



Effect of Low-level Laser Therapy With Different Locations of Irradiation on Postoperative Endodontic Pain in Patients With Symptomatic Irreversible Pulpitis: A Double-Blind Randomized Controlled Trial

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Abstract

Introduction: This double-blind, placebo-controlled, clinical trial aimed to investigate the analgesic efficacy of low-level laser therapy (LLLT) with two different locations, and their comparison, in postoperative endodontic pain (PEP) levels in molars diagnosed with symptomatic irreversible pulpitis.

Methods: Seventy-five patients with a molar tooth, diagnosed with symptomatic irreversible pulpitis, were divided into three groups of placebo, buccal only irradiation (BI), and buccal and lingual irradiation (BLI), with 25 cases being in each group. The participants received similar single-visit nonsurgical endodontic treatments. Then, a sham laser was used in the control group instead of LLLT. Individuals in BI and BLI groups received 80-second irradiation on the buccal surface and 80-second irradiation on each of the buccal and lingual surfaces respectively. A laser with an 808 nm wavelength, power of 100 mW, and a fiber diameter of 600 μ m was used. PEP was assessed using a 0-100 mm VAS 4, 8, 24, and 48 hours after the treatment.

Results: BLI showed a significantly higher reduction of PEP compared to placebo in all time intervals of this study. BLI was significantly more effective than BI 8 hours after the treatment. However, intragroup differences between BLI and BI groups at other time intervals and between BI and placebo groups in all time intervals were not significant. The number of taken analgesics in the BLI group was significantly lower than the placebo group and was on a statistical borderline compared to the BI group.

Conclusion: LLLT with BLI was an effective measure as a supplement to oral analgesics in the reduction of PEP compared to the placebo.

Keywords: Endodontic treatment; Laser; Low-level laser therapy; Postoperative pain; Root canal therapy.

Introduction

Postoperative endodontic pain (PEP), one of the important endodontic complications, occurs with an incidence of 3%-58%.¹ The elevated levels of inflammatory mediators, which are seen in periapical tissue damage, resulting in the activation or sensitization of peripheral nociceptors, cause peripheral hyperalgesia.^{1,2}

Different approaches such as intracanal medicaments, corticosteroids, and non-steroidal anti-inflammatory drugs (NSAIDs) have been recommended to reduce

PEP.³⁻⁵ Low-level laser therapy (LLLT) has been used in dentistry in the past 40 years and has also been used for this intent.^{6,7} LLLT can induce analgesic effect by the following mechanisms: altering the pain threshold, increasing the synthesis of endogenous endorphins, decreasing bradykinin synthesis, reducing histamine release, and altering prostaglandin synthesis.^{8,9}

Pain relief with primary or adjuvant LLLT has been shown efficient in orthodontic treatments, periodontic procedures, dental surgeries, musculoskeletal pain,

and PEP.^{6,10-13} A previous clinical trial showed the efficacy of LLLT in a significant reduction of PEP after endodontic surgery.¹⁴ However, another study did not find a significant clinical benefit for LLLT in endodontic surgery.¹⁵ Furthermore, the effect of LLLT on PEP in patients with symptomatic apical periodontitis has been reported significantly beneficial.¹⁶ Two separate studies that evaluated the effect of LLLT on PEP in patients who underwent endodontic retreatment reported different outcomes. One of them reported a significant effect of LLLT on PEP; on the other hand, the other study demonstrated no significant difference between LLLT and placebo.^{6,17} Besides, two separate systematic reviews of randomized controlled clinical trials showed that the data for the effect of phototherapy on PEP are not sufficient yet and are controversial in some instances. However, the use of LLLT for the reduction of PEP was promising.^{19,20}

Prior studies used different irradiation methods and dosages; however, to the best of our knowledge, there was no study comparing the efficacy between different irradiation locations of LLLT. The current lack of evidence led us to design this double-blind, placebo-controlled, randomized clinical trial. This study aimed to investigate the analgesic efficacy of LLLT with two different locations, and their comparison, in PEP levels in molars diagnosed with symptomatic irreversible pulpitis.

Materials and Methods

The minimum sample size required to detect differences between three groups with a standard deviation of 2 mm visual analog scale (VAS) was 25 per group, considering type I and type II error of 0.05 and 0.20 respectively.

The samples were made up of the patients diagnosed with symptomatic irreversible pulpitis of a first or a second molar, attending the Department of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

The inclusion criteria were: the absence of any systemic diseases, the age range of 18 to 60 years, a molar tooth with symptomatic pulpitis with spontaneous pain or lingered by cold or heat, mobility less than 1 mm in either direction, and the absence of periodontal pocket around the tooth. The exclusion criteria were: pregnancy or nursing present for female participants, lidocaine hypersensitivity, no response to cold and heat tests, the absence of bleeding after pulpal exposure (i.e., necrotic pulp diagnosis), and not taking analgesics or antibiotics up to 6 hours before the treatment.

After signing informed consent, 75 patients were randomly divided into two groups of placebo ($n=25$) and experimental ($n=50$). The similarity of the groups in gender, location of the tooth, and other possible interfering factors were checked and confirmed using the chi-square test and Kruskal-Wallis test. Individuals in the experimental group were randomly divided into two subgroups of the BLI group ($n=25$) and BI group (n

$=25$). New patients were included in the study in place of lost patients. All enrolled individuals reported their preoperative pain on a 100 mm VAS diagram before the treatment. Vitality tests were performed on the buccal surface of teeth using Endo ice (1,1,1,2 tetrafluoroethane; Hygenic Corp, Akron, OH) and warm gutta-percha for cold and heat tests respectively, and the VAS was performed again. All enrolled patients had a lingered or severe response to the cold test.

The practitioner, who was an endodontist, performed the same single-visit nonsurgical endodontic treatment for each individual within 75 to 90 minutes. The involved molar was anesthetized using inferior alveolar nerve block or local infiltration, and supplementary injections when primary anesthesia failed. Cartridges containing lidocaine with 1:80 000 concentrations of epinephrine were used. The hybrid technique including hand instrumentation and rotary nickel-titanium (Pro-Taper; DENTSPLY, Switzerland) technique was used for canal preparation. The final apical file was #25 to #40 with regard to the initial size of canals. Canals were rinsed with two ccs of 2.5% sodium hypochlorite between each step, and obturation was done using cold lateral condensation technique with gutta-percha (Meta-Biomed, South Korea) and resin-based sealer (AH 26[®]; DENTSPLY, Switzerland). The access cavity was finally restored with a temporary filling material with at least 4 mm thickness. The occlusal reduction with 1 mm off from the occlusion was also performed.

After the treatment, individuals in the placebo group received fake laser therapy, using a dental light cure device. Participants in the BI group received laser irradiation only on the buccal surface of mesial and distal mucosa overlying apices of the target tooth. Patients in the BLI group received laser irradiation on both buccal and lingual surfaces of mesial and distal mucosa. Laser irradiation was obtained with a single dose of an 808 nm wavelength (Whitening Lase II- Laser DMC, Samsung, Korea), power of 100 mW, and a fiber diameter of 600 μ m. Irradiation was done for 80 seconds for BI and 160 seconds for BLI (80 seconds for each buccal or lingual side). Ibuprofen 400 mg was prescribed to take if unbearable pain was present. For patients with gastrointestinal problems, acetaminophen 650 mg was prescribed, alternatively.

The randomization table was provided by a statistician who was blinded to the measures and aims of the study. A nurse put a printed piece of paper with "buccal only" or "buccal and lingual" text on it, in opaque sealed black bags. Each bag had a code on it and only the code distinguished the used method, using the randomization table. After the practitioner opened the bag, the code was written down in the patient's profile. The investigator, who assessed VAS information 4, 8, 24, and 48 hours after the treatment through phone calls, was unaware to the randomization table, and the practitioner, who performed the treatment and irradiated the affected teeth, was also unaware of the

aim of the study. Besides, all participants were blinded because of using the sham laser for the placebo group.

The chi-square test was used to compare all demographic factors between the groups except educational status. The Kruskal-Wallis test was used for a comparison of educational status and the number of taken analgesics. Comparisons of PEP between groups and within each group were performed using repeated measures ANOVA and Bonferroni tests respectively. The results were shown as mean \pm standard deviation (SD), and all the statistical tests were interpreted at a 95% confidence interval (CI). The analyses were carried out with SPSS 18 (SPSS Inc. Released 2009, PASW Statistics for Windows, Version 18.0, Chicago).

Results

As listed in Table 1, aside from apical lucency ($P = 0.016$), there was no significant difference between the groups in any demographic factors. PEP was reduced significantly in all three groups in all time intervals compared to the preoperative pain levels (Table 2 and Figure 1).

According to Table 3, BLI was significantly efficient compared to placebo in all time intervals. Although BI reduced PEP more than the placebo, the difference between BI and placebo was not statistically significant ($P > 0.05$). Patients in the BLI group experienced significantly lower PEP levels than those in the BI group, 8 hours ($P =$

0.002) and 48h ($P = 0.034$) after the treatment. However, this difference was not statistically significant at other time intervals ($P > 0.05$). Age or gender did not correlate with the severity or incidence of PEP ($P > 0.05$).

The mean number of taken analgesic medications was 2.16 ± 1.625 (CI 95%: 1.49–2.93) for the placebo group, 1.8 ± 1.871 (CI 95%: 1.03–2.57) for the BI group, and 0.8 ± 0.645 (CI 95%: 0.53–1.07) for the BLI group. This number was significantly lower for the BLI group compared to the placebo group ($P = 0.001$). However, this number for the BLI group was on a statistical borderline ($P = 0.054$) compared to the BI group. Furthermore, the difference in the number of taken analgesic medications between the BI group and the placebo group was not statistically significant ($P > 0.05$).

Discussion

In the present study, we aimed to inspect the efficacy of LLLT with BI and BLI in reducing PEP in molar teeth with symptomatic irreversible pulpitis. The first null hypothesis of this study was that LLLT with either BI or BLI had no significant effect on PEP, compared to the placebo. Our second null hypothesis was that there was no superiority for the BLI group compared to the BI group in terms of PEP levels. Our results rejected both null hypotheses, as BLI of LLLT showed a significant reduction of PEP compared to the placebo. However, the

Table 1. Demographic Factors in Each Group

		Placebo	BI	BLI	P value
Sex	Male	16 (64%)	13 (52%)	15 (60%)	0.681
	Female	9 (36%)	12 (48%)	10 (40%)	
Age (y)	<30	9 (36%)	11 (44%)	10 (40%)	0.601
	30-50	10 (40%)	10 (40%)	13 (52%)	
	> 50	6 (24%)	4 (16%)	2 (8%)	
Education	Lower grades	2 (8%)	1 (4%)	4 (16%)	0.137
	High school diploma	12 (48%)	9 (36%)	12 (48%)	
	Bachelor	10 (40%)	11 (44%)	7 (28%)	
	MSc and higher grades	1 (4%)	4 (16%)	2 (8%)	
Location of tooth	Maxilla	7 (28%)	9 (36%)	11 (44%)	0.499
	Mandible	18 (72%)	16 (64%)	14 (56%)	
Percussion test	Positive	17 (68%)	15 (60%)	14 (56%)	0.675
	Negative	8 (32%)	10 (40%)	11 (44%)	
Palpation test	Positive	7 (28%)	4 (16%)	2 (8%)	0.171
	Negative	18 (72%)	21 (84%)	23 (92%)	
Tooth mobility	Grade I	1 (4%)	1 (4%)	0 (0%)	0.598
	Negative	24 (96%)	24 (96%)	25 (100%)	
Radiographic lucency	Present	8 (32%)	9 (36%)	1 (4%)	0.016
	Absent	17 (68%)	16 (64%)	24 (96%)	

Table 2. Preoperative and Postoperative Pain in 3 Different Groups (mm \pm SD)

	Preoperative Pain	4 h After the Treatment	8 h After the Treatment	24 h After the Treatment	48 h after the Treatment
Placebo group	62.8 \pm 17.9	45.6 \pm 23.4	37.2 \pm 21.5	19.2 \pm 19.1	9.2 \pm 16.5
BI group	64.4 \pm 15.3	42.4 \pm 24.3	30.8 \pm 23.6	11.6 \pm 14.9	4.4 \pm 8.7
BLI group	63.6 \pm 15.2	29.6 \pm 21.5	11.6 \pm 16.2	3.2 \pm 8.5	1.6 \pm 6.2

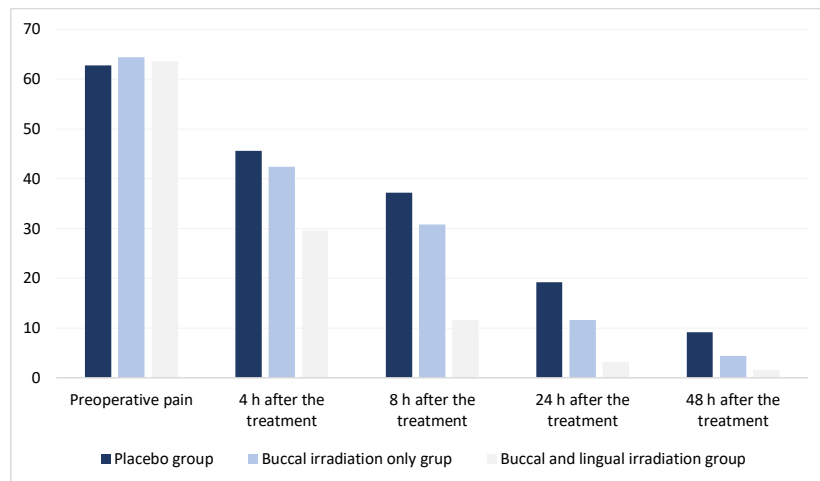


Figure 1. Preoperative and Postoperative Pain Levels (on 0-100 mm VAS) in 3 Groups and Different Time Intervals.

intragroup difference between BLI and BI was significant only 8h after the treatment.

Patients with symptomatic irreversible pulpitis are at the utmost risk of PEP. Moreover, PEP predominantly occurs in molar teeth.²⁰ Thus, molar teeth with symptomatic irreversible pulpitis were selected for the present study. Previous studies showed lower PEP levels for single-visit treatments than double-visit treatments; however, some other studies contradict this outcome.²¹⁻²⁴ Due to the homogeneity of samples, we only included single-visit treatments in the present study.

Wavelengths in the near-infrared spectrum can penetrate biological tissue deep to 5 mm; it is more profound than the blue-visible or red-visible spectrum.²⁵⁻²⁷ Therefore, it is eligible to affect periapical tissues. In most of the previous similar studies, wavelengths within 808-980 nm were used for pain relief.⁹ Previous studies focused on buccal irradiation or both buccal and lingual irradiation (BLI); however, to the best of our knowledge, they did not compare the efficacy of either method, comparing each other.^{6,7,28} Gender, preoperative endodontic pain, and type of the involved tooth are considered as risk factors for a higher prevalence of PEP.²⁹ In this study, these factors were

homologized in all three groups. Although we tried to match or control these factors as much as possible, apical radiolucency was seen significantly more in BI; however, its role as a predictor for PEP was not significant, like the other factors.^{20,30}

Confirming some previous studies,^{16,31-33} the levels of PEP did not correlate with age in the present study. Watkins et al stated that PEP significantly decreased with increasing age.³³ Nevertheless, Ali et al reported that PEP levels were higher in the old age group.³⁴ These vast controversies in reports may be related to the multifactorial nature of PEP, making it hard to evaluate and manage. Also, we found no significant correlation between gender and PEP, similar to another study.¹⁶ Conversely, some other studies reported that women experienced PEP with a more incidence.³⁴⁻³⁶ This difference may result from different sampling, different study designs, or cultural differences in the foresaid studies.

A previous study showed that patients who received LLLT took significantly fewer analgesics compared to the placebo group.⁶ Our results from LLLT with BLI confirm this outcome; however, we found no significant change between BI and placebo regarding the number of taken analgesics. Collectively, it can indicate that using LLLT may reduce the need for analgesic medications. It is beneficial, especially when analgesics are contraindicated for any reason.

Several studies showed that LLLT with BLI, as BLI in the present study, was significantly efficient in reducing PEP.^{7,28,37,38} In agreement, our results showed a significantly more efficacy for BLI in all time intervals, compared to the placebo. In another study, Nunes et al compared the analgesic efficacy of indium-gallium-aluminum laser irradiation on both buccal and lingual surfaces with ibuprofen. They found that laser irradiation was significantly more effective in the reduction of PEP compared to ibuprofen.³⁹ Collectively, it seems that irradiation on both buccal and lingual surfaces could

Table 3. Intragroup Statistical Comparisons in Each Time Interval

Time (Hours After the Treatment)	Groups	P Value
4	Placebo BI	1
	Placebo BLI	0.007
	BI BLI	0.073
8	Placebo BI	0.484
	Placebo BLI	0.000
	BI BLI	0.002
12	Placebo BI	0.109
	Placebo BLI	0.000
	BI BLI	0.117
24	Placebo BI	0.259
	Placebo BLI	0.034
	BI BLI	1

reduce PEP levels. When irradiating on only the buccal surface, the periapical region close to the lingual surface may receive lower energies than the periapical region close to the buccal surface and vice versa. Probably, it could explain the findings of this study.

Our findings showed no significant difference between BI and the placebo in the reduction of PEP. Several studies did not report the exact protocols of irradiation, whether only the buccal surface was irradiated or not. It can misleadingly produce inconclusive and controversial results. Besides, prior studies, generally, used different irradiation protocols and dosages. For instance, a 940 nm wavelength diode laser with a total energy of 4 J/cm² was reported significantly favorable in pain after impacted third molar surgery.⁴⁰ Carrillo et al used a 633 nm wavelength He-Ne laser with a total energy of 10 J/cm².⁴¹ Furthermore, Arslan et al used a 970 nm wavelength diode laser with a total power of 2.86 W/cm² for 30 seconds.⁶ These wide varieties in the methods and procedures may also produce controversial results, and therefore, the evidence for the efficacy and favorability of LLLT in the endodontic field can be misleading. On the basis of our results, which showed a significant difference between two different settings of irradiation, we suggest that the irradiation location of LLLT, as well as the exact protocol, should be reported in future studies.

Further investigations with higher sample sizes and different wavelengths are needed to reinvestigate the outcomes of this study.

Conclusion

Using LLLT with irradiation on both buccal and lingual surfaces was significantly effective in terms of the reduction of PEP, compared to the placebo in every time interval. Furthermore, patients in the BLI group took fewer analgesic medications compared to the placebo. Our findings suggest that LLLT with BLI may be a more potent measure than BI; therefore, it can be used as a supplement to oral analgesics in reducing PEP. However, further studies with different protocols are recommended.

Ethical Considerations

This double-blind, placebo-controlled, randomized clinical trial was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RIDS.1395.357) and registered in the Iranian Registry of Clinical Trials (identifier: IRCT2017021432576N1). All the steps of this trial were performed according to the ethical standards recommended by the institutional and national research committee and the 1964 Helsinki declaration and its later revisions.

Informed Consent

Informed consent was obtained from all individuals in the present study.

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Conflict of Interests

The authors declare no conflict of interest.

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