The Effect Of Low-Level Laser Therapy On The Rate Of Tooth Movement During Maxillary Canine Retraction. A Randomized Clinical Trial

Nada Nabil Mohamed Hasan(1), Dina Hussein El-Ghoul(2) and Noha Ezzat Sabet(3)

Abstract

**Aim of the study:** evaluation of the Low-Level Laser Therapy (LLLT) efficacy to accelerate maxillary canine retraction rate.

**Materials and Methods:** The sample consisted of 15 female patients (18-25 years old) with need to extraction of the maxillary first premolars and subsequent canine retraction. All patients were randomly allocated to either right side experimental (receive infrared radiation from a semiconductor diode laser with a wavelength of 910 nm) or control, the left sides were assigned to the alternative intervention. The low level laser was applied in first day, third day and after fourteen days of canine retraction and then on every two weeks until complete canine retraction on one side was achieved. Bilaterally, canine retraction was performed with closed-coil nickel-titanium springs that applied 150 g of force on each side. Laser and control sides were compared in canine movement rate, the amount of anchorage loss, maxillary canine tip, torque, rotation and root resorption, and maxillary first molar tip during canine retraction.

**Results:** Canine rates were statistically greater in the sides irradiated with laser. Anchorage loss was statistically less in Laser side. There was no difference in canine tip, torque and root length, and molar tip between two sides.

**Conclusions:** Low level laser therapy, with the described parameters, is considered as an effective method for accelerating orthodontic tooth movement without loading the anchor unit.

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Introduction

Orthodontic patients complain constantly about the prolonged duration of orthodontic treatment (1). The average duration required for fixed orthodontic treatment is 2 years. Increased duration usually accompanies side effects such as tooth root degeneration, gingival inflammation and tooth caries (2). Researchers have tried a lot of methods to increase the speed of orthodontic tooth movement (OTM) including cortical incisions around the teeth (3,4) and injection of chemicals around the teeth such as prostaglandins (5,6), vit D3 (7,8), osteocalcin (9), parathyroid hormone (10) and corticosteroids (11) that can accelerate the tooth movement by changing bone modeling and remodeling. Distraction osteogenesis is a surgical method which accelerates tooth movement by callus formation (12,13). Vibration (14), electric current (15) and electromagnetic fields (16) are other physical methods used to accelerate tooth movement. Though these methods have been reported to be successful, they have undesirable side effects (17). To decrease the orthodontic treatment time, it is important to stimulate the bone remodeling in tissues that surround the teeth. Recent studies have shown that acceleration of tooth movement and alveolar bone remodeling can be induced by low level laser therapy (LLLT) which is not invasive as surgical methods, easy and cheap. Low level laser machine is “a device that produce light by transforming electrical energy into optical energy” (18). This study was performed to investigate the low-level laser therapy ability to increase the rate of canine retraction.

Materials and Methods

15 adult female patients from the outpatient Orthodontic Department clinic in Faculty of Dentistry, Ain-Shams University with indication for maxillary first premolar extraction and canine retraction were included in this split-mouth trial. All the patients were randomly allocated to either right side experimental (receive laser application) or control groups, the left sides were assigned to the alternative intervention. Three patients were lost to follow up. After placement of fixed orthodontic appliance, leveling and alignment till 16x22 mil stainless steel arch wire, CBCT imaging and first premolar extraction, the maxillary first molar and the maxillary second premolar were designated as the anchorage teeth and then canine retraction was performed using NiTi coil spring between the canine bracket and molar band hooks delivering 150 gm of force. Semiconductor diode laser was applied with 2.5 watt for 30 seconds. Laser was applied only buccally at the middle third of the canine root in first day, third day and after fourteen days of canine retraction and then on every two weeks until complete canine retraction on one side was achieved (figure 1). Alginate impressions were made every 4 weeks to produce a series of dental models in order to assess the maxillary canine retraction rate. At the end of the trial another CBCT images were ordered. The outcomes were evaluated using the
ortho-analyzer software after scanning of the initial and sequential dental casts by 3-shape R-750 scanner in the digital orthodontic center at Ain-Shams University to produce three-dimensional (3D) digital dental models to detect rate of canine movement, anchorage loss and canine rotation in both sides. Also cone beam computed tomography for the maxillary arch was performed at the day of maxillary first premolars extraction and at the end of the trail to be able to detect changes of maxillary canine tip, torque, root length, and maxillary first molar tip in both sides.

![Figure 1: Laser application](image)

**Results**

In comparison with the nonirradiated side, there was a statistically significant greater orthodontic movement in the laser side from T1, T2, T3, T4 as well as T5 while from T6 and T7; no statistically significant difference between mean rate of canine movement in the two sides was present (table 1) (figure 2).

By comparing the mean molar anchorage loss measurements in the two sides, control side showed statistically significantly higher mean molar anchorage loss than laser side (table 2).

Regarding canine rotation angle, there was in both sides a statistically significant decrease in canine rotation angle measurement mean post-canine retraction and between mean changes in canine rotation angle measurements, there was no statistically significant difference in the two sides (table 3).

There was a decrease in mean maxillary canine tipping measurement post-canine retraction in both sides which was statistically significant and between mean changes in maxillary canine tipping measurements in the two sides, there was no statistically significant difference (table 4).

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**Table 1:** Wilcoxon signed-rank test for comparison between rate of canine movement in the two sides

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Laser</th>
<th>P-value</th>
<th>Effect size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (4 weeks)</td>
<td>0.84</td>
<td>0.49</td>
<td>1.43</td>
<td>0.58</td>
</tr>
<tr>
<td>T2 (8 weeks)</td>
<td>0.63</td>
<td>0.60</td>
<td>1.28</td>
<td>1.10</td>
</tr>
<tr>
<td>T3 (12 weeks)</td>
<td>0.63</td>
<td>0.44</td>
<td>0.99</td>
<td>0.43</td>
</tr>
<tr>
<td>T4 (16 weeks)</td>
<td>0.50</td>
<td>0.56</td>
<td>1.23</td>
<td>0.79</td>
</tr>
<tr>
<td>T5 (20 weeks)</td>
<td>0.48</td>
<td>0.38</td>
<td>1.03</td>
<td>0.63</td>
</tr>
<tr>
<td>T6 (24 weeks)</td>
<td>0.79</td>
<td>0.50</td>
<td>1.06</td>
<td>0.14</td>
</tr>
<tr>
<td>T7 (28 weeks)</td>
<td>0.37</td>
<td>0.37</td>
<td>1.03</td>
<td>0.05</td>
</tr>
</tbody>
</table>

**Figure 2:** Bar chart illustrating mean and standard deviation values for rate of canine movement in the two sides

![Figure 2](image)

**Table 2:** Wilcoxon signed-rank test for comparison between molar anchorage loss in the two sides

<table>
<thead>
<tr>
<th>Control</th>
<th>Laser</th>
<th>P-value</th>
<th>Effect size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean SD</td>
<td>Mean SD</td>
<td>0.050*</td>
<td>1.373</td>
</tr>
<tr>
<td>2.11</td>
<td>0.85</td>
<td>1.42</td>
<td>0.55</td>
</tr>
</tbody>
</table>

**Table 3:** ANOVA test for comparison between canine rotation angle measurements in the two sides and Wilcoxon signed-rank test for comparison between changes in the two sides

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Laser</th>
<th>P-value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-canine retraction</td>
<td>37.69</td>
<td>35.35</td>
<td>0.057</td>
<td>Partial Eta Squared = 0.292</td>
</tr>
<tr>
<td>Post-canine retraction</td>
<td>25.78</td>
<td>22.34</td>
<td>0.047*</td>
<td>Partial Eta Squared = 0.314</td>
</tr>
<tr>
<td>Change</td>
<td>-11.91</td>
<td>6.36</td>
<td>-11.78</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**Table 4:** ANOVA test for comparison between canine rotation angle measurements in the two sides and Wilcoxon signed-rank test for comparison between changes in the two sides
A statistically significant increase in both sides in mean maxillary first molar tipping measurements post-canine retraction and by comparing the 2 sides, between mean changes in maxillary first molar tipping measurements, there was no significant difference (table 5).

Table (5): Wilcoxon signed-rank test for comparison between maxillary first molar tipping measurements in the two sides and comparison between changes in the two sides.

<table>
<thead>
<tr>
<th>Time</th>
<th>Control Mean</th>
<th>Control SD</th>
<th>Laser Mean</th>
<th>Laser SD</th>
<th>P-value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-canine retraction</td>
<td>15.30</td>
<td>4.91</td>
<td>14.79</td>
<td>4.96</td>
<td>0.529</td>
<td>Partial Eta Squared = 0.017</td>
</tr>
<tr>
<td>Post-canine retraction</td>
<td>10.97</td>
<td>3.85</td>
<td>9.51</td>
<td>3.70</td>
<td>0.207</td>
<td>Partial Eta Squared = 0.140</td>
</tr>
<tr>
<td>Change</td>
<td>-4.34</td>
<td>4.22</td>
<td>-5.28</td>
<td>4.34</td>
<td>0.754</td>
<td>d = 0.182</td>
</tr>
</tbody>
</table>

There was a significant decrease in mean maxillary canine length measurement post-canine retraction but there was no significant difference between mean maxillary canine length measurements in the two sides (table 7).

Table (7): ANOVA test for comparison between maxillary canine length measurements in the two sides and Wilcoxon signed-rank test for comparison between changes in the two sides.

<table>
<thead>
<tr>
<th>Time</th>
<th>Control Mean</th>
<th>Control SD</th>
<th>Laser Mean</th>
<th>Laser SD</th>
<th>P-value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-canine retraction</td>
<td>27.07</td>
<td>2.17</td>
<td>27.65</td>
<td>1.93</td>
<td>0.216</td>
<td>Partial Eta Squared = 0.135</td>
</tr>
<tr>
<td>Post-canine retraction</td>
<td>26.39</td>
<td>2.16</td>
<td>26.50</td>
<td>1.84</td>
<td>0.284</td>
<td>Partial Eta Squared = 0.109</td>
</tr>
<tr>
<td>Change</td>
<td>-0.69</td>
<td>0.38</td>
<td>-0.74</td>
<td>0.75</td>
<td>0.814</td>
<td>d = 0.186</td>
</tr>
</tbody>
</table>

Discussion

Treatment time is a major concern of orthodontic patients which usually lasts for 1 to 2 years, and even more time is required for the extraction cases. Low level laser therapy is a physical approach aid to speed up tooth movement. For this reason, this trial was designed in the form of a split mouth trial to detect the canine retraction rate with and without soft laser application in patients requiring the retraction of maxillary canines following maxillary premolars extraction, which was considered as the primary outcome. The secondary outcomes of this trial were to detect the changes in tip, torque, rotation and root length of the maxillary canine, and the maxillary first molar anchorage loss and change in its tip during maxillary canine retraction on laser and control sides using digital dental models and CBCT measurements. Patients were selected from the Orthodontic Clinic at the Faculty of Dentistry Ain-Shams University.

Inclusion criteria of this study sample was adult patients to ensure having a full set of permanent teeth and to exclude any change which may occur in the dental arch due to growth. After diagnosis and treatment planning procedures, selected patients had fixed
appliances on. Leveling and alignment were done, reaching a rigid 16 x 22 mil stainless steel arch wire in order to be suitable for canine retraction using sliding mechanics. 16 x 22 mil stainless steel arch wire was considered as the best wire for canine retraction. In order to minimize the effect of friction, the working arch wire was engaged in the canine bracket using stainless steel ligature tie. The laser medium used in this study was Indium Gallium Arsenide (InGaAs) semi-conductor diode laser applied using a laser machine (biolase epic x console) having a wavelength of 940± 10 nm and functioning in a continuous mode. In our study laser application was applied at the first day of canine retraction, then on days 3, 7 and 14 and at 1 month, then every 2 weeks until complete canine retraction on one side was performed.

Every four weeks, an alginate impression was made to be able to measure the rate of the canine retraction. These impressions produced dental models representing the position of the canines and molars along the canine retraction period.

Three-dimensional (3D) digital dental models were obtained by scanning the initial and sequential dental models using 3-shape R-750 scanner. In this study.

The rate of canine movement on both the laser and control sides was assessed. in the side irradiated with laser there was a significant greater orthodontic movement compared to the nonirradiated side from T1, T2, T3, T4 as well as T5 while from T6 and T7; no difference between mean canine movement rate in the two sides was present. According to some studies(19,20&21) the soft laser promotes the singlet oxygen appearance, which increases the adenosine triphosphate (ATP) formation in the irradiated area(21).

Several secondary outcomes were assessed in this study such as molar anchorage loss. By comparing the mean molar anchorage loss measurements in the two sides, control side showed statistically significantly higher mean molar anchorage loss than laser side. In both sides; there was a significant decrease in canine rotation angle mean measurement post-canine retraction but there was no significant difference between mean changes in canine rotation angle measurements in the two sides. In both sides; a significant decrease in mean maxillary canine tipping measurement post-canine retraction was present indicating distal canine tipping but there was no significant difference between mean changes in maxillary canine tipping measurements in the two sides, a significant increase in mean maxillary canine torque measurement post-canine retraction was found indicating mesial molar tipping but no significant difference between mean changes in maxillary first molar tipping measurements in the two sides was found. A significant increase in mean maxillary canine torque
measurement post-canine retraction was found indicating the canine crown moved more buccally, while root moved more palatally but no statistically significant difference between mean changes in maxillary canine torque measurements in the two sides was found and there was a significant decrease in mean maxillary canine length measurement post-canine retraction but there was no significant difference between mean changes in maxillary canine length measurements in the two sides.

**Conclusion**

Low level laser therapy, with the parameters of this study, can be considered as an effective method for increasing canine retraction rate during the first five months of canine retraction without loading the anchor unit or affecting canine tip, torque and root length, and molar tip.

**References**


11- Ong CK1, Walsh LJ, Harbrow D, Taverne AA, Symons AL. Orthodontic


