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The effects of low level laser therapy on the management of chronic idiopathic orofacial pain: trigeminal neuralgia, temporomandibular disorders and burning mouth syndrome

Učinak mekog lasera u liječenju kroničnih idiopatskih bolova orofacijalne regije: trigeminalne neuralgije, temporomandibularnih poremećaja i sindroma pekućih usta

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Abstract. Aim: To investigate the efficacy of different wavelengths of low level laser therapy (LLLT) in the management of orofacial pain by measuring the pain reduction using visual analogue scale (VAS). **Materials and methods:** Study involved 20 patients with trigeminal neuralgia (TN), 20 with temporomandibular disorders (TMD) and 40 with burning mouth syndrome (BMS). 50 % of the patients in each syndrome group were treated with 660 nm laser, and other 50 % with 810 nm laser. Orofacial pain was quantified by the VAS. **Results:** VAS was significantly lower after the application of LLLT, in all subjects and for both applied wavelengths ($P < 0.05$). Efficacy of 810 nm laser compared to 660 nm laser was significantly higher for all patients and in both the TN and TMD groups ($P < 0.001$; $P = 0.005$; $P = 0.024$). **Conclusions:** LLLT has proven to be an effective intervention in reducing pain in TN, TMD and BMS patients. Better results can be achieved with higher wavelengths.

Key words: burning mouth syndrome; facial pain; lasers; pain measurement; temporomandibular joint disorders; trigeminal neuralgia

Sažetak. Cilj: Ispitati učinke različitih valnih duljina mekog lasera (ML) u liječenju orofacijalnog bola mjerenjem prijavljenog bola na vizualno-analognj skali (VAS). **Materijali i metode:** U istraživanju je sudjelovalo 20 ispitanika s trigeminalnom neuralgijom (TN), 20 s temporomandibularnim poremećajima (TMP) i 40 sa sindromom pekućih usta (SPU). 50 % ispitanika u svakoj skupini liječeno je laserom 660 nm, a preostalih 50 % laserom 810 nm. Orofacijalni bol određen je prema VAS-u. **Rezultati:** Nakon primjene ML-a prijavljeni bol bio je značajno manji za sve ispitanike ($P < 0,05$). Značajno veće smanjenje bola ostvareno je primjenom lasera 810 nm za sve pacijente te za TN i TMP grupu ($P < 0,001$; $P = 0,005$; $P = 0,024$). **Zaključci:** ML pokazao se učinkovitom metodom smanjenja bola kod TN-a, TMP-a i SPU-a. Bolji rezultati ostvaruju se primjenom veće valne duljine.

Ključne riječi: bol lica; laseri; mjerenje bola; poremećaji temporomandibularnog zgloba; sindrom pekućih usta; trigeminalna neuralgija

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INTRODUCTION

Chronic idiopathic pain management is a growing challenge for both primary care physicians and specialists¹. In the orofacial region, the most common forms of chronic idiopathic pain are trigeminal neuralgia (TN), temporomandibular joint disorders (TMD) and burning mouth syndrome (BMS). In recent papers discussing the management of chronic idiopathic orofacial pain, authors state that it is crucial to have a multidimensional approach which includes pain specialists, headache neurologists, neurosurgeons, oral surgeons, liaison psychiatrists, physiotherapists, clinical psychologists and radiologists^{2,3}. According to Zakrzewska, a combination of antidepressants and cognitive behaviour therapy gives the best results in the management of chronic idiopathic orofacial pain³. Although medication is often the first line of treatment, tolerance may develop as the treatment period and the need for extra dosage increase, which leads to more side effects. A great number of patients suffering from chronic idiopathic orofacial pain are not satisfied with medical therapy because of incomplete control of pain or drug-related side effects^{4,5}. When drug therapy fails to control the pain, surgical treatment is usually proposed, especially in cases of TN pain⁵. Surgical treatment is often invasive and its results depend on many variables: experience, expertise and correct selection of technique of neurosurgery team. Unsatisfactory therapeutic, whether medicinal or surgical results necessitates finding alternative treatment.

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Low level laser therapy (LLLT) uses low-powered laser light in the range of 1-1000 mW, at wavelengths from 632-1064 nm, to stimulate a biological response. These lasers emit no heat, sound, or vibration and act by inducing a photochemical reaction in the cell, a process referred to as biostimulation or photobiomodulation⁶. Its basic effects are biostimulative, regenerative, analgesic and antiinflammatory⁷. Laboratory studies suggest that irradiation stimulates collagen production, alters DNA synthesis, and improves the function of damaged neurological tissue. It is a treatment modality that is becoming widely known because it is a noninvasive, quick, safe nonpharmaceutical intervention⁸.

The aim of this study was to investigate the efficacy of different wavelengths of laser irradiation in the management of orofacial pain by measuring the pain reduction using visual analogue scale (VAS).

MATERIALS AND METHODS

The study protocol has been approved by the Ethical Committee of the Medical Faculty, University of Rijeka and Clinical Hospital Centre Rijeka. All subjects were informed of the aims and procedures of research, as well as the fact that their medical data would be used in research. Only those subjects who gave written permission in the form of informed consent were included.

Participants

The study involved 80 patients with diagnosed chronic idiopathic orofacial pain syndrome: 20 of them with TN, 20 with TMD and 40 with BMS. Patients were examined at the Oral Medicine Unit and Prosthetic Dentistry Unit, Clinical Hospital Centre Rijeka, Faculty of Medicine, University of Rijeka. The criteria for inclusion in the study were: diagnosis of chronic idiopathic orofacial pain syndrome, absence of any systemic diseases that might be involved, absence of any local oral factors that might be involved, orofacial pain during the last 14 days, no other therapy one month before and during the study. The diagnosis for TMD was made through a standard comprehensive clinical examination based upon the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)⁹. The study included subjects suffering from myofascial pain with/without limited mouth opening. Classical TN was diag-

nosed according to the International Classification of Headache Disorders Criteria¹⁰ and the duration of illness ranged from 6 to 12 months. The criteria for inclusion in the BMS group was: BMS diagnosis and the absence of any systemic diseases or local oral factors that might be involved in the sensation of mouth burning. The individuals underwent complementary examinations (complete blood count, blood glucose level and estrogen level) and only those with normal values took part in the study. After medical, dental and social histories of each participant were collected, clinical examination was performed according to the standard clinical criteria. Each patient was evaluated according to subjective pain reporting: 0-10 VAS. Orofacial pain was quantified by the VAS, where 0 indicated "no pain" and 10 indicated "the worst possible pain"⁶.

Methods

Research was conducted during 2014. The patients were treated with LLLT 5 days per week for 4 consecutive weeks with a 660 nm or 810 nm Ga-Al-As (Gallium-Aluminum-Arsenide) diode laser (Medio LASER Combi Dental, Iskra Medical, Ljubljana, Slovenia). In each syndrome-group, 50 % of the participants were treated with 660 nm laser and 50 % of them with 810 nm laser: 10 participants of TN group, 10 participants of TMD group and 20 participants of BMS group were treated with 660 nm laser; and 10 participants of TN group, 10 participants of TMD group and 20 participants of BMS group were treated with 810 nm laser. During each session, the laser light was delivered to the tissue by a straight optical fiber with a 2 mm spot size and the output power was measured at the fiber aperture. The laser output power was monitored weekly using analogue power meters provided by the manufacturer. The output power of the laser was measured for 7 min and found to be practically constant. The treatment areas, each one being a 1 cm² surface were used on tender points diagnosed at the start of the treatment. The laser was applied for approximately 10 minutes (810 nm or 660 nm, continuous wave, 30 mW output power, 3.0 J/cm²). The treatment time (t) for each application point was calculated using the following equation¹¹:

$$t(sec) = 3.0 \frac{J}{cm^2} \times 1 \frac{cm^2}{0.003} (W)$$

The effect of the laser light was evaluated after the final treatment.

Statistical analysis

Statistical analysis of the data was performed using *Statistica* 10.10 (StatSoft Inc., Tulsa, SAD). The normal distribution of age was checked by Kolmogorov-Smirnov test. Data of age were presented as median and (5th-95th) percentile boundaries,

LLLT stimulates collagen production and improves the function of damaged neurological tissue. Better results can be achieved with higher wavelengths. It is also important for reducing costs of treatment, as we have less need for surgical treatment or medicine use. Because only 6-10 applications are necessary to achieve pain relief, LLLT may also have a positive psychological effect.

minimum and maximum. Differences in age between participants were checked using Kruskal-Wallis test. The analysis of the presence gender was performed using χ^2 test. Data of VAS were presented as median and (5th-95th) percentile boundaries. Results of VAS before and after LLLT were compared using the Wilcoxon test. Statistical analysis of VAS before and after LLLT at each wavelength was performed using Mann-Whitney test. All statistical values were considered significant at $P = 0.05$.

RESULTS

Demographic characteristics of all participants are shown in Table 1. There was no significant difference between groups regarding the age of the patients ($P = 0.149$). There were significantly more female than male patients ($P = 0.007$). In the BMS group there were significantly more female than male patients ($P = 0.004$).

In all 3 groups, for both 660 nm and 810 nm applied wavelength, VAS after LLLT was significantly lower than before LLLT. In all 3 groups, 810 nm laser showed better results assessed through VAS reduction. Efficacy of 810 nm laser compared to 660 nm laser was significantly higher in TN group and in TMD group ($P = 0.005$ and $P = 0.024$); (Table 2).

Table 1. Demographic characteristics of participants

| | Trigeminal neuralgia | Temporomandibular disorders | Burning mouth syndrome | All | P |
|------------------------|----------------------|-----------------------------|------------------------|--------------|-------|
| N | 20 | 20 | 40 | 80 | |
| Age* / years (min-max) | 53 (32-71.5) | 44.5 (28-60) | 51 (29.5-75.5) | 50 (28.5-72) | 0.149 |
| | 27-72 | 27-63 | 25-80 | 25-80 | |
| Male / n (%) | 12 (60) | 9 (45) | 9 (22.5) | 30 (30.7) | |
| Female / n (%) | 8 (40) | 11 (55) | 31 (77.5) | 50 (62.5) | |
| P | 0.392 | 0.662 | 0.004 | 0.007 | |

*data are presented as median (5th-95th) percentile boundaries, minimum and maximum

Table 2. Efficacy of different wavelengths assessed through VAS reduction

| Orofacial pain syndrome | N | Laser wavelength (nm) | VAS before* | VAS after* | P |
|-----------------------------|----|-----------------------|-------------|-------------|---------|
| Trigeminal neuralgia | 10 | 660 | 7 (2-9) | 6.5 (2-8) | 0.043 |
| | 10 | 810 | 7 (5-10) | 4 (1-5) | 0.005 |
| | | | 0.940 | 0.005 | |
| Temporomandibular disorders | 10 | 660 | 6.5 (3-10) | 6 (2-9) | 0.018 |
| | 10 | 810 | 7 (4-10) | 3 (1-8) | 0.005 |
| | | | 0.762 | 0.024 | |
| Burning mouth syndrome | 20 | 660 | 7 (2-9.5) | 4.5 (1-8) | 0.001 |
| | 20 | 810 | 6 (3.5-9) | 4 (1-6.5) | < 0.001 |
| | | | 0.508 | 0.460 | |
| All | 40 | 660 | 7 (2-9.5) | 5.5 (1-8) | < 0.001 |
| | 40 | 810 | 6 (4-10) | 3.5 (1-6.5) | < 0.001 |
| All | 80 | | 0.736 | < 0.001 | |

*data are presented as median (5th-95th) percentile boundaries

DISCUSSION

Results of this study showed that subjective pain, measured using VAS, after the use of LLLT was significantly lower in patients with TN, TMD and BMS, for both 660 nm and 810 nm lasers. By performing searches on Medline database using: LLLT, TN, TMD and BMS as keywords non of the research was found. Therefore, we concluded that this was the first research that investigated different wavelengths of LLLT in the treatment of TN, TMD and BMS.

One of the studies on the use of LLLT in the management of different disorders of orofacial region, performed by Pinheiro *et al.* showed reduction of pain in TMD, TN, inflammation, tooth hypersensitivity and aphtae after the application of LLLT. Authors suggested that the reduction of pain in TMD patients may be due to an increased release of β -endorphins, whereas the

reduction of pain in TN patients may be a result of a recovery of the neuronal activity and function¹².

A majority of the studies on the use of LLLT in the management of chronic idiopathic orofacial pain involved TMD. Statistically significant reduction of pain in the laser group in relation to the placebo was observed in research by Gray *et al.*¹³, Bertolucci and Grey¹⁴, Fikáčková *et al.*¹⁵, Mazzetto *et al.*¹⁶, Öz S *et al.*¹⁷, Çetiner *et al.*¹⁸ and Venezian *et al.*¹⁹. Some of the studies reported both reduction of pain as well as a significant improvement in the range of mandibular movements and decreased tenderness of masticatory muscles²⁰⁻²². Previous studies suggest that both idiopathic TN and idiopathic BMS may be of neuropathic origin. Several authors suggested that pathogenesis of TN may involve axon and myelin changes^{23,24}. Tongue biopsies in BMS patients showed a significant reduction of epithelial nerve fibres versus

control group^{25,26}. The treatment of neuropathic pain conditions often involves a variety of medicines with many side effects and, as the treatment continues, the need for extra dosage increase^{27,28}. Medicinal management often includes antidepressants but, as studied by Tammi-alia-Salonen *et al.* antidepressants did not effectively relieve BMS associated symptoms²⁹. Effectiveness of LLLT in peripheral nerve regeneration was demonstrated in several studies³⁰⁻³². Nerve regeneration and acceleration of axonal growth was observed in rats after the application of 780 nm laser³⁰. In another study, rabbits who were treated with 901 nm laser showed thicker nerve fibers, clearer Ranvier nodes and more regular myelin layers, compared to control group³¹. In a study by Romeo *et al.* 68 % of BMS patients reported significant relief after LLLT³². Statistically significant reduction in the salivary levels of proinflammatory cytokines TNF- α and IL-6 was observed after the application of LLLT in BMS patients²⁷. In the treatment of TN, LLLT has proven effective in several studies³³⁻³⁵. Vernon and Hasbun reported no pain after 12 sessions³⁵ and a study by Eckerdal and Bastian proved LLLT efficacy at one-year follow up³⁴. Taken together, these results indicate that LLLT biostimulative effects may play an important role in the management of neuropathic pain conditions, such as idiopathic TN and idiopathic BMS.

In all 3 groups, greater VAS reduction was observed after the application of 810 nm laser compared to 660 nm laser. In a study by Carvalho *et al.*, it was observed that greater laser wavelength was associated with greater pain reduction³⁶. Previous research showed that the effectiveness of LLLT is greater when used in the spectrum of 780 to 904 nm because of increased penetration. Greater laser photobiomodulation is linked to higher irradiation protocols as well as to a greater number of sessions and frequency of application^{37,38}.

In some of the studies, LLLT did not show as effective in the management of orofacial pain conditions^{39,40}. López-Ramírez *et al.* used 810 nm laser to treat pain, facial swelling and trismus after surgical removal of impacted lower third molar³⁹. We suppose the reason why LLLT did not show as effective is because it was applied in 1

session only. Research by León *et al.* showed that 6-10 applications were necessary to achieve pain relief in TMD patients⁴¹. Carrasco *et al.* reported less TMD symptoms and greater masticatory efficiency after 8th laser session⁴². In another study, Amanat *et al.* aimed to evaluate the efficacy of LLLT in the treatment of TN, myofascial pain dysfunction syndrome and atypical facial pain⁴⁰. Authors reported no significant differences between laser group and control group, and suggested there is no significant efficacy for LLLT in the management of orofacial pain conditions.

We assume the reason why LLLT failed to show its efficiency is because all patients received pharmaceutical treatment as well. This adds support for the hypothesis that pain reduction from LLLT is achieved through an antiinflammatory action. Kim *et al.* reported greater pain relief in TN patients treated with LLLT alone compared to TN patients treated with a combination of LLLT and medications⁴³. In previous mentioned study, León *et al.* compared LLLT to drug therapy in TMD patients. LLLT group showed better results assessed through VAS⁴¹.

CONCLUSIONS

LLLT with its biostimulatory, antiinflammatory and analgesic effects has proven to be an effective intervention in reducing pain in TN, TMD and BMS patients. Nevertheless, LLLT still has not been included in every day dental practice in the treatment of chronic idiopathic orofacial pain. One of the reasons might be a lack of standardization of treatment protocol for LLLT. Therefore, one of the aims of this paper was to contribute in developing specific guidelines for the use of LLLT in patients with TN, TMD and BMS. Our research suggests that better results can be achieved with higher wavelengths. LLLT might also be important for reducing costs of treatment, as we have less need for surgical treatment or medicine use. Because only 6-10 applications are necessary to achieve pain relief, LLLT may also have a positive psychological effect, especially on patients suffering from chronic pain conditions, such as TN, TMD and BMS.

Conflicts of interest statement: The authors report no conflicts of interest.

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