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Physical properties of root cementum: Part 27. Effect of low-level laser therapy on the repair of orthodontically induced inflammatory root resorption: A double-blind, split-mouth, randomized controlled clinical trial

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Introduction: The purpose of this 2-arm-parallel split-mouth trial was to investigate the effect of low-level laser therapy (LLLT) on the repair of orthodontically induced inflammatory root resorption (OIIRR). **Methods:** Twenty patients were included in this study, with 1 side randomly assigned to receive LLLT, and the other side served as a sham. Eligibility criteria included need for bilateral maxillary first premolar extractions as part of fixed appliance treatment. OIIRR was generated by applying 150 g of buccal tipping force on the maxillary first premolars for 4 weeks. After the active force was removed, the teeth were retained for 6 weeks. LLLT commenced with weekly laser applications using a continuous beam 660-nm, 75-mW aluminum-gallium-indium-phosphorus laser with $1/e^2$ spot size of 0.260 cm^2, power density of 0.245 W/cm^2, and fluence of 3.6 J/cm^2. Contact application was used at 8 points buccally and palatally above the mucosa over each tooth root for 15 seconds with a total treatment time of 2 minutes. After 6 weeks, the maxillary first premolars were extracted and scanned with microcomputed tomography for primary outcome OIIRR calculations. Subgroup analysis included assessment per root surface, per vertical third, and sites of heaviest compressive forces (buccal-cervical and palato-apical). Randomization was generated using www.randomization.com, and allocation was concealed in sequentially numbered, opaque, sealed envelopes. Blinding was used for treatment and outcome assessments. Two-tailed paired *t* tests were used to determine whether there were any statistically significant differences in total crater volumes of the laser vs the sham treated teeth. **Results:** Total crater volumes were 0.746 mm^3 for the laser treated teeth and 0.779 mm^3 for the sham. There was a mean difference of 0.033 ± 0.39 mm^3 (95% CI, −0.21 to 0.148 mm^3) greater resorption crater volume in the sham group compared with the laser group; this was not statistically significant ($P = 0.705$). No harm was observed. Conclusions: No significant difference was found between LLLT and sham control groups in OIIRR repair. (Am J Orthod Dentofacial Orthop 2018;154:326-36)

Orthodontically induced inflammatory root resorption (OIIRR) has been described as an unavoidable pathologic consequence of orthodontic tooth movement.[1] It is a result of collateral damage to the root surface by the action of clastic cells in the removal of necrotic tissue formed from periodontal ligament compression.[2,3] Manifestations may be cemental or dentinal mineral loss, whereas circumferential

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resorption may precede apical root shortening.[1] It has been reported that up to 91% of teeth can experience some form of root length loss during orthodontic treatment.[4] A classification of severe resorption (>3 mm) has been reported in 10% to 20% of patients.[5,6] When diagnosed, a 2- to 3-month treatment pause may be recommended, since significantly reduced resorption has been found in patients who had their treatment interrupted compared with those who had not.[6] The continuation of OIIRR is thought to be related to the persistence of hyalinized tissue.[7] The cessation of orthodontic force allows for the removal of necrotic tissue, while minimizing further formation, and also enables cemental repair.

Repair has been observed histologically to begin with the migration of fibroblast-like cells and cementoblasts into the resorption lacunae and the deposition of an unmineralized cementoid matrix with subsequent mineralization.[7,8] This has been reported to occur at locations from the periphery, central part of the lesion, and all directions.[1,7] A rapid healing potential was noted up to 7 weeks; then a plateau in the rate was seen.[9]

A modality that is regaining popularity in research in the promotion of wound healing is low-level laser therapy (LLLT). It has had many synonyms such as "cold laser," "soft laser," and "LLLT." Its initial discovery was in the late 1960s with the observation of accelerated hair regrowth and wound healing in mice.[10,11] The proposed mechanism of action involves the stimulation of cellular metabolism near infrared or infrared light at a low energy density.[12] Common delivery sources include laser or light-emitting diodes, and many parameters influence the quality, quantity, and density of the light energy delivered to the target tissue. These include wavelength, light source-power, and spot size, number and frequency of applications, application time, application energy, and fluence.[12]

In response to LLLT, the effects of the in-vitro level have demonstrated improved cellular metabolism, and differentiation and proliferation of progenitor cells, osteoblasts, and cementoblasts.[13-15] Clinically, LLLT has been shown to be favorable in the healing of aphthous ulcerations[16] and effective in the prevention of oral mucositis.[17,18] Hard tissue studies have indicated an overall positive effect for bone regeneration and repair[19-23] and secondary dentinogenesis.[24,25]

The effects of LLLT on cemental repair or remodeling have been investigated in a few studies with mixed results. Alsulaimani et al[26] showed favorable histologic results with negligible radiologic changes, and Altan et al[27] observed improved cemental repair in a rodent model after LLLT application during a retention phase after cessation of orthodontic force. However, no study has investigated the effects of LLLT on the repair of OIIRR in a human model after orthodontic force cessation.

Specific objectives or hypothesis

The aim of this study was to investigate the effect of LLLT application on cemental repair during a simulated treatment pause in a human model after a 4-week period of 150 g of buccal tipping force. The volumes of tooth root resorption craters were measured on extracted premolars by microcomputed tomography (micro-CT).

MATERIAL AND METHODS

Trial design and any changes after trial commencement

This was a 2-arm parallel, split-mouth trial, with randomization of 1:1 right and left sides as LLLT treated or sham control. There were no changes after trial commencement.

Participants, eligibility criteria, and settings

Ethics approval was granted by Sydney Local Area Health District, Royal Prince Alfred Hospital Zone (ethics approval numbers X16-0276 and Human Research Ethics Committee/16/RPAH/347). Patients were screened and selected from February to November 2015 in the Department of Orthodontics, Sydney Dental Hospital in Australia, based on previously described criteria by all authors except one (P.P.).[28] These included need for bilateral maxillary first premolar extractions (necessitating moderate anchorage) and fixed appliance treatment; permanent dentition; completion of apexification; similar minimal crowding on each side of the maxillary arch; no previous orthodontic or orthopedic treatment; no unilateral or bilateral posterior crossbites; no craniofacial anomaly; no history of trauma, bruxism, or parafunction; no past or present signs and symptoms of periodontal disease; no significant medical history that would affect the development or structure of the teeth and jaws and any subsequent tooth movement; and no history of asthma. Written informed consent was obtained, pretreatment records were collected, and standardized oral hygiene instruction was provided.

Interventions

Self-ligating 0.022-in SPEED brackets and tubes (Strite Industries, Cambridge, Ontario, Canada) were bonded on the first premolars and first molars, respectively, and 150 g of buccal tipping forces was applied to the first premolars via a 0.017 × 0.025-in beta-titanium cantilever (3M Unitek, Monrovia, Calif) from