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

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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 the low-level laser therapy ability to increase the rate of canine retraction.

Materials and Methods

15 adult female patients from the out patients’ 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. Semi-conductor 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

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).

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

Time	Control		Laser		*P*-value	*Effect size (d)*
	Mean	SD	Mean	SD		
T1 (4 weeks)	0.84	0.49	1.43	0.58	0.023*	1.742
T2 (8 weeks)	0.63	0.60	1.28	1.10	0.006*	2.601
T3 (12 weeks)	0.63	0.44	0.99	0.43	0.008*	2.415
T4 (16 weeks)	0.50	0.56	1.23	0.79	0.017*	1.914
T5 (20 weeks)	0.48	0.38	1.03	0.63	0.028*	1.634
T6 (24 weeks)	0.79	0.50	1.06	0.14	0.465	0.431
T7 (28 weeks)	0.37	0.37	1.03	0.05	0.180	0.840

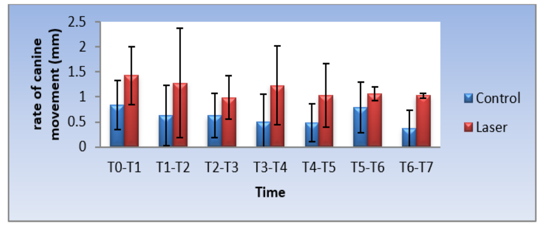

Figure 2: Bar chart illustrating mean and standard deviation values for rate of canine movement in the two sides

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

Control		Laser		*P*-value	*Effect size (d)*
Mean	SD	Mean	SD		
2.11	0.85	1.42	0.55	0.050*	1.373

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).

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

Time	Control		Laser		P-value	Effect size
	Mean	SD	Mean	SD		
Pre-canine retraction	37.69	4.35	34.13	6.69	0.057	Partial Eta Squared = 0.292
Post-canine retraction	25.78	6.37	22.34	6.15	0.047*	Partial Eta Squared = 0.314
Change	-11.91	6.36	-11.78	6.47	1.000	d =0.000

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).

Table (4): ANOVA test for comparison between maxillary canine tipping measurements in the two sides and Wilcoxon signed-rank test for comparison between changes in the two sides

Time	Control		Laser		P-value	Effect size
	Mean	SD	Mean	SD		
Pre-canine retraction	15.30	4.91	14.79	4.96	0.529	Partial Eta Squared = 0.037
Post-canine retraction	10.97	3.85	9.51	3.70	0.207	Partial Eta Squared = 0.140
Change	-4.34	4.22	-5.28	4.34	0.754	d =0.182

A statistically significant increase in both sides in mean maxillary first molar tipping measurement 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

Time	Control		Laser		P-value	Effect size
	Mean	SD	Mean	SD		
Pre-canine retraction	3.45	3.99	5.07	4.46	0.005*	2.818
Post-canine retraction	4.98	4.25	6.19	4.77	0.041*	1.457
Change	1.53	0.92	1.12	1.12	0.209	0.778

Table (6): Wilcoxon signed-rank test for comparison between maxillary canine torque measurements in the two sides and comparison between changes in the two sides

Time	Control		Laser		P-value	Effect size
	Mean	SD	Mean	SD		
Pre-canine retraction	14.79	3.20	8.87	5.06	0.012*	2.104
Post-canine retraction	20.30	5.03	13.49	6.33	0.004*	3.075
Change	5.51	3.08	4.62	5.33	0.209	0.778

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

Time	Control		Laser		P-value	Effect size
	Mean	SD	Mean	SD		
Pre-canine retraction	27.07	2.17	27.65	1.93	0.216	Partial Eta Squared = 0.135
Post-canine retraction	26.39	2.16	26.90	1.84	0.284	Partial Eta Squared = 0.103
Change	-0.69	0.38	-0.74	0.75	0.814	d =0.136

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 Orthodotic 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 first molar tipping 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.

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