

Comparative evaluation of sealing ability of Zinc Oxide Eugenol and AH Plus sealers in laterally condensed gutta percha: A dye leakage study

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ABSTRACT

Introduction: Airtight sealing of the root canal is the foremost desirable result of any root canal treatment, but getting the perfect filling of the root canal is always problematic, which could be due to multiple reasons. One such majorly reason impacting the obturation is the root canal sealer utilized.

Objective: The present study was done for evaluating microleakage in zinc oxide eugenol cement (ZOE) and epoxy resin-based sealer (AH Plus) root canal sealers using linear dye leakage method.

Methods: This in-vitro study used twenty-two extracted human single canal mandibular premolar teeth comprising 2 groups (11 in each), where sealers used for microleakage evaluation were ZOE cement sealer, and AH Plus. All the samples once cleaned, shaped and obturated were soaked in methylene blue dye for forty-eight hours with two millimeter (mm) exposed apex. The samples were then split into halves and inspected under a stereomicroscope for microleakage. The generated data were statistically analyzed using an independent t-test in SPSS version 11.

Results: All the test samples showed microleakage. However, the mean microleakage measured was considerably higher in the ZOE cement sealer at 6.18mm and 2.95mm for the Epoxy resin-based sealer (AH Plus sealer).

Conclusions: Epoxy resin-based sealer has better performance than ZOE cement sealer with minimal microleakage. Thus, Epoxy resin-based sealer showed a better prognosis and it can be considered to be adapted in clinical practice.

Keywords: Epoxy resin-based sealer, dental leakage, methylene blue, zinc oxide eugenol cement.

INTRODUCTION

The endodontic treatment comprises eradicating bacterial bulk within the pulpal canal space and filling the whole root canal framework three-dimensionally.^{1,2} Incomplete obturation of the root canal accounts for 58% of endodontic failures.^{3,4} The gutta-percha is primary root filling material used in conjunction with sealers that acts as grease and

fills the inconsistencies between the gutta percha and canal. The sealers also fill the patent and supplemental canals, bury the microscopic organisms inside the dentinal tubule and permit the repair of the periapical tissue.⁵

Sealers are resorbable when exposed to tissues and tissue fluids.⁶⁻⁸ The apical leakage of the endodontic sealers has been measured in several ways; by the degree of penetration of a dye,⁹ microbial leakage tests,¹⁰ scanning electron microscopy,¹¹ electrochemical means,¹² radioisotope penetration,¹³ and fluid filtration method.¹⁴ Among them, linear measurement of the tracer dye penetration technique is most frequently used.¹⁵

The purpose of this study was to compare the sealing ability of two different root canal sealers in vitro: Zinc Oxide Eugenol cement (Prime Dental Products, India) and epoxy-resin based sealer, AH Plus (Dentsply De Trey GmbH, Konstanz, Germany), once the root canal

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was cleaned, shaped and obturated by the measuring linear dye penetration in millimeter (mm) using the stereomicroscope.

METHODS

This study was approved by Institutional Review Committee (IRC/630/015) and it was conducted from September 2015 to August 2016.

Using the dye penetration method, two root canal sealers were tested in the extracted teeth for their sealing ability. Twenty-two freshly extracted teeth were obtained from the Dept. Oral and Maxillofacial Surgery, College of Dental Surgery (CODS), B P Koirala Institute of Health Sciences (BPKIHS), Dharan.

Grouping of the Samples

The study group comprised of two groups, with 11 samples in each arm. Group I comprised of ZOE sealer (Prime Dental) and Group II of Epoxy resin-based sealer (AH Plus sealer, Dentsply Sirona). The composition of sealers is detailed in Table 1.¹⁶

The extracted teeth with evidence of craze lines, resorption, caries below the cemento-enamel junction, previously endodontically treated tooth, and tooth with extreme root curvature were excluded from the study. The teeth were cleaned of visible debris and calculi ultrasonically and stored in a 10% formalin solution until further use.¹⁷

The access preparation was carried out with endo access bur 1 (Dentsply Maillefer). On entering the pulp chamber, the #10K file was introduced into the canal to check for the canal patency. The working length was decided with the #15 K file until the instrument tip exited from the apex. The ultimate working length was considered after shortening 1 mm from the observed root canal length.¹⁷

Canal cleaning and shaping were carried out in a crown-down fashion utilizing rotary protaper universal files in sequence as per manufacturers' instruction (Dentsply Maillefer). The coronal portion of the canal was broadened with the SX file followed by mid-canal shaping by S1, S2, and the final preparation with the F3 file. On change of each instrument, canals were irrigated with 1.0 mL of 4% sodium hypochlorite (NaOCl). Once instrumentation was completed, 3.0 mL of 17% ethylene diamine tetra acetic acid (EDTA) were placed and permitted to stay in the canal for one minute. Furthermore, saline was used to flush EDTA, and then the final flush with 1 ml of NaOCl was done followed by 5.0 mL of saline lastly.¹⁷

Obturation of the Samples

Canals were obturated using the lateral compaction method. Sealers were manipulated as per manufacturers' guidelines. Master apical gutta-percha (GP) of size F3 (Dentsply Sirona) was verified up to working length. Once verified, the GP cones were coated with one of the sealers, and canals were obturated. The spreader was used to make additional space for the accessory cones and the cones were added until there was no more space at the coronal end. Excess GP was sheared off with a heated instrument and the access cavity was restored with Fuji IX GIC (GC Corporation, Japan).¹⁷

Preparation of Specimen for Stereomicroscopic Analysis of Dye Penetration

The samples were dried for two minutes and two layers of nail varnish were coated on the external root surfaces. The external apical 2mm was spared to permit color entrance into the canals. Subsequently, the samples were immersed in freshly prepared 1% methylene blue color for 48 hours in a dappen dish. After two days, the nail varnish was removed from the root surface with an aid of acetone.

Table 1: Composition of Sealers.

Sealer	Composition
ZOE Sealer (Group I)	Powder: Zinc oxide, white rosin, zinc stearate, zinc acetate, magnesium oxide Liquid: Eugenol, olive oil
AH plus Sealer (Group II)	Epoxide paste: Diepoxide, calcium tungstate, zirconium oxide, aerosil, pigment Amine paste: 1-adamantane amine N,N'-dibenzyl-5-oxa-nonandiamine-1,9, TCD-Diamine, calcium tungstate, zirconium oxide, aerosil, silicone oil

Following this, the roots were longitudinally sectioned into halves with a chisel and prepared for assessment. Microleakage related to distinctive root canal sealers were assessed and the estimation of dye penetration was scored in millimeter (mm).¹⁷

STATISTICAL ANALYSIS

The results were analyzed using independent samples t-test in SPSS version 11 software at $p < 0.05$.

RESULTS

The mean dye penetration for zinc oxide eugenol cement sealer was high overall with as high as 6.18 mm and considerably lowers with 2.95 mm for AH Plus sealer. Almost 100% of the samples showed leakage with a standard deviation for ZOE was 1.49mm and that for AH Plus was 1.63mm. The inferential statistics using independent samples t-test between the test groups was < 0.001 , thus, signifying that ZOE sealer had more leakage when compared to AH Plus sealer. The means and standard deviation of the tested group are shown in Table 2.

DISCUSSION

Sealer is the product that seals interface between the tooth and restorative material. The major goal in leakage testing is whether the finding of more or less leakage has any adverse biological significance. Endodontic sealers are available in wide variety based on setting reaction and composition: zinc oxide eugenol, salicylate, fatty acid, glass ionomer, silicone, epoxy resin, tricalcium silicate, and methacrylate resin sealer systems. Unlike AH plus, zinc oxide eugenol sealer is widely employed for it being cost effective in the university/dental school setup in low/middle income countries.

There are several dyes like India ink, procion blue, methylene blue, silver nitrate, rhodamine B and pelican ink of which methylene blue is used in a large number of studies and provides the same leakage as butyric acid, a microbial metabolic product that has greater penetration than India ink.¹⁸ Dye penetration is based on the assumption that the depth of dye penetration represents the gap between the root canal filling and the root canal

Table 2: Comparison of linear dye leakage in mean (SD) [n=11] between ZOE and AH Plus sealer.

ZOE Sealer (Group I) n=11 Mean (SD) mm	AH Plus Sealer (Group II) n=11 Mean (SD) mm	Mean difference (95% CI) mm	P-value
6.18 (1.49)	2.95 (1.63)	3.23 (1.84 - 4.62)	<0.001

Bold signifies statistical significance at $p < 0.05$; Independent samples t-test

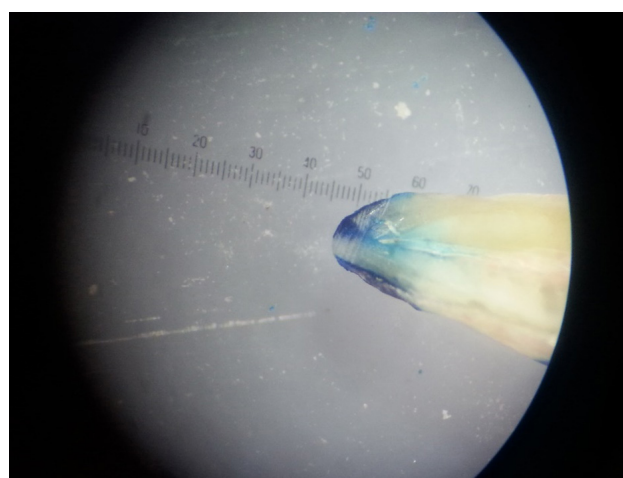


Figure 1: Leakage seen in AH Plus Sealer under a stereomicroscope.

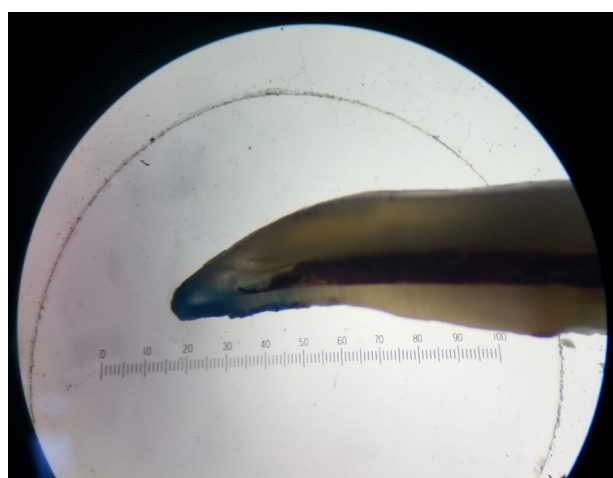


Figure 2: Leakage seen in ZOE sealer under a stereomicroscope.

walls. Dentin is hydrophilic and with most of sealers being hydrophobic, there are likely minute spaces that will influence the capillary action on dye penetration.^{16,19} The sealing of the root canal apically by the sealer is vital to prevent communication of the root canal with periapical tissue. The properties of sealers like flow, consistency, setting characteristics, solubility, and attachment to root canals are critical in getting an airtight seal of the root canal.²⁰

Irrespective of the fact that an airtight seal isn't continuously achievable by the currently utilized sealers, a fluid-tight seal is at least desirable. The insufficient obturation of the root canal with poor apical sealing has been one of the major causes of endodontic failures.²¹ Henceforth, this study was done to assess the sealing capacity of two distinctive sealers and thus, both conventional and recent sealers were compared.

The conventional zinc oxide eugenol sealer had the most dye infiltration in the two groups examined. The setting components of zinc oxide eugenol based cement are the result of equimolar blends of zinc oxide and eugenol, comprising zinc oxide included in an extended crystal network of zinc eugenolate chelate and is worsened by the carbon dioxide which is present as bi-carbonate particles within the peri-radicular region. This makes zinc-oxide eugenol a weak and uneven cement.⁵ The other conceivable reason would be credited to the dimensional changes of the material upon setting. This is often in concurrence with the discoveries of prior studies which reported a setting shrinkage of 0.3% to 1% with zinc oxide eugenol based sealers.⁶

On the contrary, AH plus sealer had minimal leakage. Our study had a similar finding to the study conducted by AL-Khatar who suggested that AH Plus demonstrates significantly less microleakage than other tested sealers. Likewise, a study was done at Humboldt University, Berlin also demonstrated that AH Plus exhibited significantly less microleakage than AH26.¹⁷ However, a study by Vishal A Mahajan had dissimilar results suggesting AH Plus sealer

with more leakage.²² When long-term sealing ability was studied, AH Plus has shown less leakage. This may be attributed to its consistent continuous expansion of 1.2%.²³⁻²⁵ The low solubility of AH Plus is mainly explained by its composition: diepoxide compounds and polyamines paste are mixed together during its manipulation. Each amine group reacts with an epoxide group to form a covalent bond. The resulting polymer is heavily cross-linked and thus rigid and strong.²⁶ The formulation also contains calcium tungstate, which is not readily soluble in water.²⁶

RECOMMENDATION

This study employed methylene blue dye to assess leakage. With the advent of new dyes, rhodamine B also has established as a good alternative to methylene blue. Henceforward, studies based on rhodamine B may open up new avenues.

LIMITATION

This is an invasive study in which the samples were sectioned longitudinally and during the procedure, there is a chance of gutta-percha being drawn from the canal modifying the results of this study.

CONCLUSIONS

Sealing of the root canal with the gutta-percha core and the sealer remains the gold standard for the obturation of the root canal. Here, the AH Plus-based sealer, had a better sealing ability, chemical bonding with dentin, and ease of placement, all of which improved the sealing of the root canal, that outperformed conventional zinc oxide eugenol-based sealer.

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Conflict of Interest: None

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