

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

Kishore Kumar Khatri ^{1*}, Akram Hassan ², Adam Husein ³, Irfan Qamaruddin ⁴, Mohammad Khursheed Alam⁵, Tamana Khatri⁶

1. BDS,MSc, PhD Student University of Sains Malaysia, Consultant at Aga khan university hospital Karachi Pak, kumar.kishore123@student.usm.my
2. BDS, MClintDent. Restorative(Perio), School of Dental Sciences, University of Sains Malaysia akram@usm.my
3. BDS,Grad Dip Clin Dent,Doc Clin Dent,FRACDS,FICD, Professor at University of Sharjah UAE, Professor at School of Dental Sciences ,University of Sains Malaysia, adamkck@usm.my
4. BDS,FCPS.PHD Ortho, Professor and HOD, Orthodontic Department, Jinnah Sindh Medical University Karachi, irfan.qamaruddin@aku.edu
5. BDS,Ph.D, Preventive Dentistry Department College of Dentistry, Jouf University, KSA mkalam@ju.edu.sa
6. BDS, TMD and orofacial pain resident at University at Buffalo, tamanak321@gmail.com

Abstract

Objectives: The study aimed to assess the impact of lower-level laser therapy delivered using an arch form tray to evaluate its impact on pain in orthodontic patients undergoing fixed orthodontic procedures in comparison to the control group which did not receive LLLT.

Methods This randomized controlled trial evaluated Pakistani patients undergoing fixed orthodontic treatment at Aga Khan Hospital for Women, Karachi, Pakistan. The study duration was six months. Participants attended routine orthodontic follow-up visits every three weeks, with a total of eight visits per patient. Randomization was performed and participants were subdivided into experimental group that received LLLT and control group that did not receive LLLT. Pain perception was also assessed. Data analysis was performed using SPSS. Repeated measures were analysed using the Friedman test, and

Results From 108 patients there were 54 participants in Group A (LLLT) and 54 in other group (non-LLLT). The mean age of participants was 22.24 ± 3.03 years. Statistically significant reduction in pain perception over time for all arch wires in the LLLT group ($p < 0.05$). Median pain scores were highest on Day 1 following arch wire placement and progressively decreased over the 7-day observation period for all wires. Further test demonstrated significant changes in pain perception over time for all arch wires ($p < 0.05$).

Conclusion When compared to traditional treatment alone, low-level laser therapy dramatically decreased the level of pain experienced throughout fixed orthodontic treatment. Patients receiving LLLT experienced a faster and more noticeable reduction in pain, especially in the initial phases after arch wire placement.

Keywords: Low level laser therapy, Pain perception, orthodontics

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Introduction

"Unpleasant sensory and emotional experience associated with actual or potential tissue damage" is how the International Association for the Study of Pain defined the word pain [1]. Pain is a common consequence arising due to orthodontic treatments, albeit its occurrence, intensity, and length may differ from one person to another and could make people consider stopping the treatment [2]. Nonsteroidal anti-inflammatory medicines are the most often utilized medications for orthodontic related management of pain [3], however they can negatively impact orthodontic tooth movement, induce gastrointestinal distress, and should not be administered to individuals allergic to them [4].

When a force is applied to the tooth during orthodontic therapy. The periodontal tissues and alveolar bone sustain the force delivered through an orthodontic bracket, which sets off a series of biological, vascular, and immunological reactions [5]. The receptors for pain get stimulated due to presence of localised inflammatory mediators that include prostaglandins and bradykinin. Constant pressure creates ischemia, which triggers an inflammatory reaction and causes the periodontal tissues to enlarge [6]. Inflammatory mediators are released when subjected to mechanical stress on the teeth, generating an inflammatory response in the periodontal tissue [7]. According to earlier research, an increase in the level of prostaglandin-E2 levels has been associated with the intensity of pain, whereas an

increase in interleukin-1 has been linked to discomfort that develops 24 hours after orthodontic force applied [8]. Numerous techniques, including the use of anti-inflammatory drugs [9], treatment with acupuncture [10], and low-level laser treatments (LLLT) [11], have been considered to reduce the discomfort caused by pain during tooth movement; however, it has been observed that the rate of movement of teeth may be impacted by use of nonsteroidal anti-inflammatory drug (NSAID) [8,12]. On the other hand, LLLT is non-invasive, simple to apply, and has fewer side effects, and has been used as a modality to reduce the incidence of orthodontic discomfort. LLLT has demonstrated biological stimulating and non-thermal impacts; the device's energy output is quite low to not surpass an irradiated tissue temperature more than 36.5 degrees Celsius [13]. Initial studies using LLLT demonstrated that laser irradiation could stimulate cell metabolic processes and local microcirculation, [9–12], in addition to suppressing pain. Several case studies have shown that LLLT speeds up tissue repair and has analgesic and anti-inflammatory benefits [14].

Due to the increasing need for orthodontic treatment, LLLT has recently emerged as an effective approach for pain reduction [14]. The pain and discomfort associated with orthodontic procedures prompt numerous individuals to discontinue or delay the treatment [15]. Additionally, some individuals neglect maintaining proper dental hygiene due to discomfort [16]. Moreover, it was claimed that there weren't any significant variations in terms of gender or age with respect to pain [17]. Following an orthodontic procedure, it is common for individuals to experience discomfort and tenderness 24 hours following the placement of appliance; when the first arch wire was placed however that pain disappears away after a week or two [14, 16, 17]. Numerous authors have established a connection between the degrees of force applied on the teeth to the level of pain experienced by the individual [14]. Relatively few studies have investigated orthodontic patients' reactions to LLLT, most of them have determined that LLLT reduced the discomfort in individuals [14,18, 19]. Lim et al. found that orthodontic patients experienced less pain when teeth were exposed to LLLT (Class 3B gallium-arsenicaluminum diode) than when a placebo was utilized [18]. Similarly another study used helium-neon laser having for 30 seconds to irradiate the teeth with an orthodontic appliance, they observed that LLLT not only decreased the level of discomfort of patient but also prevented the onset of pain [19].

In Pakistan, none of the studies conducted so far had evaluated the impact of pain on orthodontic patients using LLLT. Hence this study evaluated the influence of lower-level laser therapy when delivered using arch form tray to identify its impact on pain in orthodontic patients undergoing fixed orthodontic procedures in comparison to the other group who were not subjected to LLLT.

Materials and Method

Study design, setting, and duration

This randomized controlled trial was conducted on Pakistani participants undergoing orthodontic treatment. The study was registered at ClinicalTrials.gov (NCT04230096). It was carried out at Aga Khan Hospital for Women, Karimabad, Aga Khan University Hospital, Karachi, Pakistan. The period of study was six months. Participants attended routine orthodontic follow-up visits every three weeks, with eight visits per patient. This research followed CONSORT guidelines (Figure 1).

Patient recruitment and selection

Patient recruitment was performed by a dental officer not involved in the study. Patients indicated for fixed orthodontic treatment were sent to the principal investigator for scaling, and restorative procedures if required, and subsequently referred to the orthodontist for appliance placement. Pain intensity was recorded using a standardized proforma from baseline to the 8th visit.

Pain assessment

Pain perception was assessed using the Numerical Rating Scale (NRS), where 0 designated no pain and 10 implied unbearable pain. Patients in both groups recorded their pain levels for seven days, starting two hours after force application. Pain recording was repeated every three weeks during activation of sequential arch wires. The same protocol was used for both groups to evaluate the effectiveness of LLLT in reducing orthodontic pain.

Ethical approval

Ethical approval was obtained from the Human Research and Ethics Committee, University of Sains Malaysia (USM/JEPeM/19080496), and from the hospital administration of Aga Khan Hospital for Women, Karimabad. Written consent was acquired from all participants.

Inclusion and exclusion criteria

Inclusion criteria included Pakistani patients aged 18–30 years with Class I mild crowding (2–4 mm) according to Little's Irregularity Index, healthy periodontium, fixed orthodontic treatment with conventional brackets, ability to understand English, and ovoid arch form compatible with the laser-assisted tray.

Exclusion criteria included use of medications affecting gingival or bone metabolism, systemic diseases, pregnancy, parafunctional habits, TMJ dysfunction, craniofacial deformities, impacted teeth (except third molars), multiple missing teeth, or poor periodontal health.

Withdrawal criteria

Participants were withdrawn from the study if they failed to comply with oral hygiene instructions, Missed scheduled follow-up visits. Participants withdrew due to personal reasons such as relocation,

financial constraints, or family circumstances Developed significant root resorption (score 3) detected during six-monthly radiographic evaluation

Protection of vulnerable participants

All participants were adults aged 18–30 years and were therefore considered capable of providing informed consent. Participation was entirely voluntary, and refusal to participate did not affect the standard of orthodontic care. No financial incentives were provided.

Sample size

Sample size estimation was performed using PS software (version 3.1.2). Based on previous studies, LLLT was expected to reduce pain scores by approximately 8 units over six months, with a standard deviation of 2.195. With a significance level of 5% and a power of 80%, and assuming a 20% dropout rate, a total sample size of 108 participants was calculated. Participants were equally divided into two groups, with 54 patients allocated to each group.

Randomization

Randomization was performed using computer-generated random numbers in Microsoft Excel 2013. Participants were allocated into groups:

- Experimental group: received LLLT
- Control group: did not receive LLLT

Each group initially consisted of 54 participants with equal gender distribution. Only Group A received LLLT applied to the anterior segment of the maxillary arch.

Orthodontic treatment protocol

All patients underwent scaling and polishing one week prior to bracket bonding. Fixed orthodontic appliances were placed using a standardized protocol. Initial alignment was achieved using sequential archwires: 0.014, 0.016, 0.017 × 0.025 NiTi, and 0.019 × 0.025 NiTi. Following completion of initial alignment, a 0.019 × 0.025 stainless steel arch wire was positioned for levelling and finishing. LLLT application commenced on the same day as bracket placement for patients in the experimental group and was repeated at every three-week visit.

Alginate impressions were obtained at baseline (T0) before retraction started, and then at every visit until T8. To guarantee precision and avoid distortion, impressions were poured right away. Dental casts were measured appropriately.

Laser specifications

A Gallium–Aluminium–Arsenide (Ga–Al–As) diode laser (Lasotronix, Poland) having a wavelength of 980 nm and power output of 200 mW was used in continuous wave mode. Laser delivery was performed using a laser-assisted whitening tray available in an arch form. Laser was applied to six anterior teeth, three on each side of the maxillary arch. Only the buccal aspect was irradiated in the experimental group.

Statistical analysis

Data analysis was performed using SPSS version 22 (Chicago, USA). The Shapiro–Wilk test was used to assess data normality. As pain scores were not normally distributed, non-parametric tests were applied. Repeated measures were studied using the Friedman test. Comparison of pain score between LLLT and non-LLLT group by Mann–Whitney test. A p-value of less than 0.05 was considered statistically significant.

The study was conducted in accordance with CONSORT guidelines as stated below.

CONSORT 2010 Flow Diagram

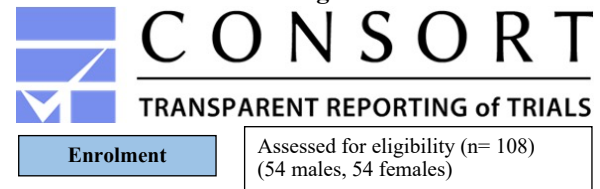


Figure 1: Consort guidelines

Results

The study comprised 108 patients in total, 54 of whom were with LLLT and 54 of whom were in non-LLLT. Participants' ages ranged from 18 to 30, with a mean age of 22.24 ± 3.03 years. Prior to treatment, every patient had Class I malocclusion with minor crowding (2–4 mm).

Table 1 demonstrated the pain perception in LLLT group. Friedman test analysis revealed statistically significant reduction in pain perception over time for all arch wires in the LLLT group ($p < 0.05$). Median pain scores were highest on Day 1 following arch wire placement and progressively decreased over the 7-day observation period for all wires. Pain scores reached zero by Day 6 or Day 7 for most arch wires, particularly during later stages of treatment using stainless steel wires. Pairwise comparisons showed significant differences between most consecutive days ($p < 0.05$). However, no significant differences were perceived between day 6 and day 7 across most arch wires, indicating stabilization and resolution of pain toward the end of the observation period.

Table 1 Pain perception in the LLLT group by the Friedman test

Wires	Day	Median (mm)	IQR	p
0.014 NiTi	Day 1	4.00	2	0.001*
	Day 2	2.00	1	
	Day 3	2.00	1	
	Day 4	2.00	1	
	Day 5	1.00	1	
	Day 6	0.00	0	

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

0.016 NiTi	Day 7	0.00	0	0.001*
	Day 1	3.00	1	
	Day 2	2.00	2	
	Day 3	1.00	1	
	Day 4	1.00	2	
	Day 5	0.00	1	
	Day 6	0.00	0	
0.017× 0.025 NiTi	Day 7	0.00	0	0.001*
	Day 1	2.00	0	
	Day 2	1.00	1	
	Day 3	1.00	1	
	Day 4	1.00	1	
	Day 5	0.00	0	
	Day 6	0.00	0	
0.019× 0.025 NiTi	Day 7	0.00	0	0.001*
	Day 1	3.00	2	
	Day 2	2.00	2	
	Day 3	1.00	2	
	Day 4	0.00	1	
	Day 5	0.00	1	
	Day 6	0.00	0	
0.019× 0.025 SS	Day 7	0.00	0	0.001*
	Day 1	2.00	2	
	Day 2	1.00	1	
	Day 3	1.00	1	
	Day 4	0.00	0	
	Day 5	0.00	0	
	Day 6	0.00	0	

IQR; Interquartile range, p; p-value, NiTi; nickel titanium, SS; stainless steel, *, significant difference (p<0.05)

Table 2 demonstrates pain perception in non-LLLT group. Friedman test results demonstrated significant changes in pain perception over time for all arch wires (p < 0.05). Unlike the LLLT group, median pain scores in the control group remained elevated throughout the 7-day period. Although a gradual reduction was observed, pain persisted until Day 7 for most arch wires, particularly during the early stages of treatment with NiTi wires. Pairwise comparisons revealed fewer non-significant differences compared to the LLLT group, indicating a slower and less pronounced reduction in pain over time.

Table 2 Pairwise comparison of different wires

Wires	Days	Z	p
0.014 NiTi	Day 1 vs Day 2	-4.185	0.001*
	Day 1 vs Day 3	-4.253	0.001*
	Day 2 vs Day 3		
	Day 4 vs Day 5		

0.016 NiTi	Day 1 vs Day 4	-4.299	0.001*
	Day 1 vs Day 5	-4.276	0.001*
	Day 1 vs Day 6	-4.226	0.001*
	Day 1 vs Day 7	-4.159	0.001*
	Day 2 vs Day 3	-3.900	0.001*
	Day 2 vs Day 4	-4.062	0.001*
	Day 2 vs Day 5	-4.285	0.001*
	Day 2 vs Day 6	-4.241	0.001*
	Day 2 vs Day 7	-3.956	0.001*
	Day 3 vs Day 4	-2.646	0.008*
	Day 3 vs Day 5	-4.400	0.001*
	Day 3 vs Day 6	-4.104	0.001*
	Day 3 vs Day 7	-3.714	0.001*
	Day 4 vs Day 5	-4.359	0.001*
	Day 4 vs Day 6	3.946	0.001*
	Day 4 vs Day 7	-3.376	0.001*
	Day 5 vs Day 6	-2.530	0.011*
	Day 5 vs Day 7	-2.044	0.041*
	Day 6 vs Day 7	-0.707	0.480
	Day 1 vs Day 2	-4.000	0.001*
	Day 1 vs Day 3	-4.460	0.001*
	Day 1 vs Day 4	-4.276	0.001*
	Day 1 vs Day 5	-4.299	0.001*
	Day 1 vs Day 6	-4.269	0.001*
	Day 1 vs Day 7	-4.184	0.001*
	Day 2 vs Day 3	-3.464	0.001*
	Day 2 vs Day 4	-3.782	0.001*

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

0.017× 0.025 NiTi	Day 2	vs	-4.093	0.001*	0.019× 0.025 NiTi	Day 3	vs	-3.827	0.001*
	Day 5					Day 7			
	Day 2	vs	-4.064	0.001*		Day 4	vs	-3.000	0.003*
	Day 6					Day 5			
	Day 2	vs	-3.919	0.001*		Day 4	vs	-3.464	0.001*
	Day 7					Day 6			
	Day 3	vs	-3.051	0.001*		Day 4	vs	-3.606	0.001*
	Day 4					Day 7			
	Day 3	vs	-4.234	0.001*		Day 5	vs	-1.732	0.083
	Day 5					Day 6			
	Day 3	vs	-4.148	0.001*		Day 5	vs	-2.000	0.046*
	Day 6					Day 7			
	Day 3	vs	-3.899	0.001*		Day 6	vs	-1.000	0.317
	Day 7					Day 7			
	Day 4	vs	-3.464	0.001*		Day 1	vs	-4.264	0.001*
	Day 5					Day 2			
	Day 4	vs	-3.578	0.001*		Day 1	vs	-4.308	0.001*
	Day 6					Day 3			
	Day 4	vs	-2.932	0.003*		Day 1	vs	-4.255	0.001*
	Day 7					Day 4			
	Day 5	vs	-2.646	0.008*		Day 1	vs	-4.237	0.001*
	Day 6					Day 5			
	Day 5	vs	-1.588	0.112		Day 1	vs	-4.237	0.001*
	Day 7					Day 6			
	Day 6	vs	0.000	1.000		Day 1	vs	-4.225	0.001*
	Day 7					Day 7			
	Day 1	vs	-4.123	0.001*		Day 2	vs	-4.000	0.001*
	Day 2					Day 3			
	Day 1	vs	-4.400	0.001*		Day 2	vs	-4.179	0.001*
	Day 3					Day 4			
	Day 1	vs	-4.320	0.001*		Day 2	vs	-4.093	0.001*
	Day 4					Day 5			
	Day 1	vs	-4.303	0.001*		Day 2	vs	-4.069	0.001*
	Day 5					Day 6			
	Day 1	vs	-4.319	0.001*		Day 2	vs	-4.064	0.001*
	Day 6					Day 7			
	Day 1	vs	-4.344	0.001*		Day 3	vs	-3.464	0.001*
	Day 7					Day 4			
	Day 2	vs	-3.000	0.003*		Day 3	vs	-3.827	0.001*
	Day 3					Day 5			
	Day 2	vs	-3.690	0.001*		Day 3	vs	-3.739	0.001*
	Day 4					Day 6			
	Day 2	vs	-3.862	0.001*		Day 3	vs	-3.710	0.001*
	Day 5					Day 7			
	Day 2	vs	-4.058	0.001*		Day 4	vs	-3.000	0.003*
	Day 6					Day 5			
	Day 2	vs	-4.167	0.001*		Day 4	vs	-2.972	0.003*
	Day 7					Day 6			
	Day 3	vs	-2.828	0.005*		Day 4	vs	-2.879	0.004*
	Day 4					Day 7			
	Day 3	vs	-3.494	0.001*		Day 5	vs	-1.732	0.083
	Day 5					Day 6			
	Day 3	vs	-3.704	0.001*		Day 5	vs	-2.449	0.014*
	Day 6					Day 7			

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

	Day 6 vs Day 7	-1.732	0.083
	Day 1 vs Day 2	-4.146	0.001*
	Day 1 vs Day 3	-4.308	0.001*
	Day 1 vs Day 4	-4.253	0.001*
	Day 1 vs Day 5	-4.246	0.001*
	Day 1 vs Day 6	-4.249	0.001*
	Day 1 vs Day 7	-4.249	0.001*
	Day 2 vs Day 3	-4.123	0.001*
	Day 2 vs Day 4	-3.963	0.001*
	Day 2 vs Day 5	-4.148	0.001*
	Day 2 vs Day 6	-4.132	0.001*
0.019× 0.025 SS	Day 2 vs Day 7	-4.132	0.001*
	Day 3 vs Day 4	-2.714	0.007*
	Day 3 vs Day 5	-3.357	0.001*
	Day 3 vs Day 6	-3.276	0.001*
	Day 3 vs Day 7	-3.276	0.001*
	Day 4 vs Day 5	-2.000	0.046*
	Day 4 vs Day 6	-2.236	0.025*
	Day 4 vs Day 7	-2.236	0.025*
	Day 5 vs Day 6	-1.000	0.317
	Day 5 vs Day 7	-1.000	0.317
	Day 6 vs Day 7	0.000	1.000

vs; versus, Z; z statistics, p; p-value, NiTi; nickel titanium, SS; stainless steel, *, significant difference (p<0.05)

The LLLT and Non-LLLT groups were compared in Table 3. There were statistically significant differences in pain perception between the LLLT and non-LLLT groups for all arch wires and nearly all time points (p < 0.05). From day 1 to day 7, the LLLT group's mean rank values consistently showed lower pain scores than the control group. LLLT was especially successful in lowering peak orthodontic

pain, as evidenced by the fact that this change was more noticeable in the first three days after arch wire installation.

Table 3 Comparison of pain score between LLLT and non-LLLT group by Mann-Whitney test

Wires	Days	Mean rank		Z	p
		Control (N = 54)	LLL T (N = 54)		
0.014 NiTi	Day 1	27.54	19.46	-2.083	0.037
	Day 2	31.11	15.89	-3.935	0.001*
	Day 3	32.76	14.24	-4.782	0.001*
	Day 4	32.65	14.35	-4.771	0.001*
	Day 5	34.11	12.89	-5.462	0.001*
	Day 6	34.09	12.91	-5.553	0.001*
	Day 7	32.78	14.22	-4.966	0.001*
	Day 1	29.04	17.96	-2.880	0.004*
	Day 2	30.28	16.72	-3.496	0.001*
	Day 3	31.17	15.83	-4.002	0.001*
	Day 4	31.37	15.83	-4.086	0.001*
	Day 5	31.41	15.59	-4.176	0.001*
	Day 6	32.41	14.59	-4.888	0.001*
	Day 7	31.09	15.91	-4.323	0.001*
0.017 ×	Day 1	30.39	16.61	-3.687	0.001*

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

0.025 NiTi	Day 2	31.63	15.37	-4.260	0.001*	Day 6	33.00	14.00	-5.400	0.001*
	Day 3	32.15	14.85	-4.525	0.001*	Day 7	32.50	14.50	-5.197	0.001*
	Day 4	32.30	14.70	-4.665	0.001*	NiTi; nickel titanium, SS; stainless steel, N; total number, LLLT; low level laser therapy, Z; z score, p; p-value, *; statistically significant (p < 0.05)				
	Day 5	32.54	14.46	-4.911	0.001*	Table 4 exhibited gender-based comparison. Comparison of pain scores between male and female participants showed no constant statistically significant differences with respect to the arch wires and across different time points (p > 0.05). Although in few instances significant differences were observed on particular days, these findings were inconsistent and not clinically relevant. Overall, gender did not significantly influence pain perception during orthodontic treatment.				
	Day 6	32.63	14.37	-5.190	0.001*	Table 4 Comparison of pain score between genders by Mann-Whitney test				
	Day 7	29.50	17.50	-3.951	0.001*					
	Day 1	27.39	19.61	-2.012	0.044*					
0.019 × 0.025 NiTi	Day 2	30.85	16.15	-3.839	0.001*					
	Day 3	31.74	15.26	-4.258	0.001*					
	Day 4	32.33	14.67	-4.606	0.001*					
	Day 5	33.48	13.52	-5.309	0.001*					
	Day 6	33.11	13.89	-5.250	0.001*					
	Day 7	33.50	13.50	-5.612	0.001*					
	Day 1	27.85	19.15	-2.276	0.001*					
0.019 × 0.025 SS	Day 2	32.11	14.89	-4.511	0.001*					
	Day 3	33.15	13.85	-5.028	0.001*					
	Day 4	33.57	13.43	-5.386	0.001*					
	Day 5	33.30	13.70	-5.436	0.001*					

Wires	Days	Mean rank		Z	p
		Male (N = 27)	Female (N = 27)		
0.014 NiTi	Day 1	21.24	25.76	-1.164	0.244
	Day 2	20.37	26.63	-1.619	0.105
	Day 3	20.07	26.93	-1.774	0.076
	Day 4	19.00	28.00	-2.346	0.019*
	Day 5	18.87	28.13	-2.384	0.017*
	Day 6	19.57	27.43	-2.064	0.039*
	Day 7	21.39	25.61	-1.128	0.259
0.016 NiTi	Day 1	20.28	26.72	-1.671	0.095
	Day 2	19.28	27.72	-2.174	0.030*

Effect of Low-Level Laser Therapy Using an Arch-Form Delivery Device on Pain Reduction in Orthodontic Patients

0.017 × 0.025 NiTi	Day 3	18.30	28.70	-2.710	0.007*	0.019 × 0.025 SS	Day 7	21.96	25.04	-0.866	0.386
	Day 4	18.61	28.39	-2.539	0.011*		Day 1	20.85	26.15	-1.388	0.165
	Day 5	18.50	28.50	-2.639	0.008*		Day 2	21.00	26.00	-1.310	0.190
	Day 6	19.52	27.48	-2.182	0.029*		Day 3	20.48	26.52	-1.574	0.115
	Day 7	20.72	26.28	-1.585	0.113		Day 4	21.37	25.63	-1.140	0.254
	Day 1	19.76	27.24	-2.000	0.045*		Day 5	21.93	25.07	-0.868	0.385
	Day 2	18.96	28.04	-2.381	0.017*		Day 6	22.59	24.41	-0.519	0.604
	Day 3	19.04	27.96	-2.331	0.020*		Day 7	22.80	24.20	-0.402	0.688
	Day 4	18.39	28.61	-2.707	0.007*		NiTi; nickel titanium, SS; stainless steel, N; total number, LLLT; low level laser therapy, Z; z score, p-value, *; statistically significant (p < 0.05)				
	Day 5	21.13	25.87	-1.287	0.198		Discussion				
0.019 × 0.025 NiTi	Day 6	21.70	25.30	-1.026	0.305	Due to inflammatory reactions in the periodontal ligament, pain is a frequent and anticipated adverse effect of orthodontic treatment, especially after arch wire insertion. With the emergence of a range of lasers with varying wavelengths in recent years, researchers supported the use of lasers for restorative, surgical, gingival, periodontal, and orthodontic treatments, among other dental operations [20, 21]. Although it has been demonstrated that the use of laser therapy advances the various dental modalities, domain of orthodontics has not employed the arch type of laser application. It takes meticulous research to demonstrate the effectiveness of lasers in various dental specialties within and between populations. Technically, the use of arch form device will ease laser application over a wide area needed. However, its efficacy not yet proven. Previously, laser was applied over a specific area that required more time.					
	Day 7	22.70	24.30	-0.530	0.596						
	Day 1	20.54	26.46	-1.529	0.126						
	Day 2	20.59	26.41	-1.522	0.128						
	Day 3	20.43	26.57	-1.584	0.113						
	Day 4	21.17	25.83	-1.214	0.225						
	Day 5	21.63	25.37	-0.995	0.320	In this study, participants with mild crowding 2-4 mm were selected in both groups. Adults are better at conveying their emotions than children [22]. The positioning of the teeth and the degree of crowding influence how much orthodontic force needs to be applied, particularly following orthodontic separator insertion or initial arch wire placement, as higher force					
	Day 6	21.83	25.17	-0.915	0.286						

may result in more pain [23]. Many previous studies' study designs did not consider the effects of the chosen age group and the level of crowding [24,25].

In line with numerous earlier research diode-based Ga-Al-As laser having a wavelength of 980 nm had been employed in this investigation [23, 26, [27]. Infrared radiation can penetrate deeper into the irradiated tissues due to its low absorption efficiency in water and hemoglobin, which may lead to issues in bone. Hence using adequate amount of laser energy is crucial for optimal results. Similar, to prior investigations by Almallah et al. and Owayda et al. who placed the separators [2,22] while studies by Qamruddin et al. and Domínguez et al. used it after the replacement of arch wires [4,28].

The results showed that the LLLT group's pain levels surged on the first day but quickly decreased over the next few days, with little to no pain reported by days six or seven. These finding are consistent with previous studies reporting that LLLT significantly reduces the intensity of pain as it generates various inflammatory mediators which comprises of prostaglandin E2 and bradykinin, thereby decreasing nociceptor stimulation [18, 21]. Similar verdicts had been shown by Jagla et al., and Tortamano et al., that reduction in pain following placement of orthodontic appliances [28, 14]. According to these findings, orthodontic patients can effectively manage their pain by continuing with LLLT treatments after a single session. A Ga-Al-As diode laser having a wavelength of 980 nm was employed in our investigation.

In contrast, patients in the non-LLLT group experienced prolonged pain that persisted throughout the observation period. This aligns with earlier research indicating that orthodontic pain typically peaks within 24 hours and may last up to one week without intervention [29-30]. However as in control group LLLT was not provided to the study participants, so pain was experienced by them, demonstrating beneficial role of LLLT in pain reduction.

The significant intergroup differences observed between different arch wires further confirmed the analgesic impact of LLLT on pain. Lim et al., Turhani et al., and Youssef et al. have reported findings that are comparable, showing less orthodontic pain after laser irradiation [18, 31, 32]. The early reduction in pain observed in this study suggests that LLLT is particularly effective during the initial inflammatory phase following force application. The use of an arch-form laser-assisted tray allowed simultaneous

irradiation of multiple teeth, making the procedure clinically feasible and time-efficient. The findings suggest that LLLT can be safely incorporated as an adjunctive therapy during orthodontic treatment to improve patient comfort and compliance.

The results of earlier research showing no significant correlation between gender and orthodontic pain experience are supported by the fact that gender did not consistently affect pain perception.

Despite the promising findings, this study has several drawbacks. A subjective self-reported scale was used to measure pain perception, which could be impacted by psychological variables and personal pain thresholds. Because of the nature of the intervention, participant blinding was not possible, which could have introduced a placebo effect. The results may not apply to full-arch orthodontic therapy because laser irradiation was restricted to the maxillary anterior portion. Furthermore, the analgesic effect of LLLT was not objectively supported by the assessment of biochemical indicators of inflammation.

Conclusion

When compared to traditional treatment alone, low-level laser therapy dramatically decreased the level of pain experienced throughout fixed orthodontic treatment. Patients receiving LLLT experienced a faster and more noticeable reduction in pain, especially in the initial phases after arch wire placement. The sense of pain was not significantly influenced by gender. LLLT seems to be a useful, non-invasive supplementary method for lowering orthodontic discomfort and enhancing patient comfort within the constraints of this study.

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