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To Determine The Push Out Bond Strength of Four Different Root Canal Sealers- An In Vitro Study.

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Abstract

Introduction: The function of a root canal filling is to obturate the canal and eliminate all portals of entry between the periodontium and the root canal. The better the seal, the better the prognosis of the tooth. Achieving the ideal seal, however, is as complex as the anatomy of the root canal system itself.

Aim: To determine and compare the push out bond strength of AH plus, zinc oxide eugenol, Sealapex and RC Seal root canal sealers: an in vitro study.

Methodology: 60 extracted single rooted teeth will be selected for the study. Each tooth will be sectioned at the cemento-enamel junction.60 roots will be randomly divided into four groups according to the obturation systems of 15 teeth each.

Group 1: AH PLUS

Group 2: zinc oxide eugenol

Group 3: Sealapex

Group 4: RC SEAL

The roots will be vertically positioned and centered in cold cured clear acrylic resin blocks. The samples will be coronally restored and stored at 95% relative humidity and 37°C for 24 h. Each root will be horizontally sectioned into 2 mm thick slices. The filling material will be loaded with a 1-mm diameter cylindrical stainless steel plunger. Loading will be performed on a universal testing machine at a speed of 0.5 mm/ min until deboning occurred. The bond strength value in megapascals (MPa) will be computed.

Statistical analysis: Mean comparison in between the multiple groups was done using one way Analysis of Variance test (ANOVA) for mean difference in between the four groups. Pairwise comparison was done using Post Hoc multiple comparison (Tukey HSD) test.

Results: It implies that, push out bond strength of (Gutta percha + Sealapex = Gutta percha + ZOE) < (Gutta percha + ZOE = Gutta percha + RC seal) < (Gutta percha + RC seal = Gutta percha + AH plus).

Conclusion: The results of present study suggest that Zinc Oxide Eugenol and Sealapex have less push out bond strength compared to AH Plus and RC Seal.

Keywords: irrigants, root canal, sealers bond strength.

Introduction

Accomplishment of successful root canal treatment is attributed to various essential factors such as proper instrumentation, biomechanical preparation, irrigation, obturation, and ultimately post-endodontic restoration. The aim of root canal treatment is to get rid of the microbial entity in root canal thereby prevent any future predilection of re-infection. In order to achieve this, proper seal is required to diminish any chance of proliferation of bacteria and future occurrence of any pathology. Sealer along with solid obturation material acts synergistically to create three dimensional hermetic seal.[1]

A great variety of endodontic sealers are available commercially. They are divided into groups according to their chemical composition. They are based on zinc oxide and eugenol, epoxy resin and calcium hydroxide.[2] AH Plus consists of a paste-paste system, delivered in two tubes of epoxide paste and amine paste in a new double barrel syringe. Epoxide paste contains Diepoxide, Calcium tungstate, Zirconium oxide and Aerosil Pigment. Amine paste contains 1-adamantane amine, N,N'-dibenzyl-5oxa-nonandiamine 1,9, TCD-Diamine, Calcium tungstate, Zirconium oxide and Aerosil Silicone oil. AH Plus has gained popularity due to its radiopacity, biocompatibility, ease of use and availability. AH Plus is known to be an epoxy-bis-phenol resin based sealer that also contains adamantine and bonds to root canal.[3]

The most commonly used sealers in root canal treatment are Zinc oxide eugenol (ZOE)-based sealers. The powder of the sealer contains zinc oxide (ZnO), which combines with a liquid, generally eugenol and has been used for its antibacterial properties.

Sealapex is a noneugenol, polymeric calcium hydroxide root canal sealant. Sealapex is calcium- based sealer which is also composed of two pastes: a catalyzer (isobutyl salicylate resin, silicon dioxide, bismuth trioxide, titanium dioxide pigment) and a base (N-ethyl toluene sulphonamide resin, silicon dioxide, zinc oxide and calcium oxide).[4] This formulation produces rapid healing and hard tissue formation.

R C Seal is an epoxy root canal sealant material offered in powder and liquid form. Epoxy root canal sealant has been used in dentistry since many years now, with outstanding performance. Epoxy root canal sealant is virtually free of formaldehyde and none of the components contain “free formaldehyde”.

Methodology

Preparation of the teeth

60 extracted single canal human teeth were selected for the study. Only those teeth with a fully formed apex were selected, whereas roots with resorption defects, fractures or open apices were excluded. The samples were decoronated at cemento-enamel junction with a low speed double faced diamond disk.

For root canal preparation, the working length of each root canal was established using K-file size 10, letting the tip of the instrument to be just visible through the apical foramen under 10 X magnification and then the instrument was withdrawn. The working length was determined by subtracting 1 mm from this measurement. Endodontic treatment was performed using Hand ProTaper instruments. Canals were enlarged up to file size F3 till the working length. During instrumentation all canals were irrigated with 2.5 ml of 5% NaOCl. The final rinse was performed using 3 ml of 5% NaOCl and 17% EDTA was kept in canal for 1 minute followed by 3 ml of normal saline. Preparation was deemed complete when the irrigating solution appeared clear of debris. The root canals were dried with #30 absorbent points. To confirm drying of the canal, five consecutive #30 absorbent points were placed in the canal for five seconds. The teeth were randomly divided into four groups, each containing 15 specimens (n= 15). Specimens were taken forward for single cone obturation.

Grouping

Group 1: AH Plus sealer- available as a two paste system. A gutta percha cone of F3 size was used for the obturation of the canal and the excess was sheared off.

Group 2: Zinc oxide eugenol- available as a powder base and liquid catalyst. A gutta percha cone of F3 size was used for the obturation of the canal and the excess was sheared off.

Group 3: Sealapex sealer- available as a two paste system. A gutta percha cone of F3 size was used for the obturation of the canal and the excess was sheared off.

Group 4: RC seal sealer- available in powder and liquid form. A gutta percha cone of F3 size was used for the obturation of the canal and the excess was sheared off.

Push out bond strength test

60 teeth were taken for push out bond strength evaluation. 15 teeth from each group were vertically positioned and centered in cold cure clear acrylic resin blocks. The samples were coronally restored with Tempfil-G and stored at 95% relative humidity and 37°C for 24 hours. The roots were sectioned at mid-root dentin to achieve a main cone diameter slightly greater than 1 mm and 2 mm ± 0.1 mm thickness using water-cooled hard tissue microtome. One section from each root specimen to give a final sample size of 15 per group were analysed to test the push out bond strength. (n=15).

At the same time the apical side of the disk was marked to ensure the plunger of the push-out test pushed from the apical to coronal direction, to avoid any interference owing to root canal taper (Figure 1). The bond strength measurement was done in the apico-coronal direction using the Universal Testing Machine with a plunger of 1 mm diameter at a cross-head speed of 0.5mm/min with a force of 1N until bond failure occurred . The force was measured in Newton (N). The bond strength measurement was converted to MPa by dividing the force in Newton by the area of bonded surface. The area of bonded surface is given by the formula $2\pi rh$. (π is a constant with an approximate value of 3.14, r is the internal diameter of the root canal and h is the height of the specimen.) (Figure 2).

Results:

Mean comparison in between the multiple groups was done using one way Analysis of Variance test (ANOVA) for mean difference in between the four groups. Pairwise comparison was done using Post Hoc multiple comparison (Tukey HSD) test.

Table 1 shows range of push out bond strength (MPa) in each group. The push out bond strength in Group 1 ranges from 1.93 -3.94 MPa and that in Group 2 ranges from 0.53-4.07 MPa. In Group 3, it ranges from 0.56-3.01 MPa while in Group 4; it was within 0.86-5.14 MPa.

Table 2 shows Mean push out bond strength (MPa) in Group 1 to be 3.1927 MPa, Group 2 had 2.0807 MPa, and in Group 3 mean push out bond strength was 1.2567 MPa. Mean strength in Group 4 was 2.9040 MPa.

Table 3 shows 95% Confidence interval of mean push out bond strength (MPa) in each group. 95% CI of bond strength in Group 1 was within 2.8573 to 3.5280 MPa, in Group 2, it was within 1.3913 to 2.7701 MPa. It was 0.8620 to 1.6513 MPa in Group 3 whereas it was within 2.2581 to 3.5499 MPa in Group 4.

Table 4 shows comparison of mean push out bond strength in between the four groups. It was found that statistically there was very highly significant ($p<0.001$) difference of mean push out bond strength in the four groups.

It implies that, push out bond strength of (Gutta percha + Sealapex = Gutta percha + ZOE) < (Gutta percha + ZOE = Gutta percha + RC seal) < (Gutta percha + RC seal = Gutta percha + AH plus).

Discussion

In this study, extracted single rooted human teeth were used to enhance the reliability of the investigation by duplicating the clinical situation. A straight rooted tooth with slight canal curvature was chosen because curved canal >20 degree would modify stress distribution.[5] All the selected teeth were having equal root lengths which were measured using digital Vernier caliper. The teeth samples were stored in normal saline solution for twenty-four hours. The root canal preparations that result in a round cross-section impart a more uniform stress distribution within the root during obturation, hence reducing fracture susceptibility.[6] Canal preparation is one of the vital step of root canal treatment and is directly related to subsequent disinfection and filling. The aim of root canal preparation is to form a continuously tapered shape with the smallest diameter at the apical foramen and the largest at the orifice to allow effective irrigation and filling.[7] During chemico-mechanical preparation, a layer of debris the smear layer is formed. Studies have shown that removal of the smear layer enhances the adhesion of sealers to the root canal wall. The smear layer adheres to the canal walls and occludes the dentinal tubules (smear plugs).[8] This negates the ability of medications to penetrate into deeper tissues, and prevents the filling material from optimally adhering to canal walls. Most authors consider the removal of the smear layer is important because it may be infected or it can prevent access to the dentinal tubules, which may contain bacteria and their by-products.[8,9]

Several studies have shown that the use of a combination of sodium hypochlorite and EDTA is particularly effective in the removal of organic and inorganic debris. Hence during shaping and cleaning of the root canal systems, irrigants like sodium hypochlorite and Ethylene diamine tetra acetic acid (EDTA) solutions were used alternatively in this study and final irrigation was done with saline.[10,11]

The current methods most frequently used in the canal obturation employ a semi-solid, solid or rigid cone cemented in the canal with the root canal cement used as a binding agent. The sealer is needed to:[8]

1. Fill in minor gaps and irregularities between the filling and the canal walls.
2. Act as a lubricant and aid in seating of the cones.
3. Fill in the patent accessory canals and multiple foramina.
4. Reinforce the root canal dentin.

In the current study four root canal sealers were compared by evaluating push out bond strength. The sealers included in the study were AH Plus, Sealapex, RC seal, and Zinc oxide eugenol sealer. The push-out bond strength test was one method to evaluate the effectiveness of root canal obturation material or technique. The other methods of testing include bacterial leakage, fluid filtration and dye penetration testing[12]. While every method of in vitro testing is supposed to replicate the clinical environment, the correlation between leakage studies and clinical success has been questioned. The push-out models have been used widely to evaluate dentin obturation interface, but its relevance has also been called into question.[13] There was also no evidence that any of these methods was the best for measuring clinical effectiveness of root canal obturation material or techniques. Each tooth was prepared so that tug-back was felt when placing the master cone. This demonstrates a tight fit that could cause an influence in push-out bond strength. Attempts were made to match the diameter of the plunger which was used in the push out testing compared to the diameter of the filling material to prevent the plunger touching the wall of the canal. All the slices were examined visually after push-out. If evidence was found that the canal wall was touched by the plunger it was discarded.

The result of study showed higher push out bond strength for AH Plus and RC seal which are epoxy resin based sealers. With the development of resin-based sealers, the strength of the bond has received greater attention and the possibility of creating a 'monoblock' between the sealer and core material which bonds to the canal walls has introduced the prospect of strengthening the root-filled tooth against fracture.[14, 15] The sealer group interacted with dentin mechanically by penetrating into open dentinal tubules and moreover the penetrating ability was enhanced by smear layer removal. Pretreatment of the dentin surface with EDTA caused a significant increase in bond strength for epoxy resin based sealer and zinc oxide eugenol based sealer.[16] AH Plus and RC seal had greater adhesion to root dentin, due to the fact that, epoxy resin-based sealers had better penetration into the micro-irregularities because of their creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin.[17] Epoxy resin-based sealers have the possibility of adhesion to dentin with lower rates of water solubility, are well tolerated by tissues, have low water absorption, and have a potential of forming monoblock.[18] This fact, allied to the cohesion among sealer molecules, increased the resistance to removal or displacement from dentin, which could be translated as greater adhesion. The higher bond strength obtained with the AH Plus, could be explained by its ability to react with exposed amino groups in collagen in order to form covalent bonds among the resin and the collagen. Root canal sealers being used worldwide are based more on resin chemistry than on essential oil catalysts. It seems reasonable to assume that plastics, resins and glues should be more adhesive to dentin and less resorbable than zinc oxide cements. So in one previous study AH-26 and AH-Plus were found to be better as compared to zinc oxide cement sealer and also showed better dentinal tubule penetration and better root canal dentin reinforcement.

In our study we found that zinc oxide eugenol sealer had less bond strength than AH Plus and RC seal sealers. Our results were supported by many other studies. Zinc oxide eugenol sealers, which were used as control, showed higher bond strength to gutta percha in comparison to dentin. This can be attributed to the setting reaction of zinc oxide eugenol mixtures which is a chelation reaction occurring with the zinc ion of the zinc oxide. Zinc oxide eugenol sealers show low bond strength to dentin and high bond strength to gutta percha because the eugenol in zinc oxide eugenol reacts with zinc oxide in the gutta percha to create a chelate bond, because the two materials have common ingredients and because eugenol in excess may soften gutta percha, increasing the sealer gutta-percha interface.[19] Wennberg et al[20] found failure of adhesion to dentin in zinc oxide based sealers and failure of adhesion to gutta-percha for epoxy resin based sealer.

Conclusion

Within the designated limitations of push out test all four sealers used in the study i. e. AH Plus, RC Seal, Zinc Oxide Eugenol and Sealapex have good bond strength. AH plus and RC Seal have more push out bond strength compared to Zinc Oxide eugenol and Sealapex, favouring higher quality of the root canal sealer, and increased clinical success.

The results of present study suggest that Zinc Oxide Eugenol and Sealapex have less push out bond strength compared to AH Plus and RC Seal, still they can be considered as a good option because of their properties and cost effectiveness.

References

1. Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. European Journal of General Dentistry. 2013 Sep 1;2(3):199.
2. Lucena-Martin C, Ferrer-Luque CM, González-Rodríguez MP, Robles-Gijón V, de Mondelo JN. A comparative study of apical leakage of Endomethasone, Top Seal, and Roeko Seal sealer cements. Journal of endodontics. 2002 Jun 1;28(6):423-6.
3. Garrido AD, Lia RC, França SC, Da Silva JF, Astolfi-Filho S, Sousa-Neto MD. Laboratory evaluation of the physicochemical properties of a new root canal sealer based on Copaifera multijuga oil-resin. International Endodontic Journal. 2010 Apr;43(4):283-91.
4. Chávez-Andrade GM, Kuga MC, Duarte MA, de Toledo Leonardo R, Keine KC, Sant'Anna-Junior A, Só MV. Evaluation of the physicochemical properties and push-out bond strength of MTA-based root canal cement. The journal of contemporary dental practice. 2013 Nov 1;14(6):1094.
5. Armstrong S, Geraldeli S, Maia R, Raposo LH, Soares CJ, Yamagawa J. Adhesion to tooth structure: a critical review of “micro” bond strength test methods. Dental Materials. 2010 Feb 1;26(2):e50-62.
6. Rundquist BD, Versluis A. How does canal taper affect root stresses?. International endodontic journal. 2006 Mar;39(3):226-37.
7. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am. 1974;18:269-96.
8. Johnson WT. Obturation of the cleaned and shaped root canal system. Pathways of the pulp. 2006:358-99.
9. Buck R, Eleazer PD, Staat RH. In vitro disinfection of dentinal tubules by various endodontics irrigants. J Endod. 1999;25(12):786-8.
10. Baumgartner JC, Mader CL. A scanning electron microscopic evaluation of four root canal irrigation regimens. Journal of Endodontics. 1987 Apr 1;13(4):147-57.
11. Grande NM, Plotino G, Falanga A, Pomponi M, Somma F. Interaction between EDTA and sodium hypochlorite: a nuclear magnetic resonance analysis. Journal of endodontics. 2006 May 1;32(5):460-4.
12. Wu MK, Van Der Sluis LWM, Wesselink PR. Comparison of mandibular premolars and canines with respect to their resistance to vertical root fracture. *J Dent*. 2004;32:265-268.
13. Oliver CM, Abbott PV et al, Correlation between clinical success and apical dye penetration.International Endodontic Journal 2001; 34 (8) :637-44

14. Thompson JI, Gregson PJ, Revell PA. Analysis of push-out test data based on interfacial fracture energy. Journal of Materials Science: Materials in Medicine. 1999 Dec 1;10(12):863-8
15. Schäfer E, Zandbiglari T, Schäfer J. Influence of resin-based adhesive root canal fillings on the resistance to fracture of endodontically treated roots: an in vitro preliminary study. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2007 Feb 1;103(2):274-9.
16. Figdor D. Apical periodontitis: a very prevalent problem. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics. 2002 Dec 1;94(6):651-2.
17. Ruddle CJ. Gauging the terminus: a novel method. Endodontic Practice. 2012.
18. Cohen S, Hargreaves KM, Berman LH. Cohen's pathways of the pulp. Mosby Elsivier. 2011:602-54
19. Lee KW, Williams MC, Camps JJ, Pashley DH. Adhesion of endodontic sealers to dentin and gutta-percha. Journal of endodontics. 2002 Oct 1;28(10):684-8.
20. Wennber A, NIOM DØ. Adhesion of root canal sealers to bovine dentine and gutta-percha. International Endodontic Journal. 1990 Jan;23(1):13-9.

Legends Tables and Figures

Table 1: Range of push out bond strength (MPa) in each group

Groups	Contents	N	Minimum	Maximum
Group 1	Gutta percha cone + AH PLUS sealer	15	1.93	3.94
Group 2	Gutta percha cone + zinc oxide eugenol sealer	15	0.53	4.07
Group 3	Gutta percha cone + Sealapex sealer	15	0.56	3.01
Group 4	Gutta percha cone + RC SEAL sealer	15	0.86	5.14

Table 2: Mean push out bond strength (MPa) of each group

Groups	Contents	N	Mean	Std. Deviation
Group 1	Gutta percha cone + AH PLUS sealer	15	3.1927	0.60559
Group 2	Gutta percha cone + zinc oxide eugenol sealer	15	2.0807	1.24491
Group 3	Gutta percha cone + Sealapex sealer	15	1.2567	0.71269
Group 4	Gutta percha cone + RC SEAL sealer	15	2.9040	1.16635

Table 3: 95% CI of mean push out bond strength in each group

Groups	Contents	N	95% Confidence Interval for Mean	
			Lower Bound	Upper Bound
Group 1	Gutta percha cone + AH PLUS sealer	15	2.8573	3.5280
Group 2	Gutta percha cone + zinc oxide eugenol sealer	15	1.3913	2.7701
Group 3	Gutta percha cone + Sealapex sealer	15	0.8620	1.6513
Group 4	Gutta percha cone + RC SEAL sealer	15	2.2581	3.5499

Table 4: Comparison of mean push out bond strength in between groups by ANOVA

	Sum of Squares	df	Mean Square	F	p value
Between Groups	34.269	3	11.423	12.073	<0.001
Within Groups	52.988	56	0.946		
Total	87.257	59			

Figure 1: The plunger pushed from apical to coronal direction

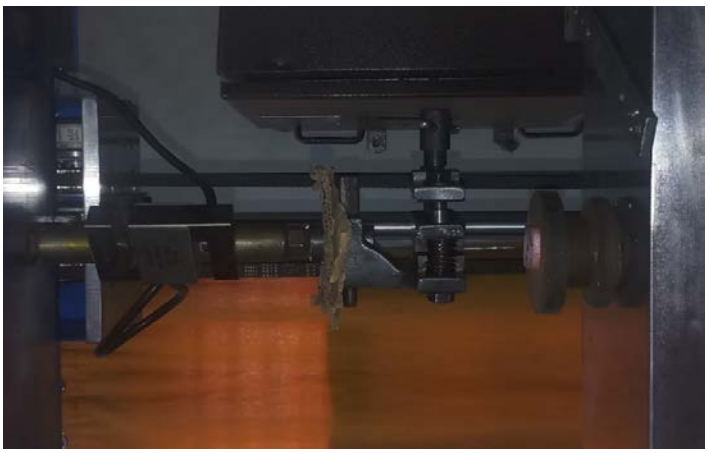

Figure 2: Debonded gutta percha cone after push out test