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Original Article

Comparative Assessment of Push-Out Bond Strength of Two Different Root Canal Sealers to Root Dentin: An *In vitro* Study

Shweta Chaubey[1], V Singh Sarita[2], S Mandlik Jyoti[3], N Gujarathi Nirmitee[1], Prishita Sharma[4]

[1]3rd Year Post Graduate Student, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India, [2]Associate Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India, [3]Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India, [4]2nd Year Post Graduate Student, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Pune, Maharashtra, India

Abstract

Introduction: Sealers are an important component for root canal obturation. They bind the gutta-percha to the root canal wall. As a binder, the most important property of the sealer is to have high bond strength. This study will evaluate the bond strength of two experimental sealer and will help to choose the one with high bond strength for successful root canal treatment.

Aim: The aim of this study is to do a comparative analysis of the push-out bond strength of two different root canal sealers to root dentin.

Materials and Methods: Twenty human permanent anterior teeth with one root and one canal were selected for this study. The teeth were decoronated and roots were biomechanically prepared with rotary ProTaper system, and obturated using two types of sealers: AH plus (Group 1, $n = 10$) and Sure-Seal root canal sealer (Group 2, $n = 10$), along with gutta-percha. The specimens were then divided into three parts (coronal, middle, and apical) by sectioning them horizontally using a diamond disk and a middle third of each section of 1 mm thickness was obtained from each sample and was subjected to the universal push-out test. The values were statistically analyzed using one-way analysis of variance and *t*-test.

Results: AH plus sealer showed a higher push-out bond strength than Sure-Seal root canal sealer that was statistically significant ($P < 0.001$). The push-out bond strength was higher in the apical and middle segment when compared to the coronal segment for both groups.

Conclusion: It was concluded that AH plus sealer has better bond strength to root canal dentin and helps in reducing endodontic failure.

Key words: AH plus, Push-out bond strength, Sure-Seal root

INTRODUCTION

The current century has run over numerous up to date headways in endodontics, such as in materials and techniques. Nonetheless, the significant objective of non-surgical endodontic treatment stays the same, that is, there should be comprehensive biomechanical preparation and complete disinfection of the root canal system to achieve a successful three-dimensional hermetic seal.[1] The life span of a root canal treated tooth is extraordinarily improved once complete debridement that eliminates the pathogenic organism is achieved. A three-dimensional seal of the root canal space and a good post-obturation restoration ensures prevention of further recontamination from the oral environment, if broken which may lead to failure of the root canal treated tooth.[2] The physical properties of the sealer that is vital in fulfilling this objective, include appropriate adaptation and bond of filling material to the wall of the root canal. Since gutta-percha does not directly adhere to the dentinal surface so an adequate and long-lasting bond must be produced by the sealer. It is

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Corresponding Author: Dr. Shweta, SG-8 1502, Saya Gold Avenue, Shipra Suncity, Indirapuram, Ghaziabad, Uttar Pradesh - 201 014, India.

also suggested that, if the sealer bonds to the root canal walls, it will limit the movement of the filling due to the presence of chemical bonding which will further improve the push-out bond strength of the sealer to the dentinal walls of the root canal.[3]

AH plus sealer (Dentsply DeTrey, Konstanz, Germany) is measured as a benchmark material for all root canal sealers, as it is been successfully used for many years and also due to its advantages with good adaptation and bond strength.[4] An epoxy resin-based sealer by composition that it is supplied as a two pastes system consisting of: paste A (bisphenol-A epoxy resin, bisphenol-F epoxy resin, calcium tungstate, zirconium oxide, silica and iron oxide pigments) and paste B (dibenzyl diamine, tricyclodecane-diamine, amino adamantane, calcium tungstate, zirconium oxide, silica, and silicone oil). The advantageous properties of the AH plus sealer are that it is biocompatible and more radiopaque, has a shorter setting time (approximately 8 h), and decrease solubility, low shrinkage, and higher dimensional stability. The research has, additionally, proven that it has good flow characteristics and it is able to penetrate up to a considerable depth into the dentinal tubules. Sure-Seal (Sure Dent Corp, Gyeonggi-do, Korea) is a hydrophilic bioceramic sealer containing calcium silicate material. It is mainly composed of calcium silicate, calcium sodium phosposilicate, zirconium oxide, and thickening agent and is available as premixed hydrophilic injectable paste having excellent flowability and is dimensionally stable with high antibacterial properties.[5]

Bond strength of endodontic sealers to dentin surface is of important significance since it reduces the chances of debonding of filling from the dentinal surface during an operative procedure or while mastication ensuring that the sealing is perfectly maintained.[6] The strength of the bond between the filling material and the root canal wall has been assessed frequently. It has been suggested that for evaluation of bonding strength the push-out test holds more weightage than the conventional shear test, because in push-out test, fracture takes place parallel to dentin bonding interface making it a true shear test.[7] This study aims to evaluate the push-out bond strength of AH plus and Sure-Seal root canal sealers to root canal dentin using the universal testing machine.

MATERIALS AND METHODS

Twenty permanent maxillary incisors that were periodontally compromised and thus extracted were selected. The root surfaces were thoroughly cleaned and teeth were subjected to surface disinfection by completely immersing in 2.5% sodium hypochlorite (Prime Dental, India) for 4 h, after which they were stored in distilled water till further use. A diamond disk was used to cut the crown of each sample at the cementoenamel junction. The roots were standardized at 13 mm length. The endodontic access cavity was prepared and a working length 1mm short of the apex, was established using a 15 K file (Mani Inc. Japan). Coronal preflaring was done for all roots using Gates Glidden Drills #2 and #3 in each canal. Biomechanical preparation was done using ProTaper rotary instruments (Dentsply), till #F2 size of ProTaper rotary system for all teeth. Disinfection and debridement of the canal were achieved using copious amounts of irrigant such as 17% aqueous Ethylenediaminetetraacetic acid (EDTA) (Prevest Dentsply) and 5 ml of 2.5% sodium hypochlorite, along with saline irrigant which were used during instrumentation. Final irrigation was completed using 5 ml of aqueous 17% EDTA (Prevest Dentsply) for 1 min, followed by a copious amount of saline (Nirlife NIRMA LIMITED). Each sample was dried with paper points (Dentsply-Tulsa Dental, Tulsa, OK). The sample teeth were divided into two experimental groups (10 each) according to the sealer used for obturation:

- Group 1 – Resin-based sealer [AH plus sealer]
- Group 2 – Bioceramic sealer [Sure Seal Root].

The samples of each group were obturated with the allocated experimental sealer using 0.6, #25 gutta-percha point (Dentsply-Tulsa Dental, Tulsa, OK) single cone obturation technique. Post-obturation, the samples were stored in a moist environment at 37°C for 1 week. Then, each sample was divided into three parts by sectioning them horizontally using a diamond disk and a middle 3rd section of 1 mm thickness was obtained from each sample. One section of 1 mm from the middle of each third of the root was obtained for evaluation. Thus, we obtained 30 sections in each group. All samples were evaluated for assessment of their push-out bond strength, using a universal testing machine (UTM; Instron). The plunger tip of the universal testing machine end had a thickness of 0.5 mm diameter. A vertical load was applied at the dentin-sealer interface in an apical to the coronal direction at 0.5 mm/min rate. The maximum load applied to the material was recorded in Newton at the time of dislodgement by the computer. Bond strength was evaluated using the following formula:

$$\text{Mpa} = N/2\pi rh$$

(Mpa: Bond Strength, N: The maximum load for each specimen, r: Root canal radius in millimeters, h: Thickness of root dentin in millimeters, π: 3.14).

Statistical analysis

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean ± SD. The level of significance was fixed at $P = 0.05$ and any value ≤0.05 was considered to be statistically significant. Student *t*-tests (two tailed, unpaired) were used to find the significance of the study parameters on continuous scale between two groups. Analysis of variance was used to find the significance of the study parameters between the groups (intergroup analysis).

RESULTS

Table 1 shows the comparative push-out bond strength for Group1 and Group 2. Using the unpaired *t*-test, it was observed that there was a statistically significant difference in the push-out bond strength for the middle ($P = 0.004$) and apical ($P < 0.001$) segments, whereas, there was no statistically significant difference seen for the coronal segment ($P = 0.098$) in both the groups. Group 1 (Resin-based sealer) shows a higher push-out bond strength than Group 2 (Bioceramic sealer). It was also observed that push-out bond strength was higher in the middle (Group 1 = 3.14) (Group 2 = 1.73) and apical segments (Group 1 = 4.98) (Group 2 = 2.32) in comparison to the coronal segment in both groups. (Group 1 = 1.98) (Group 2 = 1.05).

DISCUSSION

The prerequisite for a well obturated tooth is the complete adhesion of the sealant to the root canal dentinal wall and gutta-percha ensuring a hermetic seal.[8] Adhesion inherently plays an important role in establishing a three-dimensional seal which, in turn, affects the root strength. Comprehensive adhesion eliminates gaps between the filling material and the dentin wall, thus inhibiting fluid penetration and secondary bacterial contamination.[9] The core material and sealant must form a uniform chemical substance that adheres to the wall of the root canal to minimize leakage.[10] Gutta-percha, due to its following properties such as biocompatibility, chemical stability, radiopacity, and its ease of manipulation has been the material of choice for obturation. The bonding inability of gutta-percha puts it at a disadvantage when compared to those obturating materials that now bond to the root dentin.[2] A varied number of endodontic sealers have been used with gutta-percha to bond it to root dentin. AH plus is an epoxy biphenyl resin-based sealer that also contains adamantine which helps in mechanical adhesion to the root dentin.[11] Sure-Seal (Sure Dent Corp., Gyeonggi-do, Korea) is a premixed, injectable bioceramic sealer containing calcium silicate material with osteogenic and antibacterial properties (pH = 12) and is hydrophilic in nature.[10,12] It exhibits excellent physical properties (does not shrink on setting) and has good dentinal bond strength. Sealer-dentin adhesion is necessary under dynamic conditions to prevent sealer dislodgement under mechanical stresses caused by the operative procedure, tooth flexure, and post space preparation.[13] Bond strength can be measured using various tests such as push-out bond test, pull-out bond test, shear bond strength test, and micro-tensile bond strength test. Push-out bond strength test has the advantage of evaluating the bond strength at several root levels.[14] The force application was in an apicocoronal direction to avoid interference brought about as a result of canal taper.[6] A study conducted by Gade *et al*. compared the root-filled teeth using Endosequence BC, AH Plus, and Endomethasone N sealers on the basis of their bond strength and the result of the study showed that the bond strength of Endosequence BC sealer was lower than the AH plus root canal sealer.[15] The performance of resin-based sealer was better than the bioceramic-based sealer in the present study. This can be explained by the covalent bonds formed between the amino groups of the dentinal collagen and the epoxy resin of AH plus which resulted in a stronger link to dentin as compared to the interaction of calcium silicate of Sure-Seal root to dentin.[16] In this study, both the groups exhibited the lowest push-out bond strength in the coronal third and a highest strength in apical third followed by middle third. Mannocci *et al*. conducted a similar study, where they concluded that the high bond strength value was attributed due to the presence of low dentin tubule density within the apical dentin area.[17] The results are also in accordance with the study of Mishra *et al*.[18] This being an *in vitro* study, the bond strength of sealers which can be affected by a multitude of factors of the oral environment such as oral fluids, tissue fluids, or periapical fluids has not been accounted. Hence, further investigations are warranted to validate an ideal sealer to be used during obturation.

Table 1: Comparative evaluation of the push out bond strength at different levels using unpaired *t*-test between AH plus and sure seal root sealers

Sample Segment	Group	*n*	Mean value	Standard Deviation	*t*-value	*P*-value
Coronal	Group 1	10	1.9840	1.44572	1.745	0.098
	Group 2	10	1.0530	0.87040		
Middle	Group 1	10	3.1430	0.64579	3.353	0.004*
	Group 2	10	1.7350	1.16008		
Apical	Group 1	10	4.9890	0.74395	4.957	<0.001**
	Group 2	10	2.3260	1.52710		

$P<0.05$ – Significant*, $P<0.001$ – Highly significant**

CONCLUSION

The resin-based sealer [AH plus] demonstrates a higher bond strength to root dentin than the bioceramic sealer [Sure Seal Root]. Furthermore, for both groups, apical third segment showed a higher push-out bond strength to root dentin when compared to the middle and coronal third segment of root dentin.

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