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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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Abstract

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/cm^2, 0.25 W, 10 Hz, 10 sec; 808-nm diode: $n=20$, 8 J/cm^2, 0.25 W, continuous mode, 10 sec; 660-nm diode: $n=20$, 8 J/cm^2, 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.

Introduction

Third molars normally erupt between the ages of 18 and 24 years, but ~40% fail to do so, and, therefore, become partially or completely impacted in the bone.[1] Pericoronitis is an inflammation of the soft and hard tissues surrounding the crown of an erupting or impacted tooth (commonly the lower third molar) that is characterized by Gram-negative anaerobic bacterial growth.[2] It is generally agreed that this process is potentiated by food debris accumulating in the vicinity of the operculum and by occlusal trauma of the pericoronal tissues by the opposing tooth.[3]

Clinically, pericoronitis can be acute or chronic. The acute form is characterized by severe pain, which is often referred to adjacent areas, causing loss of sleep, swelling of the pericoronal tissues, discharge of pus, trismus, regional lymphadenopathy, pain on swallowing, pyrexia, and, in some cases, spread of the infection to adjacent tissue spaces. Patients with chronic pericoronitis complain of a dull pain or mild discomfort lasting 1–2 days, with remission lasting many months. They may also complain of a bad taste. Pregnancy and fatigue are associated with an increased occurrence of pericoronitis.[4]

Treatment considerations for acute pericoronitis include debridement and irrigation of the undersurface of the pericoronal flap, antimicrobials, and tissue recontouring. The goal of treatment is the elimination of the acute signs and symptoms of inflammation as soon as possible, including the anaerobic bacterial load.[4] As noninvasive treatments are of interest in dentistry, the therapeutic properties of low-level laser therapy (LLLT) may make it a beneficial tool for accelerating wound healing and diminishing patient complaints, as an adjunct to conventional treatment.

Since first described by Mester et al.,[5] LLLT has been used for several indications in dentistry. LLLT is defined as biostimulation with a low energy output that does not give rise to an increase in tissue temperature of the treated region above the normal body temperature. LLLT has been used for

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several treatment modalities such as the prevention of swelling and trismus after the removal of impacted third molars;[6] for pain reduction after dental treatment;[7] providing more favorable periodontal healing;[8] and for treating mucositis,[9] herpes simplex ulcers,[10] and sensory aberrations in the inferior alveolar nerve.[11] Although the anti-inflammatory and antimicrobial properties of LLLT have been widely studied, the effect of LLLT on acute pericoronitis is still controversial, with limited data published on its effects.[12]

Most LLLT studies have been conducted with helium-neon (HeNe) (532.8-nm) lasers and diode lasers,[6,12–14] but some studies have investigated the potential biostimulatory effect of low-pulse energy neodymium:yttrium-aluminum garnet (Nd:YAG) laser application.[15–18] Because of the small number of studies and variable results, the biostimulatory effects of the Nd:YAG laser remain controversial.

The use of patient-centered measures in dentistry is increasing and oral health-related quality of life (OHQoL) assessments are widely used in oral health surveys and in clinical trials.[19] Therefore, these assesments may also play an important role in clinical practice in terms of identifying needs, selecting therapies, and monitoring patient progress.[20] OHQoL has been assessed with different questionnaires, among which the short version of the Oral Health Impact Profile (OHIP-14)[21–23] is the most widely used. This questionnaire was translated and validated into Turkish by Mumcu et al.[19] The impact of symptomatic pericoronitis on QoL may be substantial, but few data on this relationship exist.[24]

As different wavelengths promote different tissue interactions, the aim of this study was to evaluate the effects of different LLLT modalities on acute pericoronitis by means of pain, trismus, and OHQoL assessments.

Methods

Participants

The study was performed in accordance with the ethical principles set forth in the Declaration of Helsinki and was approved by the local ethics committee. Written informed consent was obtained from all patients before the study.

The study group comprised 80 outpatients (39 men, 41 women) between 18 and 33 years of age, who attended the Gaziantep University Faculty of Dentistry with a complaint of pericoronitis unilaterally in the mandibular third molar region. Exclusion criteria were a history of psychiatric treatment, any chronic disease, antibiotic treatment during the previous 3 months, pregnancy/lactation, radiographic evidence of severe periodontal disease, and any other oral conditions other than pericoronitis. Patients allergic to amoxicillin and current smokers were also excluded from the study.

Study design and treatment protocols

The study consisted of four groups, with 20 patients in each, and the patients were randomly assigned to one of three LLLT groups or a placebo group.

All patients underwent a standard treatment regimen (STR) of debridement and irrigation of the undersurface of the pericoronal flap. They received standard medication of 1000 mg of amoxicillin trihydrate/potassium clavulanate (Augmentin BID; GlaxoSmithKline, Istanbul, Turkey) taken orally every 12 h for 7 days, 500 mg acetaminophen (Minoset, Roche, Istanbul, Turkey) taken orally every 8 h for 5 days, and rinsing twice a day for 10 days with chlorhexidine 0.12% (Klorhex® Drogsan-Ankara, Turkey).

In the first group ($n=20$, 11 men and 9 women with a mean age of 24.4 ± 3.6 years), the STR plus a single course of LLLT was applied to the tissues of the buccal site for 10 sec from a distance of 1 cm using the 1064-nm Nd:YAG laser (Fotona, Slovenia) with a R24 950-μm fiber handpiece. The other parameters of the Nd:YAG laser were as follows: the output energy was 0.25 W, the frequency was 10 Hz, and the beam area was 0.3 cm^2. The energy density from the distance mentioned was calculated as $\sim 8\,J/cm^2$.

In the second group ($n=20$, 9 men and 11 women with a mean age of 23.3 years), the STR plus a single course of LLLT was applied to the buccal site for 10 sec from a distance of 1 cm using the 808-nm diode (GaAlAs) laser (Fotona, Slovenia) with a R24B fiber handpiece with a continuous mode and an average power of 0.25 W. The beam area was 0.3 cm^2. The energy density from the mentioned distance was calculated as $\sim 8\,J/cm^2$.

In the third group ($n=20$, 9 men and 11 women with a mean age of 22.3 years), the patients received the STR plus a single course of LLLT using the 660-nm diode laser (Helbo, Bredent, Germany) with a power output of 0.04 W and a continuous mode for 60 sec, corresponding to an energy density of $8\,J/cm^2$ with a HELBO® 2D spot probe from a distance of 1 cm from the buccal site of pericoronitis.

The input and output power of the lasers were taken to be the same, and all the lasers had been calibrated periodically.

In the control group ($n=20$, 10 men, 10 women with a mean age of 23.3 years), the patients received the STR plus a single course of placebo laser therapy without active laser irradiation. The participants were blinded as to which treatment they received. All treatments were performed by the same dentist who used a standardized technique on all patients.

Clinical assessments

The variables studied were age, gender, degree of mouth opening, level of pain, and OHQoL by the OHIP-14 questionnaire. The degree of mouth opening, level of pain, and OHQoL were evaluated at the time of the initial examination and 24 h and 7 days after LLLT.

Measurement of mouth opening. The interincisal opening was evaluated by measuring with a caliper the maximal opening between the right maxillary and the right mandibular central incisors.[25]

Measurement of pain levels. The pain level was evaluated using a visual analogue scale (VAS) of 100 mm. All assessments were performed in the morning at the same clinic, which was free of extraneous noise, music, or conversation. All patients were asked to define their level of pain on the VAS, consisting of a scale from 0 to 100 (a 100-mm line). On this scale, 0 and 100 represented "no pain" and "the worst pain imaginable," respectively.

OHRQoL measurements. The impact of oral health on the patients' QoL was assessed using the 14-item OHIP-14

Table 1. Summary of Age and Gender Distribution Among Groups

	Control (n:20)	*660-nm diode* (n:20)	*Nd:YAG* (n:20)	*808-nm diode* (n:20)
Age (mean ± SD)	25.5 ± 4.45	22.45 ± 3.62	24.4 ± 3.58	22.25 ± 2.55
Age range	18–31	18–33	20–31	18–29
Gender (male/female)	10/10	9/11	11/9	9/11

No significant differences were detected between none of groups ($p > 0.05$).

measures. Using the OHIP measures, the patients were asked to rate the impact of their oral health on 14 key areas of OHRQoL: "What effects do your teeth, gums, and/or mouth have on each of the 14 key areas of life quality (i.e., your comfort, your speech)?" These 14 items were subdivided into seven domains (subscales): functional limitation, physical discomfort, psychological discomfort, physical disability, psychological disability, social disability, and handicap.

For the OHIP-14, the response categories were recorded on a five-point Likert scale: 0, never; 1, hardly ever; 2, occasionally; 3, fairly often; 4, very often. Higher scores in the OHIP-14 questionnaire indicated a poorer OHQoL. Summing up the responses to each of the 14 items can produce overall OHIP-14 scores, ranging from 0 (best OHQoL possible) to 56 (poorest OHQoL possible).

Measurements at all visits for a given subject were made by one calibrated examiner who was not involved in providing treatment during the study. Before the start of the study, the examiner was trained to adequate levels of accuracy and reproducibility in recording the clinical measurements.

Statistical analysis

The data were analyzed by the one-way ANOVA test. Significant differences among the groups were analyzed by the use of Duncan's multiple range tests. The level of significance was set at 0.05 for the tests. The data were analyzed using the statistical package SPSS 17.0 (Chicago, IL).

Results

The study groups were similar in age and gender ($p > 0.05$) (Table 1). None of the subjects who completed the study contacted the clinic to report any complications related to the laser application.

At baseline, the average interincisal opening was similar in all groups ($p > 0.05$). Twenty-four hours after the laser application, although there was an improvement in all the groups in relation to the interincisal opening; only the Nd:YAG and the 808-nm diode laser groups showed a statistically significant improvement ($p < 0.05$). Hence, no statistically significant difference was detected between the Nd:YAG and the 808-nm diode groups after 24 h. On the 7th day of laser application, all the groups showed a significant improvement when compared with baseline values, and there were no statistically significant differences among the groups ($p > 0.05$) (Table 2).

At baseline, the average pain levels were similar among all groups ($p > 0.05$) Twenty-four hours after the laser application, although significant decreases were detected in all the groups in relation to the pain levels, there was no significant difference among the groups ($p > 0.05$). Also, at day 7, the pain levels were significantly reduced in all groups when compared with baseline values, but no significant differences were detected among the groups ($p > 0.05$) (Table 3).

At baseline, the average OHIP-14 scores were similar in all groups ($p > 0.05$). Twenty-four hours after the laser application, although there was an improvement in all groups in relation to OHRQoL, only the Nd:YAG and the 808-nm diode laser groups showed a statistically significant improvement ($p < 0.05$). Hence, no statistically significant difference was detected between the Nd:YAG and the 808-nm diode groups after 24 h. On the 7th day of laser application, all the groups showed a significant improvement when compared with baseline values, and there were no significant differences among the groups ($p > 0.05$) (Table 4).

Discussion

In the current study, when evaluating the effects of lasers within the related parameters, we found that only the 808-nm wavelength diode laser and the 1064-nm Nd:YAG laser were effective for biostimulation, leading to trismus improvement 24 h after the laser application. The 660-nm wavelength diode laser was ineffective. Up until now, there have been limited data concerning the effects of LLLT on trismus. Carrillo et al.[14] reported that the percentage of trismus in a laser group (helium-neon, 633 nm with 10 J/cm^2

Table 2. Comparison of Baseline and 24 h-7th Day Interincisal Opening in the LLLT Groups and Controls

	Control (n:20)	*660-nm diode* (n:20)	*Nd:YAG* (n:20)	*808-nm diode* (n:20)
Baseline (mm) (mean ± SD)	35.4 ± 6.08	36.35 ± 3.87	35.15 ± 4.08	34.9 ± 4.03
24 h (mm) (mean ± SD)	37.2 ± 3.72	38.05 ± 3.37	40.25 ± 4.03[a,b]	39.0 ± 3.89[a,b]
7th day (mm) (mean ± SD)	43.4 ± 2.45[c]	42.05 ± 3.46[c]	43.45 ± 4.25[c]	41.9 ± 3.61[c]

[a]$p > 0.05$; p values represent differences from control group of changes between groups at 24 h from baseline.
[b]$p > 0.05$; p values represent differences from 660-nm diode group of changes between groups at 24 h from baseline.
[c]$p > 0.05$; p values represent changes from baseline within each group.

Table 3. Comparison of Baseline and 24 h-7th Day Pain Levels Determined by Visual Analog Scale (VAS) in The LLLT Groups and Controls

	Control (n:20)	*660-nm diode (n:20)*	*Nd:YAG (n:20)*	*808-nm diode (n:20)*
Baseline (mean ± SD)	66 ± 13	64.50 ± 21.08	68.25 ± 21.59	71.20 ± 20.70
24 h (mean ± SD)	41.0 ± 18.9[a]	41.5 ± 18.43[a]	38 ± 20.74[a]	44.25 ± 20.60[a]
7th day (mean ± SD)	25 ± 20.03[a,b]	24.25 ± 17.13[a,b]	21.5 ± 22.77[a,b]	18.0 ± 15.0[a,b]

[a]$p > 0.05$; *p*-values represent changes from baseline within each group.
[b]$p > 0.05$; *p*-values represent changes from 24 h within each group.

of energy density) was significantly less than the percentage of trismus in a placebo group up to 7 days after extraction of lower third molars. Aras and Güngörmüs[6,26] observed that irradiation with a diode laser at 808 nm and 4 J/cm^2 significantly decreased trismus after surgery. On the other hand, Lopez-Ramirez et al.[27] reported that LLLT (AsGaAl, 810 nm 5 J/cm^2 of energy density) did not show beneficial effects in reducing trismus and pain after removal of impacted lower third molars. In addition, Roynesdal et al.[28] reported that soft-laser treatment with a 6-J semiconductor laser at 830 nm, 40 mW had no beneficial effect on swelling, trismus, and pain after third molar surgery. Using intraoral LLLT, Carrillo et al.[14] applied the laser to six different points at the site of the surgical incision; this led to an effect on a wide area, including the mastication muscles. Aras and Güngormüş[6,26] used LLLT with a handpiece with a 3-cm^2 spot size to treat an area that included the mastication muscles. According to these authors, surgical procedures may cause spasms of certain muscles, especially the masseter; therefore, intraoral laser application on a narrow area would not affect this muscle directly. Lopez-Ramirez et al.[27] reported that although the improvement in trismus following LLLT was not statistically significant, LLLT yielded favorable results in terms of reducing trismus. They claimed that this reduction in trismus may be related to the effect of LLLT on the relaxation of mastication muscles other than the masseter, such as the medial pterygoid. Although the muscle mainly involved in trismus in acute pericoronitis is not clear, it is possible that the medial pterygoid muscle may be more affected than the masseter muscle. The possible role of the medial pterygoid muscle in acute pericoronitis-related trismus and the direct impact of intraoral LLLT on this muscle may explain the beneficial effect of LLLT on trismus improvement in the current study. Although our findings are in contrast with those of Roynesdal et al.,[28] there are insufficient data related to this study's laser parameters and application area. Moreover, the results of the current study showed that the 660-nm diode laser was ineffective in improving trismus within the parameters used.

Although it has been postulated that low-energy lasers have analgesic capabilities, particularly in neuralgia and muscle-related pain, their effect on inflammation-related pain is controversial.[6,27,29,30] Some investigators who evaluated the role of LLLT in the reduction of pain have tried to explain this phenomenon as interference with the mediation of the pain message and/or the stimulation of endorphin production. According to the results of our study, no statistically significant differences were observed in the levels of pain in any of the groups. This finding is in agreement with some previous studies.[27,31,32] In contrast with our results, Markovic and Todorovic[29] reported a reduction in pain by applying the AsGaAl laser after the surgical removal of the third molars. They claimed that this effect seems to be dose dependent. However, Lopez-Ramirez et al.[27] suggested that they found some limitations in Markovic and Todorovic's[29] study, such as no indication of the exact time of pain assessment and variability inherent to the study design, when comparing results from different individuals. Although Lopez-Ramirez et al.[27] used similar doses (5 J/cm^2 of energy density, a wavelength of 810 nm) as did Markovic and Todorovic,[29] they did not find any beneficial effect of LLLT on pain reduction. On the other hand, although we used different wavelengths to compare the impact of wavelength on LLLT-induced pain reduction, we did not find any additional effect of LLLT with any of the wavelengths on inflammation-associated pain.

Although there is accumulating evidence to support the biostimulatory effect of LLLT on various tissues, the mechanisms of this effect are still unclear. There are also little data concerning the pathogenesis of pericoronitis.[33] The role of tumor necrosis factor-alpha (TNF-α) in pericoronitis pathogenesis was previously shown by Beklen et al.[34] Moreover,

Table 4. Comparison of Baseline and 24 h-7th Day OHIP-14 Scores in the LLLT Groups and Controls

	Control (n:20)	*660 nm-diode (n:20)*	*Nd:YAG (n:20)*	*808 nm-diode (n:20)*
Baseline (mean ± SD)	26.1 ± 8.03	27.05 ± 7.89	28.6 ± 4.04	27.8 ± 4.63
24 h (mean ± SD)	19.4 ± 7.55[a]	17.85 ± 6.04[a]	15.7 ± 3.44[a,c,d]	15.35 ± 4.16[a,c,d]
7th day (mean ± SD)	12.4 ± 7.41[a,b]	13.2 ± 4.79[a]	11.15 ± 3.39[a]	10.9 ± 4.56[a]

[a]$p > 0.05$; *p* values represent changes from baseline within each group.
[b]$p > 0.05$; *p* values represent changes from 24 h within each group.
[c]$p > 0.05$; *p* values represent differences from control group of changes between groups at 24 h from baseline.
[d]$p > 0.05$; *p* values represent differences from 660-nm diode group of changes between groups at 24 h from baseline.
OHIP, Oral Health Impact Profile.

Mesquita-Ferrari[35] reported that LLLT decreased the release of proinflammatory cytokines. Although we did not undertake any biochemical investigation in the current study, the biostimulatory effect of LLLT on acute pericoronitis may be related to its suppressive impact on proinflammatory cytokine release, particularly TNF-α.

In a previous study, McNutt et al.[24] demonstrated the unfavorable effect of pericoronitis on OHRQoL. In this study, the subjects had confirmed symptoms of pericoronitis, and OHRQoL was evaluated with OHIP-14, similar to our study. The OHIP-14 mean score of all the subjects in McNutt et al.'s study showed a better profile when compared with our subjects' baseline scores. One of their exclusion criteria was major signs/symptoms of pericoronitis. In our study, we included only patients with acute pericoronitis symptoms and, hence, our higher reported baseline OHIP-14 severity score seems logical. In the current study, an improvement in OHRQoL was detected in the Nd:YAG and the 808-nm diode laser groups 24 h after the laser treatment. Hence, no significant differences were detected on the 7th day. Although there are a lack of data evaluating the effects of LLLT on OHRQoL in pericoronitis treatment or third molar surgery, the effect of LLLT on HRQoL has been evaluated by a number of studies.[36–38] The findings of our study are in agreement with those of other studies, which reported an additional beneficial effect of LLLT on HRQoL.[36–38] In the current study, the improvement in OHRQoL with LLLT may be related to its beneficial effects on trismus.

Conclusions

The results of the present clinical study demonstrate that both the 1064-nm Nd:YAG and the 808-nm diode lasers were effective in improving trismus and OHRQoL in acute pericoronitis. However, the 660-nm diode laser was not effective in improving any of the pericoronitis symptoms we evaluated. Within the limitations of this study, we demonstrated that the 1064-nm Nd:YAG laser has biostimulatory effects and improves OHRQoL, suggesting that it may be used for LLLT. Further studies are needed with different irradiation parameters and larger patient groups to evaluate biostimulatory and OHRQoL improvements in acute pericoronitis with this simple and noninvasive method.

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Author Disclosure Statement

No competing financial interests exist.

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