Completeness of Root Canal Obturations: Epiphany Techniques versus Gutta-Percha Techniques

Samuel R. Epley, D MD, Jacob Fleischman, DMD, Gary Hartwell, DDS, and Carmen Cicalese, DMD

Abstract

This project was designed to determine how a new resin based obturation material compared with traditional gutta-percha techniques in its ability to fill the prepared root canal space. Eighty single-rooted palatal and distal roots of extracted human first molars were used. The root canals were instrumented with hand and rotary files and divided into four groups. Gutta-percha and the new resin based material was used with lateral condensation or continuous wave obturation. The roots were sectioned at 1, 3, and 5 mm from the apex and examined under magnification. Using a computer program, the surface areas of voids were calculated and compared. The gutta-percha, lateral condensation method was the only group that demonstrated significantly more voids. There were no statistically significant differences among any of the other three groups. *(J Endod 2006;32:541–544)*

Key Words

Continuous wave, epiphany, lateral condensation, obturation, resilon

From the University of Medicine and Dentistry of New Jersey, Newark, NJ.

Address requests for reprints to Samuel R. Epley, 863 Breckenridge Ct., New Hope, PA 18938. E-mail address: epleysam@hotmail.com.

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One of the keys to success of root canal therapy is to adequately obturate the prepared root canal space. The primary purpose for using obturating materials is to create a seal that will prevent penetration of irritants from the oral cavity into the radicular tissue via unfilled root canal space (1). The success of a clean, well prepared root canal system will be compromised if the root canal system is not properly obturated. Schilder (2) suggests that the ideal root canal obturating material should be well adapted to the canal walls and its irregularities and that the entire length of the canal be densely compacted with a homogeneous mass of gutta-percha. The amount of sealer should be minimized while the amount of core material should be maximized.

The technique using lateral condensation of gutta-percha cones with a root canal sealer is considered to be a commonly accepted technique for obturation in Endodontics (3). This continues to be the method of choice of many clinicians and is being taught at many dental schools (4). In the 1960s, Schilder (2) introduced the warm vertical compaction technique for root canal obturation. This technique has been modified by Buchanan (5) with the introduction of the continuous wave obturation method. The advantage of these techniques is that the warmed gutta-percha is more adaptable to the small irregularities that exist in the walls of the prepared root canal system. All of these techniques have been used successfully with a variety of root canal sealers. The gold standard for root canal sealers is Grossman's zinc oxide eugenol formula.

Recently, a new technique has been introduced that is being advertised as the next generation of root canal obturating methods. The new Epiphany Obturation System (Pentron Clinical Technologies LTD, Wallington CT) uses Resilon (Resilon Research LLC, Madison, CT), which is a thermoplastic synthetic polymer-based root canal filling material. Based on polymers of polyesters, Resilon contains bioactive glass and radiopaque fillers. It performs like gutta-percha, has the same handling properties, and for retreatment purposes may be softened with heat or dissolved with solvents like chloroform. Similar to gutta-percha, there are master cones in all International Standards Organization (ISO) sizes, and accessory cones in different sizes are available as well. In addition, Resilon pellets are available, which can be used for the backfill when warm thermoplasticized techniques are used. The sealer, Epiphany Root Canal Sealer is a dual curable dental resin composite sealer (6).

This new method utilizes a resin-based sealer system, which the manufacturer claims bonds to both the obturating material and the root canal walls (7). The new system can be utilized with any of the popular gutta-percha root canal obturation techniques: lateral condensation, vertical compaction, continuous wave, and thermoplasticized gutta-percha. This new method employs the use of a priming agent, special sealer and obturation cones. As noted above, one key to successful root canal therapy is the completeness of the seal provided by the obturating materials. To date no study has compared how complete the root canal system is obturated with this new system as compared to the traditional methods using gutta-percha and a zinc-oxide eugenol root canal sealer.

The purpose of this in vitro study was to compare the presence of voids in root canals obturated with the new resin-based system versus voids present in canals obturated by two traditional methods using a zinc-oxide eugenol sealer. Three levels in the apical 5 mm of the obturated root canals were inspected under magnification for the presence of voids and the surface area of the voids was measured with a BioQuant computer software system. The differences were then compared to determine if statistical differences existed between techniques.

TABLE 1. Void area at 1 mm sections (μm^2)

Material	Technique	Void Area
Gutta-percha	Lateral condensation	5501.6
Gutta-percha	Warm vertical	2146.6
Epiphany	Lateral condensation	1337.8
Epiphany	Warm vertical	2487.7

Materials and Methods

Eighty single-rooted palatal and distal roots of extracted human first molars were used. The crowns were sectioned from the teeth, and the roots were visually examined and verified to have only one canal, a closed apex and no severe curvatures. The patency of each root canal system was then verified with a #10 K file (Dentsply Maillefer, Tulsa, OK). The file was passed through the apex and pulled back to be flush with the major foramen. Verification of the working length was accomplished under a Zeiss surgical microscope (Zeiss, Germany) under 12× magnification. The root canals were hand filed to a size #20 K file to the working length. The canals were irrigated initially with 3 ml of 2.5% NaOCl (America's Choice, Montvale, NJ). All root canals were then instrumented to working length with ProTaper NiTi rotary files, sizes S1, S2, F1 (Dentsply, Tulsa, OK) and Glyde root canal lubricant (Dentsply Maillefer). The roots were irrigated with 1 ml of 2.5% NaOCl between each file size. The apical diameter was widened to size #40, 0.04 taper ProFile NiTi file (Dentsply). Each prepared canal was then rinsed with 17% EDTA (Pulpdent, Watertown, MA). A final rinse of 3 ml of sterile water (Baxter Healthcare Corporation, Deerfield, IL) was used. The canals were dried with paper points (Dentsply Maillefer).

The 80 roots were randomly divided into four groups of 20 each, and the method used for each group is described as follows.

Group 1 Obturation

Fine-Medium (FM) gutta-percha master points (Dentsply Maillefer) that had been trimmed to a size 40 using a gutta gauge (Dentsply Maillefer) were fitted to working length with tug-back. The points were then coated with Roth sealer (Roth International LTD., Chicago, IL) and seated to place. Lateral condensation was accomplished using a D11 NiTi hand spreader (Dentsply Maillefer) and Fine-Fine (FF) accessory cones, which were coated with the sealer before placement into the canal. Accessory cones were added and compacted until a FF cone could not be introduced more than 2 mm into the canal. The excess gutta-percha was then removed with a System B heat source (Analytic Endodontics, Sybron Dental Specialties, Glendora, CA) and the remaining gutta-percha was vertically compacted using Buchanan pluggers (Analytic Endodontics, Sybron Dental Speciaties, Glendora, CA).

Group 2

FM gutta-percha master points were fitted with tug-back, coated with Root sealer and seated into the canal as described for group 1. A system B heat source with a 0.08 tip was then used to remove the gutta-percha to a level within 3 to 4 mm of the working length. The remaining gutta-percha plug was then compacted with Buchanan pluggers. Sealer was reapplied to the canal wall and the remaining root canal space was obturated with Obtura II thermoplasticized gutta-percha (Obtura Spartan, Fenton, MO). The thermoplasticized gutta-percha was compacted with Buchanan pluggers.

Group 3

FM Ephiphany master points (Pentron Clinical Technologies, LLC) were trimmed to a size #40 using a gutta gauge and fitted to working length with tug-back. Epiphany primer was then introduced into the canal using a paper point as per the manufacturer's recommendations (6). The Epiphany master point was coated with Epiphany sealer and seated into the canal. Lateral compaction was accomplished using a D11 NiTi hand spreader and FF Epiphany accessory cones. The accessory cones were coated with sealer and placed until they could not be introduced more than 2 mm into the canal. The excess Epiphany points were removed using a system B heat source, and vertically compacted using Buchanan pluggers.

Group 4

The FM Epiphany master points were fitted, the root canal was prepared and the master cone was seated the same as for group 3. A system B heat source with a 0.08 tip was then used to remove the excess Epiphany material to a level within 3 to 4 mm of the working length. The Epiphany material remaining in the canal plug was then compacted with Buchanan pluggers. The Epiphany sealer was reapplied to the canal wall and the remaining canal space was obturated with Epiphany material using the Obtura II thermoplasticized system and compacted with Buchanan pluggers.

The four groups were stored separately for 2 wk at 37°C to allow sealer to completely set. The teeth were then randomly assigned numbers to ensure anonymity. The evaluation phase was accomplished by sectioning each root with a 6 inch diamond coated 15 HC sectioning disk (0.012 × 1.5) (Buehler, Lake Bluff, IL) in an Isonet 1000 precision saw (Buehler) running at 975 rpm at the following lengths: 1 mm from the apex, 3 mm from the apex, and 5 mm from the apex. The disk was kept wet at all times. Each section was then digitally photographed using a stereomicroscope (Olympus DP11 and SZ, Tokyo, Japan) at a 75.5× magnification. The images were transferred to a computer and a BioQuant software program (R & M Biometrics, Nashville, TN) was used to measure the surface area obturated with each technique and to calculate the surface area that was devoid of obturating material. The surface areas devoid of material (voids) present at each level and for each obturation technique were statistically compared.

The surface area devoid of material was calculated and statistically analyzed with a statistical software program SAS 9.1 (SAS Institute Inc., Cary, NC). Significance was determined to be at a p value <0.0083. Each method of obturation was analyzed and compared. An analysis was also accomplished to compare the two types of obturating materials. Differences were also analyzed for each level of sectioning. A two-way ANOVA for each section was used to find significance.

Results

At the 1 mm level (Table 1), there were no differences between the gutta-percha and Epiphany materials or between the lateral condensation and warm vertical continuous wave obturation techniques. At the 3 mm level (Table 2), lateral condensation with gutta-percha and Roth sealer was found to have significantly more voids (Fig. 1) than either of the Epiphany groups and the gutta-percha, Roth sealer group using the continuous wave obturation technique. At the 5 mm level (Table 3), no differences were found between either of the materials or between either of the obturating techniques. There were no significant differences between groups 2, 3, and 4 at any level.

TABLE 2. Void area at 3 mm sections (μm^2)

Material	Technique	Void Area
Gutta-percha	Lateral condensation	15974.4
Gutta-percha	Warm vertical	5117.6
Epiphany	Lateral condensation	4472.7
Epiphany	Warm vertical	2570.6

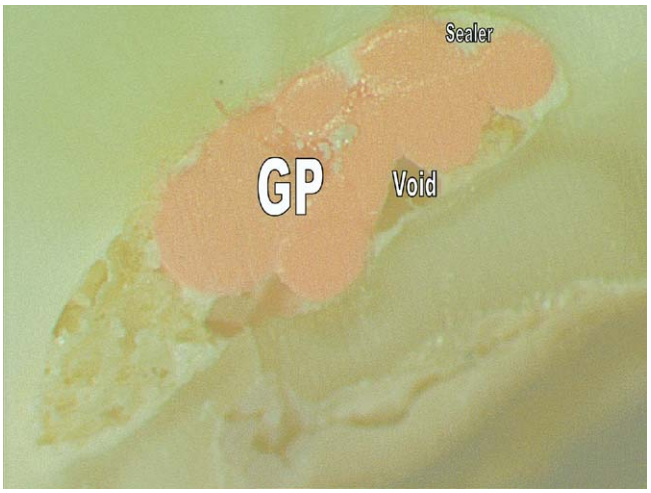

Figure 1. Illustration of gutta-percha, sealer, and voids.

Discussion

Complete Obturation without voids will ensure a more homogeneous and complete fill of the root canal system. It is desirable and would be ideal if all voids could be eliminated. Other studies (6, 8) utilizing this new obturation material have used bacterial leakage models for evaluating completeness of canal fill. This is the first study to evaluate the presence of voids when the Epiphany system is used for obturating the root canal system. This provides additional information with regard to how well the root canal system is obturated when using this new obturating system.

Studies have shown that obturation by cold lateral compaction produces voids that may remain devoid of sealer, or possibly be filled with sealer that may eventually resorb away. This would potentially decrease the quality of the obturation (9). In addition, this type of obturation lacks homogeneity with spaces found between master and accessory cones, and poorly adapts to the root canal walls (2). To aide with this potential problem, an injectable thermoplasticized gutta-percha was introduced, with the hope of achieving a more dense three-dimensional root canal fill (10). In a study by Budd, this injectable technique was shown to replicate the intricacies of the root canal system and was able to achieve a seal equal or better to that of other methods (11). By utilizing a thermoplasticized technique, the amount of obturation material present in the canal would theoretically exceed the amount that would be present if obturation was done via lateral condensation. This was shown to be the case in an experiment by Lea. Acrylic blocks were weighed before obturation, and then again after obturation with either cold lateral condensation or the continuous wave of obturation technique. The continuous wave technique resulted in a significantly greater mass of gutta-percha (12).

Coronal and apical leakage are two important factors related to achieving successful root canal therapy. Jacobson (13) found that teeth obturated with gutta-percha using lateral condensation, leaked statistically faster coronally than those teeth obturated with gutta-percha using the continuous wave of condensation technique and an obtura II (Obtura Spartan, Fenton, MO) backfill.

Other studies performed have compared the apical sealing ability of laterally condensed gutta-percha with sealer, versus high-temperature thermoplasticized gutta-percha with sealer. In a dye leakage study by Vizgirda, no significant difference was found in leakage between these two groups (14).

From the Toronto Study, a 4 to 6 yr outcome assessment study of initial endodontic therapy, treatment technique emerged as a major determinant of endodontic healing, which according to this paper meant no apical periodontitis, signs or symptoms. Using thermoplasticized gutta-percha, the healed rate was 90%, while it dropped to 80% using lateral compaction. Other factors such as gender, number of roots, and root filling length were less significant predictors of healing (15).

It appears from most of the above studies, that obturation with thermoplasticized gutta-percha may be superior to oburation with lateral condensation. Although this may be the case, the question still remains as to whether gutta-percha is still the best material to use to achieve the most hermetic seal of the root canal space. Several studies by Shipper (8, 16) have asserted that gutta-percha may not be the best material to use for root canal obturation. Rather, a new material called Resilon should completely replace the use of gutta-percha. A dog model was used to compare gutta-percha and resilon with regard to preventing formation of apical periodontitis subsequent to coronal bacterial inoculation. Each material was tested via lateral condensation and vertical condensation. The results showed mild inflammation in 82% of teeth in the gutta-percha groups, but only in 19% of the resilon groups. There was no significant difference found between the two methods of obturation used within each group. Thus, it was concluded that gutta-percha and sealer, regardless of technique, would not result in a dependable seal. The sealer used with resilon is able to form a bond to the dentin wall and core filling material, thereby creating a single entity, or monoblock system. This monoblock system would hold true for both obturation methods. Resilon, unlike gutta-percha, would therefore not rely on sealer to fill the gaps between itself and the root canal wall (8). In a second experiment, Shipper used an in vitro bacterial leakage study of endodontically treated teeth to again assert that gutta-percha has a poor sealing capacity (16).

Controversy also exists as to whether or not smear layer removal is necessary for root canal filling materials and sealers to penetrate dentinal tubules. Many studies have concluded that it is mandatory for its removal to attain proper penetration into dentinal tubules (17–19). Various regimens have been suggested for smear layer removal. There was 3 ml of 17% EDTA for 3 min, followed by a 3 ml rinse with 1% NaOCl, was sufficient to achieve complete smear layer removal in Kokkas's experiment (20). Most experiments advocating complete smear layer removal have been performed in vitro. Our study used 17% EDTA for 1 min, followed by a final rinse with sterile water. Although this study used a different method for smear layer removal, an in vivo study by Vassiliadis showed that the presence of a smear layer did not inhibit dentinal tubule penetration by a Grossman type sealer (21). With regard to apical and coronal leakage, Cobankara concluded that smear layer removal has a positive effect in reducing both apical and coronal leakage (22). Our study could possibly have benefited from evaluation of the effectiveness of our smear layer removal regimen under an SEM, to confirm adequacy of smear layer removal.

In this study, the only statistical difference found with any of the comparisons made, was that there were more voids present in the lateral condensation Roth at the 3 mm level. There were no significant differences between the continuous wave gutta-percha Roth sealer group and either of the two techniques using the Epiphany material.

TABLE 3. Void area at 5 mm sections (μm^2)

Material	Technique	Void Area
Gutta-percha	Lateral condensation	16256.9
Gutta-percha	Warm vertical	1580.6
Epiphany	Lateral condensation	3245.1
Epiphany	Warm vertical	5554.7

The other three groups did have some voids present but they were extremely small when compared to those found in the lateral condensation, Roth sealer group (Table 1). The results demonstrate that the voids present in the two Epiphany obturation techniques were not statistically different from those found with the continuous wave gutta-percha, Roth sealer method at all three levels of sectioning.

The operator who defined the void areas for analysis by the BioQuant software was blinded as to which samples were matched to which techniques. An area of concern with this particular research methodology was that a human operator must define the void areas. The same operator defined the voids for all samples, and parameters were set within the software to recognize color patterns found in voids that were different from the obturation material and tooth structure. These parameters are not always perfect, but the same parameters were used for all samples. The BioQuant software requires further testing. However, from this experiment, it appears to be a good, user-friendly method to use for calculating surface areas from color digital photographs.

Conclusion

This study demonstrated that two obturating techniques using the new resin based Epiphany obturation material were comparable to the continuous wave Roth sealer technique in eliminating voids in the obturated root canal space and were only significantly better than the gutta-percha, Roth sealer lateral condensation method for preventing voids at the 3 mm level.

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