J Res Dentomaxillofac Sci

http://www.jrdms.dentaiau.ac.ir

e(ISSN): 2383 -2754
p(ISSN):2588-4166

JRDMS Journal of Research in Dental and Maxillofacial Sciences

Comparison of Tubular Penetration of AH26, EasySeal, and SureSeal Root Canal Sealers in Single-Rooted Teeth Using Scanning Electron Microscopy

S Toursavadkohi[1] , F Zameni[2*], M Afkar[1]

[1]Assistant professor, Endodontics Dept, Faculty of Dentistry, Tehran Medical Sciences, Islamic Azad University, Tehran, Iran
[2] Dentistry Student, Tehran Medical Science, Islamic Azad Dental University, Tehran, Iran.

Original Article

ARTICLE INFO

Article Type
Original Article

Article History
Received: May 2018
Accepted: Apr 2018
ePublished: Jun 2018

Keywords:
Epoxy Resin-Based Root Canal Sealer,
Dentin, Root Canal Preparation,
Root Canal Filling Materials,
Scanning Electron Microscopy,
Tooth Root

ABSTRACT

Background and Aim: **Tubular penetration of root canal sealers prevents filling material displacement and overgrowth of microorganisms in dentinal tubules. The aim of this study was to compare the tubular penetration of AH26, EasySeal, and SureSeal sealers in single-rooted teeth using scanning electron microscopy (SEM).**

Materials and Methods: **Fifty human single-rooted teeth were included in this experimental study. After root canal preparation, AH26 was used in group 1, EasySeal was used in group 2, and SureSeal was used in group 3 using the lateral condensation technique. Sections at 3 mm and 6 mm from the apex were prepared and subjected to SEM analysis. Analysis of variance (ANOVA), post hoc and paired t-tests were used to compare the deepest dentinal penetration of root canal sealers.**

Results: **The deepest tubular penetration at 3 mm from the apex was 0.85±0.19 mm in group 1, 1.32±0.21 mm in group 2, and 1.17±0.42 mm in group 3; the difference was significant (P=0.01). The deepest tubular penetration at 6 mm from the apex was 1.09±0.3 mm in group 1, 2.12±0.45 mm in group 2, and 1.88±0.43 mm in group 3; the difference was significant (P=0.0001). The mean deepest tubular penetration was lower at 3 mm from the apex compared to the penetration at 6 mm from the apex (P=0.02).**

Conclusion: **It seems that tubular penetration of AH26 sealer is less than that of EasySeal and SureSeal at 3-mm and 6-mm sections.**

Please cite this paper as: **Zameni F, Toursavadkohi S, Afkar M. Comparison of Tubular Penetration of AH26, EasySeal, and SureSeal Root Canal Sealers in Single-Rooted Teeth Using Scanning Electron Microscopy. J Res Dentomaxillofac Sci. 2018;3(3):27-32.**

***Corresponding author:**
F Zameni
zameni.fatemeh@yahoo.com

Introduction:

Elimination of microorganisms from root canal space and preventing the recontamination of the space are ideal goals for root canal treatment. Root canal sealers are used to fill the microscopic gap between core materials and root canal walls.(1) Furthermore, the sealer that penetrates into dentinal tubules may trap residual bacteria that had previously penetrated into the tubular dentin.(2) Therefore, sealer penetration might render a more predictable root canal treatment.(3) The presence of a smear layer in prepared root canal walls may occlude the dentinal tubules, thus preventing root canal sealer from penetrating into dentinal tubules. This layer might interfere with the adaptation of filling materials to root canal walls.(4,5) There is no real chemical bond between root canal sealers and the dentinal wall of root canals; however, tubular penetration of root canal sealers may enhance the micromechanical bonding of sealers and subsequent sealing properties of root canal sealers.(6) Wettability, surface tension, and hydrophilic properties of root canal sealers may interfere with their tubular penetration.(7)

Tubular penetration of root canal sealers can be analyzed by light, confocal or scanning electron microscopy (SEM).(4,8,9) The main advantages of SEM over light or confocal microscopes are the high magnification and more precise detection of surface details and sealer penetration margin.(10)

AH26 (Dentsply DeTrey GmbH, Konstanz, Germany) is an epoxy resin-based sealer with good sealing properties; however, previous studies have shown that this sealer has no chemical bonding to the dentinal wall of root canals.(11) EasySeal (Komet Brasseler GmbH & Co., Lemgo, Germany) is an epoxy resin-based root filling material. This sealer has a low solubility; it is flowable and shows great resistance to high temperatures.(12)

SureSeal (Sure Dent Corp., Gyeonggi-do, Korea) is a bioceramic sealing material. This sealer is biocompatible, osteogenic, highly antibacterial (pH=12), and hydrophilic.(13)

The aim of this in-vitro study was to compare the tubular penetration of AH26, EasySeal, and SureSeal sealers in single-rooted extracted teeth using SEM.

Materials and Methods

Fifty intact human central incisors with straight root canals and mature apices (a #10 patency file can pass through the apical foramen) were used in this experimental study. An initial periapical radiograph was obtained from the teeth to confirm the presence of a single straight root canal within the root and the absence of pathologic root resorptions. The teeth were distributed randomly into group 1: AH26 (n=15), group 2: EasySeal (n=15), group 3: SureSeal (n=15), and a control group (no sealer, n=5).

Standard access cavities were prepared using a high-speed handpiece and water coolant. The working lengths of the teeth were established by reducing 1 mm after a #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) had passed the apical foramen. Samples with apical constriction bigger than a #20 K-file were excluded. The root canals were shaped using the step-back technique with a #40 master apical file (MAF), and the rest of the canal was flared to #60 by reducing 0.5 mm from the working length with each file number. The smear layer was removed using 17% ethylenediaminetetraacetic acid (EDTA; CinaBartar Co., Tehran, Iran) and 5.25% sodium hypochlorite (NaOCl), each for one minute. The final irrigation was done with distilled water.(4) Finally, the root canals were dried using paper points.

AH26 was used in group 1, EasySeal was used in group 2, and SureSeal was used in group 3 using ultrasonic tip E9 (Woodpecker, Guangxi, China) for 10 seconds circumferentially, and obturation was done using the lateral condensation technique (#40 master apical cone, #25 spreader, and #20 lateral cones). All the samples were incubated for 2 weeks for the complete setting of the sealers. Each tooth was embedded in self-cure acrylic resin for section preparations. One-mm-thick sections, perpendicular to the long axes of the teeth, were prepared at 3 mm and 6 mm from the anatomic apices using CNC machine (Delta Electronics, Taoyuan, Taiwan). The prepared sections were rinsed with 17% EDTA solution to remove superficial debris. The sections were gold coated and analyzed for the deepest penetration level of sealers into dentinal tubules using SEM (Hitachi S-4160, Tokyo, Japan).

Low-magnification (x20) images were used for estimating the deepest penetration site of the sealer. High-magnification (x500) images were used to determine the exact point of sealer penetration (Figure 1).[6]

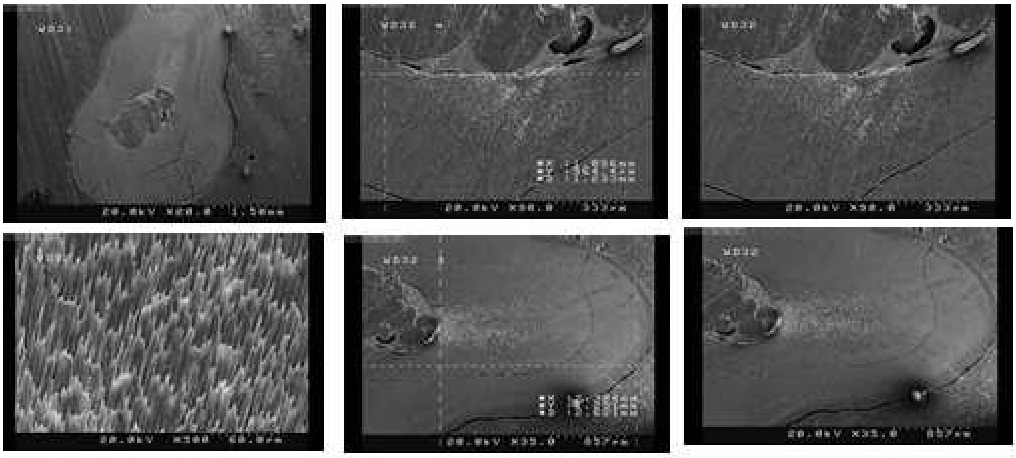

Figure 1. Tubular penetration of the studied sealers at 6 mm from the apex

The deepest penetration levels in the experimental groups at 3 mm and 6 mm from the apex were analyzed and compared using analysis of variance (ANOVA), post hoc and paired t-tests.

Results:

The deepest tubular penetration at 3 mm from the apex was 0.85±0.19 mm in group 1, 1.32±0.21 mm in group 2, and 1.17±0.42 mm in group 3; the difference was significant (P=0.01). The deepest tubular penetration at 6 mm from the apex was 1.09±0.3 mm in group 1, 2.12±0.45 mm in group 2, and 1.88±0.43 mm in group 3; the difference was significant (P=0.0001).

The mean deepest tubular penetration in group 1 at the 3-mm section (0.85±0.19 mm) was lower compared to the penetration at the 6-mm section (1.09±0.3 mm); the difference was significant (P=0.02).

The mean deepest tubular penetration in group 2 at the 3-mm section (1.32±0.21 mm) was lower compared to the penetration at the 6-mm level (2.12±0.45 mm); the difference was significant (P=0.0001).

The mean deepest tubular penetration in group 3 at the 3-mm section (1.17±0.42mm) was lower compared to the penetration at the 6-mm level (1.88±0.43mm); the difference was significant (P=0.0001; Table 1).

Table 1: The mean ± standard deviation (SD) of the deepest tubular penetration (mm) of AH26, EasySeal, and SureSeal sealers at 3 mm and 6 mm from the apex

Groups \ Sections	3 mm from the apex	6 mm from the apex	P-value
Group 1: AH26	0.85±0.19	1.09±0.3	P=0.02
Group 2: EasySeal	1.32±0.21	2.12±0.45	P=0.0001
Group3: SureSeal	1.17±0.42	1.88±0.43	P=0.0001
P-value	P=0.01	P=0.0001	

Discussion:

Penetration of root canal sealers into radicular dentinal tubules renders a better sealing ability and prevents residual bacteria from regrowth within the tubular space. Increasing the sealer-dentinal wall contact area preserves a better hermetic seal.[14] There is no real chemical bonding between most of root canal sealers and dentinal walls; therefore, tubular penetration of sealers causes a better mechanical retention of root filling materials within root canal space.[15]

This study indicated that the tubular penetration of EasySeal and SureSeal was more than that of AH26 group at both 3-mm and 6-mm levels from the anatomic apices, while the overall penetration of the sealers was deeper at the 6-mm level compared to the 3-mm level.

The deeper penetration of EasySeal sealer compared to SureSeal can be explained by the lower film thickness of this sealer, which may overcome its lower hydrophilic properties compared to SureSeal sealer.[16] The deeper tubular penetration of sealers, at the 6-mm section compared to the 3-mm section, can be explained by the higher thickness of dentinal tubules in the middle and coronal parts compared to the apical part of the root.[17]

There are various techniques for sealer placement in root canal space including the use of a lentulo spiral and ultrasonic devices with up and down movement of the master cone, file or spreader; the ultrasonic technique renders better sealer distribution within root canal space. [18]

Confocal microscopy, stereomicroscopy, and SEM are used for detection of tubular penetration of root canal sealers; the latter provides higher magnification and allows for better observation of surface topography.[19]

The presence of a smear layer obstructs the tubular ostium and prevents sealer penetration into tubular space; therefore, removing the smear layer using 17% EDTA and 5.25% NaOCl enhances tubular penetration of root canal sealers.[4,20] Irrigant delivery system has no effect on tubular penetration of root canal sealers.[21]

De-Deus et al concluded that the vertical compaction technique causes deeper penetration of root canal sealers compared to the lateral condensation or single-cone techniques, while the lateral condensation technique renders better sealer distribution in root canal space, especially in the middle and coronal thirds.[19] On the other hand, Jeong et al concluded that warm vertical compaction technique does not influence the tubular penetration of calcium silicate-based sealers.[22]

In an SEM study for assessment of the tubular penetration of AH Plus and Epiphany sealers, Kara Tuncer and Tuncer concluded that the tubular penetration of AH26 sealer enhances using 17% EDTA, maleic acid or citric acid as final irrigation after removing the smear layer from radicular dentinal walls.[23]

In an in-vitro study using a confocal microscope, Chandra et al detected maximum tubular penetration in the RealSeal group followed by the AH Plus, RoekoSeal, and EndoRez groups.[24] The maximum penetration was detected in the coronal third followed by the middle and apical parts;[24] their results were comparable to those of our study.

In an SEM study by Khader, it was concluded that tubular penetration levels of AH Plus and Apexit Plus were the same, while the Tubli-Seal group showed less penetration.[6] In the mentioned study, longitudinal sections of roots were studied instead of horizontal sections; the latter allows for better observation of tubular penetration of sealers in all directions.

In a confocal microscopic study by Kuçi et al, it was concluded that removing the smear layer enhances the tubular penetration of MTA Fillapex but it had no such effect on AH26 sealer.[4] They stated that the MTA Fillapex group exhibited deeper tubular penetration compared to the AH26 group, and the reason for this difference can be attributed to different methods for tubular penetration assessment and different sealer placement techniques.[4]

Attur et al studied the possible correlation between dentinal tubule penetration and microleakage of three root canal sealers including AH26, zinc oxide eugenol (ZOE), and mineral trioxide aggregate (MTA) using dye leakage and SEM methods.[25] In the mentioned in-vitro study, it was shown that AH26 had a lower microleakage score than the other sealers, and MTA demonstrated the least penetration ($P<0.05$). They concluded that there was an inverse relationship between microleakage and tubular penetration of root canal sealers; the deeper the penetration, the lesser is the leakage.[25]

Weis et al compared the average sealer cement film thickness and the extent and pattern of sealer penetration (AH26) into dentinal tubules in association with four obturation techniques (continuous wave compaction, lateral compaction, Thermafil, and SimpliFill) in curved root canals. [26] They concluded that sealer thickness was strongly dependent on the obturation technique. Considering that minimal sealer thickness and fewer voids are indicative of the long-term sealing ability, they stated that Thermafil resulted in the best outcome. They observed extensive sealer penetration into dentinal tubules, which was unrelated to the obturation technique.[26]

Based on studies by Sevimay and Kalayci [27] and De-Deus et al[28], the correlation between tubular penetration of endodontic sealers and their sealing ability is controversial.

In an SEM study by Moradi et al, it was concluded that AH26 sealer exhibited more tubular penetration in the middle and apical parts of the canal in both short and long follow-ups compared to ExciTE® F DSC (Ivoclar Vivadent);[29] this result is comparable to that of our study.

Conclusion:

The results of the present study indicated that the tubular penetration of EasySeal is significantly higher than that of AH26 and SureSeal at 3 mm and 6 mm from the apex, while the overall penetration of the sealers was deeper at the 6-mm level compared to the 3-mm level.

Acknowledgement:

This article is based on general dentistry thesis No. 25642 registered at faculty of Dentistry, Tehran Medical Sciences, Islamic Azad University, Tehran, Iran.

References:

1.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 Nov-Dec;17(6):579-82.

2.Kwang S, Abbott P. The presence and distribution of bacteria in dentinal tubules of root filled teeth. Int Endod J. 2014 Jun;47(6):600-10.

3.Kumar NS, Palanivelu A, Narayanan LL. Evaluation of the apical sealing ability and adaptation to the dentin of two resin-based Sealers: An in vitro study. J Conserv Dent. 2013 Sep;16(5):449-53.

4.Kuçi A, Alaçam T, Yavaş Ö, Ergul-Ulger Z, Kayaoglu G. Sealer penetration into dentinal tubules in the presence or absence of smear layer: a confocal laser scanning microscopic study. J Endod. 2014 Oct;40(10):1627-31.

5.Turkel E, Onay EO, Ungor M. Comparison of Three Final Irrigation Activation Techniques: Effects on Canal Cleanness, Smear Layer Removal, and Dentinal Tubule Penetration of Two Root Canal Sealers. Photomed Laser Surg. 2017 Dec;35(12):672-81.

6. Khader MA. An In Vitro Scanning Electron Microscopy Study to Evaluate the Dentinal Tubular Penetration Depth of Three Root Canal Sealers. J Int Oral Health. 2016;8(2):191-4.

7. Al-Haddad A, Abu Kasim NH, Che Ab Aziz ZA. Interfacial adaptation and thickness of bioceramic-based root canal sealers. Dent Mater J. 2015;34(4):516-21.

8.Macedo LMD, Silva-Sousa Y, Silva SRCD, Baratto SSP, Baratto-Filho F, Abi Rached-Júnior FJ. Influence of Root Canal Filling Techniques on Sealer Penetration and Bond Strength to Dentin. Braz Dent J. 2017 May-Jun;28(3):380-84.

9.Machado R, Silva Neto UX, Carneiro E, Fariniuk LF, Westphalen VP, Cunha RS. Lack of correlation between tubular dentine cement penetration, adhesiveness and leakage in roots filled with gutta percha and an endodontic cement based on epoxy amine resin. J Appl Oral Sci. 2014 Jan-Feb;22(1):22-8.

10.Rouhani A, Ghoddusi J, Naghavi N, Al-Lawati G. Scanning electron microscopic evaluation of dentinal tubule penetration of Epiphany in severely curved root canals. Eur J Dent. 2013

Oct;7(4):423-8.
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 Mar;10(2):131-4.
12.Sonntag D, Ritter A, Burkhart A, Fischer J, Mondrzyk A, Ritter H. Experimental amine-epoxide sealer: a physicochemical study in comparison with AH Plus and EasySeal. Int Endod J. 2015 Aug;48(8):747-56.
13. Huang Y, Celikten B, de Faria Vasconcelos K, Ferreira Pinheiro Nicolielo L, Lippiatt N, Buyuksungur A, et al. Micro-CT and nano-CT analysis of filling quality of three different endodontic sealers. Dentomaxillofac Radiol. 2017 Dec;46(8):20170223.
14. Deniz Sungur D, Purali N, Coşgun E, Calt S. Push-out bond strength and dentinal tubule penetration of different root canal sealers used with coated core materials. Restor Dent Endod. 2016 May;41(2):114-20.
15.Wiesse PEB, Silva-Sousa YT, Pereira RD, Estrela C, Domingues LM, Pécora JD, et al. Effect of ultrasonic and sonic activation of root canal sealers on the push
facial adaptation to root canal dentine. Int Endod J. 2018 Jan;51(1):102-11.
16.Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod. 2013 Oct;39(10):1281-6.
17.Lo Giudice G, Cutroneo G, Centofanti A, Artemisia A, Bramanti E, Militi A, et al. Dentin morphology of root canal surface: a quantitative evaluation based on a scanning electronic microscopy study. BioMed Res Int. 2015;2015:164065.
18.Nikhil V, Singh R. Confocal laser scanning microscopic investigation of ultrasonic, sonic, and rotary sealer placement techniques. J Conserv Dent. 2013 Jul;16(4):294-9.
19.De-Deus G, Gurgel-Filho ED, Maniglia-Ferreira C, Coutinho-Filho T. Influence of the filling technique on depth of tubular penetration of root canal sealer: a scanning electron microscopy study. Braz J Oral Sci. 2004 Apr-Jun;3(9):433-38.
20.Sonu KR, Girish TN, Ponnappa KC, Kishan KV, Thameem PK. “Comparative evaluation of dentinal penetration of three different endodontic sealers with and without smear layer removal” - Scanning electron microscopic study. Saudi Endod J. 2016;6(1):16-20.
21.Generali L, Cavani F, Serena V, Pettenati C, Righi E, Bertoldi C. Effect of Different Irrigation Systems on Sealer Penetration into Dentinal Tubules. J Endod. 2017 Apr;43(4):652-6.
22.Jeong JW, DeGraft-Johnson A, Dorn SO, Di Fiore PM. Dentinal Tubule Penetration of a Calcium Silicate-based Root Canal Sealer with Different Obturation Methods. J Endod. 2017 Apr;43(4):633-7.
23.Kara Tuncer A, Tuncer S. Effect of different final irrigation solutions on dentinal tubule penetration depth and percentage of root canal sealer. J Endod. 2012 Jun;38(6):860-3.
24.Chandra SS, Shankar P, Indira R. Depth of penetration of four resin sealers into radicular dentinal tubules: a confocal microscopic study. J Endod. 2012 Oct;38(10):1412-6.
25.Attur KM, Kamat S, Shylaja KA, Tegginmani V, Patil D, Choudary RP. A comparison of apical seal and tubular penetration of mineral trioxide aggregate, zinc oxide eugenol, and AH26 as root canal sealers in laterally condensed gutta-percha obturation: An in vitro study. Endodontology. 2017;29(1):20-5.
26.Weis MV, Parashos P, Messer HH. Effect of obturation technique on sealer cement thickness and dentinal tubule penetration. Int Endod J. 2004 Oct;37(10):653-63.
27.Sevimay S, Kalayci A. Evaluation of apical sealing ability and adaptation to dentine of two resin-based sealers. J Oral Rehabil. 2005 Feb;32(2):105-10.
28.De-Deus G, Brandão M, Leal F, Reis C, Souza EM, Luna AS, et al. Lack of correlation between sealer penetration into dentinal tubules and sealability in nonbonded root fillings. Int Endod J. 2012 Jul;45(7):642-51.
29. Moradi S, Ghoddusi J, Forghani M. Evaluation of dentinal tubule penetration after the use of dentin bonding agent as a root canal sealer. J Endod. 2009 Nov;35(11):1563-6.