ORIGINAL RESEARCH PAPER

Dentistry

A COMPARATIVE EVALUATION OF PUSH-OUT BOND STRENGTH OF FIBRE POSTS USING FOUR DIFFERENT ENDODONTIC SEALERS.

KEY WORDS: Root canal sealers, fibre post, universal testing machine, stereomicroscope

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ABSTRACT

A significant progress had been there in the development of adhesives for fibre reinforced composite (FRC) posts for retention of the core material in endodontics in recent years. Adhesion of the fibre posts to root dentin is decided by various factors and the root canal sealers may play an important role in the adhesion. The choice and type of root canal sealer used is one factor that can be controlled by the operator.

There have been many types of sealers used for endodontic treatment, all have their own perks and flaws. The purpose of the study is to determine the retentive strength of fibre posts with root canal wall after using four different types of endodontic sealers.

INTRODUCTION

The selection of an appropriate restorative material for natural function and esthetic rehabilitation in mutilated teeth is one of the key problems in dentistry. When the crown portion of endodontically treated tooth is close to being damaged, intraradicular posts are recommended to provide retention between the prosthetic crown and the remaining tooth structure. Post retention is critical to the long-term longevity of the endodontically treated tooth. Fibre-reinforced composite posts have seen increased use in recent years because of advantages such as acceptable aesthetics, similar modulus of elasticity to dentin, stress dispersion across a wider surface area on root canal walls, and a minimal risk of vertical root fracture. Bonding of fibre post to root dentin is always challenging. There are multiple factors that are beyond operator's control. A variety of circumstances have been observed to obstruct the bonding of fibre posts to root dentin such as presence of smear layer, moisture, incomplete monomer penetration, incomplete light penetration, polymerisation, etc. The type of root canal sealer used during obturation is one factor that can be controlled by the operator of these variables. [1]

Typically, push out bond strength determines the extent of resistance to the dislodgement of a filling material when applied to root canal dentine. In order to establish push out bond strength, a tensile load is positioned vertically to the long axis of the root till the filling is displaced. [2]

Uregan et al. indicated that push out bond strength showed better assessment of the bond strength than the conventional shear tests. [3] The push-out bond strength test conducted in this study is relatively easy to perform, can replicate similar clinical conditions, has accurate specimen standardization, has minimal stress and has less technique sensitive. [2]

AIMS AND OBJECTIVE:

The study aimed to investigate the influence of different sealers on push out bond strength of the fibre posts. General objective of the research was to evaluate the push out bond strength of the fibre post luted with the help of dual cure adhesive cement after using four different root canal sealers. The failure modes were studied under the stereomicroscope.

Methods Of Sample Selection:

After getting approved by Institutional Ethical committee/ Institutional Review board, the study on 60 mandibular premolars extracted for orthodontic or periodontal purposes were done. Inclusion criteria includes non-carious, single rooted, teeth with fully formed apices, absence of calcifications, straight root canal, (verified radiographically).

METHODOLOGY

This study included 60 mandibular single-rooted premolars with mature apices extracted for therapeutic reasons. Decoronation was done at cemento-enamel junction to create a standardised length of roots (16mm). A size 10 stainless steel endodontic K-file was used to negotiate the root canal until the tip of the file was seen at the apical foramen. Radiographs were taken to confirm the working length, which was calculated by subtracting 1 mm from the initial length, all of the canals were instrumented to the working length upto #30-6 % taper with Neoendo flex rotary files after glide path preparation. Throughout instrumentation, copious irrigation was done with 5.25% sodium hypochlorite solution and normal saline. For the final irrigation, 5 mL of 17% ethylenediaminetetraacetic acid was used for 1 minute, followed by 5 mL of normal saline.

Samples were divided randomly into four groups (n=15), based on the sealer used: AH Plus (Dentsply) in Group A, Bio-C (Angelus) in Group B, Guttaflow 2 (Coltene) in Group C and MTA Fillapex (Angelus) in Group D.

The obturation was done for each of the group with the respective sealers according to the manufacturer's instructions. Temporary restoration (Cavitemp) of 2mm thickness was placed on the coronal parts of canals. For 1 week, all of the samples were incubated at 37°C in 100% humid environment.

Post space preparation (10mm) was done with the drills provided by the manufacturer. The root canals were irrigated with distilled water, followed by 17% EDTA and normal saline as final irrigant. Then the samples were dried with paper points before the fibre posts (Coltene tenax) (1.3mm) were being bonded with dual cure resin cement (Paracore, Coltene Whaledent). Following that, the samples were cut into 2mm slices at the coronal, middle, and apical thirdsof the post length with water cooled saw. Samples were mounted on a base and performed the push-out test on each specimen with a crosshead speed of 1 mm/minute under a universal testing machine. Data was collected and recorded. Each specimen was examined under a stereomicroscope to determine the failure mode.

Statistical Analysis:
Data were analysed using the two-way ANOVA and the *post-hoc* Tukey's test. The *P* value of ≤0.05 was considered as the level of significance. table

RESULTS:
According to the inference of this study, a significant reduction in the adhesive resistance of root apical third was observed in all the three groups, regardless of the endodontic sealer used.

Table 1: Descriptive Statistics Of The Push-out Bond Strength(in MPa) For Different Study Groups At All Cross-sectional Levels.

Levels and Groups	Group A(n=15)	Group B(n=15)	Group C(n=15)	Group D(n=15)
Coronal	$141\pm29.3_{a1A5}$	$112\pm41.2_{a2B5}$	$91.5\pm40.5_{a3C5}$	$86.2\pm33.7_{a4C5}$
Middle	$87.6\pm16_{b1A6}$	64 ± 15.4^{b2B6}	$48.1\pm14.2_{b3C6}$	$35.6\pm16.2_{b4C6}$
Apical	$25.9\pm3.59_{c1A7}$	$20.5\pm5.28_{c2B7}$	$16.8\pm4.39_{c3C7}$	$10.2\pm3.87_{c4D7}$

Total sample size- *60;n=15:*sample size per group 1:Group A;2:Group B;3:Group C;4:Group 5:coronal third;6:middle third;7:apical third

**:Statistically highly significant(*P*<0.01*)*

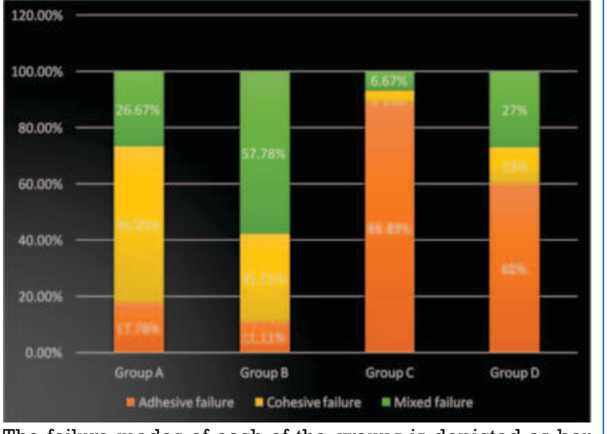
Different lowercase superscript letters denote a statistically significant difference within the group/within periods (*P*<0.05)

Different uppercase superscript letters denote a statistically significant difference between two groups(*P*<0.05)

Table 2: Comparisons Of The Actual Differences In The Push-out Bond Strength Between The Cross-sectional Levels For Each Of The Study Groups

Tukey's multiple comparisons test	**Mean Diff.**	**Adjusted P Value**
Group A		
Coronal vs. Middle	53.08	<0.0001**
Coronal vs. Apical	114.8	<0.0001**
Middle vs. Apical	61.77	<0.0001**
Group B		
Coronal vs. Middle	48.45	0.0013**
Coronal vs. Apical	91.97	<0.0001**
Middle vs. Apical	43.52	<0.0001**
Group C		
Coronal vs. Middle	43.99	0.0030**
Coronal vs. Apical	75.30	<0.0001**
Middle vs. Apical	31.31	<0.0001**
Group D		
Coronal vs. Middle	50.62	0.0001**
Coronal vs. Apical	76.03	<0.0001**
Middle vs. Apical	25.41	<0.0001**

NS: not statistically significant (*P*>0.05), *:statistically significant(*P*<0.05); **:highly statistically significant (*P*<0.01)



The failure modes of each of the groups is depicted as bar graph (Fig 1):

DISCUSSION
The bond strength of post-cement-dentin interface is influenced by the density of dentinal tubules, number of dentinal tubules, depth of sealer penetration into the tubules and the polymerization rate of resin cement. [4] According to the inference of our study, a significantreduction in the push out bond strength of root apical third was observed in all the three groups, regardless of the endodontic sealer used.

The bond between the intraradicular dentin and the post is traditionally achieved by an adhesive resin cement, which will be bonded both on the dentin surface and the surface of the post. However, the influence of root canal sealers may affect the bond of fibre posts to dentin. The push-out test which uses a shearing stress at the dentin-post-cement interfaces, simulates the clinical conditions.

In this study, it was found that the push out bond strength of Group A (AH Plus) is highest of all, followed by Group B (Angelus BioC). Group C (Guttaflow) showed slight higher bond strength values compared to Group D (MTA Fillapex).

Anjaneya Shiva Prasad (2021) studied the push out bond strength of fibre posts after using AH Plus and Bioceramic sealer. He found that AH Plus showed greater bond strength than Bio-C (Angelus), which is similar to this study. [1]

Ghanadan(2015) compared the effects of different sealers on fibre post bond strength. He concluded that the resin-based sealer have greater bond strength as compared to Guttaflow, which is similar to our study. [5]

The lower bond strength of Group D (MTA Fillapex) can be explained by the higher percentage of gap-containing regions observed due to MTA Fillapex lower adaptation to canal walls because sealers containing salicylate in the composition exhibit initial volumetric shrinkage during the setting reaction, increasing the contraction factor. On the contrary, epoxy resin sealers (AH Plus) are considered to have low contraction factor and some degree of expansion during the setting reaction as in BioCeramic sealer. The resin content in MTA Fillapex sealer is less as compared to AH Plus, which might also be one of the reasons why MTA Fillapex showed more number of adhesive failures as compared to the other two groups. This was similar to the study done by Anjaneya Shiva Prasad. [1]

The higher amount and diameter of dentinal tubules at coronal third allows better penetration of the resin sealers into the tubules resulting in greater bond strength at the coronal third of the tooth. These characteristics make the root dentin conditioning and adhesive penetration into dentinal tubules at the apical third most difficult for the resin cements. The porous regions into the hybrid layer leave spaces around the collagen fibrils, generating lower values of bond strength from coronal to apical portions of the canal.[6] Also, there is incomplete polymerizationof the resin cement at the apical third because of the farthest distance from the light source during curing. [7] The possible explanation for this result can be attributed to the difficulty in access the root canal during adhesion or post cementation and nonuniform adaptation of the adhesive material.

Today, the concept of a monobloc has accomplished novel implications with break throughs in dentin adhesive technology as well as amassed a heightened interest in its application to Endodontics.[8]

The literal meaning of the word monobloc is 'Single unit'. In fact this philosophy was first popularized in 1996 with the bonding of epoxy resin– based, carbon fibre–reinforced posts to root dentin as a mechanically homogeneous monobloc.[8]

For adhesive failure, we had considered the cases of debonding that has occurred at the interfacial surface between the resin and the dentinal walls. Debonding taking place within the entity of the cement itself was considered as cohesive failure. Whereas, for debonding in both the regions in the same slide, mixed failure is considered.

In this study, AH Plus (Group A) showed the failure mode which was mostly cohesive in character, which is similar to the findings of Eldeniz et al. [9], Shokouhinejad et al., [10] and Vilanowa et al. [11] This may be attributed to the presence of epoxy resin in their composition, which is similar to the composition of the resin cement. This had led to the increased bond between AH Plus and the resin cement.

In this study, it was found that the Angelus BioC (Group B) had more mixed type failures than the other two groups. The probable cause is that the Bio-C sealer is made of monobasic calcium phosphate, which facilitates the reaction with calcium hydroxide to produce water and hydroxyapatite when the sealer is activated by water. [12] Furthermore, the nanofiller in this sealer can improve bond strength. [13] Therefore, the BC sealer group had a higher rate of mixed failure than the other two groups.

In this study, we had found that the Guttaflow (Group C) had more adhesive failure. This is because of higher sealer penetration rate into the dentinal tubules. Therefore, there was higher amount of sealer remnant inside the tubules which hinders the proper penetration of the resin cement, therefore decreasing the bond strength. [14]Majumdar TK (2021) studied the sealer penetration depth and interfacial adaptation of AH PIus, Apexit Plus and guttaflow under confocal laser scanning microscope.[15]

Therefore, there was higher amount of sealer remnant inside the tubules which hinders the proper penetration of the resin cement, therefore decreasing the bond strength.

CONCLUSION

Within the limitations of the study, it can be concluded that the bond strength of AH Plus (epoxy resin sealer) is highest as compared to Angelus BioC (bioceramic sealer), Guttaflow (cold flowable sealer) and MTA Fillapex (MTA based sealer). Irrespective of the sealers used, in our study we can conclude that the push out bond strength is highest at coronal third, followed by middle and apical thirds of the root. These findings do correlate with many of the previous studies.

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