Comparative Analysis of Microleakage and Seal for 2 Obturation Materials: Resilon/Epiphany and Gutta-Percha

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ABSTRACT

Objective: Microleakage continues to be a main reason for failure of root canal therapy, where the challenge has been to achieve an adequate seal between the internal tooth structure and the main obturation material, gutta-percha. The Resilon/Epiphany (R/E) system uses a new obturation material that bonds chemically with the internal tooth structure, thereby decreasing the possibility of microleakage. The purpose of this study was to compare dye leakage in root canals filled with R/E and those in which gutta-percha was used.

Methods and Materials: Pulpectomies were performed on 105 extracted human single-canal mandibular incisors. The teeth were then randomly divided into 2 groups: 1 was obturated with gutta-percha and the other with R/E. Obturation was performed using the lateral condensation technique. The teeth were then incubated for 10 days, 1 month or 3 months in a heated water bath solution with dye to simulate conditions in the human oral cavity. Teeth were sectioned and examined under dissecting and scanning electron microscopes to assess dye penetration, seal and bonding.

Results: Resilon as the main obturation material consistently resulted in less microleakage than gutta-percha at all 3 time intervals.

Conclusion: The R/E system provides a new material for root canal treatment. R/E creates a chemical bond with the internal tooth structure over the entire root area that is maintained over time, thus representing a better option than gutta-percha. Further studies on R/E will help validate its use and determine its long-term success rates in vivo.

MeSH Key Words: dental leakage/prevention & control; dental pulp cavity/microbiology; root canal filing materials; root canal obturation methods

Since its introduction in 1914 by Callahan, gutta-percha has been the standard obturation material used in root canal therapy. The 3 main functions of obturation are to entomb any bacteria remaining within the root canal system; to stop the influx of periapical tissue-derived fluid from re-entering the root canal to feed the surviving bacteria; and to prevent coronal leakage of bacteria.[1] Although gutta-percha has many desirable properties, including chemical stability, biocompatibility, non-porosity, radiopacity and the ability to be manipulated and removed, it does not always meet the 3 main functions of obturation.[1] Gutta-percha does not bond to the internal tooth structure, resulting in the absence of a complete seal.[2] This produces a poor barrier to bacteria microleakage and is considered to be one of the weakest points in root canal therapy.[3] Many attempts have been made to resolve the problem through variations in obturation technique including vertical and lateral condensation and the use of reverse-fill (Obtura II, Obtura Spartan, Fenton, Mo.) or touch and heat (System B, SybronEndo, Orange, Calif.) systems. These methods have reduced

Figure 1: The Epiphany primer, Epiphany sealer and Resilon points.

microleakage to a certain degree but have still failed to eliminate the problem.[4]

Within the last couple of years, new strides have been made to overcome the problem of microleakage. The disadvantages of gutta-percha in endodontic therapy have led to a call for new and improved products, and one such product is the Resilon/Epiphany (R/E) system (Pentron Clinical Technologies, Wallingford, Conn.). Resilon is a synthetic, thermoplastic resin filling material that is believed to overcome the limitations and problems with gutta-percha. The system consists of Epiphany primer, Epiphany sealer and Resilon core material (**Fig. 1**). The root canal is flushed with 17% ethylenediaminetetraacetic acid (EDTA) for 1–2 minutes to remove residual sodium hypochlorite (NaOCl) so as not to disrupt the sealer bond. The canal is then dried with paper points, although complete drying is not necessary as the sealer is hydrophilic. The canal is coated with primer to prepare the surface, then sealer is applied; the sealer comes in a dual syringe with auto-mix tips. The core material (Resilon points) is then used to obturate the canal space. On completion of obturation, the coronal surface is cured to provide an immediate seal in this area. Obturation using this system creates a bonded seal with the dentinal tubules within the root canal system. In essence, it produces a "monoblock" effect, where the core material, sealer and dentinal tubules become a single solid structure, thus meeting Figdor's criteria.[1]

A study by Shipper and others[5] investigated coronal leakage using *Streptococcus mutans* and *Enterococcus faecalis* in teeth filled with gutta-percha versus Resilon using both lateral and vertical condensation techniques for obturation. They amputated the coronal portions of 120 extracted single-canal teeth. The roots were randomly divided into 8 groups, depending on the obturation material and technique used. Resilon showed significantly less coronal microleakage: 10% to 16% of the specimens showed leakage, compared with gutta-percha where approximately 80% of the specimens leaked.

Another important study by Shipper and others[6] looked at periapical inflammation after root canal treatment in dogs, in which vital roots were aseptically treated. After 4 weeks, access cavities were made and cotton pellets soaked in bacteria were placed in the cavities and sealed in the canal. This pellet placement was repeated every 2 weeks for 14 weeks. After the 14-week span, the animals were killed and the apices of the treated roots were evaluated. Of 22 roots treated with gutta-percha, 18 (82%) showed mild periapical inflammation compared with 4 (14%) of 21 roots treated with Resilon.

We set out to investigate dye leakage in root canals filled with R/E compared with gutta-percha. Previous studies have not looked at the longevity of the R/E system in the oral environment. We wanted to determine whether the R/E chemical bond and seal were preserved over time and how they compared with gutta-percha.

Methods and Materials

Randomly chosen single-rooted human mandibular incisors (105) were used in this study. The teeth had been previously extracted and stored in a 10% formalin solution until they were needed. The singularities of the canals were determined by analysis of mesial–distal view radiographs of each tooth. The teeth were then randomly divided into 7 groups, each consisting of 15 teeth. Pulpectomies were performed on 6 of the groups using rotary instrumentation consisting of RaCe (Brasseler USA, Savannah, Ga.), ProFiles (Dentsply, York, Pa.) and Gates Glidden drills using the step-back technique. Final smoothing of the canal was done with a #35 hedstrom file. A 2.5% NaOCl solution was used as an irrigant with the insertion of each instrument. EndoGel (Jordco Inc., Beaverton, Ore.) was also used as a lubricant with the RaCe and Profiles drills. Each specimen was prepared to a size 35 and an apical stop was confirmed with a master point.

Of the 6 groups, 3 were prepared for obturation with gutta-percha. Canals were rinsed with NaOCl and dried with absorbent paper points. The canals were then coated with Tubli-Seal (Kerr Corp., Orange, Calif.) with a #25 K file, and the master point was inserted into the canal.

Table 1 Assessment of leakage in coronal (Cor), mid (Mid) and apical (Api) sections of roots obturated with Resilon or gutta-percha after incubation for 10 days, 1 month and 3 months

	No. of teeth showing no leakage (n = 15)								
	10 days			1 month			3 months		
Obturation material	Cor	Mid	Api	Cor	Mid	Api	Cor	Mid	Api
Gutta-percha	9	7	8	6	6	2	0	2	0
Resilon	11	12	10	10	9	9	9	7	8

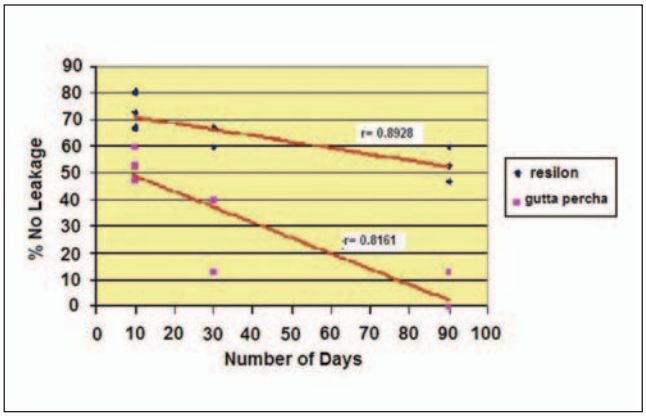

Figure 2: Comparative regression analysis of the percentage of microleakage between Resilon and gutta-percha filled teeth over time.

Accessory gutta-percha points were added using the lateral condensation method.

The other 3 groups were prepared for obturation using the R/E system. The canals were rinsed with distilled water, flushed with EDTA and dried with absorbent paper points. A dry paper point was soaked with Epiphany primer and used to coat the root canal walls. The Resilon core material master point was then coated in Epiphany sealer and inserted into the canal. Subsequent accessory points of Resilon core material were also coated with the sealer and added to the canal through lateral condensation. Once the obturation was completed the coronal surface was light cured for 40 seconds.

The coronal portion of all 6 groups was then restored using 37% phosphoric acid etchant for 15 seconds. Adper Singlebond Plus (3M ESPE, St. Paul, Minn.) was applied to the tooth structure and cured for 10 seconds, then Filtek Supreme (3M ESPE) composite resin was used in increments of 2 mm to fill and restore the cavity. Each increment was light cured for 40 seconds. The external root surface from the cementoenamel junction to 1 mm from the apex of teeth in all 6 groups and the control group was painted with 2 coats of nail polish (Sally Hansen, Del Laboratories Inc., Canada).

All teeth were incubated for 72 hours in saline at 37°C. Each group was then put into a separate Petri dish with saline solution and blue ink dye (Sanford Corporation, Oak Brook, Ill.) and placed in an incubator set at 37°C. The 3 groups of gutta-percha and the 3 groups of Resilon-filled teeth were kept in the incubator for 10 days, 1 month or 3 months. The control group remained in the incubator for the entire 3 months.

After incubation, the teeth were removed from the dye-containing solution. The root region of each tooth was sectioned twice using a flat-bed diamond cutter, resulting in 3 sections of root: the coronal third, middle third and apical third.

The cross-sectional surfaces of the root sections were examined under a dissecting microscope for evidence of dye penetration between the obturation material (gutta-percha and Tubiseal or R/E) and the internal root structure to confirm the presence or absence of microleakage. The control group was examined to confirm that dye penetration did not come from the areas that were painted with nail polish. Two randomly chosen cross-sectional samples from each of the 6 groups obturated with either gutta-percha or Resilon were also viewed under a scanning electron microscope (SEM). These samples were mounted on an aluminum stub, coated with gold atoms and examined using the JEOL 840A SEM to assess the interface between the obturation material and tooth structure at magnifications of 500 and 1,000 times.

Results

At all 3 incubation intervals, less leakage was apparent in the R/E obturated teeth sections than in the gutta-percha groups (**Table 1**). When the data were subjected to comparative regression analysis, Resilon was superior over all time intervals with an R value of 0.8928 compared with gutta-percha with an R value of 0.8161 (**Fig. 2**).

Two random samples from each group were observed under SEM. R/E samples showed a significantly superior seal for all 3 incubation periods compared with gutta-percha (**Figs. 3** to **6**). A complete seal was not observed in any of the gutta-percha samples.

Discussion

Studies of the R/E system have confirmed the superiority of this material. Bonding is clear between the obturation material and the tooth, showing promise for its future

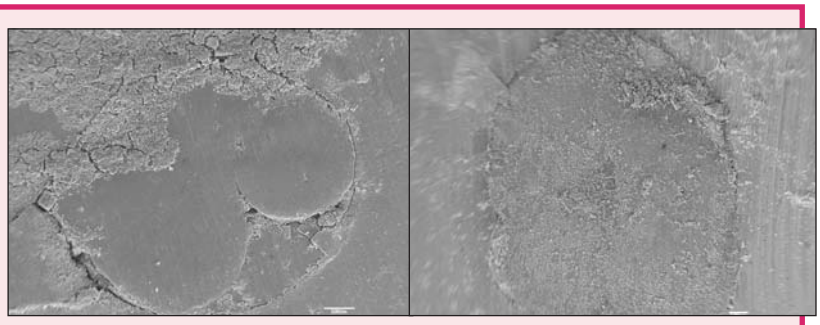

Figure 3: Scanning electron micrograph (SEM) of cross-sections of teeth 10 days after obturation with gutta-percha (a) and Resilon (b). (500× magnification)

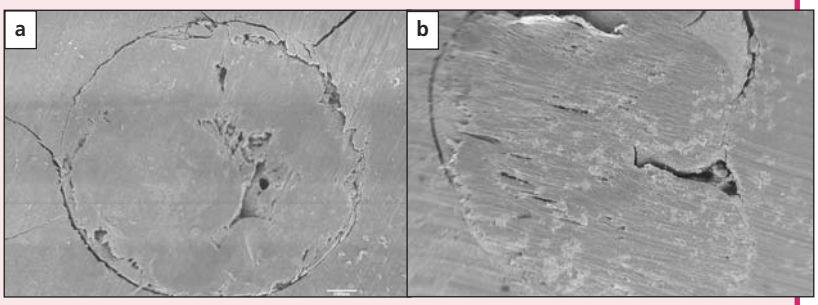

Figure 4: SEM of cross-sections of teeth 1 month after obturation with gutta-percha (a) and Resilon (b). (500× magnification)

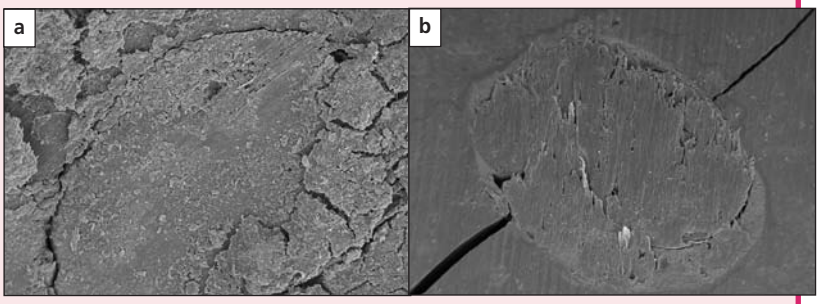

Figure 5: SEM of cross-sections of teeth 3 months after obturation with gutta-percha (a) and Resilon (b). Note: The crack in b occurred during cross-sectioning of the specimen. (500× magnification)

use in endodontics. However, there have been limited studies to evaluate the longevity of the material and its seal within the oral environment. Our study aimed to determine whether R/E can create a "monoblock" with the tooth structure and to compare R/E with gutta-percha in terms of dye leakage. At all 3 time intervals, gutta-percha was inferior to R/E. With gutta-percha, leakage increased with time. R/E, on the other hand, not only produced a superior seal compared with gutta-percha, but also maintained an adequate seal over all time intervals.

Because an in vivo study to test for leakage in humans was impractical and unethical, we tested dye leakage in vitro. Although this test has been used in numerous endodontic studies, a bacterial leakage study would have had more significance. Thus, further studies to test such leakage must be conducted in animals.[6]

As shown in **Table 1**, gutta-percha formed a consistently poorer seal. This raises the question of the need for an alternative material for obturation. R/E is such a new material that may fill that need. With the R/E system, the use of primer before the Epiphany sealer prepares the tooth root surface through an etching process that creates finger-like dentinal projections. This allows for a lock and key type bond between the tooth and the sealer and core material. The data in **Table 1** illustrate how R/E provided a more consistent seal along all regions of the root structure compared with gutta-percha. Furthermore, viewed through the SEM, this bond was observed to form a uniform transition from the tooth to R/E material even at a magnification of 1000× (**Figs. 3** to **6**). Gutta-percha, on the other hand, failed to produce a complete seal and there was evidence of a space at the tooth–filling interface in many of the gutta-percha samples.

It must be noted that this study was strictly in vitro and measured dye leakage with respect to the 2 materials; the results may not coincide with those achieved in a biological system.

In addition, there are some areas of concern with respect to the use of the R/E system. Sensitivity of the materials to technique must be further explored. Concerns lie in the operator's ability to place primer and sealer in the apical portions of root canals. There is also concern over the potential for biodegradability of R/E, as the filling material contains polycaprolactone.[10]

Conclusion

Problems associated with the inadequate seal formed by gutta-percha when used as an obturation material have been known for decades. Researchers and clinicians have tried numerous methods to alleviate this problem but with little success. The R/E system provides a new material for root canal treatment. Resilon not only creates a chemical bond with the internal tooth structure over the entire root area, but its seal is maintained over time to a greater degree than gutta-percha's. This and other studies show that R/E has the potential to replace gutta-percha in this setting.

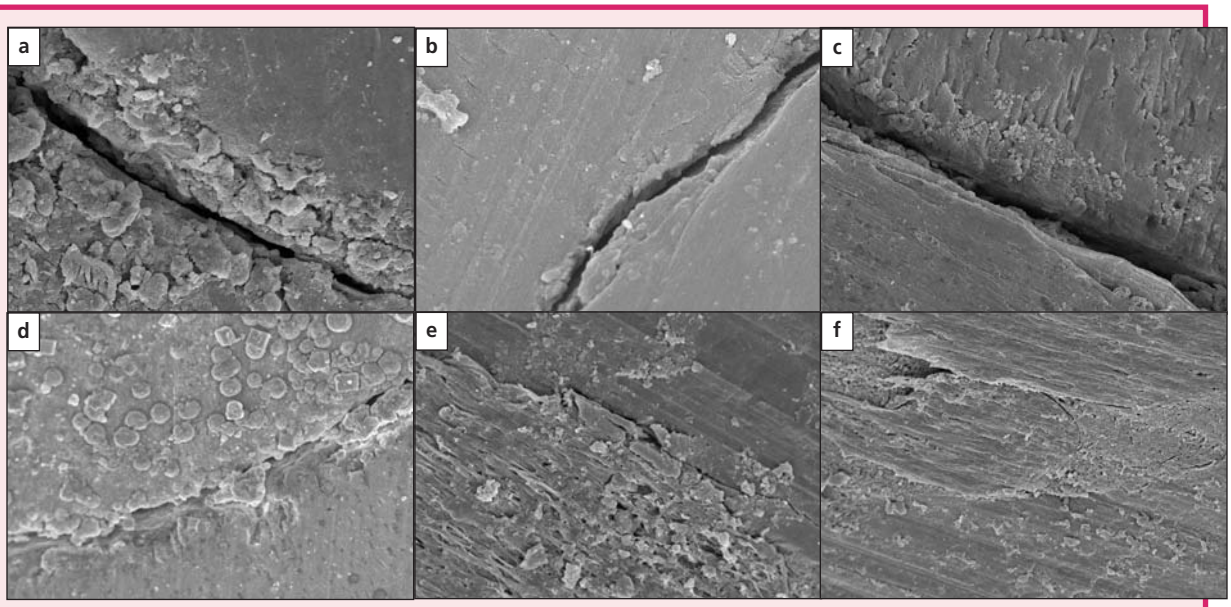

Figure 6: Higher magnification SEM of cross-sections of teeth obturated with gutta-percha after 10 days (a), 1 month (b) and 3 months (c) and with Resilon after 10 days (d), 1 month (e) and 3 months (f). (1000× magnification)

Further studies on R/E will help validate its use. Other needed research includes in vivo studies showing long-term success rates of this material, as well as comparisons of R/E with gutta-percha using different obturation techniques in long-term studies. Further research is also needed on the placement of primer and sealer in the apical portion of the canal.

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References

1. Figdor D. Apical periodontitis: a very prevalent problem. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002; 94(6):651–2.

2. Saunders WP, Saunders EM. Assessment of leakage in the restored pulp chamber of endodontically treated multirooted teeth. *Int Endod J* 1990; 23(1):28–33.

3. Trope M, Chow E, Nissan R. In vitro endotoxin penetration of coronally unsealed endodontically treated teeth. *Endod Dent Traumatol* 1995; 11(12):90–4.

4. Mounce R, Glassman G. Bonded endodontic obturation: another quantum leap forward for endodontics. *Oral Health* 2004; 94(7):13–16, 19–22.

5. Shipper G, Orstavik 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(5):342–7.

6. Shipper G, Teixeira FB, Arnold RR, Trope M. Periapical inflammation after coronal microbial inoculation of dog roots filled with gutta-percha or resilon. *J Endod* 2005; 31(2):91–6.

7. Teixeira FB, Teixeira EC, Thompson JY, Trope M. Fracture resistance of roots endodontically treated with a new resin filling material. *J Am Dent Assoc* 2004; 135(5):646–52.

8. Teixeira FB, Teixeira EC, Thompson J, Leifelder LF, Trope M. Dentinal bonding reaches the root canal system. *J Esthet Restor Dent* 2004; 16(6):348–54.

9. Magnusson B, Kligman AM. The identification of contact allergens by animal assay. The guinea pig maximization test. *J Invest Dermatol* 1969; 52(3):268–76.

10. Tay FR, Loushine RJ, Weller RN, Kimbrough, WF, Pashley DH, Mak YF, and others. Ultrastructural evaluation of the apical seal in roots filled with a polycaprolactone-based root canal filling material. *J Endod* 2005; 31(7):514–9.