

Efficacy of low level laser therapy in reducing postoperative pain after endodontic surgery—A randomized double blind clinical study

M. B. Kreisler¹, H. Al Haj¹,
N. Noroozi¹, B. Willershausen²,
B. d'Hoedt¹

¹Department of Oral Surgery, ²Department of Operative Dentistry, Johannes Gutenberg University Mainz, Augustusplatz 2, 55131 Mainz, Germany

M. B. Kreisler, H. Al Haj, N. Noroozi, B. Willershausen, B. d'Hoedt: Efficacy of low level laser therapy in reducing postoperative pain after endodontic surgery—A randomized double blind clinical study. *Int. J. Oral Maxillofac. Surg.* 2004; 33: 38–41. © 2003 International Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Abstract. 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, Oralial 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.

Key words: low level laser therapy; endodontic surgery; postoperative pain.

Accepted for publication 27 May 2003

Introduction

The application of low energy lasers in the field of dentistry and oral surgery has been described since the 1970s. Low energy laser light is supposed to reduce

pain, to accelerate wound healing and to have a positive effect on inflammatory processes. The exact biological mechanisms induced by low level laser therapy (LLLT), however, are not fully eluci-

dated^{3,25}. Altered cellular functions, as ATP, protein and prostaglandin synthesis, phagocytosis, neurotransmitter release, cell growth and differentiation as well as membrane potentials and binding



Fig. 1. Following suturing, the operation site was irradiated with an 809 nm diode laser. An application tip was used, ensuring a constant distance from the end of the optical fibre to the superficial tissue layers. The handpiece was moved in an overlapping manner over the operation site.

affinities have been discussed to be responsible for the low energy laser effects¹.

More than 30 clinical studies and case reports were found in a Medline search investigating oral soft laser applications, but only in 17 trials, the putative positive laser effect was evaluated using a placebo group, a double-blind study design and randomization. In these investigations, LLLT was used for the prevention of pain, swelling or trismus after removal of impacted third molars^{2,5,17,19,22,24} and periodontal surgery procedures¹⁵ as well as for reducing orthodontic postadjustment pain^{10,13}. Moreover, soft lasers were used for the treatment of craniomandibular disorders⁸, chronic facial pain⁹, chronic sinusitis¹⁶, gingivitis²⁰, herpes simplex²¹, dentinal tooth hypersensitivity⁷, and sensory aberrations in the inferior alveolar nerve¹¹. The results were controversial. While some studies reported on a positive laser effect with regard to the investigated parameters^{7,10,11,13,17,21,24} others showed no or only negligible clinically relevant influence of LLLT^{2,5,8,9,15,16,19,20,22}.

Despite reliable study designs, information on the energy fluence during laser irradiation and on the mode of operation of the respective laser system was only given in 8 of 17 and in 6 of 17 publications. Considering the information given, energy fluence was between 0.5 and 48 J cm⁻². The number of laser treatments was between 1 and 12. No

explanations were given for the choice of the respective irradiation parameters, indicating that an agreement on ideal parameters for the respective indication has not been reached yet.

To the authors' knowledge, the application of LLLT after endodontic surgery procedures has not been investigated yet. The aim of the present study was to evaluate the effect of 809 GaAlAs soft laser irradiation on postoperative pain after apicectomies.

Material and methods

Patients

Fifty-two healthy objects over 18 years of age (31 woman, 21 men, mean age: 39.3 years, SD: 15.4 years) presenting in the Department of Oral Surgery, Johannes Gutenberg-University Mainz with the need of endodontic surgery were included into the study. Informed consent was obtained from the participating patients. The study was approved by the local ethic commission.

Patients were not included into the trial if one of the following criteria applied: severe general disease (ASA-classes 3 and 4), pregnancy, known allergies to local anaesthetics and NSAIDs, acute pain symptoms at the time of surgery, acute apical periodontitis, recent history of chronic pain medication. When endodontic surgery was performed on maxillary molars, a necessary palatal access entailed an exclusion from

Table 1. Patients' profiles and teeth treated in the laser and the placebo group

	Laser	Control
<i>n</i>	26	26
Sex (m/f)	10/16	11/15
Age (mean/SD)	39.3/14.7	39.2/16.0
Front teeth	8	12
Canines	4	1
Premolars	6	7
Molars	8	6

the study to ensure a comparability of the degree of surgical difficulty.

A total of 25 front and 27 lateral teeth was treated with a similar distribution in both groups (Table 1). The operations were performed by various surgeons using standardized techniques. Ultracain® DS (Hoechst Marion Roussel, Frankfurt, Germany) with 4% articain and 1:200 000 adrenaline was used as local anaesthetic with a mean volume of 3.1 ml. The duration of the procedures was between 30 and 60 min. Silk sutures (3-0) were used for wound closure. Neither sedation nor antibiotics were given. Ibuprofen 400 was prescribed as analgesic and patients were instructed to use it when needed. Patients presented for a follow-up on the first postoperative day. Sutures were removed after 7 days.

Laser treatment

The participants were randomly assigned into an active and a placebo group. Subsequently to suturing, 26 patients had the operation site treated with an 809 nm-GaAlAs-laser (oralaser voxx, Oralial GmbH, Konstanz, Germany). A 600 micron optical fibre and an application tip was used to ensure a constant distance of 10 mm from the end of the fibre to the tissue (Fig. 1). Power output was determined by means of an energy meter was 50 mW (cw-mode). The operation site was irradiated for 150 s with overlapping movements over the operation wound. The total energy applied was 7.5 J. Laser treatment was performed once. Laser treatment was simulated in a further 26 patients. The handpiece was inserted into the patient's mouth, the laser, however, was not activated. Laser treatment was performed by a third person. The operator, the assistant and the patients wore protective glasses.

Pain assessment

Patients were instructed to quantify their postoperative pain level in the morning

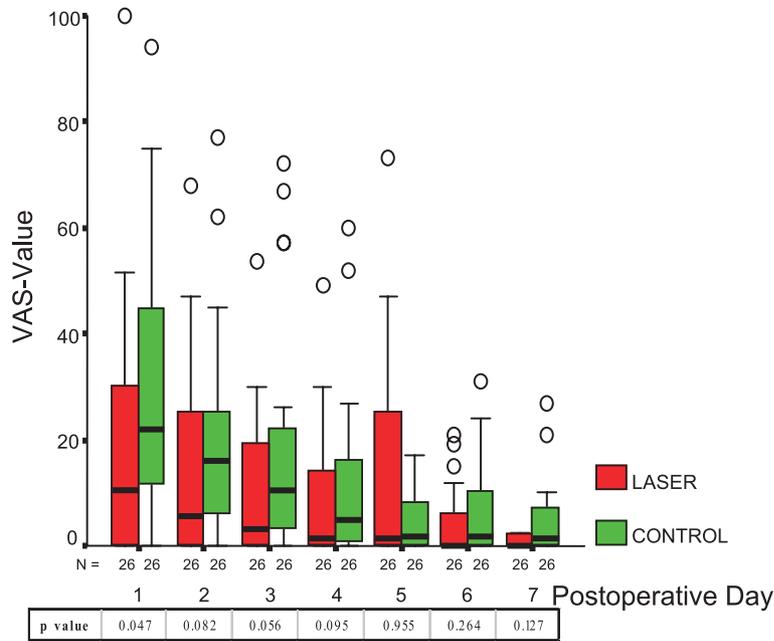


Fig. 2. Box-plot showing the pain level over a seven day follow-up period in the active laser and the placebo group. A positive laser effect was discernible throughout the period of investigation. The differences, however, were significant ($P=0.47$, Mann-Whitney U-test) on the first postoperative day only.

of 7 postoperative days by means of a visual analogue scale (VAS) prior to taking any pain medication. The visual analogue scale consists of a 10 cm line anchored at one end by the label 'No pain' and at the other end 'Worst possible pain'. The patient marks on the line the spot for the pain intensity which is then measured^{4,6,18}. Patients were given a form with 7 scales for the respective day after surgery which were returned at the appointment for suture removal.

Statistics

Non-parametric statistic analysis was used. Data was presented using the box-plot design. The pain level for each postoperative day was presented for the active and in the placebo group. Differences on the respective days were analyzed with a Mann-Whitney rank sum test at a 5% level of significance. A professional statistics package ((SPSS for Windows, Release 10.0.5 (1999), SPSS Inc., Chicago, IL, USA) was used.

Results

Initially, 74 patients were included in the study. Twenty-two objects had to be excluded because the questionnaires were not returned or were not filled in correctly. Data from 52 individuals is presented in Fig. 2. The pain level in

both groups decreased from the 1st to the 7th postoperative day as shown by the medians (black line across the box). A moderate inter-individual variability was discernible. The pain level in the active laser group, however, was lower throughout the 7 day follow-up period. On the first postoperative day the differences were statistically significant (Mann-Whitney U-test, $P=0.47$). The differences decreased towards the end of the investigated time period.

Wound healing was estimated to be within normal limits in both groups when assessed on the first postoperative day and at suture removal. One patient in the control group presented with a mild local wound infection on the third postoperative day which was treated with a local antiseptic. No other complications occurred.

Discussion

It can be concluded that postoperative pain relief after apicectomies can be achieved irradiating the operation site subsequent to suturing. The irradiation parameters in this study were chosen deliberately and laser treatment was performed once since no generally acknowledged recommendations are available. Although a slight positive effect was evident until the end of the follow-up period, the differences were significant on the first postoperative day only. This

might be attributed to a vanishing laser effect after 24 h. A similar effect was observed in an *in vitro* study¹². It remains to be investigated if this effect can be prolonged by repeated laser treatment or a higher total energy applied. Repeating the irradiation procedure on several days, however, seems rather impractical, particularly as patients will find it simpler to self-medicate with simple analgesics. The indication of the accurate energy fluence is very difficult if not entirely impossible in a clinical setting since the irradiated area cannot be determined exactly, especially when performing overlapping movements of the laser handpiece. Moreover, it is not clear what percentage of the laser light is reflected, scattered, transmitted and absorbed in the tissue of different individuals. This is dependent on the thickness and molecular composition of the tissue. It is not known whether the depth of the bony defect might be of relevance for the putative laser effect. Therefore comparisons to studies with different indications might be misleading.

Six well-controlled studies investigating the potential of LLLT in reducing postoperative sequelae after impacted third molar removal revealed nonuniform results. CARRILLO et al. (1990) investigated the effect of postoperative wound irradiation with an helium-neon laser (633 nm) operated in the cw-mode at an energy fluence of 10 J cm^{-2} . With regard to the pain level and facial swelling there were no differences between the laser ($n=34$) and the placebo group ($n=34$) in the first 4 postoperative hours. No information was provided on the pain level in the following time. A significantly reduced trismus was found in the laser group up to 7 days after surgery, which might be related to the laser treatment². In a clinical trial by TAUBE et al. (1990) symmetrically embedded lower wisdom teeth were removed in the same operation. In this cross-over study including 17 patients, the randomly assigned test side was laser (HeNe) treated for 2 min at a power output of 8 mW in the pulsed mode (50 pps). The authors were not able to detect any significant differences in the pain level between the two sides²². WAHL & BASTÄNIER (1991) investigated the HeNe laser in a group of 90 patients undergoing surgical third molar removal. Laser treatment was performed after surgery and on the first, second, and third postoperative day. The authors detected slightly reduced pain levels in the active group throughout the follow-up period.

The differences were not statistically significant²⁴. The energy fluence cannot be calculated from the data given. RØYNESDAL et al. 1993 described a slightly reduced pain level up to 9 h after surgery when the operation site was laser (830 nm semiconductor laser, total energy applied: 6 J) treated. The differences in the crossover study were not statistically significant. The same was true for the postoperative swelling and trismus¹⁹. In a study of FERNANDO et al. (1993) a group of 64 patients undergoing surgical removal of four impacted third molars in general anaesthesia had one randomly selected operation side treated with a 830 nm semiconductor laser at a total energy emission of 4 J. No evidence of a positive laser effect with regard to pain and swelling was found 3 and 7 days after surgery⁵. In contrast, NECKEL & KUKIZ (2001) found statistically significant pain reduction in a group of 210 individuals (cross-over design) after 809 nm diode laser irradiation of operation sites¹⁷. A comparison of all studies presented, however, is not possible due to varying study design concerning the follow-up time, difficulties in measuring operating variables related to pain as well as different laser types and irradiation parameters.

A cross-over study design, e.g. with bilaterally symmetrical impacted third provides best information on the effect of a treatment method since it considers the individual disposition of a patient to pain, swelling and trismus formation¹⁴. With endodontic surgery, a cross-over design is not feasible and the potential effects must be derived from inter-individual comparisons.

The normal postoperative sequelae after endodontic surgery are milder than in third molar surgery. A moderate oedema is usually observed, which is primarily dependent on the duration of surgery, traumatization of the soft tissues by the retractor and the individual disposition to oedema formation²³. Postoperative pain and oedema control can be sufficiently achieved by intermittent cooling and administration of NSAIDs. None the less methods of postoperative pain reduction without any known side effects, as LLLT, can increase patients' acceptance of oral surgery procedures. The additional treatment time of approximately 3 min does not mean excessive stress for the patient, if in turn the laser treatment can reduce the postoperative pain level.

Within the limitations of this study it can be concluded that LLLT can be

beneficial for the reduction of postoperative pain after endodontic surgery. Its clinical efficiency and applicability, however, require further investigation. This is in particular true for the optimal energy dosage and the number of laser treatments needed after surgery.

References

1. BASFORD JR. Low intensity laser therapy: Still not a established clinical tool. *Lasers Surg Med* 1995; **16**: 331–342.
2. CARRILLO JS, CALATAYUD J, MANSO FJ, BARBERIA E, MARTINEZ JM, DONADO M. 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* 1990; **40**: 31–36.
3. CONLAN MJ, RAPLEY JW, COBB CM. Biostimulation of wound healing by low-energy laser irradiation. A review. *J Clin Periodontol* 1996; **23**: 492–496.
4. DIXON JS, BIRD HA. Reproducibility along a 10 cm vertical visual analogue scale. *Ann Rheum Dis* 1981; **40**: 87–89.
5. FERNANDO S, HILL CM, WALKER R. A randomised double blind comparative study of low level laser therapy following surgical extraction of lower third molar teeth. *Br J Oral Maxillofac Surg* 1993; **31**: 170–172.
6. FREYD MJ. The graphic rating scale. *J Educ Psychol* 1923; **14**: 83–102.
7. GERSCHMAN JA, RUBEN J, GEBART-EAGLEMONT J. Low level laser therapy for dental tooth hypersensitivity. *Aust Dent J* 1994; **39**: 353–357.
8. GRAY RJM, QUAYLE AA, HALL CA, SCHOFIELD MA. Physiotherapy in the treatment of temporomandibular joint disorders: a comparative study of four treatment methods. *Br Dent J* 1994; **176**: 257–261.
9. HANSEN HJ, THORØE U. Low power laser biostimulation of chronic oro-facial pain. A double blind placebo controlled cross-over study in 40 patients. *Pain* 1990; **43**: 169–179.
10. HARAZAKI M, TAKAHASHI H, ITO A, ISSHIKI Y. Soft laser irradiation induced pain reduction in orthodontic treatment. *Bull Tokyo Dent Coll* 1998; **39**: 95–101.
11. KHULLAR SM, BRODIN P, BARKVOLL P, HAANÆS HR. Preliminary study of low-level laser treatment of long-standing sensory aberrations in the inferior alveolar nerve. *J Oral Maxillofac Surg* 1996; **54**: 2–8.
12. KREISLER M, CHRISTOFFERS AB, AL HAJ H, WILLERSHAUSEN B, D'HOEDT B. Low level 809 nm diode laser-induced in vitro stimulation of the proliferation of human gingival fibroblasts. *Lasers Surg Med* 2003; **32**: 189–196.
13. LIM HM, LEW KK, TAY DK. A clinical investigation of the low level laser therapy in reducing orthodontic postad-

- justment pain. *Am J Orthod Dentofacial Orthop* 1995; **108**: 614–622.
14. LOEKKEN P, OLSEN I, BRUASET I, NORMAN PEDERSEN K. Bilateral surgical removal of impacted lower third molar teeth as a model for drug evaluation: a test with ibuprofen. *Eur J Clin Pharmacol* 1975; **8**: 209–216.
15. MASSE JF, LANDRY RG, ROCHETTE C, DUFOUR L, MORENCY R, D'Aoust P. Effectiveness of soft laser treatment in periodontal surgery. *Int Dent J* 1993; **43**: 121–127.
16. MOUSTSEN PA, VINTER N, AAS-ANDERSEN L, KRAGSTRUP J. Laser treatment of sinusitis in general practice assessed by a double-blind controlled study. *Ugeskr Laeger* 1991; **153**: 2232–2234.
17. NECKEL C, KUKIZ P. Biostimulation: A comparative study in the postoperative outcome of patients after third molar extraction. *J Oral Laser Appl* 2001; **1**: 215–219.
18. REVILL S, ROBINSON J, ROSEN M, HOGG M. The reliability of linear analogue for evaluating pain. *Anaesthesia* 1976; **31**: 1191–1198.
19. RØYNESDAL AK, BJØRNLAND T, BARKVOLL P, HAANAES HR. The effect of soft-laser application on postoperative pain and swelling. *Int J Oral Maxillofac Surg* 1993; **22**: 242–245.
20. RYDÉN H, PERSSON L, PREBER H, BERGSTRÖM J. Effect of low energy laser irradiation on gingival inflammation. *Swed Dent J* 1994; **18**: 35–41.
21. SCHINDL A, NEUMANN R. Low-intensity laser therapy is an effective treatment for recurrent herpes labialis infection. Results from a randomized double-blind placebo-controlled study. *J Invest Dermatol* 1999; **113**: 221–223.
22. TAUBE S, PIÖREN J, YLIPAVALNIEMI P. Helium-neon laser therapy in the prevention of post-operative swelling and pain after wisdom teeth extraction. *Proc Finnsh Dent Soc* 1990; **86**: 23–27.
23. TETSCH P. *Wurzelspitzenresektion*. München: Carl Hanser Verlag, Wien 1986.
24. WAHL G, BASTÄNIER S. Der Softlaser in der postoperativen Nachsorge bei dentalveolären Eingriffen. *Zahnärztl Welt Reform* 1991; **100**: 512–515.
25. WALSH LJ. The current status of low level laser therapy in dentistry. Part 1. Soft tissue applications. *Aust Dent J* 1997; **42**: 247–254.

Address:

Matthias B. Kreisler
 Department of Oral Surgery
 Johannes Gutenberg-University Mainz
 Augustusplatz 2
 55131 Mainz
 Germany
 Tel: 00496131175090
 Fax: 00496131173434
 E-mail: matthiaskreisler@web.de