



An *In Vitro* Evaluation of Apical Leakage in Gutta-percha/AH Plus and Resilon/Epiphany-filled Root Canals Using Two Dye Penetration Techniques

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ABSTRACT

Aim: Aim of the present study was to evaluate the apical leakage in gutta-percha/AH plus and resilon/epiphany filled root canals using two dye penetration techniques.

Materials and methods: Sixty freshly extracted human single-rooted teeth were collected. The crown portion of each tooth was sectioned from the cemento-enamel junction using a diamond disk. The canals were instrumented using Step back technique up to a caliber of 40. The roots were randomly divided into four experimental groups of 15 sample units each. All the groups are obturated using lateral compaction technique. Samples were placed in India ink and stored in an incubator for 7 days after which they were thoroughly washed under tap water and dried. The roots were divided into longitudinal splitting technique with diamond disks and using clearing technique was checked for linear dye penetration using stereomicroscope. The surfaces were scanned and surfaces with greatest dye penetration were measured by using De winter Biowizard software system.

Results: The mean leakage for groups I, II, III, and IV are 2.31980, 2.68140, 4.11567, and 4.21047 respectively. One-way

ANOVA was applied to the mean leakage scores of different groups, found a significant difference between mean leakage scores. F value of 3.266 and it was found to be significant with a *p* value of 0.028. Significant differences were obtained for mean comparisons of groups I and III, groups I and IV and groups III and IV. Further, between groups I and II, groups II and III, and groups III and IV no significant differences were observed.

Conclusion: In conclusion, gutta-percha/AH Plus sealed root canals showed lesser leakage than the Resilon Epiphany groups and there was no significant difference in the two different methodologies used for dye penetration.

Clinical significance: Tightly adapted endodontic filling material is one of the goals in successful clinical endodontics and Improvements in the adhesive technology have fostered attempts to reduce apical and coronal leakage by bonding to the root canal walls to obtain a solid monoblock.

Keywords: Apical sealing, AH Plus, Clearing technique, Longitudinal splitting, Resilon-epiphany.

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INTRODUCTION

One of the keys to the success of pulp space therapy is to adequately obturate the prepared pulp space. The achievement of a three-dimensionally well-filled root canal system by a well compacted and tightly adapted endodontic filling material is one of the goals of successful clinical endodontics.¹

The most commonly used material for root canal obturation is gutta-percha combined with a sealer. It is considered as a "Gold Standard" filling material.² Gutta-percha as a core material does not bond to the root dentin walls, leakage takes place at the sealer/ gutta-percha

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interface, or the sealer/dentin interface.³ Improvements in the adhesive technology have fostered attempts to reduce apical and coronal leakage by bonding to the root canal walls to obtain a solid monoblock.

The three components of the Epiphany soft resin endodontic system are claimed by the manufacturer to be compatible and bondable with each other and can create a monoblock that prevents bacterial leakage and also increase the fracture resistance of filled roots.

The promising monoblock concept of resilon, filled with epiphany sealer claims to eliminate or be superior to conventional gutta-percha obturation technique. Since lateral compaction and dye penetration technique to study the sealing capability are one of the most widely used techniques they have been used in this study because of their ease in performance and their ability to provide sufficient data about apical leakage.⁴

Hence the present study was conducted with two objectives:

- To compare the level of apical leakage in root canals filled with gutta-percha/AH Plus and resilon/epiphany system
- To compare the leakage using two different methodologies for measuring dye penetration namely the longitudinal splitting and clearing technique.

MATERIALS AND METHODS

The present study was done in the Department of Conservative Dentistry and Endodontics, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India.

Sixty freshly extracted human single-rooted teeth were collected and stored in 1% thymol in normal saline solution until further use. The crown portion of each tooth was sectioned from the cemento-enamel junction using a diamond disk. The average lengths of sectioned roots were approximately 10 mm. The teeth were preselected

using stereomicroscope to exclude those with cracks, external structural faults or immature apical foramina.

The canals were instrumented using step back technique up to a caliber of 40. The canals were irrigated using 5.25% NaOCl and 1 mL of 17% EDTA alternatively for 3 minutes to remove the smear layer followed by a final rinse of saline. The root canals were dried with sterile paper points before filling.

The roots were randomly divided into four experimental groups of 15 sample units each. All the groups are obturated using lateral compaction technique.

- *Group I:* Lateral compaction of gutta-percha with AH Plus sealer (Fig. 1) (longitudinal splitting technique) After coating the canal with the sealer, a master gutta-percha cone of size 40 and 0.02 taper was placed till the working length. Lateral compaction was performed using finger spreader and medium fine accessory gutta-percha cones until the root canal was filled.
- *Group II:* Lateral compaction of gutta-percha with Ah Plus sealer (clearing technique) After coating the canal with the sealer, a master gutta-percha cone of size 40 and 0.02 taper was placed till the working length. Lateral compaction was performed using finger spreader and medium fine accessory gutta-percha cones until the root canal was filled.
- *Group III:* Lateral compaction of resilon with epiphany (Fig. 2) sealer (longitudinal splitting technique) After the canal is coated with the epiphany sealer, the resilon master cone of 40 sizes, 0.02 taper, coated with the sealer is placed in the canal to the working length. Lateral compaction was performed using a spreader and placing medium-fine Resilon accessory points dipped in resin sealer until the root canal was filled.
- *Group IV:* Lateral compaction of resilon with epiphany sealer (clearing technique) After the canal is coated with the epiphany sealer, the Resilon master cone of 40 sizes, 0.02 taper, coated with



Fig. 1: Gutta-percha/AH Plus used in the study



Fig. 2: Resilon-Epiphany used in the study

the sealer is placed in the canal to the working length. Lateral compaction was performed using a spreader and placing medium-fine Resilon accessory points dipped in resin sealer until the root canal was filled.

After obturation, the excess gutta-percha was removed with the hot instrument and condensed vertically. Resilon groups were cured at the coronal orifice using visible light for 30 seconds (Fig. 3). The coronal orifice was sealed with zinc phosphate and glass ionomer cement followed by composite resin.

All the samples were stored in relative humidity (37°C and 100% humidity) in an incubator for 7 days. The samples were dried, and the root surface was coated with two layers of nail varnish leaving the apical 3 mm (Fig. 4). Samples were placed in India ink and stored in an incubator for 7 days after which they were thoroughly washed under tap water and dried.

Longitudinal Splitting Technique

All samples of groups I and III were split longitudinally with diamond disks and were checked for linear dye penetration using stereomicroscope.

Clearing technique (Fig. 5)

All samples of groups II and IV were subjected to clearing technique.

Clearing procedure

Steps involved for clearing procedure:

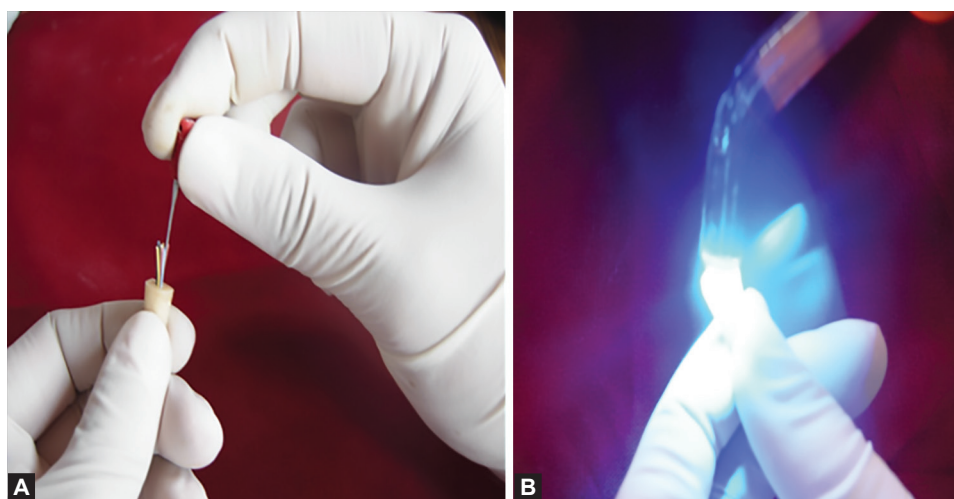
- *Decalcification*: Samples were placed in 10% HNO₃ for 3–6 days and the end pt of decalcification was checked by taking radiographs periodically.
- *Dehydration*: After the samples are taken out, they are rinsed thoroughly with water and dehydration is carried out in absolute alcohol of increasing concentration (70%, 90% and 100%) for 20 minutes each.
- *Clearing*: Finally after dehydration, all the samples are subjected to clearing by placing in methyl salicylate for several hours.

After Clearing

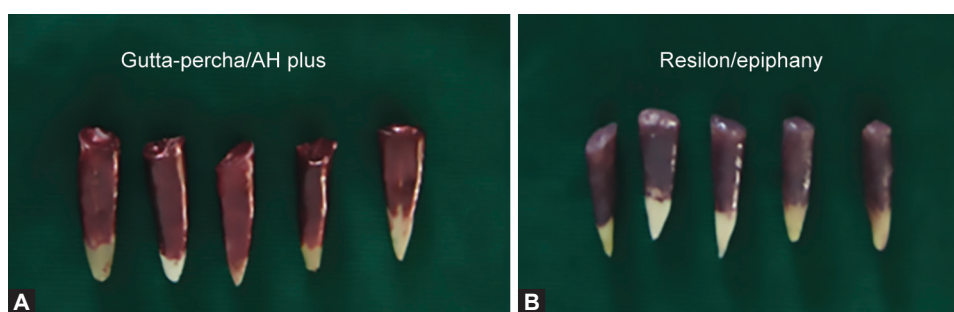
All the root samples are then examined under a stereomicroscope to observe the surfaces on which there is greatest dye penetration. The surfaces are scanned and surfaces with greatest dye penetration were measured by using De winter Biowizard software system (Fig. 6).

Statistical Analysis

All the statistical procedures were done through SPSS for Windows (version 16.0) and Minitab (version 11.0) for windows. Pairwise comparison between four groups was done by independent samples 't' test. Data obtained were



Figs 3A and B: Obturation of root samples using (A) Gutta-percha//AH Plus; (B) Resilon/Epiphany



Figs 4A and B: Coating of samples with varnish leaving apical 3 mm



Figs 5A and B: (A) Materials used for clearing technique; (B) End point of decalcification

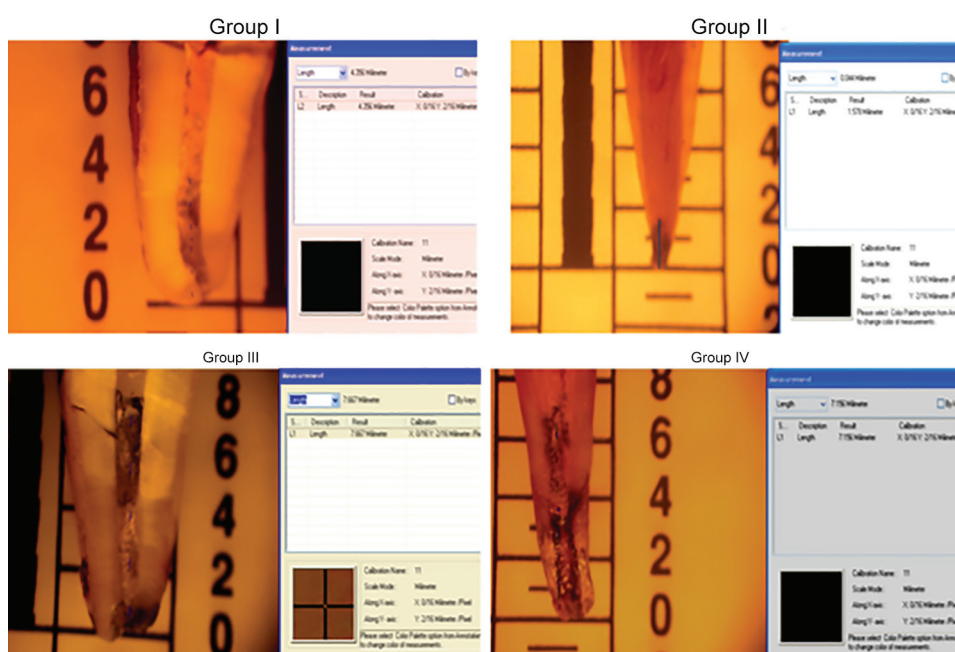


Fig. 6: Software assessment

statistically analyzed using one way analysis of variance test at 5% level of significance.

RESULTS

Table 1 shows the mean leakage for groups I, II, III, and IV are 2.31980, 2.68140, 4.11567, and 4.21047, respectively. The standard deviations for these mean scores for groups I, II, III, and IV are 1.403559, 1.848671, 2.686575, and 2.179272, respectively.

Table 2 reveals when one-way ANOVA was applied to the mean leakage scores of different groups, found a significant difference between mean leakage scores. F value of 3.266 and it was found to be significant with a p value of 0.028.

Pairwise comparison between four groups done by Duncan’s multiple comparison test procedures which showed there was a significant difference in mean leakage

scores between group I to groups III and IV, group II to group III and group IV. No significant differences were

Table 1: Comparison of mean leakage scores and standard deviation of the experimental groups

Groups	Means	Std. dev.
I	2.31980	1.403559
II	2.68140	1.848671
III	4.11567	2.686575
IV	4.21047	2.179272

Table 2: Comparison of four groups (I, II, III and IV) with respect to apical dye leakage by one-way ANOVA test

	SS	df	MSS	F value	p value	Significance
Between Groups	42.505	3	14.168	3.266	0.028	S
Within groups	242.963	56	4.339			
Total	285.468	59				

Table 3: Pairwise comparison between four groups using Duncan's multiple range test

Groups	Subset for alpha = .05	
	I	II
I	2.31980	
II	2.68140	
III		4.11567
IV		4.21047

found for groups I and II, and groups III and IV as they were in the same subset (Table 3).

Significant differences were obtained for mean comparisons of groups I and III, groups I and IV and groups III and IV. Further, between groups I and II, groups II and III, and groups III and IV no significant differences were observed in Table 4.

DISCUSSION

In the final analysis, it is the sealing off of the complex root canal system from the periodontal ligament and bone which ensures the health of the attachment apparatus against the breakdown of endodontic origin.² A plethora of studies have indicated that microleakage whether from an apical or coronal direction, adversely affects the success of root canal therapy. Long-term success can be achieved by thoroughly evaluating and managing the anatomical parameters that influence microleakage during nonsurgical root canal therapy.⁵ Resilon is introduced since it has the potential to challenge gutta-percha as a root filling material thus creating a monoblock effect.

Several techniques have been developed for placing gutta-percha into the root canal system. Nevertheless, the cold lateral compaction is still the most widely used filling technique and serves as a reference for assessing other techniques. However, as there is a demand for saving teeth with complex pathology and root canal morphology, it is sometimes easier to combine the merits of various techniques in a hybrid form to simplify the filling procedure. Under the conditions of this study, neither material produced an effective apical seal but the samples of GP/AH Plus showed no leakage as opposed to Resilon group.

There was a significant difference (p value = 0.028) between the two materials used for obturation in terms of dye penetration, i.e., gutta-percha/AH Plus group showed significantly less leakage (2.319 and 2.681) irrespective of the assessment technique used in comparison to the Resilon/Epiphany group (4.115, 4.210).

The lack of an effective seal with neither of the material used in our study is consistent with other studies conducted by Tay et al.,⁶ Verissimo et al.⁷ shows significantly higher dye penetration values for Resilon Epiphany system. However, studies conducted by

Table 4: Pairwise comparison between four groups by independent samples 't' test (student's unpaired t-test)

Groups	Mean	SD	t-value	p-value	Significance
I	2.31980	1.403559	0.603	0.551	NS
II	2.68140	1.848671			
I	2.31980	1.40356	2.295	0.029	S
III	4.11567	2.68657			
I	2.31980	1.40356	2.825	0.009	S
IV	4.21047	2.17927			
II	2.68140	1.84867	1.703	0.100	NS
III	4.11567	2.68657			
II	2.68140	1.84867	2.072	0.048	S
IV	4.21047	2.17927			
III	4.11567	2.686575	0.106	0.916	NS
IV	4.21047	2.179272			

Stratton⁸ Pawinska⁹ Bodrumlu et al.¹⁰ found Resilon Epiphany system to give a better seal.

One apparent reason for the poor seal of resilon/epiphany in both the groups could be due to the creation of interfacial stresses during polymerization because of shrinkage associated with the conversion of double bonds to single bonds.¹¹ Wu KM and Wesselink¹² considered C-factor to play a major role as it becomes higher in the long narrow root canal. Insufficient relief of shrinkage stresses causes debonding to occur during polymerization. One of the other reasons could be the role of the hybrid layer which in the apical part of the root canal does not favor the adhesive techniques. Least of all water sorption and solubility are the other factors which lowered the physical/mechanical properties of Epiphany sealer.¹³ The presence of superficial uncured layer in Epiphany sealer even after its setting time can be attributed to oxygen inhibition.¹⁴

The possible reason for GP/AH Plus showing better results when compared with RES in both the techniques could be due to GP which was found to expand in the presence of humidity and this property was found to close the micrographs.¹² AH Plus per se has a sealing capacity superior to most other sealers and it also shows continuous expansion over time in a liquid environment.

The methodology using tooth immersion in various types of dyes (eosin, methylene blue, black India ink, Procion brilliant blue, and others), reported for the first time by Grossman in 1939, is perhaps most widely used, mainly because it is easy to perform and easily reproducible. The phenomenon of capillarity is of utmost importance in this passive method used mainly for assessing apical leakage, as the tooth apex is submerged in the dye that penetrates through any space between the canal walls and filling material.

With regard to dyes, particle molecule size, pH and chemical reactivity are expected to affect the degree of penetration. A large number of studies have used Indian

ink as it is inexpensive, easy to manipulate, has a high degree of staining and a molecular weight lower than that of bacterial toxins and also has the advantage of not dissolving during the demineralization and clearing process.⁷

Though not statistically significant, groups using Clearing technique showed more leakage values probably because dye penetration is observed in three dimensions, which enables the reading of the maximum extent of the dye in tenths of millimeters.

CONCLUSION

Therefore under the conditions of this study gutta percha/AH Plus sealed root canals showed lesser leakage than the Resilon Epiphany groups and there was no significance in the two different methodologies used for dye penetration. It is unlikely, however, that the sealing failure observed in both the materials resulted solely from problems inherent in the sealers or the obturating technique *per se*.

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