Effectiveness of Three Different Retreatment Techniques in Canals Filled With Compacted Gutta-Percha or Thermafil: A Scanning Electron Microscope Study

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Abstract

Introduction: This study evaluated the root canal wall morphology under scanning electron microscopy magnification after removal of 2 types of root canal fillings by using ultrasonic tips, nickel-titanium (NiTi) rotary instruments, and hand K-files. **Methods:** Thirty-six extracted roots were filled by using AH Plus (DeTrey-Dentsply, Konstanz, Germany) as a sealer with Thermafil (Tulsa Dental Products, Tulsa, OK) (18 roots) or warm vertically condensed gutta-percha (18 roots). All fillings were removed up to the middle third by using Gates Glidden drills. The retreatment was completed by using K-files (group 1), M-Two NiTi rotary instruments (group 2), or ESI ultrasonic tips (group 3) in 12 roots each. Root canals were irrigated by using 10% ethylenediaminetetraacetic acid and 2.5% NaOCl. The samples were split longitudinally and observed by scanning electron microscopy (100–2000×). The presence of smear layer, filling debris, and the surface profile was evaluated in each picture. Kruskal-Wallis (analysis of variance) and Mann-Whitney tests were used to evaluate the differences between the obturation techniques, the 3 retreatment methods, and the canal thirds ($P < .05$). **Results:** Resin sealer tags were observed inside dentinal tubules. No statistical differences ($P > .05$) were found among the 3 retreatment methods. No statistical differences were observed between Thermafil and vertically compacted warm gutta-percha for each group or between the coronal third used as control, middle, and apical thirds. **Conclusions:** All retreatment techniques showed similar performances in terms of smear layer morphology, debris, and surface profile. None of them completely removed filling debris from dentinal tubules of apical third. *(J Endod 2009;35:1433–1440)*

Key Words

Gutta-percha removal, K-files, Ni-Ti instruments, root canal retreatment, Thermafil, ultrasonic tips

The clinical success rate of endodontic retreatments has been estimated to vary between 50% and 90%, depending on the effective elimination of necrotic tissue, bacteria, and infected obturation material such as gutta-percha and cements from root canal (1–4).

Gutta-percha might be removed by using solvents, stainless steel rotary, manual, heated endodontic and ultrasonic instruments (1, 5, 6). However, retreatment techniques do not completely remove the obturation materials from the root canal (1, 6, 7).

The Thermafil (Tulsa Dental Products, Tulsa, OK) root canal obturation system has greatly simplified root canal filling procedures but has probably made retreatment procedures more difficult (7). *In vitro*, the Thermafil system produces a homogeneous mass of gutta-percha in the canal (8). However, an oval-shaped canal might compromise the quality of root fillings, even when using thermoplasticized techniques like Thermafil or thermomechanical compaction (9). A radiographic study by Baratto-Filho et al (7) showed that Pro-File nickel-titanium (NiTi) rotary instruments could not completely remove the gutta-percha present in Thermafil root canal fillings.

The development of ultrasonic tips (10) and rotary NiTi instruments has modified endodontic therapy. The ability of these new systems during retreatments has been studied by *in vivo* investigations (11, 12). Other *in vitro* studies evaluating the use of NiTi rotary instruments to remove root canal filling materials demonstrated that they are timesaving but fail to remove all debris (7, 13–16).

Ultrasonic endodontic tips have been proposed for root canal instrumentation, the removal of broken instruments, and cavity root-end preparation (10). Unfortunately, no complete information is yet available regarding their ability to remove gutta-percha and sealer from root canals.

The amount of gutta-percha remaining in root canals after retreatment with manual files and solvents has been measured by using radiographs, dental operating microscopes (17–21), and, more recently, by scanning electron microscopy (SEM) observation (1, 5, 13, 15–23).

For these reasons, further morphologic investigations are required to establish whether NiTi and ultrasonic instruments are effective in removing debris from inner dentin of previously filled root canals. M-Two (Sweden & Martina, Padova, Italy) NiTi instruments have been studied and used in daily clinical practice. They present positive rake angles, no radial lands, progressive blade chamber (pitch) in the apical-coronal direction, and a noncutting tip. The M-Two cross-sectional design resembles that of the S-File (24).

The aim of this study was to undertake an SEM investigation into the effectiveness of 3 different retreatment methods (ultrasonic tips, NiTi rotary instruments, and K-file

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manual instruments) in removing warm vertically condensed gutta-percha or Thermafil filling material from previously *in vitro* filled root canals.

Materials and Methods

Root Canal Preparation

Thirty-six single-rooted straight teeth of similar length extracted for periodontal reasons were selected. The crowns were removed with a diamond bur at cementoenamel junction level by using a high-speed water-cooled handpiece. Two longitudinal grooves of 1-mm depth were prepared with a diamond bur on the palatal and buccal surfaces of each root to facilitate vertical splitting for microscopic observation after retreatment.

The glide path was verified with a 10 K-file (FKG, La Chaux-de-Fonds, Switzerland). Samples with 2 canals or calcification were excluded from the study. Coronal thirds were enlarged with Gates Glidden 1-2-3 (Maillefer-Dentsply, Ballaigues, Switzerland), followed by K-file 10-15-20-25-30-35-40-45-50 used in step-back sequence. The apical gauging for each canal was set at 35 with K-files. Each sample was irrigated with 5 mL NaOCl at 2.5% (Niclor 2.5; Ogna, Muggiò, Italy) and 5 mL liquid ethylenediaminetetraacetic acid (EDTA) at 10% (Tubuliclean; Ogna) during canal preparation. The root canals were dried with sterile paper points (Mynol, Milwaukee, WI) and filled with vertical condensation of warm gutta-percha with System B (Sybron Endo, Orange, CA) (N = 18) or Thermafil (N = 18). AH Plus (DeTrey-Dentsply, Konstanz, Germany) was used as sealer. Regardless of the working length (WL) of each tooth, the extension of the root canal filling was uniformly limited to 15 mm from the apical extension of the filling, so that the volume of the gutta-percha was as equal as possible for all teeth (1). Each root was covered with a pellet and Coltosol (Coltene, Kostanz, Germany) and then immersed in tap water and stored for 2 weeks at room temperature in a test tube.

The samples were randomly assigned to 1 of 3 groups for retreatment. Each retreatment group was composed of 12 elements, 6 filled with AH Plus/Thermafil and 6 obturated with AH Plus/warm gutta-percha vertically compacted with System B.

Retreatment Technique

Coltosol cement was gently removed by using ultrasound tips (Piezon 5; Castellini, Bologna, Italy) in both filling groups (AH Plus-Thermafil and AH Plus-gutta-percha). As first retreatment step, different Gates Glidden 4-3-2 at 1000–1200 rpm were used in all 36 filled roots for preliminary treatment of the coronal third and half of the medium third to remove most of the gutta-percha up to half the length of the root canals.

In the Thermafil group, the entire portion of the plastic carrier and gutta-percha was easily removed with the Gates Glidden, and only small plastic fragments were probably left inside the root canals.

Throughout the procedures, 5 mL of 2.5% NaOCl and 5 mL of 10% EDTA were used to irrigate the root canals.

Group 1: NiTi Retreatment Group (N = 12)

A size 15 K-file was used to reach the preliminary WL. A size 40 M-Two NiTi rotary instrument (Sweden & Martina) on a 16:1 reduction handpiece powered by an electric motor (Tecnika Digital Torque Control Motor; ATR, Pistoia, Italy) with a constant speed of 300 rpm, and low torque was introduced into the root canal up to approximately 2.0 mm to the WL and gently used for 60 seconds. A size 20 (4% tapered) M-Two rotary instrument followed by size 25 (6%)-30 (4%)-35 (5%)-40 (4%) M-Two at 250 rpm were used to the WL. A rotary motion was alternated with the push-pull movement. A NiTi Mtwo instrument size 40 was used, so that it was approximately 0.05 mm larger than the original preparation.

Group 2: K-Files Retreatment Group (N = 12)

A size 15 K-file was used to reach the preliminary WL. Retreatment was carried out by K-files with a push-pull movement alternated with a rotary motion. K-files of different sizes were used until the WL was reached and the root was cleaned. A K-file 40 was used as last file at the apex.

Group 3: Ultrasound Retreatment Group (N = 12)

A size 15 K-file was used to determine the WL of the root canals. Ultrasound ESI tips of different sizes (15–35) mounted on a Piezon 5 (Castellini) were used in a circumferential motion until the WL was reached. The master tip at WL was no. 35. A K-file 40 was then used to finish apical thirds.

A final irrigation with 2.5 mL of NaOCl, 2.5 mL of EDTA, and 2.5 mL of NaOCl concluded the retreatment procedure in the 3 groups.

The retreatment procedure in each group was considered complete when apical file 40 fitted loosely in the root canal at full WL, and no debris of materials was visible to the naked eye on the file surfaces after removal from the canal (19).

SEM Preparation

The samples were fixed in a 4% glutaraldehyde 0.2 mol/L sodium cacodylate buffer solution for 48 hours and then sectioned in half with a chisel. Random halves were dehydrated in graded alcohol concentrations, dried, and then gold-sputtered (Sputter Coater; SPI, Toronto, Canada) and observed by SEM (JEOL 5200; JEOL, Tokyo, Japan).

After a general survey of the root canal walls, 3 SEM photos of each third of the root canal were taken, 2 at a magnification of 2000× to score the smear layer and inorganic debris (coronal, middle, and apical) and 1 at 75× or 100× to evaluate the surface profile.

The images were saved digitally with proprietary software (SemAfore; JEOL) and individually scored blind by 2 trained operators.

SEM Evaluation Methods

In selected SEM pictures the absence or presence of the smear layer and filling debris was rated and scored by using a predefined scale (24, 25) by an independent observer. The dentin surface profile was assessed by evaluating the presence of grooves, pits, and predentin areas (Table 1).

Each root canal was divided into 4 portions (coronal, coronal-medium, apical-medium, apical), and each portion was evaluated separately. The medium thirds were divided into 2 different portions (coronal medium and apical medium) because the coronally placed portion was instrumented with Gates-Glidden and only the apical part with 1 of the 3 tested retreatment techniques. Coronal third and coronal part of the middle third served as positive controls.

Statistical Analysis

Data analysis was performed by using the Kruskal-Wallis test (analysis of variance) to evaluate differences between the results of the 3 retreatment methods in the 4 different root canal portions. The Mann-Whitney test was used to compare differences between the 2 obturation systems within each retreatment group. Box and whisker plots were drawn for each single parameter, showing the differences between the 3 retreatment instruments, the canal thirds, and the 2 obturation systems. The length of the notch represents an approximate 95% confidence interval for the median. Overlapping notches indicate no significant difference between the sample medians.