Original Article

EFFECT OF LASER APPLICATION ON PAIN CONTROL DURING ORTHODONTIC TOOTH MOVEMENT

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https://doi.org/10.51847/Ws2sSrJKwP

ABSTRACT

The aim of this study was to assess the effectiveness of applying LASER on pain perception in orthodontic patients during molar distalization. After sample size calculation, eighteen patients (age 13-18 years) were selected from Department of Orthodontics, Faculty of Dentistry, Mansoura University, Egypt. After the application of the eligibility criteria, only fifteen patients remained requiring bilateral molar distalization. Pain-experience for molar distalization with control group over LASER group quadrant is on the same patient. Facial pain scale used to evaluate pain experience. Statistical evaluation was performed for the data obtained from analysis using SPSS 20 for windows and t-test with $P<0.05$. Wilcoxon signed-rank test was used in evaluation the difference. No difference in values of pain experience for gender and age of patients ($P>0.05$). There was a statistically significant decrease in Pain. Experiencing pain was statistically significant till third day. It was not significant between the groups from the fourth day. LASER application is an effective and non-compliance dependent approach which can reduce pain experience during orthodontic treatment.

Key words: Laser, Pain, Tooth movement, Distalization, Orthodont.

Introduction

Pain relief during orthodontic tooth movement considers one of the main goals to achieve during treatment in recent years [1, 2]. The desire to decrease the time of treatment was the challenge. Since the first LASER development in 1960 [3], dental interest in LASER has been high. Researchers have continued to enhance their dental treatment using LASER application. The versatile, convenient, and nature of the LASER device has helped orthodontists to use LASER in several applications such as bracket deboning, diagnostic procedures, and prevention of white spot lesions [4].

Soft LASER therapy is a unique category of LASER application. It has been called low-level LASER therapy (LLLT) or cold LASER therapy. The bio-stimulatory action of LASER has been noticed in 1967 which paved its way for use in several ways; e.g., acceleration of orthodontic tooth movement, retention protocols, assisting in maxillary expansion, and pain-control during orthodontic treatment [5].

Although the LASER technique is a modern approach in orthodontic treatment, some debate has been recorded about its reducing pain sensation [6]. Consequently, Many reviewers tried to question the effectiveness of LASER as a way of reducing pain [7]. Also, The analgesic effect mechanism of LASER is still unclear [8]. However, it was believed that LASER has neural regenerative properties with anti-inflammatory biological reactions. This reaction stimulates cell proliferation and differentiation enabling its effect [9]. The studies that were carried out before recorded the LASER affection ability in inflammatory processes reduction which simulates the mechanism of the anti-inflammatory drug [10]. Many researchers documented the LASER effect in improving blood supply and fastening recovery [11].

The anteroposterior discrepancy is considered one of the main problems facing orthodontists during treatment. Treating this discrepancy has different modalities depending on growth status and different treatment objectives. Many of these cases require dental correction (molar distalization or molar de-rotation). Furthermore, extraction of permanent teeth is an option of treatment modalities [6] however; non-extraction concepts have been favored widely. Distalization of maxillary first molar can be carried out by many appliances such as distal jet, pendulum appliance, sectional jig assembly, and Keles slider. The application of high force of the distalizers is associated with pain experience. Therefore, this study aimed to evaluate the LASER effect on pain control during molar distalization.

Materials and Methods

This randomized split-mouth controlled clinical research included 18 patients under distaliztion of molar (11 females and 7 males). The patient's age ranged from 13–18 years. This study was held between May 2019 and April 2021. In these patients, each quadrant of the maxillary arch was divided to control (Group A, no LASER therapy) and study group (Group B, LASER therapy). Neither participant nor allocator knows the recruitment system. Ethical approval was obtained from the ethical committee with code no:

A07070519. All possible complications and treatment plans were explained in detail to the parents and the patients. Informed consent was signed by the parents after they agreed on the treatment to allow using their data for scientific purposes.

The patient will be considered eligible for this study if they met the following inclusion criteria: Age range (13-18) years, skeletal Class I or mild Class II relationship, skeletal class 1 pattern, bilateral Class II molar relationship, mild to moderate maxillary sagittal arch length discrepancy, free from Systemic diseases, proper oral hygiene, no alveolar bone loss, free periodontal diseases. While the exclusion criteria were hypo divergent or hyper divergent skeletal pattern, systemic diseases, abnormal oral habits, diastemas, periodontal disease, alveolar bone loss, posterior crowding, or poor oral hygiene.

Interventions

Distalization appliance

The researchers instructed the participant to rinse using chlorhexidine 0.2% before applying the screws. Subsequently, two screws (3M Unitek, Monrovia, California, USA) (2 × 8 mm) were placed to the anterior palate [12].

Application of intraoral mini screw to support distalization appliances were applied to all candidates and molar bands were placed around maxillary first molars and then the screws were covered by the two caps [13]. Molar bands were soldered with 1.1-mm diameter stainless steel joining wires to the caps. a heavy Ni-Ti coil spring(American Orthodontics, Wisconsin, USA), 0.055-inch diameter 11 mm in length was placed between the gridlock screw on the wire and the tube in a maximum compression [14]. The amount of force output was around 240 g. (T0) at that time point, the records were begun. Candidates recalling for reactivation of the springs was done weekly **Figure 1**.

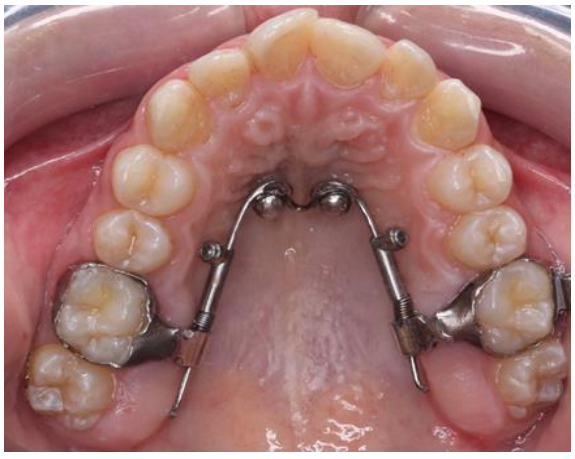

Figure 1. Showing molar distalizer

LASER device

After random allocation, the LASER group was irradiated with low-level GA-Al-As LASER (810 nm, 5 J/cm^2). Continuous mode with a frequency of 2 Hz and a power output of 0.2 W of a gallium-aluminum-arsenide semiconductor diode LASER emitting infrared radiation was used. The LASER was applied to the palatal and buccal aspect of the molar region for 80 seconds weekly **(Figures 2 and 3)**. The LASER application was in accordance with Photon LASER plus unit protocol (DMC, São Carlos, São Paulo, Brazil) [15]. During LASER application, the tip was applied in close contact to the apical, middle, and cervical third of root on the buccal and lingual side. Candidates were instructed to document the pain experience level from day 1 to 7 days following the first LASER session on Wong-Baker Faces Rating Scale. The pain scale has number of faces, which range from happy to crying with corresponding numbers from 0 to 5 [16]. The data were collected and statistically evaluated using SPSS 20 (Microsoft, Chicago, IL, USA) and t-test with $P < 0.05$. Wilcoxon signed-rank test was used in evaluating the difference.

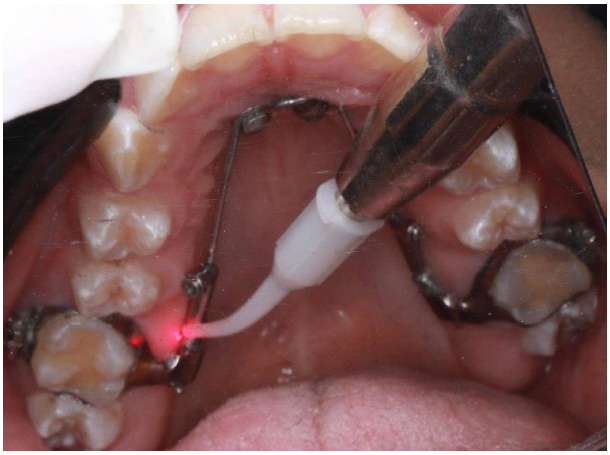

Figure 2. showing LASER irradiation on the palatal aspect of the molar

Figure 3. showing LASER irradiation on the buccal aspect of the molar

Sample size calculation

The sample size calculation based on a type I error frequency of 5% and minimum power of the study (1–β) was set at 0.80. A previous pain level study on humans was the guide [15]. The study aim was to detect a 50% difference at least in the pain degree. According to the power analysis, 15 patients contributed to this study.

Randomization

Performing the randomization
Using opaque, identical, sealed envelopes, 15 envelopes contained standard-sized treatment allocation papers (for the side of the arch quadrant to apply LASER in). Before the intervention, each candidate was asked to pick one of the sealed envelopes. The allocation paper was shown to the candidate and then kept in a different place.

Blinding
A coded system was used to ensure the blindness of the allocator. After allocation of the patients, each patient was blind to the LASER application side on the upper arch, after follow up the statistician was also blind to the patients' result analysis sides.

Results and Discussion

Of 18 patients, 3 were excluded due to incomplete questionnaires. Thus, the data of 15 patients, which included 5 males and 10 females, with a mean age of 15.4±3 years were statistically analyzed.

Table 1 shows the mean pain score in the LASER and control quadrants at different time points. The peak of the pain level was noted on day 1 in both groups with maximum pain was noted at 24 h in the control group (mean=3.13) and continuing in decreasing till minimum pain level was on day 7 in both groups. A t-test was applied for comparing the pain score between the LASER and control quadrants at different time points. As shown in **Table 1**, the difference in the pain score between the two groups was significant on day 1, day2, and day3 (P<0.05). However, on the remaining days, the pain score was not statistically significant between the two groups (P>0.05) **(Table 1)**.

Table 1. showing pain experience in (group A) over (Group B) from day1 to day 7 postoperatively

Duration	Pain in Group A		Pain in Group B		P-value
	Mean	SD	Mean	SD	
Day 1	3.13	0.099	2.2	0.94	0.013*
Day 2	2.93	0.96	1.93	1.1	0.013*
Day 3	2.4	0.73	1.53	1.06	0.015*
Day 4	1.73	0.96	1.4	0.91	0.338
Day 5	1.2	0.86	1.13	0.74	0.822
Day 6	1.26	0.7	1.07	0.7	0.88
Day 7	0.8	0.67	0.66	0.72	0.9

P value < 0.05 is considered statistically significant

One of the main challenges of orthodontic treatment is the pain level. Many interventions such as LASER therapy have been used to reduce the pain during the treatment. Although the LASER analgesia effect is a new treatment modality that has the advantages of being non-invasive, being easy to apply, the available studies are quite controversial; Therefore, the current study was held to determine the LASER role on pain control [17]. The Bio-modulation effect of LASER is based on Arndt–Schulz law. This law states that a small dose of drug or any substance has a stimulating effect, whereas a higher dose has an inhibitory effect.

Many studies used different wavelengths of LASER therapy for the procedure varying from 635 nm to 980 nm with 0.04–60 J/cm^2 as the energy density, with different types of LASERS. Different researchers used different wavelength radiation of LASER and obtained different results for pain control. Matys *et al.* [18], used 635 nm, Furquim *et al.* [5], used 808 nm, Guram *et al.* [15], and Youssef *et al.* [19]. used 810 nm. Qamruddin *et al.* [20], used 940 nm and Pandit *et al.* [21] 980 nm. Meta-analysis indicated a weaker response rate at 780 nm 5 J/cm^2 with an output power of 20 mW.

28% of orthodontic patients have been reported to discontinue treatment due to pain. Despite pain vary among patients; studies reported degree of pain during orthodontic treatment regardless of age or gender [5]. Also, analgesics are commonly prescribed to reduce pain, the use of analgesics to reduce pain is not preferred as it can decrease the rate of orthodontic tooth movement by disrupting the osteoclast activity and inhibiting prostaglandin action [22].

Verschueren *et al.* [23] observed a photo bioactive reaction that stimulates cellular proliferation and differentiation following LASER application. These reactions led to the increase of the circulation of local blood, which removes the pain-inducing inflammatory mediators and enhances the cellular activities. Accelerating the removal of pain-inducing substances such as prostaglandins, histamine, dopamine, and substance P and decrease pain through the reduction of prostaglandin-E2 levels and helping in the inhibition of cyclooxygenase-2, interleukin-1 beta, tumor necrosis factor-alpha, and edema is the mechanism of LASER in pain control.

Deana *et al.* [6], conducted a systematic review and meta-analysis in the MEDLINE, Web of Science, EMBASE, Scopus, and Cochrane Library databases which had twenty articles. The reduction of spontaneous and chewing pain with LASER application with wavelength varies between 780–940 nm in orthodontic treatment. Researchers observed that 810 nm LASER was found to be the most effective. Bayani *et al.* [24] from a randomized controlled trial study concluded that single irradiation from LASER to be the best strategy for orthodontic pain control.

We have found that there was a reduction in pain experience initially for 3 days with LASER compared to the control group. Later on, the pain experience became similar in both groups. Our results are in agreement with the results of Guram *et al.* [15], who observed lower pain experienced in the LASER group over control Group B from 6 h time to 7th day postoperatively. There was a gradual decrease in pain perception in both groups. It was statistically significant till the 2nd day, and after the 3rd day, it was not significant between the groups [15]. Also, our results are consistent with the results of Sobouti *et al.* [22] who observed lower pain perception with LASER compared to the control side. Similar to our study, Doshi-Mehta G *et al.* [25], Eslamian *et al.* [26], Farias RD *et al.* [27], Bicakci AA *et al.* [28], and Youssef *et al.* [19] found a reduction in orthodontic pain using 810 wavelengths LASER

In contrast to our results, Furquim *et al.*, Al Sayed Hasan *et al.* [5, 29] observed no significant reduction in pain sensation with LASER. In disagreement with our study, Li FJ *et al.* held a systematic review studying the LASER therapy effect on orthodontic pain. Randomized controlled trials on LASERs for orthodontic pain in MEDLINE and Cochrane Library were collected. 11 randomized controlled trials (RCTs) in the study of low-level LASER therapy (LASER) for orthodontic pain management were documented. Therefore, for the bias risk of RCTs and methodological shortcomings included, insufficient evidence was submitted to judge whether LASER was effective in relieving orthodontic pain [30].

Conclusion

The study concluded that LASER has shown promising effects in pain control during the orthodontic treatment compared to the control group. Furthermore, research is required for evaluating the role of LASER on orthodontic treatment in a larger sample size.

Acknowledgments: We acknowledge the efforts of Dr. Mostafa Elsayad in statistical analysis.

Conflict of interest: None

Financial support: None

Ethics statement: The study protocol was approved by IRB (code no. A07070519)

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