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Evaluation of apical microleakage of three endodontic sealers using dye penetration method: An invitro study

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Abstract

Background: the favorable outcome of an endodontic treatment rests on the three-dimensional and complete obturation of the root canal which reduces micro leakage and entry of microbes in the periradicular region. Sealers help in attainment of a fluid impervious seal of the root canal in combination with gutta percha thus acting as a critical component of filling procedure.

Aim: The aim of present in vitro study was to comparatively evaluate the apical microleakage of three endodontic sealers.

Material & Method: forty five extracted similar sized first premolar were selected for the study. Cleaning and shaping was done and teeth were obturated with lateral condensation obturation technique using eugenol based sealer (Tubli-Seal, Kerr Dental), a resin based sealer (AH Plus, Dentsply, Konstanz, Germany)and a MTA based sealer (MTA Fillapex, Angelus, Londrina, Brazil).

Leakage evaluation was done using dye penetration method. One-way analysis of variance and unpaired t test were used to compare the groups for dye penetration.

Results: AH Plus sealer showed better apical sealing ability than the other two sealers tested (P<0.01).

Conclusion: Under the limitations of present study all the sealers studied- AH Plus, Tubliseal and MTA Fillapex allowed apical microleakage to occur to varying extent .

Keywords: sealer, obturation, resin, MTA, Eugenol, GP

Introduction

The favorable outcome of an endodontic treatment rests on the proper debridement of the complexities of the root canal, followed by fluid tight obturation of the prepared space in three dimensions. The main objective of obturating the root canal is to reduce microleakage and entry of microbes in the periradicular region. Strindberg and Allen stated that the main reason for endodontic failure was not being able to achieve a three dimensional seal of the root canal.[1] According to Washington study on endodontic success and failure roughly 60 percent of endodontic failures are due to deficient obturation of the root canal space. [2]

Sealers help in attainment of a fluid impervious seal of the root canal in combination with gutta percha thus acting as a critical component of filling procedure.[3] An ideal root canal sealer should offer an excellent seal when set, dimensional stability, a sufficient setting time to ensure working , insolubility against tissue fluids, proper adhesion with canal walls, and biocompatibility.[4,5] It acts as filler for accessory canals, minor discrepancies and canal irregularities where primary filling material fails to reach. Several sealers have been marketed and are classified on the basis of their chemical composition such as glass ionomer, epoxy resin, silicone, eugenol, calcium hydroxide and the lately introduced bioceramic based sealers. [3]

Endodontic sealers based on zinc oxide and eugenol have been used clinically since various decades, because they have acceptable physicochemical properties.[6] It is usually considered for comparing new sealers. Unlike resin based sealers, the setting process of eugenol based sealers involves a chelation reaction between eugenol and zinc ion.[7]

Resin sealers have proven to be a popular substitute for eugenol based sealers due to their property to offer exceptional apical sealing capacity. However, such sealers do not give the most approving biological response.[6] Even though these sealers help to achieve superior adhesion to canal walls, none of the sealers have been able to completely seal the root canals.

A novel calcium silicate-based sealer has been lately introduced as an endodontic filling material.[15] The strongest interest in developing mineral trioxide aggregate (MTA) based endodontic materials is because of the exceptional biocompatibility, bioactivity and osteoconductivity of MTA.[8] The sealer presents appropriate bioactivity to stimulate formation of mineralized tissue in osteoblast like cell culture.[9] However there is no scientific literature which has proved its efficacy conclusively.

Thus, this study compared three different sealers- AH Plus, Tubliseal and MTA Fillapex for their sealing ability using dye penetration method.

Materials and Methodology

Forty five extracted similar sized human mandibular first premolar were collected. The following inclusion and exclusion criteria were followed for selecting the teeth-

Inclusion criteria

1. Teeth with single canal and mature apex.
2. Teeth with apical foramen patent to size 10 no. K file.
3. Teeth with less than 10 degrees of canal curvature.

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Exclusion criteria

1. Teeth with open apex.
2. Teeth with caries, cervical abrasion or fractures.
3. Teeth with old restorations or endodontic manipulation.
4. Teeth with internal or external resorption.
5. Teeth with dilacerations.

All the selected teeth were debrided and cleansed using an ultrasonic scaler (Woodpecker) to remove the soft tissues and calculus flecks followed by examination under stereomicroscope to check for any cracks. All the teeth were then stored in normal saline until use.

All the forty teeth taken for study were de-coronated with a diamond disc (Taboom, China) mounted on a micromotor straight hand piece (NSK, Japan) under constant water spray to a standard length of 15 mm.

Preparation of root canals

Patency was achieved by placing a size #10 K file (Dentsply Malliefer, Switzerland). Working length was determined by introducing a size #15 K file (Dentsply Malliefer, Switzerland) into the root canal until it was just visible at the apical foramen, then 1 mm was subtracted from this measurement. Crown-down technique was used for canal instrumentation.

Root canals were prepared sequentially using Nitiflex K files (Dentsply Malliefer, Switzerland) to size #50. The canals were irrigated with 3% Naocl solution (Prime Dental, India) after each file size using a 30 gauge side-vented endodontic needle (Prime Dental, India).

After completion of the instrumentation, irrigation of all the canals was done with 17% EDTA solution (Prevest, DenPro) for 1 minute followed by 5% Naocl solution for 1 min, to eliminate the smear layer. A size #10 K-file (Mani, Japan) was passed 1mm through the apical foramen to remove any dentinal plugs and to ensure that the foramen was patent for dye penetration. Finally, the root canals were dried up with paper points (Dentsply Maillefer, Switzerland).

Subsequently teeth were divided into 3 groups of 15 teeth each depending upon the sealer used for obturation. In Group 1 eugenol based sealer (Tubli-Seal, Kerr Dental), in Group 2 a resin based sealer (AH Plus, Dentsply, Konstanz, Germany)and in Group 3 a MTA based sealer (MTA Fillapex, Angelus, Londrina, Brazil) was used.

The sealers were mixed according to the manufacturer's guidelines and were introduced into the canal using a lentulo-spiral (Mani,, Japan) which was kept 3mm to 4mm short of the working length. This process was repeated twice to ensure that an adequate amount of sealer was placed in each canal. The root canal filling was performed by lateral condensation of cold gutta-percha with finger spreaders (Mani,, Japan).

Two coats of nail varnish were applied to all the external root surfaces except the apical 3mm around the apical foramen.

Leakage evaluation

The apical sealing ability of the samples was measured using dye penetration method. The samples were immersed in methylene blue dye (Merck, Mumbai) for 7 days at 37^{o} C. After 7 days, samples were washed under running water for 15 minutes and dried. The nail varnish was scrapped out with a scalpel and the samples soaked in acetone for 1 h to remove remains of nail varnish. The samples were then air dried.

The roots were grooved longitudinally in a bucco-lingual direction without disturbing the GP using a fine diamond disc and then split. This step was carefully performed to ensure that the sectioning process did not damage the inside of the canal. Following this, dye penetration was measured in mm from the most apical extent of GP to the most coronal extent under a stereomicroscope.

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Statistical Analysis

Unpaired t test was used to assess the results statistically to compare differences in the depth of dye penetration amongst the three groups using spss (Statistical Package for the Social Sciences) software. Analysis of Variance (anova) with P = 0.05 was used to perform comparison test.

Results

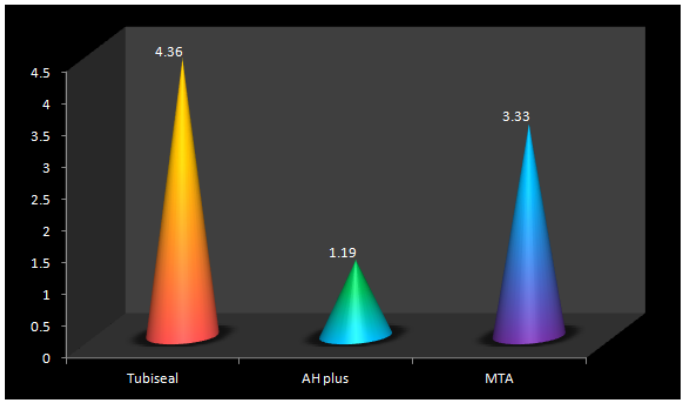
The mean leakage for the three experimental groups is shown in Table 1 and Graph 1. The mean dye penetration in different groups was Tubliseal group was 4.36 ± 1.25 mm while in the AH plus group was 1.19 ± 0.56 mm and 3.33 ± 0.99 mm in the MTA Fillapex group. It was found that there was significant difference between the dye penetration in different groups with t value = 27.43 and p value =0.01

Table 1: Comparison of dye penetration in different sealers

Group	N	Mean	Std. Deviation	T value	P value
Tubliseal	15	4.36	1.25	27.43	0.01*
AH plus	15	1.19	.56		
MTA	15	3.33	.99		
Total	45	2.96	1.64		

*significant

Graph 1: Comparison of dye penetration in different sealers



Discussion

As well as the obturation technique, the use of a sealer is essential to obtain a fluid impervious seal between the dentinal wall & the core obturation material.[10] Several types of endodontic sealers have been recommended to achieve this goal and consequently, the evaluation of apical sealing ability of the sealers is important. Hovland & Dumsha (1985) considered that most leakage takes place at the cement-canal wall interface.[11]

The current study compared the apical sealing ability of three disparate root canal sealers. All the sealers investigated- AH Plus, Tubliseal and MTA Fillapex permitted apical microleakage to occur to variable extent . Even though none of them exhibited complete sealing ability, excellent apical sealing was observed using AH Plus sealer (P<0.01) whilst greater leakage was noted with both Tubliseal & MTA Fillapex sealers.

AH Plus is considered as a gold standard to be compared with all the other sealers. It is a sealer based on epoxy resin derived from AH 26, whose good sealing ability has been demonstrated in previous studies.[12] According to the results from the present study, AH Plus was superior to the ZOE based sealer (Tubliseal) as well as to the MTA based sealer (MTA Fillapex). The result is in accordance with the findings of De Almeida et al. where the three sealers allowed some leakage to occur, although leakage with epoxy resin sealer (AH Plus) was significantly less than with zinc oxide & eugenol sealer (Fill Canal) or glass ionomer sealer (Ketac-Endo).[6]

The favourable results for AH Plus may be related to its flowability & high dimensional stability, leading to a reduction in marginal leakage.[13] A further physical parameter which can also be decisive with regard to the quality of the root canal filling is the film thickness. AH Plus has a film thickness of 26 µm, which is clearly below

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the value of less than 50 µm required by the ISO standard for root canal sealing materials (ISO 6876).

Mc Michen et al. compared 5 root canal sealers for their physical properties including film thickness & found that the greatest film thickness recorded was for Tubliseal & least for AH plus. Timpawat et al. also verified that AH Plus had good resistance to leakage with reduced solubility, which suggests better adaptation of this material to dentin walls.[13]

Greater measured leakage for ZOE based sealers compared with epoxy resin-based sealers was also found by other authors (Barkhordar et al. 1989, Limkangwalmongkol et al. 1991, Oguntebi & Shen 1992)[15,16,17]

The ZOE based sealers were introduced in endodontics by Grossman, in 1936, to be used in conjunction with the GP or silver cones in root canal fillings. In the present study, the maximum leakage was observed for groups obturated using Tubliseal. Poor sealing ability of the sealer can be attributed to its high solubility, increased film thickness & shrinkage on setting.

Also, according to the results of present study the MTA fillapex displayed more microleakage than AH Plus but less than Tubliseal. Sonmez et al. also showed that MTA Fillapex has less sealing ability compared to AH Plus, & ProRoot MTA using the dye penetration method.[18] Furthermore, the results of the present study coincide with those of another study done by Al-Haddad et al (2015) that reported that bioceramic-based sealers had more gaps compared with AH Plus.[19] This can be attributed to physical properties of MTA Fillapex, which has average film thickness of 39.6 µm more than that of AH Plus thus increasing the solubility of the material.

However, it should be kept in mind that this is an in-vitro study & there is always some error in the measurements even in fully controlled in-vitro conditions. Future research should also be done using advanced devices (Micro- Computed Tomography) for determining the sealing ability of the sealers.

Conclusion

Within the confines of this study following conclusions were drawn

1. In the present study all the sealers studied- AH Plus, Tubliseal and MTA Fillapex allowed apical microleakage to occur to varying extent .
2. AH Plus sealer showed better apical sealing ability than the other two sealers tested ($P<0.01$).
3. Further in vivo studies are to be done to correlate with present study.

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