Efficacy of Retreatment Techniques for a Resin-Based Root Canal Obturation Material

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Abstract

Resilon/Epiphany obturation system is emerging as an alternative to gutta-percha (GP). The efficacy of retreatment techniques for Resilon removal has not been determined. The purpose of this study was to evaluate two commonly used retreatment techniques in the removal of Resilon. Sixty single-canal teeth were instrumented and obturated with either Resilon/Epiphany or GP/AH Plus. Each canal was randomly allocated to receive one of the two retreatment techniques—ProFile 0.06 rotary files combined with heat or chloroform. The time required to remove the obturation material was recorded and the cleanliness of canal walls was determined by stereomicroscope and electron microscopy. The results demonstrated that chloroform combined with rotary files was more efficient in material removal compared to heat ($p < 0.05$). Resilon was faster to remove than GP. Both techniques resulted in cleaner canal walls in the apical third of the teeth obturated with Resilon when compared to GP ($p < 0.05$). *(J Endod 2006;32:341–344)*

Key Words

Gutta-percha, resilon, root canal retreatment

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For over 100 years, gutta-percha (GP) has been the most commonly used material to obturate the root canal system. Although not the ideal filling material, GP fulfills many of the characteristics that Grossman in 1940 espoused (1). One of the disadvantages of GP as a root canal obturation material is its poor sealing ability; therefore, it must be used with a root canal sealer to provide an effective seal (2). However, when the coronal restoration is defective or absent, contamination with saliva may cause root canal sealer dissolution, thus providing a space for bacterial penetration that may contribute to the failure of the treatment (3). In addition, dentin removal during root canal treatment has been shown to weaken teeth and make them more susceptible to fracture (4, 5). Obturation with GP does not provide the teeth with any additional strengthening mechanisms. Therefore, GP-filled teeth may be more prone to fracture than intact teeth (6).

Recently a new root canal filling material was introduced. Resilon (Resilon Research LLC, Madison, CT) is a thermoplastic synthetic polymer-based root canal filling material containing bioactive glass and radiopaque fillers (7). The manufacturer claims that its handling characteristics are similar to those of GP. The significant improvement of Resilon when compared to GP is claimed to be its bonding to the dentinal walls when used in conjunction with its sealer, Epiphany root canal sealer, and forms a "monoblock" within the canal (8). Preliminary studies have shown that Resilon has significantly less microleakage when compared to GP (7, 9). A study by Tay et al. concluded that neither GP with AH Plus sealer (Dentsply, Tulsa, OK) or Resilon with Epiphany root canal sealer provided a "complete hermetic apical seal"; however, the authors suggest that an advantage to using Resilon with Epiphany root canal sealer over GP and sealer is the attainment of an "immediate coronal seal" because of the system's dual cure characteristic (10). Canals obturated with Resilon have also been shown to be more resistant to fracture when compared to GP (8).

Because of its acclaimed superior characteristics, Resilon is emerging as a promising alternative to GP. The number of teeth obturated with Resilon is expected to rise significantly in the near future. Although the long-term success rate of this new system is unknown, a number of reasons will necessitate retreatment of Resilon-filled teeth. The complexity of the root canal anatomy, the breakdown of the seal provided by the obturation and/or restoration of the tooth, or an inadequate initial root canal treatment may lead to nonhealing (11). A recent study demonstrated the susceptibility of biodegredation of Resilon "by bacterial/salivary enzymes (12). In such cases, nonsurgical endodontic retreatment would be indicated to clean, shape, and obturate the previously root treated tooth.

Many techniques have been advocated for the removal of GP from the root canal system. These include rotary files, ultrasonic instruments, heat, hand files combined with heat or chemicals, and paper points with chemicals (3). Rotary instrumentation has been shown to be more effective than Hedstrom hand files in removing GP from the root canal system (13). The effect of these retreatment techniques to remove Resilon has not been evaluated.

The purpose of this present study was to determine the effectiveness of rotary instrumentation in conjunction with heat or solvent in Resilon removal as compared to GP during root canal retreatment.

Materials and Methods

Sample Preparation

Sixty extracted human teeth with single canals were selected for this study. Only canals with mature apices and curvature of less than 20 degrees as determined by preoperative radiographs were included. These teeth were cleaned of attached tissue, autoclaved, and stored in 0.2% thymol (Sigma Chemical Co., St. Louis, MO) in normal

saline solution until use. The teeth were decoronated at the cemento-enamel junction perpendicular to the long axis of the roots so that each root was approximately 16 mm in length. The working length of each canal was established with a #15 K-file 1 mm short of the anatomical apex. The canals were instrumented using a crown-down technique with ProFile 0.06 tapered NiTi rotary instruments (Dentsply Tulsa Dental, Tulsa, OK) in a NSK Endo-Mate DT Model NE131 electric motor with a NSK F20R 20:1 reduction contra-angle (NSK Nakanishi INC., Tochigi, Japan). Master apical file was ISO size 35 for all canals. Glyde File Prep (Dentsply, Maillefer) was used as the lubricant and 5 ml of 5.25% NaOCl was used as the irrigant. The smear layer was removed by irrigating with 5 ml of 17% EDTA then by 5 ml of 5.25% NaOCl; this was followed by a final rinse of 5 ml of sterile water in all canals. The canals were then dried with sterile paper points.

The teeth were then randomly divided into two groups of 30 teeth each to receive either Resilon or GP as the obturation material. In the Resilon group, obturation was done following manufacturer technique protocol. The self-etching primer (Epiphany Primer) was introduced into the canals with sterile paper points to coat the root canal walls and excess primer was removed with sterile paper points. Then, using the continuous wave compaction technique (14), the canals of 30 roots were filled with a master cone of Resilon and back-filled with Resilon utilizing the Obtura II gun (Obtura Spartan, Fenton, MO). The other 30 canals were filled with GP (Dentsply Lexicon, Tulsa, OK) and AH Plus sealer (Dentsply) using the same continuous wave compaction and back-fill technique. Each canal orifice was sealed with 3 mm of Fuji IX GP glass ionomer restorative material (GC America Inc., Alsip, IL). Specimens were stored at 37°C in 100% humidity for 3 wk.

Retreatment

The samples with the same obturation material were further divided into two groups each containing 15 samples to receive one of the two retreatment protocols.

Protocol 1: An activated System B 0.06-tapered plugger (SybronEndo, Orange, CA) was introduced at 200°C to the point of resistance then withdrawn removing the coronal obturation material. This was followed by the introduction of a size 30 ProFile 0.06 rotary file rotating at 1300 rpm 2 to 3 mm into the canal at a time, then the flutes were cleared of debris. This sequence was repeated until the rotary file went to working length. Crown-down instrumentation was then performed using ProFile 0.06 rotary file system at 350 rpm with Glyde File Prep endodontic lubricant (Dentsply Maillefer) to remove the remaining obturation material. There was 5 ml of 5.25%NaOCl used as the irrigant in each canal with a 30-gauge endodontic irrigating needle.

Protocol 2: A reservoir for chloroform was created within the obturation material using a size 30 ProFile 0.06 rotary file rotating at 1300 rpm. Three to five drops of the solvent were introduced into the reservoir at a time. This sequence was repeated and was followed by crown-down instrumentation using ProFile 0.06 rotary file system at 350 rpm to working length until all the obturation material was removed from each canal. There was 5 ml of 5.25%NaOCl used as the irrigant with a 30-gauge endodontic irrigating needle.

A final irrigation with 5 ml of 17% EDTA followed by 5 ml of 5.25% NaOCl was used in all samples. The end-point of instrumentation during gutta-percha and Resilon removal was determined when a size 40 ProFile 0.06 rotary file went to working length and the canal walls were free of visible debris as depicted by a radiograph. The removal of the obturation materials was timed to determine the efficiency of each technique being evaluated.

TABLE 1. Time required for material removal

Groups	Time (min)
1 (GP, ProFile + System B)	4.937 ± 0.682
2 (GP, ProFile + chloroform)	3.668 ± 0.693[a]
3 (Resilon, ProFile + System B)	3.910 ± 0.402
4 (Resilon, ProFile + chloroform)	3.011 ± 0.387[b]

Data are presented as the mean ± SD of 15 samples in each group. [a]Different from groups 1 and 4 ($p < 0.05$); [b]different from groups 2 and 3 ($p < 0.05$).

Sample Analysis

The roots were sectioned longitudinally using diamond disks (Brasseler USA, Savannah, GA) and visualized using the aid of the stereomicroscope at 20× magnification (Global Surgical Corp., St. Louis, MO). A grading system was developed with respect to the amount of residual obturation material and debris at the coronal, middle, and apical portions of each canal according to the following criteria:

1. No to slight presence (0-25%) of obturation debris on the dentinal surface
2. Some presence (25-50%) of obturation debris on the dentinal surface
3. Moderate presence (50-75%) of obturation debris on the dentinal surface
4. Heavy presence (>75%) of obturation debris on the dentinal surface

Each portion of the canal was divided into two fields each having a diameter of 2 to 3 mm to be evaluated and graded.

Electron Microscopy

Representative specimens were fixed with 10% formalin solution for 24 h and rinsed three times with a phosphate buffered solution then dehydrated with ascending concentrations of ethanol (30-100%) and air dried. Each specimen was sputter-coated with gold and examined under scanning electron microscope at 15 kV.

Statistical Analysis

Time required for material removal in each group was measured in minutes and expressed as mean ± SD. Group comparison was done using one way ANOVA. A Chi-Square analysis was performed using SPSS for Windows (SPSS Inc., Chicago, IL) to analyze canal cleanliness with regards to field, area, technique and material between experimental groups. A p value of ≤ 0.05 was used to determine significance.

All sample preparation, treatment and evaluation were performed by a single operator.

Results

Time Required for Obturation Material Removal

Time required to remove the obturation material is summarized in Table 1. All techniques were able to remove the obturation material within 5 min. Time required to remove Resilon was significantly less compared to that of GP when the same technique was used ($p < 0.05$). Chloroform in combination with ProFile was more efficient than System B in combination with ProFile ($p < 0.05$).

Effectiveness of Retreatment Techniques

No significant difference was found between the two fields analyzed in each area (coronal, middle, and apical third); therefore they were combined for further evaluation. Different areas in the canals had significantly different outcome after material removal. There was significantly more debris remaining in the apical third compared to the coronal and middle thirds in all groups ($p < 0.001$). Chi-Square analysis