Lasers Med Sci (2013) 28:845–849
DOI 10.1007/s10103-012-1174-4

ORIGINAL ARTICLE

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

Maurizio Ferrante · Morena Petrini · Paolo Trentini · Giorgio Perfetti · Giuseppe Spoto

Received: 20 March 2012 / Accepted: 16 July 2012 / Published online: 28 July 2012

Abstract 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-μm 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×3) (0.3 W×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.

M. Ferrante (✉) · M. Petrini · P. Trentini · G. Perfetti · G. Spoto
Dental Materials, Department of Oral Dental Diseases,
University of Chieti—Italy,
Via Vestini 31,
66013 Chieti, Italy
e-mail: maurizio.ferrante@gmail.com

Keywords Low-level laser therapy · LLLT · Extraction · Third molars

Introduction

Third molar surgery is a common procedure performed by oral and maxillofacial surgeons. Surgical removal of an impacted third molar often involves postoperative pain, 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]. The pain reaches maximum intensity 3 to 5 h after surgery, continuing for 2 to 3 days, and gradually diminishing until the seventh day [2, 3]. Swelling reaches peak intensity in 12 to 48 h, resolving between the fifth and seventh day [4].

The use of local or systemic corticosteroids and nonsteroidal anti-inflammatory drugs are often recommended after surgical extraction of impacted lower third molars to abolish postoperative pain [5, 6], but some of them may manifest side effects such as gastrointestinal irritation, systemic bleeding tendency, and allergic reactions [7]. These observations justify efforts to find a method of postoperative pain control that does not induce side effects. In that sense, the use of low-power laser offers promising possibilities [8, 9].

The biological effects of laser were first studied in 1967 [10], and the laser therapy concept began in 1971 [11]. Since then, it has been used for the treatment of a wide variety of disorders including carpal tunnel syndrome, rheumatoid arthritis, osteoarthritis, tendinopathy, ankle sprains, epicondylitis, lumbalgia, and non-healing ulcers, among others [12, 13]. The exact biological mechanism of the analgesic effect produced by the low-level laser therapy (LLLT) still remains unclear. Many studies suggest that LLT may stimulate the increase in serotonin and acetylcholine production

at a central level and may modulate the production of histamine and prostaglandins at a peripheral level [14]. Analgesic effects are due to the increasing of endogenous endorphins (β-endorphin) and the decreasing the activity of C-fibers and bradykinin. [15, 16]. It is also able to induce morphological neurons changes, reduce the mitochondrial membrane potential, and block the fast axonal flow, leading to neural conduction blockage [17].

The anti-inflammatory effect of the LLLT could be a consequence of the inhibition of IL-6, MCP-1, IL-10, and TNF-α in a dose-dependent manner. [18] This results in an increase of the phagocytic activity, the number and diameter of lymphatic vessels, a decrease in the permeability of blood vessels and a restoration of microcapillary circulation, normalizing the permeability of the vascular wall, and decreasing the edema [19].

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 [20–22]. 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 [4, 23–37]. The aim of this study is to evaluate the effectiveness of the therapeutic laser in the control of pain, swelling, and trismus associated with surgical removal of impacted lower third molars.

Material and methods

Thirty patients between 18 and 30 years (15 men and 15 women) of age were recruited into the study; all subjects were informed of the risks of oral surgery and experimental treatment, and they signed an institutionally approved consent form.

The 30 patients meeting the inclusion criteria had the following characteristics: male or female gender, 18 to 30 years of age, healthy, impacted lower third molar(s), and III B surgical difficulty grade (scales of Pell–Gregory and Winter). Exclusion criteria included contraindications to laser therapy, systemic illness, local infection, tobacco use, oral contraceptives use, pregnancy, and lactation.

All patients were subjected to the same standardized surgical protocol by the same surgeon. The duration of the surgery was recorded. The operator who performed the LLLT in all patients of group test was different from the surgeon; another operator carried out the measurements and was blind to which patient was in control or in experimental group.

Patients were randomized into two treatment groups, each with 15 patients—an experimental group (laser) and a control group (no-laser)—and were told to avoid any analgesics 12 h before the procedure.

The experimental group received laser therapy, and the control group only routine management. The laser was applied 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. Postoperatively, all patients received amoxicillin 1 g orally every 12 h for 5 days, ketoprophene 80 mg orally every 12 h for 2 days.

In the study, a diode laser device (model: G-Laser 25 Galbiati, Italy) with a continuous wavelength of 980 nm was used, and the laser therapy was applied by using a 600-μm handpiece. Laser energy was applied at 300 mW (0.3 W) for a total of 180 s, 60 s for each point (3), 0.3 W×180 s=54 J.

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]. The size of the postoperative swelling was determined immediately after surgery on the first postoperative day (the baseline level was determined preoperatively). The distance between the tip of the chin and the lower part of the auricle lobe was measured.

After surgical procedure, all the patients were advised to note the timing and intensity of pain (visual analog scale [VAS] where patients marked the maximal pain intensity they experienced during the postoperative period). Fisher's PLSD, Scheffe and Bonferroni/Dunn were used to evaluate the presence of statistically significant differences.

Results

The results of the study showed that on the first postoperative day, the average interincisal opening in the control group was 2.40±0.61 cm; in the LLLT group, it was 2.91± 0.89 cm. On the seventh postoperative day, the average interincisal opening in the control group was 4.05±0.2 cm; in the LLLT group, it was 4.26±0.5 cm. Trismus in the LLLT group was significantly less than in the control group at the second and seventh postoperative days ($p<0.05$) (Fig. 1). At the first postoperative day, the average swelling in the control group was 15.2±0.83 cm and in the LLLT group it was 14.2± 1.0 cm. On the seventh postoperative day, the average swelling in the control group was 13.7±1.0 cm, in the LLLT group it was 13.6±1.0 cm. Postoperative swelling was significantly less in the LLLT group compared with the control group at first the postoperative day ($p<0.05$; Fig. 2). Intensity of pain

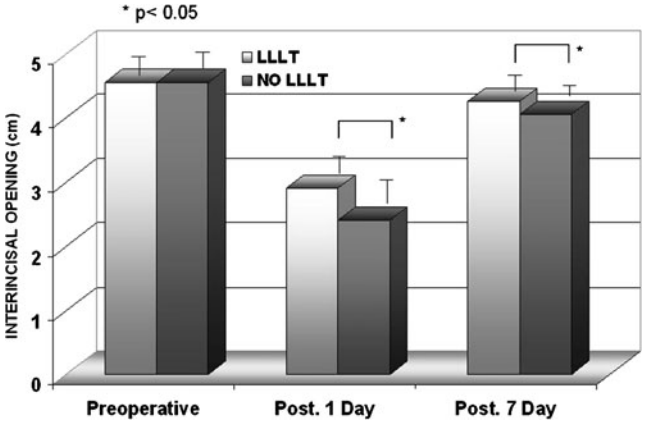

Fig. 1 Comparative survey of pre- and postoperative interincisal opening coefficients in the investigated groups

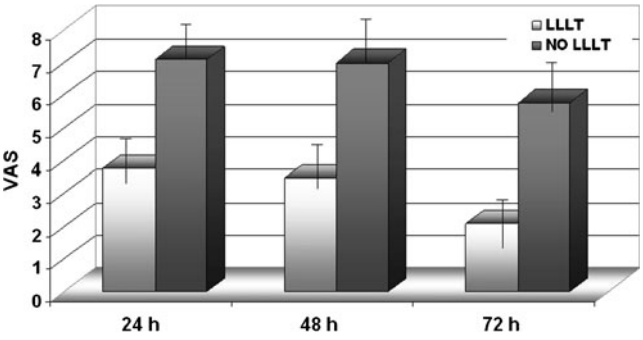

Fig. 3 Comparative survey of pre- and postoperative intensity of pain coefficients in the investigated groups

was lower in the laser group than in the control group in all evaluations, but without statistically significant differences. In the control group the pain was 7.1 at 24 h, 7.0 at 48 h, and 5.75 at 72 h; in the LLLT group it was 3.75 at 24 h, 3.48 at 48 h, and 2.08 at 72 h (Fig. 3).

Discussion

Local signs of inflammation, including pain, usually follow the removal of impacted lower third molars. Moreover, this procedure has been widely used as a model for evaluation of analgesic efficacy of various drugs or physiotherapeutic means. 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.

Controversies over bio-stimulation of tissue induced by laser therapy still exist. A lack of uniform reporting of physical and biological variables such as type of laser, output power (continuous or pulsed), frequency of pulse, wavelength, time and mode of application, distance of source from irradiated tissue, and histologic tissue differences and absorption characteristics makes standardization of results difficult. 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.

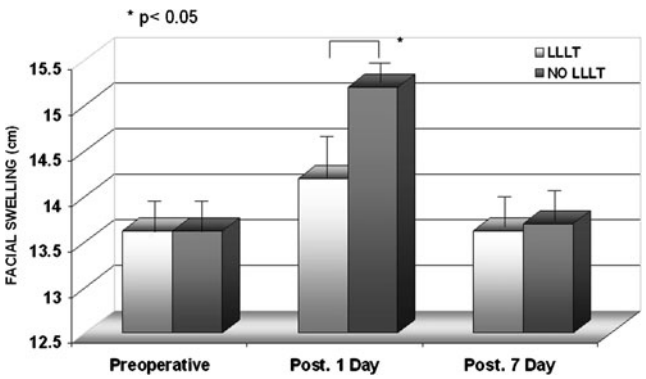

Fig. 2 Comparative survey of pre- and postoperative edema coefficients in the investigated groups

Roynesdal et al. [24] investigated the effect of soft-laser application on postoperative swelling and trismus, they carried out extraction of both lower third molars similarly impacted in two separate operations, irradiating unilaterally with a 6-J semiconductor laser at 830 nm, 40 mW, and found pain reduction—and decreases in swelling and trismus—at 9 h, without statistically significant differences. Taube et al. [25], Clokie et al. [26], and Fernando et al. [27] investigated the effect of soft-laser application only on postoperative swelling. Fernando et al. [27] carried out extraction of both lower third molars similarly impacted, using a laser semiconductor at 830 nm, 30 mW, with application intraorally at 4 J, at each surgical site in the experimental group. They reported pain and swelling levels at 24 and 72 h and on the seventh day, in addition to wound healing. There were no differences between groups in pain and swelling levels at 72 h, or in wound healing.

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. This is in contrast to Markovic and Todorovic [2, 4] who reported that intraoral low-power laser irradiation significantly reduced postoperative swelling. They evaluated postoperative pain in three groups: the first group received laser gallium/aluminum/arsenic 637 nm, 50 mW, at the surgical site, 4 J/cm^2 for 10 min; the second group received diclofenac 100 mg 1 h preoperatively; and the third was the control group. All patients had one of their lower third molars extracted, and a single evaluation found statistical differences in the reduction of pain in the laser group compared with the diclofenac and control groups.

Based on the same extraction protocol, these investigators then used four groups to compare the effectiveness of laser against dexamethasone. Group 1 received 4 J/cm^2 of laser (gallium/aluminum/arsenic, 637 nm, 50 mW) at the surgical site; group 2, the same laser dose plus an injection of dexamethasone 4 mg in the internal pterygoid muscle; group 3, the same laser dose plus dexamethasone 4 mg intramuscularly and 4 mg intraorally 6 h postoperatively; and group 4 was the control group. A single evaluation the following day found a significant reduction of swelling in all groups that received laser therapy compared with the control group; the group receiving laser and local dexamethasone exhibited even better results.

Carillo et al. [23] 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.

Neckel and Kukizl [8] studied two groups that underwent extraction of a lower third molar, applying 11 J/cm^2 of energy with a laser diode at 810 nm intraorally at the surgical site. They recorded the number of days and levels of postoperative pain. Statistical evaluation revealed significant differences, i.e., lower pain levels and duration in the experimental group compared with the control group.

The methodologies and results of these diverse studies are too varied to define the ideal parameters for use of the therapeutic laser or to evaluate its clinical effectiveness.

In the present study, we applied the laser exposures intraorally and extraorally. It was observed that trismus and swelling in LLLT group were significantly less than in the control group at the first postoperative day and that trismus in the LLLT group was significantly less than in the control group at the seventh postoperative day.

This study has demonstrated that LLLT is useful 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.

References

1. Mehrabi M, Allen JM, Roser SM (2007) Therapeutic agents in perioperative third molar surgical procedures. Oral Maxillofac Surg Clin North Am 19:69–84
2. Markovic AB, Todorovic L (2006) Postoperative analgesia after third molar surgery: contribution of the use of long-acting local anaesthetics, low-power laser and diclofenac. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 102(5):e4–e8
3. Lago ML, Dinitz FM, Serna RC, Gude SF, Gandara RJM, Garcia GA (2007) Relationships between surgical difficulty and postoperative pain in lower third molar extractions. J Oral Maxillofac Surg 65:979
4. Markovic A, Todorovic L (2007) Effectiveness of dexamethasone and low-power laser in minimizing oedema after third molar surgery: a clinical trial. Int J Oral Maxillofac Surg 36:226
5. Seymour RA, Walton JG (1984) Pain control after third molar surgery. Int J Oral Surg 13:457–485
6. Shapiro RD, Cohen BH (1992) Perioperative pain control. Oral Maxillofac Clin North Am 4:663–674
7. Little JW, Falace DA, Miller CS, Rhodus NL (1997) Dental management of the medically compromised patient. Mosby, St. Louis (MO) pp. 299,458,486
8. Neckel C, Kukiz P (2001) Biostimulation. A comparative study in the postoperative outcome of patients after third molar extraction. J Oral Laser Appl 1:215–219
9. Kreisler MB, Al Haj H, Noroozi N, Willershausen B, Hoedt B (2004) Efficacy of low level laser therapy in reducing postoperative pain after endodontic surgery—a randomized double blind clinical study. Int J Oral Maxillofac Surg 33:38–41
10. Inyushin VM (1967) On some reason of biological efficiency of monochromatic light of red laser (6300–6500 A). In: On the biological action of monochromatic red light. Alma-Ata, pp. 5–15
11. Mester E, Spry T, Sender N, Tota JC (1971) Effect of laser ray on wound healing. Amer J Surg 122:523
12. Miloro M, Miller JJ, Stoner JA (2007) Low-level laser effect on mandibular distraction osteogenesis. J Oral Maxillofac Surg 65:168
13. Silveira PC, Silva LA, Freitas TP, Latini A, Pinho RA (2011) Effects of low-power laser irradiation (LPLI) at different wavelengths and doses on oxidative stress and fibrogenesis parameters in an animal model of wound healing. Lasers Med Sci 26:125–131
14. López-Ramírez M, Vílchez-Pérez MA, Gargallo-Albiol J, Arnabat-Domínguez J, Gay-Escoda C (2011) Efficacy of low-level laser therapy in the management of pain, facial swelling, and postoperative trismus after a lower third molar extraction. A preliminary study. Lasers Med Sci. doi:10.1007/s10103-011-0936-8
15. Sun G, Tuner J (2004) Low-level laser therapy in dentistry. Dent Clin North Am 48:1061–1076
16. Hagiwara S, Iwasaka H, Okuda K, Noguchi T (2007) GaAlAs (830 nm) low-level laser enhances peripheral endogenous opioid analgesia in rats. Lasers Surg Med 39:797–802
17. Chow RT, David MA, Armati PJ (2007) 830 nm laser irradiation induces varicosity formation, reduces mitochondrial membrane potential and blocks fast axonal flow in small and medium diameter rat dorsal root ganglion neurons: implications for the analgesic effects of 830 nm laser. J Peripher Nerv Syst 12:28–39
18. Boschi ES, Leite CE, Saciura VC, Caberlon E, Lunardelli A, Bitencourt S et al (2008) Anti-inflammatory effects of low-level laser therapy (660 nm) in the early phase in carrageenan-induced pleurisy in rat. Lasers Surg Med 40:500–550
19. Albertini R, Villaverde AB, Aimbire F, Salgado MA, Bjordal JM, Alves LP et al (2001) Anti-inflammatory effects of low-level laser therapy (LLLT) with two different red wavelengths (660 nm and 684 nm) in carrageenan-induced rat paw edema. J Photochem Photobiol B 89:50–55
20. Aras MH, Güngörmüş M (2009) The effect of low-level laser therapy on trismus and facial swelling following surgical extraction of a lower third molar. Photomed Laser Surg 27(1):21–24
21. Abreu ME, Viegas VN, Pagnoncelli RM, de Lima EM, Farret AM, Kulczynski FZ, Farret MM (2010) Infrared laser therapy after surgically assisted rapid palatalexpansion to diminish pain and accelerate bone healing. World J Orthod 11(3):273–277, Fall
22. Ficácková H, Dostálová T, Navrátil L, Klaschka J (2007) Effectiveness of low level laser therapy in temporomandibular joint disorders: a placebo-controlled study. Photomed Laser Surg 25:297
23. Ozen T, Orhan K, Gorur I, Ozturk A (2006) Efficacy of low level laser therapy on neurosensory recovery after injury to the inferior alveolar nerve. Head Face Med 2:3
24. Miloro M, Repasky M (2000) Low-level laser effect on neurosensory recovery after sagittal ramus osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 89(1):12–18

25. Parker S (2007) Low-level laser use in dentistry. Br Dent J 202:131
26. Brugnera JA, Garrini DS, Donnamaria BE (2006) Atlas of laser therapy applied to clinical dentistry. Quintessence, Brazil, p 69
27. Arora H, Pai KM, Maiya A, Vidyasagar MS, Rajeev A (2008) Efficacy of He-Ne laser in the prevention and treatment of radiotherapy-induced oral mucositis in oral cancer patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 105(2):180–186
28. Iijima K, Shimoyama N, Shimoyama M, Mizuguchi T (1993) Effect of low-power He-Ne laser on deformability of stores human erythrocytes. J Clin Laser Med Surg 11:185–189
29. Passarella S, Casamassima E, Molinari S, Quadliaricllo P, Catalano I, Cingolani A (1984) Increase of protein electrochemical potential and ATP synthesis in rat mitochondria irradiated in vitro by helium-neon laser. FEBS Lett 175:95–99
30. Walsh LJ (1997) The current status of low-level laser therapy in dentistry. Part 1. Soft tissue applications. Aust Dent J 42:247–254
31. Carrillo JS, Calatayud J, Manso FJ, Barberia E, Martinez JM, Donado M (1990) A randomized double-blind clinical trial on the effectiveness of helium-neon laser in the prevention of pain, swelling and trismus after removal of impacted third molars. Int Dent J 40:31–36
32. Roynesdal AK, Bjornland T, Barkvoll P, Haanaes HR (1993) The effect of soft-laser application on postoperative pain and swelling. A double-blind, crossover study. Int J Oral Maxillofac Surg 22:242–245
33. Taube S, Piironen J, Ylipaavalniemi P (1990) Helium-neon laser therapy in the prevention of postoperative swelling and pain after wisdom tooth extraction. Proc Finn Dent Soc 86:23–27
34. Clokie C, Bentley KC, Head TW (1991) The effects of the helium-neon laser on postsurgical discomfort: a pilot study. J Can Dent Assoc 57:584–586
35. Fernando S, Hill CM, Walker R (1993) A randomised doubleblind comparative study of low-level laser therapy following surgical extraction of lower third molar teeth. Br J Oral Maxillofac Surg 31:170–172
36. Aras MH, Güngörmüş M (2010) 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. Lasers Med Sci 25:641–645
37. Amarillas-Escobar ED, Toranzo-Fernández JM, Martínez-Rider R, Noyola-Frías MA, Hidalgo-Hurtado JA, Serna VM, Gordillo-Moscoso A, Pozos-Guillén AJ (2010) Use of therapeutic laser after surgical removal of impacted lower third molars. J Oral Maxillofac Surg 68:319–324