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Research Article

The Effect of Dual Diode Laser: (810,980) nm in Acceleration of Orthodontic Tooth Movement :A Case Report

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Abstract: Patients are very concerned about the lengthy nature of orthodontic treatment. It is necessary to find a non-invasive way to quicken physiologic tooth movement. This study's objective was to assess the effectiveness of low-intensity laser therapy in shortening the time and discomfort of orthodontic treatment. **Experimental work:** Using a split-mouth study to compare tooth movement with conventional treatment and laser-accelerated orthodontic tooth movement. A patient presenting with a class II division I malocclusion characterized by the misalignment of the upper and lower teeth as classified by Angle's molar classification system was indicated to undergo fixed orthodontic appliance orthodontic treatment. The treatment plan involved bilateral extraction of the upper first premolar teeth on both sides and distalization of the anterior segment to close the created space. For an experimental investigation, a patient was chosen at random and given right-side radiation using a dual diode laser (810,980 nm wavelength, 100 mW output power). **Results:** The tooth movement was measured over a period of 15 weeks; the first three orthodontic activations on the study side included scheduled laser treatment (the first month, laser-assisted treatment on days (0,3,7, and 14), the following two months, on days (0 and 14) from the day of orthodontic activation, and another 3 months of follow-up only); it was observed that orthodontic tooth movement was significantly higher in the study side than in the control side, as measured clinically using a digital vernier. We also noticed a considerable decrease in pain levels following a visual analog test. **Conclusion:** LLLT might clinically considerably speed orthodontic tooth movement and greatly lessen discomfort using the parameter settings employed in this investigation.

Keywords: bio-stimulation, low-level laser therapy, orthodontic tooth movements, and dual diode laser.

1. Introduction

The lengthy orthodontic treatment duration is one of the main issues that orthodontists and adult patients may encounter. Depending on the severity of the malocclusion and the patient, it may take adults an average of 2-3 years to finish the treatments (Ruan and Chen, 2018). This is a significant amount longer than the time needed for adolescents. The lengthy nature of orthodontic treatments is frequently thought to increase the likelihood of patient disengagement or decreased compliance. Furthermore, root resorption, gingivitis, and tooth decay are all risks that are exacerbated by lengthy orthodontic therapy (Kanzaki et al., 2002). The piezocision technique, corticotomy, photobiomodulation, low-level laser therapy, electric stimulation, pulsed electromagnetic fields, and mechanical and physical methods, among others, have all been the subject of numerous studies looking into ways to speed up orthodontic tooth movement (Yi J. et al., 2017), (Aplimova A. et al., 2020), (Mheissen et al., 2020), and (Kau C. H. et al., 2013).

In order to support the biomechanics of tooth movements, noninvasive low-level laser treatment (LLLT) has been implemented in an orthodontic clinic. When it comes to providing analgesic and anti-inflammatory benefits, LLLT might be viewed as an alternate strategy (Li FJ et al., 2015). Pain alleviation, tooth movement, and root resorption may all benefit from it. (Turhani et al., 2006, Youssef et al., 2008, and Altan et al., 2015).

It has been demonstrated that LLLT, when administered for the right amount of time and at the right intensity, accelerates the production of fibroblasts, osteoclasts, and osteoblasts, as well as angiogenesis and collagen synthesis (S. E. Zahra et al., 2009). Red or infrared light delivers free electrons to the mitochondria's electron transport chain at the molecular level to reduce oxidative stress and produce more Adenosine Triphosphate ATP (M. Greco et al.,1989). This series of events, in turn, activates growth-signaling pathways and stimulates a number of transcription factors (A. C. Chen,2011), increasing the overall amount of growth factors produced (T. I. Karu and S. F. Kolyakov,2005).

This prospective, randomized clinical trial's objective was to determine how low-level laser therapy affected the movement of teeth under Class II orthodontic appliances.

2. Methods

This case report was created as a component of a split-mouth study to investigate the effect of low-level laser therapy on tooth movement during Class II orthodontic treatment. Parents and patients signed informed permission forms after receiving thorough information about the potential dangers and advantages. Between April and October of 2022, the orthodontic department of Al-Karama Specialized Dental Center patients ‘data were collected, and the trial protocol was registered with the Al-Karkh Directorate of the Ministry of Health.

3. Diagnosis

A 13-year-old boy patient who needed orthodontic treatment was referred to the Alkarama Specialty Dental Center's orthodontics department.To confirm the need for orthodontic treatment, a history, radiographic, and clinical examination were first carried out. The patient's clinical and medical fitness, lack of medication use, and lack of prior orthodontic treatment were all discovered during the patient's history. Patients were evaluated radiographically to rule out any issues and to assess the health of their teeth and jaws. The patient was found to have Class II division 1 malocclusion during the clinical examination due to the protrusion of the maxilla, with an increased overjet of around 8 mm, and the patient was diagnosed with class ll division l malocclusion. The specifics of the treatment plan were disclosed to the parents. The Informed Consent Form (ICF) was then signed, and the low-power laser method was used to complete the treatment.

3.1 Treatment Protocol and Follow-Up:

A. Fixed orthodontic appliance:
Upper Roth brackets (Dentarum, Germany), and NiTi wires (Dentarum, Germany) in sizes (12, 14, 16, 18, and 16x22) for leveling and alignment were used to place a fixed orthodontic device for the upper arch.

B. Extractions:

After leveling and alignment, extraction of the upper first premolar was indicated for orthodontic correction necessity and then performed.

C. Canine distalization:

A heavy gauge wire 16x22 stainless wire was used and started retraction of the anterior segment from teeth (13-23) with a crimpable hook and mini-implants by using of power chain which is activated every 3 weeks. A force gauge was also used to measure the retraction force with 150 grams. (Youssef M. et al., 2008)

D. Study design*:*

There was a split-mouth design. The study side and control side were on the same person, with the study side being on the left and the control side being on the right. An 810,980 nm gallium-aluminum-arsenide (GaAlAs) diode laser was used to administer bio-stimulation to the study side, whereas the control group just received standard orthodontic retraction.

E. Laser irradiation and parameters:

QuickLase 810+980 nm (Canterbury, United Kingdom), a high-intensity laser, was used for the procedure. The fiber was cleaved following the treatment, and all precautions were followed to maintain an aseptic chain as well as care linked to the use of laser instruments, such as the use of safety glasses by the patient, operator, and assistant. The laser settings were 12 J (2x60sx100 mW)(Doshi G. et al.,2012) for each application. Each exposure point, alongside the canine root, three points buccally and three points palatally, distributed cervically, medially, and apically, received 2 J in continuous mode, transmitted by a 300 m optical fiber, with dual wavelengths of (810+980) nm in infrared emission for 20 seconds. To perform laser irradiation following orthodontic activation, a high-intensity diode laser was employed in contact mode with these six application points (Fig. 1) and (Fig. 2a,2b).

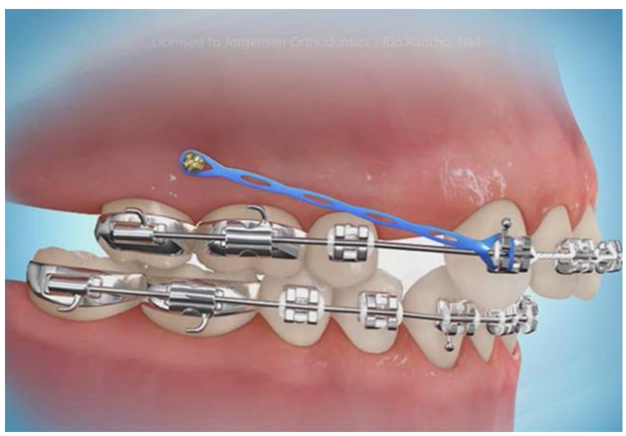


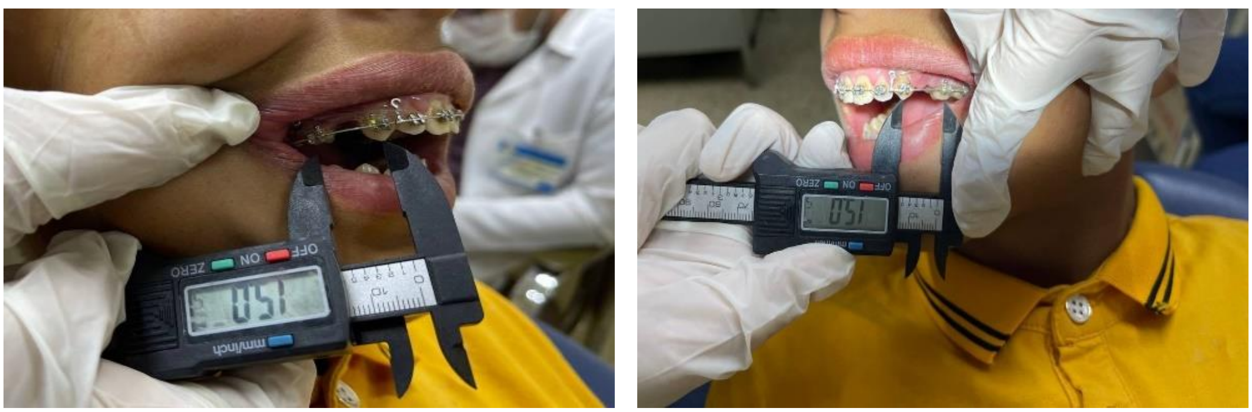
Fig. 1. Points of laser exposure along canine root (same positions buccally and palatally), 20 seconds at each point.

F. Treatment follow-up:

With a total number of 8 laser irradiation sessions, after the first orthodontic activation laser was applied on days (0,3,7,14). For the following two activations on the day (21,35) and (42,56). Measurements of extraction spaces were taken with each activation for 6 months using a digital caliper for both the study and control sides, Pain levels were also taken into account for both sides using VAS (Visual Analog Scale) for six months. Distance measurements between the cusp tip of the right and left canine and the buccal cusp of the maxillary 2nd premolar, they were considered reference points for the measurement of anterior segment movement. The distance between these two reference points was recorded every 21 days as shown in Fig. 3 (a and b). After 3 months of orthodontic activation accompanied by 8 sessions of LLL bio-stimulation, followed by 3 months of follow-up, the study side showed space closure more than the control side (Fig. 4) as shown in Table 1, the patient also experienced pain reduction for the study side as compared for the control side.

(a) **(b)**

Fig.2. Laser irradiation inside patient's mouth: (a) buccally, and (b) palatally.



(a) **(b)**

Fig.3. Distance measurement between the two reference points for: (a) left and (b) right side inside the patient's mouth.

Fig.4. Difference in extraction space closure between experimental and control group inside patient's mouth.

Table 1: Treatment progress for study and control sides (distance and pain level).

Time interval for orthodontic activation	Distance measurement for study side in mm	Pain levels for study side	Laser irradiation for study side	Distance measurement for control side in mm	Pain levels for the control side	Laser irradiation for the control side
Day 0	15	6	✓	15	7	×
Day 3	-	-	✓	-	-	×
Day 7	-	-	✓	-	-	×
Day 14	-	-	✓	-	-	×
Day 21	14.2	1	✓	14.8	3	×
Day 35	-	-	✓	-	-	×
Day 42	13.6	0	✓	13.8	2	×
Day 56	-	-	✓	-	-	×
Day 63	12.5	0	×	13.5	0	×
Day 84	9.3	0	×	12.02	0	×
Day 105	6.16	0	×	11.15	0	×

4. Discussion

The fact that orthodontic treatment takes a long time and is uncomfortable is one of the main obstacles that may influence patients' decisions regarding the treatment. Several strategies have been investigated to quicken the process; some of these include low-level laser therapy, vibrational therapy, corticotomy-assisted orthodontics, micro-osteoperforation, pharmaceutical interventions, and innovative orthodontic appliances. These accelerating tooth movement strategies produced satisfactory outcomes by increasing the number of osteoclasts and activating already existing osteoclasts to stimulate bone resorption (Diravidamani K. et al.,2012), low-level laser therapy was one of these methods. The advantage of using such laser irradiations rather than drugs or chemicals demonstrates that they have no adverse systemic effects on the body of the patient, nor pain or discomfort, unlike other methods. In the field of medicine, various circumstances, wavelengths, and energy densities have been used to study the interactions of low-level lasers (LLL) with bone components. (Genc G et al.,2013).

laser therapy bio-stimulation effect on the acceleration of orthodontic tooth movement and reducing pain was investigated in this case report using dual diode semiconductor (GaAlAs) laser (980,810) nm with (0.1 W) power, first month: 4 times (days 0, 3, 7, 14); starting from the second month: every 15 days 2. For 20 seconds, for each point. The rate of extraction space closure can be accelerated by biostimulation using an 810 nm diode laser, it was found. As a result, it has the potential to accelerate tooth mobility during orthodontic treatment. (Arumughan S et al.,2018).

Low-level laser (LLL) effects on several cells that are intimately associated with bone remodeling, particularly osteoblasts, have been examined in cytological studies (Amid R et al.,2014). These investigations show that LLLT could encourage differentiation then proliferation. According to animal research, LLLT might have a favorable effect on bone regeneration and quicken experimental tooth movement (Kawasaki K and Shimizu N,2000) (Yoshida T et al.,2009). In the present study, both the laser and non-laser sides had relatively low pain scores. In line with earlier studies (M. Harazaki and Y. Isshiki,1997) (P. Deshpande et al.,2016), the first day of coil activation was when the highest pain scores were recorded. The amount of pain between the experimental and control groups was significantly different. Studies showing the pain-relieving effects of LLLT (Almallah M. M. E. et al.,2020) (Qamruddin I et al.,2020) during canine retraction (Doshi-Meta G and Bhad-Patil W. A.,2012). Which gave similar findings to those obtained by this case report. Youssef et al. evaluated orthodontic pain, and pain levels were collected every 21 days after the placement of nickel-titanium closed-coil springs until full canine retraction. They reported significant reductions in pain scores during all phases of low-intensity laser therapy (Youssef M. et al., 2008).

Similar results were observed in our study on day 21, as shown in Table 1, with pain levels for the study group being significantly lower than those of the control group and pain duration for the study side being shorter than that of the control side for the duration of treatment because pain caused by inflammation may be relieved by low-level laser therapy (LLLT) because it lowers levels of prostaglandin E2 (PGE2), interleukin 1 (IL1), and tumor necrosis factor (TNF), as well as oxidative stress, edema, and neutrophil influx (Alikhani M. et al.,2015). Nonetheless, some researchers find no statistically significant difference in the discomfort caused by canine retraction (Limpanichkul W. et al., 2006; Heravi F. et al., 2014) (Heravi F. et al., 2014). The patient's discomfort reaction was measured using the visual analog scale. Furthermore, some researchers evaluated the rate of tooth movement when using LLLT, Doshi et al. used laser irradiation on the study side on Days 3, 7, and 14 of the first month to determine the rate of tooth movement when LLLT was applied. After that, on the 15th of every month until canine retraction is complete. Maxilla's Mean Tooth Movement Rate increased by an average of 4.5 months at the end of months in the laser group (Doshi G. et al.,2012). Similar results were obtained by this case report with a 4.99mm space difference recorded for the study side on day 105 as demonstrated by Table 1 and Fig. 4 and canine space was nearly closed. Heravi et al. used laser irradiation on Days 4, 7, 11, 15, and 28 in the first month after Activation and on Days 32, 25, 39, 43, and 56 in the second month, and after 56 days there was no difference between the laser group and the control group (Heravi F. et al.,2014). However, in our study, it was found by using the parameters employed that the rate of retraction was almost 58% greater on the study side while the control side was only closed by nearly 25% at the end of 105 days of follow-up there was nearly 5mm difference between both sides.

5. Conclusions

Due to its bio-stimulatory effects, which generated an elevated biological response in the periodontium next to the tooth, it was concluded that LLLT could be clinically useful in accelerating orthodontic tooth movement under the conditions of the current randomized controlled experiment. In order to understand the mechanisms underlying the biostimulation effects, determine the best laser settings, and identify any adverse effects, additional research examining various irradiation parameters, longer experimental times, and more frequent time points is required.

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دراسة أولية لليزر الثنائي: (980،810) نانومتر في تسريع حركة الأسنان التقويمية

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الخلاصة: يشعر المرضى بقلق بالغ إزاء طول مدة علاج تقويم الأسنان. من الضروري إيجاد طريقة غير جراحية لتسريع حركة الأسنان الفسيولوجية. كان الهدف من هذه الدراسة هو تقييم فعالية العلاج بالليزر منخفض الشدة في تقصير الوقت وعدم الراحة في علاج تقويم الأسنان. **العمل التجريبي:** باستخدام دراسة الفم المنقسم لمقارنة حركة الأسنان بالعلاج التقليدي وحركة الأسنان التقويمية المسرَّعة بالليزر، تمت الإشارة إلى مريض يعاني من سوء إطباق من الدرجة الثانية -الدرجة الأولى لعلاج تقويم الأسنان بجهاز تقويم الأسنان الثابت مع قلع ثنائي لأسنان الضاحك العلوية الأولى وبُعد الجزء الأمامي لإغلاق المسافة المتكونة. بحث عن تصميم الفم المنقسم لمريض سيتم قلع ضواحك العلوية الأولى منه. لإجراء تحقيق تجريبي ، تم اختيار المريض عشوائياً وإعطاء إشعاع الجانب الأيمن باستخدام ليزر ثنائي الصمام (طول موجي 810،980 نانومتر، طاقة 100 ميلي واط). **النتائج:** تم قياس حركة الأسنان على مدى 15 أسبوعًا. تضمنت التفعيلات الثلاثة الأولى لتقويم الأسنان في جانب الدراسة العلاج بالليزر المجدول (الشهر الأول، العلاج بمساعدة الليزر في الأيام (7،3،0 و 14) ، الشهرين التاليين ، في الأيام (0 و14) من اليوم لتفعيل تقويم الأسنان، و3 أشهر أخرى من المتابعة فقط)؛ كان أعلى بشكل ملحوظ في جانب الدراسة منه في جانب التحكم ، كما تم قياسه سريريًا باستخدام الورنية الرقمية. لاحظنا أيضًا انخفاضًا كبيرًا في مستويات الألم بعد اختبار Visual Analog Scale. **الخلاصة:** قد يسرع LLLT سريريًا حركة الأسنان التقويمية بشكل كبير ويقلل بشكل كبير من الألم باستخدام إعدادات المستخدمة في هذا التحقيق.