In Vitro Resistance to Fracture of Roots Obturated with Resilon or Gutta-percha

Jeanne Monteiro, MDS, Ida de Noronha de Ataide, MDS, Paul Chalakkal, MDS, and Pavan Kumar Chandra, MDS

Abstract

Introduction: There have been varied results from studies comparing postendodontic fracture resistance between teeth obturated with Resilon or gutta-percha. This study was performed to evaluate the fracture resistance of roots obturated by using Resilon (RealSeal system) or gutta-percha (with AH Plus sealer). **Methods:** Eighty extracted human mandibular single-rooted premolars stored in 10% formalin were used in the study. They were prepared by using a crown-down technique, debrided with NaOCl, ethylenediaminetetraacetic acid, and sterile water and divided into 4 groups. Obturation was performed by using the lateral condensation method. The negative control group consisted of unfilled specimens, and the positive control group consisted of those obturated with flowable, dual-cure composite resin. All root specimens were stored for 2 weeks in 100% humidity to allow complete setting of the sealer. Each specimen was mounted in acrylic in a polyvinyl ring and tested for fracture resistance with the Universal testing machine. The loading fixture of the machine was mounted with its spherical tip aligned with the center of the canal opening of each root. A vertical loading force was applied until it fractured the root. The force values were subjected to statistical analysis including analysis of variance and Fisher least significant difference testing. **Results:** Teeth obturated with Resilon were more resistant to fracture than those obturated with gutta-percha. The difference was found to be highly significant (P = .00001). **Conclusions:** Resilon increased the resistance to fracture of single-rooted teeth *in vitro*. *(J Endod 2011;37:828–831)*

Key Words

AH Plus, gutta-percha, RealSeal, Resilon, root fracture

From the Goa Dental College and Hospital, Bambolim, Goa, India.

Address requests for reprints to Dr Paul Chalakkal, Lecturer, Department of Pedodontics and Preventive Dentistry, Goa Dental College and Hospital, Bambolim, Goa, India 403202. E-mail address: atomheartpaul@yahoo.com

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Clinicians have long sought to reinforce tooth structure. Adhesive dental materials are now available that might offer an opportunity to reinforce the endodontically treated tooth through the use of bonded sealers in the root canal system (1). Ever since dentin bonding systems have advanced in restorative dentistry, their potential use in endodontics as an obturating material has gained popularity. If a dental material could be developed that would bond to the dentinal walls of the root canal, theoretically the material ought not only to provide a good seal but also to reinforce the endodontically treated tooth (2). Resilon is a polymer-based thermoplastic resin containing bioactive glass, bismuth oxychloride, barium sulfate, and radiopaque fillers. Many advantages of Resilon (SybronEndo, Orange, CA) have been reported, which include reduction in postendodontic leakage and periapical inflammation and improvement in root strength. These advantages have been attributed to the monoblock concept, whereby the Resilon core is bonded to the sealer, and the resulting complex is bonded to root dentin by a resin-based primer (3–5). Gutta-percha has been widely accepted for years as the gold standard obturating material. However, the disadvantage with gutta-percha and sealer is its inability in creating a dependable seal for the root canal system (3, 4).

Many authors have reported little difference between the 2 obturating materials (Resilon with RealSeal sealer and gutta-percha with AH Plus sealer [Dentsply DeTrey, Konstanz, Germany]) with regard to postendodontic fracture resistance of teeth (6–10). Nagas et al (11) showed that the fracture resistance of roots is not affected by the obturation system but by the intraorifice barrier used. Other factors held responsible for postendodontic root fracture include loss of tooth structure; stresses induced from cavity preparation, instrumentation, obturation, irrigation, coronal restoration; and inappropriate selection of tooth abutments for prosthesis (12). Therefore, it was decided to compare the fracture resistance between teeth obturated with gutta-percha with AH Plus sealer or Resilon with RealSeal. The null hypothesis assumed was that there would be no difference in fracture resistance of roots whether obturated with gutta-percha with AH Plus sealer or Resilon with RealSeal sealer.

Materials and Methods

Extracted mandibular single-rooted first and second premolars with closed apices and without excessive curvatures were used in this study. The teeth were stored in 10% formalin after they fulfilled the following 2 criteria. Each root had a minimum length of 14 mm and a maximum buccolingual diameter of 5 ± 1 mm (measured with a vernier caliper). Before experimentation, each tooth was washed with sterile water and observed under an operating microscope (25× magnification; Carl Zeiss, Oberkochen, Germany) to rule out teeth with fractures or cracks. The teeth were sectioned at the cementoenamel junction with a diamond disk such that the length of each root was standardized to 14 mm. The canals were instrumented with ProTaper (Dentsply Tulsa Dental, Tulsa, OK) rotary instruments by using a 1:64 reduction handpiece (NiTi Control; Dentsply Maillefer, Tulsa, OK) at a speed of 250 rpm per manufacturer's instructions. Estimation of the provisional working length was made by placing size 15 K-file (Dentsply Maillefer) into the root canal until it was observed at the apex. The final working length was ascertained after subtracting 1 mm from this length. Shaping file S_1 was carried into the canal short of working length, followed by file Sx that was used with a brush stroke until two thirds of its overall length was below the

canal orifice. File S_1 was then used to working length, followed by S_2. Next, finishing File F_1 was taken to working length and withdrawn. The size of the apical foramen was then gauged by using an ISO #20 hand K-file, after which finishing file F_2 was used. The size of the apical foramen was then gauged with an ISO #25 hand K-file, after which file F_3 was used to working length. Only those teeth that required finishing with file F_3 constituted the final sample of teeth. Throughout the entire sequence of operations, irrigation was performed with an endodontic irrigating needle and syringe by using 2.5% sodium hypochlorite. Recapitulation was performed with an ISO #15 K-file, subsequent to the use of each ProTaper file. After completion of instrumentation, all specimens received a flush of sodium hypochlorite, followed by 17% ethylenediaminetetraacetic acid (EDTA)–SmearClear (SybronEndo) for 2 minutes. All specimens were finally irrigated with sterile water. The canals were dried with paper points.

The selected tooth specimens (n = 80) were then randomly assigned into 4 experimental groups (n = 20 for each group) by using a simple random sampling method. Each tooth was serially allocated to boxes (groups) numbered from 1–4; the fifth tooth was allocated in box number 1 and so on. The following procedures were performed on teeth in each group: group 1, lateral condensation with Resilon (RealSeal system); group 2, lateral condensation with gutta-percha and AH Plus sealer; group 3, the specimens were not obturated (negative control); group 4, the specimens were obturated with flowable, dual-cure composite resin (Rebilda DC; VOCO, Cuxhaven, Germany) (positive control).

All procedures for the 4 groups were done according to manufacturers' instructions. The root canal openings of all specimens were sealed with a non-eugenol temporary filling material, Cavit G (3M ESPE, St Paul, MN). All root specimens were stored for 2 weeks in an incubator at 25°C in 100% humidity to allow the sealer to set completely. Each apical root end was embedded in 12.5-mm height of acrylic resin in a polyvinyl ring, leaving 9 mm of the root exposed and 5 mm embedded (root length was 14 mm). This was done with a 30-gauge round orthodontic wire that was bent into a "J" shape. The short handle of the "J" was looped around the canal orifice of each sample and the long handle to the outer surface of the polyvinyl ring. This allowed the tooth to be suspended in the center of the ring, parallel to the long axis of the ring. Acrylic resin was adapted into the ring to stabilize the sample. A carbide bur was used to remove the temporary material and to shape the root canal access of each tooth just enough to accept the loading fixture, after blinding the number on the boxes. Each polyvinyl ring containing a root specimen was mounted for evaluation of fracture resistance. A loading fixture was mounted with its spherical tip (r = 2 mm) aligned with the center of the canal opening of each specimen (Fig. 1). A vertical loading force was applied at a crosshead speed of 1.25 mm per minute until it fractured the roots. Fracture was defined as the point at which a sharp and instantaneous drop greater than 25% of the applied load was observed (5). The test was terminated at this point, and the recorded force was measured on the dial gauge of the Universal strength testing machine (Hounsfield, UK).

The data were subjected to analysis of variance to compare mean difference of fracture resistance among the 4 groups. A multiple comparison test with Fisher least significant difference was used to find the significant difference between any pair of groups. A P value $<.05$ was considered a statistically significant difference.

Results

Although the roots were narrower mesiodistally, a majority of them had fractured buccolingually. Table 1 shows the fracture resistance values for each group. The greatest mean value of fracture resistance (640.46 N) was offered by the positive control group (obturated with dual-cure composite resin), whereas the least (395.75 N) was offered by the negative control group (without any obturation). However, the group obturated with Resilon and RealSeal sealer offered more resistance to fracture (510.11 N) than those obturated with gutta-percha and AH Plus sealer (414.72 N). The analysis of variance showed a highly significant difference with respect to mean fracture resistance between the 4 groups ($P = .00001$). The multiple comparisons test (Fisher least significant difference method) revealed that there was a significant difference in mean fracture resistance between any 2 groups, except between the negative control and gutta-percha groups. Thus, the null hypothesis was rejected.

Discussion

There have been varied outcomes from studies comparing the intraradicular sealing abilities between the 2 systems (Resilon system versus gutta-percha with AH Plus sealer). Some authors have reported little difference between the two (13–17), whereas others have reported the later to be superior to the Resilon system (18–23). Secondary monoblocks are those that have 2 circumferential interfaces, one between the cement and dentin and the other between cement and the core material. In a root canal the C factor can be greater than 1000. Hence, any polymerizing endodontic sealer would be subjected to large polymerization stresses during the setting process, resulting in debonding and gap formation along the periphery of the root

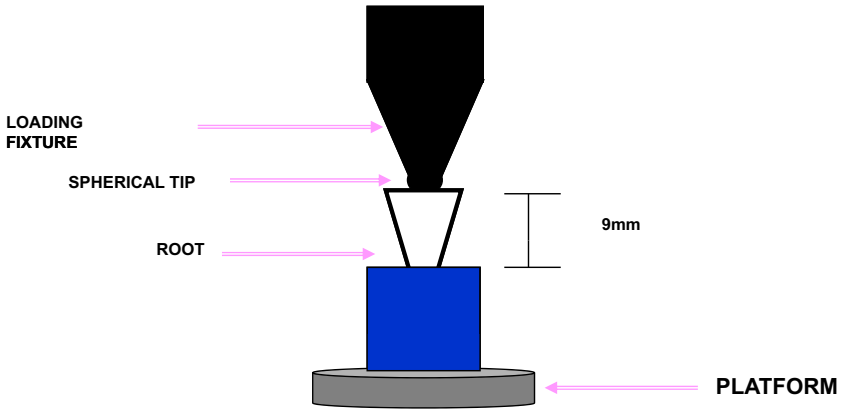

Figure 1. Polyvinyl ring containing root specimen mounted against loading fixture with its spherical tip (r = 2 mm) aligned with center of canal opening of each specimen.