Original Research Paper

Volume - 14 | Issue - 09 | September - 2024 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Endodontics

COMPARATIVE EVALUATION OF DIFFERENT INTRACANAL MEDICAMENT ON THE PUSH OUT BOND STRENGTH OF CALCIUM SILICATE BASED SEALERS TO ROOT DENTIN: AN EX VIVO STUDY

Tanya Seth	Post Graduate, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India
Parul Bansal	Professor and Head, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India
Mohit Kumar	Associate Professor Department of Dentistry, Kalyan Singh Government Medical College, Bulandshahr, Uttar Pradesh, India.
Megna Bhatt	Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India
Nikita Sharma	Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India
Pulkit Arora	Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India

ABSTRACT **Aim:** "Present study aimed to comparatively evaluate the effect of different intracanal medicaments on the push-out bond strength of Ceraseal and Bio-C sealer. **Methodology:** "sixty single-rooted human mandibular premolars were endodontically prepared till size F3. Teeth were divided into 3 groups (n=20). Group 1 (n=20) no medicament control group, Group 2 (n=20) calcium hydroxide and Group 3 (n=20) double antibiotic paste. Each group was divided into two subgroups depending on the sealer used (n=10). Subgroup A, Ceraseal sealer (n=10), Subgroup B, Bio-C (n=10). After sectioning, the samples were tested for push-out bond strength." **Results:** "The Double Antibiotic Paste Group (DAP) showed a more pronounced statistical significant decrease in bond strength compared to the Calcium Hydroxide Group. Bio-C sealer outperformed Ceraseal sealer. Both sealers had their push-out bond strength lowered by intracanal medication which was statistical significant. There was a statistical significant difference in declination of push-out bond strength from the cervical to the middle and then the apical third." **Conclusion:** Calcium hydroxide as compared to DAP had a less detrimental impact on the push-out bond strength of sealers among the two medications utilized.

KEYWORDS : BIO-C sealer, Calcium Hydroxide, Calcium silicate sealer, Ceraseal sealer, DAP, Intracanal medicament, Push-out bond strength.

INTRODUCTION

Use of intracanal medicaments is a crucial step for the ideal disinfection for successful root canal treatment. Chemo mechanical preparation alone cannot eliminate the microorganisms that are surviving in the dentinal tubules. After canal instrumentation, an intracanal medicament is utilized to eradicate any leftover microorganisms.[1]

A most commonly used intracanal medicament, calcium hydroxide (CH) is effective against most endodontic infections. It is believed that the hydroxyl ions in calcium hydroxide are responsible for its high alkaline pH and its antimicrobial properties.[2] A number of medications have been suggested or utilized as Calcium hydroxide substitutes. Double Antibiotic Paste (DAP), which solely contains Ciprofloxacin and Metronidazole is suggested as a TAP substitute as an intracanal dressing to overcome discoloration caused due to Minocycline.[3] They are renowned for completely suppressing root canal infections microbiologically.

Calcium hydroxide, zinc oxide eugenol and resin-based sealers have long been the go-to options for root canal treatment. There is a continual cycle of innovation in root canal sealers, with each new generation offering better characteristics.[4] These days bioceramic materials are all the rage as root canal sealers. They have a number of advantages, such as neutralizing acids which aids in tissue healing and the capacity to release calcium ions which aids in MSC differentiation and remineralization. Biocompatibility, osteoconductivity, radiopacity, adhesion and an acceptable sealing capability are just a few of the benefits these endodontic sealers offer.[5] Bio-C, a root canal sealer based on calcium silicate offers several desirable qualities including a short setting time, excellent sealing of complicated root canal systems, volume stability, the ability to be stored for an extended period of time, and an easy-to-mix dual-syringe system.[6] An additional sealer, Ceraseal is a premixed bioceramic sealer based on calcium silicate that contains bioactive components such as dicalcium silicate (1–10%) and tricalcium silicate (20–30%).[7]

The bonding of the sealer to root dentin may be reduced due to the remnants of intracanal medicament which are present in the inner dentin wall. These remnants alter the root dentin's surface characteristics. Hence, after the procedure complete elimination of the intracanal medicament needs to be taken out knowing the fact that complete removal of the medicament is not easy.[8]

The main factor in maintaining the root canal's integrity is the bond strength of the sealer and dentin.[9] Endodontic sealers effectiveness is heavily dependent on it since it increases tensile strength, stops microleakage of materials and microorganisms and stabilizes the root filling material even more creating a hermetic seal.[10] Therefore, in order to determine how well the sealers adhered to the root canal wall following the removal of intracanal medication, a push-out test was done.

Methodology

Selection of Samples

Sixty single-rooted human mandibular premolar teeth extracted for orthodontic or periodontal reasons with straight matured roots were selected and stored in a 5% chloramine-T solution before use in the experiment.

Sample Preparation

A flat coronal reference point of 14 mm in length was achieved for all samples using decoronation. A size 15k file was inserted to standardize the apical foramina patency; the working length was computed 1mm

short of that place, so the tip is just visible.

To prepare the root canals of the specimen, Pro Taper Gold files (Dentsply Tulsa Dental, Tulsa, OK, USA) up to size F3 were used. In between each instrument change, the canals were irrigated with 5 mL of 2.5% NaOCl for 60 seconds, 5 mL of 17% EDTA for 60 seconds, and finally 10 mL of distilled water. With the use of paper points (Dentsply Maillefer), the specimens were allowed to dry. After that the roots were divided into three categories based on the medicament that was utilized in the study:

1) Group 1:- Control (no medicament)
2) Group 2:- Calcium Hydroxide
3) Group 3:- Double Antibiotic Paste

In Group 1 no medicament was used into the specimens. In Group 2 (Calcium Hydroxide) the calcium hydroxide paste (AVUECAL) which comes in a premixed syringe form was inserted into the canal with the help of a syringe tip. In Group 3 (Double Antibiotic Paste) equal amount of tablets of Metronidazole and Ciprofloxacin were crushed with the help of mortar and pestle and mixed with distilled water (1 g/mL) in a 1:1 ratio. The root canals were prepared and then filled with the medicament using a lentulo spiral set at 5000 rpm and 2 mm below the working length. For a week, the specimens were kept at 37°C with 100% humidity to mimic real-life clinical situations. After one week in Group 2 and Group 3, for the medicaments removal the specimens were irrigated with 10 mL 17% EDTA followed by 10 mL 3% NaOCl and a final rinse with 5 mL distilled water activated by sonic activator (GLIN LED SONIC PRO). Subsequently, the root canals were dried using paper points. Group 1, Group 2 and Group 3 were additionally divided into two subgroups based on the sealer used:
Subgroup A- Ceraseal sealer
Subgroup B- Bio-C sealer

The sealer application was completed in compliance with the manufacturer's guidelines. Both the sealers used in the study comes in a premixed form with a syringe tip. The syringe tip was inserted straight into the canal and the appropriate size F3 Pro Taper gutta-percha points were obturated using the single cone method. The excess gutta-percha was removed using a heated plugger. For the 24 hours preceding testing, the root specimens were subjected to 37°C and 100% relative humidity.

Push-out Bond Strength Test

The specimens were prepared for the push-out bond strength test by sectioning them transversely into three 1 mm slices, one for the cervical third, one for the middle third, and one for the apical third. The digital caliper was used to standardize the thickness of each piece to 1 mm.

To verify the push-out bond strength, the universal testing equipment was employed. Using tips with sizes of 1, 0.5, and 0.3 mm respectively, the root filling material was loaded for the cervical, middle, and apical areas. The crosshead was used to apply a push-out force from the cervical to the apical direction at a rate of 1 mm/min until the bond was broken. By dividing the force by the surface area of each specimen, the push-out bond strength at failure was determined in Megapascals (Mpa)."

The following formula was used to determine the area in each section:
$Area = 2\pi r \times h$
Where π = "constant value of 3.14"
r = "radius of the intraradicular area (root canal radius)" and
h = "height (the root dentin slice's thickness) in mm."
After collecting the data, it was tabulated and analyzed statistically.

Statistical Analysis

The SPSS 21.0 version was used for the data analysis. For the purpose of group comparison, the one-way ANOVA test was used. For the post hoc analysis, the independent t test was used. Any p-value below 0.05 was deemed to indicate statistical significance.

RESULTS

On applying one-way ANOVA test for Intergroup comparison the push-out bond strength of Group 1A,1B was significantly higher than Group 2A, 2B and Group 3A,3B which was shown to be true at cervical, middle and apical thirds in all groups Group 3 showed significantly least push out bond strength.(Table 1).

For intragroup comparison post hoc Bonferroni test was used. It was found that Subgroup A showed significantly higher push-out bond strength as compared to Subgroup B irrespective of medicament use. (Table 2)

The apical thirds showed significantly least push-out bond strength values followed by the middle and the cervical third for all the groups.

DISCUSSION

In the present study intergroup comparison revealed that highest bond strength was exhibited by the Control Group in which no medicament was placed. It was found that prior application of Calcium Hydroxide and Double antibiotic paste reduced the push-out bond strength of both Bio-C and Ceraseal sealer.

There was a decrease in the push-out bond strength of both tested sealers in specimens prepared with calcium hydroxide, indicating that residual calcium hydroxide had an adverse effect on this feature. Because the sealers and dentin are unable to form chemical connections due to the presence of residual calcium hydroxide, the strength of the push-out bond is diminished. This is due to the fact that it changes their capacity to adapt to dentinal walls. In accordance to the study both Ghabraei et al. (2017)[11] and Guiotti et al. (2014)[12] found that applying an intracanal dressing of calcium hydroxide weakened the bond strength of root canal sealer to dentin.

When comparing the two groups, we found that Calcium Hydroxide had a far less impact on the two sealer's push-out bond strength than Double antibiotic paste. There may be a combination of factors including reduced demineralization and surface roughness effects on radicular dentin and the possible beneficial impact of residual calcium hydroxide on the chemical bonding of the cements based on calcium silicate, that contribute to Group 2's (calcium hydroxide) higher bond strength compared to Group 3 (double antibiotic paste). Hegde V et al.[13] found comparable results with sealers exhibiting a greater mean push-out bond strength following calcium hydroxide dressing compared to double antibiotic paste dressing.[13]

The investigation found that Double antibiotic paste Group had statistically lower push-out bond strength of the sealers compared to Calcium Hydroxide Group. This might be because antibiotic paste, when used for longer durations, is certain to cause alterations on the dentinal surface. For reasons such as chemical stability, tonicity management, physiological compatibility and several antibiotics have acids which are added to them. Demineralization is much accelerated when dentin is exposed to these acidic antibiotic pastes for longer durations as opposed to shorter durations. Research suggests that demineralization and adverse effects on mechanical characteristics may occur in tooth hard tissues exposed to double antibiotic paste. Research by Gokturk H et al[14] found that compared to the group that received calcium hydroxide dressings, the one that received double antibiotic paste dressings beforehand had a lower mean push-out bond strength.

Bio C sealer exhibited higher bond strength to root dentin compared to Ceraseal sealer in all three intragroup comparisons. This is because the setting reaction of the sealer uses the moisture in the medium to form a calcium silicate hydrate gel, rather than the other way around. In addition, the sealer is able to penetrate the root canal's small imperfections more effectively because to its high flow rate. Indicating chemical attachment to dentin, it encourages the development of a mineral infiltration zone.[6]

All of the group's bond strengths declined most noticeably as they moved from the coronal to the apical direction in this investigation. The decrease in tubule density from the coronal to the apical thirds explains this phenomenon by making the tubules less porous, allowing less sealer to penetrate them.[15] Apical region adhesion may be compromised due to reduced sealer penetration into dentinal tubules caused by irrigation solutions not reaching the apical area and the resulting partial smear layer removal. Helvacıoğlu Kıvanç et al[16] also reached the same conclusion with individuals who stated that the bond strength was low at the apical area due to structural differences between the root thirds in terms of canal shape and collagen/mineral content. Results showing a decrease in push-out bond strength from the cervical to the apical direction were also seen in a research by Gupta et al.[15]

CONCLUSION

Based on the study's limitations, it can be inferred that the push-out

bond strength of the Ceraseal and Bio-C sealers in the cervical, middle, and apical root thirds was negatively affected by the preceding administration of intracanal medicament dressing.

Calcium hydroxide, when compared to double antibiotic paste, has a less detrimental impact on the push out bond strength of sealers. Hence, calcium hydroxide as an intracanal medicament should be preferred over DAP. But regardless of the use of intracanal medicament dressing, the push-out bond strength values for Ceraseal sealer were lower than those for Bio-C sealer in all three root segments.

Table 1: Intergroup Comparison Of Push-out Bond Strength

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	60	3.4217	1.24025	.16012	3.1013	3.7421	1.65	6.71
2.00	60	1.7302	.82494	.10650	1.5171	1.9433	.60	3.89
3.00	60	.9648	.31136	.04020	.8844	1.0453	.49	1.94
Total	180	2.0389	1.35012	.10063	1.8403	2.2375	.49	6.71
P VALUE								0.001
POST HOC					GROUP 1>2>3			

Table 2: Push-out Bond Strength Of Different Sealers In Group 2 And Group 3 At Different Levels Of Root Section.

Comparison of Push-out bond strength of Ceraseal sealer and Bio-C sealer in Group 2 (Calcium Hydroxide) at Cervical, Middle and Apical region						
		N	Mean	Std. Deviation	Std. Error Mean	P VALUE
CERVICAL	Ceraseal sealer	10	1.5300	.37562	.11878	0.001
	Bio- C sealer	10	3.0930	.58754	.18580	
MIDDLE	Ceraseal sealer	10	1.1790	.26531	.08390	0.001
	Bio- C sealer	10	2.1520	.52072	.16467	
APICAL	Ceraseal sealer	10	.9270	.29208	.09236	0.001Bio-C> Ceraseal
POST HOC	Bio- C sealer	10	1.5000	.35917	.11358	
Comparison of Push-out bond strength of Ceraseal sealer and Bio-C sealer in Group 3 (Double Antibiotic Paste) at Cervical, Middle and Apical region.						
		N	Mean	Std. Deviation	Std. Error Mean	P VALUE
CERVICAL	Ceraseal sealer	10	1.0340	.22451	.07100	0.001
	Bio- C sealer	10	1.3280	.35770	.11312	
MIDDLE	Ceraseal sealer	10	.8240	.16126	.05099	0.001
	Bio- C sealer	10	1.0320	.25862	.08178	
APICAL	Ceraseal sealer	10	.6960	.15005	.04745	0.001Bio-C> Ceraseal
POST HOC						

REFERENCES

1. Kim D, Kim E. Antimicrobial effect of calcium hydroxide as an intracanal medicament in root canal treatment: a literature review - Part I. In vitro studies. Restor Dent Endod. 2014; 39:241-52.
2. Farhad A, Mohammadi Z. Calcium hydroxide: a review. Int Dent J. 2005; 55:293–301.
3. Ozturk TY, Guneser MB, Taschieri S, Maddalone M, Dincer AN, Venino PM et al. Do the intracanal medicaments affect the marginal adaptation of calcium silicate-based materials to dentin? J Dent Sci. 2019; 14:157–62.
4. Madhuri Gv, Varri S, Bolla N, Mandava P, Akkala L, Shaik J et al. Comparison of bond strength of different endodontic sealers to root dentin: An in vitro push-out test. J Conserv Dent. 2016; 19:461-4.
5. Marques Ferreira M, Martinho JP, Duarte I, Mendonça D, Craveiro AC, Botelho MF, et al. Evaluation of the Sealing Ability and Bond Strength of Two Endodontic Root Canal Sealers: An In Vitro Study. Dent J. 2022; 10:1-10.
6. Veeramachaneni C, Aravelli S, Dundigalla S. Comparative evaluation of push-out bond strength of bioceramic and epoxy sealers after using various final irrigants: An in vitro study. J Conserv Dent. 2022; 25:145-50.
7. Zamparini F, Prati C, Taddei P, Spinelli A, Di Foggia M, Gandolfi MG et al. Chemical-Physical Properties and Bioactivity of New Premixed Calcium Silicate Bioceramic Root Canal Sealers. Int J Mol Sci. 2022; 23:1-21.
8. Aydin MN, Buldur B. The effect of intracanal placement of various medicaments on the bond strength of three calcium silicate-based cements to root canal dentin. J Adhes Sci Technol. 2018; 32:542–52.
9. Jaganath BM, Rudranaik S, Krishnegowda SC, Nirmala KB, Nagashetty YH. Comparative evaluation of push-out bond strength and mode of failure of three different obturating materials: An in vitro study. J Conserv Dent Endod. 2024; 27:608–12.
10. Sarrafan A, Soleymani A, Bagheri Chenari T, Seyedmajidi S. Comparison of push□out bond strength of endodontic sealers after root canal drying with different techniques. Clin Exp Dent Res. 2023; 9:314–21.
11. Ghabraei S, Bolhari B, Yaghoobnejad F, Meraji N. Effect of Intra-Canal Calcium Hydroxide Remnants on the Push-Out Bond Strength of Two Endodontic Sealers. Iran Endod J 2017; 12:168-72.
12. Guiotti FA, Kuga MC, Duarte MA, Sant'Anna A, Faria G. Effect of calcium hydroxide dressing on push-out bond strength of endodontic sealers to root canal dentin. Brazilian oral research. 2014; 28:1-7.
13. Hegde V, Arora S. Effect of intracanal medicaments on push-out bond strength of Smart-Seal system. J Conserv Dent Endod. 2015; 18:414-8.
14. Gokturk H, Ozkocak I, Buyukgebiz F, Demir O. An in vitro evaluation of various irrigation techniques for the removal of double antibiotic paste from root canal surfaces. J Appl Oral Sci. 2016; 24:568-74.
15. Gupta A, Kumar M, Taneja S. Effect of intracanal calcium hydroxide dressing on the push out bond strength of AH Plus, MTA Fillapex®, and endosequence BC sealer. Endodontology. 2020; 32:33-7.
16. Helvacıoğlu Kıvanç B, Deniz Arısu H, Uçtaşlı MB, Okay TC. The effect of different adhesive system applications on push out bond strengths of glass fiber posts. J Adv Prosthodont 2013; 5:305-11.