlled clinical trials have been reported. This has resulted in publication of a number of expert consensus reports for utilizing LLLT as part of standard clinical management, including:

- The Lancet – systematic review of LLLT for neck pain [1].
- British Medical Journal (BMJ) – systematic review and guidelines for treating tennis elbow [2].
- International Association for the Study of Pain (IASP) – fact sheets for myofascial pain syndrome, osteoarthritis and neck pain [3].
- The World Health Organization (WHO) – task force on neck pain systematic review [4].
- British Journal of Sports Medicine (BJSM) – systematic review for frozen shoulder [9].
- American Physical Therapy Association (APTA) – systematic review and clinical practice guidelines for achilles tendinopathy [10].
- European Society for Medical Oncology (ESMO) – clinical practice guidelines for oral mucositis [11].
- Multinational Association for Supportive Cancer Care (MASCC) – clinical practice guidelines for oral mucositis [12].

Whilst most of the clinical evidence for LLLT has been obtained from treating musculoskeletal pain, many trials relating to oral and maxillofacial indications have also now been published (Table 1).

Apart from an enhanced rate of postoperative healing [80,126] and better tissue remodeling, LLLT is also a major benefit for patients who are in pain, are needle phobic or cannot tolerate non-steroidal inflammatory drugs (NSAIDs) [13–15].

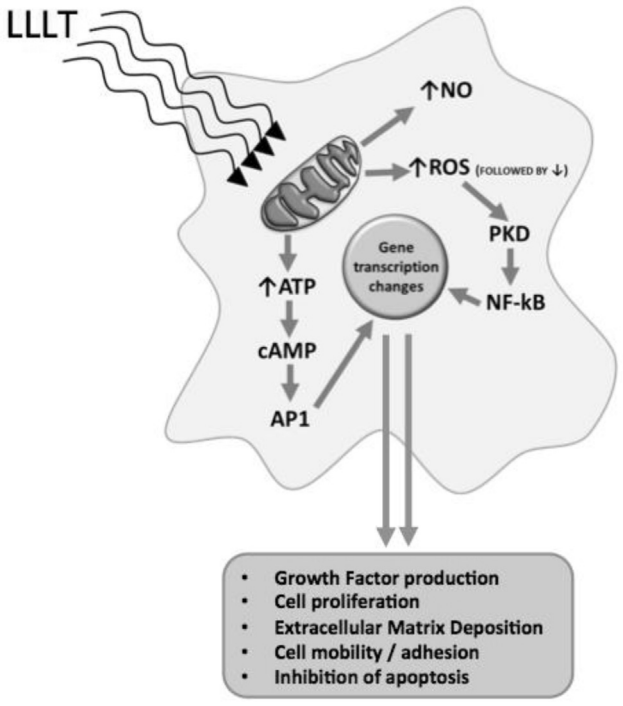


**Fig. 1 – The cellular effect of low level light therapy (LLLT) on cellular metabolism. LLLT is proposed to act via mitochondria displacing nitric oxide (NO) from the respiratory chain and increasing levels of adenosine triphosphate (ATP) and reactive oxygen species (ROS). These changes act via intermediaries cyclic adenosine monophosphate (cAMP) and protein kinase D (PKD) to activate transcription factors AP-1 and NF-κB resulting in changes in gene expression and subsequent downstream production of chemical messengers implicated in the cellular changes seen following LLLT exposure.**

## 3. Mechanism of action of LLLT

Most of the effects of LLLT can be explained by light absorption within the mitochondria [16–18] (Fig. 1). Cells can contain up to several thousand mitochondria, which generate cellular energy (ATP) from oxygen and pyruvate. In addition, in stressed or ischemic tissues, mitochondria synthesize nitric oxide (mtNO) [19–21], which competes and can displace oxygen from binding to Cytochrome c oxidase (CcO) (the terminal enzyme in the electron transport chain necessary for energy generation) [22]. Two negative effects result: reduced ATP synthesis and increased oxidative stress (leading to inflammation via activation of the inflammatory "master switch" transcription factor, NF-κB) [19–21,23–25].

### 3.1. *The consequences of LLLT on hypoxic/stressed cells*

#### 3.1.1. *Primary effect: absorption by cytochrome c oxidase*

CcO absorbs red and near-infrared light, the transfer of light energy by this enzyme triggers a series of downstream effects [16,26–29] (Fig. 1).

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**Table 1 – Oral and maxillofacial indications of LLLT.**

| Oral specialty | Application | LLLT effect | Refs |
|---|---|---|---|
| Endodontics | Dentinal hypersensitivity | Reduced tactile and thermal sensitivity | [97–99] |
| | Pulp | Improved dentin formation in the dental pulp | [94–96] |
| | | Promotion of HDP cell mineralization | |
| Maxillofacial | Bisphosphonate related osteonecrosis of the jaw | Reduced pain, reduced edema, pus and fistulas, improved healing | [91–93] |
| | Mandibular distraction | Improved bone trabeculation and ossification | [88–90] |
| | Mandibular advancement | Improved bone formation in condylar region | |
| | | Improved osteogenesis | |
| | Temporo-mandibular joint disorder | Reduced pain | [85–87] |
| | | Improved range of mandibular movement | |
| | Trauma to the mandibular | Improved bone healing | [84] |
| Oral pathology | Burning mouth syndrome | Reduced symptoms, reduced pain | [81–83] |
| | HSV | Improved healing and reduced reoccurrence | [123–125] |
| | Lichen planus | Reduced lesion size, less pain | [120–122] |
| | | As effective as corticosteroids | |
| | Oral mucositis | Reduced incidence, duration and severity | [63,118,119] |
| | Xerostomia/dryness | Regeneration of salivary duct epithelial cells | [115–117] |
| | | Improved salivary flow, improved antimicrobial characteristics | |
| Oral surgery | Healing | Improved healing after gingivectomy, reduced gingival Inflammation | [56,60,80] |
| | Paresthesia/alveolar nerve | Improved mechanical sensory perception | [77–79] |
| | Third molar extraction | Reduced pain, reduced swelling, improved trismus | [64,65,76] |
| Orthodontics | Orthodontic pain | Reduced pain | [42,112–116] |
| | | Faster remodeling | |
| | Titanium implants | Improved healing | [73–75] |
| | | Improved attachment | |
| | | Improved osseointegration | |
| | Tooth movement | Accelerated tooth movement | [58,112,113] |
| | | Improved osteoblast/osteoclast activity | |
| | | Improved collagen deposition | |
| Pediatric | Cavity preparation | Reduced pain | [56,88,111] |
| | Mandibular distraction | Faster healing | |
| | Gingivitis | | |
| Periodontics | Chronic gingivitis | Reduced inflammation | [56,57,110] |
| | | Improved healing | |
| | Periodontal ligament | Increased early hyalinization | [57,108,109] |
| | Periodontitis | Improved pocket depth | [105–108] |
| | | Less inflammation | |
| Prosthodontics | Denture stomatitis | Reduced yeast colonies | [102–104] |
| | | Reduced palatal inflammation | |
| | Implants | Faster bone formation | [74,75,101] |
| | | Improved bone–implant interface strength | |
| | | Improved osseointegration | |

#### 3.1.2. *Secondary effect: modulation of ATP, nitric oxide and reactive oxygen species*

Changes in ATP, reactive oxygen species and nitric oxide occur due to light absorption by CcO, which are redox state and dose dependent. In hypoxic or otherwise stressed cells it has been shown that following LLLT, nitric oxide is released from CcO, ATP synthesis is increased and oxidative stress is reduced [30–34].

#### 3.1.3. *Tertiary effect: downstream intracellular responses (gene transcription, and cellular signaling)*

There are many downstream effects of LLLT including nitric oxide release, increased ATP synthesis and reduced oxidative stress. These effects are context and cell type dependent. Either directly or indirectly these biochemical intermediates affect components in the cytosol, the cell membrane, and nuclear functions that control gene transcription and subsequently regulate cellular responses such as proliferation, migration, necrosis and inflammation [30–34].

#### 3.1.4. *Quaternary effect: extracellular, indirect, distant effects*

Tissues that have not absorbed photons can also be affected indirectly via bioactive molecules released from cells that have been stimulated by absorbed light. Cells in the blood and lymph can also be activated and subsequently promote systemic effects such as autocrine, paracrine, and endocrine and termed as “bystander” effects.

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**Table 2 – Irradiation parameters (The "Medicine").**

| Parameter | Unit | |
|---|---|---|
| Wavelength | nm | The structure of cytochrome c oxidase and its redox state determines the wavelengths of light, which will be absorbed [16–18]. The optimum wavelength is not universally agreed, but most common LLLT devices used in dentistry are typically within the 600–1000 nm range. There are many absorption peaks for cytochrome c oxidase in that range, they penetrate tissues well (up to 850 nm), and many clinical trials have shown a successful outcome |
| Power (Flux) | W | The most common LLLT devices used in dentistry are in the range 50–200 mW, but irradiance is just as important (if not more so), especially for large beam areas |
| Beam area | $cm^2$ | Beam area is required for calculating irradiance, but is difficult to measure and frequently misreported. Diode laser beams are typically not round (more often they are elliptical) and the beams are usually brighter in the middle and gradually weaken toward the edge (Gaussian distribution). This has been poorly understood by many researchers and errors are frequently made when reporting beam area. The aperture does not necessarily define the beam size, which should be measured using a beam profiler and reported at the $1/e^2$ point [50,100] (Table 4) |
| Irradiance (radiant incidence) | $W/cm^2$ | Power or flux areal density is the product of Power (W)/beam area ($cm^2$) and its proper radiometric term is *irradiance* [51]. This parameter is frequently misreported due to difficulties with measuring beam area [50,72]. Studies that have accurately measured beam irradiance carefully and taken measurements at the target depth report successful tissue repair and anti-inflammatory effects in the range of 5–55 $mW/cm^2$ at the target [69–71]. Analgesia typically requires higher power densities; a systematic review of laboratory studies found power densities >300 $mW/cm^2$ are necessary to inhibit nerve conduction in C-fibers and A-delta fibers [39] |
| Pulse structure | Peak power (W)<br>Pulse frequency (Hz)<br>Pulse width (s)<br>Duty cycle (%) | If the beam is pulsed, then the reported power should be the "Average Power" and calculated as follows: peak power (W) × pulse width (s) × pulse frequency (Hz) = average power (W). A review of the effect of pulses [68] concludes that "there was some evidence that pulsed light does have effects that are different from those of continuous wave light. However further work is needed to define these effects for different disease conditions and pulse structures. A subsequent study on traumatic brain injury in mice [67] showed that 10 Hz to be more effective than 100 Hz or CW in reducing the neurological severity score |
| Coherence | | Coherent light produces laser speckle (Table 4), which has been postulated to play a role in the photobiomodulation interaction with cells and sub-cellular organelles. No definitive trials have been published to-date to confirm or refute this but it is clear that coherence is not required for positive clinical effects [7] |

### 3.2. *Edema/lymphatic flow*

There is good evidence that LLLT also improves lymphatic flow. A systematic review of eight clinical trials of LLLT for post-mastectomy lymphoedema concludes that "There is moderate to strong evidence for the effectiveness of LLLT for the management of breast cancer related lymphoedema" [36]. A controlled clinical trial on football players with second degree ankle sprains, found a significant reduction in edema volume in the laser group compared with the placebo [37]. A laboratory trial on Carrageenan-induced edema in the mouse paw also found that treating lymph nodes alone was sufficient to reduce the swelling [38]. The mechanism of action of the LLLT however was not elucidated.

### 3.3. *Analgesia*

Analgesic effects are probably a result of a different biological mechanism from those of the increased ATP/reduced oxidative stress model described above. According to a systematic review of laser analgesia mechanisms by Chow et al. [39], laser light with higher irradiance (>300 $mW/cm^2$), when absorbed by nociceptors, exert an inhibitory effect on Aδ and C pain fibers, which slows conduction velocity, reduces amplitude of compound action potentials and suppresses neurogenic inflammation. Chow's own laboratory studies suggest that LLLT blocks anterograde transport of ATP-rich mitochondria in dorsal root ganglion neurons. Varicosities result from the inhibitive effect, which is normally associated with disruption of microtubules and the resulting block of anterograde transport of ATP-rich mitochondria. Interruption of fast axonal flow reduces the availability of ATP necessary for microtubule polymerization, and maintenance of the resting potential [39]. This effect is completely reversible and may last only 48 h [40–42], however, more work is needed to fully characterize the complex mechanism of action.

### 3.4. *Myofascial trigger points*

The palpable nodules in taut muscle bands and contraction of muscle fibers that lead to muscle spasms and limited joint movement are referred to as myofascial trigger points.

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**Table 3 – Dose parameters Time/Energy/Fluence ("Dose").**

| | | |
|---|---|---|
| Energy (Joules) | J | Calculated as: Power (W) × time (s) = Energy (J)<br>Using Joules as an expression of dose is potentially unreliable as it assumes an inverse relationship between power and time and ignores irradiance (Table 2) |
| Radiant exposure | J/cm$^2$ | Calculated as: Power (W) × time (s)/beam area = Radiant exposure (J/cm$^2$)<br>Using radiant exposure as an expression of dose is also potentially unreliable, as it assumes an inverse relationship between power, time and irradiance (Table 2). A reciprocal relationship would assume that similar therapeutic effects would be observed at the same radiant exposure regardless of I an t (e.g. high irradiance for short exposure times), which may not be the case |
| Irradiation time | s | Given the potential lack of reciprocity described above, the more accurate way to record and prescribe LLLT is to define the irradiation parameters, then define the irradiation time and not rely solely on the radiant exposure applied. Typically, treatment times are in the range 30–60 s per treatment point |
| Treatment interval | Hours, days or weeks | One treatment of acute injuries (or immediately post op) has clinically meaningful effects (though follow-up treatment the next day may also be welcomed by the patient). For chronic non-healing or chronic pain pathologies, LLLT typically requires two or three treatments a week for several weeks to achieve clinical significance |

They are a component of several pain conditions, including migraine, tension-type headaches, temporomandibular disorder and neck pain. The motor end plate is central to the etiology of the disorder and electromyography (EMG) studies have shown abnormally high electrical activity over trigger points. Electrical activity is reduced after LLLT and clinical studies have shown that LLLT has immediate and cumulative effects on reducing pain [43–46], however, the mechanism of action resulting on this effect is not yet fully elucidated.

## 4. LLLT parameters

For LLLT to be effective, the applied irradiation parameters including wavelength, power, irradiance, exposure time, and pulse need to be applied within limits.

### 4.1. *Irradiation parameters*

If the incorrect irradiation parameters are used or applied for the incorrect period of time, then treatment will likely be ineffective. If the irradiance is too low and/or the delivery time is too short, then there will also be no significant effect. Alternatively, if the irradiance is too high and/or the treatment time is too long, then the benefit is abrogated and sometimes unwanted inhibitory effects occur [47–49].

Unfortunately, many researchers fail to accurately measure or even report some of these parameters in their studies. This is due, in part, to a poor appreciation of the relevance of these parameters and also because some of these measurements require the use of expensive instrumentation by trained engineers or physicists [50].

Parameters should be considered in two parts: the 'medicine' and the 'dose' and are described in Tables 2 and 3.

### 4.2. *Dose*

Having established suitable irradiation parameters, they must be applied for the adequate exposure period. If the incorrect irradiation parameters are used or applied for the incorrect irradiation time, then treatment will likely be ineffective [47,48,52,53].

Energy (J) or energy density (fluence) (W/cm$^2$) is often, incorrectly, referred to as "dose". These are different calculations and, on their own, are both potentially flawed methods of reporting this therapy. Table 3 provides the formulas, the correct radiometric terms and discusses the associated limitations.

### 4.3. *Depth of penetration*

Wavelengths in the range 700–850 nm penetrate tissues well and may achieve 5 mW/cm$^2$ at 5 cm depth when beam power is 1 W and irradiance is 5 W/cm$^2$ (unpublished data). Smith's [54] report on photobiological fundamentals provides data on light penetration through the human hand. Broad spectrum light projected through this tissue and measurements using a spectrophotometer demonstrated that most visible light does not pass through the hand but far red and near-infrared in the range 670–900 nm penetrates particularly well, with two peaks around 725 nm and 810 nm. Similar studies on rats identified a tissue penetration peak at 810 nm [55].

### 4.4. *Treatment*

There are four common clinical targets for LLLT and include:

1. The site of injury, disease or dysfunction to promote healing, remodeling and reduce inflammation [56–60].
2. Lymph nodes to help reduce edema and inflammation [36,38,61].
3. Nerves to induce analgesia [39,40,42,62].
4. Trigger points to reduce tenderness and relax contracted muscle fibers [43–46].

Treatment times per therapy point are typically in the range of 30–60 s. As little as one treatment point may be exposed in some cases, but as many as 15 points may be treated for more complex dysfunction's such as temporo-mandibular joint disorder [43–46].

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**Table 4 – Glossary.**

| | |
|---|---|
| Beam profiler | An instrument for measuring the beam intensity distribution |
| Laser speckle | A random fuzzy looking pattern produced by coherent laser light. Technically speaking they are a random intensity pattern produced by the mutual interference of a set of wavefronts |
| LED | Light emitting diode. A narrow spectral width (one color) semiconductor light source |
| Off-label | Use for a condition other than that for which it has been officially approved by a regulatory authority (e.g. FDA in USA, CE for Europe, Health Canada, TGA in Australia) |
| "Per point" | The region of treatment which may be a small area for a single laser beam (<1 $cm^2$) or a large area of many $cm^2$ for a cluster/array of incorporating many laser diodes or LEDs |
| Systematic review | A review in which research about a topic has been systematically identified, appraised and summarized |
| Tissue remodeling | The third phase of tissue repair after inflammation and cell proliferation. |
| $1/e^2$ point | Light beams do not typically have defined edges and the beam distribution is not usually uniform. To calculate power density laser physicists use the mathematical function $1/e^2$ to define the area. This is the area in which 86.5% of the power is contained |

## 5. Safety

There is less risk associated with LLLT (particularly the LED systems) than for the class IV surgical lasers most Academy of Laser Dentistry (ALD) members are familiar with. The potential hazards are mostly ocular rather than representing any risk from excessive temperatures, as most LLLT devices are class 3B lasers or LEDs, though some LLLT devices are defocused class IV lasers. In most cases, LLLT devices emit divergent beams (not collimated), so the ocular risk diminishes over distance (in the range of several meters). Indeed, manufacturers are obliged to provide the nominal ocular hazard distance (NOHD) within their user instructions. ANSI Z136.3 (2011) is the current definitive USA document on laser safety in healthcare environments (www.ansi.org) and IEC 60825 is the International Standard. Part 8 provides guidelines for the safe use of laser beams on humans (www.iec.ch) and there is also a European Union directive aimed to improve the health and safety of workers and reducing risks arising from exposure to artificial optical radiation (2006/25/EC; osha.europa.eu).

### 5.1. *Contraindications*

The North American Association for Laser Therapy conference in 2010 held a consensus meeting on safety and contraindications. Their main recommendations were:

- EYES – Do not aim laser beams into the eyes and everyone present should wear appropriate safety spectacles.
- CANCER – Do not treat over the site of any known primary carcinoma or secondary metastasis unless the patient is undergoing chemotherapy; its use however can be considered in terminally ill cancer patients for palliative relief.
- PREGNANCY – Do not treat directly over a developing fetus (consequences unknown).
- EPILEPTICS – Be aware that low frequency pulsed visible light (<30 Hz) might trigger a seizure in photosensitive, epileptic patients. It is essential that patients are adequately protected from pulsing beams.

### 5.2. *Adverse effects*

The Lancet review on neck pain [1] reported that "half (of) the studies obtained data for side-effects, with tiredness reported in the laser-treated group in three studies, and this was significant in one study. An oral mucositis review [63] reported: "all (of) the studies investigated possible side-effects, but none found side-effects or adverse effects beyond those reported for placebo LLLT. Five trials reported explicitly that LLLT was well tolerated among patients".

A chronic joint disorder systematic review [44] reported: "In terms of side effects, six of the LLLT trials with optimal dose explicitly stated in their report that no adverse effects were observed. One trial however reported an incident of transient adverse effects for one patient in each group."

### 5.3. *USA Food and Drug Administration*

There are no LLLT devices cleared specifically for use in treating oral conditions that are currently reported within the literature. However, there are many devices cleared for temporary relief of muscle and joint pain that could be applied to TMJ dysfunction. Currently, other applications are likely to be "off label"(Table 4).

## 6. Conclusion

LLLT is a safe effective treatment to enable enhanced healing, better tissue remodeling, reduced inflammation and analgesia for use in a wide range of oral pathologies. It is drug free and relatively side-effect free and appears to be efficacious where many current pharmaceuticals are not [13–15,64–66].

## Acknowledgements

This report is independent research funded by the National Institute for Health Research (Invention for Innovation (I4I), Product Development Awards, II-LB-0712-20003). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.

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# Efficacy of red and infrared lasers in treatment of temporomandibular disorders--a double-blind, randomized, parallel clinical trial.

Pereira TS, Flecha OD, Guimaraes RC, de Oliveira D, Botelho AM, Ramos Gloria JC, Aguiar Tavano KT

AIM: Low-level laser therapy has still not been well established, and it is important to define a standardized protocol for the treatment of temporomandibular disorders (TMDs) using low level laser. There is no consensus on controlled clinical trials concerning the best option for laser therapy with regard to wavelength. The aim of this study was to evaluate the efficacy of red and infrared laser therapy in patients with TMD, using a randomized parallel-group double-blind trial. METHODOLOGY: Each hemiface of 19 subjects was randomized to receive intervention, in a total of 116 sensitive points. Pain was measured at baseline and time intervals of 24 hours, 30 days, 90 days, and 180 days after treatment. Irradiation of 4 J/cm2 in the temporomandibular joints and 8 J/cm(2) in the muscles was used in three sessions. RESULTS: Both treatments had statistically significant results (P<0.001); there was statistical difference between them at 180 days in favor of the infrared laser (P=0.039). There was improvement in 24 hours, which extended up to 180 days in both groups. CONCLUSION: Both lasers are effective in the treatment and remission of TMD symptoms.

Cranio 2014 Jan 32(1) 51-6

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24660647

# Evaluation of pain, jaw movements, and psychosocial factors in elderly individuals with temporomandibular disorder under laser phototherapy.

Rodrigues JH, Marques MM, Biasotto-Gonzalez DA, Moreira MS, Bussadori SK, Mesquita-Ferrari RA, Martins MD

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Few studies have been carried out on the application of laser phototherapy (LPT) for treating painful temporomandibular disorder (TMD) in elderly population that is growing worldwide. The aim of the present study was to evaluate the pain, jaw movements, and psychosocial factors in ten elderly patients with painful TMD before and after LPT. All patients were evaluated before and after LPT by using the Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD) axes I and II. For pain assessment, a visual analogue scale (VAS) was used. The LPT was carried out with an GaAlAs diode laser (780 nm; spot size 0.04 cm2) in punctual and contact mode. Two settings of irradiations were applied as follows: in patients presenting myofascial pain, 10 mW, 5 J/cm2, 20 s, 0.2 J per application point; and in patients with joint TMD, 70 mW, 105 J/cm2, 60 s on five points, 4.2 J per point. Two sessions of LPT were carried out per week over four consecutive weeks, in the total of eight sessions. Data was statistically analyzed ($p < 0.05$). Significant pain reduction was found in all patients. There were increase in maximum mouth opening without pain and reduction in muscle pain during right and left lateral excursion. A significant reduction in chronic pain severity ($p = 0.02$) and significant improvements in depression ($p = 0.038$) and nonspecific physical symptoms with pain ($p = 0.0167$) were observed. The present findings indicate that LPT is able to promote pain relief and improvement of jaw movements in elderly patients with TMD, with a positive effect on psychosocial aspects.

Lasers Med Sci 2013 Dec 24

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24366293

# Evaluation of anti-nociceptive and anti-inflammatory activity of low-level laser therapy on temporomandibular joint inflammation in rodents.

Barretto SR, de Melo GC, Dos Santos JC, de Oliveira MG, Pereira-Filho RN, Alves AV, Ribeiro MA, Lima-Verde IB, Quintans Junior LJ, de Albuquerque-Junior RL, Bonjardim LR

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The aim of this study was to investigate the analgesic and anti-inflammatory activity of low-level laser therapy (LLLT) on the nociceptive behavioral as well as histomorphological aspects induced by injection of formalin and carrageenan into the rat temporomandibular joint. The 2.5% formalin injection (FRG group) induced behavioral responses characterized by rubbing the orofacial region and flinching the head quickly, which were quantified for 45min. The pretreatment with systemic administration of diclofenac sodium-DFN group (10mg/kg i.p.) as well as the irradiation with LLLT infrared (LST group, 780nm, 70mW, 30s, 2.1J, 52.5J/cm(2), GaAlAs) significantly reduced the formalin-induced nociceptive responses. The 1% carrageenan injection (CRG group) induced inflammatory responses over the time-course of the study (24h, and 3 and 7days) characterized by the presence of intense inflammatory infiltrate rich in neutrophils, scanty areas of liquefactive necrosis and intense interstitial edema, extensive hemorrhagic areas, and enlargement of the joint space on the region. The DFN and LST groups showed an intensity of inflammatory response that was significantly lower than in CRG group over the time-course of the study, especially in the LST group, which showed exuberant granulation tissue with intense vascularization, and deposition of newly formed collagen fibers (3 and 7days). It was concluded that the LLLT presented an anti-nociceptive and anti-inflammatory response on the inflammation induced in the temporomandibular joint of rodents.

J Photochem Photobiol B 2013 Dec 5 129 135-42

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24231378

# Comparative clinical study of light analgesic effect on temporomandibular disorder (TMD) using red and infrared led therapy.

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Low-level laser therapy (LLLT) has been widely applied in pain relief in several clinical situations, including temporomandibular disorders (TMD). However, the effects of LED therapy on TMD has not been investigated. This study aims to evaluate the effects of red and infrared LEDs on: (1) tissue temperature in ex vivo and (2) pain relief and mandibular range of motion in patients with TMD. Thirty patients between 18 and 40 years old were included and randomly assigned to three groups. The two experimental groups were: the red LED (630 +/- 10 nm) group and the infrared LED (850 +/- 10 nm) group. The irradiation parameters were 150 mW, 300 mW/cm2, 18 J/cm2, and 9 J/point. The positive control group received an infrared laser (780 nm) with 70 mW, 1.7 W/cm2, 105 J/cm2, and 4.2 J/point. LED and laser therapies were applied bilaterally to the face for 60 s/point. Five points were irradiated: three points around the temporomandibular joint (TMJ), one point for the temporalis, and one near the masseter. Eight sessions of phototherapy were performed, twice a week for 4 weeks. Pain induced by palpating the masseter muscle and mandibular range of motion (maximum oral aperture) were measured at baseline, immediately after treatment, 7 days after treatment, and 30 days after treatment. There was an increase in tissue temperature during both the red and the infrared LED irradiation in ex vivo. There was a significant reduction of pain and increase of the maximum oral aperture for all groups ($p >/= 0.05$). There was no significant difference in pain scores and maximum oral aperture between groups at baseline or any periods after treatment ($p >/= 0.05$). The current study showed that red and infrared LED therapy can be useful in improving outcomes related to pain relief and orofacial function for TMD patients. We conclude that LED devices constitute an attractive alternative for LLLT.

Lasers Med Sci 2013 Oct 3

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24197518

# The efficacy of low-level laser therapy for the treatment of myogenous temporomandibular joint disorder.

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Low-level laser therapy (LLLT) has been commonly used for the treatment of painful musculoskeletal conditions, but the results of previous studies on this subject are controversial. The aim of this study was to evaluate the efficacy of LLLT in the management of patients with myogenic temporomandibular joint disorders (TMDs). In this randomized, double-blind clinical trial, 20 patients with myogenic TMD were randomly divided into laser and placebo groups. In the laser group, a pulsed 810-nm low-level laser (average power 50 mW, peak power 80 W, 1,500 Hz, 120 s, 6 J, and 3.4 J/cm(2) per point) was used on painful muscles three times a week for 4 weeks. In the placebo group, the treatment was the same as that in the laser group, but without energy output. The patients were evaluated before laser therapy (T1), after six sessions of laser application (T2), at the end of treatment (T3), and 1 month after the last application (T4), and the level of pain and the amount of mouth opening were measured. There was a significant increase in mouth opening and a significant reduction of pain symptoms in the laser group ($p < 0.05$). A similar improvement was not observed in the placebo group ($p > 0.05$). Between-group comparisons revealed no significant difference in pain intensity and mouth opening measurement at any of the evaluation time points ($p > 0.05$). LLLT can produce a significant improvement in pain level and mouth opening in patients affected with myogenic TMD.

Lasers Med Sci 2013 Jan 15

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23318917

# Low level laser therapy as an adjunctive technique in the management of temporomandibular disorders.

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The purpose of this study was to assess the effect of low level laser therapy on subjects with intra-articular temporomandibular disorders (IA-TMD), and to quantify and compare severity of signs and symptoms before, during, and after the laser applications. The sample consisted of 45 subjects randomly divided into three groups (G) of 15 subjects each: G-I: 15 individuals with IA-TMD submitted to an energy dose of 52.5 J/cm2; G-II: dose of 105.0 J/cm2; and G-III: placebo group (0 J/cm2). In all groups, the applications were performed on condylar points on the masseter and anterior temporalis muscles. Two weekly sessions were held for five weeks, totaling 10 applications. The assessed variables were: mandibular movements and painful symptoms evoked by muscle palpation. These variables were measured before starting the study, then immediately after the first, fifth, and tenth laser application, and finally, 32 days after completing the applications. The results showed that there were statistically significant differences for G-I and G-II at the level of 1% between the doses, as well as between assessments. Therefore, it was concluded that the use of low level laser increased the mean mandibular range of motion and reduced painful symptoms in the groups that received effective treatment, which did not occur in the placebo group.

Cranio 2012 Oct 30(4) 264-71

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23156967

# Evaluation of low-level laser therapy effectiveness on the pain and masticatory performance of patients with myofascial pain.

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This study investigated the effect of low-level laser therapy (LLLT) on the masticatory performance (MP), pressure pain threshold (PPT), and pain intensity in patients with myofascial pain. Twenty-one subjects, with myofascial pain according to Research Diagnostic Criteria/temporomandibular dysfunction, were divided into laser group (n = 12) and placebo group (n = 9) to receive laser therapy (active or placebo) two times per week for 4 weeks. The measured variables were: (1) MP by analysis of the geometric mean diameter (GMD) of the chewed particles using Optocal test material, (2) PPT by a pressure algometer, and (3) pain intensity by the visual analog scale (VAS). Measurements of MP and PPT were obtained at three time points: baseline, at the end of treatment with low-level laser and 30 days after (follow-up). VAS was measured at the same times as above and weekly throughout the laser therapy. The Friedman test was used at a significance level of 5 % for data analysis. The study was approved by the Ethics Committee of the Federal University of Sergipe (CAAE: 0025.0.107.000-10). A reduction in the GMD of crushed particles ($p < 0.01$) and an increase in PPT ($p < 0.05$) were seen only in the laser group when comparing the baseline and end-of-treatment values. Both groups showed a decrease in pain intensity at the end of treatment. LLLT promoted an improvement in MP and PPT of the masticatory muscles.

Lasers Med Sci 2012 Nov 10

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23143142

# Effectiveness of Physiotherapy and GaAlAs Laser in the Management of Temporomandibular Joint Disorders.

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Abstract Objective: Low-level laser therapy (LLLT) is a treatment method commonly used in physiotherapy for musculoskeletal disorders. The aim of this study was to monitor the function of temporomandibular joint (TMJ) and surrounding tissues and compare the objective measurements of the effect of LLLT. Background data: LLLT has been considered effective in reducing pain and muscular tension; thus improving the quality of patients' lives. Materials and Methods: TMJ function was evaluated by cephalometric tracing analysis, orthopantomogram, TMJ tomogram, and computer face-bow record. Interalveolar space between central incisors before and after therapy was measured. Patients evaluated pain on the Visual Analog Scale. LLLT was performed in five treatment sessions (energy density of 15.4 J/cm(2)) by semiconductive GaAlAs laser with an output of 280 mW, emitting radiation wavelength of 830 mm. The laser supplied a spot of approximately 0.2 cm(2). Results: Baseline comparisons between the healthy patients and patients with low-level laser application show that TMJ pain during function is based on anatomical and function changes in TMJ areas. Significant differences were seen in the posterior and anterior face height. The results comparing healthy and impaired TMJ sagittal condyle paths showed that patients with TMJ pain during function had significantly flatter nonanatomical movement during function. After therapy, the unpleasant feeling was reduced from 27.5 to 4.16 on the pain Visual Analog Scale. The pain had reduced the ability to open the mouth from 34 to 42 mm. Conclusions: The laser therapy was effective in the improvement of the range of temporomandibular disorders (TMD) and promoted a significant reduction of pain symptoms.

Photomed Laser Surg 2012 May 30(5) 275-80

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22551049

# Evaluation of low-level laser therapy in patients with acute and chronic temporomandibular disorders.

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The purpose of this study was to address the following question: among patients with acute or chronic temporomandibular disorders (TMD), does low-level laser therapy (LLLT) reduce pain intensity and improve maximal mouth opening? The sample comprised myogenic TMD patients (according Research Diagnostic Criteria for TMD). Inclusion criteria were: male/female, no age limit, orofacial pain, tender points, limited jaw movements and chewing difficulties. Patients with other TMD subtypes or associated musculoskeletal/rheumatologic disease, missing incisors teeth, LLLT contra-indication, and previous TMD treatment were excluded. According to disease duration, patients were allocated into two groups, acute (<6 months) and chronic TMD (>/=6 months). For each patient, 12 LLLT sessions were performed (gallium-aluminum-arsenide; lambda = 830 nm, P = 40 mW, CW, ED = 8 J/cm(2)). Pain intensity was recorded using a 10-cm visual analog scale and maximal mouth opening using a digital ruler (both recorded before/after LLLT). The investigators were previously calibrated and blinded to the groups (double-blind study) and level of significance was 5% ($p < 0.05$). Fifty-eight patients met all criteria, 32 (acute TMD), and 26 (chronic TMD). Both groups had a significant pain intensity reduction and maximal mouth opening improvement after LLLT (Wilcoxon test, $p < 0.001$). Between the groups, acute TMD patient had a more significant pain intensity reduction (Mann-Whitney test, $p = 0.002$) and a more significant maximal mouth opening improvement (Mann-Whitney test, $p = 0.011$). Low-level laser therapy can be considered as an alternative physical modality or supplementary approach for management of acute and chronic myogenic temporomandibular disorder; however, patients with acute disease are likely to have a better outcome.

Lasers Med Sci 2012 Feb 25

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22367394

# [Efficacy evaluation of low-level laser therapy on temporomandibular disorder].

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OBJECTIVE: To evaluate effectiveness of low-level laser therapy (LLLT) on temporomandibular joint (TMJ) pain. METHODS: The patients with TMJ pain were randomly assigned laser group (n=21) or control group(n=21), once a day for 6 consecutive days of treatment. TMJ pain and function were measured at baseline, just after treatment course, 1 month and 2 months after the treatment. RESULTS: The changes of visual analogue scale (VAS) were appearing over time in both groups but presented statistically significant differences between groups (P<0.001). VAS of laser group decreased faster than that of control group. The same tendency occurred for painless maximum vertical opening (MVO), left lateral excursion (LLE) and right lateral excursion (RLE), which increased faster in laser group. There were no statistically significant differences between groups and evaluation times for protrusion excursion (PE), but an interaction between group and evaluation times existed and should be explored further. CONCLUSION: LLLT is an appropriate treatment for TMJ pain.

Hua Xi Kou Qiang Yi Xue Za Zhi 2011 Aug 29(4) 393-5, 399

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21932661

# Management of myofascial pain: low-level laser therapy versus occlusal splints.

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The present study was designed to compare the effects of low-level laser with occlusal splints in patients with signs and symptoms of myofascial pain (MP) dysfunction syndrome. A total of 40 (34 women and 6 men, with a mean age of 32.84 [SD, 10.70] years) were selected after the diagnosis of MP according to the Research Diagnostic Criteria for Temporomandibular Disorder. The patients were randomly divided into 2 groups: study group (n = 20) and control group (n = 20). Low-level laser was applied to patients in the study group 2 times per week, for a total of 10 sessions. Patients in the control group were instructed to wear occlusal splints 24 h/d for 3 months. The functional examination was based on Research Diagnostic Criteria for Temporomandibular Disorder and pressure pain threshold values were obtained with the aid of an algometer in both groups. Patients' self-report of pain was evaluated with visual analog scale. Comparisons were made within and between the groups before and after treatment. Vertical movements showed statistically significant improvements after the treatments in both groups ($P < 0.01$), but when the groups were compared with each other, there were no significant difference between the groups. In both groups, tenderness to palpation of the muscles decreased significantly. Pressure pain threshold evaluations and visual analog scale scores revealed similar results, too. This particular type of low-level laser therapy (820 nm, 3 J/cm2, 300-mW output power) is as effective as occlusal splint in pain release and mandibular movement improvement in MP.

J Craniofac Surg 2010 Nov 21(6) 1722-8

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21119408

# Measurements of jaw movements and TMJ pain intensity in patients treated with GaAlAs laser.

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The aim of this study was to evaluate the effectiveness of low-level laser therapy (LLLT) on the improvement of the mandibular movements and painful symptoms in individuals with temporomandibular disorders (TMD). Forty patients were randomly divided into two groups (n=20): Group 1 received the effective dose (GaAlAs laser lambda 830 nm, 40 mW, 5J/cm(2)) and Group 2 received the placebo application (0 J/cm(2)), in continuous mode on the affected condyle lateral pole: superior, anterior, posterior, and posterior-inferior, twice a week during 4 weeks. Four evaluations were performed: E1 (before laser application), E2 (right after the last application), E3 (one week after the last application) and E4 (30 days after the last application). The Kruskal-Wallis test showed significant more improvements ($p<0.01$) in painful symptoms in the treated group than in the placebo group. A significant improvement in the range of mandibular movements was observed when the results were compared between the groups at E4. Laser application can be a supportive therapy in the treatment of TMD, since it resulted in the immediate decrease of painful symptoms and increased range of mandibular movements in the treated group. The same results were not observed in the placebo group.

Braz Dent J 2010 21(4) 356-60

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20976388

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

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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.

Clin J Pain 2010 Sep 26(7) 611-6

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20664343

# Lasertherapy efficacy in temporomandibular disorders: control study.

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Temporomandibular dysfunction is characterized by the presence of painful joint/muscular symptoms muscle in the face. The main justification for the use of lasers in laser therapy dysfunction is its analgesic effect, which was observed in most studies in the literature. AIM: We evaluated the effectiveness of laser therapy in the treatment of temporomandibular disorders. METHODS: 50 volunteers with temporomandibular disorders were divided into two groups (control and experimental) had amplitudes of movements of mouth opening, right and left laterality recorded before and after laser application. Was also recorded, the score the individual gave to pain by visual analog scale and, through physical examination, the pain points. We used the AsGaAl laser with a 40mW power, with 80J/cm(2) for 16 seconds at four selected points for just one session with reassessment after a week. Study design: Clinical. RESULTS: It was noted that laser therapy increased the mean amplitude of mandibular movements ($p = 0.0317$) and decreased significantly (43.6%) the pain intensity measured by the visual analog scale. CONCLUSIONS: The laser decreases the painful symptoms of the patient after application through its analgesic and/or a placebo effect.

Braz J Otorhinolaryngol 2010 Jun 76(3) 294-9

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20658006

# Wavelength effect in temporomandibular joint pain: a clinical experience.

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Temporomandibular disorders (TMDs) are common painful multifactorial conditions affecting the temporomandibular joint (TMJ) and whose treatment depends on the type and symptoms. Initially, it requires pain control, and, for this, drugs, biting plates, occlusal adjustment, physiotherapy or their association are used. Lately, laser phototherapy (LPT) has been used in the treatment of pain of several origins, including TMDs. This study reports the treatment of a selected group of 74 patients treated at the Laser Center of the Federal University of Bahia between 2003 and 2008. Following standard anamneses, clinical and imaging examination and with the diagnosis of any type of TMD, the patients were prepared for LPT. No other intervention was carried out during the treatment. Treatment consisted of three sessions a week for 6 weeks. Prior to irradiation, the patients were asked to score their pain using a visual analog scale (VAS). Lasers of wavelength (lambda)780 nm, lambda790 nm or lambda830 nm and/or lambda660 nm were used at each session (30/40 mW; spot (varphi) approximately 3 mm; mean dose per session 14.2 +/- 6.8 J/cm(2); mean treatment dose of 170 +/- 79.8 J/cm(2)). Of the patients, 80% were female ( approximately 46 years old). At the end of the 12 sessions the patients were again examined, and they scored their pain using the VAS. The results were statistically analyzed and showed that 64% of the patients were asymptomatic or had improved after treatment and that the association of both wavelengths was statistically significant (P = 0.02) in the asymptomatic group. It was concluded that the association of red and infrared (IR) laser light was effective in pain reduction on TMJ disorders of several origins.

Lasers Med Sci 2009 Jun 30

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19565312

# Low intensity laser therapy in temporomandibular disorder: a phase II double-blind study.

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The purpose of this study was to evaluate the analgesic effect of Low Intensity Laser Therapy (LILT) and its influence on masticatory efficiency in patients with temporomandibular dysfunction (TMD). This study was performed using a random, placebo-controlled, and double-blind research design. Fourteen patients were selected and divided into two groups (active and placebo). Infrared laser (780 nm, 70 mw, 60s, 105J/cm2) was applied precisely and continuously into five points of the temporomandibular joint (TMJ) area: lateral point (LP), superior point (SP), anterior point (AP), posterior point (PP), and posterior-inferior point (PIP) of the condylar position. This was performed twice per week, for a total of eight sessions. To ensure a double-blind study, two identical probes supplied by the manufacturer were used: one for the active laser and one for the inactive placebo laser. They were marked with different letters (A and B) by a clinician who did not perform the applications. A Visual Analogue Scale (VAS) and a colorimetric capsule method were employed. Data were obtained three times: before treatment (Ev1), shortly after the eighth session (Ev2), and 30 days after the first application (Ev3). Statistical tests revealed significant differences at one percent (1%) likelihood, which implies that superiority of the active group offered considerable TMJ pain improvement. Both groups presented similar masticatory behavior, and no statistical differences were found. With regard to the evaluation session, Ev2 presented the lowest symptoms and highest masticatory efficiency throughout therapy. Therefore, low intensity laser application is effective in reducing TMD symptoms, and has influence over masticatory efficiency [Ev2 (0.2423) and Ev3 (0.2043), observed in the interaction Evaluations x Probes for effective dosage].

Cranio 2008 Oct 26(4) 274-81

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19004308

# Effectiveness of low-level laser therapy in temporomandibular joint disorders: a placebo-controlled study.

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OBJECTIVE: Low-level laser therapy (LLLT) treatment for pain caused by temporomandibular joint disorders (TMD) was investigated in a controlled study comparing applied energy density, subgroups of TMD, and duration of disorders. BACKGROUND DATA: Although LLLT is a physical therapy used in the treatment of musculoskeletal disorders, there is little evidence for its effectiveness in the treatment of TMD. METHODS: The study group of 61 patients was treated with 10 J/cm(2) or 15 J/cm(2), and the control group of 19 patients was treated with 0.1 J/cm(2). LLLT was performed by a GaAlAs diode laser with output of 400 mW emitting radiation wavelength of 830 nm in 10 sessions. The probe with aperture 0.2 cm(2) was placed over the painful muscle spots in the patients with myofascial pain. In patients with TMD arthralgia the probe was placed behind, in front of, and above the mandibular condyle, and into the meatus acusticus externus. Changes in pain were evaluated by self-administered questionnaire. RESULTS: Application of 10 J/cm(2) or 15 J/cm(2) was significantly more effective in reducing pain compared to placebo, but there were no significant differences between the energy densities used in the study group and between patients with myofascial pain and temporomandibular joint arthralgia. Results were marked in those with chronic pain. CONCLUSION: The results suggest that LLLT (application of 10 J/cm(2) and 15 J/cm(2)) can be considered as a useful method for the treatment of TMD-related pain, especially long lasting pain.

Photomed Laser Surg 2007 Aug 25(4) 297-303

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17803388

# Low intensity laser application in temporomandibular disorders: a phase I double-blind study.

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The purpose of this study was to evaluate the effectiveness of low intensity laser therapy (LILT) for the control of pain from temporomandibular disorder (TMD) in a random and double-blind research design. Forty-eight (48) patients presenting temporomandibular joint (TMJ) pain were divided into an experimental group (GI) and a placebo group (GII). The sample was submitted to the treatment with infrared laser (780 nm, 70 mW, 10 s, 89.7 J/cm2) applied in continuous mode on the affected temporomandibular region, at one point: inside the external auditive duct toward the retrodiskal region, twice a week, for four weeks. For the control group, two identical probes (one active and one that does not emit radiation) were used unknown by the clinician and the subjects. A tip planned for laser acupuncture was used and connected to the active point of the probe. The parameter evaluated was the intensity of pain after palpation of the condylar lateral pole, pre-auricular region and external auditive duct, according to the Visual Analogue Scale (VAS). Four evaluations were performed: Ev1 (before laser application), Ev2 (after 4th application), Ev3 (after 8th application) and Ev4 (30 days after the last application). Data were submitted to statistical analysis. The results showed a decrease in the pain level mainly for the active probe. Among the evaluations, the Ev3 exhibited lower sensitivity to palpation. In conclusion, the results show that low intensity laser is an effective therapy for the pain control of subjects with TMD.

Cranio 2007 Jul 25(3) 186-92

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17696035

# Evaluation of low-level laser therapy in the treatment of temporomandibular disorders.

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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.

Photomed Laser Surg 2006 Oct 24(5) 637-41

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17069496

# Arthralgia of the temporomandibular joint and low-level laser therapy.

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OBJECTIVE: This case report describes the treatment of a patient with arthralgia of the temporomandibular joint (TMJ) caused by disc displacement. BACKGROUND DATA: The goal of the treatment of TMJ arthralgia is to decrease pain by promotion of the musculoskeletal system's natural healing ability. METHODS: This report describes the complex treatment of TMJ arthralgia. Low-level laser therapy (LLLT) was chosen for its antiinflammatory and analgesic effects. Laser therapy was carried out using the GaAlAs diode laser with an output power of 400 mW, emitting radiation with a wavelength of 830 nm, and having energy density of 15 J/cm2; the laser radiation was applied by contact mode on four targeted spots in 10 sessions. Physiotherapy was recommended to this patient to prevent the injury of intraarticular tissue caused by incorrect movement during opening of the mouth. Splint stabilization and prosthetic treatment were used to reduce overloading of the TMJ, resulting from unstable occlusion and to help repositioning of the dislocated disc. RESULTS: Five applications of LLLT led to decrease of pain in the area of the TMJ on the Visual Analog Scale, from 20 to 5 mm. The anti-inflammatory effect of the laser was confirmed by thermographic examination. Before treatment, the temperature differences between the areas of the normal TMJ and TMJ with arthralgia was higher than 0.5 degrees C. However, at the conclusion of LLLT, temperatures in the areas surrounding the TMJ were equalized. CONCLUSION: This study showed the effectiveness of complex non-invasive treatment in patients with arthralgia of the TMJ. The analgesic and anti-inflammatory effects of LLLT were confirmed by infrared thermography.

Photomed Laser Surg 2006 Aug 24(4) 522-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16942435

# Management of mouth opening in patients with temporomandibular disorders through low-level laser therapy and transcutaneous electrical neural stimulation.

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OBJECTIVE: The aim of this study was to evaluate the effectiveness of low-level laser therapy (LLLT) and transcutaneous electrical neural stimulation (TENS) on the improvement of mouth opening in patients with temporomandibular disorder (TMD). BACKGROUND DATA: TMDs are conditions that affect the form and/or function of the temporomandibular joint (TMJ), masticatory muscles, and dental apparatus. Often TMD is associated with pain localized in the TMJ and/or in the muscles of the face and neck. METHODS: This clinical trial was performed in 10 patients, 18-56 years old, diagnosed with TMD of multiple causes. All patients received both methods of treatment in two consecutive weeks. LLLT was delivered via a 670-nm diode laser, output power 50 mW, fluence 3 J per site/4 sites (masseter muscle, temporal muscle, mandibular condyle, and intrauricular). TENS therapy was applied with a two-electrode machine at 20 W, maximum frequency of 60 Hz, adjusted by the patient according to their sensitivity. The amplitude of mouth opening was recorded before treatment and immediately after using a millimeter rule; the measurements were performed from the incisal of the upper incisors to the incisal of the lower incisors. A paired t-test was applied to verify the significance of the results. RESULTS: A significant improvement in the range of motion for both therapies was observed immediately after treatment. Comparing the two methods, the values obtained after LLLT were significantly higher than those obtained after TENS ($p < 0.01$). CONCLUSIONS: Both methods are effective to improve mouth opening. Comparing the two methods, LLLT was more effective than TENS applications.

Photomed Laser Surg 2006 Feb 24(1) 45-9

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16503788

# Laser application effects on the bite strength of the masseter muscle, as an orofacial pain treatment.

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OBJECTIVE: The present research studies the effects of AsGaAl (low-intensity laser) on the bite strength of the masseter muscle in order to evaluate the contribution of laser therapy in patients with orofacial pain. BACKGROUND DATA: Studies on laser therapy suggest its usefulness in the treatment of temporomandibular disorders. This paper presents the effects of low-intensity laser in the contraction of the masseter muscle in patients with neuromuscular discomfort. METHODS: Fifteen patients of both genders, ages 19-29, suffering from pain in the masseter muscle, were exposed to laser application (AsGaAl) applied from a 2-mm distance. RESULTS: All patients showed improvement in muscle contraction strength of about 2.51-3.01 kgf on the right and left masseter muscle. CONCLUSIONS: These results suggest that low-level laser application is an effective tool for the treatment of patients with orofacial pain.

Photomed Laser Surg 2005 Aug 23(4) 373-6

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16144479

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

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We investigated if low level laser therapy (LLLT) of the joint capsule can reduce pain in chronic joint disorders. A literature search identified 88 randomised controlled trials, of which 20 trials included patients with chronic joint disorders. Six trials were excluded for not irradiating the joint capsule. Three trials used doses lower than a dose range nominated a priori for reducing inflammation in the joint capsule. These trials found no significant difference between active and placebo treatments. The remaining 11 trials including 565 patients were of acceptable methodological quality with an average PEDro score of 6.9 (range 5-9). In these trials, LLLT within the suggested dose range was administered to the knee, temporomandibular or zygapophyseal joints. The results showed a mean weighted difference in change of pain on VAS of 29.8 mm (95% CI, 18.9 to 40.7) in favour of the active LLLT groups. Global health status improved for more patients in the active LLLT groups ( relative risk of 0.52; 95% CI 0.36 to 0.76). 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

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=12775206

# Low-level laser therapy is an important tool to treat disorders of the maxillofacial region.

Pinheiro AL, Cavalcanti ET, Pinheiro TI, Alves MJ, Miranda ER, De Quevedo AS, Manzi CT, Vieira AL, Rolim AB

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OBJECTIVES: The authors report on the effects of low-level laser therapy (LLLT) in the treatment of maxillofacial disorders. SUMMARY AND BACKGROUND DATA: Further to our previous studies, this paper reports the results of the use of LLLT on the treatment of several disorders of the oral and maxillofacial region. This paper presents LLLT as an effective method of treating such disorders. METHODS: Two hundred and five female and 36 male patients ages between 7 and 81 years old (average 38.9 years old), suffering from disorders of the maxillofacial region, were treated with 632.8, 670, and 830 nm diode lasers at the Laser Center of the Universidade Federal de Pernambuco, Recife, Brazil (UFPE). The disorders included temporomandibular joint (TMJ) pain, trigeminal neuralgia, muscular pain, aphatae, inflammation, and tooth hypersensitivity postoperatively and in small hemangiomas. Most treatment consisted of a series of 12 applications (twice a week) and in 15 cases a second series was applied. Patients were treated with an average dose of 1.8 J/cm2. RESULTS: One hundred fifty four out of 241 patients were asymptomatic at the end of the treatment, 50 improved considerably, and 37 were symptomatic. CONCLUSIONS: These results confirm that LLLT is an effective tool and is beneficial for the treatment of many disorders of the maxillofacial region.

J Clin Laser Med Surg 1998 Aug 16(4) 223-6

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=9796491

# 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 myofacial 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(2). 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 and10 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.

Photomed Laser Surg 2011 Sep 9

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21905852

# Can low reactive-level laser therapy be used in the treatment of neurogenic facial pain? A double-blind, placebo controlled investigation of patients with trigeminal neuralgia

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Neurogenic facial pain has been one of the more difficult conditions to treat, but the introduction of laser therapy now permits a residual group of patients hitherto untreatable to achieve a life free from or with less pain. The present investigation was designed as a double-blind, placebo controlled study to determine whether low reactive-level laser therapy (LLLT) is effective for the treatment of trigeminal neuralgia. Two groups of patients (14 and 16) were treated with two probes. Neither the patients nor the dental surgeon were aware of which was the laser probe until the investigation had been completed. Each patient was treated weekly for five weeks. The results demonstrate that of 16 patients treated with the laser probe, 10 were free from pain after completing treatment and 2 had noticeably less pain, while in 4 there was little or no change. After a one year follow-up, 6 patients were still entirely free from pain. In the group treated with the placebo system, i.e. the non-laser probe, one was free from pain, 4 had less pain, and the remaining 9 patients had little or no recovery. After one year only one patient was still completely free from pain. The use of analgesics was recorded and the figures confirmed the fact that LLLT is effective in the treatment of trigeminal neuralgia. It is concluded that the present study clearly shows that LLLT treatment, given as described, is an effective method and an excellent supplement to conventional therapies used in the treatment of trigeminal neuralgia.

Key words: Low reactive-level laser therapy, trigeminal neuralgia, short and long term results, double-blind, placebo effect, controlled study

Laser therapy 1996:8:247 – 252

# Laser Therapy for Pain of Trigeminal Neuralgia

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The pain of trigeminal neuralgia is thought to be triggered by abnormal afferent impulses from the trigeminal nerve. Such a hypothesis may explain the efficacy of antiepileptic drugs in treating the pain. One experimental model for trigeminal neuralgia is the prolonged firing' of neurons in the spinal trigeminal nucleus oralis of cats after stimulation of the maxillary nerve. Stimulation of ipsilateral and contralateral fibers, as well as forelimb cutaneous and muscle afferents in animals, inhibits afferent trigeminal impulses. Both oral and extraoral vibratory and extraoral electrical stimulation inhibit orofacial pain in humans. If laser irradiation alters neuronal firing ' it is reasonable to assume that repeated irradiation to peripheral nerves and to the oral region in humans may raise the threshold of spinal trigeminal neurons and thus relieve pain.

Human subjects (N-18) received irradiation of the skin overlying peripheral nerves with a helium-neon laser (lmw, 632.5nm, 2OHz) for 20 s to each site. This treatment was accompanied by irradiation of the skin overlying painful facial areas for 30-90 9 according to a predetermined protocol. Control subjects (N-17) received placebo treatment by an apparatus that looked identical to the laser apparatus but emitted no radiation. Laser or placebo therapy was repeated 3 times a week for 10 weeks. Subjects in the experimental group exhibited a statistically significant reduction in the intensity of pain as measured by the visual analog scale ($p < 0.002$) and the number of painful episodes. These results, combined with previous research, indicate that laser therapy may provide relief from some kinds of chronic pain.

This research supports the notion that the peripheral nervous system may be photosensitive. For example, various types of laser alter the firing pattern of isolated cells via a non-thermal mechanism. In particular, transcutaneous irradiation with a low-power helium-neon laser (632.5nm) produces long-term suppression of a spinal cord reflex and application of a lower power argon laser (488nm; 25mw) suppresses epileptic discharge in rat brain slices in vitro. Future research must be done to discern the mechanism of photosensitivity of nerves.

not available online, contact James Carroll

# Low-level laser therapy is an important tool to treat disorders of the maxillofacial region.

Pinheiro AL, Cavalcanti ET, Pinheiro TI, Alves MJ, Miranda ER, De Quevedo AS, Manzi CT, Vieira AL, Rolim AB

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OBJECTIVES: The authors report on the effects of low-level laser therapy (LLLT) in the treatment of maxillofacial disorders. SUMMARY AND BACKGROUND DATA: Further to our previous studies, this paper reports the results of the use of LLLT on the treatment of several disorders of the oral and maxillofacial region. This paper presents LLLT as an effective method of treating such disorders. METHODS: Two hundred and five female and 36 male patients ages between 7 and 81 years old (average 38.9 years old), suffering from disorders of the maxillofacial region, were treated with 632.8, 670, and 830 nm diode lasers at the Laser Center of the Universidade Federal de Pernambuco, Recife, Brazil (UFPE). The disorders included temporomandibular joint (TMJ) pain, trigeminal neuralgia, muscular pain, aphatae, inflammation, and tooth hypersensitivity postoperatively and in small hemangiomas. Most treatment consisted of a series of 12 applications (twice a week) and in 15 cases a second series was applied. Patients were treated with an average dose of 1.8 J/cm2. RESULTS: One hundred fifty four out of 241 patients were asymptomatic at the end of the treatment, 50 improved considerably, and 37 were symptomatic. CONCLUSIONS: These results confirm that LLLT is an effective tool and is beneficial for the treatment of many disorders of the maxillofacial region.

J Clin Laser Med Surg 1998 Aug 16(4) 223-6

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=9796491

# A randomized clinical trial of the effect of low-level laser therapy before composite placement on postoperative sensitivity in class V restorations.

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This study aimed to investigate the efficacy of low-level laser irradiation when applied just before placement of resin composite on reducing postoperative sensitivity of class V lesions. In this randomized clinical trial, 31 patients with 62 class V cavities were included (two teeth in each participant). The teeth were randomly assigned into laser and placebo groups. After cavity preparation, the teeth in the experimental group were subjected to irradiation from a low-power red laser (630 nm, 28 mW, continuous wave, 60 s, 1.68 J), which was applied for 1 min on the axial wall of the cavity. In the control group, the same procedure was performed but with laser simulation. Then, a self-etch adhesive was applied and the cavities were restored with a microhybrid resin composite. Before treatment and on days 1, 14, and 30 after treatment, tooth sensitivity to a cold stimulus was recorded using a visual analogue scale. Data were analyzed by Friedman and Wilcoxon signed-rank tests ($p < 0.05$). Pain scores after restorative procedures were significantly lower in the laser group compared to the placebo application ($p < 0.05$). Although both groups experienced a significant improvement in pain and discomfort throughout the follow-up periods ($p < 0.001$), the changes in visual analogue scale (VAS) scores between baseline and each follow-up examination were significantly greater in the laser than the placebo group ($p < 0.05$). Low-level laser therapy (LLLT) before placement of resin composite could be suggested as a suitable approach to reduce postoperative sensitivity in class V restorations.

Lasers Med Sci 2014 May 9

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24811085

# Use of low level laser therapy for oral lichen planus: report of two cases.

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Oral Lichen Planus is a chronic inflammatory disease of unknown etiology. Erosive/ ulcerative oral lichen planus is often a painful condition that tends to become malignant, urging appropriate therapy. Laser therapy has recently been suggested as a new treatment option without significant side effects. This article presents two cases of erosive/ ulcerative oral lichen planus, who had not received any treatment before, treated with 630 nm low level laser. Lesion type and pain was recorded before and after treatment. Severity of lesions and pain were reduced after treatment. Low Level Laser Therapy was an effective treatment with no side effects and it may be considered as an alternative therapy for erosive/ulcerative oral lichen planus.

J Dent (Shiraz) 2013 Dec 14(4) 201-4

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24724146

# Efficacy of low-level laser therapy in treatment of recurrent aphthous ulcers - a sham controlled, split mouth follow up study.

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Introduction: Apthous 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 +/- 1.10 days as compared to 8.90 +/- 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.

J Clin Diagn Res 2014 Feb 8(2) 218-21

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24701539

# Does low-level laser therapy decrease swelling and pain resulting from orthognathic surgery?

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Low-level laser therapy (LLLT) could be an alternative for the treatment of swelling and pain after orthognathic surgery, but there is a paucity of data in the literature on the effects of its use. This study verified the efficacy of an LLLT protocol to reduce swelling and pain after orthognathic surgery. Ten healthy patients who underwent a bilateral sagittal split with Le Fort I osteotomy were randomly selected for this study. The LLLT protocol consisted of intraoral and extraoral application to one side of the face after surgery (irradiated side); application to the other side was simulated (non-irradiated side). The irradiated and non-irradiated sides were compared regarding the swelling coefficient and were assessed for pain using a visual analogue scale. There were no significant differences between the irradiated and non-irradiated sides regarding swelling and pain in the immediate postoperative assessment. Swelling decreased significantly on the irradiated side in the postoperative assessments on days 3, 7, 15, and 30. Self-reported pain was less intense on the irradiated side at the 24-h (1.2 vs. 3.4) and 3-day (0.6 vs. 2.1) assessments, but at 7 days after surgery neither side showed pain. This LLLT protocol can improve the tissue response and reduce the pain and swelling resulting from orthognathic surgery.

Int J Oral Maxillofac Surg 2014 Mar 25

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24679851

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

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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. Study Design: This preliminary study is a randomized clinical trial, with an experimental group (n=17) which received laser light and a control group (n=14), placebo. All participants received laser applications, divided after surgery in days 1, 2, 3, 5, 10, 14, 21 and 28. Neurosensory impairment was evaluated clinically with 5 tests; visual analog scale (VAS) for pain and sensitivity, directional and 2 point discrimination, thermal discrimination, each one of them performed before and after surgery on day 1, and 1, 2 and 6 months. Participants and results evaluator were blinded to intervention. Variables were described with absolute frequencies, percentages and medians. Ordinal and dichotomous variables were compared with Mann Whitney's and Fisher's test respectively. Results: Results demonstrate clinical improvement in time, as well as in magnitude of neurosensory return for laser group; VAS for sensitivity reached 5 (normal), 10 participants recovered initial values for 2 point discrimination (62,5%) and 87,5% recovered directional discrimination at 6 months after surgery. General VAS for sensitivity showed 68,75% for laser group, compared with placebo 21,43% (p-value = (0.0095)). Left side sensitivity (VAS) showed 3.25 and 4 medians for placebo and laser at 2 months, respectively (p-value = (0.004)). 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

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24608207

# Effects of low-level laser therapy on orthodontics: rate of tooth movement, pain, and release of RANKL and OPG in GCF.

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The aim of the study was evaluate tooth movement, receptor activator of nuclear factor KB ligand (RANKL), osteoprotegerin (OPG), and RANKL/OPG ratio in gingival crevicular fluid (GCF) in compression side and pain level during initial orthodontic tooth treatment to determine the efficacy of low-level laser therapy (LLLT). Ten volunteers who required fixed appliance positioned from the upper first premolars to upper first molars were selected. For each patient, the upper first premolar of the quadrant 1 was chosen to be irradiated with a laser diode at 670 nm, 200 mW, and 6.37 W/cm2, applied on the distal, buccal, and lingual sides during 9 min on days 0, 1, 2, 3, 4, and 7. The same procedure was applied in the first premolar of the contralateral quadrant inserting the tip but without laser emission. Samples of GCF from the compression side of the upper first premolars to distalize were collected at baseline and after 2, 7, 30, and 45 days posttreatment for determination of RANKL and OPG by enzyme-linked immunosorbent assay. In addition, tooth movement was assessed by scanning models and pain intensity was assessed using a visual analog scale. There was improvement in the parameters studied (pain, tooth movement, levels of RANKL in GCF, and RANKL/OPG ratio) in the laser group when compared to the control group, although differences were not statistically significant. The accumulated retraction of the upper premolar at 30 days was higher in the laser group, and this difference was statistically significant between groups. LLLT delivered in repeated doses (six times in the initial 2 weeks) leads in some extent to a slight orthodontical improvement.

Lasers Med Sci 2013 Dec 18

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24346335

# Use of laser in orthodontics: applications and perspectives.

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Laser technology got in these years a more and more important role in modern dentistry and, recently, also in orthodontics was proposed the utilization of laser devices. The aim of this work is to describe the utilization of this technology both in soft and hard oral tissues to improve orthodontic treatment. Several cases, with different wavelengths (532, 810, 980, 1064, 2940 and 10600 nm) and in different times of the treatment (before, during and after) are presented. All the cases reported showed, according to the literature, that the use of the laser related to orthodontic treatment offers several advantages when compared with conventional methods. In the soft tissues surgery it allows to reduce or eliminate the use of anesthetic injection, to avoid use of sutures and to bond bracket in dry enamel; associated with orthophosphoric acid, it gives a stronger adhesion of the brackets to the enamel and, in the case of porcelain brackets, it detaches them without damages; at low power (LLLT) it permits to control the pain of the first period after bonding and, by increasing the speed of teeth movement in the bone, reduces the time of the treatment.

Laser Ther 2013 22(2) 115-24

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=24155556

# The Effects of 830 nm Light-Emitting Diode Therapy on Acute Herpes Zoster Ophthalmicus: A Pilot Study.

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BACKGROUND: Skin lesions and pain are the most distinctive features of herpes zoster. Light-emitting diode (LED) therapy is an effective treatment known for its wound-healing effects. OBJECTIVE: To determine whether the LED treatment affects wound healing and acute pain in acute herpes zoster ophthalmicus. METHODS: We recruited 28 consecutive Korean patients with acute herpes zoster ophthalmicus for the study. In the control group (group A), 14 subjects received oral famcyclovir. In the experimental group (group B), 14 subjects received oral famcyclovir and 830 nm LED phototherapy on days 0, 4, 7, and 10. In order to estimate the time for wound healing, we measured the duration from the vesicle formation to when the lesion crust fell off. The visual analogue scale (VAS) was used for the estimation of pain on days 4, 7, 10, and 14. RESULTS: The mean time required for wound healing was 13.14+/-2.34 days in group B and 15.92+/-2.55 days in group A (p=0.006). From day 4, the mean VAS score showed a greater improvement in group B, compared with group A. A marginal but not statistically significant difference in the VAS scores was observed between the two groups (p=0.095). CONCLUSION: LED treatment for acute herpes zoster ophthalmicus leads to faster wound healing and a lower pain score.

Ann Dermatol 2013 May 25(2) 163-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23717006

# Clinical evaluation of the efficiency of low-level laser therapy for oral lichen planus: a prospective case series.

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Oral lichen planus (OLP) is an inflammatory disease that can be painful, mainly in the atrophic and erosive forms. Numerous drugs have been used with dissimilar results, but most treatments are empirical. However, to date, the most commonly employed and useful agents for the treatment of OLP are topical corticosteroids. The study objective was to detail the clinical effectiveness of low-level laser therapy (LLLT) for the management of OLP unresponsive to standard topical therapy. The authors studied a prospective cohort of 30 patients affected by OLP, who received biostimulation with a 980-nm gallium-aluminum-arsenide (GaAlAs) diode laser (DM980, distributed by DMT S.r.l., Via Nobel 33, 20035, Lissone, Italy). Outcome variables, statistically evaluated, were: the size of lesions; visual analogue score of pain and stability of the therapeutic results in the follow-up period. Eighty-two lesions were treated. We reported significant reduction in clinical scores of the treated lesions and in reported pain. No detailed complications or therapy side effects were observed during the study. As previously reported by our group with a preliminary report, this study suggests that LLLT could be a possible treatment choice for patients with unresponsive symptomatic OLP, also reducing the possible invasiveness correlated with other therapies.

Lasers Med Sci 2013 Apr 3

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23549680

# Laser Therapy of Recurrent Aphthous Ulcer in Patient with HIV Infection.

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The recurrent aphthous ulcer (RAU) is a pathological change found in the oral mucosa, characterized by painful single or multiple ulcers. The etiologic aspect of RAU is not well understood; however it is known that due to lower CD4 cell counts patients had higher prevalence of these oral lesions, and immunosuppressed patients with HIV are predisposed. Patient FC is African descent, 26 years old, male, HIV + CD4 67 cells/mm(3), with minor RAU in the upper and lower right side lip, measuring about 4 mm, and major RAU in tongue and the tonsillar pillar measuring 2 cm. The patient was treated with laser therapy with the objective to help reverse the damage and decrease the symptoms. After one week there was remission of the lesions. The laser showed to be an important alternative therapy that promoted analgesic, healing effects and improving the quality of life of patients.

Case Report Med 2012 2012 695642

# Effect of frequent laser irradiation on orthodontic pain.

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Abstract Objective: To analyze the effect of low-level laser therapy (LLLT) on perception of pain after separator placement and compare it with perceptions of control and placebo groups using a frequent irradiation protocol. Materials and Methods: Eighty-eight patients were randomly allocated to a laser group, a light-emitting diode (LED) placebo group, or a control group. Elastomeric separators were placed on the first molars. In the laser and LED groups, first molars were irradiated for 30 seconds every 12 hours for 1 week using a portable device. Pain was marked on a visual analog scale at predetermined intervals. Repeated measure analysis of variance was performed for statistical analysis. Results: The pain scores of the laser group were significantly lower than those of the control group up to 1 day. The pain scores in the LED group were not significantly different from those of the laser group during the first 6 hours. After that point, the pain scores of the LED group were not significantly different from those of the control. Conclusions: Frequent LLLT decreased the perception of pain to a nonsignificant level throughout the week after separator placement, compared with pain perception in the placebo and control groups. Therefore, LLLT might be an effective method of reducing orthodontic pain.

Angle Orthod 2012 Dec 14

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23241006

# Effect of low-level laser therapy on pain following activation of orthodontic final archwires: a randomized controlled clinical trial.

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OBJECTIVE: The purpose of this study was to evaluate the efficacy of GaAlAs laser light to reduce pain induced by post-adjustment orthodontic final archwire, compared with a placebo control group, and also to evaluate if there are differences in pain gradient when conventional brackets or self-ligating brackets are used for orthodontic treatment. BACKGROUND DATA: Previous reports indicate that laser therapy is a safe and efficient alternative to alleviate pain caused in the initial stages of treatment, but there are no studies about its efficacy during the last stages of orthodontic treatment. METHODS: The initial sample was 60 orthodontic patients from a private practice, treated by straight wire technique, 30 of them with mini brackets Equilibrium((R)) (Dentaurum, Ispringen, Germany) and 30 with self-ligation In-Ovation C ((R)) (GAC/Dentsply, Tokyo, Japan) slot 0.022 inch brackets. The archwires used in the final stage of orthodontic treatment were stainless steel 0.019x0.025 inch, slot 0.022 inch in both groups. In a design of divided mouth, the dental arches were randomly assigned to receive one dental arch irradiation with 830 nm 100mW therapeutic laser (Photon Lase II), for 22 sec (2.2 J, 80 J/cm(2)) along the vestibular surface and 22 sec (2.2 J, 80 J/cm(2)) along the palatal surface of the root in the randomly selected arch. The opposite dental arch received placebo treatment, with the laser light off. Pain was evaluated using a visual analog scale (VAS) after 2, 6, and 24 h, and 2, 3, and 7 days of application. RESULTS: The time course of pain showed the same tendency in both groups, reaching a peak 24 h after the archwire activation. The application of laser therapy reduced pain for any period of time up to 7 days ($p<0.00001$) and for any kind of bracket. CONCLUSIONS: Low intensity laser application reduces pain induced by archwires used during the final stage of orthodontic treatment, without any interference regarding the kind of bracket, as reported by patients.

Photomed Laser Surg 2013 Jan 31(1) 36-40

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23240876

# Laser therapy and the pain-related behavior after injury of the inferior alveolar nerve: possible involvement of neurotrophins.

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Nerve-related complications have been frequently reported in dental procedures, and a very frequent type of occurrence involves the inferior alveolar nerve (IAN). The nerve injury in humans often results in persistent or chronic neuropathic pain characterized by spontaneous burning pain accompanied by allodynia and hyperalgesia. In this investigation we used an experimental IAN injury in rats to which we associated laser therapy to assess how laser stimulates nerve repair in experimental animals. We also studied the nociceptive behavior (allodynia von Frey test) before and after the injury and the behavioral effects of treatment with laser therapy. Since neurotrophins are essential for the process of nerve regeneration, we used immunoblotting techniques to approach the effects of laser therapy upon the expression of nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF). The injured animals treated with laser had an improved nociceptive behavior. In irradiated animals there was an enhanced expression of NGF (53%) and a decrease of BDNF expression (40%) after laser therapy. These results indicate that BDNF plays a locally crucial role in pain-related behavior development after IAN injury, increasing after lesions (in parallel to the installation of pain behavior) and decreasing with laser therapy (in parallel to the improvement of pain behavior), whereas NGF probably contributes for the repair of nerve tissue and acts by improving the pain-related behavior, thus increasing after laser therapy.

J Neurotrauma 2012 Nov 29

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23190308

# Low-Level Laser Therapy for Treatment of Pain Associated with Orthodontic Elastomeric Separator Placement: A Placebo-Controlled Randomized Double Blind Clinical Trial.

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Abstract Objective: The objective of this study was to evaluate the effectiveness of the use of irradiation with a low-level laser therapy (LLLT), wavelength 830 nm, for treating pain inherent to tooth movement caused by orthodontic devices, simulated by positioning interdental elastomeric separators. Methods: Sixty orthodontic patients were randomly assigned to two groups: GA (ages 12-25 years; mean 17.1 years) was the control, and GB (ages 12-26 years; mean 17.9 years) the intervention group. All patients received elastomeric separators on the mesial and distal surfaces of one of the lower first molars, and immediately after insertion of the separators received irradiation as randomly indicated. The intervention group (GB) received irradiation with LLLT (aluminum gallium arsenide diode), by a single spot in the region of the radicular apex at a dose of 2 J/cm(2) and application along the radicular axis of the buccal surface with three spots of 1 J/cm(2) (wavelength 830 nm; infrared). Control group (GA) received irradiation with a placebo light in the same way. This was a double-blind study. All the patients received a questionnaire to be filled out at home describing their levels of pain 2, 6, and 24 h and 3 and 5 days after orthodontic separator placement, in situations of relaxed and occluded mouth. Results: The patients in the intervention group (LLLT) had lower mean pain scores in all the measures. The incidence of complete absence of pain (score=0) was significantly higher the intervention group. Conclusions: Based on this study, authors concluded that single irradiation with LLLT of wavelength 830 nm efficiently controlled the pain originating from positioning interdental elastomeric separators, to reproduce the painful sensation experienced by patients when fixed orthodontic devices are used.

Photomed Laser Surg 2012 Nov 15

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=23153291

# The effect of low level laser therapy on pain reduction after third molar surgery.

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AIM: The aim of this study was to evaluate the effects of low level laser on the postoperative pain of patients who had to undergo third molar surgery. METHODS: In a randomized clinical setting, 100 patients were assigned to two groups of 50 in each. Every patient underwent surgical removal of one mandibular third molar (with osteotomy). After suturing the flap, the soft laser was applied to every patient. In group I laser radiation was applied by the dental assistant with output power of 100 mW, in continuous mode with sweeping motion, in group II, the laser hand piece was only brought into position without releasing energy, so that no patient knew which group he belonged to. The patient was given a pain evaluation form where they could determine their individual pain level and duration. RESULTS: The statistical tests showed significant difference in pain level between laser and control group ($P<0.001$) but no significant difference found in pain duration in two groups ($P=0.019$). CONCLUSION: The result of this study verifies the positive effect of the soft-laser therapy in the postoperative complication after third molar extraction.

Minerva Stomatol 2012 Jul-Aug 61(7-8) 319-22

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22976514

# Effects of low-level laser therapy as an adjunct to standard therapy in acute pericoronitis, and its impact on oral health-related quality of life.

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OBJECTIVE: The purpose of this study was to evaluate the effect of low-level laser therapy (LLLT) as an adjunct to standard therapy in acute pericoronitis. METHODS: Eighty acute pericoronitis patients were randomly assigned to one of four LLLT groups: (neodymium:yttrium-aluminum garnet [Nd:YAG] 1064-nm: n=20, 8 J/cm2, 0.25 W, 10 Hz, 10 sec; 808-nm diode: n=20, 8 J/cm2, 0.25 W, continuous mode, 10 sec; 660-nm diode: n=20, 8 J/cm2, 0.04 W, continuous mode, 60 sec; or a placebo laser control group: n=20). After standard treatment, LLLT or a placebo laser were applied to the treatment area at a distance of 1 cm from the buccal site. Interincisal opening, pain perception, and oral health-related quality of life (OHRQoL) were evaluated at baseline, 24 h, and 7 days after laser application. The data were analyzed by the one-way ANOVA test. RESULTS: We found that the trismus and the OHRQoL in the Nd:YAG and the 808-nm diode groups were significantly improved when compared with the 660-nm diode and control groups at 24 h ($p<0.05$). No statistically significant differences were detected on day 7 among the groups with regard to any of the parameters evaluated. CONCLUSIONS: The results demonstrate that both the 1064-nm Nd:YAG and the 808-nm diode lasers were effective in improving trismus and OHRQoL in acute pericoronitis. Taking into account the limitations of this study, we conclude that the 1064-nm Nd:YAG laser has biostimulatory effects and improves OHRQoL, making it suitable for LLLT.

Photomed Laser Surg 2012 Oct 30(10) 592-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22974370

# Effect of low-level laser therapy after extraction of impacted lower third molars.

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The aim of this study is to evaluate the effectiveness of the low-level laser therapy (LLLT) in the control of pain, swelling, and trismus associated with surgical removal of impacted lower third molars. Thirty patients were randomized into two treatment groups, each with 15 patients-group test (LLLT) and a group control (no-LLLT)-and were told to avoid any analgesics 12 h before the procedure. In group test, the 980-nm diode-laser (G-Laser 25 Galbiati, Italy) was applied, using a 600-mum handpiece, intraorally (lingual and vestibular) at 1 cm from the involved area and extraoral at the insertion point of the masseter muscle immediately after surgery and at 24 h. The group control received only routine management. Parameters used for LLLT were: continuous mode, at 300 mW (0.3 W) for a total of 180 s (60 s x 3) (0.3 W x 180 s = 54 J). Group test showed improvement in the interincisal opening and remarkable reduction of trismus, swelling and intensity of pain on the first and the seventh postoperative days. Although LLLT has been reported to prevent swelling and trismus following the removal of impacted third molars, some of these studies reported a positive laser effect while others did not. All references to the use of laser therapy in the postoperative management of third molar surgery employ different methodologies and, in some, explanations as to selection of their respective radiation parameters are not given. This study has demonstrated that LLLT, with these parameters, is useful for the reduction of postoperative discomfort after third-molar surgery.

Lasers Med Sci 2012 Jul 28

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22843310

# Analgesic effect of a low-level laser therapy (830 nm) in early orthodontic treatment.

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The aim of this study was to evaluate the pain sensation that orthodontic patients experience when elastic separators are placed between molars and premolars and to determine the degree of analgesic efficacy of low-level laser therapy (LLLT) compared to a placebo treatment. The study was conducted with 20 volunteers who were fitted with elastic separators between the maxillary molars and premolars. One quadrant was randomly chosen to be irradiated with an 830-nm laser, 100 mW, beam diameter of 7 mm, 250 mW/cm(2) applied for 20 s per point (5 J/cm(2)). Three points were irradiated in the buccal face and three were irradiated in the palate. The same procedure was applied in the contralateral quadrant with a placebo light. A visual analogue scale was used to assess pain 5 min, 6 h, 24 h, 48 h, and 72 h after placement of the separators. Maximum pain occurred 6-24 h after placement of the elastic separators. Pain intensity was significantly lower in the laser-treated quadrant (mean, 7.7 mm) than in the placebo-treated quadrant (mean, 14.14 mm; p = 0.0001). LLLT at these parameters can reduce pain in patients following placement of orthodontic rubber separators.

Lasers Med Sci 2012 Jul 21

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22814893

# Efficiency of low-level laser therapy in reducing pain induced by orthodontic forces.

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Abstract Objective: The aim of this study was to investigate the effect of low-level laser therapy (LLLT) on reducing post-adjustment orthodontic pain via evaluation of gingival crevicular fluid (GCF) composition changes at the level of prostaglandin-E(2) (PGE(2)) and visual analogue scale (VAS). Background data: LLLT has been found to be effective in pain relief. PGE(2) has the greatest impact on the process of pain signals and can be detected in GCF in order to investigate the response of dental and periodontal tissues in a biochemical manner. Materials and methods: Nineteen patients (11 females and 8 males; mean age 13.9 years) were included in this study. Maxillary first molars were banded and then a randomly selected first molar at one side was irradiated (lambda820 nm; continuous wave; output power: 50 mW; focal spot: 0.0314 cm(2); exposure duration: 5 sec; power density: 1.59 W/cm(2); energy dose: 0.25 J; energy density: 7.96 J/cm(2) for each shot), while the molar at the other side was served as placebo control. The GCF was collected from the gingival crevice of each molar to evaluate PGE(2) levels, before band placement, 1 and 24 h after laser irradiation. Pain intensity was analyzed at 5 min, 1 h, and 24 h after band placement by using VAS. Results: Although no difference was found in pain perception at 5 min and 1 h, significant reduction was observed with laser treatment 24 h after application ($p<0.05$). The mean PGE(2) levels were significantly elevated in control group, whereas a gradual decrease occurred in laser group. The difference in PGE(2) levels at both 1 and 24 h were statistically significant between two groups ($p<0.05$). Conclusions: The significant reductions in both pain intensity and PGE(2) levels revealed that LLLT was efficient in reducing orthodontic post-adjustment pain.

Photomed Laser Surg 2012 Aug 30(8) 460-5

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22775467

# Low-level laser therapy on the treatment of oral and cutaneous pemphigus vulgaris: case report.

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Pemphigus vulgaris is a chronic autoimmune mucocutaneous disease that initially is manifested by painful intraoral erosions and ulcers which spread to other mucosa and the skin, generally more than 5 months after oral lesion manifestation. The treatment consists of prednisone alone or in combination with an immunosuppressive agent, and the clinical response is perceived within 2 to 4 weeks. Low-level laser therapy has been effective in accelerating the healing of injured tissue, thus inducing cell proliferation and increasing ATP, nucleic acid, and collagen synthesis. We reported two cases of pemphigus vulgaris that received systemic treatment associated with low-level laser therapy for oral and cutaneous lesions. We observed prompt analgesic effect in oral lesions and accelerated healing of oral and cutaneous wounds. Therefore, the present report suggests LLLT as a noninvasive technique that should be considered as an adjuvant therapy in oral and skin disorders in patients with PV.

Lasers Med Sci 2012 Apr 27

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22538841

# Laser GaAlAs (lambda860 nm) Photobiomodulation for the Treatment of Bisphosphonate-Induced Osteonecrosis of the Jaw.

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Abstract: Objective: The aim of this article is to report a case of bisphosphonate-induced osteonecrosis (ONJ-BP) of the jaw treated by curettage of the necrotic bone, low-level laser therapy (LLLT), and antibiotic therapy. Background data: ONJ-BP is characterized by painful ulcerations of the oral mucosa, is prone to bone necrosis that does not heal within 8 weeks after diagnosis, and is often difficult to treat. No definitive standard of care has been established for ONJ-BP. LLLT improves wound healing, relieves pain, and appears to be a promising treatment modality for patients with ONJ-BP. Materials and methods: An 82-year-old man taking intravenous bisphosphonate presented with ONJ-BP after tooth extraction. The patient was treated by LLLT using a GaAlAs diode laser with the following settings: wavelength, 860 nm; 70 mW; continuous wave; and spot size 4 mm(2). An energy density of 4.2 J/cm(2) per point was applied in a punctual contact manner every 48 h for 10 days, in association with antibiotic therapy and curettage of the necrotic bone. Reduction in painful symptoms was reported after the second irradiation session, and tissue healing was complete at the end of the third week following oral curettage. The patient was followed up for 12 months and exhibited good oral healt and quality of life. Conclusions: The therapeutic protocol used in this study had a positive effect on tissue healing and remission of painful symptoms, resulting in better oral health and quality of life for the patient.

Photomed Laser Surg 2012 May 30(5) 293-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22509722

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

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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 Mar 141(3) 289-97

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22381489

# [Low power laser efficacy in the therapy of inflamed gingive in diabetics with parodontopathy].

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BACKGROUND/AIM: There is clear evidence on direct relationship between periodontal disease and diabetes mellitus. Many investigations point out greater prevalence and severity of periodontal disease among diabetic patients. During last decade, low level laser therapy has been used in periodontal therapy. It has biostimulative effect, accelerates wound healing, minimizes pain and swelling, and there is almost no contraindication for its usage. The aim of the paper was to investigate the efficiency of low level laser therapy as adjuvant tool in reduction of gingival inflammation in diabetic patients. METHODS: The study incuded 150 participants divided into three groups: group I (50 participants with diabetes mellitus type 1 and periodontal disease), group II (50 participants with diabetes mellitus type 2 and periodontal disease), group III (nondiabetic participants with periodontal disease). Gingival health evaluation was done using gingival index Loe-Silness. Soft and hard deposits were removed, periodontal pockets cleaned and GaA1As low level laser therapy (5 mW) applied five consecutive days. In each patient, low level laser therapy was not applied on the left side of the jaw in order to compare the effects of the applied therapy. After the first, third and fifth therapy and one month after the last visit gingival index was evaluated. Before the first and after the fifth therapy exfoliative cytology of gingiva was done and nuclei areal was analyzed morphometrically. RESULTS: After all investigated periods, gingival index and nuclei areal were significantly decreased comparing to values before the therapy, at both jaw sides ($p < 0.001$). After the 1st, 3rd and 5th therapy, the t-test showed a significantly decreased gingival index at the lased side of jaw comparing to non-lased side. CONCLUSION: Low level laser therapy is efficient in gingival inflammation elimination and can be proposed as an adjuvant tool in basic periodontal therapy of diabetic patients.

Vojnosanit Pregl 2011 Aug 68(8) 684-9

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21991792

# [Assessment of the effectiveness of low level laser in the treatment of alveolar osteitis].

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BACKGROUND/AIM: Alveolar osteitis (AO) is the extraction wound healing disorder with a presence of severe pain. Low level laser therapy stimulates cell metabolism and microcirculation, have has pronounced analgesic, antiedematous and anti-inflammatory effect and speeds up wound healing process. The aim of this study was to present results of clinical research that examined the effectiveness of low level laser in pain relief and healing of extraction wounds with alveolar osteitis in the lower jaw which was formed on the second day after tooth extraction. METHODS: The study was conducted on 60 subjects divided into the study and the control group. In both groups extraction wounds were processed in similar way, except that in the study group was applied daily treatment of low level laser with a total of eight sessions of radiation, while in the control group extraction wounds were dressed with zinc oxide eugenol paste, which was changed every 48 hours up to the pain cessation. Measurement of pain intensity was done with a visual analogue scale (VAS) 10 min prior to processing of extraction wounds and daily for the next eight days. Assessment of the effectiveness of low level laser on healing of extraction wounds was performed on the day eight of the treatment. RESULTS: On the day five after beginning of the treatment of extraction wounds with alveolar osteitis in the patients of the study group a lower average value of pain as compared to the control group was registered. This difference was increased within the following days. Extraction wounds healing in the study group was more successful and faster than in the control group. CONCLUSION: This study suggested that the reduction of pain was more pronounced in the patients with alveolar osteitis whose extraction wounds were subjected to low level laser radiation in comparison to those in which extraction wounds were treated with zinc oxide eugenol paste.

Vojnosanit Pregl 2011 Jun 68(6) 506-10

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21818918

# The effect of two phototherapy protocols on pain control in orthodontic procedure-a preliminary clinical study.

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Phototherapy with low-level coherent light (laser) has been reported as an analgesic and anti-inflammatory as well as having a positive effect in tissue repair in orthodontics. However, there are few clinical studies using low-level LED therapy (non-coherent light). The aim of the present study was to analyze the pain symptoms after orthodontic tooth movement associated with and not associated with coherent and non-coherent phototherapy. Fifty-five volunteers (mean age = 24.1 +/- 8.1 years) were randomly divided into four groups: G1 (control), G2 (placebo), G3 (protocol 1: laser, InGaAlP, 660 nm, 4 J/cm(2), 0.03 W, 25 s), G4 (protocol 2: LED, GaAlAs, 640 nm with 40 nm full-bandwidth at half-maximum, 4 J/cm(2), 0.10 W, 70 s). Separators were used to induce orthodontic pain and the volunteers pain levels were scored with the visual analog scale (VAS) after the separator placement, after the therapy (placebo, laser, or LED), and after 2, 24, 48, 72, 96, and 120 h. The laser group did not have statistically significant results in the reduction of pain level compared to the LED group. The LED group had a significant reduction in pain levels between 2 and 120 h compared to the control and the laser groups. The LED therapy showed a significant reduction in pain sensitivity (an average of 56%), after the orthodontic tooth movement when compared to the control group.

Lasers Med Sci 2011 May 31

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21626017

# The effect of low level laser therapy on pain during dental tooth-cavity preparation in children.

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AIM: To evaluate the effect of low level laser therapy on pain during cavity preparation with laser in paediatric dental patients. STUDY DESIGN AND METHODS: The study was carried out on 10 children aged 6 to 9 years old for a total of 20 primary molar teeth. For laser preparation an Er: YAG laser was used. Half of the preparations were treated by low level laser therapy (LLLT) before laser preparation and the remaining half without LLLT (non-LLLT) before laser preparation. All cavities were prepared by ER: YAG laser, restored with light-cured composite resin following the application of acid etching and bonding agent. Children were instructed to rate their pain on the visual analogue scale (VAS) from 0 to 5 points. Statistical analyses were performed using Mann Whitney U test. RESULTS: VAS Median (min-max) scores were 1(0-2) for LLLT and 3(1-4) for the non-LLT treated children. Between LLLT and non- LLLT groups results were statistically significant ($p<0.01$). CONCLUSIONS: The use of LLLT before cavity preparation with laser decreased pain in paediatric dental patients.

Eur Arch Paediatr Dent 2011 Apr 12(2) 93-5

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21473840

# Effect of intraoral low-level laser therapy on quality of life of patients with head and neck cancer undergoing radiotherapy.

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BrazilBACKGROUND: Low-level laser therapy has been used to reduce complications of head and neck cancer treatment. The aim was to assess the impact of laser in the quality of life (QOL) of patients receiving radiotherapy. METHODS: Sixty outpatients were randomly assigned into 2 groups. The laser group received applications and the placebo group received sham laser. QOL was assessed using the University of Washington QOL questionnaire. A repeated-measures analysis of variance (ANOVA) was used for comparisons of overall QOL scores and Mann-Whitney test compared changes in domain scores. RESULTS: A decrease in QOL scores was observed in both groups and the reduction in the laser group was significantly lower ($p < .01$). Changes in QOL scores regarding pain, chewing, and saliva domains were evident in the placebo group. Both health-related QOL and overall QOL were rated higher by patients who received laser therapy. CONCLUSION: Laser therapy reduces the impact of radiotherapy on the QOL of patients with head and neck cancer. 

Head Neck 2011 Apr 5

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21472883

# Observation of Pain Control in Patients with Bisphosphonate-Induced Osteonecrosis Using Low Level Laser Therapy: Preliminary Results.

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Abstract Background: Bisphosphonate-related osteonecrosis of the jaw (BRONJ) is an adverse side effect associated with bisphosphonate (BP) therapy, especially when parenteral BP administration is used. Patients affected by BRONJ present wide areas of exposed necrotic bone, particularly after surgical oral procedures. The main symptom is pain that is poorly controlled by common analgesic drugs. Recently, many studies have pointed to the beneficial effect of low-level laser therapy (LLLT) in pain reduction for many pathological conditions. The purpose of this study is to investigate whether LLLT could be helpful in managing BRONJ by reducing the problems associated with this condition and the use of analgesic drugs. Methods: Twelve patients affected by BRONJ were monitored at the Complex Operative Unit of Oral Pathology. Among these patients, only seven referred to pain in necrotic areas and were recruited for LLLT. Laser applications were performed with a double diode laser simultaneously emitting at two different wavelengths (lambda = 650 nm and lambda = 904-910 nm, spot size = 8 mm). All of the patients were irradiated with a fluence of 0.053 J/cm(2) for 15 min five times over a period of 2 weeks, in a non-contact mode, approximately 1 mm from the pathologic area. The patient's maximum and minimum pain was recorded using a numeric rating scale (NRS) evaluation before and after the treatment. Statistical analysis was performed using the Kruskal-Wallis test. Results: Six patients showed significant pain reduction, and only one patient indicated a worsening of the symptoms, which was probably related to a reinfection of the BRONJ site, which occurred during the study. A statistically significant difference ($p < 0.05$) was found between the NRS rates before and after the protocol. Conclusions: This pilot study suggests that LLLT may be a valid technique to support the treatment of BRONJ-related pain, even though the low number of cases in this study does not permit any conclusive consideration.

Photomed Laser Surg 2011 Jan 16

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21235406

# A Comparative Pilot Study of Low Intensity Laser versus Topical Corticosteroids in the Treatment of Erosive-Atrophic Oral Lichen Planus.

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Abstract Background and Objective: Treatment of oral lichen planus (OLP) remains a great challenge for clinicians. The aim of our study was to compare the effect of low intensity laser therapy (LILT) with topical corticosteroids in the treatment of oral erosive and atrophic lichen planus. Materials and Methods: Thirty patients with erosive-atrophic OLP were randomly allocated into two groups. The experimental group consisted of patients treated with the 630 nm diode laser. The control group consisted of patients who used Dexamethason mouth wash. Response rate was defined based on changes in the appearance score and pain score (Visual Analogue Scale) of the lesions before and after each treatment. Results: Appearance score, pain score, and lesion severity was reduced in both groups. No significant differences were found between the treatment groups regarding the response rate and relapse. Conclusion: Our study demonstrated that LILT was as effective as topical corticosteroid therapy without any adverse effects and it may be considered as an alternative treatment for erosive-atrophic OLP in the future.

Photomed Laser Surg 2011 Jan 8

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21214369

# Management of myofascial pain: low-level laser therapy versus occlusal splints.

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The present study was designed to compare the effects of low-level laser with occlusal splints in patients with signs and symptoms of myofascial pain (MP) dysfunction syndrome. A total of 40 (34 women and 6 men, with a mean age of 32.84 [SD, 10.70] years) were selected after the diagnosis of MP according to the Research Diagnostic Criteria for Temporomandibular Disorder. The patients were randomly divided into 2 groups: study group (n = 20) and control group (n = 20). Low-level laser was applied to patients in the study group 2 times per week, for a total of 10 sessions. Patients in the control group were instructed to wear occlusal splints 24 h/d for 3 months. The functional examination was based on Research Diagnostic Criteria for Temporomandibular Disorder and pressure pain threshold values were obtained with the aid of an algometer in both groups. Patients' self-report of pain was evaluated with visual analog scale. Comparisons were made within and between the groups before and after treatment. Vertical movements showed statistically significant improvements after the treatments in both groups ($P < 0.01$), but when the groups were compared with each other, there were no significant difference between the groups. In both groups, tenderness to palpation of the muscles decreased significantly. Pressure pain threshold evaluations and visual analog scale scores revealed similar results, too. This particular type of low-level laser therapy (820 nm, 3 J/cm2, 300-mW output power) is as effective as occlusal splint in pain release and mandibular movement improvement in MP.

J Craniofac Surg 2010 Nov 21(6) 1722-8

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=21119408

# Effects of low-level laser treatment on mouth dryness.

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Mouth dryness (MD) is usually followed by inadequate mechanical cleaning of the mouth and decrease in the levels of salivary antimicrobial proteins (including secretory immunoglobulin A (sIgA)). It is accompanied by difficulties during speaking and food swallowing, with an unpleasant taste, burning sensations in the mouth and higher susceptibility to oral diseases. Low-level laser treatment (LLLT) can intensify cell metabolism and its application on salivary glands could improve salivation. The purpose of this study was to evaluate the effects of LLLT on salivation of patients suffering from MD. The study included 17 patients with MD. Their major salivary glands were treated with low intensity laser BTL2000 on 10 occasions. The whole unstimulated and stimulated saliva quantities were measured just before the 1st, after the 10th and thirty days following the last (10th) treatment. In the samples of unstimulated saliva concentrations of sIgA were estimated by using ELISA method and its quantity in the time unit was calculated. The visual analogue scale (VAS) score was used to assess burning and/or pain intensity at these three time points. Statistical tests revealed significant salivation improvement quantitatively and qualitatively, i.e. increase in the quantity of saliva and sIgA. VAS score was also significantly improved and no side effects were observed. Conclusions: According to the results of this study, application of LLLT to xerostomic patients' major salivary glands stimulates them to produce more saliva with better antimicrobial characteristics and improves the difficulties that are associated with MD. This simple non-invasive method could be used in everyday clinical practice for the treatment of MD.

Coll Antropol 2010 Sep 34(3) 1039-43

# Laser Phototherapy for Stevens-Johnson Syndrome: A Case Report.

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Abstract Stevens-Johnson syndrome (SJS) is a life-threatening dermatosis characterized by epidermal sloughing and stomatitis. We report the case of a 7-year-old boy in whom laser phototherapy (LPT) was highly effective in reversing the effects of an initial episode of SJS that had apparently developed in association with treatment with phenobarbital for a seizure disorder. The patient was first seen in the intensive care unit (ICU) of our institution with fever, cutaneous lesions on his extremities, trunk, face, and neck; mucosal involvement of his genitalia and eyes (conjunctivitis); ulcerative intraoral lesions; and swollen, crusted, and bleeding lips. He reported severe pain at the sites of his intraoral and skin lesions and was unable to eat, speak, swallow, or open his mouth. Trying to prevent and minimize secondary infections, gastric problems, pain, and other complications, the patient was given clindamycin, ranitidine, dipyrone, diphenhydramine (Benadryl) drops, and morphine. In addition, he was instructed to use bicarbonate solution and Ketoconazole (Xylogel) in the oral cavity. Because of the lack of progress of the patient, the LPT was selected. At 5 days after the initial session of LPT, the patient was able to eat gelatin, and on the following day, the number and severity of his intraoral lesions and his labial crusting and swelling had diminished. By 6 days after his initial session of LPT, most of the patient's intraoral lesions had disappeared, and the few that remained were painless; the patient was able to eat solid food by himself and was removed from the ICU. Ten sessions of LPT were conducted in the hospital. The patient underwent three further and consecutive sessions at the School of Dentistry, when complete healing of his oral lesions was observed. The outcome in this case suggests that LPT may be a new adjuvant modality for SJS complications.

Photomed Laser Surg 2010 Oct 25

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20973736

# Treatment of Burning Mouth Syndrome with a Low-Level Energy Diode Laser.

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Abstract Objective: To test the therapeutic efficacy of low-level energy diode laser on burning mouth syndrome. Background: Burning mouth syndrome is characterized by burning and painful sensations in the mouth, especially the tongue, in the absence of significant mucosal abnormalities. Although burning mouth syndrome is relatively common, little is known regarding its etiology and pathophysiology. As a result, no treatment is effective in all patients. Low-level energy diode laser therapy has been used in a variety of chronic and acute pain conditions, including neck, back and myofascial pain, degenerative osteoarthritis, and headache. Methods: A total of 17 patients who had been diagnosed with burning mouth syndrome were treated with an 800-nm wavelength diode laser. A straight handpiece was used with an end of 1-cm diameter with the fiber end standing 4 cm away from the end of handpiece. When the laser was applied, the handpiece directly contacted or was immediately above the symptomatic lingual surface. The output used was 3 W, 50 msec intermittent pulsing, and a frequency of 10 Hz, which was equivalent to an average power of 1.5 W/cm(2) (3 W x 0.05 msec x 10 Hz = 1.5 W/cm(2)). Depending on the involved area, laser was applied to a 1-cm(2) area for 70 sec until all involved area was covered. Overall pain and discomfort were analyzed with a 10-cm visual analogue scale. Results: All patients received diode laser therapy between one and seven times. The average pain score before the treatment was 6.7 (ranging from 2.9 to 9.8). The results showed an average reduction in pain of 47.6% (ranging from 9.3% to 91.8%). The burning sensation remained unchanged for up to 12 months. Conclusion: Low-level energy diode laser may be an effective treatment for burning mouth syndrome.

Photomed Laser Surg 2010 Oct 22

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20969436

# Clinical evaluation of low-level laser treatment for recurring aphthous stomatitis.

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OBJECTIVE: The aim of the present study was to assess the effect of low-level laser on the control of pain and the repair of recurring aphthous stomatitis (RAS). BACKGROUND: One of the most frequent pathologic conditions in the oral cavity is RAS. This multifactor immunologic inflammatory lesion causes patient discomfort, and treatment is controversial because of its unknown etiology. A number of treatment modalities have been proposed, but none is definitive. Low-level laser treatment (LLLT) has been used for lesions of an inflammatory nature, not as an inhibitor of the process, but for its modulating action and reparative effect on tissues. MATERIALS AND METHODS: Twenty patients with RAS were divided into one group treated with a topical corticoid agent (n = 5) and another group treated with laser (n = 15). Group I received conventional treatment with triamcinolone acetonide 4 times per day. The patients in Group II received laser treatment with an InGaA1P diode laser with wavelength of 670 nm, 50 mW, 3 J/cm(2) per point in daily sessions (once per day) on consecutive days. Both treatments were applied until the disappearance of the lesions. All patients were evaluated on a daily basis, and the following clinical parameters were determined during each session: pain intensity before and after treatment and clinical measurement of lesion size. RESULTS: The results revealed that 75% of the patients reported a reduction in pain in the same session after laser treatment, and total regression of the lesion occurred after 4 days. Total regression in the corticoid group was from 5 to 7 days. CONCLUSION: The use of LLLT under the conditions administered in the present study demonstrated analgesic and healing effects with regard to RAS.

Photomed Laser Surg 2010 Oct 28 Suppl 2 S85-8

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20950190

# Infrared laser therapy after surgically assisted rapid palatal expansion to diminish pain and accelerate bone healing.

Abreu ME, Viegas VN, Pagnoncelli RM, de Lima EM, Farret AM, Kulczynski FZ, Farret MM

The aim of this study was to illustrate how gallium arsenite aluminum diode laser (824 nm) irradiation can reduce postsurgical edema and discomfort and accelerate sutural osseous regeneration after surgically assisted rapid palatal expansion (SARPE). An adult patient with an 8-mm transverse maxillary discrepancy was treated with SARPE. Infrared laser therapy was started on the 7th postoperative day, with a total of eight sessions at intervals of 48 hours. The laser probe spot had a size of 0.2827 cm2 and was positioned in contact with the following (bilateral) points: infraorbital foramen, nasal alar, nasopalatine foramen, median palatal suture at the height of the molars, and transverse palatine suture distal to the second molars. The laser was run in continuous mode with a power of 100 mW and a fluency of 1.5 J/cm2 for 20 seconds at each point. Subsequently, an absence of edema and pain was observed. Further, fast bone regeneration in the median palatal suture could be demonstrated by occlusal radiographs. These findings suggest that laser therapy can accelerate bone regeneration of the median palatal suture in patients who have undergone SARPE. World J Orthod 2010;11:273-277.

World J Orthod 2010 Fall 11(3) 273-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?
cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=20877738

# Low-level laser therapy for pain caused by placement of the first orthodontic archwire: a randomized clinical trial.

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INTRODUCTION: The purpose of this study was to clinically evaluate the effect of low-level laser therapy (LLLT) as a method of reducing pain reported by patients after placement of their first orthodontic archwires. METHODS: The sample comprised 60 orthodontic patients (ages, 12-18 years; mean, 15.9 years). All patients had fixed orthodontic appliances placed in 1 dental arch (maxillary or mandibular), received the first archwire, and were then randomly assigned to the experimental (laser), placebo, or control group. This was a double-blind study. LLLT was started in the experimental group immediately after placement of the first archwire. Each tooth received a dose of 2.5 J per square centimeter on each side (buccal and lingual). The placebo group had the laser probe positioned into the mouth at the same areas overlying the dental root and could hear a sound every 10 seconds. The control group had no laser intervention. All patients received a survey to be filled out at home describing their pain during the next 7 days. RESULTS: The patients in the LLLT group had lower mean scores for oral pain and intensity of pain on the most painful day. Also, their pain ended sooner. LLLT did not affect the start of pain perception or alter the most painful day. There was no significant difference in pain symptomatology in the maxillary or mandibular arches in an evaluated parameter. CONCLUSIONS: Based on these findings, we concluded that LLLT efficiently controls pain caused by the first archwire.

Am J Orthod Dentofacial Orthop 2009 Nov 136(5) 662-7

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19892282

# Effect of Low-Level Laser Irradiation on Bisphosphonate-Induced Osteonecrosis of the Jaws: Preliminary Results of a Prospective Study.

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Abstract Objective: The aim of this study was to detail the clinical efficacy of low-level laser therapy (LLLT) for the management of bisphosphonate-induced osteonecrosis of the jaws (ONJ-BP). Background: ONJ-BP is the correct term, recently emerged, to describe a significant complication in a subset of patients receiving drugs such as zoledronic acid, pamidronate, and alendronate. No definitive standard of care has been set for ONJ-BP and no definitively agreed guidelines have been provided. There is currently no consensus on the correct approach to the issue. Materials and Methods: The investigators studied a prospective cohort of 20 patients affected by ONJ-BP, who received biostimulation with a pulsed diode laser (GaAs). Patients were exposed to a 904-nm infrared laser (50 kHz, 28.4 J/cm(2) energy density, 40% duty cycle, spot size 0.8 cm). Outcome variables were the size of lesions, edema, visual analogue score of pain, presence of pus, fistulas, and halitosis. Preoperative results were compared with the postoperative outcome and statistically evaluated. Results: Four weeks after LLLT, a statistically significant difference was observed for reported pain ($p = 0.0001$), clinical size ($p = 0.0034$), edema ($p = 0.0005$), and presence of pus and fistulas ($p = 0.0078$ and $p = 0.03$, respectively). Conclusion: This study suggests that LLLT would appear to be a promising modality of treatment for patients with ONJ-BP, providing that clinical efficacy is safe and well tolerated, especially by those patients who require conservative treatment. Of course, this needs to be addressed further in larger and randomly controlled studies in different clinical settings.

Photomed Laser Surg 2009 Oct 1

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19795990

# Low-level laser therapy and myofacial pain dysfunction syndrome: a randomized controlled clinical trial.

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Myofacial pain dysfunction syndrome (MPDS) is the most common reason for pain and limited function of the masticatory system. The effects of low-level lasers (LLLs) for controlling the discomfort of patients are investigated frequently. However, the aim of this study was to evaluate the efficacy of a particular source producing 660 nm and 890 nm wavelengths that was recommended to reduce of the pain in the masticatory muscles. This was a double-blind and placebo-controlled trial. Sixteen MPDS patients were randomly divided into two groups. For the laser group, two diode laser probes (660 nm (nanometers), 6.2 J/cm(2), 6 min, continuous wave, and 890 nm, 1 J/cm(2) (joules per square centimetre), 10 min, 1,500 Hz (Hertz)) were used on the painful muscles. For the control group, the treatment was similar, but the patients were not irradiated. Treatment was given twice a week for 3 weeks. The amount of patient pain was recorded at four time periods (before and immediately after treatment, 1 week after, and on the day of complete pain relief). A visual analog scale (VAS) was selected as the method of pain measurement. Repeated-measures analysis of variance (ANOVA), the t-test and the paired t-test were used to analyze the data. In each group the reduction of pain before and after the treatment was meaningful, but, between the two groups, low-level laser therapy (LLLT) was more effective (P = 0.031) According to this study, this type of LLLT was the effective treatment for pain reduction in MPDS patients.

Lasers Med Sci 2008 Nov 12

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19002646

# Enamel matrix derivative and low-level laser therapy in the treatment of intra-bony defects: a randomized placebo-controlled clinical trial.

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Aim: The aim of this study was to evaluate the immediate post-operative pain, wound healing and clinical results after the application of an enamel matrix protein derivative (EMD) alone or combined with a low-level laser therapy (LLLT) for the treatment of deep intra-bony defects. Material and Methods: This study was an intra-individual longitudinal test of 12 months' duration conducted using a blinded, split-mouth, placebo-controlled and randomized design. In 22 periodontitis patients, one intra-bony defect was randomly treated with EMD+LLLT, while EMD alone was applied to the contra-lateral defect site. LLLT was used both intra- and post-operatively. Clinical measurements were performed by a blinded periodontist at the time of surgery, in the first week and in the first, second, sixth and 12th month. Visual analogue scale (VAS) scores were recorded for pain assesment. Results: The results have shown that the treatment of intra-bony defects with EMD alone or EMD+LLLT leads to probing depth reduction and attachment-level gain. In addition, EMD+LLLT had resulted in less gingival recession ($p<0.05$), less swelling ($p<0.001$) and less VAS scores ($p<0.02$) compared with EMD alone. Conclusion: This study shows that EMD is an effective, safe and predictable biomaterial for periodontal regeneration and LLLT may improve the effects of EMD by reducing post-operative complications.

J Clin Periodontol 2007 Dec 13

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=18081859

# The effect of low-level laser therapy during orthodontic movement: a preliminary study.

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It has been emphasized that one of the most valuable treatment objectives in dental practice is to afford the patient a pain-free treatment. By the evolution of the laser applications, the dental committee aimed to achieve this goal without analgesic drugs and painful methods. Orthodontic treatment is one of these concerns, that one of the major components of patient to reject this treatment is the pain accompanied during the different treatment phases. Another great concern of the patient is not to get through prolonged periods of treatment. The aim of this study is to evaluate the effect of the low-level (GaAlAs) diode laser (809 nm, 100 mW) on the canine retraction during an orthodontic movement and to assess pain level during this treatment. A group of 15 adult patients with age ranging from 14 to 23 years attended the orthodontic department at Dental School, Damascus University. The treatment plan for these patients included extraction of the upper and lower first premolars because there was not enough space for a complete alignment or presence of biprotrusion. For each patient, this diagnosis was based on a standard orthodontic documentation with photographs, model casts, cephalometric, panorama, and superior premolar periapical radiographies. The orthodontic treatment was initiated 14 days after the premolar extraction with a standard 18 slot edgewise brackets [Rocky Mountain Company (RMO)]. The canine retraction was accomplished by using prefabricated Ricketts springs (RMO), in both upper and lower jaws. The right side of the upper and lower jaw was chosen to be irradiated with the laser, whereas the left side was considered the control without laser irradiation. The laser was applied with 0-, 3-, 7-, and 14-day intervals. The retraction spring was reactivated on day 21 for all sides. The amount of canine retraction was measured at this stage with a digital electronic caliper (Myoto, Japan) and compared each side of the relative jaw (i.e., upper left canine with upper right canine and lower left canine with lower right canine). The pain level was prompted by a patient questionnaire. The velocity of canine movement was significantly greater in the lased group than in the control group. The pain intensity was also at lower level in the lased group than in the control group throughout the retraction period. Our findings suggest that low-level laser therapy can highly accelerate tooth movement during orthodontic treatment and can also effectively reduce pain level.

Lasers Med Sci 2008 Jan 23(1) 27-33

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17361391

# Postoperative analgesia after lower third molar surgery: contribution of the use of long-acting local anesthetics, low-power laser, and diclofenac.

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OBJECTIVES: Postoperative pain is a common phenomenon after surgical extraction of lower third molars (LTM), and its successful control is an essential part of routine oral surgery. The aims of the study were twofold: (1) to evaluate the postoperative analgesic efficacy, comparing long-acting and intermediate-acting local anesthetics; and (2) to compare the use of low-power laser irradiation and the nonsteroid anti-inflammatory drug diclofenac, which are claimed to be among the most successful aids in postoperative pain control. STUDY DESIGN: A twofold study of 102 patients of both sexes undergoing surgical extraction of LTM was conducted. In the first part of the study, 12 patients with bilaterally impacted LTMs were treated in a double-blind crossover fashion; local anesthesia was achieved with 0.5% bupivacaine plain or 2% lidocaine with 1:80.000 epinephrine. In the second part of the study, 90 patients undergoing LTM surgical extraction with local anesthesia received postoperative low-power laser irradiation (30 patients) and a preoperative single dose of 100 mg diclofenac (30 patients), or only regular postoperative recommendations (30 patients). RESULTS: The results of the first part of the study showed a strikingly better postoperative analgesic effect of bupivacaine than lidocaine/epinephrine (11 out of 12; 4 out of 12, respectively, patients without postoperative pain). In the second part of the study, low-power laser irradiation significantly reduced postoperative pain intensity in patients premedicated with diclofenac, compared with the controls. CONCLUSION: Provided that basic principles of surgical practice have been achieved, the use of long-acting local anesthetics and low-power laser irradiation enables the best postoperative analgesic effect and the most comfortable postoperative course after surgical extraction of LTMs.

Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006 Nov 102(5) e4-8

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17052624

# Pain relief by single low-level laser irradiation in orthodontic patients undergoing fixed appliance therapy.

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INTRODUCTION:
The objective of this study was to analyze the effect of single low-level laser therapy (LLLT) irradiation on pain perception in patients having fixed appliance treatment.
METHODS:
Seventy-six patients (46 women, 30 men; mean age, 23.1 years) enrolled in this single-blind study were assigned to 2 groups. The patients in group 1 (G1; 38 patients, 13 men, 25 women; mean age, 25.1 years) received a single course of LLLT (Mini Laser 2075, Helbo Photodynamic Systems GmbH & Co KG, Linz, Austria; wavelength 670 nm, power output 75 mW) for 30 seconds per banded tooth. The patients in group 2 (G2; 38 patients, 17 men, 21 women; mean age, 21.0 years) received placebo laser therapy without active laser irradiation. Pain perception was evaluated at 6, 30, and 54 hours after LLLT by self-rating with a standardized questionnaire.
RESULTS:
Major differences in pain perception were found between the 2 groups. The number of patients reporting pain at 6 hours was significantly lower in G1 (n = 14) than in G2 (n = 29) ($P < .05$), and the differences persisted at 30 hours (G1, n = 22; G2, n = 33) ($P < .05$). At 54 hours, no significant differences were seen between the number of patients reporting pain (G1, n = 20; G2, n = 25), although the women had a different prevalence between G1 (n = 11) and G2 (n = 15) ($P = .079$). At 6, 30, and 54 hours, more than 90% of the subjects in both groups described the pain as "tearing."
CONCLUSIONS:
LLLT immediately after multibanding reduced the prevalence of pain perception at 6 and 30 hours. LLLT might have positive effects in orthodontic patients not only immediately after multibanding, but also for preventing pain during treatment.

Am J Orthod Dentofacial Orthop. 2006 Sep;130(3):371-7.

http://www.ncbi.nlm.nih.gov/pubmed/?term=16979496

# Efficacy of low level laser therapy in reducing postoperative pain after endodontic surgery-- a randomized double blind clinical study.

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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.

Int J Oral Maxillofac Surg 2004 Jan 33(1) 38-41

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# Usefulness of low-level laser for control of painful stomatitis in patients with hand-foot-and-mouth disease.

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OBJECTIVE: The aim of this study was to evaluate the usefulness of low-level laser therapy (LLLT) for the control of painful stomatitis in patients with hand-foot-and-mouth disease (HFMD). BACKGROUND DATA: LLLT has been successfully applied to various painful oral mucosal diseases, although there have been few reports on LLLT for HFMD patients. MATERIALS AND METHODS: Through a randomized double-blind placebo controlled trial, the painful period of HFMD stomatitis was compared between the LLLT group (n=11) and the placebo LLLT one (n=9), which had similar clinical backgrounds. The LLLT parameters supplied were as follows: wavelength of 830 nm, power of 30 mW, frequency of 30 Hz, and energy output of 1.1 J/cm2. Acceptability and safety of the treatment were also evaluated. RESULTS: The painful period was shorter in the LLLT group (4.0 +/- 1.3 days) than in the placebo LLLT one (6.7 +/- 1.6 days) with a statistically significant difference ($p<0.005$). The treatment was judged acceptable for 90.0% (18 of 20) of patients. No adverse events were observed in any cases. CONCLUSION: LLLT is a useful method to control HFMD stomatitis by shortening the painful period, with its high acceptability and lack of adverse events.

J Clin Laser Med Surg 2003 Dec 21(6) 363-7

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