Cervical microleakage in root canals treated with Er:YAG and Nd:YAG laser

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Abstract

Cervical microleakage was evaluated in sealed root canals previously treated with Er:YAG and Nd:YAG lasers. Ninety-two single-rooted maxillary human canines were prepared with the crown-down technique and irrigated with distilled and deionized water. The samples were distributed randomly into 9 groups of 10 teeth each. One tooth was used as a positive control and one as a negative control. In group I, 1.2 ml of EDTAC was applied during 5 min. In groups II to V, radicular dentine was irradiated with Er:YAG laser (Opus 20, Opus Dent, Israel) at the following parameters: 200 mJ and 8 Hz, 200 mJ and 16 Hz, 400 mJ and 8 Hz, or 400 mJ and 16Hz, respectively, for 60 s. In groups VI to IX, radicular dentine was irradiated with Nd:YAG laser (Fotona Medical Lasers, Slovenia) at 10 Hz and 1 W, 10 Hz and 2 W, 15 Hz and 1 W, or 15 Hz and 2 W, respectively, for 60 s. The canals were then sealed by the lateral condensation technique with an epoxy resin-based sealer. The roots were immersed in India ink for 15 days and then cleared to visualize the level of cervical microleakage with a measurement microscope. The results were evaluated by the Kruskal-Wallis test, which showed no statistical significance ($p>0.01$) for parameter variations of the Er:YAG laser when compared to the control group. However, the increase in frequency and potency for Nd:YAG laser decreased the microleakage when compared to the control group.

1. INTRODUCTION

Root canal treatment can be a series of procedures for cleaning, shaping and filling the root canal system. The correct use of instruments and irrigating solutions for the chemo-mechanical preparation of the root canal is fundamental for complete success of the therapy. One of the aims of this procedure is the removal of smear layer. According to Kennedy et al. (1), smear layer is a negative factor in root canal sealing because it forms an interface between the sealing material and the root canal walls, thus reducing adhesion. A well filled root canal is essential for successful endodontic treatment. The quality of the obturation is related to various factors such as: obturation technique, sealer, root canal preparation and irrigation solution used for smear layer removal (2).

One of the greatest challenges of endodontic treatment is the complete cleaning of the root canal, eliminating all pulp remnants, bacteria, smear layer, pre-dentin and other organic material that can interfere with success.

Different chemical solutions and their associations have been recommended for use with instrumentation of root canals to remove debris, smear layer and disinfect the root canal. Among the recommended solutions, ethylenediaminetetraacetic acid (EDTA) is the most accepted for smear layer removal (3-4). According Yamada et al (5) and Sen et al (6), the smear layer is composed of organic and inorganic components, which can be removed by association of chelating solutions and sodium hypochlorite.

Therefore, there has been great interest for the removal of this residue layer before filling allowing the penetration of the sealer in the dentine canalicilli and a more intimate contact of the sealer with the dentine surface (3,6). Many studies have evaluated the efficiency of the obturation of the root canal from the apical direction, and in the last two decades, researchers have begun evaluating coronal leakage (7-9).

Recently, Er:YAG and Nd:YAG lasers have been studied for applicability in Endodontics. Laser radiation is also used for cleaning the root canal and has shown great potential in endodontics. With increasing developments and

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applicability of the laser, much research has been carried out in the last decade with promising results for disinfection and smear layer removal. Er:YAG laser irradiation removes the smear layer produced during endodontic instrumentation and is an alternative to enhance root canal cleaning. (3, 10)., while Nd:YAG lasers remove smear layer and melt and recrystallize dentinal tissue and reduce apical leakage in teeth obturated with epoxy-based root canal sealers (11).

A great variation of energy and frequency have been used for irradiation with these lasers. Thus, the aim of this study was to determine cervical microleakage after the removal of smear layer. Cervicall microleakage was evaluated in sealed root canals previously treated with Er:YAG and Nd:YAG lasers with different parameters compared to 17% EDTAC.

2. METHODOLOGY

Ninety-two maxillary human canines, that had been stored in 0.1% thymol solution and 9ºC until use, were used in this study. The teeth were washed in running water to remove traces of anti-septic solution and the crowns were cut with high speed rotation and a 2135 (KG Sorensen, Sao Paulo, SP, Brazil) cylindric diamond bur. Canal instrumentation was performed by the crown-down technique up to a #50 K-file (Dentsply-Maillefer, Ballaigues, Switzerland). Ten ml of distilled and deionized water was used for irrigation in all cases. Working length was established 1 mm from the apex. The teeth were separated randomly into 9 groups of 10 teeth each. One tooth was used as a positive control and one as a negative control. In group I, 1.2 ml of 17% EDTAC was applied during 5 min. In groups II to V, radicular dentine was irradiated with Er:YAG laser (Opus 20, Opus Dent, Israel) at the following parameters: 200 mJ, 8 Hz and 480 pulses; 200 mJ, 16 Hz and 960 pulses; 400 mJ, 8 Hz and 480 pulses; 400 mJ, 16 Hz and 480 pulses, respectively, for 60 s. In groups VI to IX, radicular dentine was irradiated with Nd:YAG laser (Fotona Medical Lasers, Slovenia) at 10 Hz and 1 W; 10 Hz and 2 W; 15 Hz and 1 W; 15 Hz and 2 W, respectively, for 60 s. Er:YAG laser was irradiated with a 17 mm of length and 1.3 mm diameter sapphire fiber copolled to a handpiece and the Nd:YAG laser was applied with a 0.25 µm quartz fiber optic tip also coupled to a handpiece. The canals were then sealed by the lateral condensation technique with an epoxy resin-based sealer (Sealer 26, Dentsply, Petrópolis, RJ, Brazil).

The gutta-percha cones were sectioned at the cervical entrance with a heated instrument and the entrance was sealed with Cotosol (Vigodent, Rio de Janeiro, RJ, Brazil). The teeth were placed in an incubator at 37ºC and 95% humidity for a period of 3 times the setting time of this cement. After this period, the seal was removed and the external surface was impermeabilized with cyanoacrylate (Super Bonder), exceeding the cervical opening. The teeth were placed in India ink, and vacuum was applied (25 Kg/cm^2) for 10 min to remove air bubbles. The teeth were then stored at 37ºC for 15 days.

The teeth were subsequently washed for 1 h in running water and the cyanoacrylate was removed. The teeth were placed in 5% hydrochloric acid (Merck, Darmstadt, Germany), dehydrated in 70, 80, 96 and 100% alcohol (4 h each), and then cleared in methylsalicylate (Vetec, Rio de Janeiro, Brazil). After clearing, coronal leakage was measured in mm with a microscope (Nikon, Tokyo, Japan), and the results were analyzed statistically with the Kruskal-Wallis test.

3. RESULTS

With the application of 17% EDTAC, cervical microleakage was less and was statistically different from the groups in which Er:YAG was applied, independent of the potency and frequency. However, compared with the groups in which Nd:YAG was applied, there was a statistically significant difference only when 1 W and 10 Hz was used and a similarity with the other potencies and frequencies. There was also a statistically significant difference between microleakage of the groups treated with Er:YAG and Nd:YAG independent of the potency and frequency (Table 1).

Table 1. Cervical microleakage (means ± SD) of sealed root canals.

G I EDTAC	G II Er:YAG 200mJ8Hz	G III Er:YAG 200mJ 16Hz	G IV Er:YAG 400mJ 8Hz	G V Er:YAG 400mJ 16Hz	G VI Nd:YAG 1W 10Hz	G VII Nd:YAG 2W 10Hz	G VIII Nd:YAG 1W 15Hz	G IX Nd:YAG 2W 15Hz
0.072	10.840	0.910	0.530	0.470	1.450	0.340	0.300	0.000
0.607	12.230	0.920	0.940	0.560	1.280	0.390	0.290	0.310
0.000	0.000	0.460	0.550	0.430	1.240	0.000	0.620	0.000
0.000	5.300	0.440	0.590	0.570	0.380	0.310	0.360	0.290
0.000	0.460	0.570	0.870	0.460	0.330	0.670	0.310	0.000
0.160	10.600	0.670	0.360	0.390	0.410	0.320	0.290	0.250
0.620	0.510	0.430	0.650	0.470	0.440	0.390	0.340	0.000
0.241	9.520	0.530	0.520	0.500	0.410	0.370	0.370	0.000
0.300	12.880	0.840	1.560	0.610	0.550	0.200	0.290	0.210
X = 1.69 ± 2.47	**X= 6.23 ± 5.53**	**X= 0.58 ± 0.28**	**X= 1.88 ± 3.65**	**X= 0.56 ± 0.21**	**X = 0.65 ± 0.49**	**X = 0.49 ± 0.52**	**X = 0.39 ± 0.16**	**X = 0.29 ± 0.44**

4. DISCUSSION

This study confirmed that smear layer leads to cervical microleakage of the root canal sealed with Sealer 26 and lateral condensation technique. This technique is the most popular (9) because it includes additional accessory cones to fill spaces. The methodology used is important for the study of cervical microleakage because India ink ions have smaller molecules than bacteria and their subproducts. Ink leakage indicates there is leakage in the filling and that bacteria and their subproducts can pass.

Alves et al. (13) observed that *Campylobacter rectus, Peptosteptococcus micros, Fusobacterium nucleatum, Prevotela intermedia* digest the smear layer easing their penetration. When smear layer is not removed, the durability of both cervical and apical seal should be evaluated over a long period, because it may disintegrate and dissolve, creating a void between the root canal wall and the sealer.

In this study, leakage was found in all groups studied, only the depth of microleakage varied. This was also observed Behrend et al. (14), Leonard et al. (15) and Taylor et al. (16). However, the use of Er:YAG laser did not show better effects on coronal leakage when compared with EDTAC.

When EDTAC was compared to Nd:YAG laser there was a statistically significant difference only when 1 W and 10 Hz was used and a similarity with the other potencies and frequencies, characterizing the groups with the lowest cervical microleakage. The increase in the frequency led to lower cervical microleakage in both sutdied potencies.

The lower microleakage values found for Nd:YAG laser can be explained by the exposure and re-cristalization of the dentine canalicilli performed by this laser which leads to a reduction of permeability (17).

Because a major goal of root canal filling is to prevent bacterial penetration and protect periapical tissues from disease, EDTA, Er:YAG or Nd:YAG lasers that remove smear layer should be used because they reduce cervical microleakage.

5. CONCLUSIONS

However, for the best result in laser application a new fiber optic tip that scatters the laser light in all direstions and surfaces of the root canal leading to a uniform surface, and new sealers, techniques and methods for root canal treatment must be developed, because cervical or apical leakage of the root canal filling is an important factor of treatment failure.

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