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RESEARCH ARTICLE

EVALUATION OF APICAL MICRO-LEAKAGE OF AH PLUS, MTA FILLAPEX AND ZOE SEALERS IN THE PRESENCE AND ABSENCE OF MOISTURE IN ROOT CANALS

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ABSTRACT

Aim: The aim of this IN VITRO study was to examine and compare the apical micro-leakage of AH PLUS, MTA Fill, ZOE apex sealers in dry and moist root canals by dye penetration method using stereomicroscope.

Materials and Methods: This experimental study was performed on 38 extracted teeth with single root canal. Hand protaper files were used for preparation of the canals. Root canals were filled with a single gutta-percha cone, using one of the three sealers, under dry and wet root canal conditions (6 teeth in each group) and one positive control group and one negative control group. Orifices were sealed with glue wax and all root surfaces were covered with nail polish except the positive control group. After ten days in 100% humidity, teeth were placed in methylene blue (p^H7), and then were cut in longitudinal axis. Blue color permeability was measured by stereomicroscope in micrometers. Data were analyzed by factorial design.

Results: Mean apical micro-leakage was significantly lower in the dry groups ($P < 0.001$). Minimum and maximum micro-leakage was seen in AH26 and ZOE, respectively. MTA Fillapex did not exhibit a significant difference in apical micro-leakage between dry and moist conditions ($P > 0.05$).

Conclusion: AH26 provided the least apical micro-leakage under dry conditions while ZOE had the highest micro-leakage under moist conditions. MTA Fillapex provided acceptable apical seal regardless of moisture.

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INTRODUCTION

Ideally, an effective hermetic endodontic seal should blockthe communication between apical foramen and surrounding peri-apical tissues. Lack of an appropriate apical seal has been reported as the most common reason for failure of root canal therapy. (Weine, 1976; Ingle *et al*., 2002) Failure of the apical seal allows undebrided irritants to escape from the canal into the peri-apical tissue to initiate an inflammatory response. (Goldman *et al*., 1988) Endodontic sealers are commonly used with guttapercha to reach an optimal apical seal.

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The filling material should adequately seal the root canal and simultaneously prevent fluid percolation into the root canal space, stimulate the resolution of periapical pathologies, and encourage deposition of cementum to achieve biological seal. (Goldman *et al*., 1988) Various studies have been done on the sealing ability of different sealers and different levels of residual moisture in the root canal have been shown to alter the sealing properties of conventional and resin-based sealers.(Maryam Ehsani *et al*., 2014) However, there are only few studies about apical micro-leakage using MTAFillapex sealers in comparison to other widely used sealers, or about the effect of the moisture on apical micro- leakage of the sealers. (Maryam Ehsani *et al*., 2014) Therefore, this study is aimed to compare the apical microleakage of three commonly used root canal sealer cements in dry and wet root canal conditions.

MATERIALS AND METHODS

This experimental study was performed on 38 freshly extracted teeth with straight root canals. Non-carious sound human single rooted premolars (maxillary second and mandibular) were collected. Teeth with fracture lines, resorption, developmental deformities such as dilacerations, dens in dente etc. were excluded. Also, teeth with calcifications and pre-treated teeth were excluded.Teeth were mechanically cleaned with hand scaler and stored in the container with lid containing 0.9% sterile saline at room temperature until further processing.

Tooth preparation

Teeth crown were cut near the CEJ using a diamond disc and a high-speed handpiece (NSK, Tokyo, Japan) with water coolant. All prepared teeth were again held in 0.9% sterile saline at room temperature until the test time. Access openings were done.Working length measurement done by visual method. No. 15 K file (Dentsply, Dentsply/ Maillefer, Ballaigues, Switzerland) was inserted into the root canal until the tip became visible at the apical foramen; this distance minus 1 mm was taken as the working length. For root canal preparation, the canals were preflared using Gates Glidden drills and canals were prepared using Hand Protaper by sequential use of S1,S2,F1,F2 (Dentsply).Alternate irrigation after each file with 5 ml of 3% sodium hypochlorite and isotonic saline were used. EDTA was used during instrumentation to remove the smear layer. The patency of the apical foramen confirmed with a size10 K-File. The canals were finally dried with paper points. Five consecutive #30 paper points were placed in the canal for five seconds and had to remain dry. The teeth were randomly divided into one control and six test groups, each containing six specimens.

Application of sealers

The three tested sealers were the following:

Group A- AH PLUS sealer (Dentsply Ltd, Konstanz, Germany)
Group B- MTA Fillapex sealer (Angelus Indústria de ProdutosOdontológicos S/A, Londrina, Brazil)
Group C- ZOE sealer. (Tubli-Seal, Kerr Sybron, Salerno, Italy)

All sealers were prepared according to the instructions of the manufacturers. Upon preparation, the sealer was placed on lentulo spiral. Lentulo spiral was placed in the canal at the working length. Then using a forceps, F1 & F2 gutta-percha cones were placed in the canal upto working length as per canal prepared and obturation done. Radiographs were takenfrom the buccal aspects of each tooth to assess the quality of the root canal filling. The same procedure was repeated for another three groups in moist condition. For canal wetting, with syringe needle 0.02 ml saline was poured into the canal.One tooth as a positive control and one tooth as negative controls remained unfilled after canal preparation.

Application of varnish

The root canal orifices were sealed with glue wax.Root covered with two layers of nail varnish except for the apical 1 mm of the root tip. Apical foramina of the teeth in negative controls were also covered with glue wax. The specimens were stored in an incubator at the controlled temperature of 37°C with 100% humidity for ten days to allow the sealers to set.

Methylene blue dye immersion

The samples were immersed in methylene blue pH 7.0 at 37 ^{0}C for 3 days. Then the specimens were washed with distilled water. The amount of leakage was measured in each half of each tooth, from the working length to the most coronal part of the root canal to which the dye had penetrated.

Measurement of micro-leakage

Root of each tooth was grooved longitudinally on both sides, using a rotating diamond disc and handpiece (NSK, Japan) under constant cooling with distilled water. Sectioned along longitudinal axis close to the center of the canal and then were split, and each half examined under a stereomicroscope. To measure dye penetration, a stereomicroscope XTL 3400E, Magnification: 10 X was used. The amount of leakage was measured from the apex to the highest amount of dye penetration in micrometers using computer software on the image captured by a digital camera Chroma Systems PvtLtd, India Model: MVIG 2005 mounted on the stereomicroscope.

Statistical Analysis

The data were analyzed by General Factorial Design by MINITAB Software
Where factors are- 2

1. Sealer
2. Moisture condition

Factor levels 3,2
No. of Observations: 36
Replicates: Sample size per experiments:6

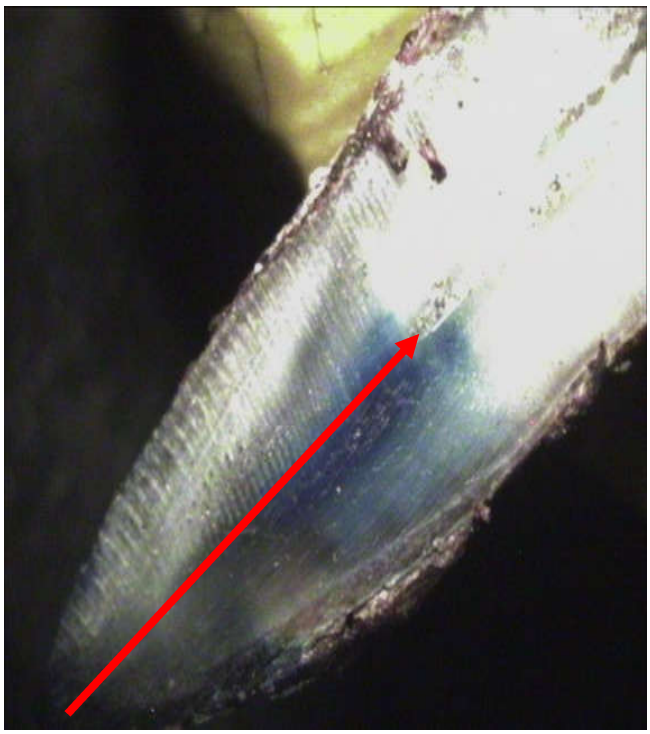

Figure 1. Measurement of dye penetration to the long axis of the tooth

Table 1. Comparison of mean apical micro-leakage (in micrometer) with four sealers evaluated under dry and Moist conditions

Condition	AH PLUS	MTA Fillapex	ZOE	P-value
Dry	232.9 ±43.27	456.77±38.19	784.67±46.55	<0.001
Moist	316.6± 40.29	480.69±32.88	860.76±74.55	<0.001
P-value	0.000	0.000	0.01	—
Total	243.24±43.27	462.33±43.44	768.87±36.13	—

RESULTS

Mean total apical micro-leakage of all study sealers was 468.77±183.04µm (dry canal groups, 434.61 ± 180.31 µm; moist canal groups, 488.09 ± 185.67µm). The lowest rate of apical micro-leakage was seen in AH plus sealer (243.24 ± 43.27 µm) and the highest apical micro-leakage was related to ZOE sealer (768.87 ± 36.13µm). AH plus sealer had the lowest rate of apical micro-leakage in dry and wet canals.

DISCUSSION

Moisture may prevent sealer setting by increasing or reducing its working or setting time and may interfere the entrance of the sealer into the dentinal tubules and also decreases adhesion of sealers to dentin and bond strength. (Vanderweele *et al*., 2006) However, conditions such as inadequate isolation, exudate withdrawal from apex, inadequate apical extrusion of paper points while drying up, inflammatory lesions and presence of cyst around the root interfere with the complete drying up of the canal. Statistics showed that there are significant differences between different sealers in dry or wet conditions. (Vanderweele *et al*., 2006; Camilleri, 2007; Gandolfi *et al*., 2009) In this study, AH PLUS sealer showed the least apical microleakage with a mean microleakage of 232.9 µm in dry condition and 316.6 µm wet condition. MTA FILLAPEX sealer showed a mean microleakage of 456.77µm in dry condition and 480.69µm in wet condition. In wet condition it is about near to AH PLUS but difference is statistically significant. Zinc Oxide Eugenol sealer showed highest microleakage as compared to both groups in both dry and wet conditions. According to Moradi S, NaghaviN, RohaniEJavidi M. MTA Fillapex has been demonstrated previously to have a better apical seal compared to AH26 and AHPLUS. However, many studies showed AH26 and AH PLUS had the lowest rate of apical microleakage in the presence and absence of moisture. In our present study also, AH PLUS showed better result than MTA FILLAPEX in both moisture conditions. (Moradi *et al*., 2009; Horning and Kessler, 1995; Roggendorf *et al*., 2007) The individual difference in manipulation and application of sealers can be a reason for this difference. Further, the amount of moisture within the root canal may be a confounding factor that affects the apical microleakage. (Moradi *et al*., 2009) According to Oksan T, Aktener BO, Sen BH, Tezel H. Use of chemically active, adhesive root canal sealers may play an important role in minimizing apical leakage. The surface contact between the intracanal walls and the filling material is increased and apical seal may be improved. But presence of moisture decreases that surface contact and increases microleakage. (Oksan *et al*., 1991) According to Vanderweele *et al*. 2006, Camilleri 2007, Gandol *et al*. 2008 Because MTA is calcium silicate cements set in the presence of moisture such as blood and other uids with a great clinical advantage, it appeared interesting to develop endodontic sealers based on calcium silicate hydraulic cements.(Vanderweele *et al*., 2006; Camilleri, 2007; Gandolfi *et al*., 2009) Nagas *et al.* found that the degree of residual moisture significantly affects the adhesion of root canal sealers to radicular dentin. For the tested sealers Including AHplus and MTA Fillapex, it may be advantageous to leave canals slightly moist before filling (J Dent Res Dent Clin Dent Prospect 2014; 8(3):125-129). (Nagas *et al*., 2012) Zmener *et al*. In spite of hydrophilicity of some sealers, water cannot completely be displaced. He demonstrated that water permeation during the polymerization process might result in the entrapment of water droplets within the sealer dentin interface and this might result in bond disruption and microleakage resulting bond strength reduction. (Zmener *et al*., 2008) Roggendorf *et al*. 2007, AH Plus is a hydrophobic epoxy resin-based sealer, and traces of moisture (i.e. wet dentine) negatively affect the adhesion of AH Plus to canal walls. The adhesiveness of AH Plus to root dentine may be based on the formation of a covalent bond by an open epoxide ring to exposed amino groups in the collagen network. (Roggendorf *et al*., 2007) Schafer E, Z and biglari T 2003 AH plus used in dry canals showed the significantly better apical sealing ability and these data are in accordance with the results of previous reports. In the study about solubility of root-canal sealer in water and artificial saliva, AH plus presented the least leakage when compared with other sealers. This is because of its low solubility that might be related to the characteristics of its resinous matrix, which is more resistant to the solubility. Also AH plus showed some expansion during setting procedure, so this property compensates for the polymerization stress that are created during shrinkage. (Schafer and Zandbiglari, 2003)

But Jin-Ah Jang, Hee-Lyang Kim, Mi-Ja Her, Kwang-Won Lee, Mi-Kyung Yu 2010 stated that significantly more leakages occur when AH plus group were used in moist and/or wet canal. (Jin-Ah *et al*., 2010) Roggendorf *et al*. has described similar result. It is believed that the AH plus sealer did not adapt well to dentin walls because of the hydrophobic properties of epoxy resins. (Roggendorf *et al*., 2007) And a study reported that all the specimens filled with AH plus sealer leaked within 13 days. This could be because of shrinkage of this epoxy type sealer during setting. Thus moisture may be the relevant factor for theseadverse effects.According to Wu MK, De Gee AJ, Wesselink PR. Zinc oxide eugenol based root canal sealer showed gross leakage due to poor adhesive property. Another reason for low sealing ability of zinc oxide eugenol is the sudden setting of this material (transition from paste to solid mass) which may be responsible for debondingfrom dentinal walls or cohesive fracture caused by shrinkage setting stresses, which may explain the higher leakage. (Wu *et al*., 1994)

Conclusion

Micro-leakage in AH PLUS sealer group in both moist and dry conditions was significantly lower than that of other sealers. Maximum micro-leakage was seen in the ZOE group under moist conditions. Overall, moisture had a negative effect on the apical seal, except for MTA Fillapex sealer.

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