



# Low-level laser therapy for alleviation of pain from fixed orthodontic appliance therapy: A randomized controlled trial

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## Keywords

Fixed orthodontic appliance therapy, low level laser therapy, pain, soft lasers

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Received 12 December 2015;

Accepted 20 January 2016

doi: 10.15713/ins.jcri.103

## Abstract

**Background:** Pain as a result of tooth movement is a common clinical symptom for orthodontic patients. Pain increases after the placement of the first arch wire ranging from slight discomfort to throbbing pain. Pharmacological therapy may have undesirable side effects. Furthermore, it has been observed that use of non-steroidal anti-inflammatory drugs impedes tooth movement which is critical for any orthodontic treatment. For these reasons, there is high need of other non-pharmacological interventions to manage pain.

**Objective:** The study was designed to assess the efficacy of low-level laser therapy (LLLT) in alleviating pain from fixed orthodontic appliance therapy.

**Materials and Methods:** The study group comprised 30 subjects undergoing fixed orthodontic therapy. They were categorized into three groups with 10 subjects in each group as intervention (LLLT) group (IG) – received LLLT, placebo (blind) group (PG) – received simulated LLLT, and control group (CG). Pain was evaluated using a pain questionnaire at 1, 24, 48, and 72 h after LLLT.

**Results:** At 48 h statistically significant difference in pain score was noted between IG and CG ( $P = 0.001$ ) while IG and PG were insignificant ( $P = 0.088$ ). At 72 h statistically significant difference in pain score was noted between IG and PG (0.08); IG and CG were 0.001 while PG and CG were insignificant (0.915).

**Conclusion:** LLLT reduced the duration and intensity of the pain in patients undergoing fixed orthodontic therapy.

## Introduction

International Association for the Study of Pain taxonomy defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.” Pain is a subjective response and is dependent on innumerable factors such as age, gender, individual pain threshold, psychological condition, emotional status and stress, cultural differences, and previous pain experiences.<sup>[1,2]</sup> Dental procedures are often associated with pain and apprehension.<sup>[3,4]</sup> Orthodontic pain usually appears hours after the force is applied, spikes at around 12-36 h and slowly declines to the baseline value within 7 days.<sup>[1-3,5]</sup> Although patients desire orthodontic treatment, the pain accompanying the treatment procedures has a negative effect and often reduces patient acceptance and compliance, and is a key deterrent to

continuation of treatment.<sup>[1,4-6]</sup> However, tooth movement is possible only through the process of inflammation and pain is an inseparable part.

Of the several methods available to alleviate pain non-steroidal anti-inflammatory drugs (NSAIDs) have been commonly used. However, they come with a major drawback of hampering osteoclastic activity which reduces tooth movement rate. In addition, they can cause allergies, gastric ulcers and bleeding disorders. The alternatives employed for pain relief include vibratory stimulation, chewing gum, anesthetic gel, bite wafers, transcutaneous electrical nerve stimulation, and low level laser therapy (LLLT).<sup>[1,2,4]</sup>

LLLT displays a non-thermal and biomodulative effect on the respiratory chain system within mitochondria increasing the production of adenosine triphosphate (ATP), thus accelerating wound healing and orthodontic tooth movement. Ambiguity

exists about the exact mechanism of pain relief produced by LLLT. It has been postulated that LLLT modifies nerve conduction by affecting the production, discharge and metabolism of different neurochemicals, including endorphins and enkephalin. Pain relief has been linked to inhibition of nerve de-polarization (especially C fibers), reactivation of enzymes targeted at pain-inductive factors, production of ATPs and increasing the local blood flow and lastly reduction of prostaglandin levels E2 (PGE2) and inhibition of cyclooxygenase.<sup>[2,3,5]</sup> Optimum dose of LLLT also pilots the growth of new endothelium and vasculogenesis leading to faster healing.

A few studies have been conducted across globe to assess use of LLLT in patients undergoing orthodontic treatment and concluded that LLLT was beneficial form of alternative method.<sup>[1,7-10]</sup> However, such studies in Indian subcontinent are lacking.

In this backdrop, the present study was designed to assess LLLT in alleviating pain from fixed orthodontic appliance therapy among Indian population and to ascertain and utilize a method to provide pain relief and reduce morbidity in patients undergoing fixed orthodontic appliance therapy without any potential ill effects.

## Materials and Methods

The study group comprised 30 subjects of either gender in the age group of 16-25 years reporting to the Department of Oral Medicine and Radiology or enrolled for fixed orthodontic appliance therapy at the Department of Orthodontics and Dentofacial Orthopedics. The study was approved by Institutional Ethical Review Board.

The inclusion criteria were (1) subjects with malocclusion (Angle's Class 2 Division 1, Class 2 Division 2, Class 3, dental midline discrepancy, anterior cross bite, single tooth malposition, over jet, overbite) necessitating fixed orthodontic appliance therapy and enrolled for the same, and (2) subjects agreeing to the research procedures by signing the informed consent.

The subjects were excluded if they (1) were on pharmacological therapy with NSAID's for any medical condition, (2) were contraindicated in any way for undergoing LLLT, and (3) suffered with chronic pain disorders, or had a history/evidence of neurological and psychiatric disorders. The subjects were randomly assigned to any of the three groups.

Group 1: LLLT Group: 10 patients received fixed orthodontic appliance therapy and LLLT.

Group 2: Placebo group (PG): 10 patients received fixed orthodontic appliance therapy and simulated LLLT.

Group 3: Control group (CG): 10 patients received fixed orthodontic appliance therapy but no LLLT.

All patients received their fixed orthodontic appliance along with arch wire placed in one arch. LLLT was started immediately after placement of the first arch wire for the experimental group by one investigator with all due precautions. A gallium arsenide portable laser therapeutic system (Class 3B) with a wavelength of

904 nm (Prometheus-M, Manufacturers - Optical Technologies, Bulgaria) was used for the purpose.

The laser beam was applied to both the buccal and lingual mucosae overlying the root of each tooth with arch wire. Each area was irradiated with impulse power of 10 W and frequency of 60 Hz for 2 min using a 5 mm nozzle (that emits a 12 mm zone of irradiation) with contact method of irradiation. Patients were instructed not to take any analgesic drugs during the course of the study. The PG had LLLT procedure simulated in the patient's mouth without any laser output. The CG did not receive any LLLT.

Pain was evaluated in all three groups using a pain questionnaire at 1, 24, 48 and 72 h after LLLT. The questionnaire used by Tortamano *et al.* was modified and adopted with pain scales to be recorded at different intervals.<sup>[8]</sup> Data obtained were subjected to statistical analysis.

## Results

Behavior of pain studied after LLLT and comparison among the groups receiving LLLT. Table 1 showed that severe pain was experienced by LLLT subjects was on 1<sup>st</sup> day of arch wire placement while other group subjects had severe pain on the 2<sup>nd</sup> day. Pain experienced by LLLT group was for shorter duration of 3 days while others experienced pain for more than 7 days.

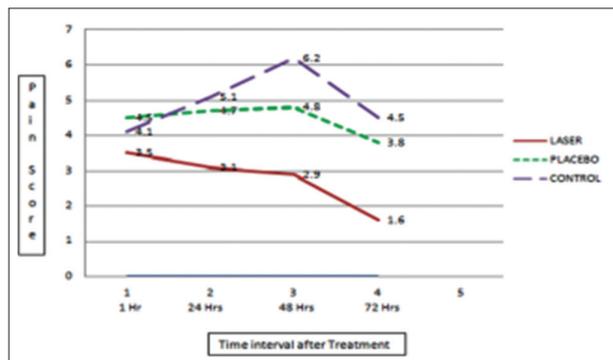
The mean pain scores for LLLT group were 3.5 at 1<sup>st</sup> h and 1.6 at 72 h which was far lesser than scores by other two group subjects [Table 2]. Mean pain scores of LLLT group was lesser than other two groups at all-time intervals followed by PG and CG, respectively [Figure 1].

**Table 1:** Severe pain experienced

Category	Severe pain experienced in 7 days after arch wire placement (in days)	Pain disappeared (in days)
Laser	1	3
Placebo	2	>7
Control	2	>7

**Table 2:** Mean pain scores among subjects of different groups

Category	Pain scores			
	1 h after RX	24 h after RX	48 h after RX	72 h after RX
Laser				
Mean	3.500	3.100	2.900	1.600
Standard deviation	1.4337	1.5951	2.3781	0.9661
Placebo				
Mean	4.500	4.700	4.800	3.800
Standard deviation	1.9003	1.2517	1.3984	1.6865
Control				
Mean	4.100	5.100	6.200	4.500
Standard deviation	2.0790	2.1833	1.6193	1.7159



**Figure 1:** Comparison of pain scores at different time intervals

**Table 3:** Multiple comparisons of groups (*post-hoc* with Bonferroni test)

Dependent variable	Category versus category	Mean difference	Standard error	95% confidence interval
1 h after RX	Laser Placebo	1.0000	0.8160	0.693
	Laser Control	0.6000	0.8160	1.000
	Placebo Control	0.4000	0.8160	1.000
24 h after RX	Laser Placebo	1.6000	0.7693	0.142
	Laser Control	2.0000*	0.7693	0.045
	Placebo Control	0.4000	0.7693	1.000
48 h after RX	Laser Placebo	1.9000	0.8260	0.088
	Laser Control	3.3000	0.8260	0.001*
	Placebo Control	1.4000	0.8260	0.305
72 h after RX	Laser Placebo	2.2000*	0.6694	0.008*
	Laser Control	2.9000*	0.6694	0.001*
	Placebo Control	0.7000	0.6694	0.915

\*Statistically significant  $P < 0.05$

Multiple comparisons among three groups obtained by *post-hoc* with Bonferroni test for 95% confidence interval depicted in Table 3 showed that statistically significant ( $P < 0.05$ ) difference was noted between LLLT and CG at 48 h, while at 72 h statistically significant ( $P < 0.05$ ) difference was noted between LLLT group and the other two groups.

**Discussion**

The percentage of orthodontic patients experiencing pain varies from 70% to 95% in literature.<sup>[3]</sup> Pain is attributed to orthodontic compression forces which lead to ischemia, inflammation, and edema in the periodontal tissues.<sup>[3,4]</sup> The immediate pain response is due to compression of periodontal ligament (PDL), and the delayed response is caused by PGs, histamine and substance P induced hyperalgesia of PDL.<sup>[3,6]</sup>

LLLT is defined as laser therapy with a low-energy output to keep the temperature of the treated tissue below 36.5°C or normal body temperature.<sup>[2]</sup> Also known as soft lasers, LLLT has gained popularity in recent years due to its distinctive advantages

in analgesia, bio-stimulation and no known adverse effects. The penetrative depth of LLLT is proved to be greater than visible laser and biostimulation of bone is a more effective.<sup>[9-11]</sup> The gallium-arsenide unit used in the present study had penetration depth of 30 mm. The laser irradiation was for 2 min each on lingual and buccal aspects of middle third region of roots of teeth with arch wire. Similar application at middle third region of root was performed by Lim *et al.*<sup>[7]</sup> However, it was only on buccal side with time duration of 15, 30 and 60 s, while in contrast, Tortamano *et al.* used application pattern where roots were irradiated at cervical, middle and apical thirds for 16 s each on either side.<sup>[8]</sup> In the present study, 2 min of irradiation on the middle third of each surface was performed based on the fact that minimum efficient laser application time is 2-3 min.<sup>[8]</sup> The middle third of root was irradiated as the laser nozzle tip used had an emission zone of 12 mm which is approximately the mean length of the human teeth roots.

As pain perception is very subjective, an age range of 16-25 years for study subjects was considered so that scoring recorded by them would be dependable. The provided questionnaire was a simplified pain scale to be recorded at designated time periods by the study participants.

This study intended to assess and analyze pain caused by the inflammatory process due to tooth movement in patients undergoing orthodontic treatment after placing the arch wire. Other associated factors, such as severity of crowding, and extraction/non-extraction, were not considered which may influence pain properties. The present study showed that maximum pain was experienced on the day of arch wire placement in LLLT group; while PG and CGs experienced it on the 2<sup>nd</sup> day. Furthermore, the duration of pain was shortened in the laser group wherein pain disappeared on 3<sup>rd</sup> day while the pain was experienced for more than a week by other groups. These findings are in accordance to previous studies, however, maximum pain experienced by LLLT group was on 2<sup>nd</sup> day.<sup>[8]</sup>

In the current study, pain was maximum in LLLT group on the day of arch wire placement, i.e., score of 3.5 at 1 h after laser treatment and gradually decreased to a pain score of 3.1 at 24 h and to 1.6 after 3 days. On the contrary PG had a maximum score of 4.8 after 48 h which gradually decreased to score of 3.8 after 3 days while CG had 6.2 after 48 h and 4.5 after 3 days. Pain experienced by the LLLT group on 2<sup>nd</sup> day was about 2.9 and was declining with time, while subjects in other groups experienced maximum pain. Bicakci *et al.*<sup>[12]</sup> observed no difference in pain perception at 5 min and 1 h of laser application while a significant reduction was noted at 24 h after application of laser. He also found that mean PGE2 levels were significantly elevated in CG, whereas a gradual decrease occurred in laser group.

The mean pain score of the LLLT group was lower than placebo and control at all-time intervals nevertheless, the difference was not statistical significant between the groups at 1 h and 24 h while at 48 h there was statically significant difference between LLLT and CG. After 3 days, there was statically significant difference between laser and control, and laser and placebo; while it was insignificant when compared between

placebo and control. Turhani *et al.* found contrasting results on assessing pain relief by single LLLT irradiation of banded teeth at 6, 30 and 54 h.<sup>[1]</sup> They found that patients reporting pain at 6 and 30 h were lower in laser group which was statistically significant and concluded that LLLT was effective in orthodontic pain management.

Overall the results solicit to conclude that LLLT can be accepted and used as a novel treatment modality and can be effectually employed for the alleviation of pain in an orthodontic therapy patient and improve the quality of treatment.

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**How to cite this article:** Deshpande P, Patil K, Mahima VG, Shivalinga BM, Suchetha M, Ranjan A. Low-level laser therapy for alleviation of pain from fixed orthodontic appliance therapy: A randomized controlled trial. *J Adv Clin Res Insights* 2016;3:43-46.