An In Vitro Evaluation of the Contents of Root Canals Obturated With Gutta Percha and AH-26 Sealer or Resilon and Epiphany Sealer

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Abstract

The purpose of this study was to compare the contents of root canals obturated with gutta percha and AH-26 sealer (Dentsply, Tulsa, OK) to canals obturated with the Resilon and Epiphany (Pentron, Wallingford, CT) system. Canal contents were assessed by determining the percentage of canal space occupied by core material, sealer, voids, and debris. Forty extracted human maxillary anterior teeth were instrumented, and the teeth were randomly assigned to either the gutta percha/AH 26 group or the Epiphany/Resilon group. Canals were obturated, and the teeth were subsequently embedded in resin and sectioned horizontally at 2, 4, and 6 mm from the anatomic apex. Sections were photographed by using a low vacuum scanning electron microscope. Image-J (Wayne Rasband; National Institute of Health, Bethesda, MD) software was used to quantify the proportion of core material, sealer, voids, and debris in each canal. Percentages and statistical comparisons for each method were compared. There were no significant differences found among the two groups in terms of the percentage of core ($p = 0.9$), sealer ($p = 0.58$), debris ($p = 0.999$), or voids ($p = 1.00$). Additionally, there were no differences in the percentage of core material, sealer, debris, or voids at any of the examined levels (2, 4, or 6 mm). *(J Endod 2007;33:1359–1363)*

Key Words

Epiphany sealer, resilon, scanning electron microscope

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Adequate three-dimensional obturation of the properly instrumented root canal is a vital step toward successful root canal therapy (1). The properties of an ideal root canal obturation material are as follows: easily introduced into the canal, property to seal the canal both apically and laterally, minimal setting shrinkage, impervious to moisture, nonirritating to the periradicular tissues, no discoloring to the tooth, easily retrievable, sterile, antimicrobial, and radiopaque (2).

Gutta percha has long been accepted as the material of choice of many practitioners (3). Countless products have been introduced claiming to perform better than gutta percha or to improve gutta percha. However, no material has been as successful or as widely accepted as gutta percha because of its ease of manipulation, property to seal the canal, and radio-opacity (4). AH 26 (Dentsply, Tulsa, OK) is a commonly used sealer and has been shown to adequately seal the root canal when used with gutta percha (5, 6).

Resilon obturation material (Epiphany; Pentron Corporation, Wallingford, CT) has recently been introduced. This system claims to have many advantages over gutta percha while still retaining many of gutta percha's properties. The manufacturers and previous researchers of this product claim that the sealer bonds both to the obturation material as well as the canal walls, thus creating what they call a "monoblock" of material (7, 8). Previous studies have evaluated the bacterial leakage over a period of 30 days using obturated, unrestored roots (7, 8). Studies such as these do not necessarily attest to the material's properties within the root. The Resilon obturation material relies on a dual-cure resin sealer system. The coronal aspect is light cured, whereas the remaining material is expected to autopolymerize. Bacterial leakage could be prevented for some time if only the coronal aspect were cured. However, routinely throughout the course of treatment, a few millimeters of coronal-filling material are removed to accommodate posts or chamber-retained buildup materials, eliminating the light-cured portion of the material.

Canal obturation is required to impede the flow of bacteria and toxins to the periapical tissue (9). The warm vertical condensation technique described by Schilder fulfills these criteria and will be the obturation method in this study (10). The goal of obturation is to provide a complete filling of the canal in all dimensions (1). Contents of obturated canals can be quantified by sectioning obturated canals and then evaluating the canals microscopically (11, 12). This method of evaluation allows assessment of obturation as a function of canal contents after treatment.

The purpose of this study was to compare the contents of root canals obturated with gutta percha and AH 26 to canals obturated with the Resilon system. Canal contents were assessed by determining the percentage of canal space occupied by obturation material, sealer, voids, and debris.

Materials and Methods

Forty human, single-rooted, maxillary anterior teeth were collected from the Oral Health Department under IUPUI/Clarian IRB study number 0308-74. All teeth were evaluated radiographically to ensure normal anatomy, no gross pulpal calcifications, and canal curvature of less than 30° as evaluated by using Schneider's method (13). Teeth were sterilized in 5.25% sodium hypochlorite for a period of 2 weeks before initiating experimental procedures; subsequently, teeth were stored in normal saline at 37°C.

After sterilization and using universal precautions, ideal access preparations were made in each tooth. The working length was determined by passing a #10 stainless steel K-flex file to the apical foramen and then subtracting 1 mm using the incisal edge as the reference point. Canal preparation was achieved by using the Profile ISO Series .06 taper, nickel-titanium rotary instrument system (Tulsa Dental Products, Tulsa, OK) and an electric motor with 1:8 reduction contra-angle hand piece at 300 rpm (AEU-20 Endodontic System; Dentsply-Tulsa Dental, Johnson City, TN). Rc Prep (Premier Dental Products, King of Prussia, PA) and 5.25% sodium hypochlorite were used as irrigation and file lubrication. A crown-down technique of instrumentation was used beginning with the largest orifice shaper and finishing when the green .06 (size .035mm) reached the working length. After instrumentation with each consecutive file, apical patency was confirmed by using a #10 stainless steel K-flex file, and file lubrication/irrigation was replaced. After instrumentation, canals were irrigated with 5.25% sodium hypochlorite followed by treatment with 17% ethylenediaminetetraacetic acid (Roydent, Johnson City, TN), irrigation with 5.25% sodium hypochlorite, and a final rinse with .12% chlorhexidine gluconate (Zila Pharmaceuticals, Phoenix, AZ). Canals were dried thoroughly with paper points.

Obturation Groups

The 40 teeth were randomly divided into 2 groups of 20. The first group of 20 was obturated with gutta percha and AH 26 sealer. The second group of 20 was obturated with Resilon.

Teeth selected for the first group were obturated as follows. The walls of each canal were thoroughly coated with AH 26 sealer (Dentsply-Tulsa Dental, Johnson City, TN) by using a sterile paper point. A sealer coated size 35.06 master gutta-percha cone (Roydent, Johnson City, TN) was then seated to working length. The System B heat source (EIE/Analytic Technology, Richmond, WA) was set to 200°C, and heat was applied to the obturation material within the canal. The System B plugger was advanced into the canal until the tip was 4 to 7 mm from the predetermined working length. Vertical pressure was applied to the unheated plugger for a period of 10 seconds. Then, a 1-second burst of heat was applied, and the plugger was removed. A #9 Schilder plugger was used to vertically condense the apical gutta percha. The Obtura II (Obtura/Spartan, Fenton, MO), set to 200°C with a 23-G tip, was used to fill the remaining canal space with thermoplasticized gutta percha, which was subsequently vertically condensed with a #10 Schilder plugger. Excess material was removed by using a #6 slow-speed round bur.

Teeth selected for the second group were obturated as follows. Epiphany primer was placed into the canals by using a pipette, and excess primer was removed with sterile paper points. Epiphany sealer was applied to the canal by using a paper point. A master Resilon point was coated with Epiphany sealer and seated to working length. The System B heat source was set to 150°C. Warm vertical condensation was done as descried above. The Obtura II, set to 150° C with a 23-G tip, was used to fill the remaining canal space with heated Resilon, which was subsequently vertically condensed with a #10 Schilder plugger. Excess material was removed by using a #6 slow-speed round bur, and the coronal material was light cured for 40 seconds by using a light-emitting diode curing light (Patterson Dental Supply, St. Paul, MN). All samples were allowed to set in 100% humidity at 37°C.

Specimen Embedding and Sectioning

A container for the embedding of samples was created by submersing glass vials (SKS Bottle and Packaging, Watervliet, NY) into a container filled with polyvinylsiloxane impression material (Examix NDS; GC America, Alsip, IL). The glass vials were removed, leaving a space to embed the specimens. A small amount of sticky wax was placed on the crown of each tooth for stabilization purposes, and the tooth was inverted and placed into the well. Teeth were then embedded in Epofix Epoxy Resin (Struers A/S, Westlake, OH) mixed to the manufacturer's instructions and cured for at least 24 hours. Specimens were removed from the embedding apparatus, and resin apical to the root end was ground until first contact with the root tip. The resin blocks were marked at 2.0 mm, 4.0 mm, and 6.0 mm from the root apex. A circular microtome saw (Gilling-Hamco, Thin Sectioning Machine; Hamco Machines, Inc, Rochester, NY) was used to make sections at the apical portion of the mark and perpendicular to the long axis of the tooth. Debris was removed and sections were smoothed with 600-grit silicone carbide sandpaper (Leco, St Joseph, MI) and Deagglomerated Alumina (Buehler-Gamma Micropolish II, Lake Bluff, IL) before microscopic examination.

Microscopic Evaluation

Each section was examined by using the JSM-5310 Low Vacuum Scanning Electron Microscope (JOEL, Tokyo, Japan) set at 100× magnification. Digital photographs of each sample were taken and saved as Adobe Photoshop (Adobe, San Jose, CA) files. A light microscope was used to accurately identify canal contents. Adobe files were transferred to the Image-J (Wayne Rasband; National Institute of Health, Bethesda, MA) software. By using this software, canal contents were outlined and marked as sealer, obturation material, voids, or debris (Fig. 1). Each of these factors was then quantified and expressed as a percentage of total canal area. A Nikon measure scope UM-2 (Nikon, Tokyo, Japan) was used to verify canal contents while examining scanning electron microscope photographs. The percentage of canal space occupied by obturation material, sealer, voids, and debris was compared between the gutta percha and AH 26 sealer group and the Resilon and Epiphany group.

The percentages of core, sealer, debris, and voids were calculated by using the total canal area as the denominator. Percentages were summarized across distances and by distance for each of the methods. Summary statistics presented are the number of observations for each method and at each distance, the mean, the standard deviation, the standard error, the minimum, and the maximum. The percentages for each method were compared by using a repeated-measures analysis of variance model with fixed effects for method, distance, and the method by distance interaction. Because the assumption of homogeneity of variance was violated when the raw percentages were analyzed, the percentages were transformed by using arcsine (square root [percent]). Statistical comparisons were made by using model-based estimates on the transformed scale. Because there are multiple outcomes for the same sample and because there are multiple distances at which we compare the two methods, the Sidak adjustment was used to control for overall type 1 error at the 5% level.

Repeatability

To analyze the repeatability of measurements, repeated measurements were paired with their corresponding original measurements. Differences were summarized by type (area, obturation material, debris, voids, and sealer) by using the summary statistics listed previously. Intraclass correlation coefficients (ICCs) were calculated as the ratio of variation between specimens to total variance. Because the total vari-

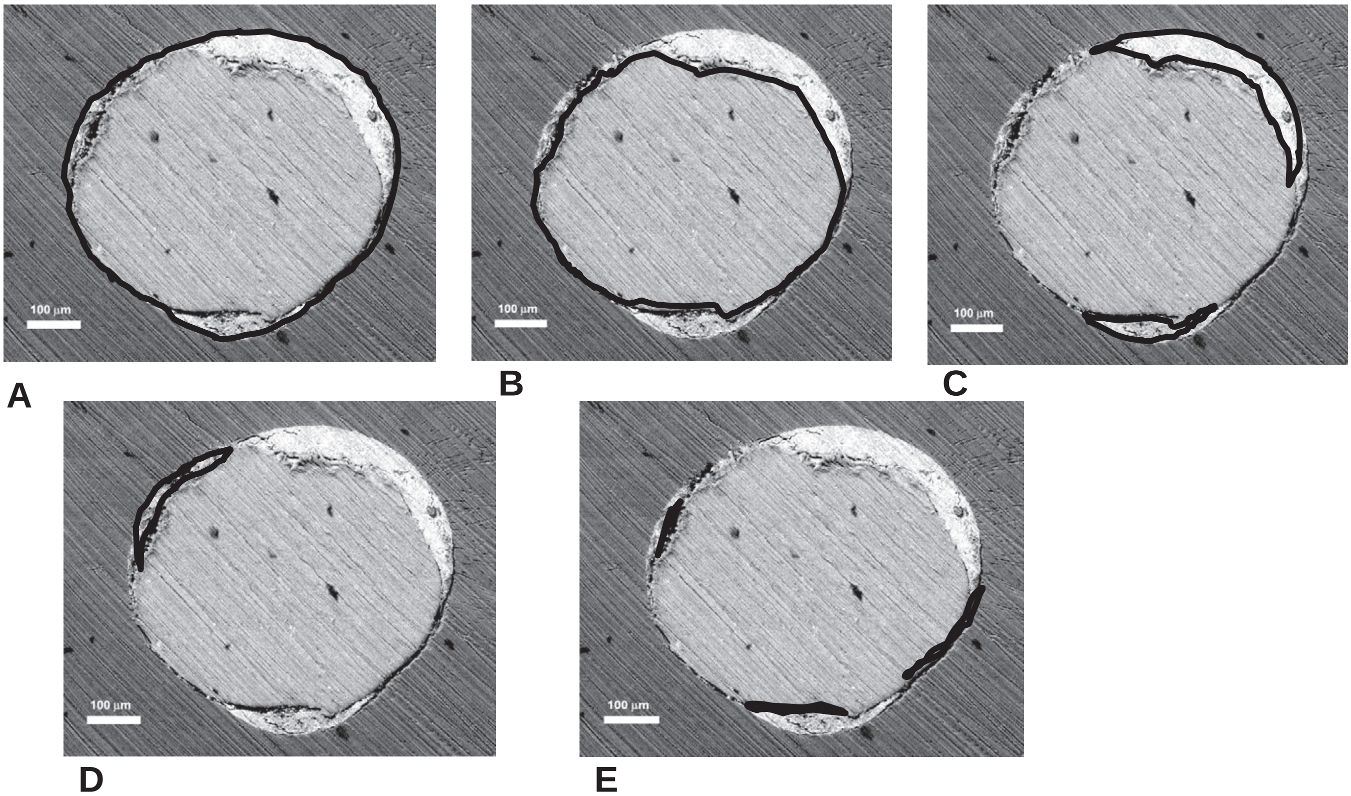

Figure 1. SEM cross-sections: (*A*) the area of the canal space measure, (*B*) the area of the core material measured, (*C*) the area of the sealer measured, (*D*) the area of debris measured, and (*E*) the area of voids measured.

ance is the sum of two components, variance between specimens and variance within a specimen (ie, between repeats), a small ICC indicates that a substantial percentage of the variability comes from the measurement process.

Results

Comparison of the core material reveals that Resilon core material occupied 92.01% of the canal, whereas gutta percha occupied 88.72% of the canal. Debris occupied 0.10% of the canals obturated with gutta percha and 0.19% of the canals obturated with Resilon. The percentage of voids found was nearly identical for both materials, with voids found to comprise 2.03% of the canal space when gutta percha was used and 2.06% of the canal space when Resilon was used. The greatest discrepancy between obturation materials was discovered when the percentage of the sealer was examined. Only 6.86% of the canal space was filled with Epiphany sealer, and 9.15% of the canal was occupied by AH-26. Although this is the greatest difference, the materials were statistically the same.

There were no significant differences found among the two groups overall in terms of the percentage of core ($p = 0.9$), sealer ($p = 0.58$), debris ($p = 0.999$), or voids ($p = 1.00$). At each distance this is also true. Although evaluation of the percentage of sealer resulted in the lowest p value at 0.58, this is still far from showing a significant difference. The mean percentages of core, sealer, voids, and debris for the two obturation methods were not statistically different. This is true when the groups are examined as a whole or when analyzed at the different distances from the apex. The values for ICC approaching 1.0 indicate excellent repeatability between the measurements. Figure 2 shows the mean percentage of core, sealer, debris, and voids for the obturation methods at the 2-, 4-, and 6-mm levels.

Core Material Results

Examination at the 2-mm level indicates that Resilon occupied slightly more of the canal space at 91.24% compared with 90.19% of gutta percha at the same level. Again, at the 4-mm level, Resilon occupied slightly more of the canal (88.62%) compared with gutta

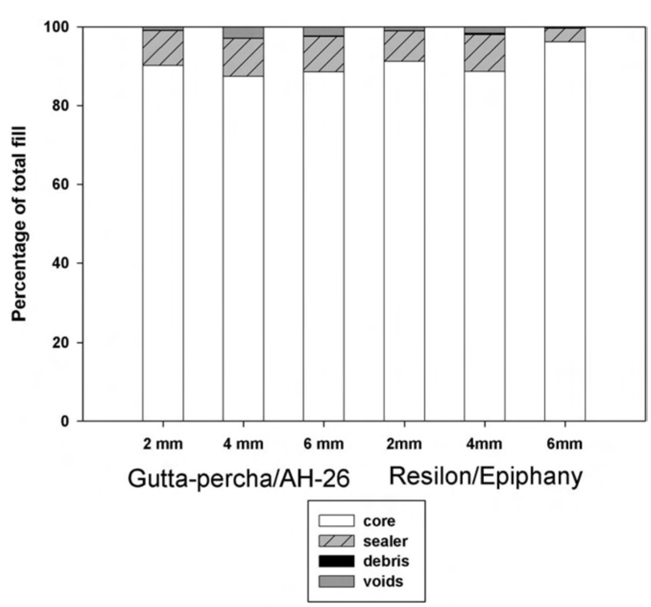

Figure 2. The mean percentage of core, sealer, debris, and voids for the obturation methods at 2, 4, and 6 mm.

percha (87.39%). The 6-mm level showed the greatest disparity between materials, with Resilon occupying the overall highest percentage of canal space at 96.16% compared with 88.56% for gutta percha. The overall range was fairly small, with the lowest being gutta percha at 4 mm occupying 87.39% and the highest being the Resilon samples at 6 mm.

Sealer

A slightly higher proportion of sealer was found at the 2-mm level in the gutta-percha (8.87%) samples when compared with the Resilon group (7.72%). The 4-mm level samples were nearly identical, with 9.65% of the canal space occupied with sealer in the gutta-percha group versus 9.39% in the Resilon group. The greatest difference in the percentage of sealer was found at the 6-mm level. The gutta-percha group resulted in 8.93% sealer as compared with only 3.46% in the Resilon samples. This was the largest difference of any of the groups; however, with a p value of 0.0947, this difference was not significant.

Debris Results

The 2-mm level showed debris as 0.09% of gutta percha and 0.11% of canals obturated with Resilon. The 4-mm samples of gutta percha were comprised of 0.05% debris as compared with 0.31% of the Resilon samples. Examination of the 6-mm level showed that debris comprised 0.17% of the canal space in the gutta-percha samples and 0.15% of the Resilon samples.

Voids Results

The results were similar for both materials at all levels, and no differences were significant. The evaluation of the 2-mm level indicated that the gutta-percha samples had only 0.85% voids and the Resilon groups had 0.92%. The 4-mm level showed the greatest overall percentage of voids, for both the gutta-percha and Resilon groups, 2.91% and 3.07%, respectively. The results for the 6-mm level were similar in both groups. Gutta-percha samples had 2.32% of the canal space occupied by voids, and the Resilon samples had 2.18% voids.

Discussion

Gutta percha has been the canal obturation material of choice for nearly 150 years and is well accepted by the dental community as the standard obturation material. It stands to reason that if the material is available in preparations similar to gutta percha and the handling characteristics are similar, then the material should occupy a similar space in the obturated canal. This was found to be true in the current study. Analysis and comparison of canals obturated with either system showed that the canal contents were nearly identical. No statistical differences were found when canals were examined at the 2-, 4-, or 6-mm levels for the presence of core material, sealer, debris, or voids.

A fundamental difference between gutta-percha techniques and that of Resilon is that Resilon is engineered to form a chemical bond to the sealer, and the sealer bonds to the canal wall. This interaction minimizes leakage of bacteria and fluids. Although this is an advantage clinically, this interaction makes it difficult to distinguish the sealer from the other core material on visual examination. Experimental groups reflected this interaction, and it was, at times, difficult to determine the boundary between Resilon and Epiphany. This problem was addressed by the use of scanning electron microscope analysis aided by light microscopy. The combination of techniques allowed us to more accurately determine the amount of sealer and core material. Regions of material comprising sealer and core material blended were recorded as core material.

Maxillary anterior teeth were chosen because their large canal diameter would allow a greater overall amount of obturation material to place within each canal, thereby allowing any variations to be noted more easily. Crowns were left intact and ideal access preparations were made in each tooth, as opposed to decoronation of the teeth for access. Leaving the crowns in place was done in an effort to simulate clinical conditions and increase the validity of results.

The percentage of gutta percha occupying the canal was lower than Resilon at all levels. Although none of the differences were statistically significant, at the 6-mm level, the difference was 7.6% of the total canal space. Similarly, the sealer data had no significant differences. The 2- and 4-mm levels were nearly identical, but, at the 6-mm level, AH 26 occupied 5.47% more of the total canal space than did Epiphany. Some of this difference could be reflected in the fact that in areas in which Resilon and Epiphany intermixed, the tendency was to include these zones as core material rather than as sealer.

Results for debris and voids were almost identical at all levels for both groups. Debris occupied a very small proportion of the canal ranging from 0.05% for Resilon at the 4-mm level up to 0.31% for gutta percha at the 4-mm level. Voids tended to occupy a greater area of canal than did debris. The smallest proportion of voids was seen in the gutta-percha group at the 2-mm level (0.85%), and the greatest proportion was found in the Resilon group at 4 mm (3.07%).

Subjectively, voids found in Resilon samples tended to be located around the periphery between the canal wall and the sealer. This is in contrast to gutta-percha samples, which tended to have voids located more randomly.

A study by Epley et al (14) evaluated only the size of voids in cross-sections of roots obturated by using gutta percha and Roth sealer or Resilon and Epiphany sealer. A comparison of the results of this study is difficult because the proportion of canal space devoid of obturation material is not mentioned. Their results are similar to this study in that at the 1-mm and 5-mm levels there were no differences between the material's ability to occupy canal space. However, at the 3-mm level in teeth obturated with cold lateral condensation, they found that obturation with Resilon tended to result in a smaller area of voids when compared with gutta percha and Roth sealer.

Conclusion

The results indicated that there was no statistical difference in the percentage of core material, sealer, debris, or voids when teeth were obturated with Resilon and Epiphany sealer as compared with gutta percha and AH-26 sealer.

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