Comparison of Rotary Instrumentation and Continuous Wave Obturation to Reciprocating Instrumentation and Single Cone Obturation with a Hydrophilic Sealer

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Abstract

This in vitro study compared the effectiveness between ProFile 29 Series rotary system followed by continuous wave obturation and the Endo-Eze system. Thirty-six human mandibular canine and premolar teeth were randomly separated into 2 groups of 18. Each tooth was embedded in resin and sectioned at 2, 6, and 12 mm from the apex and viewed under the scanning electron microscope at 50–150× magnification. The percentages of canal space occupied by gutta-percha, sealer, debris, and voids were measured and analyzed with Image J software. Results were calculated by using an analysis of variance model with fixed effects for method, distance, and distance interaction. Repeatability of measurements and intraclass correlation coefficients were calculated. These results demonstrated that obturation with the continuous wave technique achieved significantly more gutta-percha occupying the canal space than the Endo-Eze system. Under the conditions of this study, the continuous wave technique was less likely to exhibit voids than the Endo-Eze technique. Furthermore, neither the Profile Series 29 nor the Endo-Eze system cleaned and shaped elliptical canals consistently. *(J Endod 2008;34:99–101)*

Key Words

Hydrophilic sealer, reciprocating instrumentation, rotary instrumentation, single cone

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The development of nickel-titanium (NiTi) rotary files has revolutionized endodontics and allowed practitioners to treat root canals efficiently. However, rotary files have the disadvantage of producing only circular preparations (1, 2). Barbizam et al. (3) found hand instrumentation was more efficient than rotary. However, neither technique completely cleansed the root canal.

Chemomechanical instrumentation contributes to the success of root canal therapy. Total three-dimensional filling is as important (4). There is little research on the single-cone technique with a hydrophilic resin sealer (5). The Endo-Eze system (Ultradent, South Jordan, UT) uses reciprocating instrumentation, a single gutta-percha cone, and a hydrophilic resin sealer for obturation. It is stated that a reciprocating action cleans and shapes elliptical and ribbon-shaped canals better than the rotary system. The purpose of this study was to compare the differences of canal space contents between the Endo-Eze system and the Profile Series 29 (Dentsply, Tulsa, OK) instrumentation and continuous wave obturation.

Materials and Methods

Thirty-six human mandibular single-canal canine and premolar teeth were obtained from the Department of Oral and Maxillofacial Surgery, Indiana University School of Dentistry in accordance with Institutional Review Board guidelines. Teeth were randomly separated into 2 groups of 18. Radiographic images of each tooth were obtained from the mesiodistal and buccolingual views to exclude teeth with calcifications, curvatures greater than 30 degrees, and anatomic abnormalities. Teeth with restorations or caries invading the pulp were excluded. All samples were sterilized for 2 weeks in 10% formalin and stored in deionized water. Ideal coronal access was made before cleaning and shaping of the root canal.

In group 1, working length was determined as 1 mm short of the anatomic foramen with a #10 K-File (Lexicon; Tulsa Dental Products, Tulsa, OK); Rc Prep (Premier Dental Products, King of Prussia, PA) and 5.25% sodium hypochlorite were used with each consecutive file. Profile Orifice Openers (Tulsa Dental Products, Tulsa, OK) were used to flare the coronal half. The canals were prepared with Profile .06 tapered files (Dentsply) until the blue .06 reached the working length. Apical patency was maintained, and 5.25% sodium hypochlorite was used as a final rinse.

In group 2, working lengths were established the same as group 1. Canal preparation by Endo-Eze shaping files was used with the Endo-Eze Reciprocating Handpiece (Ultradent). Cleaning and shaping were followed according to manufacturer's instructions. ChlorCid and File-Eze (Ultradent) were used during instrumentation.

The canals were dried with paper points before obturation for group 1. The continuous wave group included a medium gutta-percha point (Lexicon; Tulsa Dental Products) placed to working length with Roth 801 Elite Sealer (Roth Dental Company, Chicago, IL). Excess gutta-percha was removed at the canal orifice with the System B plugger (EIE/Analytic Technology, San Diego, CA) at 200°C. The System B fine medium tip was placed to 5 mm within the working length. The cooled System B tip with pressure was left at this point for 10 seconds, followed by a 1-second burst of heat and removal of the tip. Finally, the Obtura II (Obtura/Spartan, Fenton, MO) was used to back-fill the canal with thermoplasticized gutta-percha.

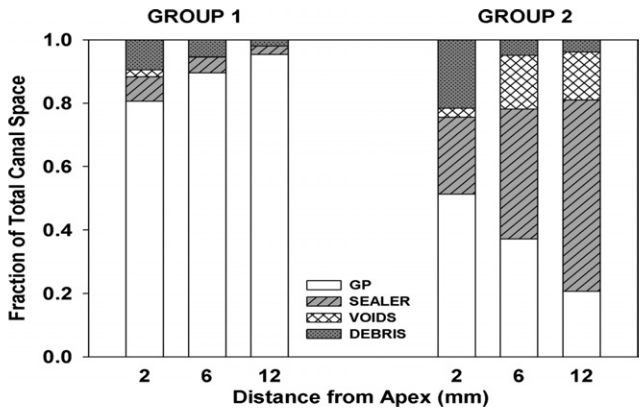

Figure 1. Fraction of total canal space at 2, 6, and 12 mm for the 2 groups.

Obturation for group 2 included a size #35 gutta-percha cone (Ultradent Premium Stiff Gutta-Percha; Ultradent) fitted to length. The canal was dried with a capillary tip and luer vacuum adapter (Chemglass, Vineland, NJ) followed by paper points. Next, the NaviTip (Ultradent) was placed loosely to 2 mm short of the apex. The tip was withdrawn slowly while expressing Endo-REZ coronally. Bubbles were avoided by burying the tip in the Endo-REZ as it was withdrawn from the canal, and then the master cone was inserted to length. The Endo-REZ was allowed to set for 40–50 minutes. Once set, Cavit (3M ESPE, Seefeld, Germany) was placed. Both groups were radiographed from a mesiodistal direction following obturation to ensure no voids existed.

After the teeth were separately embedded in Epofix resin (Struers, Ballerup, Denmark), the resin blocks were placed in an incubator for 48 hours for setting. The resin blocks were ground until the root apices were visible below the surface of the resin. Horizontal sections were made perpendicular to the long axis of the tooth at 2.0, 6.0, and 12.0 mm from the root apices with a 5 × .014 × ½ inch circular microtome saw (Gilling-Hamco, Thin Sectioning Machine; Hamco Machines, Inc, Rochester, NY). Sections were polished with 600-grit silicone carbide sandpaper and Deagglomerated Alumina (Buehler-Gamma Micropolish II) before imaging to eliminate debris.

Sections from both groups were viewed under a scanning electron microscope (SEM) at 50–150× magnifications and transferred to Adobe Photoshop 6.0. Each section was examined under a Nikon Measurescope UM-2 (Nikon, Tokyo, Japan) at 400× magnification to identify contents. The measurescope was used only for canal content identification and not for analysis. With the images from Adobe Photoshop 6.0, canal content percentages were calculated with the Image-J software (Wayne Rasband; National Institutes of Health, Bethesda, MD). The cross-sectional area of the canal space was outlined and measured with this software. The percentages of gutta-percha, sealer, debris, and voids were calculated with an analysis of variance model with fixed effects for method, distance, and distance interaction.

To ensure data reproducibility, the principal evaluator randomly re-examined 10% of the total samples to measure the intrarater reliability. Intraclass correlation coefficients (ICCs) were calculated as the ratio of variation between specimens to total variance. Because the total variance is the sum of 2 components, variance between specimens and within a specimen (ie, between repeats), a small ICC indicates a substantial percentage of the variability comes from the measurement process.

Results

The fractions of canal space at 2, 6, and 12 mm for both groups are summarized in Fig. 1. The ICCs for area, debris, gutta-percha, sealer, and voids were 99.94%, 99.98%, 99.97%, 99.99%, and 99.99%, respectively.

Debris was defined as dentin shavings, pulp tissue, and uninstrumented canal space. At 2, 6, and 12 mm, group 1 demonstrated 9.41%, 5.36%, and 1.90%, respectively. At 2, 6, and 12 mm, group 2 demonstrated 21.55%, 4.88%, and 3.87%, respectively. The overall mean percentage of debris was not statistically significant between the 2 methods.

At all levels, group 1 produced a greater mean percentage of gutta-percha compared with group 2, and the data were statistically significant. At 2-, 6-, and 12-mm levels, group 1 showed a mean percentage of 80.58%, 89.58%, and 95.39%, respectively. For group 2 at 2-, 6-, and 12-mm levels, a mean percentage of 51.23%, 37.15%, and 20.71% were seen.

The mean percentage of sealer was significantly larger for the Endo-Eze system than the Profile Series 29 and continuous wave group. At the 2-, 6-, and 12-mm levels, the mean percentages of group 1 were 7.77%, 4.92%, and 2.66%, respectively. At the 2-, 6-, and 12-mm levels, the mean percentages of group 2 were 24.39%, 41.04%, and 60.31%, respectively.

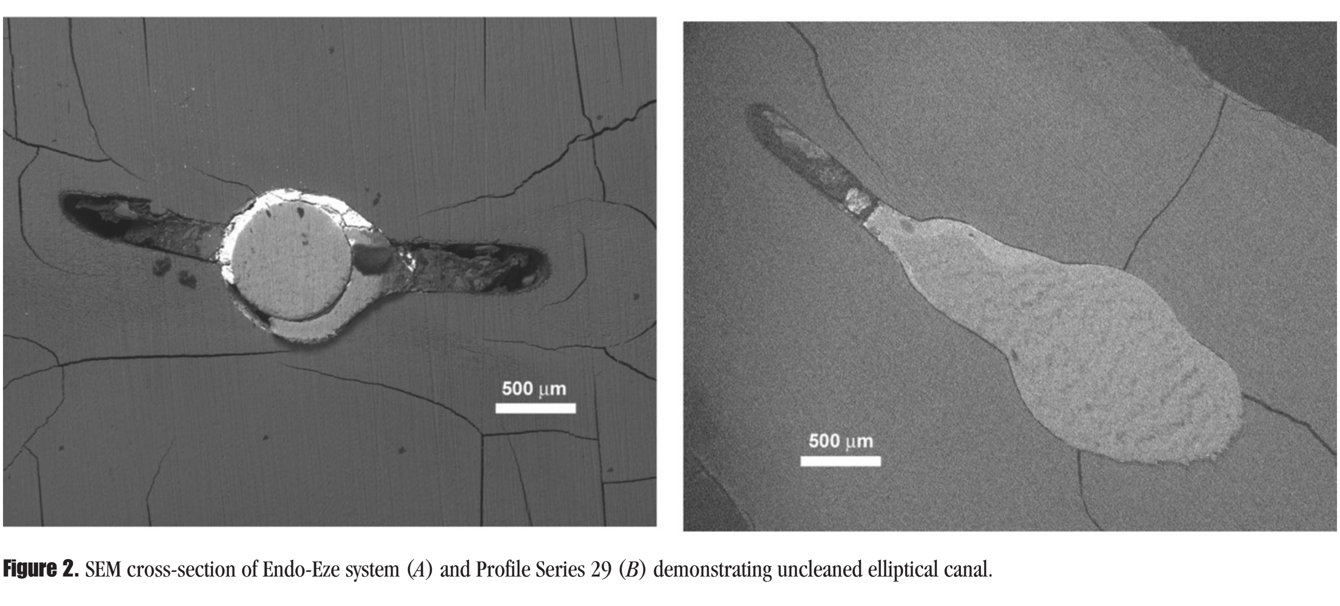

Figure 2. SEM cross-section of Endo-Eze system (*A*) and Profile Series 29 (*B*) demonstrating uncleaned elliptical canal.

The mean percentage of voids was significantly larger for the Endo-Eze system than the Profile series 29 and continuous wave group at 6 mm and 12 mm but not at the 2-mm level. At the 2-, 6-, and 12-mm levels, group 1 demonstrated a mean percentage of 2.23%, 0.18%, and .04%, respectively. At the 2-, 6-, and 12-mm levels, group 2 demonstrated 2.84%, 16.93%, and 9.75%.

Discussion

Vertucci (6) studied several thousand human permanent teeth. He concluded that many of the root canal systems, especially mandibular premolars and canines, were not perfectly round. Current rotary instruments produce round preparations, leaving areas of the canal untouched (7). Kerekes and Tronstad (8) stated that to clean elliptical canals efficiently, the canal would have to be enlarged to an excessive apical size, leading to possible perforation or vertical root fracture. The Endo-Eze reciprocating handpiece was developed to clean and shape canals without altering the root anatomy and to prevent overthinning of dentin and excessive enlarging of the canal.

Fig. 1 demonstrates the percentages of debris for groups 1 and 2. At all levels the comparison of the 2 groups was not statistically significant. Despite copious irrigation with 5.25% hypochlorite or ChlorCid, large amounts of debris remained in both groups. Because of the preparation produced by rotary instruments, the ribbon-shaped canals were not cleaned and shaped thoroughly by the Profile Series 29 (Fig. 2). However, the Endo-Eze system was not able to remove debris more consistently than the Profile Series 29 group.

Card et al. (9) researched whether a larger apical size could decrease the total amount of bacteria from the canal. The authors found that mandibular canines and premolars canals instrumented to a size 80 Profile 29 Series file or Lightspeed file (Lightspeed Technology Inc, San Antonio, TX) were rendered 100% bacteria-free. Therefore, if a larger apical preparation was used in this study, less debris in both groups might have been present.

Group 1 demonstrated an increase in the percentage of gutta-percha from 2 mm to 12 mm from the apex. This can be explained by varying depths of the system B plugger. Jung et al. (10) studied the effects of different temperatures and penetration depths of the system B plugger on the percentage of gutta-percha in the canal. They concluded that it is not the temperature that determines the percentage of gutta-percha; rather, the more apical the System B tip is placed, the greater is the percentage of gutta-percha. In this study, the System B tip was placed within 5 mm of working length; therefore, the apical one third of the canal contained less gutta-percha.

The thickness of sealer has been shown to vary depending on the obturation technique. The single-cone technique requires more sealer and a greater thickness than other obturation methods. This increase in sealer volume might lead to an increase in shrinkage, producing more voids and ultimately more leakage (11–13). In this study, the Endo-Eze system required more sealer, and several voids were detected.

Initially in this study, the Endo-REZ did not set and was viscous. Also, the cross-sections under the SEM exhibited numerous voids. The company was contacted, and they stated an improved Endo-REZ had been developed. The new Endo-REZ used in this study was more fluid but still did not set. To ensure maximum setting time, all teeth were incubated for 48 hours. A possible reason the Endo-REZ did not completely set might be due to retained water in the root canal. Despite the use of both paper points and a luer vacuum adapter to dry the root canal, small amounts of water could have remained. The manufacturer has found oxygen to delay setting in the presence of chlorine. In this study, sodium hypochlorite was the final rinse. Irrigating with ethylenediaminetetraacetic acid or ascorbic acid as a final rinse might allow proper setting (14).

Conclusions

This study demonstrated that the continuous wave group achieved significantly more gutta-percha occupying the canal space than the Endo-Eze system at all levels. The percentages of gutta-percha and sealer were indirectly proportional. A warm technique like continuous wave produces a greater amount of gutta-percha occupying the canal when compared with a single-cone technique. The mean percentages of voids were significantly larger at 6 mm and 12 mm for the Endo-Eze group compared with the Profile Series 29 and continuous wave group.

Both rotary and reciprocating instrumentation were unable to clean and shape elliptical canals consistently. In the majority of sections, the warm vertical group possessed less debris than the Endo-Eze group, but this was not statistically significant. Since the rotary instruments produce only circular preparations, portions of elliptical canals will be left untouched. A continued effort to make an instrument that prepares ribbon-shaped canals more effectively is needed.

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