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Original Research

Influence Of Different Intracanal Medicaments on The Bond Strength Of Bioactive Glass Sealer – An Invitro Study

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ABSTRACT

The prime purpose of the cleaning shaping procedures is to manage intracanal infection by achieving a significant reduction in the intracanal bacterial load and infected dentin. Disinfection of the root canal is tedious goal therefore association of the mechanical preparation with irrigation solutions and intracanal medicaments was proposed to reduce the infection of root canal.

Aim and objective: To investigate the influence of the remaining volume of different intracanal medicaments on the bond strength of bioactive glass sealer.

Materials and Methods: 45 single rooted premolars were standardized and prepared using rotary files.

The specimens were then randomly divided into three groups (n = 15) based on the intracanal medicaments used as follows: Group 1 -Bio c temp ;Group 2 -Metapex ;Group 3 - Calcium hydroxide

After 1 week, rinsing of the medicaments was done and the samples were obturated with gutta percha/bioactive glass sealer. Each roots were sectioned and 3 slices of dentin 1 mm thick were obtained from each root third. And the push-out bond strength were evaluated using universal testing machine.

Results: Bioactive glass sealer showed higher bond strength with the prior placement of bio-c temp medicament when compared to the other groups.

Disscussion: some medicaments may alter dentin surface properties, thereby enhancing or reducing bond strength, which directly affect the long term sealing ability and success of endodontic treatment.

Conclusion: Bio-c temp proved to be better intracanal medicament than other tested groups in terms of the push out bond strength of the sealer.

INTRODUCTION

The primary goal of endodontic treatment is to make the root canal free of bacteria and their byproducts and to create a tight hermetic seal that prevents reinfection. It is impossible to obtain complete disinfection of root canal system through chemomechanical method due to the complex anatomy of the root canal system. Intracanal medicaments assist in disinfection of the root canal system[1]. Intracanal medicament should be effective throughout its period of application, penetrate dentinal tubules, eliminate bacteria, and act as a physicomechanical barrier, preventing root canal reinfection and nutrient supply to the remaining bacteria with little toxicity to periradicular tissue.

Viable microorganisms that remain even after root canal preparation and disinfection contribute significantly to the failure of root canal therapy.The most common species isolated from the root canals with secondary apical periodontitis are Candida albicans and Enterococcus faecalis.Therefore, the use of an intracanal dressing has been suggested by several studies as a valuable adjunct to chemomechanical preparation in disinfection of the root canal system[2].

Among various intra-canal medicaments (ICMs) used, non-setting calcium hydroxide (CH) has been a preferred choice for many years. It demonstrates

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high antibacterial potential, effectively dissolving pulp remnants within the canal, and exhibiting efficacy in neutralizing bacterial endotoxins, thereby aiding in periapical healing. However, its notable high alkalinity and elevated pH may pose a risk of breaking down protein structures, potentially impacting the mechanical properties of dentin [3]. Additionally, incomplete removal of (CH) from the root canal may adversely affect the sealer's ability to penetrate dentinal tubules, thereby influencing the long-term prognosis . To address these limitations, alternative medicaments have been explored, aiming to preserve the mechanical properties of dentin.

Metapex oil-based intracanal medicament containing calcium hydroxide serves as a temporary obturating material in between appointments. Calcium hydroxide shows limited action against facultative anaerobes and Candida albicans species but effective against obligate anaerobes[1]. Removal of calcium hydroxide before obturation is important in obtaining hermetic seal.

With advancements in dentistry, a novel pre-formulated calcium silicate paste called Bio-C Temp has emerged as an alternative to conventional intra-canal medicaments. Bio-C Temp stands out as a unique bioceramic sealer with antimicrobial potential and bioactivity. However, there is limited evidence concerning the impact of Bio-C Temp on the push-out bond strength (PBS) of Bioactive glass endodontic sealer and the microhardness (MH) of intracanal dentin. Hence, further investigation and exploration are warranted to better understand the implications of these materials in endodontic applications [3].

The challenge with the use of intracanal medicaments is the difficulty to remove them completely from the root canal. This could act as a physical barrier between radicular dentin and the material that negatively influence the adhesion and penetration of the filling materials into the dentinal walls[5].On the contrary, prior placement of intracanal medicaments was demonstrated to enhance the adhesion of the root filling material or have no effect on it.No abundant information about the effect of these medicaments on the bond strength of bio active glass sealer. Therefore, we aimed to evaluate the effect of effect of the prior application of intracanal medicaments on the bond strength of bioactive glass sealer to root dentin.

MATERIALS AND METHODS

This study was conducted in the Department of Conservative Dentistry and Endodontics of Peoples College of Dental Sciences and Research Centre, Bhopal over the period of 6 months. The study was approved by the Institutional Ethical Committee. 45 single rooted human premolars which were extracted due to orthodontic reasons were used in the study. Completely erupted teeth with closed apices, sound enamel, and dentin without any carious lesion, cracks, restorations, or developmental disturbances were included in the study. Cleaning of plaque, calculus, tissue remnants, and other deposits was done using periodontal scaler.

PREPARATION AND OBTURATION

The teeth were decoronated and the root length was standardized at 16mm. Working length was measured by deducted 1 mm short of apical foramen with K-file (mani K-File 25mm # 10).

A.  B. 

Fig. 1 (A) teeth were decoronated and (B) working length was established using # 10 K-file.

All root canals were instrumented using Protaper Gold Rotary file upto size 25 and irrigated with 3% Naocl throughout preparation. Final irrigation was achieved using 3 ml of 17% EDTA for 1 minute followed by 5 ml of saline.

The specimens were then randomly divided into three groups (n = 15) based on the intracanal medicaments used as follows:

Group I: placement ofBio c temp intracanal medicament into the canal (fig.2.A)

Group 2 –placement of Metapex (fig.2.B)

Group 3 –placement of Calcium hydroxide (fig.2.C)

A. 

Group 1 -Bio c temp placement

B. 

Group 2 –Metapex placement

C. 

Group 3 – Calcium Hydroxide placement

FIG. 2: Placement of intracanal medicament into the canal

All intracanal medicaments were applied according to the manufacturer and the orifice was sealed using IRM . The specimens were incubated for 1 week at 37°C with 100% humidity. After 1 week, rinsing of the medicaments was done using 10 ml 17% EDTA followed by 10 ml 3% Naocl, and a final irrigation of 5 ml distilled water. After that, the canals were dried using paper points.

OBTURATION

Canal were coated with Bioactive Glass sealer (NISHIKA)(fig.3) and filled by the single-cone technique. Following obturation, a heated plugger was used to remove excess gutta-percha and sealer to the canal orifice with IRM and incubated for 2 weeks at 37°C with 100% humidity to ensure setting of the materials.

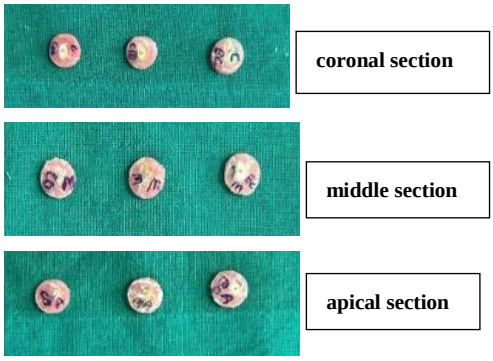
Fig.3 Placement of bioactive glass sealer

PUSH-OUT BOND TEST

Each root was embedded in cold-cure epoxy resin (fig.4). After setting, the specimen was sectioned transversally using diamond disk. The cutting disk was placed perpendicular to the root long axis, and 5 mm from the apex of each root was discarded due to presence of lateral canal and apical remifications. Specimen was sectioned and three slices of dentin 2.0 mm thick were obtained from each root third (fig.5).

Fig.4Root embedded in cold cure acrylic

Fig.5 Three slices of dentin from each root third



Universal testing machine (UTM) was used to assess the push out bond force. A 0.8 mm diameter cylindrical stainless-steel plunger was equipped in the UTM (fig.6). The Instron machine was activated at a speed of 0.1mm/min until the sealer of the filling material was displaced. Then the bond strength was calculated in Mpa.

Fig.6 Universal testing machine for evaluation of push-out bond strength.

RESULTS

Descriptive Interpretation of Pushout Bond Strength by Intracanal Medicament

The study evaluates the pushout bond strength of three different intracanal medicaments—BioC, Metapex, and Calcium Hydroxide—across various root locations: apical, middle, and cervical.

Apical Region

In the apical region, BioC demonstrates the highest mean pushout bond strength of 14.3892 with a standard deviation of 0.76195. Metapex follows with a mean bond strength of 11.7685 and a standard

Table 1: Descriptive values of pushout bond strength among various intracanal medicaments

Intracanal medicament	N	Minimum	Maximum	Mean	Std. Deviation
BioC					
Apical	12	13.12	16.19	14.3892	.76195
Middle	12	13.17	17.03	15.5447	1.09409
Cervical	12	25.59	28.44	26.8243	.93038
Metapex					
Apical	12	10.56	13.44	11.7685	.97552
Middle	12	10.38	14.46	12.3426	1.11839
Cervical	12	18.15	21.06	19.6421	.81509
Calcium hydroxide					
Apical	12	7.93	10.79	9.4680	.82380
Middle	12	8.77	12.50	10.7558	1.13963
Cervical	12	15.38	17.69	16.5631	.77286

Table 2: Comparative evaluation of pushout bond strength among various intracanal medicaments

Location	Intracanal medicament	Mean	S.D	95% Confidence Interval		'F' statistic	P value
				Lower bound	Upper bound		
Apical	BioC	14.3892	.76195	13.9051	14.8733	98.729	.000*
	Metapex	11.7685	.97552	11.1487	12.3883		
	Calcium hydroxice	9.4680	.82380	8.9446	9.9914		
Middle	BioC	15.5447	1.09409	14.8496	16.2399	57.181	.000*
	Metapex	12.3426	1.11839	11.6320	13.0532		
	Calcium hydroxice	10.7558	1.13963	10.0317	11.4798		
Cervical	BioC	26.8243	.93038	26.2332	27.4154	469.204	.000*
	Metapex	19.6421	.81509	19.1242	20.1600		
	Calcium hydroxice	16.5631	.77286	16.0721	17.0542		

*=Significant; NS=Not Significant

Graph 2: Comparative evaluation of pushout bond strength among various intracanal medicaments

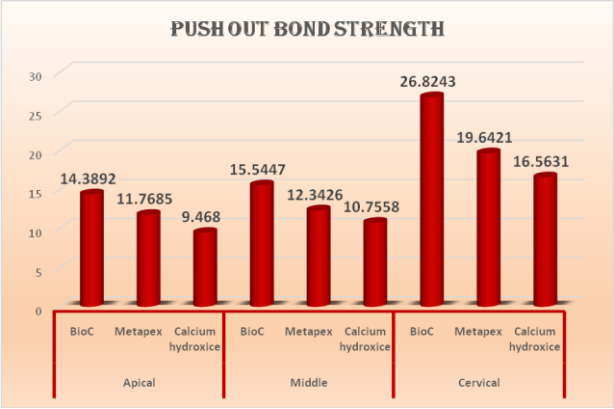


Table 3: Pairwise comparison of pushout bond strength among various intracanal medicaments

Pairs	Mean Difference	Std. Error	Significance
Cervical			
Bio C versus Metapex	2.62067*	.35046	.000*
Bio C versus Calcium hydroxide	4.92123*	.35046	.000*
Metapex versus Calcium hydroxide	2.30056*	.35046	.000*
Middle			
Bio C versus Metapex	3.20207*	.45623	.000*
Bio C versus Calcium hydroxide	4.78895*	.45623	.000*
Metapex versus Calcium hydroxide	1.58688*	.45623	.004*
Apical			
Bio C versus Metapex	7.18219*	.34378	.000*
Bio C versus Calcium hydroxide	10.26117*	.34378	.000*
Metapex versus Calcium hydroxide	3.07898*	.34378	.000*

*=Significant; NS=Not Significant

deviation of 0.97552. Calcium Hydroxide shows the lowest mean bond strength of 9.4680 with a standard deviation of 0.82380. A significant p-value of 0.000 indicate a statistically significant difference in bond strengths among the medicaments in the apical region.

Middle Region

In the middle region, BioC again shows the highest mean pushout bond strength at 15.5447 with a standard deviation of 1.09409. Metapex has a mean bond strength of 12.3426 and a standard deviation of 1.11839. Calcium Hydroxide displays a mean bond strength of 10.7558 with a standard deviation of 1.13963. A significant p-value of 0.000 confirm a significant difference in bond strengths among the medicaments in the middle region.

Cervical Region

In the cervical region, BioC significantly outperforms the other medicaments with a mean pushout bond strength of 26.8243 and a standard deviation of 0.93038. Metapex follows with a mean bond strength of 19.6421 and a standard deviation of 0.81509. Calcium Hydroxide shows a mean bond strength of 16.5631 with a standard deviation of 0.77286. A significant p-value of 0.000 indicate a highly significant difference in bond strengths among the medicaments in the cervical region.

Across all locations—apical, middle, and cervical—BioC consistently demonstrates the highest mean pushout bond strengths, making it the most effective intracanal medicament among the three studied. Metapex shows moderate bond strength, while Calcium Hydroxide consistently has the lowest bond strength across all regions. The significant p-values across all regions indicate that the differences in pushout bond strength among the intracanal medicaments are statistically significant.

Across all root locations—cervical, middle, and apical—BioC consistently exhibits significantly higher pushout bond strengths compared to both Metapex and Calcium Hydroxide. Metapex shows higher bond strengths than Calcium Hydroxide in all regions, but it is outperformed by BioC. The significant p-values confirm the statistical differences between each pair of medicaments, indicating that the choice of intracanal medicament has a substantial impact on pushout bond strength.

DATA ANALYSIS

The data obtained were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS Version 25; Chicago Inc., IL, USA). Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons.

Shapiro Wilk test was performed to determine the normality of the data for determining pushout bond strength between various intracanal medicaments. The test showed no significant difference and hence confirmed that the data obtained were normally distributed.

Variables were compared using mean value and standard deviation. The mean for different readings for bond strength was assessed using one way Analysis of Variance (ANOVA). Tukeys post hoc test was applied to find significant difference between pairs. P value lesser than 0.05 was considered to be statistically significant.

DISCUSSION

Dislodgment resistance of root canal filling from root dentin could be an indicator of the durability and prognosis of endodontic treated teeth. The bond strength of root canal filling materials is affected by different factors, including anatomy of the root canal, the prior placement of intracanal medicaments, obturation materials and techniques, slice thickness, and final irrigation protocol[1].

The number and density of dentinal tubules vary along the root canal thirds. However, it has been reported that the alterations in tubular density along the canal walls are unlikely to change the adhesion of root canal sealers. In this study, the bond strength primarily decreased in the coronal to apical direction without any medicaments. This result is comparable with results from several studies showing that the adhesion of root sealers generally decreased in the coronal to apical direction[8].This can be explained by the decreasing tubule density from coronal to apical, which reduces sealer penetration into the smaller tubule diameter in the apical thirds.The lack of access to the apical region of irrigation solutions and the consequent incomplete removal of the smear layer may decrease the penetration of sealer into dentinal tubules and may thereby affect adhesion in the apical region[4].

The present study was based on the hypothesis that there would be no significant difference in the PBS of bioactive glass sealer to the radicular dentin after using contemporary intra-canal medicaments. The hypothesis was rejected as Bio-C Temp treated teeth exhibited better outcomes for push-out bond strength than CH [3]. Bio-C Temp facilitates maximum surface hardness which can be elucidated by the process of forming calcium salt deposits in connective tissues by the release of Ca+2 and OH- ions during hydration[3]

Intracanal medication based on bioceramic compounds has a high concentration of free CaO, low concentration of C3S and C2S and a long chain polymer. The low concentration of C3S and C2S causes the crystals formed by the hydration reaction to separate due to the amount of material present and the interference of the polymer, making it difficult for these crystals to intertwine and consequently to harden the product, which facilitates its removal, especially in flattened areas. To the contrary, medication based on calcium hydroxide, in an aqueous solution, dissociates into calcium and hydroxyl ions; reducing its solubility and facilitating its penetration into dentinal tubules and polar areas, which may explain the larger remaining volume, adhering to the walls of root canals acting as a mechanical barrier. In contrast, the lowest bond strength values were observed for teeth that received calcium hydroxide-based medication, irrespective of the filling sealer used Thus it is suggested that after conventional irrigation, a larger amount of calcium hydroxide remnant remained on the walls of the root canals, resulting in a physical barrier between the root dentin and endodontic sealer[6]. This could also chemically react with sealer and interfere in its physical chemical properties, reducing flow, working time, film thickness,and sealer penetration

into dentinal tubules,consequently affecting the apical sealing capacity, thus decreasing the bond strength[10].

The manufacturer of Bio-C Temp boasts that this calcium silicate-based dressing allows for a stable and prolonged release of Ca+2 ions along with high alkalinity, which is conducive to a potent antibacterial effect. In addition, it has high biocompatibility, which promotes its use in regeneration and apexification procedures. A recent study reported that it favors osteoblast viability and differentiation, allowing for periapical repair[7]

The limitations of a study are Limited clinical relevance, Simplified methodology, Small sample size, Homogeneous samples, Bioactive glass sealer variability. Acknowledging these limitations is crucial for understanding the scope of the study and for guiding future research that aims to address these constraints.

CONCLUSION

The study results indicate that Bio-C Temp demonstrated superior intracanal medicament properties compared to other tested groups of calcium hydroxide specifically in terms of the push-out bond strength of the sealer. The choice of medicament plays a crucial role in preserving dentin integrity and optimizing the adhesion and sealing ability of bioceramic sealer, thereby affecting the long term success of endodontic treatment.

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