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Brief Report

Histological Evaluation of the Use of Diode Laser as an Adjunct to Traditional Periodontal Treatment

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ABSTRACT

***Objective:* The aim of this study was to describe *in vivo* effects of scaling and root planing associated with 980-nm diode laser irradiation on periodontally diseased root surfaces. *Background Data:* Rapid advances in the development of laser technologies used in dental offices demand careful evaluation of the respective histopathologic effects of each new system. There have been no reports of scaling and root planing associated with 980-nm diode laser effects on root surfaces after *in vivo* application. *Methods:* Single rooted teeth and multiple rooted teeth considered for extraction due to severe periodontal disease were included in the study. For light microscopic investigation, a resin-embedding technique was used to cut the undecalcified teeth into 30-μm-thick cross-sections and stained. The following parameters were recorded by a blind examiner: remaining debris, root surface morphology, and thermal side effects. *Results:* Root surfaces instrumented with hand instruments and diode laser *in vivo* did not show detectable surface alterations. There were no signs of thermal side effects in any of the teeth treated. *Conclusion:* The present *in vivo* study showed that associated therapy was suitable for non-surgical periodontal treatment. The results suggest that the diode laser may be routinely used as an adjunct to scaling and root planing without damage to the cementum tissue.**

INTRODUCTION

THE ADJUNCTIVE USE of lasers in the treatment of inflammatory periodontal diseases is a fairly recent clinical procedure that is gaining momentum in dental practice. Scaling and root planing are traditionally used to restore gingival health by removing plaque, calculus, and endotoxins adhered to tooth roots causing inflammation and periodontal disease. The use of lasers is one of the most recent methods in non-surgical periodontal treatment.[1,2]

Clinical studies demonstrated a positive effect of many laser systems (Nd:YAG, Er:YAG, argon, CO_2, and diode laser) when used alone and associated with root scaling and planing.[3–6] Laser application counteracts some limits of conventional treatment (dentine hypersensivity and local infection). In this way, thermal and photodisruptive laser effects result in the elimination of periodontopathogenic bacteria regardless of laser wavelength.[7–9]

However, several *in vitro* studies indicated that diode lasers may severely damage root surface structures and inhibit new cellular attachment when certain energy levels are exceeded, and concluded that the use of laser could be more harmful than beneficial.[10–12] Side effects of this type of laser treatment have not been completely determined yet.

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The present study is part of a research protocol to investigate the clinical possibilities of InGalAsP laser (980 nm) application in periodontology. It focuses on the possible histological effect of scaling and root planing associated with laser irradiation on human root surfaces *in vivo*. The aim of this study was to analyze morphological changes of the root cementum after conventional periodontal treatment and diode laser at clinical power outputs, at irradiation times, and at working angles in real clinical conditions of use.

METHODS

Specimens

Five, non-carious, single-rooted and multiple-rooted periodontally involved teeth after conventional scaling and root planing and diode laser irradiation *in vivo* were extracted. The teeth were considered for extraction due to severe destructive periodontal disease and based on informed consent of the patients included in this study. Each tooth satisfied the following criteria:

- Probing pocket depths +8 mm
- Mobility in horizontal and vertical direction (grade 3)
- No signs of carious or artificial damage on the root surface (dental restorations, crowns)
- No periodontal root surface treatment within the last 12 months
- No root fractures or anatomical abnormalities

Furthermore, patients suffering from systemic diseases that could influence the outcome of periodontal therapy were excluded from the study.

Apparatus and devices

The laser equipment used in this study was an InGalAsP diode laser device (Intermedic. Barcelona, Spain) with a wavelength of 980 nm, energy of 2 W of power applied with pulse repetition (100-msec pulse and stop of 50), 2-mm-diameter tip, focused and in contact with continuous isotonic normal saline for cooling to avoid any undesired change in temperature. The clinical procedure has been described previously as follows[5]:

a. Periapical anaesthesia using 5% licodaine and adrenalin 1:100,000.
b. Conventional scaling and root planing with new hand instruments (Gracey curets) in order to remove calculus and facilitate the application of laser optical fiber.
c. For the laser procedure, the optical fiber is introduced, and ascending and descending movements are practiced; those movements should be slow to increase laser efficacy, since it works with low intensity (the maximum power of this diode laser is 15 W). Special attention has to be paid to the direction of the optical fiber, since it must be parallel to the tooth longitudinal root axis.
d. Repetition of scaling is done to remove detritus and calculus remaining within the sulcus.
e. In the second laser procedure, as in the first procedure, this is done to remove calculus remains, prevent sensitivity of the working area, and undergo curettage of periodontal pocket.

All dental extraction was performed under local anesthesia without forceps by the same operator. Macroscopically, all root surfaces appeared unaltered by the extraction procedure. Then, the teeth were stored in 10% Formaldehyde prior to their histological examination.

Histological study

All teeth were dehydrated in a graded alcohol series and embedded in metacrylate resin (Technovit 7200; Heraus Kulzer GmbH, Werheim, Germany) using a standard method.[13] After that, cross-sections were cut with a diamond saw at 100–150 µm. The slices were ground automatically by a special machine to a thickness of 30 µm. All histological sections were stained with Levai Laczko staining and evaluated under a light microscope by one blind and calibrated examiner. The following parameters were recorded: remaining debris (yes/no), percentage of the observed root surface craters (yes/no), exposed dentin (yes/no), and thermal side effects, such as carbonization, melting, and cracking (yes/no).

RESULTS

Microscopic analysis of the irradiated specimens did not reveal any degree of alteration on the root surface. The specimens presented a superficial smear layer that varied in amount and shape, but there was practically no alteration on the root surface. Histologically, there were no signs of major thermal side effects on the teeth such as charring, melting, carbonization, necrosis, and fusion. The results are shown (Figs. 1–3). Calculus-free areas examined microscopically did not show grooves and crater-like defects in any cross-sections observed (Figs. 4 and 5). In one slice, we observed small remains of hard deposits (i.e., calculus) (Fig. 6).

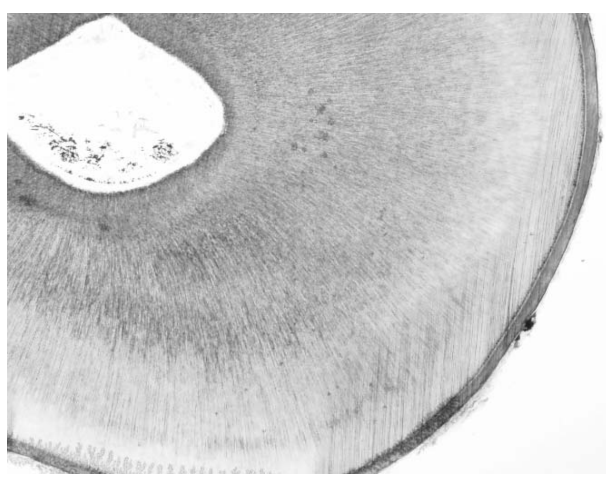

FIG. 1. Photomicrograph of *in vivo* treated root surfaces. Original magnification, ×20. ×40.

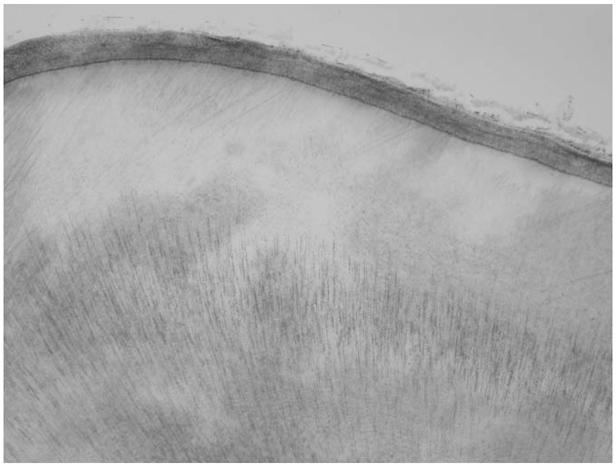

FIG. 2. Photomicrograph of *in vivo* treated root surfaces. Original magnification, ×40.

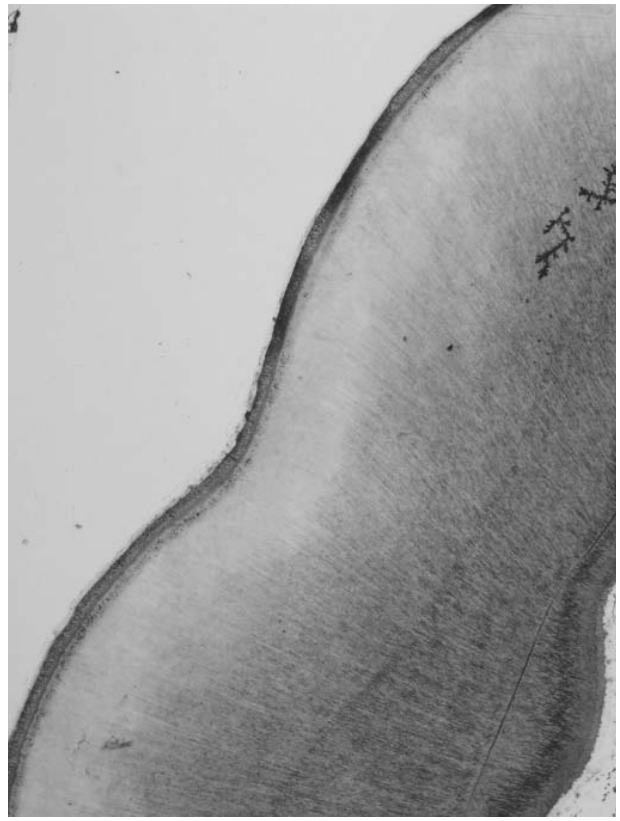

FIG. 4. Photomicrographs of furcal area in a molar teeth after scaling and root planning with hand instruments and diode laser irradiation. Original magnification, ×20.

DISCUSSION

Periodontal research in past years has been extensive, with researchers and clinicians looking for better treatment and therapy options. Root surface instrumentation (scaling and root planing) remains the cornerstone of non-surgical periodontal treatment. However, clinical observations and experimental studies show hopeful results for incorporating laser irradiation into non-surgical periodontal therapy. Laser devices are typically easy to handle and painless, and do not seem to produce adverse effects.

In clinical practice, however, the optic fiber must be inserted carefully into the periodontal space, with a fixed working angle between the laser fiber and the collateral periodontal tissues, which is not repeatable in experimental studies *in vitro*. This working angle varies between 0° and 30°, and for this reason we analyzed single-rooted and multi-rooted teeth (anterior and posterior teeth). Furthermore, environmental clinical conditions of temperature, humidity, and blood contamination cannot be reproduced in *in vitro* studies in spite of water irrigation of the optic fiber. In biological tissues, absorption is mainly due to the presence of free water molecules, proteins, pigments, and other macromolecules. Kreisler et al. indicated in their study that the diode laser application for pocket decontamination in periodontal therapy may cause damage to hard tissue when blood is present, if the laser parameters are not correct.[12] In our study, the teeth were scaled and root planed, and then irradiated to reproduce a real clinical protocol previously tested.[5] A blood film on the root surface may be decisive for possible morphological alterations, since it considerably enhances light absorption on the tooth structure.[12] Because laser light is poorly absorbed in water but highly absorbed in hemoglobin and other dark pigments, tissues with good blood supply (such as the periodontal ligament) or tissues with blood contamination reveal a high absorption capacity. This possible adverse effect might be mitigated by constant cooling of the laser tip; however, it is still hypothetical whether the cooling would be sufficient to avoid all adverse effects. The results that we obtained in this study, nonetheless, confirm the absence of collateral effects.

FIG. 3. Cemento-enamel junction of a treated teeth. Original magnification, ×40.

The findings of this study do not agree with results from a previous *in vitro* and *in vivo* study that showed that the diode laser (GaAlAs, 810 nm, 1.8 W pulse/pause relation 1:10) was unsuitable by itself for calculus removal and altered the root surface in an undesirable manner.[10] However, in this study

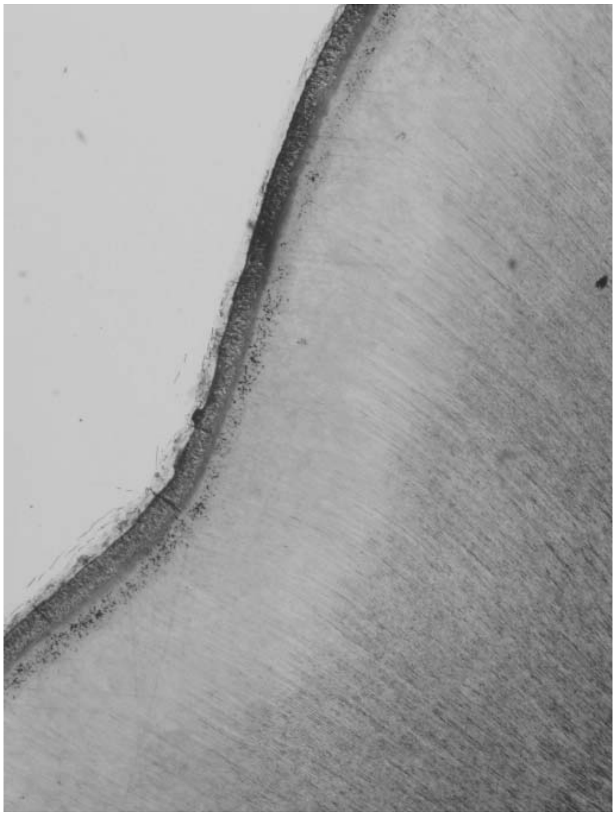

FIG. 5. Higher magnification of previous image. Notice that in the furcal area there was not signs of side effects. Original magnification, ×40.

Schwarz et al. had studied the use of laser irradiation without conventional treatment (scaling and root planning), and therefore their study design is different from ours and the results not comparable. In this respect, it is important to consider the results of our study, which have shown complete removal of subgingival calculus (inclusive of molar furcations). The objective of using diode laser irradiation as adjunct scaling and root planing would be to improve the efficacy of root instrumentation and to minimize collateral effects (decontamination effect and dentine hypersensivity).

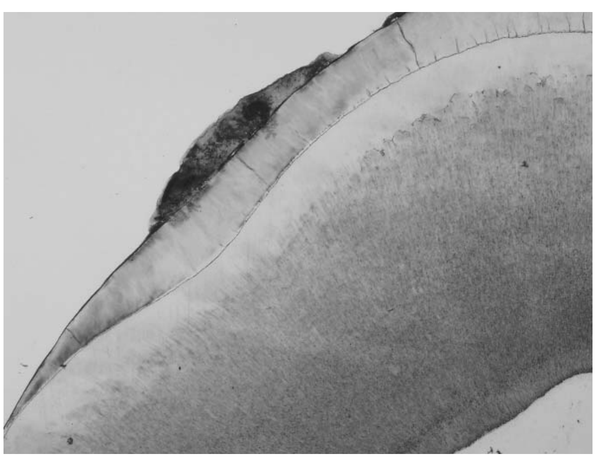

FIG. 6. Note hard deposits (i.e., calculus) in enamel of a teeth treated. Original magnification, ×20.

In another *in vitro* study, Theodoro et al.[14] reported that the application of an 810-nm diode laser did not cause any microscopically detectable alterations on the root surface, because the absorption coefficient of water is small. However, these findings might be due to the mode of laser emission, to different laser wavelength, to the time of exposure, to the working angle, and to use of a saline solution to minimize the thermal damage of laser irradiation.

CONCLUSION

Our study supports the clinical use of diode laser in periodontology because of its minimal effect on the cementum tissue. The results of this study have prompted us to begin treating periodontal patients with a association of conventional and laser therapy in order to make best use of the specific advantages of each clinical procedure.

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