Lasers Med Sci (2010) 25:641–645
DOI 10.1007/s10103-009-0684-1

ORIGINAL ARTICLE

Placebo-controlled randomized clinical trial of the effect two different low-level laser therapies (LLLT)—intraoral and extraoral—on trismus and facial swelling following surgical extraction of the lower third molar

Mutan Hamdi Aras · Metin Güngörmüş

Received: 20 May 2008 / Accepted: 12 May 2009 / Published online: 31 May 2009

Abstract The purpose of this study is to compare the effects of extraoral and intraoral low-level laser therapies (LLLT) on postoperative trismus and oedema following the removal of mandibular third molars. Forty-eight patients who were to undergo surgical removal of their lower third molars were studied. Patients were randomly allocated to one of three groups: extraoral LLLT, intraoral LLLT, or placebo. In the study, a Ga-Al-As diode laser device with a continuous wavelength of 808 nm was used, and the laser therapy was applied by using a 1×3-cm handpiece. The flat-top laser beam profile was used in this therapy. For both of the LLLT groups, laser energy was applied at 100 mW (0.1 W) for a total of 120 s (0.1 W×120 s=12 J). Patients in the extraoral-LLLT group (n=16) received 12-J (4 J/cm^2) low-level laser irradiation, and the laser was applied at the insertion point of the masseter muscle immediately after the operation. Patients in the intraoral-LLLT group (n=16) received 12-J (4 J/cm^2) low-level laser irradiation intraorally at the operation site 1 cm from the target tissue. In the placebo group (n=16), the handpiece was inserted intraorally at the operation site and then was touched extraorally to the masseter muscle for 1 min at each site (120 s total), but the laser was not activated. The size of the interincisal opening and facial swelling were evaluated on the second and seventh postoperative days. At the second postoperative day, trismus (29.0±7.6 mm [p=0.010]) and swelling (105.3±5.0 mm [p=0.047]) in the extraoral-LLLT group were significantly less than in the placebo group (trismus: 21.1±7.6 mm, swelling: 109.1±4.4 mm). Trismus (39.6±9.0 mm [p=0.002]) in the extraoral-LLLT group at the seventh postoperative day was also significantly less than in the placebo group (29.0±6.2 mm). However, at the seventh postoperative day in the intraoral-LLLT group, only trismus (35.6±8.5 [p=0.002]) was significantly less than in the placebo group (29.0±6.2 mm). This study demonstrates that extraoral LLLT is more effective than intraoral LLLT for the reduction of postoperative trismus and swelling after extraction of the lower third molar.

Keywords Low-level laser therapy · Extraoral application · Intraoral application · LLLT · Mandibular third molar · Trismus · Oedema

M. H. Aras
Faculty of Dentistry,
Department of Oral and Maxillofacial Surgery,
Gaziantep University,
Gaziantep, Turkey

M. H. Aras (✉)
Gaziantep Universitesi Dis Hekimligi Fakultesi,
Cerrahi A.D 27310,
Gaziantep, Turkey
e-mail: mutanhamdi@hotmail.com

M. Güngörmüş
Faculty of Dentistry,
Department of Oral and Maxillofacial Surgery, Ataturk University,
Erzurum, Turkey
e-mail: gungormusm@yahoo.com

M. Güngörmüş
Ataturk Universitesi Dis Hekimligi Fakultesi,
Cerrahi A.D 25240,
Erzurum, Turkey

Introduction

Surgical removal of an impacted third molar often involves postoperative swelling and loss of jaw function. The many factors that contribute to these situations are complex, but they originate from an inflammatory process that is initiated

by surgical trauma [1]. Several methods have been used to inhibit these postoperative sequelae, including the use of local or systemic corticosteroids, nonsteroidal anti-inflammatory drugs, tube drains, different incisions, and low-level laser therapy [1–6]. The application of low-energy lasers in the field of dentistry and oral surgery has been popular since the 1970s. LLLT has been used for the prevention of swelling and trismus after the removal of impacted third molars, following periodontal surgery procedures, for reducing orthodontic postadjustment pain, as well as for the treatment of chronic facial pain, chronic sinusitis, gingivitis, herpes simplex, dentinal tooth hypersensitivity and sensory aberrations in the inferior alveolar nerve [6]. Although LLLT has been used to prevent postoperative swelling and trismus after third-molar surgery, the results are controversial. This might be due to varying study designs, differentiations or difficulties in the measurement of variables related to postoperative sequelae as well as to different lasers and handpiece types and different irradiation parameters [7–12]. The purpose of this study was to compare the effects of extraoral and intraoral low-level laser therapies (LLLT) on postoperative trismus and oedema following the removal of mandibular third molars.

Patients and methods

Forty-eight outpatients (14 men, 34 women) between 18 and 27 years of age who were to undergo surgical removal of mandibular third molars having partial bone impaction were studied. Only one tooth was surgically extracted, even if both mandibular third molars should have been extracted in these patients. All removed mandibular third molars were in a mesioangular position and had partial bone retention. Patients were excluded from the study if their medical history or physical examination suggested adrenal cortical suppression or corticosteroid use during the previous 3 months. The study was approved by the local ethics commission and informed written consent was obtained from all patients. The participants were randomly assigned into one of two LLLT groups, intraoral or extraoral LLLT, or into a placebo group. Articaine HCL 2.5% plus 1:100.000 epinephrine (Ultracaine D-S forte Ampul, Aventis, Istanbul, Turkey) was used for inferior alveolar and buccal nerve blocks. All operations were performed by the same surgeon who used a standardized technique on all patients. The duration of the surgery was recorded. In the study, a Ga-Al-As diode laser device (model; Doctor Smile erbium and diode laser, Lambda Scientifica S.r. l, Vicenza, Italy) with a continuous wavelength of 808 nm was used, and the laser therapy was applied by using a 1×3-cm handpiece. The flat-top laser beam profile was used in this therapy. Laser energy was applied to both treatment groups at 100 mW (0.1 W) for a total of 120 s (0.1 W×120 s=12 J). Patients in the extraoral-LLLT group (n=16) received 12-J (4 J/cm^2) low-level laser irradiation at the insertion point of the masseter muscle immediately after the operation. Patients in the intraoral-LLLT group (n=16) received 12-J (4 J/cm^2) low-level laser irradiation intraorally at the operation site 1 cm from the target tissue. In the placebo group (n = 16), the handpiece was inserted intraorally into the operation site and then was touched extraorally to the masseter muscle for 1 min at each site (120 s total), but the laser was not activated. The participants were blinded as to which treatment they received.

The interincisal opening was evaluated by measuring with a caliper the maximal opening between the right maxillary and right mandibular central incisors before surgery [2]. Before surgery, the outer contour of the cheek was measured by using the method described by Amin and Laskin [13]. Trismus and oedema are the most pronounced between the 48th and 76th postoperative hours [14], so these measurements were repeated on postoperative days 2 and 7 to register the degree of trismus and facial swelling. After each operation, 500 mg oral penicillin (amoxicillin) (Alfoxil; Abfar, Istanbul, Turkey) was administered three times per day for 5 days, benzidamin HCL + Klorheksidin glukonat gargle antiseptic solution (Farhex, Santa Farma, Istanbul, Turkey) was also administered three times per day for 5 days as was 500 mg acetaminophen (Minoset, Roche, Istanbul, Turkey). All measurements were performed by the same

Table 1 The mean and standard deviation of the pre- and postoperative interincisal opening in the placebo, extraoral- and intraoral-LLLT groups

	Groups	n	Mean (mm)	SD	p-value
Preoperative	Placebo	16	46.125	4.319	>0.05
	Extraoral-LLLT	16	45.938	7.996	
	Intraoral-LLLT	16	45.875	5.932	
Postoperative second day	Placebo	16	21.125	5.175	0.010
	Extraoral-LLLT	16	29.000	7.642	
	Intraoral-LLLT	16	26.063	8.037	
Postoperative seventh day	Placebo	16	29.000	6.186	0.002
	Extraoral-LLLT	16	39.625	9.018	
	Intraoral-LLLT	16	35.562	8.485	

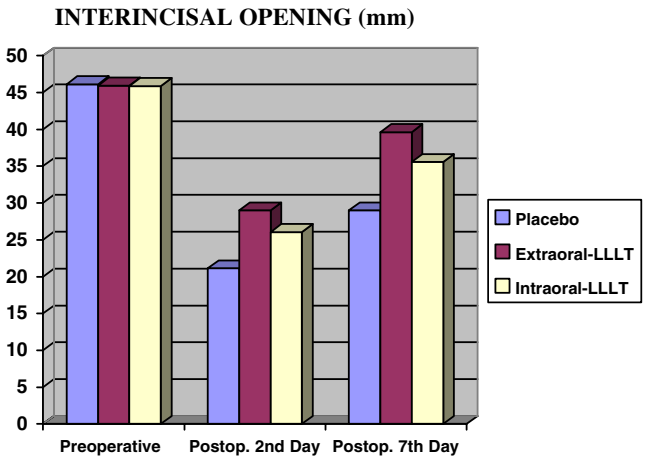

Fig. 1 Comparative survey of pre- and postoperative interincisal opening coefficients in the investigated groups

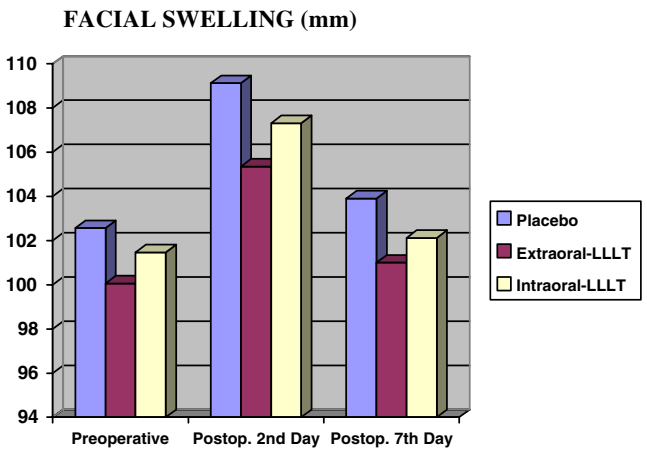

Fig. 2 Comparative survey of pre- and postoperative oedema coefficients in the investigated groups

examiner. The data were analyzed by one-way analysis of variance. Significant differences among the groups were analyzed by the use of Duncan's multiple range test.

Results

There was no statistical difference in the duration of the surgery between the groups (placebo group: 18.9±4.6 min; extraoral-LLLT group: 19.1±4.3 min; intraoral-LLLT group: 17.9±3.0 min; [$p>0.05$]). None of the patients showed any adverse reactions to the applied treatment.

On the second postoperative day, the average interincisal opening in the placebo group was 21.1±5.2 mm, in the extraoral-LLLT group it was 29.0±7.6 mm and in the intraoral-LLLT group it was 26.1±8.0 mm. On the seventh postoperative day, the average interincisal opening in the placebo group was 29.0±6.2 mm, in the extraoral-LLLT group it was 39.6±9.0 mm and in the intraoral-LLLT group it was 35.6±8.5 mm. Trismus in the extraoral-LLLT group was significantly less than in the placebo group at the second and seventh postoperative days ($p=0.010$). However, trismus in the intraoral-LLLT group was significantly less than in the placebo group only at the seventh postoperative day ($p=0.002$) (Table 1) (Fig. 1).

At the second postoperative day, the average swelling in the placebo group was 109.1±4.4 mm, in the extraoral-LLLT group it was 105.3±5.0 mm and in the intraoral-LLLT group it was 107.3±3.0 mm. On the seventh postoperative day the average swelling in the placebo group was 103.9±4.1 mm, in the extraoral-LLLT group it was 101.0±5.2 mm and in the intraoral-LLLT group it was 102.1±3.2 mm. Postoperative swelling was significantly less in the extraoral-LLLT group compared with the placebo group at second the postoperative day ($p=0.047$). However, postoperative swelling was not significantly different in the intraoral-LLLT group compared with the placebo group (Table 2) (Fig. 2).

Discussion

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

Table 2 The mean and standard deviation of pre- and postoperative facial swelling in the placebo, extraoral- and intraoral-LLLT groups

	Groups	*n*	Mean (mm)	SD	*p*-value
Preoperative	Placebo	16	102.563	3.842	>0.05
	Extraoral-LLLT	16	100.063	5.585	
	Intraoral-LLLT	16	101.469	3.143	
Postoperative second day	Placebo	16	109.125	4.391	0.047
	Extraoral-LLLT	16	105.344	4.952	
	Intraoral-LLLT	16	107.313	2.966	
Postoperative seventh day	Placebo	16	103.906	4.128	>0.05
	Extraoral-LLLT	16	101.000	5.180	
	Intraoral-LLLT	16	102.125	3.222	

Table 3 Reported postoperative effectiveness of LLLT on trismus and oedema in previous studies

Authors	Trismus	Edema
Roynesdal et al. (1993)	Ineffective	Ineffective
Taube et al. (1990)	Not reported	Ineffective
Fernando et al. (1993)	Not reported	Ineffective
Clokie et al. (1991)	Not reported	Ineffective
Markovic et al. (2007)	Not reported	Effective
Carrillo et al. (1990)	Effective	Ineffective

others did not (Table 3). Roynesdal et al. [11] investigated the effect of soft-laser application on postoperative swelling and trismus, while Taube et al. [12], Fernando et al. [9] and Clokie et al. [8] investigated the effect of soft-laser application only on postoperative swelling. All of these authors reported that soft-laser treatment had no beneficial effect on swelling and trismus after third-molar surgery. In all of these studies, the authors used different lasers at different power and dose, and all had applied the laser intraorally (Table 4). In our study, we found that intraoral-LLLT was effective in reducing trismus only at the seventh postoperative day. There were no significant differences in swelling between the intraoral-LLLT group and the placebo group. This is in contrast to Markovic and Todorovic [10] who reported that intraoral low-power laser irradiation significantly reduced postoperative oedema. In our study, it was observed that postoperative oedema was significantly less only in the extraoral-LLLT group at the second day after surgery.

On the other hand, Carillo et al. [7] reported that the percentage of trismus in the laser group was significantly less than in the placebo group up to 7 days after surgery. In addition, they noted that helium-neon laser treatment had no beneficial effect on swelling after third-molar surgery. Although Carillo et al. [7] used intraoral LLLT, they applied the laser to six different points at the site of the surgical incision. Our findings correspond to the results of Carillo et al. [7] for trismus only at the seventh postoperative day. In our study, it was observed that trismus in the intraoral-LLLT group was significantly less than in the placebo group 7 days after surgery.

Roynesdal et al. [11] and Fernando et al. [9] used an 830-nm diode laser system in their studies. This wavelength was close to the one used in our study. Although the other authors [7, 8, 10, 12] who treated postoperative inflammation symptoms after third-molar surgery used a diode laser system in their studies, the wavelengths of these lasers were different (Table 4). Roynesdal et al. [11] applied 6-J laser energy at 40 mW of power, and reported that the laser treatment did not have a beneficial effect on swelling and trismus after third-molar surgery. Fernando et al. [9] used a laser at 30 mW mean power. They inserted the laser into the post-extraction socket and irradiated it for 132 s with a dose of 4 J of laser energy. They reported that there was no difference between the laser-treated and placebo groups with regards to swelling on the third and seventh postoperative days. Although the wavelength of the lasers used in the Roynesdal et al. and Fernando et al. studies were close to our laser wavelength, our study results were different. Both Roynesdal et al. and Fernando et al. reported that low-level laser therapy did not have a beneficial effect on postoperative symptoms. However, neither of the studies provided any data on the fluence of the lasers or information about the type of laser probes that were used. This means that we do not know the laser dose that 1 mm^2 was exposed to. Therefore, in their studies, the laser light may not have been adequate. In addition, perhaps the laser light was applied intraorally in their studies. These laser parameters may negatively effect their study results because our study results showed that extraoral laser therapy at 4 J/cm^2

Table 4 The methods and laser parameters of LLLT in previous studies

Authors	Laser wavelengths	Laser output power	Laser dose/energy	Number of application	Application method
Roynesdal et al. (1993)	830 nm	40 mW	6 J	1 Preop- 1 Postop	Intraorally
Taube et al. (1990)	632.8 nm	8 mW	0.96 J	1 Postop	Intraorally
Fernando et al. (1993)	830 nm	30 mW	4 J	1 During operation	Intraorally
Clokie et al. (1991)	632.8 nm	10 mW/ 5.4 mW/cm^2	1.8 J 0.97 J/cm^2	1 Postop	Intraorally
Markovic et al. (2007)	637 nm	50 mW	4 J/cm^2	1 Postop	Intraorally
Carrillo et al. (1990)	632.8 nm	300 mW/cm^2	10 J/cm^2	1 Postop (6 Different point)	Intraorally
Present study Extraoral-LLLT Group	808 nm	100 mW	4 J/cm^2	1 Postop	Extraorally
Present study Intraoral-LLLT Group	808 nm	100 mW	4 J/cm^2	1 Postop	Intraorally

dose decreased postoperative trismus and swelling after third-molar surgery.

Oral surgery might cause the spasm of some muscles, especially the masseter. However, intraoral laser therapy did not directly affect the masseter muscle. In previous studies, LLLT after third-molar surgery has used intraoral laser exposures, with different laser devices and handpieces of different dimensions [7–12]. In the present study, we applied the laser exposures either intraorally or extraorally with a 1 × 3-cm handpiece and 4 J/cm^2. It was observed that both trismus and swelling in the extraoral-LLLT group were significantly less than in the placebo group at the second postoperative day and that trismus in the extraoral-LLLT group was significantly less than in the placebo group at the seventh postoperative day. In the intraoral-LLLT group, only trismus was significantly less than in the placebo group at the seventh postoperative day.

Conclusions

This study has demonstrated that extraoral LLLT is more effective than intraoral LLLT for the reduction of postoperative trismus and swelling after third-molar surgery. The effects of LLLT are probably dependent on the method of its application.

Acknowledgements This study was supported by an Ataturk University Scientific Research Projects Fund.

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