COMPARATIVE EVALUATION OF DENTINAL TUBULE PENETRATION AFTER OBTURATION USING FOUR DIFFERENT ROOT CANAL SEALERS –SEM STUDY

Dr Mukesh Kumar Hasija1 Dr Deepti Wadhwa2, Dr Virender Yadav3

1 (Assistant Professor) Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Jamia Millia Islamia, New Delhi.

2 (Senior Resident) DDU Hospital Hari Nagar Delhi.

3 (Senior Lecture) SN Medical College Agra.

Corresponding author: Dr Mukesh Kumar Hasija
E-mail: mukesh85hasija@gmail.com
Address: 1 W.Z- 415 Second Floor Nanakpura Hari Nagar, Delhi- 110064

ABSTRACT

Objective: The purpose of this study was to compare the adaptability of four different root canal sealers by evaluating the penetration depth into the dentinal tubules and tag density using scanning electron microscope (SEM).

Methodology: Twenty freshly extracted central incisors were prepared and randomly obturated under 4 experimental groups 1.) Resilon epiphany system 2.) AH plus sealer and gutta percha 3.) ZOE sealer and gutta percha 4.) MTA Fillapex sealer with gutta percha. Specimens were sectioned longitudinally into 2 halves two weeks after obturation. Adaptation to dentinal wall, depth of penetration into dentinal tubules and tag density were measured at coronal, middle, apical areas with stereomicroscope and SEM. Results were statically analyzed thereafter

Results and Conclusion: The depth of penetration in group found to be statistically significant as compared to other group in SEM evaluation while stereomicroscope results showed the mean value in all the group non significant.

Keywords: Resilon epiphany system, MTA Fillapex, AH plus, scanning electron microscopy, sealer penetration.
Introduction:

Root canal therapy, despite having a high degree of success, may not lead to the desired healing response. The three dimensional obturation with hermetic seal of root canal system is key for endodontic success. The basic motive is to prevent infection or reinfection of the root canal via coronal/apical leakage of microorganisms and their byproducts. In addition to this root canal fillings should also bond to the dentinal tissue in order to strengthen the weakened root structure. But the problem with present root filling material gutta percha is that it does not bond with the tooth structure. So the resin based sealer were introduced to get their benefit of bonding to dentine on the canal walls. But the fact is that GIC and resin cements do bond to root dentin but do not bond to gutta-percha. Further the modulus of elasticity of gutta-percha points (ca. 80 MPa) is 175–230 times lower than that of dentin (ca. 14,000–18,600 MPa) making them too plastic to reinforce roots after endodontic therapy.

The resilon epiphany system is the first obturation system that claim its ability to form a “monobloc” between the canal walls and obturation material. Resilon is a synthetic polymer-based material and contains bioactive glass and radiopaque fillers. Epiphany is dual cure resin composite - mixture of BisGMA, ethoxylated BisGMA, UDMA and hydrophilic difunctional methacrylates with fillers. Epiphany obturation system consisted of a core material (Resilon), a dual-curing resin-based sealer (Epiphany), and a self-etching.

MTA fillapex is a type of sealer made from addition of a water-soluble polymer to mineral trioxide aggregate (MTA) resulted in material that is suitable for use as an endodontic sealer. It is basically mixture of MTA, salicylate resin, natural resin and bismuth. According to the manufacturer, the characteristic properties of MTA include bonding to dentine, antimicrobial activity, favors hard tissue mineralization, excellent flow and biocompatibility.

The purposes of this study were to (i) evaluate, in vitro (by stereomicroscope), the presence of the sealing ability and the adaptability (ii) evaluate, by SEM, the gutta-percha/resilon-resin-dentin interface of root canal fillings performed with vertically condensed single
cone gutta-percha/resilon with 4 different sealers.

Materials and Methods

Twenty eight freshly extracted maxillary central incisors and canines were collected and rendered free of calculus and other soft tissue debris using hand scalers. The samples were then stored in aqueous solution containing 0.001% thymol at room temperature for no longer than six months. The inclusion criteria were single straight-rooted teeth with mature and intact apices, patent canals with a curvature angle of 0-10° (Schneider 1971), no prominent cracks, and no developmental anomalies.

Specimen Preparation:

The teeth were decoronated at the cement-enamel junction by using a water cooled, high speed diamond bur to get 16 mm standard length for each sample. The working length estimation was done 1mm short of the length of inserted #15 K file visible at apex. The root surfaces of the sample teeth were grooved horizontally at a distance of 2 mm, 6 mm, and 10 mm from the anatomical apex, using a straight diamond point in a contra-angle low-speed handpiece. The grooving was done in order to define the position of SEM images for evaluation.

Each root canal was prepared using protaper rotary instruments sequentially up to a F3 (VDW, Munich, Germany) with the crown-down technique while irrigating frequently with 5% NaOCl, 17% EDTA, and normal saline with a needle inserted 1-2 mm short of the working length. The final irrigation was done using 5ml 3% NaOCl first followed by then flushing with 3 ml of 17% of EDTA (ethylenediaminetetraacetic acid) solution for 1 minute in order to remove smear layer. The canals were dried with paper points. The roots were randomly divided into four groups of seven roots each, according to sealer used.

Total samples
N=28

Group 1 resilon-epiphany system (n=7)
Group 2 AH 26‡ + gutta percha (n=7)
Group 3 zinc oxide eugenol + gutta percha (n=7)
Group 4 MTA fillapex + gutta percha (n=7)
In group 1 the resilon-epiphany system was used for obturation. The Epiphany primer was introduced into the canal with a paper point and waited for 30 sec. Epiphany sealer was applied to the canal with a lentulo spiral with a slow speed handpiece on canal walls. Resilon point was coated with Epiphany sealer and fitted to working length with tug-back. The roots were light-cured from the coronal side for 40 s using a halogen light-curing unit.

In group 2-4, the sealers were then prepared according to the manufacturer's instructions. The sealer was then applied to the canal with a lentulo spiral filler. The F3 master gutta-percha point was coated with AH26 sealer/MTA fillapex sealer/zinc oxide eugenol sealer (according to group). The F3 cone was seated in the canal 1 mm short of the working length and single cone technique obturation was done. Conventional vertical condensation of gutta-percha was performed with heated pluggers. Excessive gutta percha cones were removed followed by the placement of provisional restoration Cavit (3M ESPE). After obturation, radiographs were obtained from the buccal and mesial aspects of each tooth to evaluate the obturation radio graphically. The samples were then stored in a humidor at 37°C and 100% humidity for 2 weeks to allow the complete setting of the sealer.

**Evaluation**

The samples were grooved with diamond burs from the coronal to apical third using double-sided abrasive diamond discs mounted in a straight handpiece. The samples were then split longitudinally into two halves using a rongeur instrument. The samples were then examined under stereomicroscope at magnification 20 X specimens were then prepared for a scanning electron microscope (SEM) evaluation. The SEM specimens were examined at 500 X, 10000 X and 1500 X magnification and microphotographs were captured.

For SEM analysis, the specimens were dehydrated at 37°C for 7 days and sputtered with gold (SCD 050Sputter Coater, Bal-Tec, Balzers, Liechtenstein). The root halves were examined using a SEM (LEO435VP; LEO Electron microscopy, Cambridge, UK) at 10-15 kV and at a standard magnification of 1000X. One image was made at the position of each groove prepared in the root surface(Figures 1).
The results of SEM were evaluated using Ray and Seltzer criteria:

1. Extremely good adhesion-- a smooth contact line on sealer dentine interface without gaps, and with massive penetration of the sealers inside the tubules.

2. Good adhesion-- a slightly curved contact line on sealer dentin interface with some gaps between sealers and dentine walls.

3. Relatively good adhesion-- gaps were often found between sealers and dentine walls with an unclear and curved contact line in sealers dentine interface.

The images taken in the buccolingual and mesiodistal direction were evaluated by three examiners. The observers were unaware of the method and the type of filling material used. The observers were encouraged to change the brightness and contrast, and to perform gray-scale inversion (positive/negative) in order to enhance the image quality. No time limit was set for viewing.

**Statistical Analysis**

For statistical analysis, analysis of variance (ANOVA) was used to compare the variance within groups and between groups among the study groups. ANOVA at a particular time interval revealed the differences among them. The Student’s t test was performed to evaluate the statistical significance.

**Results**

The Scanning electron microscope results showed the mean value in group I (2.6 ± 0.065) is significantly higher than the mean Value in group II (1.8 ± 0.046) (p< 0.0001), group III (1 ± 0.037) and group IV (1.5 ± 0.022). (Table 1)

While the stereomicroscope results the mean value in all the groups were found to be non significant.

![Graph showing mean values of SEM and Stereomicroscope results](chart.png)

**Table 1** *Mean rating of all the four groups*

*Blue: SEM*

*Green: stereomicroscope*
confirmed the conclusions of previous works about dental adhesive penetration into dentinal tubules and the presence of a hybrid-like layer, both of which were found in almost all of the sections observed.\textsuperscript{5}

The Bondability of Resilon to methacrylate resin-based root canal sealers is supposed to be derived from the inclusion of the urethane dimethacrylate resin. Further resilon epiphany system help in improving the fracture resistance of endodontically treated teeth as it is resin based. AH plus is also composed of resin material and but shrink after setting thus showed its inability to bond with gutta percha.\textsuperscript{6}

The fact that the sealer penetration into the dentinal tubules (mechanical interlocking) increases the interface between the filling material and the dentin might influence the sealing ability of the obturation. The differences in adhesive properties of endodontic sealers were expected, because of their physical and chemical composition. In this study, the different results between the examined sealers suggest that the structure and the coherence of the sealers’ matrix into the dentinal tubules might be the most crucial

**Discussion**

The complete sealing of the canal seems to be difficult when using a combination of gutta percha and any of the root canal sealer used. But the observations performed by SEM
factors determining the penetration depth of the smear layer–free root canals.

MTA sealer presented higher disintegration in contact with humidity before its complete setting. Thus Chemical adhesion between dentin and MTA based sealer cannot be achieved. It might be because the MTA Fillapex Sealer depends on water for setting in a manner that is analogous to ProRoot MTA or MTA-Angelus product.

Conclusion:

- Resilon epiphany has a strong sealing ability and excellent adhesion to dentinal walls and resilon based cones.
- AH PLUS showed excellent bond to dentin (rated 1) with a slightly weaker adhesion capacity to gutta-percha cones in comparison to resilon.
- MTA Fillapex should be only used as endodontic sealer, mainly in endodontic accidents of difficult access as it disintegrates and doesn’t bond to dentinal wall uniformly.
- ZOE sealer should not be used in single cone obturation as it does not bond either to gutta percha and dentinal wall.

References


