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EFFECT OF LOW-LEVEL LASER THERAPY (LLLT) ON BONE-BORNE MAXILLARY EXPANSION: A RANDOMIZED CONTROLLED CLINICAL TRIAL

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ABSTRACT

Background: Maxillary transverse deficiency treatment during puberty is one of the main orthopedic treatments performed in an orthodontic clinic. The aim of any orthopedic maxillary expander is to increase the skeletal effect with limit the side effects on the dentition. Low-level laser therapy (LLLT) has been used in orthodontics to accelerate tooth movement. The purpose of this study was to study the effect of LLLT on the rate of bone-borne maxillary expansion.

Methodology: A sample of 24 female patients with transverse maxillary deficiency and bilateral posterior crossbite (age range 10-13 years old) were included in this study. The sample was divided into two groups: Group I: Bone-bone palatal expansion only and Group II: Bone-borne palatal expansion with LLLT. During the 15 days of active palatal expansion, a digital gauge was used to measure the midline diastema, inter-canine, inter-premolar and inter-molar width every day. The results were then used to compare between the two groups in order to study the effect of LLLT on the rate of expansion.

Results: A midline diastema started to appear within the 7th to 10th day of expansion. A statistically significant increase was noticed in the inter-canine and inter-premolar width in the first and third day of expansion. There was no statistically significant increase in the inter-molar rate of expansion between the groups.

Conclusion: Low-level laser therapy caused a significant increase in the rate of inter-canine and inter-premolar width on the first and third day of the expansion phase.

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INTRODUCTION

Maxillary transverse deficiency accompanied with posterior crossbite is a common orthodontic problem that compromises the function of mastication and esthetics.

In 1860, Angell was the first to describe maxillary expansion. It has then gained its popularity by Haas since 1961[1]. Orthopedic maxillary expansion aims to produce heavy forces by the expanders to maximize the skeletal response by opening the mid palatal suture, with minimizing the orthodontic tooth movement [2,3]. To avoid the side effects presented by the tooth-borne expanders such as alveolar bone resorption[4], bone-borne mini-screw supported palatal expanders were presented[5,6]. Laser therapy has been introduced in so many fields in dentistry for a wide variety of uses. The laser radiation that causes bio-stimulation of the tissue which causes pain reduction and accelerates tooth movement is called "Low-Level Laser Therapy (LLLT)". The purpose of this study is to study the effect of LLLT on the rate of bone-borne maxillary expansion.

MATERIALS AND METHODS

This randomized clinical-controlled trial was registered at the Evidence Based Center and approved by the Research Ethics Committee of the Faculty of Dentistry, Cairo University. All patients were informed about the study and informed written consents were signed. The study was carried out in the clinic of the Orthodontics department, Faculty of Dentistry, Cairo University, where the subjects were selected and the trial was performed. All the patients included in this study were recruited from the out-patient clinic. Egyptian female patients with an age range of 10 to 13 years old with bilateral posterior cross bite were included in this study. Patients with surgical or other treatment that might affect rapid maxillary expansion, congenital malformations, have undergone previous orthodontic therapy, or that had any systematic or periodontal disease were excluded from this study. The **sample size was based on two groups using PS software output.** The study was performed of a continuous response variable from independent. Group I and Group II subjects with 1 Group I per Group II subject. In a previous study the response within each subject group was normally distributed with standard deviation 1.6. If the true difference in the Group I and Group II means is 2.2, we will need to study **9** Group I subjects and **9** Group II subjects to be able to reject the null hypothesis that the population means of the two groups are equal with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. Considering drop out a sample size 11 or 12 per group is appropriate. After calculating the sample size, a sample of 24 patients were included in the study by 12 patients for each group. Group I was the patients that underwent bone-borne palatal expansion only and Group II was the patients that underwent bone-borne palatal expansion with LLLT. Dental and medical history were taken from each patient. Thorough clinical examination was performed to confirm the presence of bilateral posterior skeletal crossbite and a narrow v-shaped palate. Patient records of dental casts and intra- and extra- oral photographs were obtained before expansion and after 15 days of the active expansion phase. The bone-borne hyrax expander used for this study was supported by four 10 mm mini-screws places between the 1st and 2nd premolar and another screw placed between the 2nd premolar and 1st molar on each side of the palate. The appliance was soldered to stainless-steel rings that were later adapted on the mini-screw heads **figure 1**.

Initial activation of four rounds was performed by the orthodontist on the first day followed by two rounds a day by the patient for 15 days of expansion. During the active expansion phase, clinical measurements were performed by two practitioners using a digital gauge to measure the midline diastema, inter-canine, inter-premolar and inter-molar distances every day as following **figure 2**:

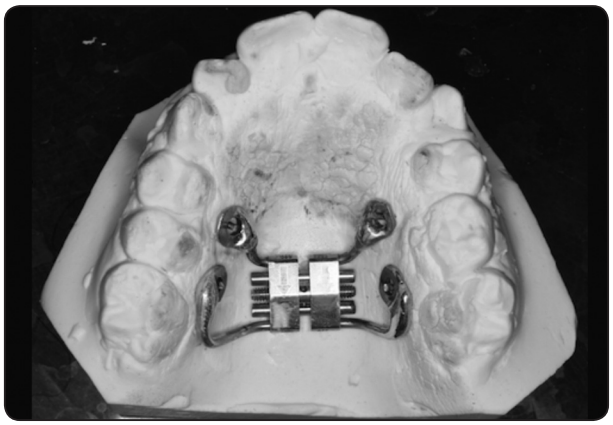

Fig. (1): Bone-borne Hyrax Expander

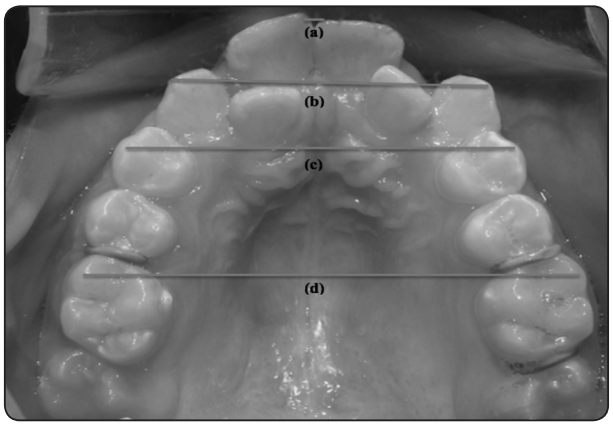

Fig. (2): Clinical intra-oral measurements: (a) Midline diastema (b) inter-canine width (c) inter-premolar width (d)inter-molar width.

- Midline diastema (mm): the distance between the mesial incisal angle of the upper central incisors.
- Inter-canine width (mm): the distance between the cusp tips of the upper right and left canines.
- Inter-premolar width (mm): the distance between buccal cusps of the upper left and right first premolars.
- Inter-molar width (mm): the distance between the mesio-buccal cusps of the upper fist molars.

In the laser group, LLLT was performed using Biolase (EPIC 10 Console) with active medium InGaAs (Indium gallium arsenide) Semi-conductor diode via the tooth whitening tip (Rectangular 35mm x 8 mm = 2.8cm^2) according to the manufacturer instructions by using the following parameters: Wavelength: 780 nm, Power density: 40 mW, Energy density: 10J/cm^2, Energy per point: 32 J, Continuous wave, Time: 8 seconds. Application was done in points, distributed in 4 application areas around the mid-palatal suture: 2 anterior areas from jackscrew to the canines and 2 posterior areas from the jackscrew to the first molars. After the 15 days of active expansion, the hyrax appliance was kept in place and locked using composite to be used as a retainer.

Statistical Analysis:

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data. Comparisons between pre and post in each group were done using paired t test. Comparisons between the 2 groups regarding quantitative variables were done using the non-parametric Mann-Whitney test. P-values less than 0.05 were considered as statistically significant.

RESULTS

The amount of expansion was measured every day clinically during the expansion phase in both groups. Two observers measured the diastema, inter-canine width, inter-premolar width (buccal cusp), and inter-molar width (mesio-buccal cusp) using a digital gauge within the 15 days of treatment. A diastema started to appear within the 7th to 10th day of expansion. A statistically significant increase was noticed in the inter-canine width on the first day of 32.77±1.92mm and 29.88±3.57 mm and on the third day of 33.5±1.5 mm and 29.1±1.12 mm within the

laser and non-laser groups respectively. There was also a statistically significant increase in the inter-premolar width in the first day 38.5±2.21 mm and 35.94±2.72 mm and on the third day 38.88±1.31 mm and 36.2±1.1 mm within the laser and non-laser group respectively.

Figures 3 and 4. There was no significant difference in the inter-molar expansion rate within both groups. The diastema was shortly closed after the hyrax appliance was locked in the retention phase. The expansion was obvious due to crowding relief.

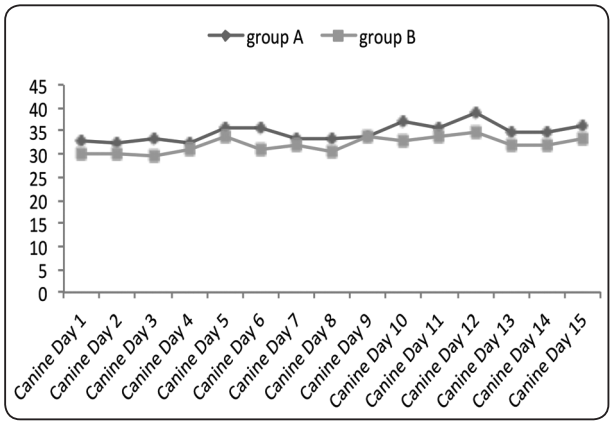

Fig. (3): Mean value of the inter-canine width measurements in relation to time in both groups.

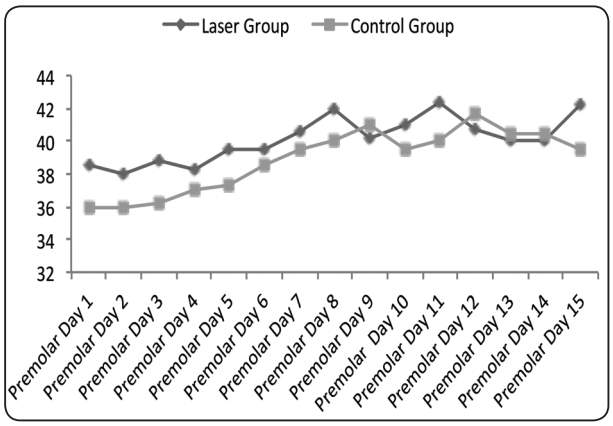

Fig. (4): Mean value of the inter-premolar width measurements in relation to time in both groups.

DISCUSSION

Rapid palatal expansion has been a widely accepted method of treatment for children and adolescents with transverse maxillary deficiency. A greater response to rapid palatal expansion therapy has been reported in younger subjects, whereas in the older subjects the appliance becomes less effective[7]. Therefore, the female patients recruited for this study were chosen in their pre-pubertal or pubertal phase of growth between the age of 10-13 years old with a normal growing pattern and an open mid-palatal suture that was confirmed using an occlusal radiograph.

Bone-borne palatal expansion devices were used to overcome the limitations of the tooth-borne palatal expansion devices. The mini-screw supported hyrax appliance was anchored directly on the palate using four 10 mm mini-screws to maximize the force applied directly on the bone. The mini-screws were placed between the 1st and 2nd premolars and between the 2nd premolars and 1st molars on both sides 6-8 mm above the gingival margin to reduce hindering of tooth movement during treatment, and to provide versatility in appliance design[8].

Low-Level laser therapy (LLLT) was reported in several studies to have the ability to accelerate bone regeneration in the mid-palatal suture during palatal expansion by stimulating its osteoclastic activity. This feature lead to accelerating palatal expansion and reducing the buccal rolling of the posterior teeth which is an unwanted dental side effect [9,10].

In this study, we chose to use the bone-borne hyrax palatal expander along with LLLT to study its effect on the rate of palatal expansion. The laser protocol used in this study was similar to the dose used in a study conducted by F. Cepera et al[10]. LLLT was applied in the same locations as mentioned for the first 5 days of active expansion.

During the expansion phase, the diastema, inter-canine, inter-premolar, and inter-molar width were

measured every day using a digital gauge. The measurements obtained were used to form a curve that compared the rate of expansion between the none-laser and the laser group. The diastema started to appear in both groups within the 7th to 10th day of expansion.

The rate of expansion in the laser group was found to have a significant increase in the inter-canine and inter-premolar width on the first and third days of active expansion. These findings which could be attributed to the initial effect of laser in the active expansion phase is in accordance with the study of Cepera et al[10]**.** They applied the same dose of laser used in this study with a tooth-borne hyrax expander and found that during the active expansion period, the laser group showed a significant decrease in density. This finding suggested reduction of bone level in the area, which caused facilitation in opening the mid-palatal suture in the laser group.

CONCLUSION

Regarding the rate of expansion, there was a significant increase in the inter-canine and inter-premolar rate of expansion on the first and third days in the laser group due to the initial effect of LLLT in the active expansion phase.

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