Original Article

An *In vitro* Comparison of Pushout Bond Strength of Resilon with MetaSEAL and AH Plus Sealers

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Abstract

Aim: The aim of this study is to evaluate and compare the pushout bond strengths of Resilon with two different sealers: Resilon/MetaSEAL (methacrylate based) and Resilon/AH Plus (an epoxy resin-based sealer). **Materials and Methods:** Forty single canal anterior teeth were decoronated at cementoenamel junction and standardized to 10 ± 1 mm length. Working length was determined followed by biomechanical preparation. Then, the specimens were randomly assigned into two groups of 20 teeth each based on the sealer used with Resilon. All canals were obturated using single-cone obturation technique. Root samples were prepared for pushout testing. The universal testing machine gave the debonding force for individual specimen. This was done for all the specimens. **Statistical Analysis:** This was done by using unpaired Student's *t*-test. **Results:** The roots filled with Resilon/MetaSEAL had higher bond strength (1.49 ± 0.09 MPa) compared to Resilon/AH Plus (0.90 ± 0.04 MPa) group. The difference in bond strength was statistically significant ($P = 0.0000$). **Conclusion:** Through this pushout bond strength test, it could be noted that MetaSEAL did appear to bond to the dentin and could be used as a potential endodontic sealer.

Keywords: *AH Plus, metaseal, pushout test, Resilon*

Introduction

Resilon (Resilon Research, North Branford, Conn.) was introduced as an alternative to gutta-percha and is believed to be an adhesive root filling material. The constituents in Resilon are difunctional methacrylate resin, bioactive glass, and radiopaque fillers such as bismuth oxychloride and barium sulfate. It is a thermoplastic synthetic resin material whose performance, handling characteristics, and appearance are similar to gutta-percha.[1]

MetaSEAL (Parkell Inc, Edgewood, NY, USA) is a fourth generation polymethylmethacrylate-based resin sealer. It contains an acidic resin monomer 4-methacryloxyethyl trimellitate anhydride (4-META). It is dual-cured and self-adhesive, thereby eliminating the priming step.[2] There are claims that the sealer MetaSEAL bonds to gutta-percha, Resilon, and dentin as well.[3]

The inclusion of 4-META makes MetaSEAL self-etching, hydrophilic, and self-adhesive. MetaSEAL is one of the sealers that have been introduced during the last decade as a result of popularization of techniques that involve the simultaneous bonding of the root canal sealers to the dentin and root filling materials, creating a monoblock.[4]

MetaSEAL shows improvements in bond strength and resistance to pushout test indicating its potential to bond to the intraradicular dentin.[5] The formation of a monoblock is believed to be the plus point of MetaSEAL.[6]

Hence, through his *in vitro* study, the pushout bond strengths to the intraradicular dentin were evaluated and compared by using Resilon along with two different sealers Resilon/MetaSEAL (methacrylate based) and Resilon/AH Plus (an epoxy resin-based sealer).

Materials and Methods

A sample of forty human single-rooted, single-canal anterior extracted teeth were collected cleaned and stored in 0.1% thymol solution.

The teeth that were included for the study were with completely formed root apices, without any resorptive defects and without any cracks. Decoronation of the teeth was

How to cite this article: Sarangi P, Mallick R, Satapathy SK, Sharma G, Kouser F, Mohapatra S. An *In vitro* Comparison of pushout bond strength of resilon with MetaSEAL and AH plus sealers. Contemp Clin Dent 2017;8:613-6.

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Access this article online

Website: www.contempclindent.org

DOI: 10.4103/ccd.ccd_666_17

Quick Response Code:

done at the cementoenamel junctions with diamond disc to eliminate any variables in access preparation and kept in petri dishes. The root specimens were standardized to 10 ± 1 mm length to serve as a stable reference for all measurements. Working length was established by placing an ISO No. 15 Stainless Steel K-file into the canal until it was visible at the apical foramen and then decreasing 1 mm of the file length. Cleaning and shaping were done by using K3 NiTi rotary instruments in a gear reduction handpiece (X-SMART Endodontic Motor, Dentsply) in a crown down manner, to size #40.

Irrigation was done with 10 ml of 3% sodium hypochlorite solution between the use of each instrumentation. After instrumentation, all specimens received a final flush with 10 ml. of 17% EDTA. The canals were dried with paper points, and specimens were then randomly assigned into two groups of 20 teeth each based on the sealer used. The groups were Group I: Resilon/MetaSEAL and Group II: Resilon/AH Plus. The materials for obturation were manipulated according to the manufacturer's instructions. All canals were obturated using single-cone obturation technique and then coronally sealed with Cavit™ – G.

The samples were then wrapped in moist gauze and stored for 2 weeks in the incubator at 37°C to mimic the clinical scenario and also to allow the sealer to set. Following 2 weeks, root samples were prepared for pushout strength testing. Each root was horizontally sectioned into approximately 2mm thick slices to obtain coronal, middle, and apical sections and each specimen were subjected to pushout test using universal testing machine. By using the universal testing machine, the debonding force for individual specimen was obtained. The formula which was used to calculate the pushout bond strength was debond stress (MPa) = debonding force (N)/area (mm^2); where debonding force is the maximum force before debonding and area is the average value of the perimeter times the thickness.

The data obtained for bond strength values were then subjected to unpaired Student's *t*-test.

Results

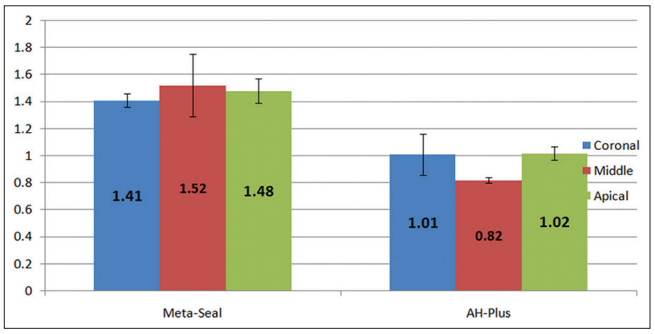
The results showed that the roots filled with Resilon/MetaSEAL (Group I) had the higher pushout bond strength (1.49 ± 0.09 MPa) compared to Resilon/AH Plus (Group II) (0. 90 ± 0.04 MPa) groups. The difference in bond strength was statistically significant (P = 0.0000) [Tables 1, 2 and Graph 1].

Table 1: Comparison of mean bond strength between groups

Group 1	Group 2	*t*-test	*p*
1.49±0.09	0.90±0.04	21.36	<0.001

Table 2: Comparison of mean bond strength between groups according to location

Location	Group 1	Group 2	*t* value	*p*
A	1.41±0.05	1.01±0.15	10.43	<0.001
B	1.52±0.23	0.82±0.02	12.39	<0.001
C	1.48±0.09	1.02±0.05	17.95	<0.001



Graph 1: Comparison of mean bond strength between groups according to location

Discussion

Modern endodontics involves the substitution of a polymer for the conventionally used gutta-percha, identified as Resilon (Pentron Technologies), which is based on polyester chemistry and contains bioactive glass, bismuth oxychloride, and barium sulfate. Resilon and gutta-percha are similar in the aspect that there are master cones and accessory cones in different sizes. In addition, Resilon pellets are available, which can be used for backfilling with warm thermoplasticized techniques. Even the handling properties are same and for retreatment, purposes heat softening or dissolving with solvents such as chloroform can be done. The composite sealer epiphany which is a mixture of dimethacrylate, ethoxylated dimethacrylate, urethane dimethacrylate, and hydrophilic difunctional methacrylates[7] is used along with Resilon.

Because Resilon is a synthetic, polymer-based composite, the resin sealer attaches to it, as well as to the bonding agent used to penetrate into the dentinal tubules, forming a "monoblock" composed of filling material, resin sealant, bonding agent, and dentin. This monoblock does not occur when gutta-percha is used as the core material because the sealer, even if resin based, does not bind to gutta-percha and tends to pull away from the gutta-percha on setting.[7] This endodontic monoblock is supposed to be more resistant to bacterial penetration and root fracture as compared with roots filled with conventional filling materials.

Another sealer MetaSEAL has been introduced with claims that it bonds to gutta-percha, Resilon, and dentin as well. It is dual-cured and self-adhesive, thereby eliminating the priming step.[3] MetaSEAL (Parkell Inc, Edgewood, NY, USA) is a fourth generation polymethylmethaacrylate

based resin sealer and contains an acidic resin monomer (4-META).

The inclusion of 4-META makes MetaSEAL self-etching, hydrophilic, and self-adhesive. MetaSEAL is one of the sealers that have been introduced during the last decade as a result of popularization of techniques that involve the simultaneous bonding of the root canal sealers to the dentin and root filling materials, creating a monoblock.[4]

An improved bond and the formation of a monoblock root canal obturation are claimed to be the main advantages of Resilon/Epiphany system and MetaSEAL sealer.[4,6,8] These properties should be reflected by improvements in interfacial strength and dislocation resistance between the root-filling material and intraradicular dentin, which may be evaluated using thin-slice pushout tests.[9] Thus, in the present study, the push-out bond strengths to the intraradicular dentin were evaluated and compared by using resilon along with two different sealers: Resilon/MetaSEAL (dual-cured methacrylate based) and Resilon/AH Plus (an epoxy-resin-based sealer).

Research on the MetaSEAL disclosed good hydrophilic properties, thus helping create long resin tags in radicular dentin that is formation of a hybrid layer has been shown by transmission electron microscopy.[10,11] Babb *et al*.[11] compared the bond strength of MetaSEAL with the bond strength of RealSeal SE and EndoRez. They found that MetaSEAL had a higher pushout Bond strength than RealSeal SE or EndoRez.[11] The authors did not use any core obturating material in their study, and the effect of bulk of the sealer used might have affected the bond strength results. When using with Resilon or Gutta-percha, the amount of sealer is thinned out, and this could reduce the bond strength.

Similar findings were also reported in studies by Stiegemeier *et al*.[3] and Costa *et al*.[12] which showed MetaSEAL to have a greater pushout bond strength than other methacrylate resin-based sealers.[3,12]

MetaSEAL has been reported to present relatively void-free as well as gap-free interfaces when used with a matched single-cone technique suggesting that its adhesion ability is high enough to overcome shrinkage stresses.[13] The slow self-curing mechanism of MetaSEAL might have promoted stress relief through prolonged plastic flow during setting of the sealer.[4,13,14]

MetaSEAL is a dual-cured sealer, and light curing is recommended by the manufacturer for an immediate coronal seal that will prevent coronal leakage. However, as has been suggested previously,[13,15] light curing was not performed and searing off the sealer from the canal orifices was not carried out by using heat in the current study to avoid expediting the setting of the sealer[14] and limiting the plastic flow that relieves the shrinkage stress.[14,16] All of these factors might have contributed to the reinforcing effect and greater bond strength of MetaSEAL when used with the matched-taper single-cone technique in the present study and in the previous studies.[3,4,15,17,18]

Conclusion

The bond strength of root canal sealers to dentin is important for maintaining the integrity of the seal in root canal filling, thus preventing any bacterial ingress from the oral cavity and periradicular tissues that might cause posttreatment complications. Although adhesive endodontics is becoming increasingly popular these days; further research is required to understand the properties of these methacrylate-based sealers particularly of MetaSEAL, so that it can be used more efficiently in the field of endodontics.

Financial support and sponsorship

This study was financially supported by SCB Dental College and Hospital, Cuttack, Odisha, India.

Conflicts of interest

There are no conflicts of interest.

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