Comparison of the Area of Resin-based Sealer and Voids in Roots Obturated with Resilon and Gutta-Percha

Kamran Gulsahi, DDS, PhD, Zafer C. Cehreli, DDS, PhD,† Emel O. Onay, DDS, PhD,* Fugen Tasman-Dagli, DDS, PhD,‡ and Mete Ungor, DDS, PhD**

Abstract

The aim of this study was to compare the cross-sectional area of sealer plus voids of Epiphany sealer surrounding root fillings completed with Resilon cones and laterally compacted gutta-percha. The root canals of extracted human mandibular premolars were prepared to a final size of 40 (0.06 taper). The teeth were then randomly assigned into 2 groups (n = 12/group) for the filling procedures in conjunction with Epiphany sealer: group 1, Resilon cones, and group 2, gutta-percha. Horizontal sections were obtained every 1 mm up to 5 mm from the apical foramen. The sections were digitally photographed under magnification, and the cross-sectional area of the root canal and the area occupied by the sealer and voids were calculated, after which statistical comparisons were made. No differences were found between the sealer plus void or void area of Resilon or gutta-percha groups at any level of sectioning ($P > .05$). Comparisons within each obturation group showed that there was no significant difference between any level of sectioning with regard to the ratio of sealer plus void area or void area to that of the root canal ($P > .05$). Within the experimental conditions of the present study, both obturating techniques with the Epiphany sealer exhibited similar amounts of sealer and void area, regardless of the apical level of sectioning compared. *(J Endod 2007;33: 1338–1341)*

Key Words

Epiphany, gutta-percha-filled area, lateral condensation, resin-based obturation material, sealer area

From the *Department of Endodontics, Faculty of Dentistry, Baskent University; and †Department of Pediatric Dentistry and ‡Department of Endodontics, Faculty of Dentistry, Hacettepe University, Ankara, Turkey.

Address requests for reprints to Kamran Gulsahi, DDS, PhD, Department of Endodontics, Faculty of Dentistry, Baskent University, 11. sokak, No. 26, 06490 Bahcelievler, Ankara, Turkey. E-mail address: kgulsahi@yahoo.com.

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Complete obturation of the root canal with an inert filling material and creation of a fluid-tight seal are among the major goals of successful endodontic treatment (1). Among numerous obturation techniques and filling materials available, gutta-percha continues to be the material of choice, owing to its unique chemical and physical properties (2). Recently, Resilon Research (Madison, CT) introduced Resilon obturating points and resin sealer. This product is used in combination with a self-etching primer to create a solid monoblock (3). Resilon is a polymer-based thermoplastic resin material (4) and is used in conjunction with the Epiphany Root Canal Sealant (Pentron Clinical Technologies, Wallingford, CT), which is a dual-curable resin material containing dimethacrylates. The primer of Epiphany is an aqueous solution of an acidic monomer. Previous studies have evaluated various aspects of this new obturation system including microbial leakage, bond strength, sealing ability, and fracture resistance (4-7).

Although the Epiphany sealer has been primarily developed to be used in combination with a polymer-based obturator, the use of Epiphany in conjunction with gutta-percha cones could offer a potential advantage, because gutta-percha is far less expensive than Resilon. A recent study has shown that the combination of gutta-percha and Epiphany had higher (but not significantly) sealing ability than that of the Resilon and Epiphany (6). Also, the combined use of gutta-percha and Epiphany has shown significantly greater bond strength than Resilon and Epiphany (8).

Today, most root canal filling methods use different formulations of gutta-percha, cemented into the root canal with a sealer (9-12). Endodontic sealers are capable of filling imperfections and increasing the adaptation of gutta-percha (13). On the other hand, root canal sealers are not dimensionally stable and might dissolve partially over time as a result of their low resistance to leakage (14–16). Thus, to achieve optimal results, the amount of sealer should be minimized, while increasing the mass of the core filling material (16-21). However, it might also be hypothesized that a methacrylate-based sealer such as Epiphany is stable over time when applied properly, but the filling should not contain unfilled areas (voids).

In light of these observations, the purpose of this study was to investigate and compare the cross-sectional area of sealer and voids in the apical region of root canal fillings completed with laterally compacted Resilon and gutta-percha cones with the new resin-based Epiphany sealer.

Materials and Methods

Specimen Preparation

Freshly extracted mandibular human premolars were placed in saline solution and stored at 4°C until actual experiments. The crowns were removed at cementoenamel junction by using a water-cooled, low-speed diamond saw (Isomet 4000; Buehler, Lake Bluff, IL). Twenty-four roots, macroscopically similar in size and with straight and single root canals (as verified radiographically), were selected and reduced to a standardized size of 18 mm from the coronal aspect. The working length was established 1 mm short of the apical foramen. The canal orifices were coated with sticky wax resin to prevent the outflow of the irrigating solution through the apical foramen. The middle and coronal thirds of roots were prepared with ISO size 50, 70, 90, and 110 Gates Glidden (Moyco Union Broach, York, PA) drills. Roots were further instrumented with the System GT NiTi rotary files (Dentsply Maillefer, Ballaigues, Switzerland) in a crown-down manner and enlarged to size 40/0.06 taper. After each instrument, the canals were irrigated with

5 mL 2.5% NaOCl. Irrigation procedures were performed with the roots held upside down to prevent pooling of the irrigant (22). After preparation, the root canals received a final irrigation of 5 mL 17% ethylenediaminetetraacetic acid and 5 mL 2.5% NaOCl, after which the canals were flushed with 10 mL distilled water to avoid the prolonged effect of irrigating solutions. Roots dried with paper points were randomly assigned into 2 obturation groups (n = 12/each).

In group 1, a size 40, 0.06 taper Resilon cone was inserted to the working length with tug-back. The Epiphany Primer was placed into the canal with a syringe, and after 30 seconds, the excess was removed with a paper point. With an insulin syringe, 0.05 mL of freshly mixed Epiphany was injected into the canal orifice. Then, a master Resilon cone (size 40/0.06 taper) was gently seated into the canal and condensed with a #25 finger spreader. Fine accessory Resilon cones were inserted until they could not be introduced more than 3 mm into the root canal without measuring the extent of spreader penetration. Approximately 4 accessory cones were inserted per root canal, and the quality of the filling was confirmed with radiographs. Excess cones were removed with a warm excavator, and final vertical compaction was completed with a size 11 plugger to a depth of approximately 1 mm.

In group 2, the Epiphany primer and sealer were applied into the root canals as with group 1. Thereafter, a size 40, 0.06 taper gutta-percha master point (Dentsply/Maillefer) was seated into the root canal with tug-back. Lateral compaction was performed as with group 1 by using accessory gutta-percha cones. Removal of the excess gutta-percha cones and final vertical compaction were accomplished in the same manner.

All roots were light-cured for 40 seconds from the coronal aspect. The coronal access of specimens was restored by using a hybrid resin composite material (Spectrum TPH; Dentsply), bonded with a total-etch single-bottle adhesive system (Prime&Bond NT; Dentsply). All clinical procedures were made by the same operator.

Sectioning and Image Analysis

The specimens were stored for 2 weeks at 37°C and 100% humidity to allow the sealer to set completely. Then, horizontal sections were obtained every 1 mm up to 5 mm from the apical foramen. During sectioning, the specimens were subjected to continuous water cooling to prevent frictional heat and, thus, smearing of Resilon or gutta-percha that could tend to hide areas of sealer. The coronal surfaces of sections were digitally photographed at 40× magnification under a stereomicroscope and transferred to an IBM-compatible PC. AutoCAD 2000 software (Autodesk Inc, San Rafael, CA) was used to calculate the cross-sectional area of the root canal and the area filled by the sealer (and voids, if present) (Fig. 1).

For each specimen, the ratio of sealer plus voids to root canal area was calculated by dividing sealer plus void area by the root canal area. The ratio of voids (alone) was also calculated by dividing the area of voids by the root canal area. SPSS statistical software (Version 11.5; SPSS Inc, Chicago, IL) was used for statistical analysis of the data. For each section (1–5 mm), statistical comparisons between the Resilon and gutta-percha groups were made with Mann-Whitney *U* test with Bonferroni correction (5 tests/group). Differences within each obturation group for each level of sectioning were analyzed statistically with Friedman test. A *P* value $<.05$ was considered as statistical significance.

Results

The ratios of the cross-sectional area of sealer plus voids and the cross-sectional area of voids to that of the root canal are presented in Table 1 as means and standard deviations. There were no significant differences between groups 1 and 2 with respect to sealer plus voids or voids at any of the levels tested (Fig. 2, $P > .05$).

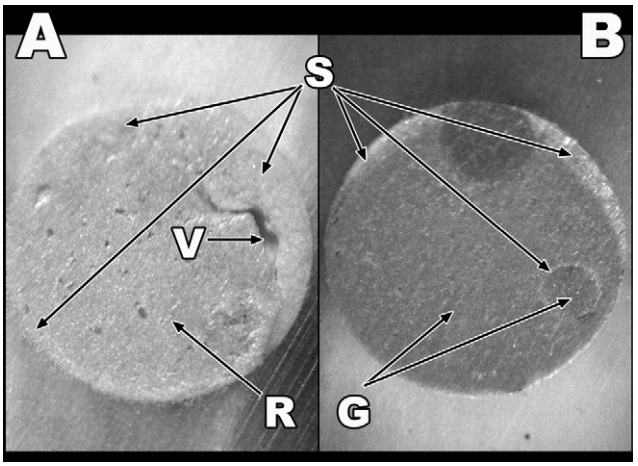

Figure 1. Representative 5-mm sections of Resilon + Epiphany (*A*) and gutta-percha + Epiphany (*B*) groups demonstrating gutta-percha (G), Resilon (R), sealer (S), and void (V).

Comparisons within each obturation group showed that there was no significant difference between any level of sectioning with respect to the ratio of sealer area plus voids to that of the root canal ($P = .232$ for Resilon + Epiphany and $P = .194$ for gutta-percha + Epiphany groups, respectively). Similarly, there was no significant difference between the ratio of voids to that of the root canal ($P = .156$ for Resilon + Epiphany and $P = .897$ for gutta-percha + Epiphany groups, respectively) at any level of sectioning.

Discussion

The quality of the root canal filling in the apical third is important (23), and assuming that minimal sealer thickness and fewer voids are good measures of long-term sealing ability (21), this study was designed to quantify and compare the presence of sealer and voids within the 1–5 mm apical level by using Resilon and gutta-percha cones with the new resin-based Epiphany sealer. A number of researchers have preferred not to use a sealer to prevent methodologic problems such as standardizing the volume of sealer (19, 23, 24). Indeed, despite a standardized amount of sealer being used in the present study, it might be difficult to standardize the amount of sealer reaching the apical region (19). On the other hand, including a sealer might facilitate gutta-percha movement (19) and, more notably, simulate the clinical condition (25).

Previous studies comparing the sealing ability of Epiphany plus gutta-percha and Epiphany plus Resilon combinations have reported conflicting results. By using a bacterial leakage test with *Streptococcus mutans* and *Enterococcus faecalis*, Shipper et al (4) have reported significantly higher leakage with the Epiphany plus gutta-percha combination, compared with that of the Epiphany plus Resilon system. The superior sealing capability of the latter root-filling system was attributed to the "mono-block" that is created by adhering of the Epiphany sealer to both the Resilon filling and the dentin walls (4). Onay et al (6) reported that the combination of gutta-percha plus Epiphany had higher (but not significant) sealing ability than that of the Resilon plus Epiphany. Citing their previous work in which both filling techniques were compared in terms of push-out bond strength test (8), the authors inversely correlated the higher bond strength of the Epiphany sealer and gutta-percha combination with the relatively lower apical leakage obtained in their fluid filtration study. The authors explained that gutta-

TABLE 1. Ratios of the Cross-sectional Area of Sealer + Voids and Voids to the Area of Root Canal

Section (mm)	n	Group 1 (Resilon + Epiphany)		Group 2 (Gutta-percha + Epiphany)	
		Sealer + voids	Voids	Sealer + voids	Voids
1	12	0.121 ± 0.182	0.02 ± 0.03	0.111 ± 0.178	0.01 ± 0.03
2	12	0.058 ± 0.068	0.02 ± 0.04	0.123 ± 0.200	0.01 ± 0.02
3	12	0.042 ± 0.084	0.005 ± 0.007	0.082 ± 0.118	0.007 ± 0.01
4	12	0.052 ± 0.071	0.01 ± 0.02	0.061 ± 0.095	0.01 ± 0.01
5	12	0.073 ± 0.076	0.01 ± 0.01	0.014 ± 0.028	0.003 ± 0.01

Values are expressed as mean ± standard deviation.

percha is more compactable than Resilon, which might partially compensate for interfacial stresses generated by lateral compaction. In agreement with the findings of Onay et al, Tay et al (26) demonstrated the presence of silver deposits along the sealer-hybrid layer interface in the Epiphany plus Resilon system, concluding that the quality of apical seal achieved with the latter system was not superior to AH Plus plus gutta-percha combination.

Epley et al (27) evaluated the presence of voids when the Epiphany system was used for obturating the root canal system. They showed that lateral condensation with gutta-percha and Roth sealer (Roth International LTD, Chicago, IL) had significantly more voids at the 3-mm level, compared with both vertically or laterally compacted Epiphany and Resilon combinations, and continuous wave gutta-percha with Roth sealer. In contrast to their findings, there was no significant difference between either the ratio of voids or sealer plus voids in the present study, including those obtained at the 3-mm level of sectioning. This difference might be due to the type and size of the specimens, the type and taper of instruments, and the use of different sealers. In the study of Epley et al, palatal and distal roots of extracted first molars were used and enlarged with hand file #20, ProTaper rotary files and size 40/0.04 taper ProFile instruments (Dentsply). In addition, fine-medium gutta-percha master points (Dentsply-Maillefer) that had been trimmed to a size 40 (taper unknown) were used with the Roth sealer. In the present study, the selected mandibular premolar roots were very similar in buccolingual and mesiodistal dimensions and were adjusted to a standardized length of 18 mm. Moreover, all roots were flared with the same sequence of Gates-Glidden drills, instrumented with the same rotary file system, and obturated with cones conforming to the size (40) and taper (0.06) of the final rotary files used. Despite all attempts to provide standardization, the high standard deviations obtained herein highlight the problem of using natural teeth instead of resin blocks with simulated root canals (28) and cannot be compared with those of Epley et al because the authors did not report their standard deviations. Nevertheless, both studies report that no significant differences exist between the test groups at levels other than 3 mm. Thus, the use of master gutta-percha cones with the same taper of the prepared root canal can be considered an optimal, but not mandatory, procedure to achieve minimal sealer area and voids with the Epiphany sealer in the apical region.

The present results provided no statistically significant differences between the 2 groups. However, at the 2-mm, 3-mm, and 5-mm levels, the ratio of sealer plus void in group 2 (gutta-percha plus Epiphany) was at least twice as high as in group 1, which undoubtedly has a clinical

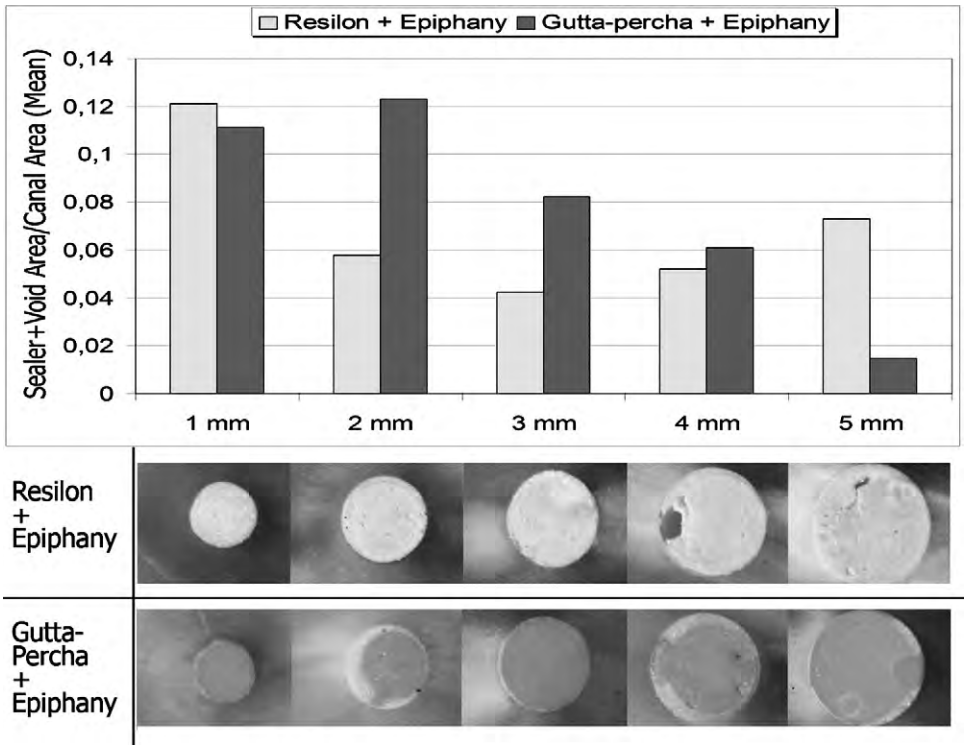

Figure 2. Ratio of the cross-sectional area of sealer + voids to the area of root canal at 1–5 mm and corresponding representative sections for each obturation method tested.

relevance. More interestingly, the ratio of voids in group 2 was twice as low as in group 1 at the 1-mm and 5-mm levels. Because the ratio of unfilled area might be clinically more important than that of sealer, these "insignificant" results show that the gutta-percha plus Epiphany combination results in less void formation. For both parameters, the limited sample size might be responsible for this "missing" statistical significance because the power is too low.

Within the experimental conditions of this study, both obturation methods with the Epiphany sealer displayed similar amounts of the sealer and void component, regardless of the levels of sectioning investigated. Because coronal microleakage has also been cited as a significant cause of post-treatment endodontic failure, further studies should be conducted to assess the adaptation of the tested obturation methods in the coronal third.

References

1. Nguyen NT. Obturation of the root canal system. In: Cohen S, Burns RC, eds. Pathways of the pulp. 3rd ed. St Louis: CV Mosby Co, 1984:205–99.
2. Levitan ME, Himel VT, Luckey JB. The effect of insertion rates on fill length and adaptation of a Thermoplasticized gutta-percha technique. J Endod 2003;29:505–8.
3. Teixeira FB, Teixeira EC, Thompson J, Leinfelder KF, Trope M. Dentinal bonding reaches the root canal system. J Esthet Restor Dent 2004;16:348–54.
4. Shipper G, Ørstavik D, Teixeira FB, Trope M. An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). J Endod 2004;30:342–7.
5. Hiraishi N, Papacchini F, Loushine RJ, et al. Shear bond strength of Resilon to a methacrylate-based root canal sealer. Int Endod J 2005;38:753–63.
6. Onay EO, Ungor M, Orucoglu H. An in vitro evaluation of the apical sealing ability of a new resin-based root canal obturation system. J Endod 2006;32:976–8.
7. Sagsen B, Er O, Kahraman Y, Akdogan G. Resistance to fracture of roots filled with three different techniques. Int Endod J 2007;40:31–5.
8. Ungor M, Onay EO, Orucoglu H. Push-out bond strengths: the Epiphany-Resilon endodontic obturation system compared with different pairings of Epiphany, Resilon, AH Plus and gutta-percha. Int Endod J 2006;39:643–7.
9. Dummer PM. Comparison of undergraduate endodontic teaching programmes in the United Kingdom and in some dental schools in Europe and the United States. Int Endod J 1991;24:169–77.
10. Leung SF, Gulabivala K. An in-vitro evaluation of the influence of canal curvature on the sealing ability of Thermafil. Int Endod J 1994;27:190–6.
11. Peak JD, Hayes SJ, Bryant ST, Dummer PM. The outcome of root canal treatment: a retrospective study within the armed forces (Royal Air Force). Br Dent J 2001;190:140–4.
12. Schäfer E, Olthoff G. Effect of three different sealers on the sealing ability of both thermafil obturators and cold laterally compacted gutta-percha. J Endod 2002;28:638–42.
13. Wu MK, Van B, Wesselink PR. Diminished leakage along root canals filled with gutta percha without sealer over time: a laboratory study. Int Endod J 2000;33:121–5.
14. Kontakiotis EG, Wu MK, Wesselink PR. Effect of sealer thickness on long-term sealing ability: a 2-year follow-up study. Int Endod J 1997;30:307–12.
15. Peters DD. Two-year in vitro solubility evaluation of four gutta-percha sealer obturation techniques. J Endod 1986;12:139–45.
16. Georgopoulou MK, Wu MK, Nikolaou A, Wesselink PR. Effect of thickness on the sealing ability of some root canal sealers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;80:338–44.
17. Schilder H. Filling of root canals in three dimensions. Dent Clin North Am 1967;11:723–44.
18. Gencoglu N, Garip Y, Bas M, Samani S. Comparison of different gutta-percha root filling techniques: Thermafil, Quickfill, System B and lateral condensation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93:333–6.
19. Wu MK, van der Sluis LWM, Wesselink PR. A preliminary study of the percentage of gutta-percha-filled area in the apical canal filled with vertically compacted warm gutta- percha. Int Endod J 2002;35:527–35.
20. Wu MK, De Groot SD, van der Sluis LWM, Wesselink PR. The effect of using an inverted master cone in a lateral compaction technique on the density of the gutta-percha fill. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;96:345–50.
21. Weis MV, Parashos P, Messer HH. Effect of obturation technique on sealer cement thickness and dentinal tubule penetration. Int Endod J 2004;37:653–63.
22. Altundasar E, Ozcelik B, Cehreli ZC, Matsumoto K. Ultramorphological and histochemical changes after ER,CR:YSGG laser irradiation and two different irrigation regimes. J Endod 2006;32:465–8.
23. De-Deus G, Gurgel-Filho ED, Malaghaes KM, Coutinho-Filho T. A laboratory analysis of gutta-percha-filled area obtained using Thermafil, System B and lateral condensation. Int Endod J 2006;39:378–83.
24. Smith RS, Weller NR, Loushine RJ, Kimbrough WF. Effect of varying the depth of heat application on the adaptability of gutta-percha during warm vertical compaction. J Endod 2000;26:668–72.
25. Gulsahi K, Cehreli ZC, Kuraner T, Dagli FT. Sealer area associated with cold lateral condensation of gutta-percha and warm coated carrier filling systems in canals prepared with various rotary NiTi systems. Int Endod J 2007;40:275–81.
26. Tay FR, Loushine RJ, Weller RN, et al. Ultrastructural evaluation of the apical seal in roots filled with a polycaprolactone-based root canal filling material. J Endod 2005;31:514–9.
27. Epley SR, Fleishman J, Hartwell G, Cicalese C. Completeness of root canal obturations: Epiphany techniques versus gutta-percha techniques. J Endod 2006;32:541–4.
28. Gordon MP, Love RM, Chandler NP. An evaluation of .06 tapered gutta-percha cones for filling of .06 taper prepared curved root canals. Int Endod J 2005;38:87–96.