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Original

Comparison of the effect of Er, Cr-YSGG laser and ultrasonic retrograde root-end cavity preparation on the integrity of root apices

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Abstract: The aim of this study was to compare the effect of Waterlase laser and ultrasonic root end cavity preparation on the integrity of root end in extracted human teeth. The canals of 60 extracted maxillary central incisors were cleaned, shaped, obturated and 3 mm of the root end was resected and examined for the presence of any cracks. Class I root-end cavities were then prepared using an ultrasonic unit or Waterlase laser. In the ultrasonic group, KIS 2D tip and medium intensity and in the laser group, 600 μm laser tips and an output power setting of 4 W with 55% water and 65% air were used to prepare the cavity which was studied for the presence of any cracks or chippings. One crack was found in the ultrasonic group, while no cracks were observed in the laser group. There was no significant difference between the two groups ($P > 0.05$). As for the chipping effect, seven cases (23%) had chipping after cavity preparation in the ultrasonic group but no chipping was found in the specimens of the laser group and the difference was statistically significant ($P < 0.05$). According to the results of this *in vitro* study, laser preserves the integrity of root-end cavities better than ultrasonic devices from the standpoint of producing chipping. (J Oral Sci 52, 77-81, 2010)

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Introduction

The use of ultrasonic tips has become widely accepted for root-end cavity preparation as they have a number of advantages including their smaller dimensions and improved access to the resected root-end cavities (1).

Saunders et al. (2) were the first to report more crack propagation in resected root-end surface with ultrasonic root-end preparation than a round bur on a slow-speed handpiece. Furthermore, Abedi et al. (3) studied the effect of root-end cavity preparation with bur and ultrasonic and concluded that significantly fewer cracks were observed with bur compared to ultrasonic. Waplington et al. (4) found no significant difference in cracking between high power ultrasonic and bur; however, the chipping was more associated with the ultrasonic device.

Studies have demonstrated that using a higher power setting of the ultrasonic device for root-end cavity preparation creates more cracks compared with medium and low powers (5,6). In another study, De Bruyne et al. (7) investigated the root-end integrity after preparing root-end cavities with medium and low power settings of the ultrasonic unit and observed no significant difference in the cracks produced between medium and low powers.

Waterlase laser (Biolase® Technology Inc, San Clement, CA, USA), an Er, Cr:YSGG laser (Erbium, Chromium: Yttrium, Scandium, Gallium and Garnet) has been presented as an effective means to resect root ends, prepare root-end cavity, staunch blood, and sterilize root apex and surrounding tissues in endodontic surgery (8). The

Waterlase cuts the hard tissues with highly energized water particles, while the soft tissue incisions are done with direct laser energy (8). A study by Karlovic et al. (9) on existing cracks in root-end cavity preparation with Er:YAG laser and ultrasonic device showed that cavity preparation with Er:YAG laser created significantly less cracks compared with the ultrasonic. Wallace (10) investigated the effect of Waterlase laser on root-end preparation and observed only one crack during cavity preparation of 36 teeth (10).

An advantage of Waterlase over other lasers is that all surgical steps including soft tissue cutting, bone removal, root-end resection, removal of pathologic and hyperplastic tissue and root-end preparation can be accomplished using only Waterlase (11). Different studies have been carried out on various methods of cavity preparation with bur, ultrasonic device and other lasers; however, Waterlase laser has not been compared with common methods of cavity preparation. The aim of this study was to compare the effect of Waterlase laser and ultrasonic root-end cavity preparation on the integrity of the root apex.

Materials and Methods

Sixty single-rooted upper central incisors with straight roots and fully-developed apices were selected for this study. The teeth were stored in 0.2% aqueous solution of thymol. The outer surface of the root was curetted mechanically and immersed in 1% NaOCl for 30 min for disinfection. The teeth were decoronated and cut up to CEJ with a diamond bur. Working length was established at 1 mm short of the anatomical apex confirmed by #15 K-file (Maillefer, Dentsply, Ballaigues, Switzerland). Root canals were cleaned and shaped using step-back technique with MAF #40 and were flared to file #80. After preparation, the canals were dried with sterile paper points and then obturated with gutta-percha (ARIA Dent, Tehran, Iran), and AH plus sealer (Dentsply, Detery Konstanz, Germany) using NiTi spreader (Maillefer, Dentsply, Ballaigues, Switzerland) with cold lateral condensation technique. Samples were kept for 48 h after obturation. Then, 3 mm of root end was resected perpendicular to the long axis of the roots with a fissure bur (D&Z, Diamant, Germany) under water spray. After root end resection, the teeth were immersed in 0.004% methylene blue solution for 48 h and then examined for the presence of any cracks using a stereomicroscope (Zeiss, Oberkochen, Germany) at ×40 magnification. Teeth with cracks were excluded and replaced with teeth devoid of cracks.

Resected root ends were photographed and the teeth were randomly divided into two groups each containing 30 teeth. One group was subjected to root-end cavity preparation with ultrasonic Kis Retrotips (Spartan Ultrasonic Tip, Kis, Fenton, Missouri, USA) and ultrasonic unit (Spartan Ultrasonic, Fenton, Missouri, USA) at a frequency of 32 kHz and medium intensity. An intermittent pressure with in-and-out motion was used to prepare a depth of 3 mm from the resected surface with cooling water. Finally, circumferential motion was used to complete the preparation.

In the other group, the root-end cavity was prepared with Er, Cr:YSGG laser with a 600 μm laser tip and a power setting of 4 W, with 55% water and 65% air according to the manufacturer's instructions. Class I cavity was prepared with 3 mm depth and 1 mm diameter. The total preparation time for both methods was less than 2 min. Teeth were immersed in the saline between test intervals.

Then, the teeth were immersed in 0.004% methylene blue solution for 48 h and again they were observed under a stereomicroscope at ×40 magnification to examine the existence of cracks and chippings by one expert operator who was blind to the experimental groups (Waterlase laser or ultrasonic device). Statistical analyses were carried out using the Statistical Package for Social Sciences version 15. Fisher's Exact test was used. *P*-values of <0.05 were considered to be statistically significant.

Results

Only one crack was seen in the ultrasonic group, while there were no cracks in the laser group (Figs. 1a and 1c) and the difference was not significant ($P > 0.05$) (Figs. 2a and 2b). Chipping was found in seven samples of the ultrasonic group (Fig. 1b), while there was no chipping in the laser group, and the difference was statistically significant ($P = 0.01$) (Figs. 2a and 2b).

Discussion

In periradicular surgery, one of the most important steps in achieving an apical seal is root-end cavity preparation in the resected root end with enough space to insert root-end filling material and prevent unnecessary damage to the tooth structure (1,12). Therefore, the present study was designed to investigate the integrity of root end following root-end cavity preparation with an ultrasonic device and laser.

According to a study carried out by Gray et al. (13), there was no difference between extracted and cadaver teeth in crack production; therefore, extracted teeth were used in this study. In addition, fissure bur was used for root resection. However, Gondim et al. (14) used a hard tissue microtome to prevent crack production. Burs were used for root resection to simulate the clinical situation; however, for the purpose of homogeneity, teeth showing cracks

following root resection were excluded from the study.

To examine the existing cracks at the root end, methylene blue dye technique and a stereomicroscope were used which, according to Wright et al. (15), is a precise method for studying cracks. Because of the possibility of producing artificial cracks during preparation of specimens, an electron microscope was not used (16).

Crack propagation in the ultrasonic group was similar to the results of Morgan et al. (17) and Peters et al. (18) (less than 5%) but it was less than the findings of Ishikawa et al. (19).

The reason for less cracking in the present study could be the medium intensity of the ultrasonic unit. According to De Bruyne et al. (7) using medium ultrasonic intensity produces significantly less cracks compared to high ultrasonic intensity. In addition, prevention of stress during teeth extraction, drying of the teeth, and storage medium contributed to the existing cracks before the experiment (18).

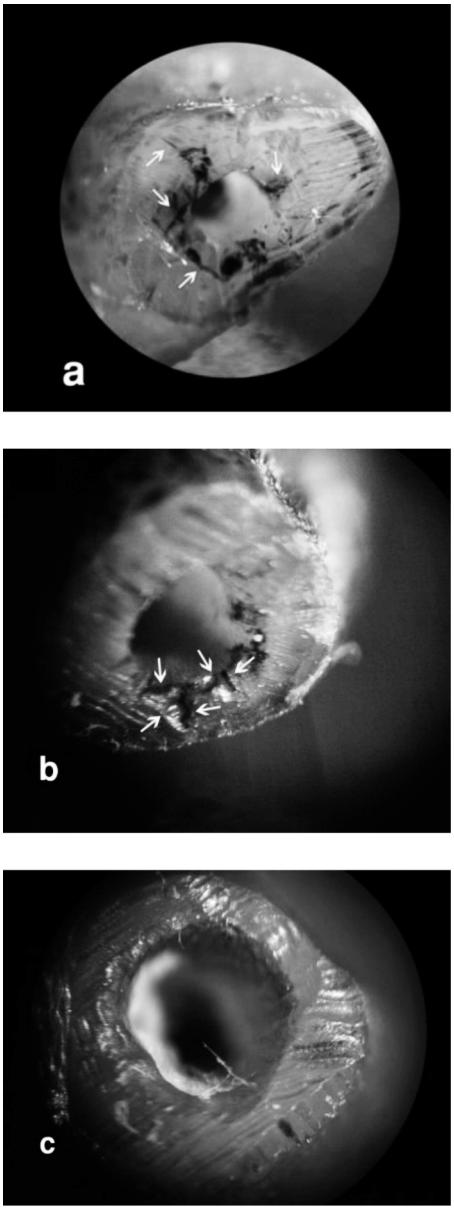
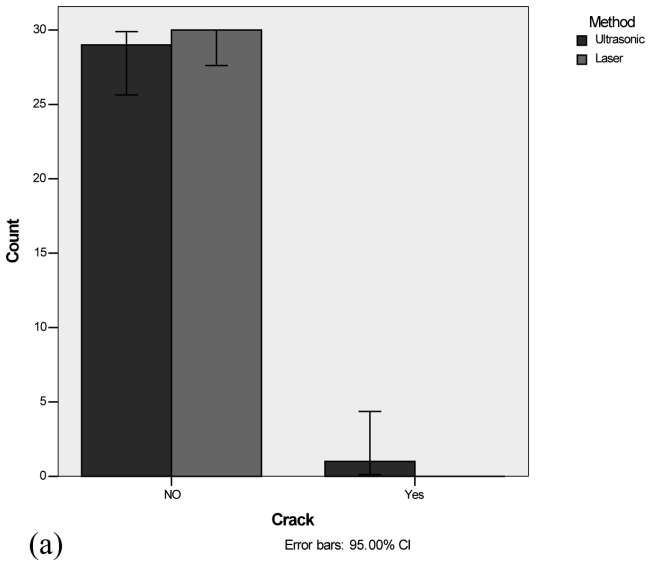
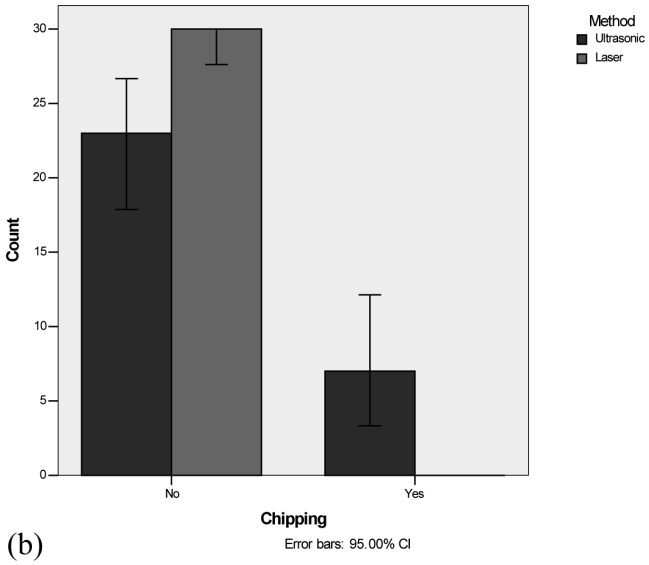


Fig. 1 Stereomicroscopic view of root end cavity preparation (original magnification ×40)
(a) Root end showing crack after ultrasonic root-end preparation (b) Root-end showing chipping at margins of ultrasonic root-end preparation with c device. (c) Root end preparation with Er,Cr:YSGG laser without crack and chipping.



(a)



(b)

Fig. 2 (a) Crack and (b) chipping in root-end cavity preparation with ultrasonic device and laser.

In the laser group, Er, Cr:YSGG pulsed laser was used for root-end cavity preparation (10). Energized water molecules cut the dentin in a way that the temperature of root surface during cavity preparation remains low, which is critical for the surrounding bone. Er, Cr:YSGG laser was used according to manufacturer's instructions and the cavities were prepared with 3 mm depth and 1 mm width. The prepared cavities had no cracks which might be attributed to the absence of crack-producing factors, namely vibration and pressure during root-end cavity preparation (10).

Chipping was also investigated following cavity preparation and the difference of the methods applied was significant (seven cases with ultrasonic vs. none with laser). In the previous studies, more chippings were observed after preparation with the ultrasonic device (13,20). Although the importance of chipping in root-end cavity preparation has not been determined, it may affect marginal seal and long-term prognosis of treatment (7). In the present investigation, chipping was considered as damage to the tooth structure involving intracanal and/or the resected surface. No chipping during root-end cavity preparation may be an advantage of the laser over ultrasonic preparation. Despite this, since the effect of chipping on sealing ability and marginal seal of root-end filling materials in periradicular surgery has not been defined, future studies are needed to determine the effect of chipping on marginal seal with different laser parameters; SEM studies are also required to find out the reason for crack formation or chipping, and temperature measurements during cavity preparation are clinically important subjects that should be studied.

Regarding the results of Rahimi et al. (21), there were no significant differences among three different thicknesses of MTA (1, 2 and 3 mm) in preventing leakage even at a thickness of 1 mm, and it seems that preparation of root-end cavity with Er, Cr:YSGG laser and filling with MTA as a root-end filling material lead to better results in periradicular surgery.

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