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Research Article

The Comparative Study of Push-out Bond Strength of Two Different Root Canal Sealers with Cold Lateral Condensation Obturation Technique - *Invitro* Study

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Abstract

Aim: To evaluate and compare the pushout bond strength of BioCeramic sealer and AH plus sealer using Gutta percha with cold lateral compaction technique.

Material and Methodology: Forty-five human extracted single rooted teeth Mandibular 1st premolar teeth with completely formed apices were selected, instrumentation were done by using Protaper Next rotary system using X1, X2 and X3. The teeth were divided into three groups based upon the sealer used Group 1: Bioceramic sealer (CeraFill RCSTM), Group 2: Epoxy resin-based sealer (AH Plus sealer), and Group 3: Obturated using Gutta percha only using cold lateral compaction technique and stored for 4 week. After obturation, each tooth was prepared for push-out bond strength test with root slices of 2mm thickness using universal testing machine.

Results: The highest bond strength was found in Group1 Bioceramic sealer (CeraFill RCSTM) ($P < 0.05$) compare to other groups. Statistical analysis is done by ANOVA, Student't' test.

Conclusion: The push-out bond strength of Bioceramic sealer was highest followed by resin based sealer and lowest bond strength was observed in Group 3

Keywords: Bioceramic Sealer; AH Plus sealer; Push-Out Bond Strength; Obturation Technique

Introduction

Success of root canal treatment depends on cleaning, shaping and disinfection of the root canal which is achieved by chemo mechanical preparation to eliminate bacteria and their by-products, and to prevent re-contamination of the root canal space [1].

As chemo-mechanical preparation of root canals couldn't achieve its primary goal regarding eradication of microorganisms responsible for endodontic diseases and as it is not able to establish a microorganism-free a root canal system despite continuous developments of root canal disinfection agents and technique, a corono-apical seal inside the root canal system is essential to prevent the proliferation of microorganisms that cause reinfection [2].

Current endodontic therapy utilizes combination of gutta percha cone and a sealer because of the complexity of root canal system, sealers need to be used to fill the irregularities and to penetrate into dentinal tubules to obtain a hermatic seal of the root canal system. The gutta percha cone blocks the apical foremen while the sealer cement is intended to seal around the gutta percha point to prevent leakage and fill the canal space. The success of root canal requires complete obturation of the root canal system and thus achieving a fluid tight seal. Different obturation techniques are used to achieve maximum adaptation of filling material with the root canal space. Cold lateral compaction obturation technique is most commonly used technique. Gutta percha has no adhesive qualities to dentin regardless of obturation techniques [3].

Root canal sealer play a major role in achieving fluid tight seal by filling the accessory and lateral canal, voids, space and irregularities between Gutta percha [3].

The choice of sealer is not only dependent on its ability to create a sound seal, but it must be well tolerated by the peri-radicular tissue and be relatively easy to manipulate, so that its optimum physical properties can be achieved[3].Adhesion to dentin lead to

greater strength of the restored tooth, more resistance to root canal fracture and clinical longevity of an endodontically treated tooth. A strong bond is essential between sealers and root dentin for maintaining the integrity of the sealer-dentin interface during tooth flexure.

AH Plus is a commonly used sealer which is an epoxy resin-based sealer having excellent sealing properties and considered as a gold standard against all new sealers.

Over the years advances in adhesive technology has led to development of new generation of the endodontic sealer capable of bonding to radicular dentin. Bio ceramic root canal sealers (CeraFill RCS™ PreVest DenPro the Future of dentistry INDIA) based on tricalcium silicate or containing calcium silicate formulations were recently introduced with a view to transferring the well-documented biocompatibility and bioactivity of di- and tricalcium silicate cements to root canal sealers [4]. It is a pre mixed and injectable cement paste.it is a hydrophilic insoluble, radio-opaque and aluminium free material based in a calcium silicate composition, which utilize the moisture naturally present in the dentinal tubule to initiate and complete its setting reaction [5]. It has a good adaptation to canal wall and form a chemical bond with the inorganic phase of dentine.

Bond strength of endodontic sealer to dentin is an important properties of filling material because it minimize the risk of filling detachment from dentin during restorative procedures or the masticatory functions, ensuring that sealing is maintained, consequently clinical success of endodontic treatment. The push out bond strength test is well known evaluation method used in several other similar studies with great reliability [7].

Materials and Methods

45 Freshly extracted permanent mandibular premolar extracted for orthodontic reason, and having straight root and single canal confirmed by radiograph were collected for the study. The teeth were stored in 1% sodium hypochlorite to eliminate organic debris. They were then removed, washed under tap water and stored in 10% Formalin solution for the disinfection of the teeth, till they were used for the purpose of the study.

Access cavities was made and canal is located. A size 10 K-file was inserted into the root canal until it is visible at the apical foramen. The working length was determined measurement and was confirmed by radiograph. Whenever there is resistance with 10 K file, Proglider were used.

The coronal enlargement was done by one flare rotary file. Then the canals were instrumented with Protaper Next files coated with Glyde chelating paste size X1, X2. After the use of every file, 5.25% sodium hypochlorite is used for irrigation.

Then final Shaping and finishing of canal was done with X3 file. The root canals were irrigated with a final sequence of 20ml of 40% citric acid for removal of the smear layer and debris, and finally canal was irrigated with saline.

The moisture in the canal was soaked by Endoaspirator tips and absorbent paper points. The master gutta-percha cones (20 no. 4%) were selected and made according to the apical size prepared. The roots were then randomly assigned into three groups (n = 15).

- **Group 1:** Bio Ceramic sealer (Cerafill RCS ™) attach with intracanal delivery tips and inserted into coronal one third and gently dispensed a small amount of sealer into the canal. Then by using a spreader canal walls are lightly coated. All the samples were obturated using cold lateral obturation technique with standardized gutta percha cones.
- **Group 2:** AH Plus (Dentsply, Maillefer, Ballaigues, Switzerland) sealer is manipulated according to the manufacturer's instructions and is coated to canal walls using spreader. Then all the samples were obturated using cold lateral obturation technique with standardized gutta percha cones.
- **Group 3:** Control Group -Root Canal was obturated using Gutta percha without sealer in cold lateral compaction technique.

The gutta-percha was sealed at orifice using heated pluggers. The coronal orifices were sealed with glass ionomer cement (Fuji, GC, and Tokyo, Japan) and varnish application was done. Then all teeth were kept moist by keeping them in a gauze moistened with sterile saline solution and were stored in an incubator at 37 °C and 100% humidity for 4 week to allow complete setting of the root canal sealers.

All the roots are vertically positioned and embedded in acrylic resin. Sectioned horizontally using a circular diamond disk at low speed with constant fresh cooling water. Three sections of 2 mm thickness were obtained at 3, 7 and 11 mm from the apex to the coronal surface.

Diameter of the canal in each aspect was calculated using a digital caliper.

Push-out bond strength test

Each specimen was carefully positioned on a custom made loading fixture, and push-out test was performed using a universal testing machine. Data were recorded using computer software.

A load was applied at a crosshead speed of 0.5 mm/min by plungers of 0.6mm in size respectively in an apical-coronal direction due to the convergence of the root canal sections. The selected diameter of the plunger was positioned so that it only contacts the filling to displace it downward.

The push-out bond strength was calculated using the following formula

Push-out bond strength (MPa) =maximum load (N)/adhesion area (mm^2)

The adhesion area was calculated by using the following formula, Area = $2\pi (r_1 + r_2) \times h$

Where $\pi = 3.14$, r_1 is the coronal radius, r_2 is the apical radius, and h is the thickness of the slice.

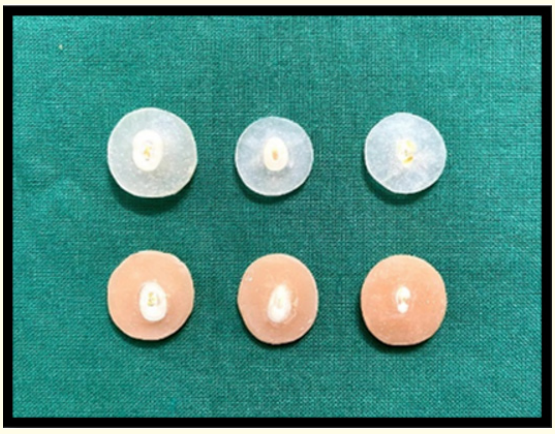

Figure 1: Root slice 2mm in thickness mounted on acrylic.

Figure 2: Push-out bond strength evaluation of slice mounted on lower segment of universal testing machine.

Result

		Sum of Squares	df	Mean Square	F	Sig.
Coronal	Between Groups	3.857	2	1.929	20.864	<.001
	Within Groups	3.883	42	.092		
	Total	7.740	44			
Middle	Between Groups	10.279	2	5.140	28.874	<.001
	Within Groups	7.476	42	.178		
	Total	17.755	44			
Apical	Between Groups	83.937	2	41.968	105.759	<.001
	Within Groups	16.667	42	.397		
	Total	100.604	44			

Table 1: One-way analysis of variance (ANOVA) for push-out bond strength test.

Site	Groups	Pairwise comparison	p value	Significance
Coronal	AH plus	Control	.004	Significant
		Bio ceramic sealer	.013	Significant
	BC sealer	Control	<.001	Significant
		AH plus	.013	Significant
Middle	AH plus	Control	<.001	Significant
		Bio ceramic sealer	.032	Significant
	BC sealer	Control	<.001	Significant
		AH plus	.032	Significant
Apical	AH plus	Control	<.001	Significant
		Bio ceramic sealer	.002	Significant
	BC sealer	Control	<.001	Significant
		AH plus	.002	

Table 2: One way ANOVA test of pushout bond strength and pairwise comparisons (Bonferroni correction) between different groups.

		Levene's Test for Equality of Variances		T- test for Equality of means				Significance
		F	Sig.	Df	P value	95% Confidence Interval of the Difference		
						Lower	Upper	
Coronal	Equal variances assumed	.252	.619	28	0.019	-.61005	-.06062	Significant
	Equal variances not assumed			24.181		-.61201	-.05865	
Middle	Equal variances assumed	.005	.947	28	0.037	-.796892	-.026308	Significant
	Equal variances not assumed			27.748		-.797050	-.026150	
Apical	Equal variances assumed	.003	.953	28	0.005	-1.43345	-.28789	Significant
	Equal variances assumed			27.990		-1.43346	-.28788	

Table 3: Student's' test between Group 1 and Group 2.

The table 3 shows the intergroup comparison with Group 1 (BC sealer) and Group 2 (AH plus). The pushout bond strength at cervical, middle and apical third of the root canal among the groups are statistically significant (p value = 0.019, 0.037 and 0.005 respectively).

The table 4 shows the intergroup comparison with Group 1 (BC sealer) and Group 3 (Control). The pushout bond strength at cervical, middle and apical third of the root canal among the groups are statistically significant (p value = 0.000, 0.000 and 0.000 respectively).

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	Df	P value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		Significance
								Lower	Upper	
Coronal	Equal variances assumed	11.58	.002	28	.000	.71667	.07695	.55904	.87430	Significant
	Equal variances not assumed			16.57		.71667	.07695	.55399	.87934	
Middle	Equal variances assumed	17.22	.000	28	.000	1.1549	.13999	.86817	1.4416	Significant
	Equal variances not assumed			14.32		1.1549	.13999	.86817	1.4545	
Apical	Equal variances assumed	12.98	.001	28	.000	3.2300	.20252	2.8151	3.6448	Significant
	Equal variances not assumed			14.82		3.2300	.20252	2.7979	3.6620	

Table 4: Student't' test between Group 1 and Group 3.

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	Df	P value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		Significance
								Lower	Upper	
Coronal	Equal variances assumed	5.445	.027	28	.002	.38133	.11432	.14716	.61551	Significant
	Equal variances not assumed			15.11		.38133	.11432	.13783	.62484	
Middle	Equal variances assumed	27.35	.000	28	.000	.743333	.127376	.48241	1.0042	Significant
	Equal variances not assumed			14.38		.743333	.127376	.47082	1.0158	
Apical	Equal variances assumed	15.73	.000	28	.000	2.36933	.19883	1.9620	2.7766	Significant
	Equal variances not assumed			14.85		2.36933	.19883	1.9452	2.7934	

Table 5: Student't' test between Group 2 and Group 3.

The table 5 shows the intergroup comparison with Group 2 (AH plus) and Group 3 (Control). The pushout bond strength at cervical, middle and apical third of the root canal among the groups are statistically significant (p value = 0.002, 0.000 and 0.000 respectively).

Discussion

The primary goal of endodontics is restoration of the treated tooth to its proper form and function in the masticatory apparatus, in a healthy state. Endodontic therapy consists of three basic phases namely: Diagnostic, Preparatory and Obturation phase. Several studies have demonstrated the presence of microorganisms, including bacteria, in the dentinal tubules and cementum following endodontic treatment. A root canal sealer with high antimicrobial activity is an important tool for reducing the growth of microbes and preventing them from re-entering the root canal system [10] because of the lack of adhesion property in gutta percha, sealer was introduced to overcome this limitation [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: Fill in minor gaps and irregularities between the filling and the canal walls, It acts as a lubricant and aids in seating of the cones, it fills in the patent accessory canals and multiple foramina, to reinforce the root canal dentin.

Almqayyad tamer nafiz recommended the use of adhesive sealers in the root canal system to reinforce the root filled teeth. Good adhesion to root canal dentin within the root canal is one of the ideal properties of sealer cements which potentially influence both micro leakage and root strength [12].

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 the mineral oxide cements. So in one previous study AH-Plus sealer was found better as compared to zinc oxide cement sealer and also showed better dentinal tubule penetration and better root canal dentin reinforcement [13].

A new formulation of AH Plus sealer. It has the same formulation as AH Plus. It has an innovative double-barrel delivery syringe, so no need for manual mixing before use, enables direct and precise placement into the canal or onto a traditional mixing pad. Thus assures a better mixture in the necessary 1:1 ratio and does not release formaldehyde upon setting. It is an epoxy bisphenol resin, more radiopaque and has a shorter setting time (approximately 8hours), lower solubility and better flow compared with AH-26 and also shows better fracture resistance as compared to other sealer. It exhibits a working time of approximately 4hours. It can be placed in the root canal without any dentin preparation or dentin adhesive and can be used with any obturating technique [25].

A sealer with epoxy resin penetrates better into the micro-irregularities, and as there is more cohesion between molecules, a greater mechanical interlock and better resistance to separation or removal occurs, thus producing increased adhesion.

Recently, a new bioceramic root canal sealer is introduced, which is commercially known as Cerafill RCS ™ BC sealer (PREVEST DenPro). It is a premixed and injectable endodontic sealer, because of its nanoparticle size it flow readily into canal irregularities and dentinal tubules. It is insoluble, hydrophilic, radiopaque and aluminium- free material based on a calcium silicate composition. Being a hydrophilic, it utilises the moisture present in the dentinal tubules to initiate and complete its setting reaction. Due to shrinkage free setting, it results in a gap-free interface between gutta-percha, sealer and dentin [14]. Manufacture claims the sealer to be highly biocompatible and is antibacterial because of its highly alkaline pH 11.16 during setting reaction. Hence AH-Plus, Cerafill RCS™ BC sealers were used in this study. All the teeth in experimental groups were obturated with the gutta percha core material and the respective sealer using the cold Lateral condensation technique. Radiographs of the root were then taken to confirm [2].

Thin root slice, 2mm ± 0.1mm in thickness was obtained and subjected to push-out test. Values obtained in newtons (N) were converted into megapascals (MPa) by dividing the load in newtons (N) by the interface bonded area as carried out in study done by H.A. Farag.

In recent years, obturating materials and sealers have been developed based on dentin adhesion technologies borrowed from restorative dentistry, in an attempt to seal the root canal system more effectively. Thus, in the present study, push-out bond strength evaluation were carried out to determine interfacial shear Bond strength of Bioceramic based sealer and AH plus Sealer.

In present study where pushout bond strength was checked in group I using bioceramic sealer the result obtained had higher bond strength in Apical >Middle>coronal, Apical region (3.91 ± 0.77MPa) followed by middle (2.57 ± 0.53MPa) and coronal region (1.94 ± 0.285MPa) in group II using AH plus sealer the result obtained had higher bond strength in Apical > Middle > coronal. Apical region (3.05 ± 0.75MPa) followed by middle (2.16 ± 0.489MPa) and coronal region (1.60 ± 0.434MPa).

Which was comparable to Caceres Carolina., *et al.* say that Bioceramics material show greater tubular penetration and better tubular adaptation in all region when comparated to AH Plus sealer [15].

Aly yousra., *et al.* founded in his study that push out bond strength of CeraSeal bioceramic sealer when comparated to AH Plus show significant higher push out bond strength in coronal region 21.14MPa followed by medial 16.23MPa and apical 15.72MPa [16] contrary to the results reported by H. M. Abada reported the higher bond strength of AH plus sealer in compare to other sealer which was significant at $p < 0.001$ highest seen at Apical (4.089 ± 1.759MPa) followed by coronal (3.957 ± 1.334MPa) and middle (3.733 ± 1.446MPa) [6].

According to Wai ying Yap the bond strength of bioceramic sealer increases with time. This result is similar to that of a study by Elbatouty., *et al,* where the push out bond strength of BC sealer was compared to AH plus and eugenol based sealer at 1week, 2week and 1 month. Their result showed an increasing trend of bond strength with time. The high bond strength of Bioceramic based sealer may be explained by its calcium silicate composition, which uses the moisture naturally present in dentinal tubules to initiate and complete the setting reaction so that shrinkage free setting occurs [19].

ANOVA test were performed Result that obtained is shown in table 1,2. According to result obtained there is significant difference between push-out bond strength between the groups. It can be seen that the calculated value of P is significant with p value of 0.001 ($P < 0.05$) which shows that all the three groups differ significantly as far as pushout bond strength is considered.

To further test that which groups shows significant difference between mean pushout bond strength data were further analyzed with Tukey post hoc test for multiple comparison. The level of significance was set at $P < 0.05$. There is highly significant difference between Group I (BC sealer) and Group II (AH Plus) (p value = 0.019, 0.037 and 0.005 respectively). Significant difference between Group I (BC sealer) and Group III (Control) (p value = 0.000, 0.000 and 0.000 respectively). Significant difference between Group II and Group III (p value = 0.002, 0.000 and 0.000 respectively). Thus, considering the results and within the limitation of present study, it can be concluded that Bioceramic based sealer exhibit increased bond strength to root dentin when compared to AH Plus sealer at all level coronal, middle, apical region.

Conclusion

Within the limitation of this *in vitro* study and under its conditions, the following were concluded

Push out bond strength values of each sealer were different and varied significantly in each area of root canal Coronal, Middle and Apical. Among the root canal sealers; Bioceramic based sealer (i.e., Cerafill RCS ™) showed higher push out bond strength than AH Plus root canal sealer.

Bibliography

1. HA Farag., *et al.* "Effect of different irrigating protocols on push out bond strength of Resilon/Epiphany obturation system". *Tanta Dental Journal* (2015): 1-8.
2. Bassem M Eid., *et al.* "Assessment of Two Root Canal Sealers Push-Out Bond Strength in Root Canals Obturated Using Two Different Obturation Techniques". *Egyptian Dental Journal* 65.1487 (2019): 1494.
3. Deepika Khandelwal., *et al.* "Recent Advances in Root Canal Sealers". *International Journal of Clinical Dentistry* 9.3 (2006).
4. David Donnermeyer., *et al.* "Retreatability of three calcium silicate-containing sealers and one epoxy resin-based root canal sealer with four different root canal instruments". *Clinical Oral Investigations* 22 (2018): 811-817.
5. APawar., *et al.* "Push-out bond strength of root fillings made with C-Point and BC sealer vs. gutta percha and AH Plus after the instrumentation of oval canals with the Self-Adjusting File vs. WaveOne". *Original Scientific* (2015).

6. HM Abada and AM Farag. "Push-out bond strength of different root canal obturation systems to root canal dentin". *Tanta Dental Journal* 12 (2015): 185-191.

7. Andari Putrianti and Munyati Usman. "Effects Of Cold Lateral Versus Warm Vertical Compaction Obturation on the Push-Out Bond Strength of Bioroot™, A Calcium Silicate-Based Sealer". *International Journal of Applied Pharmaceutics* (2020).

8. Eduardo Diogo Gurgel-Filho., *et al.* "Comparative evaluation of push-out bond strength of a MTA-based root canal sealer". *Brazilian Journal of Oral Sciences* 13.2 (2019): 114-117.

9. Mohammed S Khalil and Anas F Mahdee. "Intracanal Adaptation, Intratubular Penetration, and Push-Out Bond Strength of Different Root Canal Sealers: A Comparative *In vitro* Study". *Journal of Research in Medical and Dental Science* 9.1 (2021): 242-250.

10. Ricardo Shalina and Marissa Celine. "Comparison Of Three Bioceramic Sealers in Terms of Dentinal Sealing Ability In The Root Canal". *International Journal of Applied Pharmaceutics* 12.2 (2020).

11. Nafiz tamer almqayyad., *et al.* "Assessment of push out bond strength and interfacial adaptation of two new endodontics sealers, endosequuence BC and MTA fillapex to root canal dentine (An *in vitro* study)". *International Journal of Advanced Research* 6.3 (2018): 1043-1050.

12. Almqayyad Tamer Nafiz., *et al.* "Assessment of Push-Out Bond Strength And Interfacial Adaptation Of Two New Endodontic Sealers; Endosequence Bc And Mta Fillapex To Root Canal Dentine (An *In Vitro* Study)". International Journal of Advanced Research (2018): 1043-1050.

13. Bhat SS., *et al.* "Evaluation of resistance of teeth subjected to fracture after endodontic treatment using different root canal sealers: an *in vitro* study". *Journal of Indian Society of Pedodontics and Preventive Dentistry* 30 (2012): 305-309.

14. Shokouhinejad N., *et al.* "Push-out bond strength of gutta-percha with a new bioceramic sealer in the presence or absence of smear layer". *Australian Endodontic Journal* 39.3 (2013): 102-106.

15. Caceres., *et al.* "Dentinal Tubule penetration and adaptation of Bio-C Sealer and AH-Plus". *European Endodontic Journal* 6 (2021): 216-220.

16. Aly Y., *et al.* "Bond strength and marginal adaptation of a novel root-end filling material". *Bulletin of the National Research Centre* 44 (2020): 142.

17. Zhang W., *et al.* "Assessment of a new root canal sealer's apical sealing ability". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 107 (2009): e79-82.

18. Gaurav Jain., *et al.* "Influence of endodontic irrigants on the push-out bond strength of root canal sealers". *Journal of Dental Specialities* 7.1 (2019): 9-18.

19. Yap WY., *et al.* "An *in vitro* comparison of bond strength of different sealers/obturation systems to root dentin using the push-out test at 2 weeks and 3 months after obturation". *Medical Principles and Practice* 26 (2017): 464-469.

20. Gurgel-Fi lho ED., *et al.* "Comparative evaluation of push-out bond strength of a MTA-based root canal sealer". *Brazilian Journal of Oral Sciences* 13.2 (2014): 114-117.

21. Quintão C., *et al.* "Adhesion capacity of bioceramic and resin-based root canal sealer toroot dentin: An integrative review". *Revista Brasileira de Odontologia* 77 (2020): 1.

22. Schwartz RS. "Adhesive dentistry and endodontics. Part 2: bonding in the root canal system-the promise and the problems: a review". *Journal of Endodontics* 32.12 (2006): 1125-1134.