WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES
SJIF Impact Factor 7.421
Volume 8, Issue 4, 1170-1177 Research Article ISSN 2278 – 4357

# EFFECT OF LOW-LEVEL LASER THERAPY ON ORTHODONTIC TOOTH MOVEMENT

**Balram Choudhary[1], Himanshu Sharma*[2] and Pallavi Prakash[3]**

[1]Assistant Professor, Jawahar Lal Nehru Medical College, Ajmer, Rajasthan.

[2]BDS, MDS Senior Lecturer, Dept. of Conservative & Endodontics, Index Dental College, Indore.

[3]BDS, Om's Smile and Shine, Indore.

Article Received on
29 Jan. 2019,
Revised on 19 Feb. 2019,
Accepted on 12 March 2019
DOI: 10.20959/wjpps20194-13478

***Corresponding Author**
**Himanshu Sharma**
BDS, MDS Senior Lecture, Dept. of Conservative & Endodontics, Index Dental College, Indore.

## ABSTRACT

**AIM:** The aim of this clinical study was to evaluate the effect of low-level laser therapy (LLLT) on the rate of orthodontic tooth movement (OTM) and pain control. **Materials and Methods:** This study included 40 participants requiring extraction of all first premolars. Randomly selected split-mouth design was used. One side was irradiated with 810 nm diode laser (dose of 5.0 J/cm2) at 10 points for 10 s. Irradiation was performed just after loading canine retraction forces and on days 7th and 14th. Every 21st day, the force level of coil spring was adjusted, and LLLT protocol was repeated till retraction was complete. Measurements were recorded on study models to evaluate the rate of retraction. **Results:** Significant increase in OTM was observed on the side exposed to LLLT when compared to control side ($P < 0.05$). Statistically significant difference in pain perception was observed during first 2 days only between lased site and control site ($P < 0.05$). **Conclusion:** LLLT is a reliable tool for enhancing OTM and is effective in relieving pain at parameter settings and protocol used in this study.

## INTRODUCTION

Low-level lasers (LLL) refers to the use of red-beam or near-infrared lasers with a wavelength between 600 and 1000 nm power from 5 to 500 mW. In contrast, lasers used in surgery typically use 300 W.[1] These lasers are nonthermal. Although the exact mechanism of its effect is unknown, it is theorized that due to the low absorption by human skin the laser light can penetrate deeply into the tissues where it has a photobiostimulation effect.

The therapy performed with such lasers is often called “low‐level laser therapy” (LLLT) and the lasers are called “therapeutic lasers.” Light in infra‐red spectrum at specific wavelength penetrates the tissue and is absorbed where the light energy is converted into bio‐chemical energy, restoring normal cell function.[2]

Biologically, the orthodontic tooth movement (OTM) is a result of periodontal tissues remodeling in response to the applied mechanical force. The use of light forces is advocated to prevent bone necrosis or root resorption. This prolongs the duration of orthodontic treatment. Longer treatment duration is detrimental in terms of increased incidence of caries, root resorption, and reduced patient compliance.[3]

Although various articles are available in literature in which effect of LLLT on OTM has been evaluated, till date researchers believe that data pertaining to it are controversial and questionable. Recent systematic reviews have concluded that there is a lack of evidence regarding LLLTs effectiveness in accelerating OTM because of varying results shown by researchers. This disagreement among researchers may be due to varying laser attributes used in each study, i.e., laser type, method of application, wavelength, dose and exposure time as these parameters relate directly to laser clinical results. Hence, they have proposed that more studies with similar laser parameters should be carried out. To bridge this gap of knowledge, the present study was undertaken with an aim to evaluate the effect of LLLT on OTM and pain perception.[3-6]

## MATERIALS AND METHODS

The research proposal was approved by the Institutional Research Ethics Committee, and informed consent was obtained from all participants. A split‐mouth design was used to rule out biological variations. One side in each patient was exposed to LLLT, and it was labeled Group A whereas other side did not receive any LLLT exposure and was labeled Group B. 40 patients (32 males, 8 females, 16–24 years) diagnosed with dental Class I bimaxillary protrusion with no significant medical history requiring extraction of all first premolars for orthodontic management were selected for the study. None of the patients had crowding of more than 3 mm. Patients on medications such as long‐termn on steroidal anti‐inflammatory, bisphosphonates, hormone supplements, patient with poor periodontal health, dilacerated or impacted tooth, and pregnant females were excluded from the present study as these factors may interfere with normal OTM.

Patients were blinded for exposed and unexposed side. Full‐arch strap up was done using 0.018‐inch slot Rothbrackets in all the cases. In maxilla‐soldered Nance button and in mandible soldered lingual arch was cementedusing glass ionomer cement. First premolars of all the four quadrants were extracted, and leveling and alignment was carried out. The working archwire was 0.016‐inch stainless steel. Canines were ligated to working archwire using 0.01‐inch stainless steel ligatures. Three weeks after the insertion of working, archwire canine retraction was initiated using nickel–titanium (Ni‐Ti) closed‐coil spring (Ormco, Sybron Dental Specialities Inc., Newport Beach, CA, USA). Spring was attached to molar tube hook of first molar and power arm of canine bracket to deliver the retraction force of 150 g, which was measured using dynamometer.

Force level was evaluated and maintained by periodic recall once every 21 days till retraction of canines was complete. An infrared spectrum (810 nm wavelength) continuous wave of semiconductor diode aluminum‐gallium‐arsenide laser (Thera Laser, DMC, Sao Carlos, SP, Brazil) with irradiation area 0.4 cm2 was used for irradiation. The LLLT application was performed by one operator with an output power of 100 mW, dose of 5.0 J/cm2, and exposure time of 10 s.

To access pain, 100 mm visual analog scale was used. Patients were instructed to mark their pain level in a scale with 0 representing no pain and 100 representing severe pain. They were instructed to record pain level after 6 h, 24 h, and on day 2nd till the 7th day.

**Statistical analysis**

The collected data were compiled in a Microsoft Excel worksheet. Data were analyzed using SPSS version 18.0 software (SPSS Inc., Chicago, IL, USA). To assess intrainvestigator error, models of eight patients were remeasured 2 weeks after the first evaluations. An intrainvestigator reliability test to measure method error was conducted using Cronbach's alpha value.

Mean and standard deviation were calculated. The T1, T2, and T3 measurements were compared with paired samples *t*‐tests. $P < 0.05$ was considered statistically significant. Wilcoxon's signed‐rank test was done to study the differences in pain levels between the lased and control groups.

## RESULTS

In the present study, no difference in values was found for patient age or sex ($P > 0.05$). The data were equally distributed. Cronbach's alpha ranged from 0.83 to 0.87 demonstrating high reliability between measurementstaken 2 weeks apart. The mean age of the sample was 19.69 ± 1.40 years. The results of the paired samples *t*-tests for the comparison of the rate of canine retraction between Group A and Group B after 2 months, 4 months, and on completion of retraction are shown in Table 1. Highly significant difference was observed between site exposed to LLLT and control site ($P < 0.05$). In maxillary arch, rate of retraction after 2 months was 1.13 ± 0.13, after 4 months was 1.86 ± 0.36, and on completion was 1.92 ± 0.16 in Group A, whereas Group B demonstrated retraction rate of 0.86 ± 0.017, 0.92 ± 0.023, and 0.94 ± 0.014, respectively. In mandibular arch, rate of retraction after 2 months was 1.04 ± 0.33, after 4 months was 1.49 ± 0.27, and on completion was 1.63 ± 0.23 in Group A, whereas Group B demonstrated retraction rate of 0.79 ± 0.24,0.88 ± 0.12, and 0.92 ± 0.14, respectively. The results of the paired sample *t*-tests for the comparison of rate of canine retraction between maxilla and mandible on lased side are depicted in Table 2.Statistically significant difference was seen between them ($P < 0.0.5$).

The results of the paired samples *t*-tests for the comparison of the rate of canine retraction between maxilla and mandible on control side are shown in Table 3. Statistically significant difference was not seen between them ($P < 0.0.5$).

Statistically significant difference in pain perception was observed till the 2nd day between lased and control site ($P < 0.05$). From the 3rd daytill 7th day, no statistically significant difference in pain perception was recorded in the present study.

## DISCUSSION

Over recent years, photobiomodulation also referred to as LLLT has gained popularity among researchers for accelerating OTM and relieving pain. It has been proposed that biomodulating the effect of lasers is related to its ability to accelerate the cell metabolic alterations which in turn stimulating bone remodeling.[9-12] Studies in literature have used varying degree of wavelength to determine the effect of LLLT on OTM. Fujita used 830 nm and Gama *et al*. used 790 nm. These studies have shown conflicting findings. In our study, we used laser of 810 nm wavelength.

Sousa *et al*.[8] used continuous wave proposed that pulsed radiation is a better method of light delivery. In the present study, the continuous mode was used to study the effect of LLLT. Our study was a prospective blind study as patients did not know which side received laser exposure. A split‐mouth design was used to rule out biological variations.[13-16]

Biomodulatory effects of laser are based on Arndt–Schulz law. According to this law, a small dose of any substance/ drug has a stimulating effect, whereas higher dose is inhibitory. In our study, 5.0 J/cm2 of energy was applied. It is similar to the protocol used by Sousa *et al*. In the present study, we observed that total time required for canine retraction on lased site was 67% lesser than the time required on control site.[17]

In our study, we observed that the rate of retraction on lased side increased with time. Mean rate of retraction of 1.13 at T1 got increased to 1.92 at T3 in the maxillary region, whereas in the mandibular region, it increased from 1.04 at T1 to 1.63 at T3. Studies are available in literature which has shown opposite results. Dalaie *et al*. in their study found no significant difference in OTM between controlled and lased side. Our study compared the rate of retraction in maxilla to that of the mandible. No difference was observed on the control side whereas OTM was much rapid in maxilla as compared to mandible on the side exposed to laser. It is believed that such a difference may be due to the difference in bone densities as the laser has to stimulate deep‐rooted bone cells and periodontal ligament cells.

There are no effective clinically proven noninvasive, nonpharmacological methods used to relieve the pain caused by orthodontic treatment. Although some researchers believe that LLLT can effectively reduce the orthodontic pain, results are inconclusive till date. This gap in knowledge has been investigated in our study. Bjordal *et al* compared the analgesic effect of lasers with nonsteroidal anti‐inflammatory drugs and found results to be equivocal. in their study found no significant difference in pain perception between controlled and lased side. As per available literature, laser dose over 20 J/cm2 shows inhibitory action. To study the effect of LLLT on pain, we used dose of 5 J/cm$^2$.[17-19]

In the present study, VAS scale was used to analyze the effect of laser on pain perception. As er current literature, this is a reliable tool for such studies. In our study, we observed that difference in pain perception was significant till 2nd day.

It may be one of the reasons responsible for enhanced OTM and analgesic action postlaser exposure. Radiographs taken at regular intervals demonstrated no detrimental changes to periodontal structures. Although in the present study LLLT has shown promising results in terms of enhancing OTM and relieving pain, its limitations cannot be negated. The cost of the equipment and increased frequency of patient visit should always be considered.

Although numerous animal and humans studies have been carried out to determine the effect of LLLT on OTM, their results are conflicting. There is a need to carry out more studies with the rigorous design so that a standard LLLT protocol can be formulated.[20]

## CONCLUSION

LLLT is a reliable tool for enhancing OTM during retraction phase with no detrimental effect on periodontal tissues. Parameter settings and protocol used in the present study have shown promising results in terms of reduced treatment time. LLLT has an analgesic effect, but it is significant only during the first 2 days of activation of retraction force.

## REFERENCES

1. Uzuner FD, Darendeliler N. Dentoalveolar surgery techniques combined with orthodontic treatment: A literature review. Eur J Dent., 2013; 7: 257‑65.
2. Nishimura M, Chiba M, Ohashi T, Sato M, Shimizu Y, Igarashi K, *et al.* Periodontal tissue activation by vibration: Intermittent stimulation by resonance vibration accelerates experimental tooth movement in rats. Am J Orthod Dentofacial Orthop, 2008; 133: 572‑83.
3. Jawad MM, Husein A, Alam MK, Hassan R, Shaari R. Overview of non‑invasive factors (low level laser and low intensity pulsed ultrasound) accelerating tooth movement during orthodontic treatment. Lasers Med Sci., 2014; 29: 367‑72.
4. Davidovitch Z, Finkelson MD, Steigman S, Shanfeld JL, Montgomery PC, Korostoff E. Electric currents, bone remodeling, and orthodontic tooth movement. II. Increase in rate of tooth movement and periodontal cyclic nucleotide levels by combined force and electric current. Am J Orthod, 1980; 77: 33‑47.
5. Kale S, Kocadereli I, Atilla P, Asan E. Comparison of the effects of 1,25 dihydroxycholecalciferol and prostaglandin E2 on orthodontic tooth movement. Am J Orthod Dentofacial Orthop, 2004; 125: 607‑14.

6. Soma S, Iwamoto M, Higuchi Y, Kurisu K. Effects of continuous infusion of PTH on experimental tooth movement in rats. J Bone Miner Res., 1999; 14: 546‑54.
7. Hashimoto F, Kobayashi Y, Mataki S, Kobayashi K, Kato Y, Sakai H. Administration of osteocalcin accelerates orthodontic tooth movement induced by a closed coil spring in rats. Eur J Orthod, 2001; 23: 535‑45.
8. Sousa MV, Scanavini MA, Sannomiya EK, Velasco LG, Angelieri F. Influence of low‑level laser on the speed of orthodontic movement. Photomed Laser Surg, 2011; 29: 191‑6.
9. Doshi‑Mehta G, Bhad‑Patil WA. Efficacy of low‑intensity laser therapy in reducing treatment time and orthodontic pain: A clinical investigation. Am J Orthod Dentofacial Orthop, 2012; 141: 289‑97.
10. Hamajima S, Hiratsuka K, Kiyama‑Kishikawa M, Tagawa T, Kawahara M, Ohta M, *et al.* Effect of low‑level laser irradiation on osteoglycin gene expression in osteoblasts. Lasers Med Sci., 2003; 18: 78‑82.
11. Domínguez A, Gómez C, Palma JC. Effects of low‑level laser therapy on orthodontics: Rate of tooth movement, pain, and release of RANKL and OPG in GCF. Lasers Med Sci., 2015; 30: 915‑23.
12. Heravi F, Moradi A, Ahrari F. The effect of low level laser therapy on the rate of tooth movement and pain perception during canine retraction. Oral Health Dent Manag, 2014; 13: 183‑8.
13. Kim YD, Kim SS, Kim SJ, Kwon DW, Jeon ES, Son WS. Low‑level laser irradiation facilitates fibronectin and collagen type I turnover during tooth movement in rats. Lasers Med Sci., 2010; 25: 25‑31.
14. Coombe AR, Ho CT, Darendeliler MA, Hunter N, Philips JR, Chapple CC, *et al.* The effects of low level laser irradiation on osteoblastic cells. Clin Orthod Res., 2001; 4: 3‑14.
15. Seifi M, Shafeei HA, Daneshdoost S, Mir M. Effects of two types of low‑level laser wave lengths (850 and 630 nm) on the orthodontic tooth movements in rabbits. Lasers Med Sci., 2007; 22: 261‑4.
16. Kasai K, Chou MY, Yamaguchi M. Molecular effects of low‑energy laser irradiation during orthodontic tooth movement. Semin Orthod, 2015; 21: 203‑9.

17. Chung S, Milligan M, Gong SG. Photobiostimulation as a modality to accelerate orthodontic tooth movement. Semin Orthod, 2015; 21: 195‐202.
18. de Almeida VL, de Andrade Gois VL, Andrade RN, Cesar CP, de Albuquerque‐Junior RL, de Mello Rode S, *et al.* Efficiency of low‐level laser therapy within induced dental movement: A systematic review and meta‐analysis. J Photochem Photobiol B., 2016; 158: 258‐66.
19. Sousa MV, Pinzan A, Consolaro A, Henriques JF, de Freitas MR. Systematic literature review: Influence of low‐level laser on orthodontic movement and pain control in humans. Photomed Laser Surg, 2014; 32: 592‐9.
20. Antczak‐Bouckoms AA, Tulloch JF, Berkey CS. Split‐mouth and cross‐over designs in dental research. J Clin Periodontol, 1990; 17(7 Pt 1): 446‐53.