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Assessment Of Orthodontic Tooth Movement (OTM) Using 980-Nm Diode Gallium-Aluminum-Arsenide (Gaalas) Laser And Level Of IL-6 In Gingival Crevicularfluid

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Abstract

Aim: The current study aims to assessorthodontic tooth movement (OTM) through the use of980-nm diode gallium-aluminum-arsenide (GaAlAs) laser and level of IL-6 in gingival crevicular fluid (GCF).

Materials and Methods:30 patients were enrolled and divided into study group (left maxillary quadrant) and control group (right quadrant) in each patient. Study groupswere exposed to diode laser ondays 0, 7, 14, 21, and 28 of each month during the canine retraction phase. Tooth movement and level of IL-6 wereassessed and compared at different stages.

Results: The mean± SD distance (mm) parameter in the canine retraction phase atstage 0 was 2.24± 0.14in group I and 2.16± 0.14in group II; at stage 1 was 2.20± 0.13 in group I and 2.19± 0.10in group II; at stage 2 was 1.96± 0.20 in group I and 1.97± 0.18 in group II; at stage 3 was 1.76± 0.32 in group I and 1.80± 0.26 in group II; at stage 4 was 1.65± 0.23 in group I and 1.68± 0.18 in group II; and at stage 5 was 1.54± 0.15 in group I and 1.56± 0.16 in group II. There was nonsignificantdifference between both groups (P>0.05) (Table 1). The mean retraction velocity of the canine tooth was 0.014 in group I (laser side) and 0.013in group II (control side). There was significant difference (P<0.05) (Table 2). The mean± SD IL-6 level (pg/mL) atstage 0 was 0.07± 0.04in group I and 0.07± 0.02in group II; at stage 1 was 0.23± 0.18 in group I and 0.13± 0.56in group II; at stage 2 was 0.46± 0.32 in group I and 0.48± 0.41 in group II; at stage 3 was 0.49± 0.33 in group I and 0.34± 0.27 in group II; at stage 4 was 0.5± 0.35 in group I and 0.5± 0.34 in group II; and at stage 5 was 0.81± 0.47 in group I and 0.49± 0.31 in group II. There was nonsignificantdifference between both groups (P>0.05) (Table 3, Graph 1).

Conclusion: The authors found that diode laser increased the orthodontic tooth movement. The level of IL-6 was higher in the laser side in comparison withthe control side, but the difference was nonsignificant.

Keywords: Canine retraction, interleukin-6, orthodontic tooth movement.

Introduction

Orthodontic treatment is a lengthy procedure that takes from 1 to 3 years depending on the severity of malocclusion and type of movements needed.[1]Thus, patient cooperation is highly required. The presence of orthodontic bands and brackets can cause periodontal breakdown, dental caries, and external root resorption.[2]However, these complications may be minimized by accelerating tooth movements. Orthodontic tooth movement (OTM) initiates inflammatory-like reactions. A recent attempt is to speed up tooth movements by altering cellular response against orthodontic forces without causing trauma to teeth and periodontium.[3]

Many studies have suggested administering 1, 25(OH)2D3, prostaglandin E2, osteocalcin, and nitric oxide which may play a vital role in accelerating tooth movements. Results have demonstrated that few of these agents can cause mild pain afteralveolar bone injections.[4]Body metabolism is also affected by these agents. Hence, the main aim is to control or reduce pain intensity. Low-level laser irradiation (LLLI) is broadly utilized in the field of dentistry as it has shown better response in minimizing pain especially in OTM.[5]

Several studies have indicated that LLLI promotes OTM without causing a deleterious effect on teeth. However, there are some contradictory results fromfew studies revealingnonsignificant difference on the exposed and nonexposed side of tooth.[6] The effect of LLLI is exhibitedby inducing bone remodeling throughinitiating osteoblasts proliferation in the tension side and osteoclasts in the pressure side and also by stimulating collagen synthesis. It is evident that the level of certain cytokines, including interleukin-1 (IL-1), IL-2, IL-6, and IL-8, increases significantly during OTM.[7] Hence,the currentstudy aimed to assess OTM through the use of980-nm diode gallium-aluminum-arsenide (GaAlAs) laser and level of IL-6.

Materials andMethods

The currentstudy was conducted on 30 adult patients of both genders in the Department of Orthodontics after obtaining ethical approval from institutional ethical committee. All participants were informed aboutthe study, and their consent was obtained. 30 patients were divided into 2 groups with left maxillary quadrant as study group with laser treatment and rightmaxillary quadrant as control group (group-II) in same patient. Without laser treatment.

Participants with bimaxillary protrusion, free of systemic diseases, not on any kind of anti-inflammatory such as NSAIDs or tetracycline such as doxycycline, with no history of extraction, and with no previous orthodontic treatment were included in the study. Participants on NSAIDs, with previous history of orthodontic treatment, and not giving consent were excluded.

Following the selection of patients, meticulous oral prophylaxis was performedfollowed by instructions to use 0.2% chlorhexidine mouth wash. Alginate impressions were made, and casts were poured with dental stone. For bonding, a 0.022 × 0.028″ edgewise appliance was used, and 0.032″ SS wire transpalatal bar was utilizedfor posterior anchorage.

First premolars were extracted. Canine retraction was performed through the use ofNiTi closed coil springs on rectangular SS wires. Laser irradiation with 980-nm diode gallium-aluminum-arsenide diode laser (GaAlAs) emitting with an output power of 100 mW and dose of 5.6 J/cm^2 operating in a continuous-wave mode was utilized. Left maxillary quadrant served as the laser side (group I) and right side of maxilla in same patient as the control groupwithout laser treatment (group II). Threelaser exposures were made from the buccal side and 3 from the palatal side on study area (left side). The exposure time was 10 seconds for the cervical and middle third and 8 seconds for the apical third of the tooth. Laser irradiation was performed at baseline, 1st week, 2nd week, 3rd week, and 4th week every month during canine retraction phase.

Dental casts were again made at the end of the aligning and leveling phase, on 3rd week during canine retraction, and at the end of this phase. The distance (mm) from canine tip to tip of the mesiobuccal cusp of the first molar was measured with vernier caliper. The velocity of the movement was calculated as follows: V= d/t.

In all patients, GCF samples were collected at baseline (stage 0) on the day of treatment and before placing the wire for alignment. Stage 1 sample was obtained at the end of alignment and leveling phase. GCF was obtained on the 3rd week of each month before laser irradiation and reactivation of the appliance (stages 2–5) during the canine retraction.

Paper strips (0.2 X 1 cm) were inserted into maxillary gingival crevice for collecting GCF, left for 60 seconds, and removed. These strips were transferred into 1.5-ml sterile tubes containing 250-µl phosphate-buffered saline. The level of IL-6 (pg/mL) in each sample was calculated.

Statistical Analysis

For statistical analysis, results were aggregated, entered in MS excel sheet, and studied using SPSS version 21.0 (Chicago, IL, USA). Various statistical methods, including Kolmogorov-Smirnov and Wilcoxon signed-rank test,were utilized in this study. P value less than 0.05 was labeled as significant.

Results

Table 1 shows that mean± SD distance (mm) parameter in the canine retraction phase atstage 0 was 2.24± 0.14in group I and 2.16± 0.14in group II; at stage 1 was 2.20± 0.13in group I and 2.19± 0.10in group II; at stage 2 was 1.96± 0.20 in group I and 1.97± 0.18 in group II; at stage 3 was 1.76± 0.32 in group I and 1.80± 0.26 in group II; at stage 4 was 1.65± 0.23 in group I and 1.68± 0.18 in group II; and at stage 5 was 1.54± 0.15 in group I and 1.56± 0.16 in group II. The difference between both groups was nonsignificant (P>0.05).

Table 2presentsthat mean retraction velocity of the canine toothwas 0.014 in group I (laser side) and 0.013in group II (control side). The difference was significant (P<0.05).

Table 3indicatesthat mean± SD of IL-6 level (pg/mL) atstage 0 was 0.07± 0.04in group I and 0.07± 0.02in group II; at stage 1 was 0.23± 0.18 in group I and 0.13± 0.56in group II; at stage 2 was 0.46± 0.32 in group I and 0.48± 0.41 in group II; at stage 3 was 0.49± 0.33 in group I and 0.34± 0.27 in group II; at stage 4 was 0.5± 0.35 in group I and 0.5± 0.34 in group II; and at stage 5 was 0.81± 0.47 in group I and 0.49± 0.31 in group II. The dissimilarityamong both groups was nonsignificant (P>0.05). Graph 1 illustrates the assessment of IL-6 concentration in both groups, and it demonstratesthat IL-6 concentration was higher in group I in comparison with group II at stage 5.

Discussion

Orthodontic tooth movement may be inhibited by laser because of the effect it has on prostaglandins. OTM is initiated by alveolar bone remodeling depending on force on the pressure side.[8]Mechanical stimuli greatly affect periodontal ligament resulting in OTM. Some studies demonstrated that cytokines such as interleukin-1 (IL-1), IL-2, IL-6, and IL-8, also known as

proinflammatory cytokines, bring about the apposition-resorption process of the bone.[9]Orthodontic mechanical stress on periodontium cells causes the liberation of cytokines. Gingival crevicular fluid (GCF) may be useful in showing the level of cytokines. During OTM, the level of IL-6 increases in GCF. The cytokine level in GCF may varydueto the variation of force during orthodontic treatment.[10] The currentstudy aimed to assess OTM using 980-nm diode gallium-aluminum-arsenide (GaAlAs) laser and level of IL-6 in GCF.

In the currentstudy, 30 adult patients were recruited. We found that mean distance (mm) parameter in the canine retraction phase atstage 0 was 2.24 mmin group I and 2.16 mmin group II; at stage 1 was 2.20 mm in group I and 2.19 mmin group II;at stage 2 was 1.96 mm in group I and 1.97 mm in group II;at stage 3 was 1.76 mm in group I and 1.80 mm in group II;at stage 4 was 1.65 mm in group I and 1.68 mm in group II; and at stage 5 was 1.54 mm in group I and 1.56 mm in group II. Yassaei et al.[11] in their study,where they assessed the level of IL-6 in GCF in 11 patients and used diode laser to indicateits role in OTM, found that the mean rate of canine retraction was higher in the laser groups (0.013) than the control group (0.012). They also established that there was definitely a tendency for more canine retraction in the LLLI, but the results failed to show any significant difference between the mean rates of canine retraction of both groups (P=0.068). A paired t-test showed no significant difference in the mean concentration of IL-6 at differentstages of the treatment amongthe groups during canine distalization (P>0.05).

We found that the difference in mean retraction velocity of the canine tooth wasnonsignificantin group I (laser side, 0.014) and group II (control side, 0.013). Limpanichkul et al.[12] utilized 860 nm diode laser (25 J/cm2) at the surface level and found no increase in tooth movement in the laser group. The authors suggested in their study that the amount of absorbed energy by the tissues affected the tissue response to LLLI.

We found that there was nonsignificant difference in interleukin-6 in both groups recorded at different stages. The mean± SD of IL-6 level at stage 0 was 0.07± 0.04in group I and 0.07± 0.02in group II; at stage 1 was 0.23± 0.18in group I and 0.13± 0.56in group II; at stage 2 was 0.46± 0.32 in group I and 0.48± 0.41 in group II; at stage 3 was 0.49± 0.33 in group I and 0.34± 0.27 in group II; at stage 4 was 0.5± 0.35 in group I and 0.5± 0.34 in group II; and at stage 5 was 0.81± 0.47 in group I and 0.49± 0.31 in group II. Kansal et al.[13] conducted a study on 10 patients with diode laser and found greater rate of tooth movement in the laser group (LG) in comparison with the control group (CG).

Takeda et al.[14] conducted a study in order to assess the irradiation effect of low-energy laser on alveolar bone after tooth extraction in rats and found significant biostimulation effects of LLLI (904 nm, 20 J/cm2) on bone metabolism. The effect was found to occur at 900 nm, 20 J/cm2.

Ren et al.[15] in their study indicated significantlyhigher levels of proinflammatory cytokines, including IL-6 and IL-1 β, in the early stage of tooth movement. During the linear stage of OTM, cytokines were found to be reduced to their baselines at different time points.

The present study indicates that diode laser increases the orthodontic tooth movement. The drawback of the study is its small sample size and comparing 2 groupsonly.Further studies are required to evaluate the effectiveness of diode laser in orthodontic tooth movement with larger sample size.

Conclusion: The authors found that diode laser increased the orthodontic tooth movement. The level of IL-6 was higher in the laser side in comparison with the control side, withnonsignificant difference.

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Legends for Illustration

Tables and Graph

Table 1:Assessment of the distance parameter in the canine retraction phase.

Time interval	Group I	Group II	P value
Baseline (stage 0)	2.24± 0.14	2.16± 0.14	0.94
The end of leveling and aligning phase (stage 1)	2.20± 0.13	2.19± 0.10	0.98
The end of first month of canine retraction (stage 2)	1.96± 0.20	1.97± 0.18	1
The end of second month of canine retraction (stage 3)	1.76± 0.32	1.80± 0.26	0.91
The end of third month of canine retraction (stage 4)	1.65± 0.23	1.68± 0.18	0.82
The end of fourth month of canine retraction (stage 5)	1.54± 0.15	1.56± 0.16	1

Table 2: Retraction velocity of the canine tooth in both groups.

Groups	Mean	P value
Group I	0.014	0.01
Group II	0.013	

Table 3:Assessment of IL-6 concentration in both groups.

Time interval	Group I	Group II	P value
Baseline (stage 0)	0.07± 0.04	0.07± 0.02	1
The end of leveling and aligning phase (stage 1)	0.23± 0.18	0.13± 0.56	0.07
The end of first month of canine retraction (stage 2)	0.46± 0.32	0.48± 0.41	0.92
The end of second month of canine retraction (stage 3)	0.49± 0.33	0.34± 0.27	0.08
The end of third month of canine retraction (stage 4)	0.5± 0.35	0.5± 0.34	1
The end of fourth month of canine retraction (stage 5)	0.81± 0.47	0.49± 0.31	0.06

Graph 1: Assessment of IL-6 concentration in both groups.