Original Research

Comparative evaluation of the apical seal of Resilon™ with sealer, Guttapercha with resin sealer and Guttapercha with Zinc oxide eugenol sealer in permanent single rooted teeth– an *in vitro* study

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Abstract

Objective: The era of endodontics has taken a new dimension with the advent of a synthetic, thermoplastic resin filling material, named Resilon. Our *in vitro* study tested the efficacy of this new obturating system, versus the age-old material Guttapercha.

Materials & Methods: Forty five central incisor teeth, extracted due to periodontal reasons, were assigned to two experimental (Resilon and AH 26) and one control group. They were obturated by lateral condensation method, immersed in 2% methylene blue solution, sectioned longitudinally and examined under stereomicroscope. Dye penetration was recorded as an indicator of microleakage. Analysis of variance (One Way ANOVA) and post hoc multiple comparisons were used for statistical analyses.

Results: Analysis of variance (One Way ANOVA) showed highly significant (P<0.001)

difference among the groups tested. Post hoc multiple comparisons revealed the difference between groups, of which dye penetration in Resilon and AH 26 was significantly different from control and between themselves.

Conclusion : Resilon has better sealing ability when compared to the other two filling materials .

Introduction

The primary objectives of operative endodontics are total debridement of the pulpal space, development of a fluid–tight seal at the apical foramen and total obturation of the root canal.[1] Guttapercha has been accepted for years due to its biocompatibility, dimension stability, compactibility, thermoplasticity and ease of removal. However, there is a major flaw with filling root canals with Guttapercha and sealer in that it is unable to create a dependable seal of the root canal system.[2] A wide variety of root canal sealers are available and these include cements based on organic resins, calcium hydroxide and Zinc oxide Eugenol.[3] In an effort to improve the obturation of the root canal system new techniques and materials have been developed. The most promising new material which could be considered as a replacement for Guttapercha is Resilon™ (*Pentron Clinical Technologies, Wallingford, CT).*[4] Resilon™ is a synthetic, thermoplastic resin filling material that is believed to overcome the limitations and problems associated with Guttapercha.[5] The system consists of Resilon™ core material, Epiphany™ primer and Epiphany™ seale. There have been only a few studies conducted to test the microleakage of Resilon™ with other standard obturating materials and sealers. Hence this *in vitro* study was undertaken to evaluate the sealing ability of this new root canal filling material along with its recommended sealer and also to compare the sealing ability of this new material with routinely used root canal obturating materials (Guttapercha with AH 26® epoxy resin sealer and Guttapercha with Zinc Oxide Eugenol sealer).

Materials and Methods

A total of forty five permanent single rooted central incisor teeth extracted due to periodontal reasons, were collected and stored in 0.9% normal physiological sodium chloride solution.[6] Teeth which were not subjected to prior root canal treatment and teeth having one single canal and one main apical foramen were included in the study.[7] Teeth with calcified canals, extra canals, extremely curved canals, open apices, cracks, or external or internal resorption were eliminated. All calculus and periodontal remnants were carefully removed with ultrasonic scaling to allow better adherence of the nail polish surface sealant. The teeth were placed in three clean containers marked [a] Resilon™ [b] AH

26℅ [c] Control groups respectively and filled with physiologic saline solution and stored in the refrigerator to inhibit bacterial growth. The specimens were divided into three and all the three groups had 15 teeth each. The teeth were distributed evenly with regard to length and prepared in a standardized manner. First group was formed with Resilon™ with Epiphany™ sealer. Second Group, Guttapercha with a resin based sealer and third group kept as control was formed of Guttapercha with Zinc Oxide Eugenol sealer. All of these specimens were totally covered with three coatings of nail varnish (as surface sealant), including the apical and coronal ends. Access opening was done on each tooth and the canal working lengths were visually established by placing a size 20 K-file into each canal until the tip of the files were visible at the tip of the apical foramen. The working length was established 1 mm short of the apex. Canal systems were instrumented to the working length with a size 40 K-file using a Step back preparation technique. Apical patency was maintained throughout the procedure by passing the tip of a size 20 K-file through the foramen and to provide a standardized preparation. The root canals were irrigated with 2ml of 5.25% NaOCl (Sodium hypochlorite) after the use of each file throughout the preparation. Smear layer was removed with 2 ml of 17% EDTA; finally, the canals were flushed with 2 ml saline solution and then dried with paper points. The obturation technique used was the lateral cold condensation technique, for all the groups.

In the Resilon™ group, after drying the canals with paper points, self etch primer was placed into the root canal system to the working length with applicator tips. Dry paper points were then used to wick out the excess primer from the canal, according to the manufacturer's instructions. Next the dual syringe (containing the sealer) with the auto mixing tip attached was used to express the sealer onto a mixing pad. The sealer was then placed into the root canal system by generously coating the master cone. The canals were then obturated. Resilon™ was cured immediately at the coronal end with a curing light for 40 seconds. According to the manufacturer's instructions, light source was held 1-2 mm from the surface for 40 sec to obtain polymerization. Depth of curing was 2.5 to 3 mm per 20 seconds. The rest of the material is claimed to self cure within the next 45 minutes.[7] Upon completion of obturation, all samples were again stored in their respective containers, filled with physiological saline solution at 37⌗C for 48 hours. Then they were taken out from the containers and the entire tooth surfaces were covered with 3 layers of nail varnish, allowing each coat to dry between applications except for the apical 3 mm.[8] Post operative radiographs were exposed to evaluate the quality and density of the root canal obturation.[7] All the specimens

were placed in 2% methylene blue dye solution for 24 hours. They were then removed from the dye and rinsed with tap water, allowed to dry for 24 hours at 37#C before meticulously removing the nail varnish with a scalpel blade. Coronal tooth structure was removed with a separating disc perpendicular to the long axis of the tooth. Then they were sectioned longitudinally using water-cooled diamond discs in a bucco-lingual direction.[9] Apical leakage was determined by using the dye penetration method.[10,11] Each section was examined using a Stereomicroscope {STEMI 2000-C, Carl Zeiss, Germany} with microscope camera {MC 80, Carl Zeiss, Germany} at 40X magnification to assess the linear breakthrough of the dye using the standard measurements of a Stereomicroscope and evaluated by a single operator via pictures. After micro leakage examination, the results of the study were noted and subjected to statistical analysis.

Statistical analysis

Data were analyzed using computer software, Statistical Package for Social Sciences (SPSS) version 10. Analysis of variance (One Way ANOVA) was performed as parametric test to compare different groups. To elucidate multivariate comparisons, Duncan's Multiple Range Test was performed as post hoc analysis along with ANOVA. For all statistical evaluations, a two-tailed probability of value, < 0.05 was considered significant.

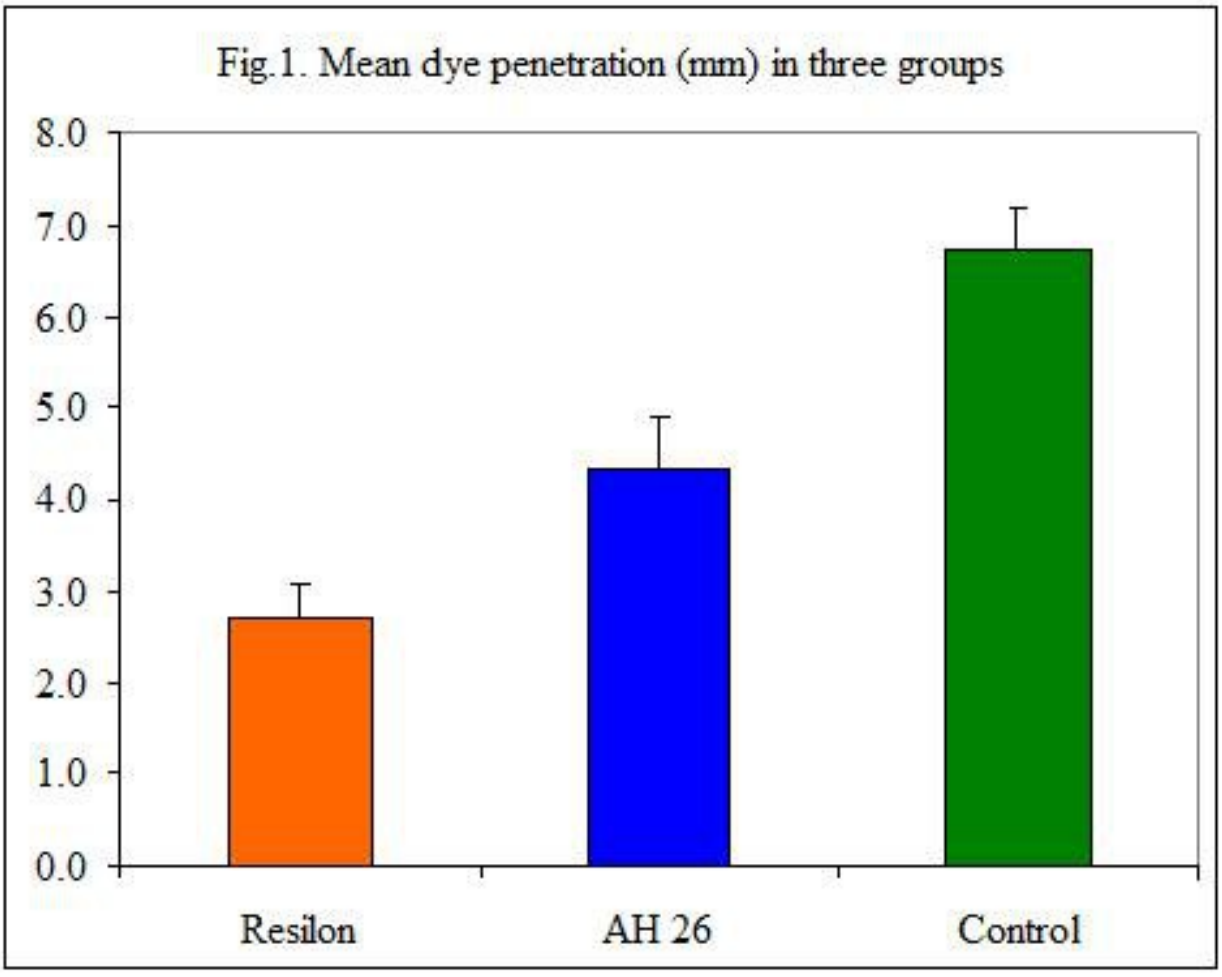
Results

The results of the study revealed that the dye penetration depends upon the type and nature of material. The control group had the maximum dye penetration with 6.76 ± 0.44 mm, where as the tested groups showed only reduced dye penetration with 2.71± 0.36mm and 4.31±0.51mm for Resilon and AH 26 respectively (Table 1, Figure 1). Analysis of variance (One Way ANOVA) revealed highly significant (P<0.001) difference among the groups tested. Post hoc multiple comparison revealed the difference between groups, of which dye penetration in Resilon and AH 26 was significantly different from control and between themselves.

Table 1. Dye penetration in teeth in three groups with different fillers

a	Mean (mm)	± SD	F value	p value (ANOVA)
Resilon	2.71[a]	0.36	275.225	< 0.001
AH 26	4.31[b]	0.59		
Control	6.76[c]	0.44		

a, b, c – Means with same superscript do not differ each other (Duncan's Multiple Range Test)



Discussion

The American Association of Endodontists (AAE) has defined root canal obturation as *"the three dimensional filling of the entire root canal system as close to the cemento-dentinal junction as possible"*. A tight apical seal is considered desirable to prevent remaining bacteria and their endotoxins from invading the apex. Filling of the root canal with Guttapercha and sealer even by the most technically proficient operator may not result in a seal that is dependable. Although

Guttapercha has been used for a long time, most agree that it would be advantageous to replace it with a filling material that provides a superior seal at all levels of the root canal system.[12] Guttapercha provides a poor barrier to the coronal to apical migration of bacteria after obturation, as it does not bond to canal walls. In comparison, promising results have been reported with resin sealers.[13] One such alternative is Resilon™, a thermoplastic synthetic polymer. The system includes three primary components: 1. The Resilon™ core material– a thermoplastic synthetic polymer-based root canal core material containing bioactive glass, bismuth oxychloride and barium sulfate (Figure 2). 2. The Epiphany™ resin sealer– a dual-curing, resin-based composite sealer (Figure 3). The resin matrix is composed of BisGMA, Ethoxylated BisGMA, UDMA, and hydrophilic difunctional methacrylates. 3. The primer– a self-etch primer that contains sulfonic acid-terminated functional monomer, 2-hydroxyethylmethacrylate (HEMA), water and a polymerization initiator.[14] Single rooted and not multi – rooted teeth specimens were taken for this *in vitro* study (Figure 4), in order to distribute the teeth with regard to length and to prepare in a standardized manner.[15,16] .Access opening was done on each tooth with the help of no.4 round bur, in a high speed contra angle airotor hand piece, according to the protocol given by *Grossman* . Chemo mechanical debridement of the root canals was accomplished with the use of Step back preparation.[17] The specimens were then obturated using the lateral cold condensation technique. Many methods have been reported in the literature to determine apical leakage of root canal fillings. Among these, the dye penetration using the passive method is most commonly used.[10]

Figure 2. Epiphany™ kit with Resilon cones

Figure 3. Resilon cones, Epiphany Sealer, Epiphany Primer, Accessory cones, Pipette and Applicator tips

Figure 4. Specimens for Resilon™ group

Microleakage was estimated between the sealer-dentin interfaces. Several studies reported that shrinkage of the resins is particularly taxing in long narrow canals where unfavorable canal configuration factors compromises the relief of shrinkage stresses *via* resin flow. Thus gaps are frequently observed between the sealer-dentin interfaces.[18-20] The measurement of the leakage was made from the apex to the point where the dye no longer penetrated the filling material or its interface with the dentinal tubules.[3] The result of this study showed that while all the materials have exhibited leakage, Resilon™ revealed the least. The reasons for the superior sealing ability of Resilon™ could be due to the following factors: a. Formation of the monoblock that is formed by the combination of chemical and mechanical bond of the Resilon™ core to the resin-based

sealer (Epiphany™) which bonds to the dentinal walls. [21] The bonding mechanism between the sealer (Epiphany™) and Resilon™ points is said to be of a mechanical and chemical combination. The resin from the sealer is able to diffuse into the Resilon™ polyester polymer matrix [mechanical], when they contact each other and then forming partial chemical polymerization with the methacrylate resin within the Resilon™ polymer matrix [possibly through hydrogen and covalent bonds].[14] The bonding between the dentinal matrix and the primer. This is thought to be because of the difunctional groups present in HEMA – a hydrophilic group and a hydrophobic group. The hydrophilic group has an affinity for the dentinal matrix and the hydrophobic group (methacrylate) group has an affinity for resin. The primer wets and penetrates the collagen meshwork, raising it almost to its original level. The primer also increases the surface energy and hence the wettability of the dentinal surface. Unfilled resin is applied to and penetrates the primed dentin, copolymerizing with the primer to form an intermingled layer of collagen and resin, which is known as the hybrid layer[16]. The disadvantages of this material include: lack of antibacterial property and susceptibility to degradation under apical or coronal micro leakage.[20] Mustafa Murat Kocak *et al* studied the apical sealing ability of different core materials used with Epiphany™ sealer and to evaluate the effect of Resilon/Epiphany™ system on creating an apical mono-block seal. Their study showed Resilon™ core material and Epiphany™ sealer had the least apical dye penetration copared with the other groups.[22] Manzoor Baba and colleagues studied the fracture resistance of teeth treated with guttapercha and Resilon and concluded that filling the canals with Resilon increased the *in vitro* resistance to fracture of endodontically treated single canal teeth when compared with guttapercha.[23] Salma B Abdo *et al* conducted an in vitro study to evaluate the sealing ability of gutta-percha-nano-HA and Resilon-Epiphany by electrochemical method and micro-computed tomography (CT) scan at 48 h and 20 months using three different obturation techniques and concluded that Nano-hydroxyapatite sealer with gutta-percha filling material provided a reasonable seal compared with Epiphany sealer and Resilon filling material.[24]

Reasons for micro leakage and inability to form a complete hermetic seal by all the three sealers used in this study could be due to the following: 1. Curvature of the canal might affect the sealing ability of a material. According to Grossman, a straight root canal extending the entire length of the root is uncommon. Either a constriction is present before the apex is reached or, as is often the case, a curvature is present. The curvature may be sharp or gradual or even double curvatures

in the shape of "S" may also occur. Success in negotiating a narrow, curved canal depends on the degree of curvature, the size and constriction of the root canal and the size and flexibility of the endodontic instrument[6]. 2. Size of the apical foramen is also an important factor in the cause for micro leakage. Variations in micro leakage can occur with the same sealer used because of the size of apical foramen. In young, incompletely developed teeth, the apical foramen is funnel shaped. As the root develops, the foramen becomes narrower. Sometimes, it may exhibit elliptical shape also. The apical foramen is not always the most constricted portion of the root canal. Constrictions can and do occur before the extremity of the root is reached. Apical constrictions are found 0.5 to 1 mm away from the root apex. 3. Lateral canals and accessory foramina have been found with enough regularity to prove that they are integral parts of a normal pulp cavity rather than exceptions. Although, according to Grossman, central incisor root canals are generally straight (75%), there are chances for lateral canals (24%) in the apical third, which the routine radiographs may miss. 4. Several studies report that shrinkage of the resins is particularly taxing in long narrow canals where unfavorable canal configuration factors compromises the relief of shrinkage stresses via resin flow. Thus gaps are frequently observed between the sealer-dentin interfaces.

Conclusion

The causes for microleakage in endodontically treated teeth may be varied. The possible reasons for the better sealing ability shown by the new obturation material Resilon™ in this *in vitro* study have been listed above. However, data from *in vitro* studies with small sample sizes cannot be adapted clinically. Further long term research has to be carried out with greater sample sizes and also information from meticulously designed in vivo studies may throw light on whether this new polymer based material can truly replace the 'gold standard' obturation material Guttapercha.

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