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ORIGINAL STUDY

Low-level Laser Effects on Orthodontic Tooth Movement of Periodontally Compromised Patients

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Abstract

Purpose: This study aimed to analyze the Low-Level Laser Therapy (LLLT) effect on periodontal parameters and the pain reduction during canine retraction in patients with compromised periodontium. **Subjects and methods:** Fourteen patients seeking orthodontic treatment, age ranging from 25 to 35 years old with compromised periodontium, were selected to participate in the present study. Patients were allocated randomly into two groups, Group I: control group. Group II: test group (LLL application). Bilateral extractions of the mandibular first premolars for all patients were done, then canine retraction was indicated. In laser group, application of LLLT was done on the mandibular anterior segment at 3, 7, 14, 28, 35, 42, and 56 days intervals from initiation of canine retraction. Periodontal parameters; namely Gingival Index (GI), Plaque Index (PI), Probing Pocket Depth (PPD) and Clinical Attachment levels (CAL) of mandibular six anterior teeth were assessed before and after full canine retraction. The pain was evaluated for each patient by using visual analog scale (VAS), during 1st week of canine retraction. **Results:** GI and PPD in the laser group were significantly reduced while results revealed that no significant difference between the two groups regarding PI and CAL. There was no significant difference between Laser and control groups when pain was assessed on day 1,2,4 and 7 respectively during the first week of canine retraction. **Conclusion:** Low-level laser irradiation has a remarkable effect on inflammation control during orthodontic treatment of patients with compromised periodontium and has no effect on pain associated with canine retraction.

Keywords: Canine retraction, Low-level laser therapy, Pain, Periodontitis

1. Introduction

Periodontitis is defined as an inflammatory disease of the supporting structures of the teeth. It is initiated by specific organisms or groups of specific organisms. It is associated with marked breakdown of the periodontal ligament and alveolar bone reduction with the deepening of the periodontal pocket, gingival recession or both [1]. Plaque is considered the main etiological factor of periodontal disease [2,3]. Therefore, any factor that allows plaque retention and hinders its adequate removal cause periodontal disease. The crowding of teeth creates inaccessible areas that make it difficult to maintain good oral hygiene [4]. Orthodontic treatment plays important role in periodontal therapy as it reduces plaque accumulation by correcting dental irregularities [5].

Orthodontic therapy is no longer a contraindication in adult patients with compromised periodontal support [6]. However, the orthodontist faces great challenges while treating those patients. One of those challenges is pain sensation which is considered one of the common complications associated with orthodontic treatment that lead to weakness in masticatory force and deterioration of oral hygiene [7]. Moreover, difficult control of gingival tissue inflammation that may lead to marginal bone loss,

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attachment loss, and gingival recession [8]. Thus, pain management and control of gingival inflammation play important role in the treatment of ortho-perio patients to ensure safe and efficient orthodontic tooth movement and reduce risks that might be associated with it.

Lasers as adjunctive therapy for nonsurgical periodontal therapy has been widely used in patients with chronic periodontitis [9,10]. Evidence proved the stimulatory effect of Low-Level Laser Therapy (LLLT) on fibroblast proliferation in addition to reducing the levels of inflammatory mediators [11,12]. It enhances the permeability of the blood vessels and promotes vasodilatation thus improving microcirculation [13]. Besides, it showed superior results in the inhibition of bacteremia and facilitate removal of subgingival calculus [14]. Previous studies have shown that LLLT has the ability to decrease the Gingival Index (GI), Plaque Index (PI), Probing Pocket Depth (PPD), and Clinical Attachment Level (CAL) [15–17].

LLLT showed palliative effects during orthodontic tooth movement. Although mechanisms that are responsible for pain reduction by LLLT still cannot be explained clearly. It was reported that LLLT has palliative and anti-inflammatory properties due to the fact that it increases local blood flow, and reduces levels of prostaglandin E2 and collagenase [18–20].

Several clinical trials were conducted to study the additional benefits of LLLT as an adjunctive therapy to Nonsurgical Periodontal Therapy (NSPT) and in controlling pain during orthodontic tooth movement with conflicting results [15,16,21,22]. In view of these results, it is worth exploring the effects of LLLT on pain and periodontal inflammation in patients with compromised periodontium.

2. Subject and methods

This study included 14 female patients seeking orthodontic treatment for the correction of crowded teeth. Patients were selected from the Orthodontic and Periodontology Clinics at Faculty of Dental Medicine for Girls, Al-Azhar University. The nature of the procedure was explained to each patient. A written informed consent was signed for each included participant who agreed to participate voluntarily prior to the commencement of that study. The research design was approved by the Ethics Committee, Faculty of Dentistry, Al-Azhar University with the final code (REC-OR-22-03).

Randomization was done using Randomize Software (Urbaniak, G. C., & Plous, S. (2013). Research Randomizer Version 4.0 Computer software. Retrieved on June 22, 2013, from *http://www.randomizer.org/*) by which patients were randomly allocated into two equal groups, 7 patients each; test group, (Laser group), and control group. Sample size was calculated using PASS 11(NCSS statistical software, Kaysville, Utah) with study power of 80%. Participants were examined to meet certain inclusion criteria. Those include, adult female patients with an age range from 25 to 35 year-old. Moreover, the presence of chronic periodontitis with pocket depth of mandibular anterior teeth did not exceed 5 mm before receiving nonsurgical periodontal therapy or/and pocket depth less than 4 mm after nonsurgical periodontal treatment. All Patients should be in need for first premolars extraction and canine retraction in at least the mandibular arch as an orthodontic treatment modality. Patients reported any systemic disease or under medical treatment that may interfere with bone metabolism were excluded.

All patients were examined clinically and diagnostic records were taken, including an Orthodontic examination sheet, extraoral, intraoral photographs, lateral cephalometric radiographs, and panoramic radiographs.

Banding and bonding for all the patients using conventional 0.022-inch Roth prescription brackets (Atlas Mini, Dynaflex, Missouri USA). The canine bracket was modified by welding an 8 mm power arm onto the bracket base to create a single-tooth power arm. Leveling and alignment of buccal segment were done while bypassing the mandibular incisors until reaching 0.017'x0.022'stainless steel wires. Temporary anchorage devices (Absoanchor TAD, Dentos inc., Taegu, Korea; 8 by 1.6 mm, self-drilling) were placed between roots of the second premolar and first molars in the mandible.

Patients were referred to the Oral and Maxillofacial Clinic, Faculty of Dental Medicine for Girls, Al-Azhar University where extraction of the first premolar was done and post-extraction instructions were given. The canine retraction was then started within 2 weeks.

The canine retraction force has been adjusted using a digital force gauge until it reached 150 g. by using memory power chain (Ormco®) for the canine retraction. It was extended between the Temporary Anchorage Devise (TAD) and the welded power arm of the canine brackets. During weekly visits, the power chain was replaced to ensure that constant force is delivered (Fig. 1).

2.1. Low-level laser application

LLL was applied using diode laser (810 nm). It was done at AL-Azhar Dental Laser Center. It was

Fig. 1. Intraoral photograph showing the force system and the mandibular buccal segment after full canine retraction.

applied on the labial vestibule of the mandibular anterior area using whitening handpiece. LLLT protocol was as follows output power 0.5 W with total energy 12 J and energy density (4.2 J/cm^2) in continuous power mode for 24 s [11]. All measures that ensure safety and protection during laser application were followed. Laser group was recalled for laser application on days 3, 7, 14, 28, 35, 42 and 56 days from the initiation of canine retraction.

The periodontal status of the patients was evaluated using Plaque Index, Gingival Index, Probing Pocket Depth measurements, and Clinical Attachment Level. The clinical measurements were obtained at the baseline, and at average 6 months interval, which is the end of the canine retraction phase. Visual Analogue Scale (VAS), for pain associated with canine retraction and patient satisfaction, was assessed during the first week of canine retraction on days 1, 2, 4, and 7.

3. Results

Periodontal parameters assessment were including Gingival Index (GI), Plaque Index(PI), Clinical Attachment Level(CAL) and Probing Pocket Depth(PPD) measurements for both groups; LLLT group and the control group. Regarding GI, at baseline there was no significant difference between both groups ($P = 0.839$). After canine retraction, the control group had a significantly higher value than the laser group ($P = 0.011$). The difference between intervals in the laser group was significantly higher than in the control group ($P = 0.016$).

Regarding PI, at baseline there was no significant difference between both groups. After canine retraction, there was no significant difference too between laser and control group ($P > 0.05$). Moreover, for CAL at the baseline and after canine retraction there were no significant difference between both, laser and control groups ($P > 0.05$). Regarding the PPD at baseline, there was no significant difference between both groups ($P = 0.282$). However, after canine retraction, the control group had a significant higher value than laser group ($P < 0.001$).The difference between intervals in the laser group was significantly higher than in the control group ($P < 0.001$). Mean and Standard Deviation (SD) values for clinical parameters in different groups (intergroup difference) were presented in (Table 1).

3.1. Pain (VAS) scores

Intergroup comparison of pain at different intervals showed that there was no significant difference between both groups ($P > 0.05$). However, the Intragroup comparison for both groups revealed that there was a significant difference between the

Table 1. Intergroup comparisons of different clinical parameters.

Parameter	Time	(Mean ± SD)		Statistic	*P* value
		Control	Laser		
GI	**Baseline**	2.50 ± 0.50	2.57 ± 0.35	26.50	0.839ns
	After canine retraction	1.50 ± 0.41	0.50 ± 0.58	44.50	0.011*
	Difference	1.00 ± 0.71	2.07 ± 0.53	43.50	0.016*
PI	**Baseline**	1.71 ± 0.39	1.79 ± 0.27	26.00	0.884ns
	After canine retraction	0.43 ± 0.53	0.71 ± 0.57	31.50	0.367ns
	Difference	1.29 ± 0.39	1.07 ± 0.53	31.50	0.372ns
CAL	**Baseline**	1.43 ± 0.53	1.21 ± 0.76	0.61	0.552ns
	After canine retraction	0.93 ± 0.61	0.50 ± 0.76	1.16	0.268ns
	Difference	0.50 ± 0.41	0.71 ± 0.57	0.81	0.443ns
PPD	**Baseline**	3.36 ± 0.20	3.27 ± 0.07	1.13	0.282ns
	After canine retraction	3.00 ± 0.20	2.36 ± 0.18	7.52	<0.001*
	Difference	0.19 ± 0.05	0.91 ± 0.18	12.19	<0.001*

*Significant (P£0.05) ns; non-significant ($P > 0.05$).

Table 2. Intergroup comparisons of post-operative pain.

Time	VAS (Mean ± SD)			
	Control	Laser	U-value	*P* value
Day 1	7.00 ± 2.00	4.57 ± 2.23	39.00	0.064ns
Day 2	6.14 ± 2.79	3.86 ± 2.48	36.00	0.153ns
Day 4	4.14 ± 2.73	1.57 ± 1.13	37.00	0.089ns
Day 7	0.86 ± 1.86	0.29 ± 0.76	28.00	0.594ns

*Significant (P£ 0.05) ns; non-significant (P > 0.05).

measured values at different intervals. Moreover, the values measured at day 1 and day 2 were significantly higher than day 7 value ($P < 0.001$). The mean and SD values for post-operative pain in different groups (intergroup difference) were presented in (Table 2 and Fig. 2).

4. Discussion

Over the past few years, the number of adults who are interested in orthodontic treatment has been increased. Orthodontic treatment of adult patients considered challenging. The prevalence of periodontal diseases among adult patients is considered the sixth most common disease and may cause tooth loss [23]. Presence of crowding and malocclusion that facilitate plaque accumulation may influence the disease progression. Orthodontic treatment in addition to periodontal therapy are important in controlling the disease progression and helps in maintaining proper oral hygiene.

Forces applied during orthodontic therapy in order to facilitate the movement of canines to their new position may cause adverse effects on the periodontium, especially in periodontally compromised patients. Low-level laser therapy has shown effects in periodontal inflammation control and orthodontic pain relief [20].

Several studies have shown the benefit of LLLT as an adjunctive therapy in managing patients with compromised periodontium in terms of control of gingival inflammation, pocket depth, clinical attachment loss and reduction of pain. Owing to the non-thermal Photo Bio-Modulation effect (PBME) of LLLT, it promotes tissue healing and pocket decontamination. However, these studies showed a discrepancy in the level of significance of the clinical parameters as PPD, GI, PI and CAL [16,17,24,25]. The diversity in outcomes may return to the different laser protocols applied in those studies [26]. Despite it is difficult to determine the best irradiation protocol, the previous studies [17,24,25] had showed the effectiveness of using diode laser 810 nm on multiple sessions. In the current study laser was applied on 3rd,7th,14, 28, 35, 42 and 56 days intervals from initiation of canine retraction, which demonstrate positive PBME in managing periodontal diseases [9,26]. Thus, the aim of the study was to analyze the effectiveness of LLLT on periodontal parameters and pain associated with canine retraction in patients with compromised periodontium.

The current study showed GI was significantly reduced in laser group when compared to the control group, this was inconsistent with several studies that proved the efficacy of LLLT in controlling gingival inflammation during orthodontic tooth movement [10,11,16].

Regarding the plaque index and clinical attachment loss, the results showed that both were reduced but no significant difference between the laser and control group, the reduction in plaque

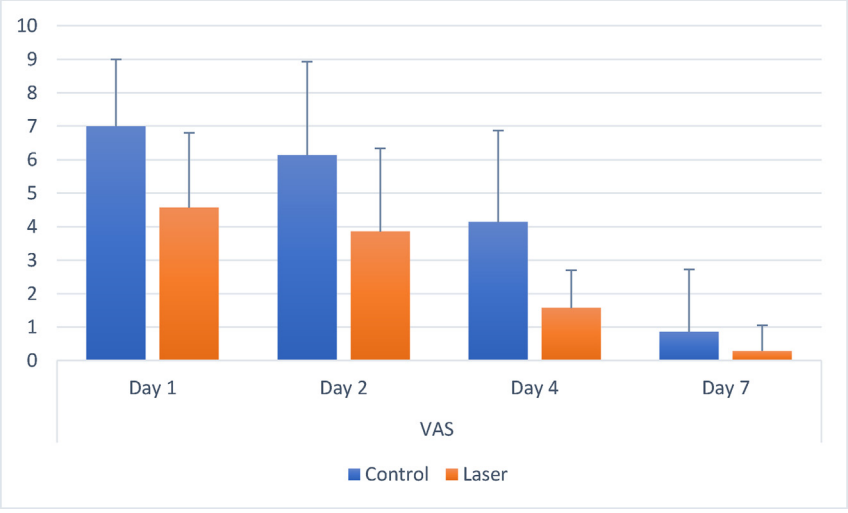

Fig. 2. Bar chart showing average VAS.

accumulation and clinical attachment loss in both groups might be attributed to the effect of orthodontic treatment in relief of crowding and elimination of inaccessible areas thus enhancing periodontal tissues health [5].

Moreover, the PPD showed significant decrease in the laser group when compared to the control group, such superior results concerning inflammation control have been reported in a previous study that compare the effectiveness of LLLT with conventional nonsurgical periodontal therapy at first, third, and sixth months after treatment [25].

Results in the current study showed that the pain associated with canine retraction in both groups changed with the same pattern over the first week of retraction, the same findings were reported before in a study done to evaluate the pain experienced by the patients after applying orthodontic forces [18]. As the intensity of pain reached its maximum value during the first day then it decreased gradually until it nearly disappeared on the seventh day. It was found that no significant difference between the two groups. However, results revealed that pain was more tolerable by patients in laser group than control group. The effect of LLLT on pain reduction is still controversial, some studies reported that it is beneficial in reducing pain during orthodontic treatment [27,28], while other studies showed no effect on pain intensity [22,29]. This difference might be due to variations in the type of laser, wavelength and the application parameters were used in these studies.

4.1. Conclusion

Promising results has been provided regarding anti-inflammatory effects of Low- Level Laser Therapy during orthodontic treatment in adult patients with compromised periodontium and in reducing pain during canine retraction.

4.2. Recommendation

These results were concluded from short observation thus long period follow-up and variable methods are recommended to provide additional verification of LLLT benefits as analgesic and anti-inflammatory.

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No Fund has been received for this study.

Conflicts of interest

There was no conflict of interest.

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