Comparative evaluation of different modes of low-level laser therapy on the rate of maxillary canine retraction

Ramadan Y. Abu-Shahba

Department of Orthodontics, Faculty of Dental Medicine, Al-Azhar University – Egypt

Abstract:

Objective: The present randomized clinical study was conducted to compare the effect of continues versus pulsated low-level laser therapy on the rate of maxillary canine retraction.
Methods: The present study was conducted on 32 maxillary canines of 16 patients had an indication for retraction of maxillary canines using NiTi closed coil springs. The mean age of 21.3 ± 2.25 years. Patients were randomly divided into two main groups according to the mode of application of low-level laser therapy. The amount of canine retraction was assessed via analysis of study models following 3D cast scanning.
Results: The comparison showed non-statistically significant differences ($P > 0.05$), between both groups for all measurements.
Conclusion: With the irradiation parameters and protocol used in the current study, both continuous and pulsated modes of application of Low-level Laser Therapy, showed no significant difference on rate of maxillary canine retraction.

Introduction:

Acceleration of orthodontic tooth movement would be advantageous for both clinicians and orthodontic patients to minimize gingival inflammation, decalcification, dental caries, root resorption, and reduced patient compliance.

Many biostimulatory effects of low-level laser therapy (LLLT) have been reported, among which reduce pain and inflammation, accelerate wound healing and bone regeneration, prevent cell death and tissue damage, improve blood circulation, and accelerate orthodontic tooth movement.1-6.

Experimental studies compared the effects of pulsated mode versus continuous mode of LLLT in dental and orthodontic field.7-11

Patients and Methods:

The present study conducted at Orthodontic Outpatient Clinics, Faculty of Dental Medicine, Al-Azhar University. According to previous clinical studies, 12-14 a sample size calculation was undertaken with G*power version 3.1 statistical software, and the estimated sample needed to have adequate power to detect a difference is 16 patients, 8 in each group.

Inclusion criteria: 13, 15-17Age range from 16 to 25 years, Malocclusion that requires extraction of the maxillary first premolars, and Good oral hygiene and periodontal conditions.

Exclusion criteria: 14, 16, 18 systemic diseases and/or medications that could interfere with orthodontic tooth movement.

The research objectives were explained to the patients and/or their parents in details and an informed consent was signed by all patients and/or their parents before starting treatment. Patients were randomly divided (via the website http://www.random.org/lists/mode) into two main groups according to the mode of application of LLLT.

The maxillary canine retraction was initiated (after the maxillary first premolar extraction and completion of leveling and alignment) on both sides at the same time. The anchorage during maxillary canine retraction was through temporary anchorage devices that were utilized according to a standardized method19, 20. A closed coil spring* was attached directly from the mini-screw head to the maxillary canine hook to initiate the retraction. The force of 150 g which was adjusted by CORREX tension gauge**and activated every 28 days.20

The canines were irradiated by a Gallium Aluminum Arsenide (Ga/Al/As) semiconductor diode laser*** and the resultant energy applied by laser either in continuous or pulsating modes are equal.21 The laser regimen was applied as following: Immediately after the mechanical activation of the canine, 3, 7, 14, 21, and 28 days after the activation. Thereafter, on every 14th day until achievement of six months of maxillary canine retraction.

An impression with subsequent study model fabrication taken immediately before first mechanical activation of maxillary canine retraction (T0) and monthly during each activation visit until achievement of six months of maxillary canine retraction.14 The orthodontic models were scanned using a laser scanner***.

The scanned models were imported into Dolphin Software*****, Using the color matching for easy model identification. Points along the rugea area similar into the two models were selected19.

The difference between the canine displacement recorded at every specified time point and the initial canine position before the initiation of retraction was calculated. The measurements of 25 of 112 models randomly selected were repeated by the same operator for the measurement error testing.

Figure 1: the force of coil spring with CORREX gauge.

* Oromco, spain
** Correx gauge (Dentaurum)
*** Lasotronix, Piaseczno, poland.
**** Dolphin Imaging version 11.95.08.50 Premium.
**** Dolphin Imaging version 11.95.08.50 Premium.

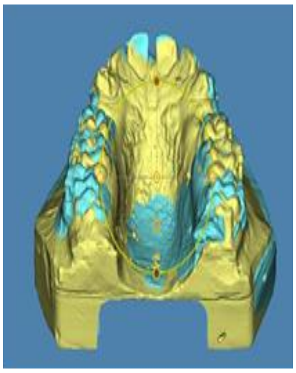

Figure 2: Superimposition of maxillary scanned models.

Results:

The patient's ages ranged 16 - 25 years with a mean age 21.3 ± 2.25 years. The results showed non-statistically significant differences (P>0.05), between the two groups in monthly amount of canine retraction in most measurements. On the other hand, the results showed statistically highly significant change (P<0.01) that was increased in the third month and difference between fourth and fifth month in continuous mode. Results showed statistically significant (P<0.05) increased in the second month in continuous mode.

Table (1): Comparison of changes in study model measurements (mm) at different intervals (per month) of maxillary canine retraction between continuous mode group and pulsated mode group using independent t-test and comparison within each group.

	Continuous Mode Group	Pulsated Mode Group	P-value
1st month	1.25 ± 0.16	1.06 ± 0.74	0.762
2nd month	1.60 ± 0.32	1.29 ± 0.21	0.036
Difference	0.35 ± 0.16	0.23 ± 0.76	0.668
3rd month	1.85 ± 0.05	1.79 ± 0.77	0.000
Difference	0.25 ± 0.37	0.50 ± 0.69	0.382
4th month	2.70 ± 0.53	2.80 ± 0.30	0.533
Difference	0.85 ± 0.59	1.01 ± 0.66	0.617
5th month	3.65 ± 0.05	2.50 ± 0.00	0.532
Difference	0.95 ± 0.48	-0.40 ± 0.15	0.000
6th month	3.10 ± 0.00	3.30 ± 0.62	0.158
Difference	0.55 ± 0.05	0.80 ± 0.62	0.274

P= Probability, Sig= Significant, SD= Standard deviation, P-value >0.05: Nonsignificant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS).

Discussion:

Regarding the effects of LLLT on the maxillary canine retraction, the results of the present study showed no significant difference in the extension of canine distal movement between both modes of application of laser compared groups at any time of the observation periods of the study. These findings are in agreement with the outcomes of Limpanichkul et al. 16, Shirazi et al.15, Ueda et al.18, Seifi et al.20, and Sonesson et al.17

In contrast to the current results, Duan et al.21 concluded that laser irradiation may fasten orthodontic tooth movement. They irradiated a canine tooth undergoing orthodontic tooth movement with diode laser with higher parameters than in the present study.

Kim et al. 13 and Yoshida et al.12 have preferred pulsed mode of LLLT. Yoshida et al.12 claimed that laser units functioning in pulsed mode show more bio-stimulatory response. However, the current findings failed to observe a significant difference between pulsed and continuous modes.

Conclusion:

1. Continuous and pulsated modes of application of LLLT, showed no significant clinical difference on rate of maxillary canine retraction.
2. Both modes of LLLT, showed a relatively similar pattern of tooth movement regarding the quantity of maxillary canine retraction at the end of the investigation period.
3. The clinical usefulness of both modes of LLLT must be considered in conjunction with the number of patient's follow-up visits, total treatment duration, and cost of treatment.

References:

1. Pavlin D, Anthony R, Raj V, Gakunga PT. Cyclic loading (vibration) accelerates tooth movement in orthodontic patients: a double-blind, randomized controlled trial. SeminOrthod 2015; 21:187-94.
2. 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.
3. Merli LA, Santos MT, Genovese WJ, Faloppa F. Effect of low-intensity laser irradiation on the process of bone repair. Photomed Laser Surg 2005; 23:212-15.
4. De Paula EC, de Freitas PM, Esteves-Oliveira M. Laser phototherapy in the treatment of periodontal disease. A review. Lasers Med Sci 2010;25:781-92.
5. Zahra SE, Elkasi AA, Eldin MS, Vandevska-Radunovic V. The effect of low-level laser therapy (LLLT) on bone remodeling after median diastema closure: a one year and half follow-up study. Orthod Waves 2009; 68:116-22.
6. Goulart CS, Nouer PR, Mouramartins L, Garbin IU, Lizarelli RD. Photoradiation and orthodontic movement: experimental study with canines. Photomed Laser Surg. 2006; 24:192-6.
7. Sousa MV, Scanavjnj MA, Sannomiya EK, Velasco LG, Angelieri F. Influence of low-level laser on the speed of orthodontic movement. Photomed LaserSurg2011; 29:191-6.
8. Doshj-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation. Am J

9. Braverman B, McCarthy RJ, Ivankovich AD, Forde DE, Overfield M, Bapna MS. Effect of helium-neon and infrared laser irradiation on wound healing in rabbits. Lasers Surg Med 1989;9:50–8.
10. Al-Watban FA, Zhang XY. The comparison of effects between pulsed and CW lasers on wound healing. J Clin Laser Med Surg 2004;22:15-8.
11. Kymplova J, Navratil L, Knizek J. Contribution of phototherapy to the treatment of episiotomies. J Clin Laser Med Surg 2003;21:35–9.
12. Yoshjda T, Yamaguchi M, Utsunomiya T, Kato M, Arai Y, Kaneda T, et al. Low-energy laser irradiation accelerates the velocity of tooth movement via stimulation of the alveolar bone remodeling. OrthodCraniofac Res 2009; 12:289-98.
13. Kim SJ, Paek JH, Park KH, Kang SG, Park YG. Laser-aided circumferential supracrestal fiberotomy and low-level laser therapy effects on relapse of rotated teeth in beagles. Angle orthod. 2010;80:385-90
14. Altan BA, Sokucu 0, Ozkut MM, Inan S. Metrical and histological investigation of the effects of low-level laser therapy on orthodontic tooth movement. Lasers Med Sci 2012; 27:131-40.
15. Shirazi M, Ahmad Akhoundi MS, Javadi E. The effects of diode laser (660nm) on the rate of tooth movements: an animal study. Lasers Med Sci 2015; 30:713-18.
16. Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofac Res 2006; 9:38-43.
17. Sonesson M, De Geer E, Subraian J, Petrén S. Efficacy of low-level laser therapy in accelerating tooth movement, preventing relapse and managing acute pain during orthodontic treatment in humans: a systematic review. BMC oral health. 2017;17:11.
18. Ueda Y, Shimizu N. Effects of pulse frequency of low-level laser therapy (LLLT) on bone nodule formation in rat calvarial cells. J Clin Laser Med Surg 2003;21:271–7.
19. SushkoBS, Lymans'kyiIuP,HuliarSO. Actionofthered and infrared electromagnetic waves of light-emitting diodes on the behavioral manifestation of somatic pain. FiziolZh 2007;53:51–60.
20. 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.