ORIGINAL RESEARCH

Effect of Two Energy Values of 810-nm Diode LLLT on Reducing Pain Caused by Orthodontic Elastomeric Separators: A Split Mouth Randomized Controlled Clinical Study

Faisal Arshad[1], H S Dharmesh[2], V S Bharathi[3], Arora Abhas Ram[4], Shamshad Begum[5]

ABSTRACT

Objective: Low-level laser therapy (LLLT) has been reported to have a local analgesic effect. Keeping in view the pain-relieving effect of LLLT the objective of this study was to determine the effect of two energy values of 810-nm diode low-level laser irradiation on dental pain induced by forces from separators in orthodontic treatment.

Materials and Methods: Thirty patients were enrolled in this study. Patients were randomly allocated to two groups. Patients were randomly assigned to either the 4-Joule laser energy group or the 16-Joule laser energy group with an allocation ratio of 1:1 using a simple randomization technique. 4-Joule or 16-Joule low-level laser irradiation was applied on one-half of the maxillary and mandibular arches for 5 days. The opposite half of the arches was considered the control in both groups. Laser irradiation was applied for 30 s in the alveolar bone between the second premolars, first molars, and second molars. Laser used in this study was Ga-Al-As laser device with a wavelength of 810 nm. Pain perception was evaluated with a standardized questionnaire that was answered by patients before and after laser irradiation. Data were analyzed by Wilcoxon and Friedman test. $P \leq 0.05$ was considered significant.

Results: The highest pain level was reported at day 2 following separator placement and decreased gradually until day 5. The pain intensity was lower in the laser group than in the control group. No statistical significance was found for both low-level laser energy values in comparison to the corresponding control group. At day 2, the pain intensity was lower in the laser group than in the control group and was statistically significant.

Conclusion: Our findings suggest that there was no statistically significant difference for both low-level laser energy values in comparison to the corresponding placebo treatments low-level laser irradiation, with the exception of the pain experienced on the highest pain perception day.

Keywords: Low level laser therapy - (LLLT), Visual analog scale - (VAS), Ga-Al-As diode device.

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[1,3,4]Senior Lecturer, [2]Reader, [5]Private Practioner

[1-3]Department of Orthodontics, Rajarajeswari Dental College, Bengaluru, Karnataka, India

[4]Department of Public Health Dentistry, Dr. Rajesh R Kambe Dental College and Hospital, Akola, Maharashtra, India

[5]Department of Oral Medicine and Radiology, Jammu, Jammu and Kashmir, India

Corresponding Author: Faisal Arshad, Senior Lecturer, Department of Orthodontics, Rajarajeswari Dental College, Bengaluru, Karnataka, India. Phone: +91-9008716729. e-mail: faisarshad@gmail.com

INTRODUCTION

Creation of space mesially and distally to teeth, which are to be banded, forms the initial step in fixed orthodontic mechanotherapy. It is well-known that placement of orthodontic separators (brass wire, elastomeric, spring type steel separators, and latex elastics) results in a painful experience for almost all patients.[1,2] Two controlled clinical trials performed by Ngan *et al*.[2,3] concluded that there was discomfort associated with separator placement.

Force applied to a tooth by orthodontic appliances results in ischemia, inflammation, and edema immediately after the compression of the periodontal ligament. Algogens such as histamine, bradykinin, prostaglandins, serotonin, and substance P are released after periodontal ligament compression and activation of the inflammatory reaction.[4]

Pain during orthodontic treatment usually appears at 2 h after application of orthodontic force, reaches a peak level at 24 h, and lasts approximately 7 days.[4,5] Pain is of multifactorial nature and depends on variables such as patient's subjective previous pain experiences, age, type of appliance, present emotional state and stress, cultural differences, and sex.[4,5] Discomfort and pain after initial separator or archwire placement are common experiences among orthodontic patients.[4,6]

The existing literature supports the use of nonsteroidal anti-inflammatory drugs (NSAIDs) for pain control, even though other methods (such as anesthetic gel,

bite wafers, transcutaneous electrical nerve stimulation, low-level laser use, and vibratory stimulation) have been suggested. The major concern regarding NSAIDs is the interference produced on inflammation associated with tooth movement process. Low doses administered for 1 or 2 days in the initial stages will not affect the tooth movement process as such.

Dental interest in lasers has been high, and research has continued to improve dental treatment through laser application.[7] The effect of low-level laser therapy (LLLT) on orthodontic pain is still controversial. Lim *et al*.,[8] in a clinical investigation on the efficacy of LLLT in reducing orthodontic pain found discouraging results, and it was not found to produce immediate pain relief in orthodontic patients. Other investigations show the effect of LLLT on reducing pain during orthodontic treatment. LLLT has no pharmacological side effects.

The aim of this study was to assess the effect of two energy values low-level laser diode of 810-nm wavelength on the pain caused by the placement of orthodontic separators. This was a controlled clinical trial with a split-mouth design on 30 patients.

MATERIALS AND METHODS

Thirty patients were enrolled in this study. Patients were randomly allocated to two groups. Patients were randomly assigned to either the 4-Joule laser energy group or the 16-Joule laser energy group with an allocation ratio of 1:1 using a simple randomization technique. 4-Joule or 16-Joule low-level laser irradiation was applied on one-half of the maxillary and mandibular arches for 5 days. The opposite half of the arches was considered the control in both groups. Laser irradiation was applied for 30 seconds in the alveolar bone between the second premolars, first molars, and second molars, (Figure 2). Pain perception was evaluated with a standardized questionnaire that was answered by patients before and after laser irradiation. Data were analyzed by Wilcoxon and Friedman test. $P \leq 0.05$ was considered significant. Laser used in this study was Ga-Al-As laser device with a wavelength of 810 nm.

Participation was based on the following inclusion criteria:

- Patients willing to sign the consent form before the initiation of orthodontic treatment
- No systemic disease
- No use of medication that might interfere with bone metabolism and gingival tissue
- No gingivitis or periodontitis
- The teeth must be free from any pathologic conditions
- Bilateral symmetry (presence of teeth on both sides of the arch).

Exclusion Criteria

The following criteria were excluded from this study:

- Patients on analgesics
- Patients on NSAIDs and hormone supplements
- Patients with chronic pain or history of neurological and psychiatric disorders
- Patients who did not return the completed questionnaires
- Patients who used any form of analgesics during the experiment
- Removal or loss of the separator during the experiment
- Patients who did not show up for any of the experimental sessions.

Elastic orthodontic separators were placed on the mesial and distal of the first maxillary and mandibular molars. Immediately after separator placement, the pain sensitivity index was determined through the visual analog scale (VAS) (Figure 1).

Laser therapy was applied on the experimental side with the equipment turned on with two different energy values, i.e., 4 joules and 16 joules and on the control side with the equipment turned off. Laser therapy was applied 30 seconds daily for 5 days. Pain level after each therapy was recorded by VAS.

Statistical Analysis

Data were analyzed by Wilcoxon and Friedman test. $P \leq 0.05$ was considered significant.

RESULTS

Data show mean pain level is similar in both sides except the 2nd day after laser therapy which was statistically

Table 1: Comparison between laser side and control side

Time (days)	Mean of pain level (experimental side)	Mean of pain level (control side)	*P* value
1st day before laser therapy	3.5	3.5	1
1st day after laser therapy	4.25	5.25	0.27
2nd day after laser therapy	4.5	7.45	0.008*
3rd day after laser therapy	3.5	6	0.34
4th day after laser therapy	2.25	4.13	0.19
5th day after laser therapy	1	2.25	0.41

Level of significance at $P<0.05$ *

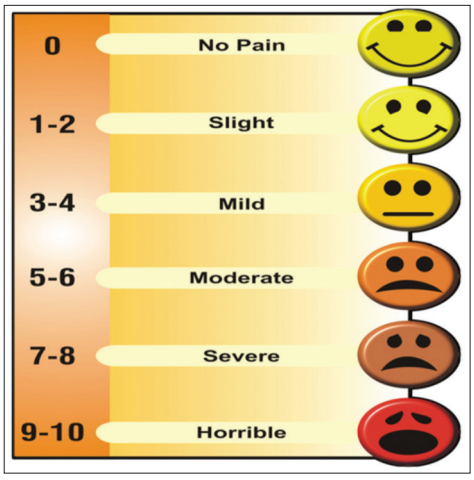

Figure 1: Visual analog pain scale

Figure 2: Laser application after separator placement

significant (P = 0.008) [Table 1]. It also shows pain level in the laser side decreased by passing the time, and it was statistically significant, and the maximum pain level was day 2, and minimum was day 5 after laser therapy. Pain level in the control side decreased by passing the time, and it was statistically significant, and the maximum pain level was on 2nd day, and minimum was on 5th day after laser therapy. No statistical significance was found for both low-level laser energy values in comparison to the corresponding control group.

DISCUSSION

Studies on pain relief by LLLT are not confined to fixed orthodontic treatment. Other studies have shown pain relief by LLLT after surgical endodontics and in patients with temporomandibular joint pain, trigeminal neuralgia, myalgia, aphthae, and hypersensitivity.[9,10]

Many authors have demonstrated that LLLT penetration into deeper tissues (i.e. bone) is more effective than the visible laser, which is normally used for gum and skin treatments.[11,12] The transmission of laser through tissue is highly wavelength specific and is optimal in the optical window of 500–1200 nm. Several authors have used different wavelengths within this optical window in a range of 670–830nm.[8,13,14] We have used laser which was Ga-Al-As diode device with a wavelength of 810 nm with two different energies 4-Joule laser energy and 16-Joule laser energy.

Pain perception varies considerably from patient to patient, and this biases the quantification of pain.[14] However, the significance level of $P < 0.05$ was a strong indicator for a statistically significant and relevant correlation between LLLT and pain reduction. However, no statistical significance was found for both low-level laser energy values, i.e. 4- and 16-joule laser energy in comparison to the corresponding control group.

Pain during fixed orthodontic treatment increases gradually from the 4th hour to 24th h but returns to a normal degree on the 7th day.[4,5,15] Patients who have higher perceptions of the severity of their malocclusions seemed to adapt faster and have less pain during orthodontic treatment.[6]

Youssef *et al.*,[16] Tortamano *et al.*,[13] Turhani *et al.*,[14] and Harazaki *et al.*,[12] for instance, applied laser in patients undergoing orthodontic treatment. The authors assessed pain during alignment and leveling or when performing canine retraction. Given that these procedures involve a higher number of teeth, they may enhance pain perception and underscore LLLT effects. Thus, it does not seem reasonable to compare these results with the present study which assessed pain perception in the presence of elastomeric separators.

In this study, we used orthodontic tooth movement (placing separator) as a model to evaluate the effect of two energies LLLT on the level of pain. Pain levels were measured for 5 days following initial placement of separators. Bernhardt *et al.*[17] noted that pain following placement of separator initiated after 2 h and reaches its maximum during sleep.

According to our study, the maximum level of pain on the test side was recorded 1 day after placement of separators which gradually declined until the 5th day. Turhani *et al.*[14] showed that laser irradiation at the beginning of orthodontic treatment reduced pain after 6 and 30 h.

Lim *et al.* evaluated the effect of LLLT on pain control after placement of separators. They observed the mean level of pain was lower in LLLT group than placebo group, but the results were not statistically significant.[8] Yousef *et al.*[16] found that pain severity in the laser group was in the lower level. Artes-Ribas *et al.*[18] evaluated the pain sensation that orthodontic patients experience when elastic separators are placed between molars and premolars and to determine the degree of analgesic efficacy of LLLT

compared to a placebo treatment. They found that pain intensity was significantly lower in the laser-treated quadrant (mean, 7.7 mm) than in the placebo-treated quadrant (mean, 14.14 mm; $P = 0.0001$).

Moaffak[19] in his study concluded that LLLT, applied at two different laser energy values, is ineffective in relieving elastomeric separators induced orthodontic pain.

Our study shows the mean level of pain in both LLLT, applied at two different laser energy values is not of significance in relieving pain induced by elastomeric separators in control and test sides. However, pain reduction was effective on day 2 in laser group as compared to control group.

CONCLUSION

- Pain was reduced significantly in the laser group as compared to control group with passing time
- LLLT, applied at two different laser energy values has similar effect in relieving pain induced with elastomeric separators.

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