**Original Article**

# Evaluating the effect of low energy laser irradiation on the rate of mandibular molar protraction in orthodontic patients

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## ABSTRACT

**Background**: Low level laser is a type of laser with various bio stimulatory effects; Potential effects of laser in accelerating bone regeneration and consequently facilitating tooth movement have been considered widely in orthodontics.

**Aims & Objectives**: Aim of this study was to assess the effects of Low level laser on the velocity of mandibular first molar protraction in orthodontic patients.

**Materials and Methods**: Total 28 young adult patients (14 females and 14 males; age range 16-25) requiring extraction of mandibular second premolars were selected and molar protraction was carried out with T-loop on a rectangular Stainless Steel wire. In each patient one side was selected by random to irradiate with low level laser and other side with placebo. Laser regimen was applied at 0, 1 and 2 days and at the end of first, second and third months. Tooth movement was measured on prepared models at the end of first, second and third month.

**Results**: We found 1.3 fold increases in rate of tooth movement in the irradiated group (p=0.000) than non-irradiated group.

**Conclusion**: Based on our findings, Low level laser accelerates tooth movement and consequently reduces treatment time.

**Key word**: Low level laser; Tooth movement; First molar, Irradiation; Protraction

## INTRODUCTION

Laser is potentially one of the most interesting inventions in dentistry. From when laser came into existence by Maiman [1], dentistry had a special approach towards it and numerous studies have been conducted on its effect in this field. Low level laser is a type of laser with various bio stimulatory effects including: wound healing [2], pain control [3,4] and accelerating bone regeneration [5,6]. Meanwhile, potential effects of laser in accelerating bone regeneration and consequently facilitating tooth movement has been considered widely in orthodontics.
For the first time, Kawasaki & Shimizu [7] assessed the effect of low level laser therapy (LLLT) on the amount of tooth movement in rats. Their findings showed that LLLT engenders an increase in the amount of tooth movement. Nevertheless, Cruz et al [8] were the first group of researchers that assessed the effect of LLLT on tooth movement in human subjects and their findings were in agreement with Kawasaki & Shimizu [7]

Despite numerous studies on animals [6,9-12] and human subjects [3,5,13-16], the effect of LLLT on the rate of tooth movement is still a matter of controversy. Some authors have reported a significant increase in the rate of tooth movement [6-8,11,13,16], while others have found no such effect [5,9,15]. Meanwhile in an animal study, authors concluded that LLLT diminished the rate of tooth movement when compared to the control group [10].
As we know, one of the most challenging and unpredictable orthodontic tooth movements is mandibular molar protraction due to the root shape and high density of mandibular bone [17,18]. Mandibular molar protraction with conventional orthodontic methods leads to anterior teeth retraction or midline deviation; moreover this prolongs treatment time because the rate of molar

protraction is inversely related to the density or cortical thickness of the bone [17,19]. Albeit some positive effects have been reported on the effect of LLLT of the rate of tooth movement, most of them have been conducted on canine retraction subjects [3-5,14-16,18]; Hence, its effect on molar protraction has only been assessed in limited animal studies [9-12,21,22] .

Because of controversial findings regarding the effects of LLLT on the amount of tooth movement and the fact that no clinical studies have been conducted to assess the effects of LLLT on mandibular molars protraction, in the present study we decided to assess the effects of LLLT on the velocity of mandibular first molar protraction in orthodontically treated patients and compare them with controls

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## MATERIAL & METHOD

In order to assess the effect of low-level laser therapy (LLLT) on the velocity of mandibular first molars protraction in orthodontic patients, a split-mouth study was conducted. Ethical approval was obtained from medical university of Shiraz, Iran (ethical approval number CT-P-89-2251) and has therefore been performed in accordance with the ethical standards laid down in the 1964 declaration of Helsinki and its later amendments. Also this clinical trial was registered on Iran clinical trial data base registry with number IRCT2015030921406N1.

Total 28 young adult patients (14 females and 14 males; age range 16-25) from the private practice of a faculty member of orthodontics department of Shiraz dental school were invited to participate in this study. Informed consent was obtained from all individual participants included in the study. All patients met all the inclusion criteria for the study. The inclusion criteria were: 1- all patients had the same vertical growth pattern-normal pattern- which was verified by evaluating Jaraback index and sum of Bjork on their lateral cephalometric images (Jaraback index 65-70 % and sum of Bjork 390˚-400˚). 2- There was no missing tooth in the lower arch. 3- Based on treatment plane, every patient needed mandibular second premolar extraction on both sides to treat dental open bite or correct molar relationship. Patients with tooth missing, horizontal growth pattern, periodontal problem, skeletal cross bite, Para functional habit, history of long term medication with NSAID and any previous second premolar extraction were excluded.

Mandibular second premolar extraction was carried out on all the subjects of the study. 7 days after the extraction, a full arch orthodontic treatment was started by standard edge wise brackets with 0.018×0.025-inch slots (American Orthodontics, North America, Canada); leveling and alignment was then performed. In order to assume maxillary first molars as reference for measurement the amount of mandibular first molar protraction,if any extractions had been done in the maxillary arch, all spaces were closed prior to the commencement of mandibular molars protraction so we could consider maxillary arch consolidated and no movements had been occurred in maxillary teeth. We considered at least 3 months between premolars extraction and mandibular molars protraction.

### Molar protraction

After the completion of leveling and alignment phase of the treatment, mandibular first molars protraction was proceed by fabrication of a T-loop with 0.016×0.022-inch stainless-steel wire (American Orthodontics, north America, Canada). The T-loop had 10 mm width and 7 mm length with the loop taking 2 mm of the whole length of spring design. T-loop was placed 1-2 mm closer to anterior segment and a 30-degree gable bend was introduced on the anterior segment; also a tip back bend of 45˚ was introduced to the wire. Before the commencement of the protraction, the arch wire was left in situ for at least one month to become passive. At each appointment, T-loop was activated 1-1.5 mm.

### Laser irradiation

In this study, a continuous wave of Diode GaAlAs laser (DD2 laser, England) with wave length of 830 nm, output power of 100 mW, spectral area 0.09 cm2, power density 1.11 W/cm2, energy dose 2.3 J/point and energy density 25 J/cm2/site was used. Laser beam was delivered by a 0.6 $^{mm}$ diameter optical fiber. The irradiation method was according to Kawasaki & Shimizu [7] and Limpanichkul et al [15]. In every patient, laser side was selected randomly individually. Alveolar mucosa of mandibular first molars was irradiated by laser at various points; three points on buccal, three points on lingual and two points on mesial sides; each point being irradiated for 45 seconds. The end tip of laser probe was covered with a sheath and the laser was placed on both case and control sides. The patients and the orthodontist were blinded to the process of laser irradiation. An operator in charge of laser irradiation placed the probe on both sides, but only pressed for irradiation side that was selected randomly for each patient. For irradiating the same side on next appointments, the irradiated side for each patient was registered. After the first laser irradiation, patients were asked to return to repeat the irradiation for the next two days and this procedure was repeated at the end of first, second and third months of the trial.

**Measurement of molar protraction**

The amount of molar protraction was evaluated at the beginning of the mandibular first molar protraction and the end of first, second and third months. The reference points were mesiobuccal cusps of the upper and lower first molars. At the start of each session, an alginate impression of both jaws was prepared; also a wax bite was taken to verify the occlusion. A digital gauge (Anyi model 110-011, Guangxi, China) was used to measure the distance between the mesiobuccal cusps of the upper and lower first molars on both sides.

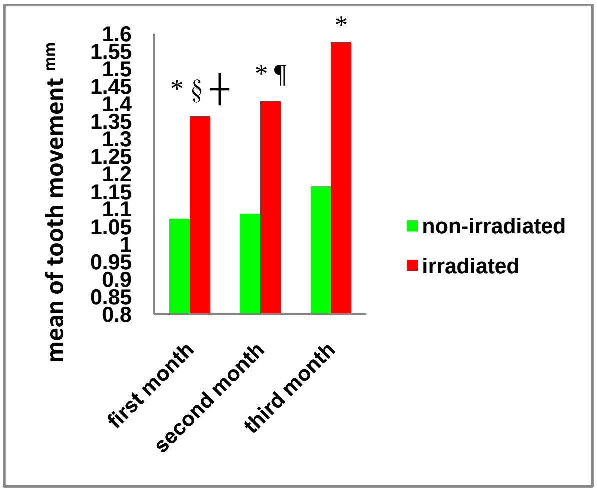
**Statistical analysis**

One-sample repeated measures ANOVA and Sidak tests were used to compare the mean tooth movement between the three time points in each group (within-group analysis). Comparison between case and control sides was done using paired *t*-test. SPSS version 17.0 (SPSS Inc, Chicago, IL, USA) was employed for statistical analysis. The significant level was considered to be α = 0.05.

## RESULTS

We found that in irradiated (laser) group, the rate of tooth movement was significantly higher than the control (non-irradiated) group (fig1); 1.3 fold increases in rate of tooth movement was shown in the irradiated group (p<0.001). Within-group analysis indicated that the mean tooth movement at the second month (1.41±0.17mm) and third month (1.57±0.21mm) were significantly greater than that of the first (1.36±0.29mm) in the irradiated group (both P<0.001). However, there was no significant difference between the second and third months of follow-up (P=0.308). Contrary to the irradiated group, tooth movement did not significantly change over time in control group (P=0.091).

**Fig 1: The mean of tooth movement in non-irradiated and irradiated group**




* : significant difference with non-irradiated group

§ : significant difference with second month in irradiated group

¶ :no significant difference with third month in irradiated group

┼ : significant difference with third month in irradiated group

The mean difference is significant at the .05 level.

**Table1: Mean tooth movement of irradiated and non-irradiated groups in first, second and third months**

| MONTH | irradiated | Non-irradiated | p |
|---|---|---|---|
| 1 | 1.36±0.29 * | 1.07±0.22** | < 0.001 |
| 2 | 1.41±0.17* | 1.08±0.22** | < 0.001 |
| 3 | 1.57±0.21¶ | 1.16±0.18 ** | < 0.001 |

*: significant differences,

**: significant differences

¶: no significant differences with first and second months in irradiated group.

Between-group comparisons revealed that the mean tooth movement in irradiated group was significantly greater that of control group for all time points (in all time points, P<0.001). The results of within- and between-group analyses are presented in Table 1.

## DISCUSSION

In this study we found that the rate of tooth movement in laser group was increased 1.3 fold when compared to the non-irradiated group; which means LLLT could accelerate the rate of tooth movement. Consequently it could diminish the duration of orthodontic treatment time. Our finding is in agreement with some animal studies [5,7,11,12,21,22] as well as human [3,8,14,21] studies. Kim et al [23] used pulsed mode of LLLT in dogs and reported 2.08 increases in the rate of tooth movement. They believed that pulsed mode has more bio-stimulatory effects but some researchers [5,7,8,14] have used continuous mode as effectively.

Most of these studies reported the same rate of increase in tooth movement in laser group as reported in our study [3,7,8,11,12]. The main difference of our study was the type of tooth movement. Most of studies have reported positive effect of LLLT on canine retraction [3,8,14,16] or maxillary molar protraction [7,11,12,21,22]. The effect of LLLT was evaluated in mandibular molar protraction has been evaluated in two animal studies [9,10] they found no significant differences between the laser and control group. Nevertheless they suggested further research need to be carried out on human subjects.

Despite compatible studies, some researches claimed that LLLT has no effect on the rate of tooth movement [9,10,15].

Limpanichkul et al [15] assessed the effect of LLLT on canine retraction in patients. Their finding showed no significant difference between laser and control groups. It was claimed that the laser energy or irradiation time could affect the results. In a split-mouth study Goulort et al [24] found that photo radiation at 5 J/cm$^3$ may accelerate tooth movement whereas higher doses at 35 J/cm$^3$ may decelerate it; that is in agreement with our study and some other studies [3,7,8,22]. However, the results of some studies [20,25] showed no significant effect on tooth movement acceleration after applying low energy density laser.

Seifi et al [10] conducted an animal study to evaluate the effect of 2 type of LLLTs on the rate of tooth movement. They found no significant differences among the two laser groups and observed a decrease in the rate of tooth movement when compared to the control group; however, they stipulated that no conclusion can be made regarding the effect of LLLT on the rate of tooth movement in human subjects because the amount of energy and the dosage are the two critical factors and what could be a high dosage for rabbits could be enough to accelerate the rate of movement in humans dosage that used for human could be high for rabbits and have negative effects.

Altan et al [25] evaluated the effect of LLLT on orthodontic tooth movement via metrical measurements and assessed the expressions of PGE2 and IL-1in gingival cervicular fluid. The study was conducted on 15 patients that underwent first premolar extractions and then canines were retracted to the extraction site. In this study, LLLT led to significant increase in tooth movement in some but not all patients. They claimed that some characteristics such as Para functional habits, premature occlusal contacts and differences in thickness or density of soft and hard tissue would be responsible for various responses to LLLT between patients.

## CONCLUSION

Despite controversial studies, our study was notable because of the type of tooth movement that was examined- mandibular first molar protraction which is one of most difficult and challenging types of tooth movement. Based on our findings, LLLT accelerates tooth movement and consequently reduces treatment time.

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