

FEATURE ARTICLE

Gutta-percha – the end of an era?

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Endodontics is the prevention or elimination of apical periodontitis. Prevention is the treatment of a vital pulp where no bacteria are present in the root canal system, and elimination is the treatment of a necrotic infected pulp. Root canal therapy comprises two principal phases.

The first is the microbial control phase, in which the root canal is prepared to ensure that the remaining bacteria in the root canal are at a minimum. This is followed by the filling phase, in which the space created for the microbial control phase is sealed to the external environment. The filling phase includes not only the root filling but the crown filling as well. In fact, after adequate microbial control, the clinician should consider the restoration of the endodontically treated tooth to begin with the root filling!

According to Figdor, the three principal functions of root canal filling are to (1) entomb the remaining bacteria within the root canal system, (2) stop the influx of periapical tissue-derived fluid from re-entering the root canal to feed the surviving bacteria, and (3) prevent coronal leakage of bacteria.¹

In 1847, Hill introduced the first gutta-percha root filling material, known as “Hills Stopping.” In 1887, the S.S. White Company started to manufacture gutta-percha points, which were first used primarily as accessory points with the use of a silver point master core material. Later, the core material was changed to gutta-percha as well. In 1914, Callahan introduced a way to soften and dissolve gutta-percha in an attempt to improve the seal of the filling material. There have been few fundamental changes to gutta-percha root fillings since 1914!

The question is how does gutta-percha with a sealer fulfill the functions of a root filling material?

Given that the success rate of endodontic therapy is lower in teeth that are filled immediately after positive culture compared with those filled after a negative culture,² it is apparent that the gutta-percha root filling is not entombing the remaining bacteria. If the gutta-percha filling were entombing bacteria, the presence or absence of bacteria at the time of root filling would not affect the outcome probability. Also, coronal leakage studies clearly indicate that the gutta-percha fill does not seal the canal adequately.³⁻⁵

It appears that gutta-percha is the weak point in endodontic therapy.⁴⁻⁶ In fact, some have claimed that our success in endodontics is related more to the quality of the coronal restoration than to the filling of the canal.⁷

The aim of this article is to present an improvement in the process of restoring endodontically treated teeth after the microbial control phase of endodontics and relates to the substitution of a polymer for the conventionally used gutta-percha. Identified as Resilon (Pentron Technologies, LLC, Wallingford, CT, USA), this gutta-percha substitute material is a thermoplastic synthetic polymer root canal filling material. Based on polymers of polyester, Resilon contains bioactive and radiopaque fillers. Clinically, this material manipulates in the same manner as gutta-percha but possesses the potential for bonding with a resin-based sealant or bonding agent. In association with an improved flexural strength and bonding potential, it offers the major advantage of preventing bacterial microleak-

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age. Furthermore, this substitute for gutta-percha is highly radiopaque.

Material Properties

The concept of dentin bonding used in restorative dentistry has been applied to endodontic treatment, with promising results reported particularly with resin sealers.^{8,9} A few studies have evaluated the potential of using dentin bonding agents and resins as root canal materials in nonsurgical root canal treatment.¹⁰⁻¹² Reasons for not using resins have centered on questionable results owing to difficult and unpredictable methods of delivery of the material into the root system and the inability to retreat the canal if necessary.¹² However, it was acknowledged that these materials may have the potential to enhance the root canal seal by reducing microleakage from both an apical and a coronal direction, thereby contributing to the success of orthograde root canal treatment.

A new material, Resilon (RealSeal, SybronEndo, Orange, CA; Epiphany, Pentron Clinical Technologies, Wallingford, CT) has been developed with the addi-

tion of a primer and resin sealer to replace gutta-percha and traditional sealers for root canal obturation (Figure 1). This system is composed of the following:

1. Resilon Primer: a self-etch primer that contains sulfonic acid-terminated functional monomer, HEMA, water and a polymerization initiator (Figure 1a).
2. Resilon sealer: a dual-curing, resin-based composite sealer (Figure 1b). The resin matrix is composed of BisGMA, ethoxylated BisGMA, UDMA and hydrophilic difunctional methacrylates. It contains fillers of calcium hydroxide, barium sulfate, barium glass and silica. The total filler content is approximately 70% by weight.
3. Resilon core material: a thermoplastic synthetic polymer-based (polyester) root canal core material that contains bioactive glass, bismuth oxychloride and barium sulfate. The filler content is approximately 65% by weight. The Resilon core materials, similar to gutta-percha cones, are available in tapers of 0.02, 0.04 and 0.06 and in acces-

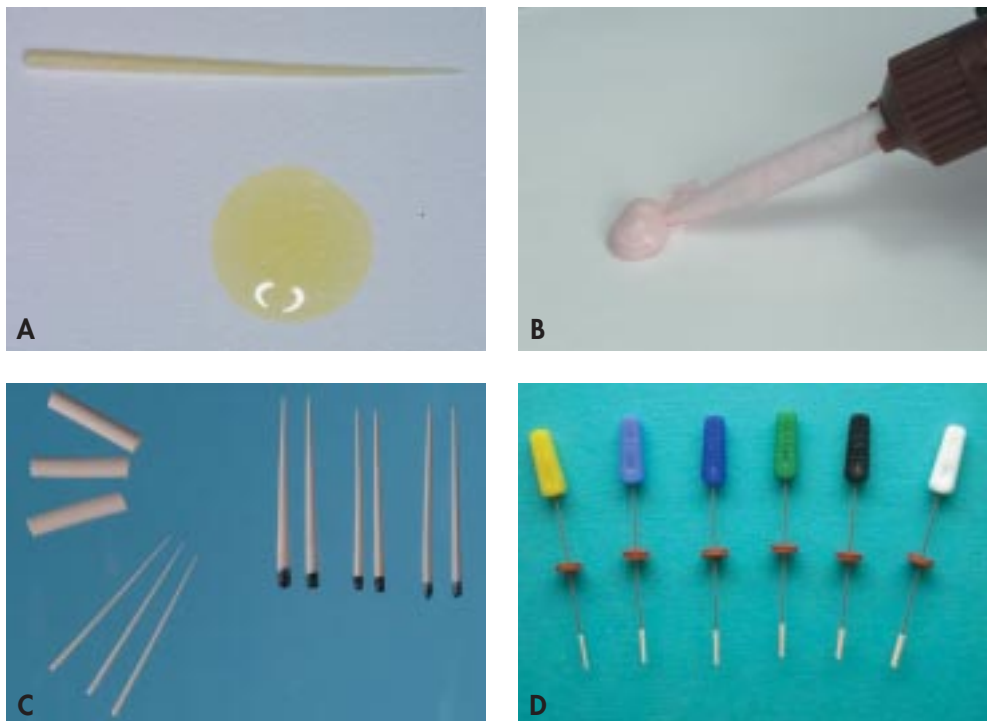


Figure 1 A, Drop of primer on a mixing pad and a paper point soaked with primer. B, The sealer is mixed through the auto-mix tip and placed on the mixing pad. C, Resilon™ core points, 0.02, 0.04 and 0.06 master points, accessory points, and thermoplastic plugs. D, Simplifil plugs of Resilon™.

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sory sizes. Additionally, pellets of this material are available for use with the Obtura II delivery system (Obtura/Spartan, Fenton, MS)(Figure 1c).¹¹

These new materials have been shown to be biocompatible, noncytotoxic and nonmutagenic and have been approved for endodontic use by the Food and Drug Administration (FDA) of the United States.

Resilon is a thermoplastic synthetic polymer-based root canal core filling material that contains bioactive glass and radiopaque fillers. Because it is a synthetic polymer, the resin sealer attaches to it, as well as to the bonding agent used to penetrate into the dentin tubules, forming what can be called a “monoblock”: filling material–resin sealer–bonding agent–dentin (Figure 2). This “monoblock” does not occur with gutta-percha as the core material because the sealer, even if resin based, does not bind to gutta-percha and, in fact, tends to pull away from the gutta-percha on setting. Resilon performs like gutta-percha, has the same handling properties and, for retreatment purposes, may be softened with heat or dissolved with solvents such as chloroform.

The core material is similar to gutta-percha in that there are master cones and accessory cones in different sizes (Figure 1c). In addition, Resilon pellets are available, which can be used for the backfill in the warm thermoplasticized techniques (see Figure 1c,3). Also necessary to complete the canal filling is the self-etch primer (Figure 1a) and the dual curable dental resin composite sealer (Figure 1b).

After finishing the instrumentation, the root canals must be flushed with 17% ethylenediaminetetraacetic acid (EDTA) and/or 2% chlorhexidine to remove residual sodium hypochlorite and then dried using sterile papers points. The Resilon points or plugs are placed into a disinfectant for 60 seconds. Two to three drops of the primer are dispensed into the mixing well. The root canal walls are coated with the primer using a pipette, syringe or paper point soaked in primer (Figures 4). Excess primer is removed using paper points, leaving the internal surfaces moist with primer. The remaining solvent can be evaporated by a gentle air spray for 5 seconds. Sealer is dispensed onto a mixing pad and placed with a master cone or lentulo spiral kept 3 mm from the apex and no faster than 300 rpm. The canal is then filled with Resilon core material (main and accessory points or thermoplastic Resilon material) using the preferred technique (Figures 5 and 6). When the Root Canal filling is completed, the coronal surface is light-cured for 40 seconds to create an immediate coronal seal (Figure 7).

Research and Clinical Implications

Important basic studies have been performed on this material. Toxikon Corporation (ISO Project Number 01-4421-G1) performed a *Salmonella typhimurium* and *Escherichia coli* reverse mutation assay, which demonstrated that (Resilon is nonmutagenic. The Epiphany sealer was evaluated and scored using the Skin Sensitization Kligman Maxi-

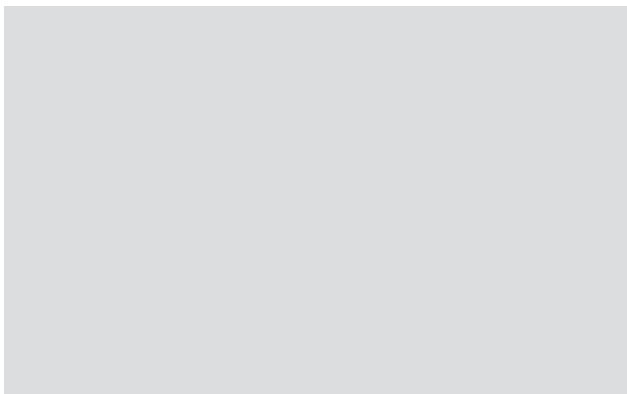


Figure 2 Scanning electronic microscopy picture demonstrating the “monoblock” concept: Primer + Hybrid Layer + Epiphany sealer.



Figure 3 Thermoplasticized Resilon™ pushed through an Obturall needle.

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Figure 4 Paper points soaked with primer inside the root canals.

mization Test and received a grade 1 reaction, which is considered not significant according to Magnusson and Kligman.¹³ Resilon is nontoxic, and the material is FDA approved.

The sealing efficacy of a root canal filling material is its most basic function in endodontic treatment and has been evaluated. Shipper et al. evaluated coronal leakage using *Streptococcus mutans* and *Enterococcus faecalis* through gutta-percha versus Resilon by two different filling techniques.¹⁴ One hundred twenty roots were prepared and randomly divided into 8 groups of 15 roots each. Roots were filled using lateral and vertical condensation techniques with gutta-percha and AH-26 sealer (groups 1 and 2) or with gutta-percha and Epiphany sealant (groups 3 and 4). Groups 5 and 6 were filled with Resilon and Epiphany sealant using the lateral or vertical condensation techniques. Groups 7 and 8 were identical to groups 5 and 6; however, *E. faecalis* was used to test the leakage. Positive and negative control groups were used. Resilon showed significantly less coronal leakage (1 or 2 of 15 specimens) than gutta-percha, in which approximately 80% of specimens leaked (Figure 8).

This study was followed by an in vivo study in dogs.¹⁵ Vital roots were aseptically treated, as in the in vitro study. After 4 weeks, the access cavities were opened and a cotton pellet soaked in bacteria was sealed into the canal. This was repeated every 2 weeks for 14 weeks, after which the animals were killed and the apices of the roots were histologically

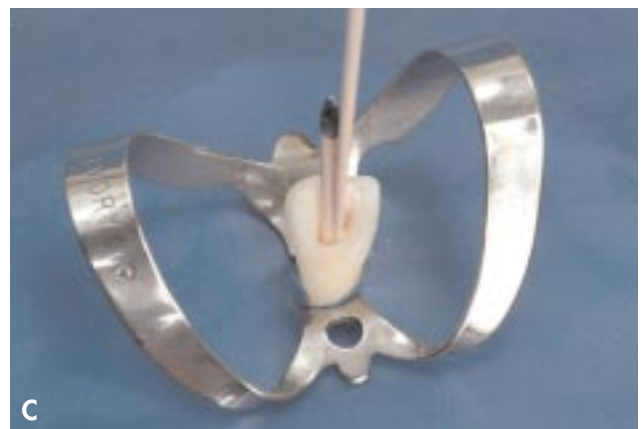
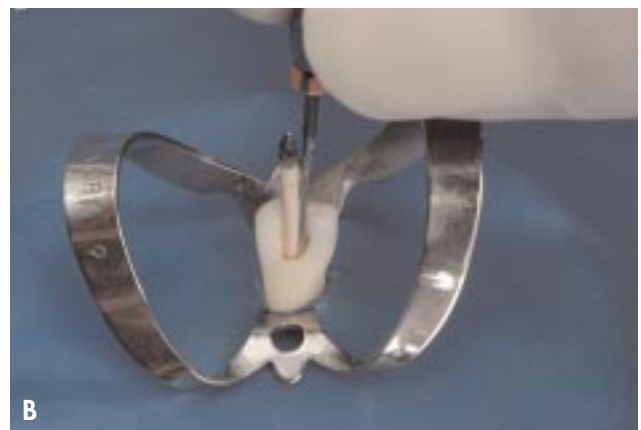


Figure 5 “Passive” lateral condensation technique. A, master cone placed to working length. B, a spreader is “passively” placed to assess if space is available for additional accessory cones and C, accessory cones dipped in sealer are placed to take up any available space.

evaluated for inflammation. The gutta-percha-filled roots demonstrated 82% (18 of 22) mild periapical inflammation, whereas the Resilon roots showed only 13% periapical inflammation (4 of 21 roots)

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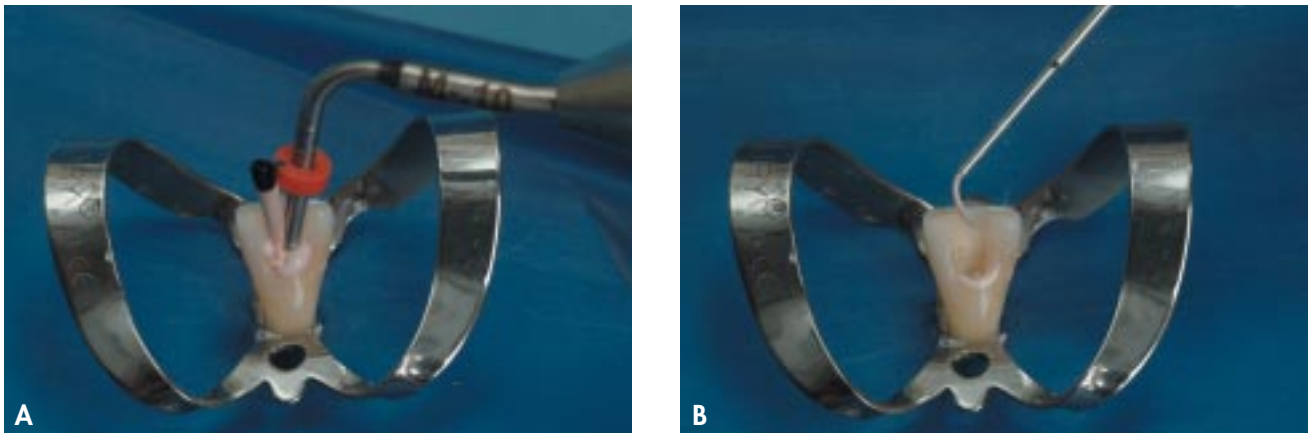


Figure 6 Vertical condensation using System B and Obtura II. A, after the master cone is placed as in 5 an appropriately sized System B plugger is used to remove the coronal two thirds of Resilon™ to allow a down pack of the remaining softened one third B, the remaining space is backfilled with Obtura II and vertical condensed.

(Figure 9). This indicates that the superior sealing ability shown by the Resilon in the in vitro experiment also relates to a decreased incidence of peri-apical inflammation.

The Resilon core is able to bond to the resin sealer, which, in turn, attaches to the self-etched root. This forms the “monoblock,” which is highly resistant to bacterial penetration (Figure 2). One of the potential disadvantages of root canal treatment is the weakening of the root through removal of dentin during instrumentation and also the filling techniques (lateral or vertical condensation). Since Resilon is a bonded resin system, it has the potential

to strengthen the root. The following in vitro study suggests that filling the canal with this material does, in fact, strengthen the root compared with gutta-percha techniques.

Teixeira et al. showed that root canals filled with Resilon were more resistant to fracture than roots filled with gutta-percha and AH-26 sealer, indicating that the monoblock concept is important not only to resist bacterial penetration through the material but also to hold the root together, thereby increasing the resistance to fracture.¹⁶ Eighty single-canal extracted teeth were prepared and randomly divided into five groups: lateral and vertical condensation with gutta-percha, lateral and vertical condensation with Resilon and a control group with no filling material. Data were subjected to analysis of



Figure 7 Light curing the filling material for 40 seconds creates an immediate 2 mm. coronal seal. The remaining sealer will set in 30 to 60 minutes.

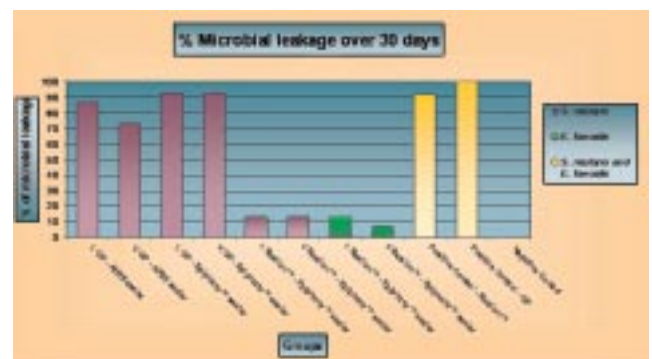


Figure 8 % coronal leakage for the various groups over a 30 day period.

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Figure 9 Peri-apical inflammation in dogs after coronal bacterial challenge for 14 weeks.

variance (ANOVA) and Fisher's PLSD tests at a 95% level of confidence using SPSS 9.0 software (SPSS Inc., Chicago, IL). Comparison among groups was performed. Table 1 shows the means and standard deviations for each experimental group. The ANOVA revealed significant difference between treatments ($p = .037$). The root resistance fracture values of the Resilon vertical and lateral groups were superior to the gutta-percha and AH-26 sealer lateral and vertical groups. However, no significant

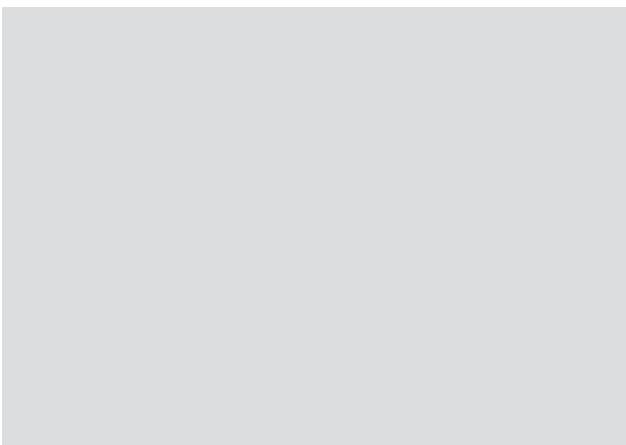


Figure 10 Filled by Cold Resilon™ Technique (Courtesy Dr. Gilberto Debelian)

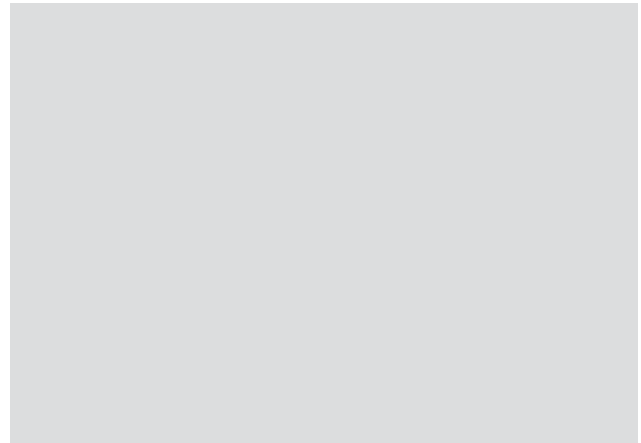


Figure 11 Filled with a warm Resilon™ technique (Courtesy Dr. Bill Watson) Obtura II;

difference was observed among the filled groups and the nonfilled group (control).

Clinically, the material is highly radiopaque and handles well with both cold (Figure 10) and heated Root Canal filling techniques (Figure 11). It appears to be biocompatible, and the sealant has considerable flow through accessory canals (Figures 11). No untoward postoperative pain has been reported by clinicians using the system, and some cases are showing healing in a short period of time (see Figures 12).

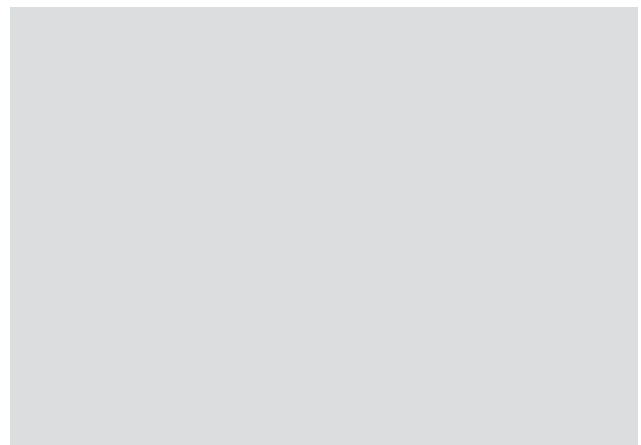


Figure 12 Case filled with the Resilon Obturating system showing healing within 6 months (Courtesy Dr. Michelle Heffernen)

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