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ORIGINAL RESEARCH

Evaluation of Apical Sealing Ability of Four Different Sealers using Centrifuging Dye Penetration Method: An *in vitro* Study

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ABSTRACT

Aim: The aim of this *in vitro* study was to evaluate the apical seal obtained with four root canal sealers AH 26, Sealapex, Endoflas FS and AH Plus, with lateral condensation.

Materials and methods: Sixty root canals were prepared using the step-back technique. The specimens were divided into four experimental groups of 12 teeth and two control groups of 12 teeth. The experimental groups were obturated by laterally condensed gutta-percha with one of the tested sealers and control groups were obturated without any sealer. Methylene blue dye penetration with centrifuging method was used to evaluate the apical sealing ability. The quantitative apical leakage of each specimen was measured after 2 weeks.

Results: The results showed no significant differences between all groups except between AH Plus and Endoflas FS (<0.05). AH Plus showed significantly less leakage than Endoflas FS.

Conclusion: AH Plus showed the least leakage compared to AH 26, Sealapex and Endoflas FS.

Keywords: Root canal sealers, Dye leakage, Apical leakage, Root canal filling, AH Plus, AH 26.

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INTRODUCTION

One of the important objectives of endodontic therapy is to totally fill the root canal system for obtaining a fluid tight seal.[1] For the success of root canal treatment, development and maintenance of a seal is a major prerequisite.[2] A complete seal of the root canal system is impossible with currently accepted materials.[3]

A successful obturation can be achieved by the combination of gutta-percha and a sealer.[4] A variety of endodontic sealers are available. Use of adhesive resins as root canal sealers have been investigated.[5,6]

Apical sealing ability of root canal filling materials has been evaluated by various methods. Centrifuging dye penetration method is the most commonly used, because of its sensitivity, ease of use and convenience.[5]

The aim of this *in vitro* study is to evaluate and compare the sealing ability of four different sealers AH 26, Sealapex, Endoflas FS and AH Plus with lateral condensation using centrifuging dye penetration method.

MATERIALS AND METHODS

Sixty extracted human maxillary central incisors with type 1 anatomy were selected. The teeth with caries, cracks, open apices or resorptive defects were excluded. The selected teeth were stored in 3% sodium hypochlorite (NaOCl) solution for 24 hours.

The crowns were sectioned at the cementoenamel junction with diamond disk. The working lengths were determined by placing a size 10 K-Flexofile (Dentsply Maillefer, Ballaigues, Switzerland) into the root canals until it was visible at the apical foramen and then subtracting 1mm from that length. The coronal two-thirds of each canal was flared using Gates Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland). The apical portion of the canal was enlarged to a minimum ISO size 30 and maximum ISO size 50 file depending on the size of the original canal and the canal was prepared using 'step back' technique. 2.5% NaOCl was used as the main irrigant and the canal was recapitulated using size 10 K-Flexofile. The final rinsing of the canal was done with 17% EDTA solution to remove the smear layer. The canal was dried with absorbent points (Dentsply Maillefer, Ballaigues, Switzerland) and ISO standardized gutta-percha cone (Dentsply Maillefer,

Ballaigues, Switzerland) with a definitive 'tug back' at working length was selected and confirmed radiographically.

The specimens were divided into 4 experimental groups of 12 samples each (groups 1 to 4) and 2 control groups of six samples each as positive and negative groups. All the groups were obturated using lateral condensation technique with different sealer for each group, the sealers were mixed according to the manufacturer's instruction. AH 26 (Dentsply, Konstaz, Germany) was used as sealer for group 1, Sealapex (Kerr Corporation, CA 92867-5422) was used as sealer for group 2, Endoflas FS (Salnor and Cia S En CS, Columbia) was used as sealer for Group 3 and AH Plus (Dentsply, Konstaz, Germany) was used as sealer for Group 4. The access were sealed with Cavit G (3M, MN 55144-1000). In the control groups, canals were obturated with lateral condensation without any sealer. The obturated specimens were stored in 100% humidity at 37°C for 2 weeks. The samples of the experimental and the positive control groups were covered with 2 layers of nail varnish, except at the apical foramen. In the negative control group, the entire surfaces were coated with 2 layers of nail varnish.

Each specimen was placed in a centrifuge tube with the apex pointing toward the open end, 2% methylene blue dye solution was added to each tube until the root was fully submerged. The specimens were centrifuged for 3 minutes at 30× gm. The specimens were removed from the dye, rinsed in running water.

Longitudinal grooves were cut in the opposing root surfaces of the specimens, without entering the contents of the obturated space and then separating the specimens into two halves.

The specimens were examined using optical microscope with stage micrometer. The linear extent of dye penetration was measured to the nearest millimeter by two independent observers and the mean value was taken (Table 1).

Statistical Analysis

In all comparisons of the variances with Fishers F-test (Table 2), the value of the F ratio fell within the critical value at the 1% level of significance ($p < 0.01$) for the appropriate degrees of freedom. Student's t-test (Table 3) was used to determine whether there were significant differences between the means of the five groups at the level of significance ($p < 0.05$). Analysis of the data showed no significant differences between all groups except between the AH Plus and Endoflas FS, AH Plus showed significantly less leakage than Endoflas FS.

RESULTS

The measurements of maximum linear dye penetration were made in order to quantify the relative leakage of each group (Table 2). Dye penetration was observed in all the specimens except the negative control. The lowest mean level of dye penetration was in AH Plus group followed by Endoflas FS, Sealapex, AH 26 and the positive control in ascending order.

DISCUSSION

For successful endodontic treatment the root canal system must be filled completely. The root canal filling should seal the canal space both apically and coronally to prevent microorganisms or tissue fluids from entering the canal space and vice versa. Apical and coronal leakages have been shown to be important reasons for root canal treatment failure.[1]

Modern endodontics employs chemomechanical approach to disinfect the root canal and obtain a hermetic seal with complete coronal and apical seal. The sealing ability of the sealer is one of the factors that determines the seal of a root canal filling.[7]

Table 1: Apical leakage of specimens among each group (in mm)

Specimen no.	*AH 26*	*Sealapex*	*Endoflas FS*	*AH plus*	*Control*	
					Positive	*Negative*
1.	0.60	0.36	0.40	0.40	0.64	0
2.	0.64	0.20	0.12	0.70	0.76	0
3.	0.92	0.52	0.50	0.28	1.36	0
4.	0.14	0.68	0.64	0.28	0.96	0
5.	0.68	0.36	0.76	0.54	1.04	0
6.	0.88	1.12	0.34	0.72	0.48	0
7.	1.24	0.98	0.88	0.16	–	–
8.	0.44	0.36	0.88	0.46	–	–
9.	0.92	0.52	0.36	0.52	–	–
10.	0.48	0.78	0.08	0.56	–	–
11.	0.52	0.08	0.36	0.82	–	–
12.	0.56	1.04	0.50	0.08	–	–
Mean	0.67	0.58	0.49	0.46	0.87	0

Table 2: Fisher's F-test

Group	*Mean ± SD*	*ANOVA value*
AH 26	0.67 ± 0.29	F = 2.2721
Sealapex	0.58 ± 0.34	p < 0.05
Endoflas FS	0.49 ± 0.26	–
AH plus	0.46 ± 0.23	–
+ve control	0.87 ± 0.31	–
–ve control	0	–

SD: Standard deviation

Table 3: Student's unpaired t-test illustrates the range of dye penetration for each group

Comparison between	*T*	*P*	*Remarks*
Groups 1 and 2	0.66	0.514	Not significant
Groups 1 and 3	1.63	0.118	Not significant
Groups 1 and 4	1.97	0.062	Not significant
Groups 1 and 5	–1.39	0.185	Not significant
Groups 2 and 5	–1.75	0.099	Not significant
Groups 2 and 4	1.05	0.307	Not significant
Groups 2 and 3	0.79	0.436	Not significant
Groups 3 and 4	0.25	0.807	Not significant
Groups 3 and 5	–2.76	0.014	Significant
Groups 3 and 5	–3.19	0.006	Highly significant

Gutta-percha is used as the core material and the root canal sealer promotes better adhesion between canal walls and gutta-percha cones. Sealer will also fill empty areas where gutta-percha is unable to fill.[8] Different types of endodontic sealers based on various chemical composition are available.[5,6]

In this study, AH 26 (epoxy resin based), Sealapex (calcium hydroxide based), Endoflas FS (zinc oxide eugenol based), and AH Plus (epoxy resin based) were used.

The sealing ability of obturation can be analyzed by different methodology such as bacterial leakage, human saliva exposure, protein complex, fluid filtration and dye leakage. Centrifuging dye penetration method remains a commonly used tool for measuring the quality of root canal fillings.[9] Dyes can chemically interact with sealing materials or dentin, which may influence its diffusion, impairing an adequate marginal leakage evaluation.[9,10] The entrapped air in the filling may alter dye penetration depth. To overcome this, use of vacuum or centrifugation has been suggested.[11,12]

Methylene blue was used as the dye as it is readily detectable under visible light, has ability to diffuse easily, not absorbable by dentinal matrix apatite crystals[13] and the most coronal extent of the leakage is easily detectable.[14] It also penetrates voids better than isotopes[15] and has a low molecular weight thereby penetrating more deeply along root canal fillings.[16]

This study was done to assess the sealing property of AH 26, Sealapex, Endoflas FS and AH Plus by the centrifuging dye penetration method.

The highest leakage in this study was shown by AH 26. It is an epoxy resin based material and showed good sealing ability when used as the sole filling in a root canal.[7] The resin could shrink in a 7-day period,[17] leading to higher leakage values.[8] The highest leakage in this study could be attributed to shrinkage of the epoxy resin based sealer.

Second highest leakage was seen in samples which used Sealapex as sealer. Sealapex is a calcium hydroxide based sealer. Sealapex has showed a significant volumetric expansion during setting due to water absorption.[18] This increases the solubility of Sealapex[19] and can affect the sealing property and the high leakage.

The second least leakage was shown by Endoflas FS. The dye penetration of Endoflas FS has not been adequately evaluated till date for comparison with the study results.

Least leakage was shown by AH Plus. AH Plus is an epoxy resin based sealer. Resin based sealers have shown to be superior to that of other sealers.[20,21] Few studies have shown that Sealapex provides a significantly better seal than others including resin-based sealers.[22,23] Zmener et al [24] and Miletic et al[25] showed that AH Plus exhibited higher leakage values than specimens filled with AH 26. This has been attributed to some components of AH Plus, such as silicon oils, which can affect the sealing ability.[26] The present study results are in disagreement with those of the aforementioned authors. The differences in evaluation methods may account for these contrary results.

The positive control showed the highest mean level of dye penetration suggestive of lesser sealing ability of gutta-percha, when used without a sealer.

CONCLUSION

A root canal sealer is required to provide a seal between the core filling material and the canal wall. AH Plus showed significantly less leakage than other groups and has got better sealing ability compared to AH 26, Sealapex and Endoflas FS. Further studies with a larger sample size along with clinical trials, in different canal configuration are needed to evaluate the sealing ability of these sealers.

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