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A Confocal Laser Scanning Microscopic Study Evaluating The Depth Of Dentinal Tubular Penetration Of Different Sealers.

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Abstract
Objective: *The present study investigated the depth of penetration of resin based sealer and Bioceramic sealer by a confocal laser scanning microscopic investigation.*
Method:
20 Mandibular single rooted premolar sound teeth were selected. Samples were decoronated at cementoenamel junction. Access opening and biomechanical preparation was done till 30.006 taper. Samples were divided into 2 groups for obturation as, Group 1-Endosequence Bioceramic sealer, Group 2- AH Plus sealer. The depth of sealer penetration into dentinal tubules was calculated using confocal laser scanning microscope. One way ANOVA and Tukeys test were applied for the pairwise comparison of the depth of sealer penetration between the groups.
Results:
There was statistical significant difference between Group 1 and Group 2 at coronal and middle third of root however there was no statistical significant difference between Group 1 and Group 2 at apical third of root. Group 1 showed more depth of penetration than group 2.
Conclusion:
The depth and consistency of dentinal tubule penetration of sealer cements appears to be influenced by the chemical and physical characteristics of the materials. Endosequence Bioceramic sealers displayed deeper and more consistent penetration.
Keywords: *AH Plus Sealer, Bioceramic Sealer, confocal laser scanning microscopic, Tubular penetration, Endosequence Bioceramic sealer*

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I. Introduction:

A root canal treatment is successful only if the three steps of extensive canal debridement, powerful disinfection, and obturation of the canal space are completed[1]. Root canal obturation with "Hermetic Seal" can prevent the seepage of bacterial toxins into the endodontic system[2]. All "portals of exit" are sealed by a three-dimensional obturation, which prevents reinfection, and periapical exudates from microleaking into the root canal area. These actions collectively create a favorable biological environment for healing[3]. Since Bowman first introduced gutta-percha to endodontics in 1867, it has been the material of choice for root canal obturation[4]. Regardless of the root canal filling method employed, one of the disadvantages of utilizing guttapercha is that it cannot hermetically seal the root canal. This disadvantage is related to the guttapercha's non-adherent nature to the canal wall. This restriction can be addressed using a sealer with gutta-percha to create a fluid-tight seal and fill up the gaps between the obturating material and the canal wall[5-7].

The root canal sealers have different functions such as antibacterial properties, acting as a lubricant for core material, increasing radio-opacity of core or filling material, prevent microleakage. Various types of sealers are available, most recently used are resin-based and bioceramic sealers. Resin-based sealers are used because of their reduced solubility, good apical seal, and micro-retention to root canal dentin. Endodontic bioceramics are not sensitive to moisture and blood contamination and therefore are not technique sensitive. They are dimensionally stable and expand slightly. When bioceramic materials come in contact with tissue fluids, they release calcium hydroxide, which can interact with phosphates in the tissue fluids to form hydroxyapatite. This may explain some of the tissue-inductive properties of the material. The present study was undertaken to compare and evaluate the depth of sealer penetration of bioceramic sealer and resin-based sealer into the dentinal tubules under confocal laser scanning microscopy.

II. Materials And Methodology:

Twenty extracted permanent mandibular premolar teeth with straight roots and completely formed root apices were chosen. Caries, fractures, cracks, and residual abnormalities in teeth were not included. Teeth were preserved in regular saline after being cleaned of any exterior debris and immersed in a 2.5% sodium hypochlorite solution for two hours.

At the cementoenamel junction, all samples were decoronated, leaving a standard length of 14 mm. The working lengths were determined to be 1 mm less than the apical foramen. Using rotary files and Universal Nickel-titanium rotary instruments (DENTSPLY, Maillefer, Switzerland) and stainless steel hand files, each tooth was prepared using the crown down procedure to size 30, 0.06 taper.

Using a size 10 K file, a recapitulation of the working length was carried out following each rotary instrument series to preserve patency and enhance irrigant penetration. After each instrument, the canal was irrigated with 1 mL of 2.5% NaOCl using a syringe and a 30-G side vented irrigation needle. After instrumentation was completed the tooth was given a final flush with 17% EDTA and 5% Sodium Hypochlorite to remove the smear layer followed by irrigation with 10ml of distilled water to remove remaining irrigant residue. The canals were dried with the help of sterile paper points.

All the samples were divided randomly into 2 groups of 10 teeth each for the obturation using master cone with respective sealers as:

Group 1: EndosequenceBioceramic sealer along with 6% gutta-percha points of size 30,0.06

Group 2: AH Plus sealer along with 6% gutta-percha points of size 30,0.06

Manipulation of each sealer material was done according to manufacturers‟ instructions. For fluorescence under confocal laser scanning microscopy, 0.1% fluorescent rhodamine B isothiocyanate was mixed with sealer. All specimens were stored in 100% relative humidity at 37°C for 24 hours to ensure complete setting of the root canal sealers.

Following the full setting of the resin, each tooth was sectioned using a slow-speed handpiece at three distinct places, measuring from the root apex 3, 6, and 9 mm, in 1-mm-thick sections perpendicular to its long axis. Consequently, the samples were divided into three sections: the coronal, middle, and apical third. The mounting of the samples on glass slides was completed, and the depth and percentage of sealer penetration into the dentinal tubules were assessed using a Confocal Laser Scanning Microscope.

Statistical Analysis:

Statistical analysis was done by using descriptive and inferential statistics using students‟s unpaired t-test, one-way ANOVA, and Turkeys test were applied for the pairwise comparison of the depth of sealer penetration between the groups and software used in the analysis were SPSS 24.0 version and GraphPad Prism 7.0 version and p <0.05 were considered to be significant.

Descriptive statistics for Depth of penetration (in micrometers) at the Coronal, Middle, and Apical sites in groups 1 and 2 are mentioned in Table 1. The graph showing the comparison of the depth of sealer penetration is given in Figure 1. Table 2 shows the mean difference between the depth of penetration (in micrometers)in groups 1 and 2. On pairwise comparison, Endosequence Bioceramic sealer showed more sealer penetration when compared to AH Plus sealer at coronal, middle, and apical thirds. There was a statistically significant difference between Group 1 and Group 2 at the coronal third (P value 0.007) and middle third (0.0001) of the root. However, there was no statistically significant difference between Group 1 and Group 2 at the apical third of the root (P value 0.073).

Table 1: Descriptive statistics for Depth of penetration (in micrometers) at Coronal, Middle, and Apical sites in groups 1 and 2

Groups		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Group 1(BC Sealer)	Coronal	10	1424.23	527.15	166.69	767.91	2083.94
	Middle	10	1104.19	186.46	58.96	736.64	1320.30

	Apical	10	1235.82	217.59	68.80	854.52	1571.77
Group 2 (AH Plus Sealer)	Coronal	10	912.61	57.71	18.25	791.14	987.21
	Middle	10	807.54	68.38	21.62	644.08	879.21
	Apical	10	1095.07	85.15	26.92	1000.21	1245.32

Fig1. The depth of sealer penetration into dentinal tubules at the coronal, middle,and apical sections.

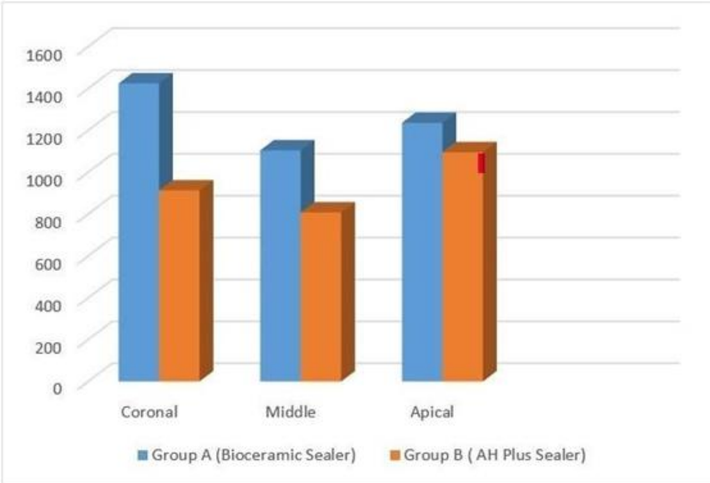

Table 2: Comparison of the depth of penetration (in micrometers) at the Coronal, Middle, and Apical sites in groups 1 and 2

Site	Mean difference	SD of difference	t-value	p-value
Coronal	511.62	167.69	3.05	0.007
Middle	292.65	62.80	4.72	0.0001
Apical	140.74	73.89	1.90	0.073

III. Discussion:

Flow allows the sealer to fill difficult-to-access areas, such as accessory canals, isthmus, narrow irregularities of the dentin, and voids present between the master and accessory cones[8]. In the present study, the depth of penetration of two resin-based root canal sealers (Endosequence Bioceramic sealer and AH Plus sealer) into the dentinal tubules was evaluated with the help of a Confocal laser scanning microscope.

Confocal laser scanning microscopy (CLSM) facilitates the acquisition of several optical images captured through the dentin's thickness. In this investigation, CLSM was chosen over the Scanning Electron Microscope (SEM) because, using fluorescent rhodamine-marked sealers, the former can detect sealer penetration along the canal circumference of each sample at magnifications as low as X50–X100[4]. A further benefit of employing CLSM in segments is the ability to visualize the sealer at many depths. Compared to SEM and traditional wide-field optical microscopy, it offers several advantages[9]. Rhodamine B has been utilized as an indication for identifying sealers within the dentinal tubules using CLSM[10]Provided that a minimal quantity of dye (under 0.2%) is incorporated, the physical qualities of the sealers remain unaffected[11].

In all the experimental groups on average, greater penetration was seen at the cervical third, followed by the middle third, and least in the apical third[12]. The fact that the diameter and quantity of dentinal tubules decrease apically in the root canal could be one explanation for this outcome. Moreover, the apical root canal wall may be contoured by tissue-like cementum, which will block the tubules, and some regions of the apical third are free of dentinal tubules. Another potential explanation for reduced sealer penetration in the apical segment could be improved smear layer removal in the coronal region[13]. It has been demonstrated that the presence of the smear layer prevents the sealers from entering the dentinal tubules[14]. Therefore, to reach near the apex and have the most impact on the full length of the canal wall, the smear layer was eliminated by sequentially using EDTA solution and then 5.25% NaOCl with the use of a 30 gauge side vented needle. To remove the impact of the leftover oxygen released from NaOCl on resin sealer polymerization, a final EDTA solution rinse was administered, followed by a distilled water rinse.

A sealer based on epoxy-bisphenol resin is called AH Plus. This root canal-bonding sealer has adamantine in it. Because of its availability, convenience of application, biocompatibility, and radiopacity, it has become more and more common among the several sealer kinds used today[15]

According to its manufacturer, Endosequence BC Sealer is a recently released calcium silicate-based BC sealer that is radiopaque, insoluble, and aluminum-free. It requires water to set and solidify[16-17]. It has a hydrophilic and biocompatible character, and as it sets, it expands to form a "self-seal."

In the current study, it was found that the depth of dentinal tubule penetration was higher in BC sealer than in AH plus sealer in all sections of the tooth. This difference in penetration of the root canal sealer into dentinal tubules can be attributed to the difference in particle size. In contrast to bigger calcium tungstate, Endosequence BC sealer penetrates deeper in tubules in the apical root area because of its extremely small particle size (less than 2 μm). AH Plus contains zirconium oxide particles that are 1.5 mm in size and have an average size of 8 mm. These particles may be difficult to penetrate the tiny tubules at the apical root area. Additionally, Endosequence BC's hydrophilic nature, low initial viscosity level, and low contact angle encourage the sealer to distribute easily over the dentinal wall and flow into all features of the canal's structure. Moreover, minimal or no shrinkage is exhibited by Endosequence BC in the setting phase. According to the literature, sealers containing calcium silicate were able to penetrate tubules as deeply as 2 mm because of the smaller particle size of BC Sealer and its high viscosity[18-19]. However, further in vivo studies should be conducted.

IV. Conclusion

It is possible to conclude that the physical and chemical properties of sealer cements affect the depth and uniformity of dentinal tubule penetration, within the constraints of the experimental design and test conditions. Endosequence Bioceramic sealer exhibited more consistent and deeper penetration than AH Plus sealer. The maximum penetration of both sealers was more in the coronal third followed by the middle third and least in the apical third.

References

[1] Schilder H. Vertical Compaction Of Warm Gutta-Percha. In: Gerstein H,Editor. Techniques In Clinical Endodontics. WB Saunders; Philadelphia, PA: 1983.Pp. 76–98.

[2] Shin JH, Lee DY, Lee SH. "Comparison Of Antimicrobial Activity Of Traditional And New Developed Root Sealers Against Pathogens Related Root Canal," Journal Of Dental Sciences 2018; 13(1): 54–59.

[3] Drukteinis S, Peciuliene V, Maneliene R, Bendinskaite R. In Vitro Study Of Microbial Leakage In Roots Filled With Endorez Sealer/Endorez Points And AH Plus Sealer/Conventional Gutta-Percha Points. Stomatologija 2009;11 (1):21-5.

[4] L. Pierce Anthony, Louis I. Grossman, And A Brief History Of Root-Canal Therapy In The United States,The Journal Of The American Dental Association 1945; 32(1): 43–50.

[5] Palanivelu CR, Ravi V, Sivakumar AA, Sivakumar JS, Prasad AS, Arthanari KK, "An In Vitro Comparative Evaluation Of Distribution Of Three Different Sealers By Singleconeobturation Technique," Journal Of Pharmacy And Bioallied Sciences 2019; 11 (2): 438–441.

[6] Gutmann JL. Adaptation Of Injected Thermoplasticized Gutta-Percha In The Absence Of The Dentinal Smear Layer. International Endodontic Journal. 1993;26(1):87–92.

[7] Gençoğlu N, Samani S, Günday M. Dentinal Wall Adaptation Of Thermoplasticized Gutta-Percha In The Absence Or Presence Of Smear Layer: A Scanning Electron Microscopic Study. Journal Of Endodontics. 1993;19(11):558–62.

[8] Candeiro GT, Correia FC, Duarte MA, Ribeiro-Siqueira DC, Gavini G, "Evaluation Of Radiopacity, Ph, Release Of Calcium Ions, And Flow Of A Bioceramic Root Canal Sealer," Journal Of Endodontics 2012; 38(6): 842–845.

[9] Tedesco M, Chain MC, Bortoluzzi EA, Da Fonseca Roberti Garcia L, Alves AMH, Teixeira CS. Comparison Of Two Observational Methods, Scanning Electron And Confocal Laser Scanning Microscopies, In The Adhesive Interface Analysis Of Endodontic Sealers To Root Dentine. Clin Oral Investig. 2018 Jul;22(6):2353-2361.

[10] Al-Haddad A, Abu Kasim NH, Cheab Aziz ZA, Interfacial Adaptation And Thickness Of Bioceramic-Based Root Canal Sealers. Dent Mater J 2015;34(4):516-21

[11] Thota MM, Sudha K, Malini DL, Madhavi SB Effect Of Different Irrigating Solutions On Depth Of Penetration Of Sealer Into Dentinal Tubules: A Confocal Microscopic Study. Contempclin Dent 2017 ;8(3):391-394.

[12] Kim Y, Kim BS, Kim YM, Lee D, Kim SY .Penetration Ability Of Calcium Silicate Root Canal Sealers Into Dentinal Tubules Compared To Conventional Resin-Based Sealer: A Confocal Laser Scanning Microscopy Study. Materials (Basel). 2019; 12(3):531

[13] El Hachem R, Khalil I, Le Brun G, Pellen F, Le Jeune B, Daou M, El Osta N, Naaman A, Abboud M. Dentinal Tubule Penetration Of AH Plus, BC Sealer And A Novel Tricalcium Silicate Sealer: A Confocal Laser Scanning Microscopy Study. Clin Oral Investig. 2019 Apr;23(4):1871-1876.

[14] Kokkas AB, Boutsioukis AC, Vassiliadis LP, Stavrianos CK. The Influence Of The Smear Layer On Dentinal Tubule Penetration Depth By Three Different Root Canal Sealers: An In Vitro Study. J Endod 2004;30(2):100-2

[15] Zhang W, Li Z, Peng B. Ex Vivo Cytotoxicity Of A New Calcium Silicate– Based Canal Filling Material. Intendod J 2010; 43(9):769-74.

[16] Ken K. A Review Of Bioceramic Technology In Endodontics. Roots 2012;4:6-12.

[17] Ersahan S, Aydin C. Dislocation Resistance Of Iroot SP, A Calcium Silicate–Based Sealer, From Radicular Dentine. J Endod 2010;36(12):2000-2.

[18] Sigadam A, Kalyansatish R, Sajjan GS, Madhuvarma K, Sita Ram Kumar M, Praveen D. Comparative Evaluation Of Sealer Penetration Depth Into Radicular Dentinal Tubules Using Confocal Scanning Microscope: An In Vitro Study. Int J Dent Mater 2020;2(3): 69-74

[19] Asawaworarit W, Pinyosopon T, Kijsamanmith K. Comparison Of Apical Sealing Ability Of Bioceramic Sealer And Epoxy Resin-Based Sealer Using The Fluid Filtration Technique And Scanning Electron Microscopy, Journal Of Dental Sciences, 2020; 15(2):186-192.