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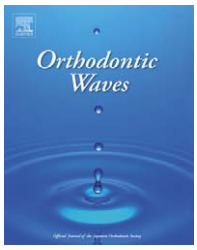

Research paper

The effect of low level laser therapy (LLLT) on bone remodelling after median diastema closure: A one year and half follow-up study

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ABSTRACT

Background and objectives: Maintenance of a corrected median diastema after orthodontic treatment often requires permanent retention. This study was performed to evaluate low level laser therapy (LLLT) effect on bone density after diastema closure and to determine whether increased density will prevent diastema relapse.

Study design: Fourteen patients (22 ± 4.78 years) with median diastema (6.79 ± 2.28 mm) were randomly allocated to a lased and a non-lased group ($i = 7$). The patients in the lased group were exposed to GaAs (904 nm, 30 mW, 5.4 J/session, 3 times/3 min each/every second day). Standardized periapical radiographs of the maxillary central incisors were taken immediately after diastema closure, and at 15 days, 45 days, 3 months, 6 months and 1.5 years. Bone density and linear distances were measured using Digora software.

Results: Diastema reopening showed no statistically significant differences between the two groups. Reduction in linear distances was noticed in the lased group. Mean percentage changes in bone density were statistically significant between the groups at 15 days and 6 months. Only the periapical area distal to the right central incisor retained significantly higher bone density after 1.5 years. There was an insignificant negative correlation between the diastema size and bone density in the lased group at all experimental periods.

Conclusions: LLL induced bone remodelling and prevented reduction in bone density in the lased group. Diastema reopening, although minor, did not seem to be significantly affected by the bone density changes. Further studies on a larger sample are necessary to optimize treatment parameters so LLL can be applied on a routine therapeutic basis.

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1. Introduction

Maxillary median diastema is common in the primary and mixed dentitions [1]. Spacing could be a stage during development and resolves spontaneously by eruption of the permanent lateral incisors and canines. In the adult dentition, the reported incidence of median diastema ranges from 5 to 20% [2–4] and is often a major aesthetic problem requiring orthodontic treatment. Closing of the median diastema is a manageable orthodontic problem, but maintenance of the end result and prevention of relapse may require a life-long retention in the form of fixed and/or removable retainers. Retention with removable appliances will result in back-and-forth movement, since retainers are not worn for 24 h every day, not to mention that no patient wants to wear a removable appliance for a lifetime. A bonded retainer has the potential to loosen, while at the same time not completely relieving the orthodontist from legal responsibilities as long as it remains in the mouth.

Low level laser (LLL) was proved to have an effect on bone remodelling. In vitro studies have shown effects on tissue cultures. The effects of HeNe laser irradiation on cultured clonal osteoblastic cells [5] were studied. Laser irradiation was observed to accelerate proliferation of the cells only in the growing phase, when the cells were considered to be undifferentiated osteoprogenitor cells. Cellular growth rate and DNA synthesis were increased.

In vivo studies have indicated that laser irradiation may have a beneficial effect on wound healing of bone by accelerating bone regeneration [6], stimulating formation of trabecular osteoid tissue [7], increasing vascularization [8] and promoting faster metabolism and reaction of bone callus by modulation of the function of osteocytes [9]. Also, LLLT in rat experiments both stimulated bone regeneration in the mid-palatal suture during expansion [6] and increased the amount of tooth movement [10]. Similarly, human studies [11,12] have shown acceleration in tooth movement during orthodontic treatment after irradiation with LLL. So far, LLLT has not been used to study the steady condition of teeth after orthodontic tooth movement. Knowing that LLL affects bone density it is hypothesized that bone irradiation after finished orthodontic treatment might increase bone density and thus prevent teeth to relapse. In turn, this might reduce the need for retention appliances and provide a more stable result. A search for a tool to alleviate the relapse of orthodontically treated, and approximated teeth in particular, must be developed on the basis of a comprehensive understanding of the supporting tissues of the teeth. Thus, the aim of the present study was to study the effect of LLLT on bone density after diastema closure and to determine whether increased density will prevent diastema from reopening.

2. Materials and methods

The Higher Committee for Research of the Suez Canal University, Egypt, approved this study. Fourteen patients, 3 males and 11 females with age 22.12 ± 4.78 years fulfilled the inclusion criteria and were selected for this prospective study: (1) maxillary median diastema of at least 3 mm; (2) all permanent teeth erupted, including second molars; (3) no previous orthodontic treatment; (4) patients should be free from any gingival inflammation and (5) should not be under any systemic medication. The patients and each legal responsible were informed about the treatment protocol and they consented to participate in this study. Diastema was measured intraorally from the mesial contact point (point of highest convexity) of the both central incisors by means of a digital caliper. Records, including study models, photos, profile, panoramic and upper occlusal radiographs, were collected before treatment and after removal of the appliance. In addition, standardized periapical radiographs of the maxillary central incisors were taken immediately after closure of the diastemas as a baseline record = ''zero time'' and at the following intervals: 15 days, 45 days (debonding of patients), 3 months, 6 months and 1.5 years after ''zero time''. Patients were then randomly allocated to the experimental (lased) and control (non-lased) groups, each comprising seven patients. Patients were treated with pre-adjusted edge wise mechanics Roth prescription brackets (Ormco Company, 1717 West Collins Orange, CA 92867, USA) with slot 0.022 in. $\times$ 0.028 in. to close the median diastema with average treatment time of 12 ± 4 months (Fig. 1). Treatment plan included leveling, alignment and closure of median diastemas by means of closed elastomeric chain on a rectangular 0.016 in. $\times$ 0.022 in. stainless steel wire. Eight cases (5 in the lased group and 3 in the non-lased group) needed frenectomy, which was done after closure of the median diastema, but before laser irradiation. Four patients were referred for gingivectomy to control the gingival condition before laser irradiation. During the retention phase, all patients received a Hawley retainer and followed a regime of 6 months full time wear, except during meals.

A class 3b LLL device (Orolaser model 1030, ORALIA medical GmbH company, Schneckenburgstraße 11, 78467 Konstanz, Germany) Gallium Arsenide (GaAs) was used in this study (wavelength 904 nm, with average power 30 mW in a continuous contact mode, average energy 5.4 J/session for 3 sessions/3 min each and pulse reptilian rate of 9999 Hz). The laser beam was delivered to the tissues in a scanning movement that covered an area of 3.3 cm^2 through a fiberoptic delivery system with a diameter of 8 mm. The fiberoptic system was sterilized after each session by cold sterilization (MICRO 10 solution—UNIDENT S.A., 1225 Chêne-Bourg, Switzerland) in full concentration for 1 h. Within the first week after closure of diastema, patients allocated in the experimental group were scheduled to laser exposure for 3 sessions; every second day, each session lasting for 3 min. The same operator did all exposures. Position and handling of the fiberoptic system was perpendicular on the therapy zone, which was the bone surrounding the roots of the upper central incisors. The entire experimental group received laser irradiation after finishing their treatment and closing the diastema, but before debonding. To detect the difference of bone density for both groups, direct digital images were taken and image analysis was done using Digora software, version 1.51 (Soredex Corporation, Tuusula, Finland). The high definition window mode was chosen to be able to delineate the outline of the central incisors clear enough. The images were analyzed and the mean bone density was measured