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Evaluating Pain Control with Laser Applications in Orthodontic Treatments

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ABSTRACT

To determine the impact of laser treatment on the perception of pain in orthodontic patients during molar distalization, 18 patients (aged 13-18 years) were chosen from the Department of Orthodontics, Faculty of Dentistry, Mansoura University, Egypt. Following the application of the eligibility criteria, only 15 patients were left in need of bilateral molar distalization; the same patient was used to measure the pain experienced during molar distalization in the quadrants of the control group and the laser group. The Wilcoxon signed-rank test was used to assess the distinction, and SPSS version 20 for Windows and a t-test with $P < 0.05$ were utilized for statistical assessment of the data gathered from analysis. There was no difference in the patient's age or gender in terms of their pain experience scores ($P > 0.05$). The reduction in pain was statistically significant. The pain was statistically significant up until the third day. On the fourth day, there was no significant difference between the groups. Applying lasers is a non-compliance-dependent and efficient method that can lessen discomfort during orthodontic treatment.

Keywords: Laser, Pain, Tooth movement, Distalization, Orthodontics

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Introduction

In recent years, reducing treatment duration has been a difficulty, and one of the major aims of orthodontic tooth motion has been pain alleviation [1, 2]. Since the first laser was developed in 1960 [3], there has been a lot of interest in lasers in dentistry. Researchers have been improving dental procedures by using lasers. Because of the laser device's nature, versatility, and ease of use, orthodontists have been able to employ it for a variety of purposes, including bracket deboning, diagnostic operations, and the prevention of white spot lesions [4].

Soft laser therapy is a special kind of laser application, also known as low-level laser therapy (LLLT) or cold laser therapy. In 1967, the bio-stimulatory action of lasers was discovered, opening the door for their use in several ways, such as accelerating orthodontic tooth motion, retention protocols, aiding in maxillary expansion, and managing pain during orthodontic treatment [5].

Despite being a contemporary orthodontic treatment method, there has been considerable discussion over the laser technique's ability to lessen pain perception [6]. As a result, some authors attempted to cast doubt on the efficacy of laser therapy as a pain relief method [7]. In addition, the analgesic impact mechanism of laser is still unknown [8]. However, it was considered that laser has brain regeneration qualities with anti-inflammatory biological responses. This reaction encourages cell proliferation and differentiation, permitting its effect [9]. Prior research documented the laser affection's ability to reduce inflammatory processes, simulating the anti-inflammatory drug's action [10]. The laser impact has been shown by several researchers to enhance blood flow and expedite healing [11].

One of the primary issues orthodontists deal with during treatment is the anteroposterior discrepancy. Depending on the growth state and treatment goals, there are many approaches to treating this disparity. Dental correction (molar de-rotation or molar distalization) is necessary in many of these instances. Additionally, permanent tooth extraction is a therapeutic option [6], although non-extraction ideas have gained a lot of support. Numerous tools, including the distal jet, Keles slider, sections jig assembly, and pendulum appliance, can be used to distalize the maxillary first molar. The distalizers' strong force application is linked to pain perception. Thus, the purpose of this study was to assess how well lasers controlled discomfort during molar distalization.

Materials and Methods

This randomized split-mouth controlled clinical research included 18 patients undergoing molar distalization (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 into a control (Group A, no laser therapy) and a study group (Group B, laser therapy). Neither the participant nor the 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 meet 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. The exclusion criteria were hypo-divergent or hyperdivergent skeletal patterns, 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 on the anterior palate [12].

Application of intraoral mini screws 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. At the time of T0, the records were begun. Candidates recalling for reactivation of the springs was done weekly **(Figure 1)**.

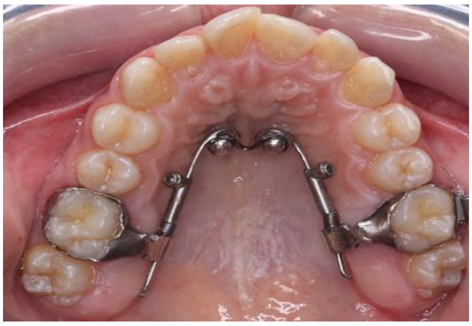

Figure 1. Molar distalization

Laser device

After random allocation, the laser group was irradiated with a 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 aspects of the molar region for 80 seconds weekly **(Figures 2 and 3)**. The laser application followed the photon laser plus unit protocol (DMC, São Carlos, São Paulo, Brazil) [15]. During laser application, the tip was applied in close contact with the apical, middle, and cervical third of the 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 the Wong-Baker faces rating scale. The pain scale has several faces, which range from happy to crying with corresponding numbers from 0 to 5 [16]. The data were collected and statistically evaluated using SPSS version 20 (Microsoft, Chicago, IL, USA) and a t-test with $P < 0.05$. Wilcoxon signed-rank test was used in evaluating the difference.

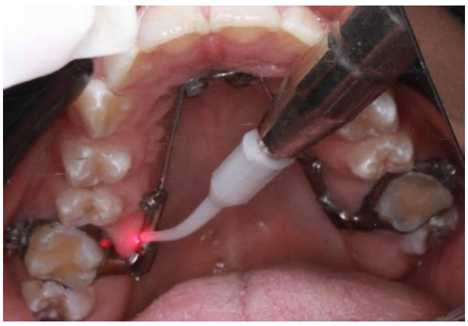

Figure 2. Laser irradiation on the palatal aspect of the molar

Figure 3. Laser irradiation on the buccal aspect of the molar

Sample size calculation

The sample size calculation was based on a type I error frequency of 5% and the 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 aimed 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). 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 the 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

Three patients out of 18 were eliminated because their questionnaires were incomplete, so the data of 15 patients—10 females and 5 males—with a mean age of 15.4 ± 3 years were statistically examined.

The mean pain score in the laser and control quadrants at various time points is displayed in **Table 1**. The pain level peaked on day 1 for both groups, with the control group experiencing the most pain at 24 hours (mean = 3.13), and then continued to decline until the lowest pain level was recorded on day 7 for both groups. The laser and control quadrants' pain scores were compared at various time points using a t-test. The two groups' pain scores differed significantly on days 1, 2, and 3 ($P < 0.05$) **(Table 1)**. On the other days, though, there was no statistically significant difference in the pain scores between the two groups ($P > 0.05$) **(Table 1)**.

Table 1. Pain experienced 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.

The degree of pain is one of the primary obstacles to orthodontic treatment, and numerous interventions, including laser therapy, have been used to alleviate this pain. The current study was conducted to ascertain the role of lasers in pain management because, even though laser analgesia is a novel treatment modality with the advantages of being non-invasive and simple to use, the existing research is highly contentious [17]. The bio-modulation effect of lasers is based on the Arndt-Schulz law, which states that a small dose of a drug or other substance has a stimulating effect, while a higher dose has an inhibitory impact.

Many research employed different wavelengths of laser treatment for the process varied from 635 nm to 980 nm with 0.04–60 J/cm^2 as the energy density, using different kinds of lasers. Various researchers employed lasers with varying wavelengths and produced varying pain management outcomes. Furquim *et al*. [5], Guram *et al*. [15], Matys *et al*. [18], and Youssef *et al*. [19] all employed 635 nm and 808 nm. Qamruddin *et al*. [20] used 940 nm, whereas Pandit *et al*. [21] utilized 980 nm. With an output power of 20 mW, meta-analysis revealed a lower response rate at 780 nm 5 J/cm^2.

According to reports, discomfort causes 28% of orthodontic patients to stop their treatment. Even yet, research has shown that orthodontic treatment causes discomfort to varying degrees for individuals of all ages and genders [5]. Additionally, although analgesics are frequently used to treat discomfort, this approach is not recommended since it may slow the rate at which orthodontic teeth move by interfering with osteoclast activity and preventing prostaglandin action [22].

After using a laser, Verschueren *et al*. [23] noticed a photobioactive response that promotes cellular differentiation and proliferation. As a result of these responses, local blood circulation increases, which eliminates inflammatory mediators that cause pain and improves cellular activity. The mechanism of laser in pain control involves accelerating the elimination of substances that cause pain, such as prostaglandins, histamine, dopamine, and substance P; reducing pain by lowering prostaglandin-E2 levels; and assisting in the inhibition of cyclooxygenase-2, interleukin-1 beta, tumor necrosis factor-alpha, and edema.

A systematic review and meta-analysis of twenty papers from the MEDLINE, Web of Science, EMBASE, Scopus, and Cochrane Library databases was carried out by Deana *et al*. [6]. In orthodontic therapy, spontaneous and chewing discomfort can be reduced by using a laser with a wavelength ranging from 780-940 nm. According to the researchers, the most effective laser was 810 nm. According to a randomized controlled trial research by Bayani *et al*. [24], the most effective method for controlling orthodontic discomfort was single laser irradiation.

We discovered that, in comparison to the control group, there was an initial three-day decrease in pain experienced with laser. Later on, both groups' experiences of pain became comparable. The findings of Guram *et al*. [15], who found that the laser group had less discomfort than control Group B from six hours to the seventh day after surgery, are consistent with our findings. Both groups had a progressive reduction in their sense of pain. It was not significant between the groups after the third day, but it was statistically significant until the second day [15]. Furthermore, our findings align with those of Sobouti *et al*. [22], who found that laser users perceived less pain than those on the control side. Similarly to our work, Doshi-Mehta *et al*. [25], Eslamian *et al*. [26], Farias *et al*. [27], Bicakci *et al*. [28], and Youssef *et al*. [19] observed a decrease in orthodontic discomfort utilizing 810 wavelengths laser.

In contrast to our findings, Furquim *et al*. [5] and Hasan *et al*. [29] found no significant decrease in pain feeling with laser. Li *et al*. [30] conducted a comprehensive evaluation of the effect of laser treatment on orthodontic discomfort, which contradicted our findings. We collected randomized controlled studies on lasers for orthodontic discomfort from MEDLINE and the Cochrane Library. Eleven randomized controlled studies (RCTs) on low-level laser treatment (laser) for orthodontic pain management were recorded. As a result of the bias risk of RCTs and methodological problems, insufficient data was presented to assess whether the laser was useful in alleviating orthodontic discomfort [30].

Conclusion

The study found that laser has demonstrated promising results in pain management during orthodontic treatment as compared to the control group. Furthermore, research is necessary to evaluate the influence of lasers on orthodontic therapy with a bigger sample size.

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Conflict of Interest: None

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