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Temperature Variation on Root Surface During Retrograde Cavity Preparation Using Different Ultrasonic Tips

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Abstract

Introduction: During root-end cavity preparation, thermal changes may occur on the external surface of the rootwhich may cause injury to the periodontium.

Objective: The aim of this study is to evaluate thermal changes during ultrasonic retrograde cavity preparationusing smooth stainless steel or diamond coated ultrasonic tips.

Methods: Root-end section level was set at 3 mm from the apex, and all the roots were resected with 90-degreeangle to their longitudinal axis. Samples were randomly divided into two groups of 10 teeth each for two differentultrasonic tips to be used, i.e. smooth stainless steel ultrasonic tip and diamond coated ultrasonic tip. Tefloninsulated type K temperature probe were used to measure temperature changes during the root-end cavitypreparations.

Results: The temperature rise value of the overall maximum temperature (mean ± standard deviation) wassignificantly higher in coated group (41.11 ± 3.02) than that of the smooth group (32.22 ± 2.44). A statisticallysignificant difference was observed between both groups ($P < 0.0001$).

Conclusion: Temperature rise is significantly higher while using diamond coated retrotips.

Keywords : temperature; retrograde cavity; preparation; ultrasonic.

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Introduction:

Successful outcomes during periapical surgeries depend mainly on the management of the resected root end (1). Unwanted communication between the diseased root canal and the adjacent periodontal ligament as a result of anatomical complexities of the root canal can cause procedure failure (2). Most of anatomic complexities that is the main source of failure can be eliminated with a 0° bevel angle root resection 3mm from the apex. The main objective of the root-end preparation is a cavity creation for placing the retrograde fillings, to ensure that the root apex is properly sealed. Recently, the most common method for retrograde cavity preparation used is ultrasonic preparation techniques instead of preparation using conventional burs(3). Away from the conservative preparation of ultrasonics, it also requires a less angulated root resection and allows the uniform distribution of the filling material and offers more effective apical sealing because it results in deeper cavity and more parallel walls that can improve the retention(4). During ultrasonic retrograde cavity preparation, thermal changes on the external root surface must be evaluated to assess the injury that may occur to the periodontium and bone tissue. Bone alkaline phosphatase inactivation has been related with high temperatures, around 56 °C (5). Another study reported that bone tissue was sensitive to heat at 47 °C (6). It has also been stated that a 1-min exposure to a 53 °C temperature may result in interruption of blood flow in the bone (7). Exposing the periodontal ligament to a 43 °C temperature may result in protein denaturation (8). However, it is generally approved that 10 °C is the critical temperature rise at which injury may occur to tooth supporting tissues (9,10).Although it is widely recommended for root-end preparations to use the ultrasonic techniques, the reports of the temperature changes evaluation during root-end cavity preparation are limited. The main objective of this study is to evaluate thermal changes during ultrasonic retrograde cavity preparation using smooth stainless steel or diamond coated ultrasonic tips.

Materials and Methods:

Twenty recently extracted, mature apex, defect-free human maxillary central incisor teeth were obtained from patients scheduled for extraction as a part of their dental treatment for periodontal reasons. Crowns were sectioned away from the teeth using a diamond disc while maintaining a 15-mm length of the root with a flattened, cut surface in order to standardize the canal length (CL)(11). Each root was cleaned, shaped and obturated. Determining working length (WL) was done by extracting 1 mm of the point where a K-file size 15 will be seen from the apical foramen. Preparation of root canal system was done using three file system Mpro Niti rotary technique (IMD, Innovative Material and Devices, Inc, Shanghai, China). Orifice opener was used to prepare coronal part of the canal followed by file size 20 taper 4% and file size 25 taper 6% preparing full working length followed by manual filling to size 50 K file with saline irrigation then drying using paper points. Obturation was done by gutta-percha and Adseal resin based sealer (Meta Biomed Co., LTD, Chungcheongbuk-do, Republic of Korea) using lateral condensation technique. After the obturation was done, every single root was numbered, and radiographed to confirm the obturation quality. The roots were put in storage in an incubator at 37◦C and 98% humidity for one week to allow complete setting of sealer(12).

3 mm from the apex was sectioned away, and all roots were resected with 90-degree angle to their longitudinal axis. A carbide tungsten operative bur was used to complete the root-end and the section surface

was smoothed with a carbide tungsten finishing bur under water spray cooling.

A single layer of aluminium foil was used to wrap each root and then embedded in an auto-polymerizing hydrophilic vinyl polysiloxane putty impression material in an acrylic tube (8 mm height and 20 mmr diameter), ensuring that each root was positioned centrally with the long axis of the root allied parallel to the acrylic tube sides with the apical end (4mm) exposed and emerging from the resin. Then the roots were detached from the tube and the aluminum foil peeled off. The root space and the root surface were coated with a thin layer of light body hydrophilic vinyl polysiloxane impression material, and the root was immediately repositioned in the acrylic resin socket. Thus, the polysiloxane occupied in the space formed by the foil representing a simulated periodontal ligament (13) and all the excess material was removed (Figure 1).

Figure 1: Root centrally embedded in putty and surrounded by a thin layer of light body polysiloxane impression material

All 20 samples were coded then distributed randomly into two groups according to the tips used to prepare the retrograde cavity into:

- Group I: Prepared by smooth stainless steel ultrasonic tip.
- Group II: Prepared with diamond coated ultrasonic tip.

A 3mm smooth stainless steel ultrasonic tip (Figure 2.A) was used to prepare group I samples and a 3mm diamond coated ultrasonic tip (Figure 2.B) was used to prepare group II samples. Root-end preparation was done by the equivalent ultrasound unit and following the manufacturers' recommendations with Endo power mode at level 6 of intensity under continuous saline solution irrigation using 5mm plastic syringe as recommended by the manufacturer.

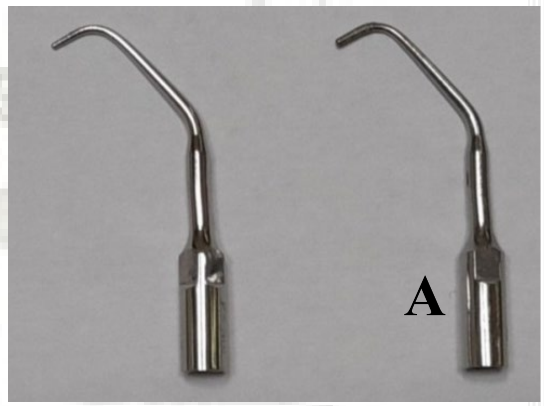

Figure 2: Woodpecker ultrasonic tips (A) E10 smooth stainless steel tip, (B) E10D diamond coated tip.

Minimal pressure and intermittent cutting with in and out movements until a 3 mm deep apical cavity from the resected surface was done, followed by circumferential motion to complete the preparation. Specimens were maintained in the silicone blocks and kept hydrated during the procedures. This procedure was accomplished by a single operator, and fixed with a pench holder while preparation is carried out to minimize external forces.

Once a visibly debris-free preparation have been obtained, the rootend cavity was considered finished. All preparations were class I according to Black's classification; the preparation is parallel to, and centered within, the anatomic outline of the pulpal space. A millimetric periodontal probe was used to check the cavity depth to standardize the retro-preparation and to make sure that there is no debris or remaining root canal filling material.

Teflon insulated type K temperature probe (model UT61B, Uni-trend Technology, China) (Figure 3) was used to measure temperature changes during the rootend cavity preparations. A temperature probe was cemented on the root surface 1mm from the root end. After few seconds, the measured value shows on the display. Room temperature was maintained at 24°C. The maximum temperature was recorded during experimental process for each specimen.

Figure 3: Uni-T Modern digital Multimeter and Teflon insulated type K temperature probe.

Results:

Statistical analysis for raw data concerning temperature rise in ° C for the evaluated groups are presented in Table 1 and figure 4.

An increased overall basal root temperature rise caused by temperature accumulation during root end cavity preparation was observed in both groups. The temperature rise value of the overall maximum temperature (mean ± standard deviation) was significantly higher in coated group (41.11 ± 3.02) than that of the smooth group (32.22 ± 2.44). A statistically significant difference was observed between both groups (P < 0.0001).

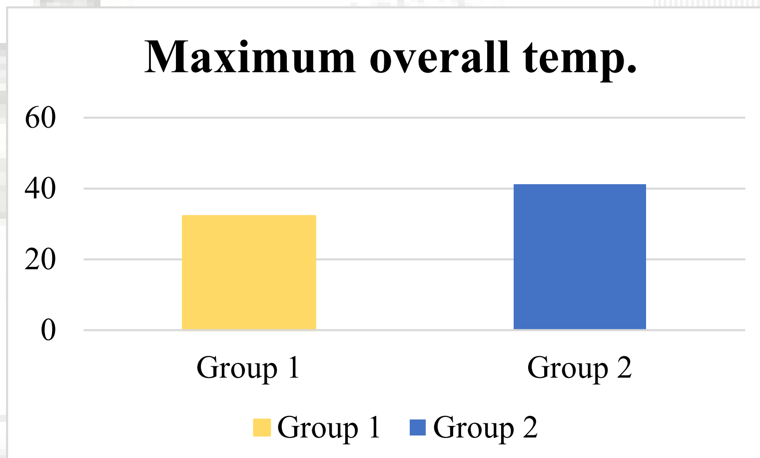

Figure 4: Bar chart showing Mean and Standard Deviation (SD) values of the Maximum overall temperature rise

Table 1: Mean temperature rise during root-end cavity preparation procedures

Group	Mean	Standard deviation	Minimum temp. rise	Median	Maximum temp. rise	P value
Group I: SS	32.22	2.44	29	33	36	P < 0.0001
Group II: DC	41.11	3.02	37	41	46	

Discussion:

The introduction of ultrasound equipments for rootend cavity preparation has significantly enhanced the treatment outcome in apicoectomy with retrofilling, several studies have confirmed it as a technical advancement with positive impact on the endodontic microsurgery clinical outcome (14,15,16). Ultrasonic retro-tips have been designed in a diversity of forms and angles improving the accessibility to the root end, reducing the aggressive cutting in tooth structure and beveling of root, and enabling cavity preparation with sufficient depth centered within the long axis of the tooth (14). Moreover, higher success rates were reported clinically when rootend cavity preparation was done using ultrasonic tips rather than classical rotary burs (16).

The aim of this study was to evaluate thermal changes during ultrasonic retrograde cavity preparation using smooth stainless steel and diamond coated ultrasonic tips.

The instruments used were the E10 stainless steel and E10D diamond-coated Woodpecker ultrasonic tips (Woodpecker Co., LTD, Guangxi, China) which were selected as there were no enough literature reviews on them and also for their economic price which is good in comparison with other tips (Satelec, NSK and Spartan). Diamond-coated (DC) retrotips produce quality root-end preparations faster and more effectively than stainless steel (SS) tips. Comparisons of DC and SS tips for root-end preparation by Peters et al (17) and Ishikawa et al (18) revealed that a shorter preparation time was required with DC retrotips than with SS tips. But on the other hand, diamond-coated tips can lose their particles with overuse (19).

In the present study, roots of maxillary central incisors were used to relatively mimic the clinical condition and to neutralize the effect of dentin thickness. Irrigation with saline was used as it was previously recommended because it causes the least amount of changes in dentin over time (20). The apical 3 mm of the apex of all roots was marked by an endodontic ruler to standardize the cutting level and was resected at a 90-degree angle to their longitudinal axis using a carbide tungsten operative bur and the section surface was smoothed with a carbide tungsten finishing bur under water spray cooling. The root surfaces were checked with a dental operating microscope (Seiler Instrument Inc., St. Louis, USA) under 16x magnification, to assess the presence of microcracks. Roots present with microcracks were discarded and replaced immediatly. A thin uniform layer of silicone (A hydrophilic vinyl polysiloxane impression material) was used to surround the root simulating the periodontal ligament, then the root was embedded in auto-polymerizing hydrophilic vinyl polysiloxane putty impression material in an acrylic tube (8 mm height and 20 mm in diameter) to simulate the surrounding bone. A teflon insulated type K temperature probe was cemented on the root surface 1mm from the root end to measure temperature changes during the root-end cavity preparations. When comparing temperature changes, the diamond coated group caused significantly higher temperature rise than stainless steel smooth group. Kocher et al (21) concluded that the temperature rise when using diamond coated sonic scaler was higher than using conventional stainless steel sonic sealer, this could be attributed to the SS removes dentin in an intermittent way, while diamond-coated sonic sealer continuously grinds it off. Madarati et al (22) stated that the diamond coated tips cut more dentin causing friction that may cause higher temperature generation. Brent et al (23) found that the DC instruments could not be introduced passively into the root canals unless the diameter of the canal was equal to, or greater than, the tip of the diamond-coated instrument. When the root-end preparation was attempted using diamond-coated instruments alone, the diamonds were rapidly worn from the tip of the instrument. Once the tip of the instrument is rounded and worn, it would not enter the canal without having to apply additional force which may be a reason explaining why DC tips caused more temperature rise than SS tips.

Conclusion:

Temperature rise is significantly higher while using diamond coated retrotips than that of smooth stainless steel retrotips.

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