RESEARCH ARTICLE

Efficacy of single dose of low-level laser therapy on spontaneous pain caused by separators in orthodontic patients: An experimental study

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Abstract

Objective: To investigate the efficacy of single dose of low-level laser therapy with respect to spontaneous pain reduction after orthodontic separator placement.

Method: The prospective, randomised, experimental study was conducted at the Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from January to June 2023, and comprised patients of either aged 12-22 years who underwent orthodontic separator placement. The patients were randomised into two groups, with those in Group A receiving a single dose of 200mW of non-contact continuous low-level laser therapy buccally on 3 points, and those in Group B receiving light emitting diode light as placebo. Pain was assessed using visual analogue scale at 24, 48 and 72 hours after the insertion of orthodontic separators. Data was analysed using SPSS 24.

Results: Of the 60 participants, 30(50%) were in group A; 19(63.3%) females and 11(36.6%) males. There were 30(50%) patients in Group B; 18(60%) females and 12(40%) males. The overall mean age was 14.95±2.09 years. Mean pain levels at 24, 48 and 72 hours were higher in Group B compared to Group A ($p<0.05$). Gender was not significantly associated with pain ($p>0.05$) at any time interval.

Conclusion: Low-level laser therapy appeared to be effective with respect to spontaneous pain reduction after orthodontic separator placement.

Keywords: Low-level laser therapy, Pain perception, Visual Analogue Scale, Orthodontic appliances, Analgesic agents.

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Introduction

Orthodontics is a specialty that is associated with the prevention, interception and treatment of dentofacial and occlusal deformities.[1] It contributes to improving facial aesthetics besides improving oral function and health, thus enhancing profoundly the psychosocial life of the person.[2] Orthodontic treatment is initiated by placing separators to create space for luting orthodontic bands onto the permanent first molars.[3] This step of separator placement is associated with high-intensity pain and discomfort during the first 4 to 24 hours of separator placement.[4] The placement of separators is usually associated with pain and discomfort, and various techniques have been suggested in the literature to alleviate these, including pharmacological agents such as nonsteroidal anti-inflammatory drugs (NSAIDS), local application of gels and patches, chewing gum, and various non-pharmacological methods, like vibratory and transcutaneous electric nerve stimulation and low-level laser therapy (LLLT).[5] LLLT is a recent technique that has shown a significant reduction in orthodontic pain by reducing blood flow, thereby reducing prostaglandin levels and diminishing cyclooxygenase-2 (COX-2) enzyme secretion, and contributing to the analgesic and anti-inflammatory effects of LLLT.[6] LLLT offers the advantages of being an easy application and being a non-invasive modality as energy produced by this technique is low; almost the same as body temperature, Besides, pain control also allows accelerated tooth movement, which is added advantage not found with NSAIDs that rather reduce the tooth movement rate.[7]

LLLT has garnered attention as a potential adjunct for reducing pain when used alongside fixed appliances, but such findings remain inconsistent. For instance, a systematic review[8] indicated that the exact protocol for laser therapy is still unclear, recommending more studies with meticulously designed methods. Similarly, a randomised controlled trial (RCT) found that both single and double application of LLLT effectively diminished pain levels associated with elastomeric separators.[9] However, other studies[10,11] have reported no significant difference in pain perception. These inconsistencies may stem from variation in study designs, laser parameters and patient demographics. Additionally, the optimal timing and frequency of LLLT application remain unclear.[7] Therefore there is a need for further research to establish standardised protocols and assess the clinical effectiveness of LLLT in reducing pain caused by orthodontic separators.

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The current study was planned to investigate the efficacy of single dose of LLLT with respect to spontaneous pain reduction after orthodontic separator placement. The null hypothesis was that LLLT would produce significantly low mean pain scores.

Patients and Methods

The prospective, randomised, experimental study was conducted at the Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from January to June 2023. After approval from the institutional ethics review board. The sample size was calculated using the World Health Organisation (WHO) calculator. Sample size was 60 with level of significance 5% with power of test 90% and the population mean values were in line with study by Qamaruddin et al,[12] ensuring a high probability of detecting a true effect while minimising false positive and negative values. The sample was raised using nonprobability consecutive sampling technique. Those included were patients of either aged 12-22 years who underwent orthodontic separator placement and had no pain at the start of the treatment, while permanent first molar exhibited tight contact with adjacent teeth both mesially and distally. Those excluded were patients with multiple fillings, root canal treatments, active gingivitis, multiple missing teeth, and/ or spacing between molars and premolars. Also excluded were patients with elastomeric separators, patients with any uncontrolled systemic diseases, patients already taking NSAIDs, and those having latex allergy.

After taking written, informed consent from all the patients, they were randomised into two groups, with those in Group A receiving LLLT, and those in Group B receiving light-emitting diode (LED) light as placebo. Patients with odd registration slip numbers were assigned to Group A, while those with even registration slip numbers were assigned to Group B.

In Group A, the application of a single dose of 200mW and 4 joules (20×0.2) LLLT was done using a diode laser (Epic X. Biolase Inc., Californian, United States) at each site for a total of 12 joules of non-contact continuous laser buccally for 20 sec each on 3 points: mesial, distal, and the middle of the root of first molar. The continuous mode was used as the non-cutting tip was placed close to the gingival tissue, but it was not touching the tissue.

In Group B, LED light was applied using an LED curing light unit (Coltolux 110-115V, Coltene/Whaledent Inc., 235 Ohio, USA). The LED was used without turning it on, which left the participant blinded to whether or not the light was applied (Figure).

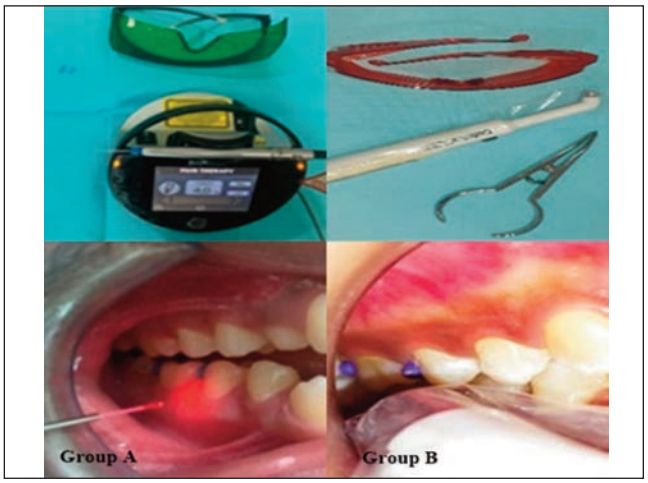

Figure: Group A comprised low-level laser therapy (LLLT) treatment, while Group B received light-emitting diode (LED) light.

The pain perception of each patient was assessed by the intensity of spontaneous pain on the 10-point Visual Analogue Scale (VAS), with 0 corresponding to no pain and 10 corresponding to severe pain. The assessments were done at 24, 48 and 72 hours after the insertion of orthodontic separators. The VAS values were divided into mild (0-4), moderate (5-7) and severe (8-10) to score severity of pain. Data was collected using a predesigned Google Form proforma. All patients were assessed on follow-up after a week.

Data was analysed using SPSS 24. Data was expressed as mean±standard deviation for age and pain, while frequencies and percentages were used for gender. Independent sample t-test was applied to compare mean spontaneous pain scores. Chi-square test was applied for intergroup comparisons, and mixed (split-plot) repeated measure of analysis of cariance (ANOVA) was used to compare pain levels over time. P≤0.05 was taken as statistically significant.

Results

Of the 60 participants, 30(50%) were in group A; 19(63.3%) females and 11(36.6%) males. There were 30(50%) patients in Group B; 18(60%) females and 12(40%) males (*p*=0.791). The overall mean age was 14.95±2.09 years.

Mean pain score at 24, 48 and 72 hours after separator placement was 5.67±0.66 (range: 2-8), 4.57±2 (range: 1-10)

Table-1: Comparison of mean severity of pain scores at 24, 48 and 72 hours (n=60).

Severity of Pain	Groups		
	Group A: Low Level Laser Mean±SD	Group B: LED Placebo Mean±SD	*p*-value
24 hours	21.33±7.303	56.33±10.662	0.001
48 hours	15.66±6.78	48.66±8.99	0.001
72 hours	9.33±5.2	34.0±6.21	0.001

LLLLT: Low-level laser therapy, LED: Light-emitting diode, SD: Standard deviation.

Table-2: Comparison of mean pain in both the groups with respect to gender.

Gender	Groups	n	Mean±SD		*p*-value
Male	Group A	11	24 Hours	6.18±1.40	0.675
	LLLT		48 Hours	4.48±2.40	0.829
			72 Hours	2.45±1.29	0.351
	Group B	12	24 Hours	7.58±0.99	0.596
	LED		48 Hours	8±0.95	0.567
			72 Hours	3.17±1.26	0.316
Female	Group A	19	24 Hours	5.26±1.33	0.084
	LLLT		48 Hours	4.42±1.95	0.658
			72 Hours	2±1.33	0.662
	Group B	18	24 Hours	7±1.49	0.246
	LED		48 Hours	6.94±1.58	0.434
			72 Hours	3.83±1.82	0.568

*Independent t-test value=Insignificant;
LLLLT: Low-level laser therapy, LED: Light-emitting diode, SD: Standard deviation.

and 2.17±1.31 (range: 0-5) in Group A. The corresponding values in Group B were 7.23±1.33 (range: 3-9), 7.37±1.45 (range: 3-10) and 3.57±1.63 (range: 1-8). The mean pain level in Group B was significantly higher across the time-points ($p<0.05$) (Table 1). Gender was not significantly associated with pain ($p>0.05$) at any time interval (Table 2). Comparison of the separator pain at 24, 48 and 72 hours with respect to gender indicated there was a non-significant change in pain over time ($p>0.05$).

Discussion

Pain, according to the International Association for the Study of Pain (IASP), is an obnoxious sensory and emotional experience associated with, or looking like it is associated with substantial or potential tissue harm.[13] Pain is always subjective as the pain threshold of every individual is different which can be affected by physical and mental impacts. Also, different variables, like natural, sociocultural, hereditary elements and others, can influence pain. Orthodontic separator placement can produce pressure, tension, soreness and pain, which can have negative implications related to the patient's attitude and compliance towards further orthodontic procedures.

For fixed orthodontic appliance treatment, creating interproximal separation between molars and premolars is essential to make room for the bands anchoring the appliance. Therefore, separation is needed to avoid excessive force during band placement.[14] An ideal separator should provide quick and effective separation without causing the patient discomfort or pain.[15]

In the present study, elastomeric separators were used because they are readily available and simple to place. They work by applying traction force or wedging action to separate the teeth, and are left in place long enough to allow initial tooth movement, ensuring slight separation when bands are fitted. However, a limitation of elastomeric separators is their difficulty in slipping into tight proximal spaces. Frequent dislodgement of these separators can cause treatment delays due to the failure to open the contact point.[16]

LLLT has been used for the past two decades as an adjunct to reduce the severity of orthodontic pain caused after the placement. It has always been beneficial to contrast LLLT and different strategies used in alleviating pain, since it opens a therapeutic window for anti-inflammatory actions that include its capacity to improve tissue overhaul. LLLT displaced Nitric Oxide (NO) from the respiratory cycle by acting through mitochondria, and thereby expanding the levels of Adenosine Triphosphate (ATP) and reactive oxygen (O2) species.[17] This leads to variations in gene expression and subsequent generation of chemical messengers. A study[18] showed that LLLT decreased pain production after orthodontic tooth movement by stimulating cellular metabolism, and regulated inflammatory and pain-relieving mediators.

Assessment of pain in the current study was done using VAS, a reliable tool, while the digital platform of Google Forms was employed for patients to record their pain levels following separator placement. This allowed instant data entry, and kept all the data organised and secure. The participants could conveniently share their pain levels from anywhere, making it easier to participate, thus minimising errors in reporting.

Pain assessments using VAS at 24, 48 and 72 hours post-placement demonstrated that there was a massive contrast in the degree of spontaneous pain between the LLLT and the LED groups (≤0.05). The finding is constant with an earlier studies.[12,19] Al-Hanbali et al[20] in an RCT demonstrated that both LLLT and Low-Intensity Pulsed Ultrasound (LIPUS) were lessened the pain induced by orthodontic separation. A systematic review[8] showed LLLT has a significant impact on pain reduction. Similarly, in a recent RCT,[21] the viability of paracetamol and caffeine administration in addition to LLLT in lessening pressure-induced pain subsequent to placing elastomeric separators around the first molars showed that the two conventions had similar pain control potential.

The current patients stated greatest degree of pain at 24 hours after separator placement in both the groups. This corroborates with the conclusions of past studies[22,23] which reported greatest pain following 24 hours of application of orthodontic forces, which was associated with the peak level of prostaglandins. There was a steady decrease in the severity of pain in the two current groups at 48 and 72 hours after the procedure, with the LLLT group showing a more remarkable decrease in pain intensity. A non-

significant difference in mean reduction in pain was found between the two genders. These findings are in contrast to a study,[24] which reported no significant age or gender differences among LLLT, LED and control groups. Some gender dimorphism was noted in a study,[10] where no gender differences were found except after the initial placebo group irradiation, where females experienced significantly higher pain levels than males at 48 hours. Nanda M et al.[25] observed that while many RCTs have been conducted to assess the effects of LLLT on pain, due to heterogeneity of the studies, especially due to different parameters used, the results were still conflicting. There are certain confounders also noted in the current study as well, like varying perception of pain among the individuals, making it difficult to standardise the response to LLLT. Laser parameters vary and differences in wavelength, power density, and exposure time can lead to inconsistent results across studies.

The current study has limitations, like having a small sample size and lacking any standardisation protocol. Moreover, individual differences in pain perception could have influenced the findings. Additional research on the use of LLLT in orthodontics is recommended to fully comprehend its benefits and applications.

Conclusion

LLLT showed reduction in pain score after the placement of elastomeric separators compared to LED placebo.

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Author Contribution:

RN: Concept, design, data collection, analysis and writing.
EA: Supervision, data analysis and writing.
BG: Data collection, editing and finalizing the text.
MUH: Submission, formatting and analysis.