**EVALUATION OF SEALING ABILITY OF THREE ROOT CANAL SEALERS**

*TAHIR ALI KHAN, BDS, MDSC  
**SAPURAM RAVINDRANATH, BDS, MDS,  
***AZHAR IQBAL, BDS  
****SM FAROOQ, BDS, MSx

**ABSTRACT**

The purpose of this study was to determine the sealing ability of three different sealers and to compare the sealing ability of three sealers. Thirty single rooted mandibular first premolar teeth were used. The crowns were removed at the cemento-enamel junction and root canals were prepared to a # 35 K-file. The teeth were randomly divided into three groups, A, K and R. Each group consisted of 10 specimens. In group A, AH Plus sealer, group K, Ketac-endo sealer and group R, Roth 801 sealer were used and obturated with gutta percha using lateral condensation technique. After storage in 100% humidity at 37°C for one week, the root surfaces were coated with nail polish (except at the apex) and suspended in 2%methylene blue dye solution for one week. The roots were sectioned longitudinally to determine the following mean values of dye penetration, group A - 2.675 mm, group K - 2.346 mm, group R - 4.929 mm. This study shows that Ketac-endo gave better seal than Roth 801 sealer.

**Key words:** AH Plus, Ketac-endo, Roth 801, Apical sealing, Lateral Condensation, dye Leakage, root canal filling.

**INTRODUCTION**

The primary objective of endodontics is total debridement of the pulpal space, total obliteration of the root canals and development of a fluid tight seal at the apical foramen1.

Basically two materials are used in combination for the filling of root canals. A solid core material is employed to fill the bulk of the space, and a cementing substance is used for the purpose of filling the discrepancies which exist between the solid core and the walls of the root canal2. A solid core alone cannot produce the desired hermetic seal. The use of a root canal sealer is required for complete and three-dimensional obturation2. The leakage through an obturated root canal takes place at the interfaces between the sealer and dentine or the sealer and gutta percha, or through voids within the sealer. Therefore, the sealing quality of a root canal filling depends much on the sealing ability of the sealer used3.

Zinc oxide eugenol-based sealers are the most frequently used because of its familiarity to the dental profession for a very long time, ease of use and less expansive in comparison to newer materials. However, the desire for achieving better results and the continuous research by academicians and manufacturers have resulted in newer materials.

Ketac-endo, a glass polyalkenoate root canal sealer was introduced by the ESPE Company in 1991 (ESPE,
Evaluation of Sealing Ability of Three Root Canal Sealers

GMBH and co KG, Seefeld, Germany) with claims of superior sealing ability. Several leakage studies have demonstrated that glass ionomer filling materials provided a superior apical seal when compared with other conventional root canal sealers. The glass ionomer sealer has the ability to bond chemically to the dentine surface. Glass ionomer sealer has good biocompatibility as it is well tolerated by the healing periapical tissues. Healing related to glass ionomer was more complete, with bone growth against the cement surface within 28 days. Glass ionomer, the modern version of silicates and perhaps the best known fluoride releasing restorative material has been shown to have anticariogenic properties due to their significant release of fluoride.

AH Plus (DeTrey, Dentsply), an epoxy amine resin-based sealer, has been introduced for use as a root canal sealer. The previous generation of epoxy amine resin-based sealers were studied and shown to have good results in their sealing ability.

The objectives of the current study were to determine the sealing ability of the three individual sealers and to compare the sealing ability of the three sealers.

MATERIALS AND METHODS

Thirty freshly extracted mandibular first premolar teeth with single canal were selected for this study. The teeth had no caries or restorations and were extracted for orthodontic treatment. The teeth were stored in 0.5% Chloramine solution.

The crowns were removed at the cemento-enamel junction. The pulp tissue from the root was extirpated with a nerve broach (xxfine, Maillefer Switzerland). A size 15 K file (Colorinox, Dentsply, Maillefer, Switzerland) was inserted into the canal to verify the patency until it was visible at the apical foramen. The rubber stop was adjusted in level with the coronal cut end of the root. Measurement was taken to obtain the root length. The working length was determined by subtracting 1 mm from the measurement previously obtained. The same procedure was followed for all the specimens.

Instrumentation was carried out using step-back technique. During instrumentation 5.25% NaOCl was used as irrigant for all specimens.

Before instrumentation and between each instrument, irrigation with 1ml of 5.25% NaOCl was done using a 25-gauge needle placed up to two thirds the length of the root canal. The canals were instrumented up to master apical file size 35. To maintain the patency of the apical foramen, a size 15 K file with rubber stop set at 2mm longer than the working length was used for recapitulation.

After completion of the instrumentation, the specimens were divided into three groups with ten specimens in each group. The groups were identified by labelling them as Group A, Group K and Group R.

All three Group specimens were irrigated with a final flush of 5.25% NaOCl solution after instrumentation to keep the smear layer intact.

The specimens in Group A, K, and R were AH Plus, Ketac-endo and Roth respectively. Each group consisted of 10 specimens.

All the specimens were kept in individual plastic containers along with a gauze piece soaked in distilled water until obturation.

The canal of each specimen was dried with absorbent paper points (Dentsply, Maillefer, Switzerland) before obturation. The sealers were mixed according to manufacturer recommendations. A standardized gutta percha cone (Colours coded, Maillefer instruments SA, Switzerland) of the same size as the master apical file was placed into the root canal up to the working length and tug back verified, for each specimen. Verified master apical cone was removed and chosen sealers were applied with lentulo spiral. All the specimens in three groups were obturated by lateral condensation technique. Post obturation radiographs were taken for all specimens (mesiodistal and buccolingual views) to assess the quality of obturation and corrections made if needed (Fig 1). After completion of obturation, an endodontic plugger was heated and 2 to 3 mm of gutta percha from the coronal end was removed in all the specimens, to facilitate the placement of a restoration to seal the coronal access. Cavit-w (ESPE) was used as a restorative material.

All the specimens were placed in separate containers with a wet gauze to maintain 100% humidity and maintained at 37°C in an incubator (Memmert GmbH+Co, Schwabach, W-Germany) for 7 days for complete setting of the sealers.
After 7 days each specimen was dried. Then it was coated with nail polish (Express finish, Maybelline, USA) three times, except the apical 2 mm which was covered with college wax (Stretch-toughened Modelling wax, Metrodent limited, England). After drying of nail polish coats, college wax was removed.

The specimens were then suspended upright in airtight containers containing 10 ml of solution (2%) of Methylene blue and kept in an incubator at 37°C for one week (Fig 2). The specimens were removed from the dye, and washed under running tap water. The specimens were then dried with air syringe and the nail polish scrapped off with a scalpel. The roots were then grooved labially and lingually with a diamond disc with intermittent cutting under water spray without involving the root canal. The specimens were then split longitudinally with a chisel.

The filling within the specimens were removed with a sharp explorer. Both the root sections of each specimen were viewed under a stereomicroscope (Olympus, Japan) with X30 magnification using electronic digital caliper. Linear measurements of the most coronal extent of dye penetration on the canal walls were recorded in mm up to two decimals. Measurements from all the specimens in all groups were tabulated. Statistical analysis of the leakage values obtained was done using the Analysis of Variance (ANOVA), Student’s t test and Scheffe test at 95% confidence interval. ANOVA (Analysis of Variance) was carried out to determine the significance of the values recorded. Where there was significant difference Post-hoc analysis (Scheffe test) was carried out to determine the difference between groups.
RESULTS

In this study measurement of maximum linear dye penetration were made to quantify the relative leakage. The mean dye penetration values are given in Table 1.

**Group A:** Group A the leakage values ranged from 0.00 mm to 4.84 mm with a mean value of 2.675 mm ±1.7

**Group K:** group K, the leakage values ranged from 1.00 mm to 5.66 mm with a mean value of 2.346 mm ±1.4

**Group R:** the leakage values of group R ranged from a minimum of 1.30 mm to a maximum of 8.85 mm, with a mean of 4.929 mm ±3.3

The results showed that mean values of apical leakage for group K was significantly less than that for group R (P<0.05). Post-hoc analysis using Scheffe test indicated that there was significantly less leakage values in group K as compared to group R. Whereas the mean values for the group K & group A had no significant difference (P>0.05). Similarly the mean values for group A and group R also did not show any significant difference (P >0.05).

DISCUSSION

In this study, dye penetration technique with methylene blue was used to compare the apical leakage. Linear measurement of the most coronal extent of dye penetration on the wall was used to evaluate the sealing ability of the root canal sealers. This is the commonly applied method to evaluate the sealing ability of different root filling materials and techniques due to its simplicity. The advantages are its non-destructive nature, leakage demonstration without need for a chemical reaction or exposure to hazardous radiation. This is a straightforward and simple method for evaluating apical microleakage. Two percent solution of methylene blue dye was used as a leakage marker because it is readily detectable under visible light, very soluble in water, able to diffuse easily, and is not absorbed by dentine matrix apatite crystals. Kersten & Moorer have also suggested that methylene blue dye had a comparable leakage to butyric acid (metabolic product of microorganisms). In 82% of leakage studies in endodontics, dye or radioisotope penetration methods have been used. Matloff et al. showed that methylene blue dye penetrates further into the canal than isotope tracers, thus giving a better representation of apical leakage. According to Ahlberg methylene blue dye may serve as an adequate indicator of leakage of microorganisms and large size endotoxins as well as toxic agents of low molecular weight. However, it is still not explained as to how dye movement compares with tissue fluid movement and bacterial migration in vivo. It seems reasonable to choose a technique that has been demonstrated to be the most effective among in vitro tests.

The sealers were selected on the basis that epoxy amine resin-based sealers have been in use since a long time with a well substantiated rate of success and newer composition with improved properties have been introduced. Glass ionomer-based sealers have a characteristic physical-chemical bonding capability. Zinc oxide eugenol-based sealers have been the traditional choice of sealer from early 1800 to the present time. The latest versions of the three types namely AH Plus, Ketac-endo and Roth 801 were selected. The method of producing longitudinal sections was used to split the specimens to examine the exposed filling and dye penetration into the material and root canal wall interface. This technique gave a true picture of the leakage pattern as compared to transverse sectioning method because it is easy to examine the exposed filling and any dye penetration into the material and at the canal wall-root filling interface, minimizing the risk of the dye washing away. Transverse sectioning of the roots is associated with the disadvantage of loss of some of the tooth structure in each cut, due to the thickness of the blade, which may

### Table 1: Minimum, Maximum and Mean Leakage Values in mm with Standard Deviation.

<table>
<thead>
<tr>
<th>Group</th>
<th>Apical leakage measurement (mm)</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>A</td>
<td>0.00</td>
<td>4.84</td>
</tr>
<tr>
<td>K</td>
<td>1.00</td>
<td>5.66</td>
</tr>
<tr>
<td>R</td>
<td>1.30</td>
<td>8.85</td>
</tr>
</tbody>
</table>
affect the accuracy of the measurement of dye penetration.10

The possible routes of dye penetration through filled root canals are between the sealer and the dentine, between the core material (gutta percha) and the sealer, through the core material, and through the sealer.9 Stereomicroscope examination of the sectioned specimens showed that leakage occurred through apical foramen between the sealer and the root canal wall, between the gutta percha and sealer and also through the sealer. Absorption of the dye in the sealers may also represent cohesive failure in the body of the sealer, creating another pathway for leakage. This study support the findings of other investigators that all root canals fillings leak10, 11, 30 except for one specimen, (in Group A which showed no leakage. This could have occurred due to inadvertent blockage of the apical foramen. Specimens allowed leakage, indicated that all had voids through the sealer or along the sealer-dentine interface. Hundred percent hermetic seal of canals occur rarely.30 The variations in the leakage values for the individual specimens in all the groups could be attributed to any entrapment of air in those specimens where leakage was minimal.31

In this study, Roth 801 sealer leaked significantly more than Ketac-endo sealer. This finding is supported by Koch et al.32. The sudden setting of zinc oxide eugenol material (transition from paste to solid mass) may be responsible for de-bonding from dentinal walls or cohesive fracture caused by stresses due to the setting shrinkage. This may explain the leakage.3 Lesser leakage with glass ionomer sealer can be attributed to its properties such as adaptability and ability to bind to dentine, which allows less dye penetration through the interface between the canal walls, cements and gutta-percha.32

It is important to remember that results of dye penetration studies indicate only the relative sealing ability of root canal fillings in vitro, and they do not indicate their ability to prevent the penetration of bacteria into filled root canals in vivo. The uses of dyes, radioisotopes and bacteria to evaluate leakage, all have inherent good or bad points. We do not have one superior system for evaluation of leakage in endodontics. Studies must be evaluated on their own merits and scientific validity.22 Further experiments should also be performed to evaluate other aspects of a material such as bio-compatibility, solubility, disintegration, radiopacity and dimensional stability.10

REFERENCES

Evaluation of Sealing Ability of Three Root Canal Sealers


