

# The Effectiveness of Low-Level Laser Therapy on Controlling Pain and Discomfort during Separator Placement before Fixation of Orthodontic Appliances

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## Abstract

**Background:** Pain and discomfort are the most common sequel of orthodontic treatment both before and after separator placement. The aim of this study was to evaluate the effectiveness of low-level laser therapy (LLLT) on pain and discomfort control during separator placement before orthodontic fixed appliance placement. **Materials and Methods:** A single-blind, split-mouth clinical trial with a sample size of six patients (12 half mouths as cases where three positions on the buccal side of each tooth lased by the power of 1 Watt diode laser before orthodontic separator placement, while the other 12 teeth acted as control where separators were placed without laser application. Assessment of pain and discomfort was done by visual analog scale. The results of pain intensity and discomfort between the study group (EG) and the control group (CG) were compared by *t*-test and ANOVA, and the level of significance was set at a level at  $P \leq 0.05$ . **Results:** The majority of the laser group experienced pain during chewing (85.70%) and most of them change their food habits (66.70%). In most of the lased cases (70%), pain intensity increased after 72 h, while among the control cases; it increased after 24 h (83.40%). There was a statistically significant difference in pain degree among the laser group at different time intervals ( $P = 0.05$ ), while on the control group, statistically significant difference was found at baseline immediately after placement of orthodontic separator ( $P = 0.05$ ). The majority of the patients' followed the instructions and did not take any medication to decrease pain intensity (66.70%). **Conclusion:** LLLT was effective in decreasing pain and discomfort during elastic separator placement for orthodontic patients with fixed appliances.

**Keywords:** Diode laser, low power laser, orthodontic treatment, pain intensity

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## INTRODUCTION

The International Association for the Study of Pain defined pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage."<sup>[1]</sup> It is a subjective experience, which cannot be easily measured.<sup>[2]</sup> The placement of separators is a common procedure used in orthodontics to fit and cement molar bands for palatal expanders, headgears, or full-fixed appliances. Pain is a burdensome side effect accompanying orthodontic treatment due to force application for tooth movement. Clinical observation indicates that these sensations usually appear a few hours after force application,<sup>[3]</sup> or during the 1<sup>st</sup> day or first couple of days of treatment, and that pain intensity falls to normal levels after 7 days.<sup>[4]</sup> Ngan *et al.* demonstrated that the

placement of separators significantly increased the amount of pain experienced both 4 and 24 h after placement. After 7 days, the pain had returned to a nonsignificant level.<sup>[5]</sup>

Pain reduction without analgesic drugs is necessary for orthodontic treatment.<sup>[5-7]</sup> Pain reduces patient acceptance and compliance and might even prompt discontinuation of treatment. To find alternatives to pain relief by drugs, investigators have looked at low-level laser therapy (LLLT).<sup>[8-10]</sup>

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LLLT is well established clinically in dentistry because of its anti-inflammatory and regenerative effects and its conditioning effect on tooth enamel.<sup>[11,12]</sup> The mechanisms underlying pain relief by LLLT are still poorly understood. Some authors attribute the analgesia to the anti-inflammatory and neuronal effects of LLLT,<sup>[13]</sup> including stimulation of nerve cell and lymphocyte respiration, stabilization of membrane potentials, and the release of neurotransmitters in the inflammatory tissue.<sup>[14-16]</sup> In addition, elongation of substance P and CGRP-rich neuritis was found to be reduced *in vitro*.<sup>[17]</sup> In previous studies, the pain was reduced by LLLT both after separation and placement of arch wires for orthodontic treatments, but no significant differences were found.<sup>[9,10]</sup>

Despite its substantial clinical value, orthodontic pain is broadly neglected and underestimated.<sup>[18-22]</sup> LLLT has been suggested as a new analgesic treatment free of the adverse effects of analgesic medications. The available studies are quite controversial, so this study was conducted to evaluate the effectiveness of LLLT in controlling pain and discomfort during separator placement before orthodontic treatment.

## MATERIALS AND METHODS

This study was a single-blind, split-mouth clinical trial. Patients of both sexes, aged between 16 and 20 years, were selected from the orthodontic clinic (Military dental hospital, Omdurman, and Khartoum dental teaching hospital). The patients were selected according to the following inclusion criteria: healthy molar, presence of proximal contacts around the maxillary first permanent molars on both sides, absence of periodontal disease, and absence of periapical pathology. Excluded were Patients with any systemic debilitating diseases (e.g., malignant neoplasias, metabolic diseases, chronic pain, neurological/psychiatric disorders, or use of medications (antibiotics, corticosteroids, bisphosphonates, analgesics, anti inflammatory agents, or contraceptives) taken up to one month before the selection).

The study was approved by the Ethical Committee of the Sudan University of Sciences and Technology. Participation was voluntary after explaining the purpose of the study and those who accepted to participate signed informed written consent.

Oral examination for the participants to check indexes of visible plaque, bleeding on probing, periodontal probing depth, and clinical attachment loss was done. The absence of periapical pathology was verified by periapical radiographs from the initial records. For each participant, the oral cavity was divided into four quadrants with respect to the right and left first molars in each quadrant in order to eliminate intersubject variability. One quadrant was designated as the laser group and the other, as the control group. For blinding and to eliminate confounding factors; a real laser beam was subjected to the laser quadrant, while the control quadrant was placebo lased by the pointer light emitted from the laser device to eliminate any psychological confounding factors. Each participant had four separators placed mesially and distally to either the right

or left maxillary or mandibular first molars. Participants in both groups were requested to rate their pain intensity and discomfort by using the visual analog scale (VAS).<sup>[23]</sup>

Diode laser 808 nm (Elexxion pico, Germany); laser irradiation was performed in continuous mode of 400 MW output power, with a single spot application in the immediate region corresponding to the buccal surfaces of the tooth at three points. One point was aimed at the interdental papilla from the mesial direction; one point was aimed at the distal and another near the apex of the root.

For the control sites, the laser unit was switched off; however, the sound signal was maintained in order to be aware of the application time, thereby maintaining the blinding of the participants. The laser was applied to each group for the same amount of time (30 s per point), corresponding to a total of 90 s per tooth.

Patients were instructed to quantify the discomfort or pain by means of a VAS, noting the intensity on a scale of 0 to 10 according to the participant's self-perception. This evaluation was performed after separator placement at the following times: before laser application T0, after 5 min (T1), 24 h (T2), and 72 h (T3). All statistical procedures performed using the SPSS version 23.0 Statistical Software Program (SPSS, Inc., Chicago, USA). A comparison of the pain intensity between different time intervals was done using a one-way ANOVA test. A comparison between the pain intensity between the laser group and the control group was done by an independent sample *t*-test. The level of significance was set at a  $P \leq 0.05$ .

## RESULTS

The results of the study showed both of the laser and the nonlaser control sites experienced pain during chewing (85.70%) [Figure 1]. The pain intensity increased after 24 h at control sites while most of the cases their pain intensity increased after 72 h [Figure 2]. The majority of the participants did not take any medication to decrease the intensity of the pain [Figure 3]. While more than half of the participants changed their food habits (66.70%) during the 1<sup>st</sup>-week duration after placement of fixed orthodontic appliances [Figure 4].

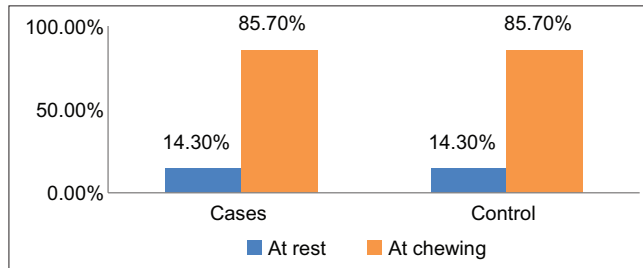
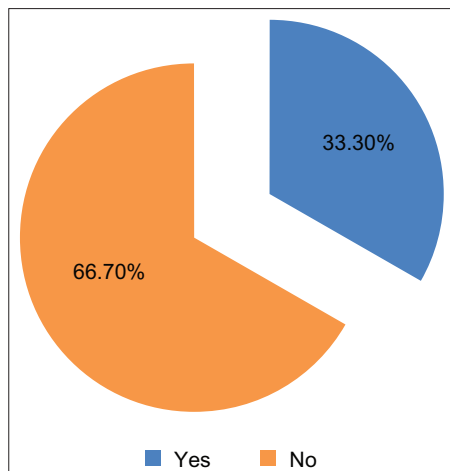
The statistically significant difference was present between the pain intensity at different time intervals for the laser group  $P = 0.05$  [Table 1], while there was a statistically significant difference of the pain intensity for the laser and control groups at baseline,  $P = 0.05$  [Table 2].

## DISCUSSION

Blinding in clinical trial studies is appropriate to prevent confounding's caused by the patient's subjectivity (uncontrolled bias). The split-mouth design used in this study is appropriate to eliminate subjectivity toward pain sensation. It can achieve meaningful results with a relatively smaller sample size, and the effects of intersubject variation can be minimized when the individual is self-matched or self-controlled.<sup>[24,25]</sup>

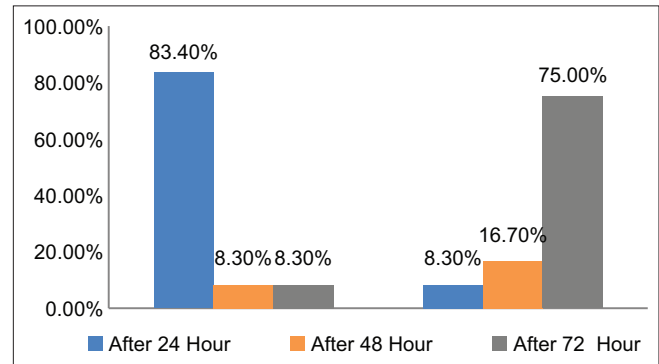
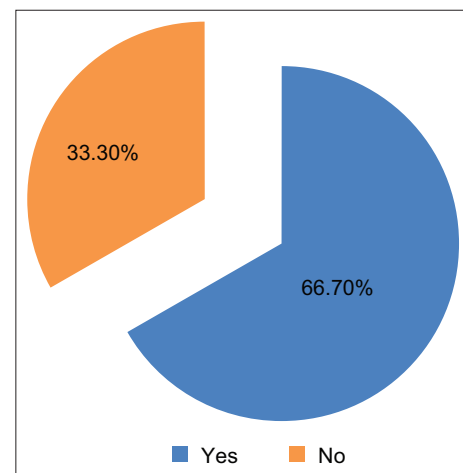
**Table 1: Intragroup comparison between pain degrees according to Visual Analog Scale at different time intervals for both (laser group) and control (nonlaser group)**

	Mean±SD					P
	Baseline	After (5 min)	After (1 h)	After (24 h)	After (72 h)	
Laser group	2.33±0.65	1.33±0.89	2.08±1.08	3.17±2.25	2.17±1.59	0.05*
Control group	2.25±1.82	2.00±1.91	2.17±1.80	3.28±3.55	3.58±2.43	0.247

\*Significant  $P \leq 0.05$ . SD: Standard deviation**Figure 1:** The highest level of pain participants experience during chewing for both; treated by laser side and control side without laser treatment**Figure 3:** Medications used to treat pain and discomfort after placement of orthodontic appliances

The VAS is a subjective method of measuring pain and has been used extensively in many clinical studies as it is described as an easy and reliable way to demonstrate small variations in pain intensity.<sup>[4,5,26]</sup> The validity of the VAS was previously utilized to record pain intensity induced by orthodontic separators or arch wire insertion in adolescent samples.<sup>[27,28]</sup> The pain VAS is self-completed by the respondent. It is an old technique as the respondent is asked to place a line perpendicular to the VAS line at the point that represents their pain intensity.<sup>[29]</sup> The standard scale followed is the Numeric Rating Scale, as it is best reflecting the pain intensity, and when compared to VAS, it can be administered verbally (therefore also by telephone) or graphically for self-completion.<sup>[30]</sup>

Pain and discomfort are the most common sequel of orthodontic treatment both after separation and placement of arch wires and one of its most significant problems.<sup>[18,19,31]</sup> About 90% of orthodontic patients find that orthodontic treatment is

**Figure 2:** Comparison of pain intensity between the sides treated by laser after separator placement and control sides without laser according to the time duration**Figure 4:** Participants changing their food habit after placement of fixed orthodontic appliance for both case side treated by laser and control side without laser treatment

painful.<sup>[20,32]</sup> Therefore, it is a critical restriction to orthodontic treatment and a common cause of treatment discontinuation.<sup>[18,20,21,33]</sup> Our results agree with the finding of others,<sup>[34,35]</sup> as they concluded that chewing was the most painful experience related to orthodontic separators placement. Due to unbearable pain sensations, the majority of our participants changed their eating habits. This is in agreement with Scheurer *et al.*, who reported that the influence of fixed orthodontic appliances on eating/chewing was significantly higher than the influence on daily life.<sup>[36]</sup>

The majority of the patients treated by LLLT before separator placement stated that their pain intensity increases after 72 h,

**Table 2: Intergroup comparison between pain intensity after placement of fixed orthodontic appliances for Cases group (treated by laser) and control group (without laser treatment)**

Pain intensity	Mean±SD		P
	Laser group	Control group	
Baseline	2.33±0.65	2.25±1.82	0.028*
After (5 min)	1.33±0.89	2.00±1.91	0.117
After (1 h)	2.08±1.08	2.17±1.80	0.119
After (24 h)	3.17±2.25	3.28±3.55	0.258
After (72 h)	2.17±1.59	3.58±2.43	0.163

\*Significant  $P \leq 0.05$ . SD: Standard deviation

while in the majority of the control cases, their pain intensity increases after 24 h. This finding is similar to others,<sup>[26,28,37,38]</sup> as their results concluded that the most severe pain is within the 1st day of separators placement, but disagreed with others studies;<sup>[35,39]</sup> in which their result revealed that experiencing the peak of separator pain on day two or day three.

The reason behind the increases of the orthodontic pain after 24–48 h may be due to the hyperalgesia of the periodontal ligament because, after separator placement, the nerve fibers of the periodontal ligaments are more sensitive to noxious stimuli such as prostaglandins, histamines, and substance P released from the inflammatory process of moving teeth.<sup>[12,40]</sup> These inflammatory mediators reach their highest concentration during this 24–48 h, which explains the peak pain response seen during this time period. Our results show that majority of the patients' compliance with the instructions given by their orthodontists to avoid over counter pain killers and not take any medication to decrease the pain intensity. This may be explained due to their voluntary participation and hopefulness of eradicating pain by this new technology (laser).

In agreement with the result by Shi *et al.*,<sup>[41]</sup> Ren *et al.*,<sup>[42]</sup> and Eslamian *et al.*,<sup>[43]</sup> LLLT shows a significant decrease of pain in interval duration, and the pain can be reduced after placement of separators effectively at 6 h, 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> day, without adverse effect reports. Furthermore, our results agree with the results by Sakurai *et al.*,<sup>[44]</sup> who found that the LLLT had significantly lower mean pain scores for both spontaneous pains and with the teeth in occlusion. On the other hand, our finding in this study is dissimilar to the finding of Lim *et al.*,<sup>[8]</sup> who found that the LLLT did not demonstrate a statistically significant reduction in orthodontic pain. Esper and Arisawa,<sup>[45]</sup> also compared the effects of LLLT and low-level LED therapy in reducing orthodontic pain and showed no significant decreases in pain levels for the laser group. These contradicting results may be due to intersubject variations that may give different results in pain perception.

Previous studies reported that the perception of orthodontic pain can be affected by various factors such as age, gender, emotional status, and past pain experience.<sup>[46]</sup> Turhani *et al.* reported a smaller difference in pain intensity between laser and placebo groups among patients over 18 years old compared

with those under 19 years.<sup>[47]</sup> They also found that women appeared to recover more quickly than men under laser therapy, suggesting variations in the effects of diode LLLT among different populations. The results of the present study show that there is only a statistically significant difference between pain degree for the case group and pain degree for the control group at baseline; this may be due to the immediate action and effect of the laser on the nerve fibers. This postulation needs to be studied.

## CONCLUSION

LLLT is effective in decreasing pain and discomfort after placement of separators for fixed orthodontic appliances. Laser treatment delayed the increases of the intensity of pain and discomfort as it appeared after 72 hours, while the group of patients treated with no laser, the intensity increased after 24 hours.

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## Conflicts of interest

There are no conflicts of interest.

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