

An *in-vitro* comparative study for assessment of apical sealing ability of Epiphany/AH Plus sealer with Resilon/gutta-percha root canal filling materials

Meraj Sultana, Mohammad A. Musani¹, Iffat M. Ahmed²

Departments of Restorative Dentistry and ²Oral and Maxillofacial Surgery, Al-Farabi Private College, Jeddah, ¹Department of Endodontics, Al Jedani Hospital, Jeddah, KSA

Corresponding author (email: <iffatahmd@gmail.com>)

Dr. Iffat M. Ahmed, Department of Oral and Maxillofacial Surgery, Al-Farabi Private College, Jeddah, KSA.

Received: 26-02-16

Accepted: 08-06-16

Published: 25-07-16

Abstract

Aims and Objectives: Endodontic treatment is directed to eliminate microbial challenges from the root canal system and to create a complete seal. The aim of this study was to assess the apical sealing ability of resin-based Epiphany-Resilon root canal filling system and to compare it with the sealing abilities of different combinations of AH Plus, gutta-percha, Epiphany, and Resilon. **Materials and Methods:** One hundred extracted human maxillary incisor roots were treated endodontically. The samples were divided into groups A, B, C, and D, with each group containing 25 samples. Group A: Canals obturated with gutta-percha and AH Plus sealer; Group B: Canals obturated with Resilon and Epiphany; Group C: Canals obturated with gutta-percha and Epiphany; Group D: Control group canals obturated with gutta-percha without a sealer. The sealing ability of each of the obturation techniques was tested using the dye penetration method followed by the clearing method using alcohol. Stereo microscope was used to measure the extent of dye penetration. Statistical data analysis was performed using analysis of variance and Tukey tests. **Results:** Microleakage was found in all the four groups. Apical extent of mean microleakage was maximum for gutta-percha, followed by Gutta-percha + AH-plus and Gutta-percha + Epiphany, and the least with Resilon + Epiphany. Statistically significant difference ($P < 0.01$) was seen in the apical leakage. **Conclusion:** All the samples tested showed microleakage. The “Epiphany soft resin endodontic obturation system” showed a superior result compared to other obturation materials.

Key words: AH Plus, apical leakage, maxillary incisors, Resilon-Epiphany

INTRODUCTION

The main objectives of treatment using non-surgical endodontics are cleaning the root canal thoroughly to eliminate bacteria and debris as much as possible, shaping the canal, and filling it completely.^[1] Obturation of the root canal is an indispensable step during root canal treatment, and therefore, it is a requisite to

perform it to the utmost clinical standards. One of the vital determinants for the success of endodontic treatment is the material chosen for obturation of the root canals.^[2] The function of root canal filling material is to prevent microorganisms and/or their toxic products from reaching the periapical tissues by sealing the entire root canal system.^[3]

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Sultana M, Musani MA, Ahmed IM. An *in-vitro* comparative study for assessment of apical sealing ability of Epiphany/AH Plus sealer with Resilon/gutta-percha root canal filling materials. J Int Soc Prevent Communit Dent 2016;6:321-6.

Access this article online	
Quick Response Code:	Website: www.jispcd.org
	DOI: 10.4103/2231-0762.186806

The most commonly used obturation material is gutta-percha because it has several desirable properties, for example, it is biocompatible, chemically stable, non-porous, radiopaque, easy to manipulate, and can be removed when necessary. However, gutta-percha has an important disadvantage, that is, it does not provide a fluid-tight seal because there is no chemical bond between gutta-percha, intraradicular dentin, and sealer. This major disadvantage of gutta-percha has led to the need for a better product.^[4]

The core material Resilon in combination with an adhesive system (Epiphany) was introduced. This thermoplastic-filled polymer core (polycaprolactone-based) has the potential to challenge gutta-percha. Ideally, a root canal sealer should bond simultaneously to intraradicular dentine walls and to the obturation material.^[4] This system also uses a primer to prepare the tooth root surface by etching which creates fingerlike dentinal projections. These dentinal projections facilitate a lock and key type of bonded seal between the three entities, that is, the tooth, sealer, and core material. Resilon is a thermoplastic synthetic resin material comprising polyester polymers, a bi-functional methacrylate resin, bioactive glass, and radiopaque fillers. Epiphany resin sealer contains bisphenol-A diglycidyl dimethacrylate (BisGMA), ethoxylated BisGMA, urethane dimethacrylate, hydrophilic difunctional methacrylates, silane-treated barium borosilicate glasses, barium sulfate, silica, calcium hydroxide, bismuth oxychloride with amines, peroxide, photo initiator, stabilizers, and pigment.^[4] Fundamentally, this system produces a “monoblock” effect, where the core filling material, sealer, and dentinal tubules become a single solid structure.^[5]

To test the sealing efficiency of obturation materials, dye penetration method is mostly used.^[6] Resilon obturation material claims to have advantages over gutta-percha such as providing a better apical seal and more resistance to fracture by bonding both to the filling material and the dentin walls.^[7,8]

Thus, the purpose of this study was to evaluate the apical sealing ability of the resin-based Epiphany + Resilon endodontic obturation system and to compare this with the sealing abilities of different combinations of sealers and obturation materials (AH Plus, gutta-percha, Epiphany, and Resilon). The null hypothesis tested in this study was that no difference exists in the apical sealing ability between the root canal filling materials and sealer groups tested.

MATERIALS AND METHODS

The present study was undertaken in the Department of Restorative Dentistry, Al-Farabi Dental College, Jeddah. A convenience sampling technique was used to select teeth for this study. The sample size was calculated using the results of the previous similar studies.^[7,9,10] One hundred freshly extracted maxillary incisors were collected based on the inclusion criteria and then divided randomly into four groups of 25 each.

Inclusion criteria

- Single rooted maxillary incisors with matured apices
- Patent canal.

Exclusion criteria

- Tooth with root caries
- Roots with fracture line or root tip fracture
- Roots with open apex
- Tooth with external/internal resorption
- Calcified canals
- Curved roots.

The crowns of the teeth were severed at cemento-enamel junction with a low speed diamond disc. The root lengths were standardized to 12 mm, following which all soft tissue calculus was removed with a periodontal scaler. Working length was determined by passing a size 15 K type file (MANI Inc., Utsonomiya, Japan) into the canal until the tip of the file was just visible through the apical foramen. The canal was then instrumented with #15 to #40 K-files using step-back technique, and irrigated with 2 ml of 5% NaOCl (Vesnsons Pvt. Ltd, India) at each file change. Finally, the canal was prepared using rotary Race 40, 4% (FKG, La Chaux De Fonds, Switzerland), number 15 K file was pushed 1 mm beyond the apex to remove any dentinal plugs and to ensure the patency of the foramen for dye (India ink dye, NICE) penetration. Then, the canal was immediately flushed with 2.5 ml of 17% ethylenediaminetetraacetic acid (EDTA) (Prime Dental Ltd) for 1 min and 2 ml of 5% NaOCl. After irrigation with 3 ml of distilled water, the root canals were dried out with an air syringe and absorbent paper points.

The samples were then divided into groups A, B, C, and D, with each group containing 25 samples.

- Group A: Canals were coated with AH Plus (Dentsply) sealer using a lentulospiral and obturated by 4% no. 40 gutta-percha (Dentsply) with accessory cones through lateral condensation

technique. At the orifice, the excess cone was severed with a heated ball burnisher

- Group B: Epiphany (Pentron Clinical Technologies, LLC) bonding material was applied after preparation of canals with the primer. Epiphany sealer was applied to the Resilon master cone (Pentron Clinical Technologies, LLC), which was then inserted in the root canal by the lateral condensation technique. At the orifice, the excess cone was severed with a heated ball burnisher. It was light-cured for 40 s (Monitex Blue, LED)
- Group C: Epiphany bonding material was applied after preparation of canals with the primer. Next, the Epiphany sealer was coated onto gutta-percha master cone and accessory cones, which were then placed in the root canal by the lateral condensation technique. At the orifice, the excess cone was severed with a heated ball burnisher. It was light-cured for 40 s
- Group D: This was the control group where canals were obturated with 4% no. 40 gutta-percha and accessory gutta-percha points. At the orifice, the excess cone was severed with a heated ball burnisher.

All the specimens were stored in saline at room temperature for 24 h after root canal filling. The external root surfaces of the teeth were coated with two layers of nail varnish except for the apical 2 mm. All teeth were vertically suspended with their apices facing downward in India ink for 1 week. After 1 week, samples were thoroughly washed under running water. Then, a lancet was used to scrape the external root surface to remove the nail varnish.

For assessment of the extent of dye penetration, a clearing technique was utilized as follows: Samples were placed in nitric acid 5% (S.D Fine Chemical Ltd) for 3 days where the acid was changed daily and tubes were agitated manually every 6 h. At the end of the 3 day period, roots were tested for decalcification using a sharp probe. Running water was used to rinse the roots for 3 hours, and then submerged in ascending

degrees of ethyl alcohol (Hong Yang Chemicals, China). Samples were left in 80% alcohol overnight, in 90% alcohol for 3 h, and finally in 100% alcohol for 3 h. Clearing was achieved by immersing the samples in methyl salicylate (S.D Fine Chemical Ltd) for 3 h.

Extent of the dye penetration through transparent roots was measured using a stereomicroscope (Magnus MSZ-TR) at a magnification of 8×, and microleakage was evaluated and values were obtained in units. These values were then converted to millimeters for dye penetration, using the following standard formula. The measurements were recorded starting from the most apical extent of obturation material to the most coronal extent of dye penetration. Statistical data analysis was done using analysis of variance (ANOVA) and Tukey test.

$$\text{Value in millimeters} = \frac{\text{No. of unit}}{\text{magnification} \times \text{Zoom Magnification}} \times \text{Eye piece}$$

RESULTS

Stereomicroscopic evaluation demonstrated dye penetration in all the tested samples [Figures 1, 2, 3] whereas the positive control samples [Figure 4] showed complete dye penetration. The apical leakage dye penetration was measured for these samples; wherein apical 4 mm of dye penetration was evaluated.

The mean microleakage values were highest in Group D (GP): 3.65 ± 0.38 mm followed by Group A (GP + AH plus): 2.58 ± 0.79 mm, Group C (GP + EP): 1.95 ± 0.57 mm and the least in Group B (R + E): 0.90 ± 0.46 mm, as shown in Table 1.

ANOVA of dye penetration in different groups showed considerable variation, as seen in Table 2 where $P < 0.001$ is statistically significant. Because P value is statistically significant, mean values in different groups differ significantly and was maximum for Group D followed by Group C, Group A, and minimum for Group B.

Table 1: Mean dye penetration values (in mm)

Group	Mean	SD	SE of mean	95% Confidence interval for mean		Min	Max
				Lower bound	Upper bound		
				Group A	2.58		
Group B	0.90	0.46	0.09	0.71	1.09	0.00	2.20
Group C	1.95	0.57	0.11	1.71	2.18	1.00	3.30
Group D	3.65	0.38	0.08	3.49	3.80	2.60	4.00

SD=Standard deviation, SE=Standard error, Min=Minimum, Max=Maximum

To detect among which groups there existed a significant difference, we performed multiple comparisons using Tukey test. When a comparative analysis of level of significance between all the groups was done, as shown in Table 3, it revealed that Group B [Figure 2] had better adaptation to both the dentin walls and the obturation material, as compared to Group C [Figure 3] followed by Group A [Figure 1] and Group D [Figure 4].

Statistically significant difference in mean microleakage was observed between Group A and B ($P < 0.001$), Group A and C ($P < 0.01$), Group A and D ($P < 0.001$), Group B and C ($P < 0.001$), Group B and D ($P < 0.001$), as well as Group C and D ($P < 0.001$).

DISCUSSION

As a consequence of the present results, the null hypothesis was rejected. Resilon + Epiphany group had the least microleakage compared to the combinations of gutta-percha + Epiphany, gutta-percha + AH Plus, and gutta-percha used as the control group.

The goal of endodontic treatment is to clean the root canal and eliminate all sources of bacteria by obturating the entire root canal system and producing an impervious apical seal. Increased apical leakage

is seen in canals sealed with the presence of a smear layer.^[11] Therefore, the smear layer was removed from the specimens using 17% EDTA.

The main advantage of Resilon over gutta-percha is that Resilon bonds to the sealer, which in turn bonds to the intraradicular dentin walls, thus creating a monoblock of material which has excellent apical seal and is more resistant to fracture.^[7,12,13] Resilon bonds through the complete length of the root canal^[8] through micromechanical retention by forming a thin hybrid layer to the self-etching primer-treated root dentin.

The main limitation of this study is that it was done *in vitro*. Nevertheless, it is recognized that lab testing remains the only valuable preclinical screening test that can predict or indicate clinical performance. Although *in-vitro* evaluation of microleakage may not simulate the clinical results exactly,^[14] they are useful for screening techniques and are justified for conducting simple comparisons.

Microleakage tests are the most favorable *in-vitro* methods for the evaluation of the sealing efficiency

Table 2: Analysis of variance table of dye penetration in different groups

Source	df	SS	Mean SS	F	P
Between Groups	3	99.283	33.094	101.856	<0.001*
Within Groups	96	31.191	0.325	-	-
Total	99	130.474	-	-	-

*Denotes significant difference. SS=Sum of Squares



Figure 1: Group A – Gutta-percha and AH Plus

Table 3: Comparative statistical analysis of different groups multiple comparisons

(I) Group (J) Group	Mean gifference (I-J)	Std. Error	Sig	95% Confidence Interval	
				Lower Bound	Upper Bound
Group A Group B	1.68200*	0.16122	0.000	1.2605	2.1035
Group C	0.63400*	0.16122	0.001	0.2125	1.0555
Group D	-1.06400*	0.16122	0.000	-1.4855	-0.6425
Group B Group A	-1.68200*	0.16122	0.000	-2.1035	-1.2605
Group C	-1.04800*	0.16122	0.000	-1.4695	-0.6265
Group D	-2.74600*	0.16122	0.000	-3.1675	-2.3245
Group C Group A	-0.63400*	0.16122	0.001	-1.0555	-0.2125
Group B	1.04800*	0.16122	0.000	0.6265	1.4695
Group D	-1.69800*	0.16122	0.000	-2.1195	-1.2765
Group D Group A	1.06400*	0.16122	0.000	0.6425	1.4855
Group B	2.74600*	0.16122	0.000	2.3245	3.1675
Group C	1.69800*	0.16122	0.000	1.2765	2.1195

*The mean difference is significant at the 0.05 level



Figure 2: Group B – Resilon and Epiphany



Figure 3: Group C – Gutta-percha and Epiphany



Figure 4: Group D – Gutta-percha

of root canal fillings and/or sealers. In this study, the method used for evaluation of leakage was linear dye penetration because of its sensitivity, easy procedure, and convenience.^[6] This method is based on the supposition that the gap between the root filling and the canal walls is represented by the depth of dye penetration.

Various in-vitro studies showed that gutta-percha fillings leak at a rapid rate^[15,16] and do not result in a dependable seal over a long term period.^[17] In this study, it was found that the gutta-percha leakage increased with time whereas Resilon + Epiphany not only produced a superior seal but also maintained it

over all time intervals. Studies have been conducted previously comparing the physical properties of gutta-percha and Resilon which observed that the shrinkage of Resilon is only 0.5% after application of heat when compared with gutta-percha, which shrinks 5–7%.^[18] Tayet *et al.*^[6] found that there was no chemical bonding of gutta-percha to AH Plus sealer whereas excellent coupling was found between Resilon and Epiphany sealer. A study^[19] suggested that there was chemical adhesion between AH Plus sealer and the dentin walls, however, no bonding was found between AH plus and gutta-percha; this lack of attachment between AH Plus and gutta-percha may allow a possible avenue for leakage. Hence, the leakage with AH plus is more than Epiphany. It was shown in this study that, at all times, gutta-percha was inferior to Resilon + Epiphany.

Under the experimental conditions of this study, the results showed that Resilon + Epiphany showed considerably lesser apical leakage than gutta-percha with different sealers. The present results agree with the results obtained by Kqiku *et al.*^[20] and Shipper *et al.*^[8] who concluded that the Resilon + Epiphany root canal filling system demonstrated less apical leakage. Previous studies drew similar conclusions using leakage tests and found that Epiphany and Resilon were superior to gutta-percha (with AH Plus sealer).^[19,21,22]

Based on the results obtained from this study, further clinical studies may be conducted to provide clinical data for assessment of the apical sealing ability in clinical application. Sensitivity of the materials to technique must be further explored. There is also concern over the possibility of biodegradation of Resilon/Epiphany because the filling material contains polycaprolactone.

CONCLUSION

Within the limitations of this study, it may be concluded that all the samples tested showed microleakage. The microleakage test done by linear dye penetration method revealed that Resilon + Epiphany group showed minimum dye penetration followed by gutta-percha + Epiphany, gutta-percha + AH plus, and maximum dye penetration was found in gutta-percha which was used as control group. Resilon + Epiphany group and the gutta-percha control group showed statistically significant difference in dye penetration. The Resilon + Epiphany resin endodontic obturation system showed a superior result to gutta-percha + AH plus and gutta-percha + Epiphany sealer with the cold lateral condensation technique.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Lotfi M, Ghasemi N, Rahimi S, Vosoughhosseini S, Saghiri MA, Shahidi A. Resilon: A comprehensive literature review. *J Dent Res Dent Clin Dent Prospects* 2013;7:119-30.
2. Bodrumlu E, Tunga U. Coronal sealing ability of a new root canal filling material. *J Can Dent Assoc* 2007;73:623.
3. Resende LM, Rached-Junior FJ, Versiani MA, Souza-Gabriel AE, Miranda CE, Silva-Sousa YT, *et al.* A comparative study of physicochemical properties of AH Plus, Epiphany, and Epiphany SE root canal sealers. *Int Endod J* 2009;42:785-93.
4. De Bruyne MA, De Moor RJ. Long-term sealing ability of Resilon apical root-end fillings. *Int Endod J* 2009;42:884-92.
5. Mohammadi Z, Jafarzadeh H, Shalavi S, Bhandi S, Kinoshita J. Resilon: Review of a new material for obturation of the canal. *J Contemp Dent Pract* 2015;16:407-14.
6. Kocak MM, Er O, Saglam BC, Yaman S. Apical leakage of epiphany root canal sealer combined with different master cones. *Eur J Dent* 2008;2:91-5.
7. Khan S, Inamdar MN, Munaga S, Ali SA, Rawtiya M, Ahmad E. Evaluation of fracture resistance of endodontically treated teeth filled with gutta-percha and Resilon obturating material: An *in vitro* study. *J Int Oral Health* 2015;7(Suppl 2):21-5.
8. Shipper G, Ørstavik D, Teixeira FB, Trope M. An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). *J Endod* 2004;30:342-7.
9. Langalia AK, Dave B, Patel N, Thakkar V, Sheth S, Parekh V. Comparative evaluation of fracture resistance of endodontically treated teeth obturated with resin based adhesive sealers with conventional obturation technique: An *in vitro* study. *J Int Oral Health* 2015;7:6-12.
10. Sandikci T, Kaptan RF. Comparative evaluation of the fracture resistances of endodontically treated teeth filled using five different root canal filling systems. *Niger J Clin Pract* 2014;17:667-72.
11. Mokhtari H, Shahi S, Janani M, Reyhani MF, Mokhtari Zonouzi HR, Rahimi S, *et al.* Evaluation of apical leakage in root canals obturated with three different sealers in presence or absence of smear layer. *Iran Endod J* 2015;10:131-4.
12. Ravi SV, Nageswar R, Swapna H, Sreekant P, Ranjith M, Mahidhar S. Epiphany sealer penetration into dentinal tubules: Confocal laser scanning microscopic study. *J Conserv Dent* 2014;17:179-82.
13. De-Deus G, Reis C, Di Giorgi K, Brandão MC, Audi C, Fidel RA. Interfacial adaptation of the Epiphany self-adhesive sealer to root dentin. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011;111:381-6.
14. Wu MK, Wessellink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. *Int Endod J* 1993;26:37-43.
15. El Sayed MA, Taleb AA, Balbahaith MS. Sealing ability of three single-cone obturation systems: An in-vitro glucose leakage study. *J Conserv Dent* 2013;16:489-93.
16. Silvestrin T, Torabinejad M, Handysides R, Shabahang S. Effect of apex size on the leakage of gutta-percha and sealer-filled root canals. *Quintessence Int* 2016;47:373-8.
17. Shashidhar C1, Shivanna V, Shivamurthy G, Shashidhar J. The comparison of microbial leakage in roots filled with resilon and gutta-percha: An *in vitro* study. *J Conserv Dent* 2011;14:21-7.
18. Kaufmann RM. Resilon-Finally an endodontic filling material for the 21st century? *The EndoFiles Fax* 2004;5(4).
19. Bodrumlu E, Tunga U. Apical leakage of Resilon™ obturation material. *J Cont Dent Pract* 2006;7:1-5.
20. Kçkiku L, Städtler P, Gruber HJ, Baraba A, Anic I, Miletic I. Active versus passive microleakage of Resilon/Epiphany and gutta-percha/AH Plus. *Aust Endod J* 2011;37:141-6.
21. Lambor RT, de Ataide Ide N, Chalakkal P, Akkara F, Shariff SA, Fernandes KS. An *in vitro* comparison between the apical sealing abilities of resilon with Epiphany sealer and gutta-percha with AH plus sealer. *Indian J Dent Res* 2012;23:694.
22. Pawar SS, Pujar MA, Makandar SD. Evaluation of the apical sealing ability of bioceramic sealer, AH plus & epiphany: An *in vitro* study. *J Conserv Dent* 2014;17:579-82.