

**Effect of low-level laser therapy on rate of orthodontic tooth movement during Enmass retraction.**

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**Abstract**

The comprehensive orthodontic treatment is associated with long duration treatment duration,. In the past, many modalities have been proposed to reduce the treatment time. Low-level laser therapy is one such non-invasive modality, which has gained wide acceptance but the evidence regarding its potential acceleratory effect is contradictory. The present study aims to evaluate the outcomes of low-level laser irradiation on the rate of orthodontic tooth movement and pain perception during enmasse retraction.

**Material and Methods**

Fourty six patients requiring enmass retraction in 1st premolar extraction space were included in this longitudinal randomized clinical control trial.enmass. Using a split-mouth study design where one side was the experimental side canine was lased using a 810nm semiconductor diode laser operated at an output power of .1W in pulsed mode for 10 seconds

**Results**

The results indicate that the mean tooth movement on control side during first 35 days was .9478 +.22 mm while as experimental side the mean tooth movement was .5217 +.11,indicating that there was 44% decreased tooth movement on the experimental side.The mean Tooth movement on the control side was 0.9174+0.29 mm while as experimental group had .4804+0.105mm indicating there was 46% percent decreased tooth movement on experimental side

The pain score mean on control side on day one was 4.30+1.69 while as on experimental side was 4.304+1.69 The pain mean score on day 7 was 0.714+ 0.8 while as on control side it was 2.93+1.5

Hence from our experiment it was concluded that LLLT decreases the tooth movement and reduces the pain perception during enmass retraction.

The duration of comprehensive fixed orthodontic therapy, on an average, is about 20-30 months<sup>1</sup> . Fink and Smith in

their study to evaluate the mean treatment duration of fixed orthodontic therapy in six orthodontic offices reported that on average it takes around 23.1 months for the fixed orthodontic treatment to be completed. It was further reported that on average non-extraction cases take 21.95 months, two premolar extraction cases take 25.0 months, and four premolar extraction cases need around 26.18 months of treatment time<sup>2</sup>.

The prolonged treatment time associated with comprehensive fixed orthodontic treatment is of concern from both patient and the practitioner viewpoint because of the increased risk of white spot lesions, dental caries, periodontal problems, external apical root resorption (EARR) and decreased patient compliance.<sup>5</sup> The prolonged orthodontic treatment thus may leave the patient with various residual defects, which are commonly known as orthodontic scars.<sup>3</sup>

Improved Bio-mechanical systems have made it possible to explore the newer methods to accelerate the orthodontic movements<sup>4</sup> Low-level laser therapy (LLLT) therapy that has been gaining acceptance as a method to accelerate orthodontic tooth movement majorly because of its non-invasive nature.

The stimulatory effects of low-level laser therapy (LLLT) were first discovered in 1967 by a Hungarian physicist Dr. Endre Mester, when he first found that the lasers can be used for faster healing in a mice model<sup>5</sup> Low-level laser therapy (LLLT) by definition is a laser beam having such a low output that it does not increase the temperature of the irradiated tissue to more than 36.5°C or the normal body temperature.<sup>1</sup> Low-level lasers are also known as soft lasers, bio-stimulation lasers, cold lasers and laser acupuncture.<sup>6</sup> The use of LLLT has been documented in the literature from past four decades. It has gained wide acceptance and applications in the field of medicine<sup>7</sup>, physiotherapy<sup>8</sup>, veterinary<sup>9</sup> and dental practices<sup>10</sup>.

Kawasaki and Shimizu published the first report on the use of LLLT for accelerated orthodontic tooth movement<sup>11</sup> their findings showed that LLLT leads to faster tooth movement when orthodontic forces are applied. Cruz *et al* working on these prepositions conducted the first human study to evaluate the effect of LLLT on the rate of orthodontic tooth movement. They found that the tooth movement was around 30% faster with laser irradiation. This study introduced the orthodontic community, with the potential benefit of LLLT for accelerated orthodontic tooth movement.<sup>12</sup> Many studies concerning the effect of LLLT on orthodontic tooth movement revealed that it accelerates the orthodontic tooth movement and there is around 30%-50% reduction in the treatment time.<sup>1,12,13</sup> On the contrary, various studies have shown that there was no significant effect of the LLLT on the rate of orthodontic tooth movement and its ability to reduce the treatment time is questionable<sup>13</sup>. Furthermore, Kim *et al* in their study found that the LLLT retards the rate of orthodontic tooth movement when used on bone grafted alveolar defects in Beagle dogs.<sup>14</sup> Recent systemic reviews concerning the effect of LLLT on orthodontic movement have concluded that well designed randomized control trials (RCTs) to determine the best parameters and protocol of laser irradiation are the need of the hour to present clear recommendations regarding the use of LLLT in accelerated orthodontics.<sup>15</sup> The aim of the present study were to Evaluate the effect of low-level laser therapy on the rate of orthodontic tooth movement.

### Material and Methods

This double-blind longitudinal clinical control trial to investigate the effects of low-level laser therapy on the rate and the amount of orthodontic tooth movement was conducted on the patients reporting to the Department of Orthodontics and Dentofacial Orthopedics. The sample size for the study included 46 patients (17 males and 29

females) treated with comprehensive fixed mechanotherapy. The study design was approved by the ethical committee of Yenepoya University.

Table 1: Age and gender distribution of the study sample.

Total Number of Participants	Mean Age (Years)	Sex Distribution
46	19.06 ± 3.97	Males - 17
		Females - 29

#### Inclusion Criteria

The patients who met the following inclusion criteria were recruited for the study:

- Patients requiring en masse retraction in the extraction space of maxillary 1<sup>st</sup> premolar.
- A healthy periodontium with no visible signs of periodontal breakdown.
- No dilaceration of canine root as assessed on the pre-treatment OPG.
- No history of medical problems, which may interfere with the normal orthodontic tooth movement.

#### Exclusion Criteria

The following exclusion criteria were used to exclude the patients who were not deemed to be fit for the study:

- Patients with a history of long-term use of medications like NSAIDs and corticosteroids as these drugs interfere with the normal orthodontic tooth movement.
- Patients with presence of any occlusal interference, hindering the movement of canine.
- Patients with skeletal crossbite, one-sided chewing or presence of any para functional habit.
- Periodontally compromised patients were precluded, as the bone quality in such patients is poor, which may have an effect on the tooth movement.
- Patients with an excessive mobility of canine or 2<sup>nd</sup> premolar as they may provide false readings.

#### Determination of Sample Size

The sample size for the study was calculated on the basis of the results of a previous study using SPSS software for Windows (G\*POWER3.2.1). Using the values for the standard deviation and keeping the power of the study at 80%, the sample size of the study came out to be 45 patients per group. Keeping in mind, the possible loss of study sample 46 patients were selected.

#### Study design

The study was based on a prospective; double-blind longitudinal study design. A randomly allocated incomplete block split-mouth study design was used to eliminate the bias of individual variations among the patients.

All the patients enrolled in the study received the patient information sheet and were briefed by the investigator regarding the study. The participants of the study consented by signing the informed consent form in the presence of two witnesses.

In each patient, a full arch banding and bonding was done with Pre-adjusted edgewise McLaughlin Bennett Trevisi (MBT) brackets of 0.022" slot. The first molars were banded using custom made or the commercially available bands. All the patients were bonded using Transbond XT™ light cure adhesive (3M Unitek, California, USA) and curing was done using LED curing light (Woodpercker, India) with an emitted wavelength of 410 - 490 nm. Depending upon the severity of the malocclusion, sequential wire placement was done to reach 0.019" X 0.025" SS wire (3M Unitek, California, USA) as the main working arch wire in all the cases.

The anchorage requirement for each case was evaluated and all the patients received some or the other modality for horizontal anchorage control, depending on requirements of the case. Second molar banding, Nance

Palatal Button, Trans-palatal arch or a combination of both were used to prevent the mesialisation of the maxillary molar. Both the Nance Palatal Button and Transpalatal arch were made in a 20-gauge (0.9mm) stainless steel wire (Koden ,India) adapted on the models and soldered onto the molar bands

The first molars and 2<sup>nd</sup> premolars, on both the sides, were also consolidated using a 0.009” stainless-steel ligature to make them as a single anchorage unit

The en-masse retraction was initiated by applying a force of 200gm on both the experimental and control side. The force was applied by using a 12mm Nickel-Titanium closed coil spring (koden orthodontic ,india)fig;1 on both the sides. The spring was placed from the buccal tube of first molar band to the power arm of the canine bracket either using a 0.009” stainless steel ligature or directly onto the power arms such that the force level of 200gm was maintained The force levels were confirmed with the help of an orthodontic corex gauge (Dentaurum, Germany)fig2 The patients were asked to immediately report any dislodgement of the spring. In such cases, it was replaced within 24 hours period. The nickel-titanium coil spring was activated once every month. The wire and the spring were removed whenever the impression for the progress models was to be made. The wire and the spring were re-ligated in a similar fashion. This was done by a single operator who was blinded about the experimental and the control side.

### Randomization

A split-mouth approach was used for the study. One side of the arch was used as the experimental side and one side was used as the control. The randomization of the experimental and control side was done by software(R. A.S,Version 1.0, May 2004).All the patients were allotted a number in the sequence of their recruitment to the study.

This number was matched with the randomly generated sequence to assign the experimental and control side.

### Laser irradiation

The experimental side was exposed using a Gallium-Aluminum -Arsenide (GaAlAs) semiconductor diode laser (ZOLAR LASER GERMANY). The laser used in this study emitted infrared radiations at a wavelength of  $810 \pm 15\text{nm}$ . (table.2)

All the safety procedures for the operator and patient were followed during the laser irradiation. Both the patient and the operator wore protection glasses protecting them from radiation in the spectrum of 810-1400nm

The laser irradiation was started on the same day as that of the start of enmass retraction. The experimental side canines were irradiated with low-level laser on the 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup> and 15<sup>th</sup> day of the first month and subsequent irradiation's were done once every week

The laser irradiation was performed on 10 sites on the canine root so as to cover the maximum surface area. Five irradiation's were done on the buccal side of the root and five on the palatal side. On each side, two irradiation doses were given on apical third of the root (one on the medial side and one on the distal side), one irradiation was given on the middle third (center of the root), and two irradiation's were given on the cervical third of the root (one on the medial side and one on the distal side) . To prevent inter-operator variations, a single operator performed all the irradiation's.The total recruitment time for study was 67 days

The progress models were obtained at the start of enmass retraction, 35days after the start of enmass retraction, 67 days after start of enmasse retraction.. A line was marked on canine and 2nd premolar on both the sides through the long axis of the crown and passing through the cusp tip . The distance between the cusp tip of the maxillary canine and the buccal cusp tip of 2nd premolar was measured

using a Digital Vernier Caliper (kristeel Incorporation, USA) with an accuracy of  $\pm 0.02\text{mm}$ . The operator who performed the measurement was blinded about the credentials of the patient as well as the experimental and control side. Another operator repeated all the measurements in 10% of the sample to check the inter-operator variability of the measurements.

Table 2: laser parameters used

Wavelength	810 $\pm$ 15nm
Laser Type	Semi conductor diode Laser
Mode	Continuous, Biostimulation
Output Wattage	.2W
Time of application / site	10seconds
Energy Density	50J/cm <sup>2</sup> /site

### Results

The experimental group received laser irradiation from a 810nm gallium-aluminum-arsenide (GaAlAs) semiconductor diode laser, operated at an output power of .2W. The laser irradiation was done on 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup> and 15<sup>th</sup> day of the first month and subsequent irradiation's were done once every week. Progress models were used to appraise the variance in the amount and the rate of tooth movement between the experimental and the control side. The results (table.3) indicate that the mean tooth movement on control side during first 35 days was .9478 +.22 mm while as experimental side the mean tooth movement was .5217 +.11, indicating that there was 44% decreased tooth movement on the experimental side ,after 60 days of irradiation The mean Tooth movement on the control side was 0.9174+0.29 mm while as experimental group had .4804+0.105mm indicating there was 46% percent decrease.

Graph 1.Total tooth movement

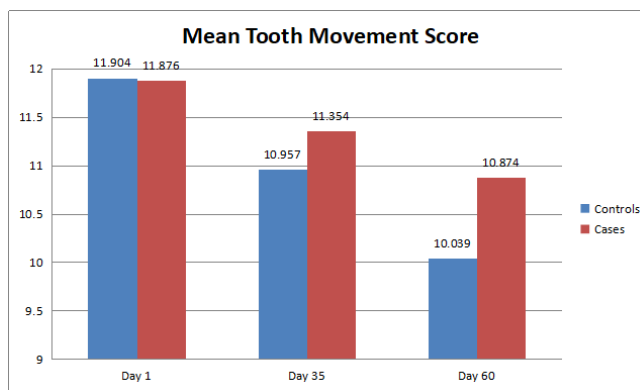


Table 3: Mean tooth movement

Pairs	Group	Mean	Std Deviation	Std Error	Student's t-test	p-value
T1-T0	Case	0.5217	$\pm 0.22795$	0.03361	-11.358	<0.001 (Sign.)
	Control	0.9478	$\pm 0.11302$	0.01666		
T2-T1	Case	0.4804	$\pm 0.10460$	0.01542	-9.352	<0.001 (Sign.)
	Control	0.9174	$\pm 0.29911$	0.04410		

### Discussion

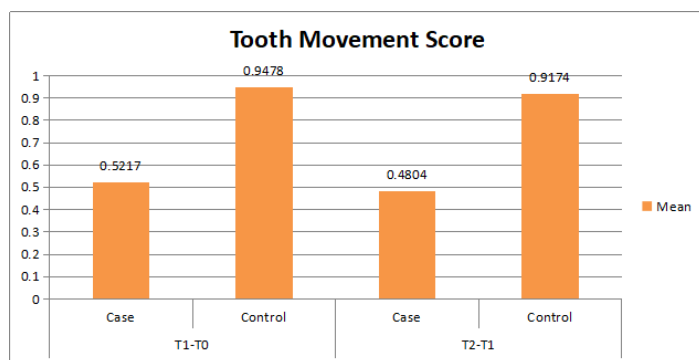
The results of the present study and some other studies like show that the decrease in tooth movement .the reason for decrease tooth movement can be either due to heat shock of macro and micro molecules as described by Coombe AR and co-workers (2001)<sup>16</sup>

The Arndt - Shultz law as stated by Kim et al which states “For every substance, small doses stimulate, moderate doses inhibit, large doses kill can be one of reasons which have to be evaluated<sup>17</sup>. The laser enegy used in this study is 50J/cm<sup>2</sup>/secwhich is highe than other studies like Mehta D et al (2012)810 nm-0.7mW- 08<sup>1</sup> joules,Marquezan et al (2013)-830 nm-100 mW-30 joules<sup>18</sup>. The high energy used in this case was obtained by not using a defocussing lens which has been used in the other studies.

Studies can be carried out at different energy levels to evaluate tooth movement response,evaluation of histological and bio-marker changes at differenet energy levels, .Further studies with complete histological examination and assessment of bio-markers are the need of the hour to elucidate the possible reason behind the

varying results obtained according to the stage of extraction socket healing. The consensus on the best-suited parameters is also required so that the low-level lasers can form a routine part of orthodontic treatment. High energy laser as a method to reinforce anchorage of can be evaluated.

Graph 2: Mean tooth movement



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