



A Comparative Study to Evaluate Regional Post Retention of A Pre Fabricated Fibre Post and Custom Cast Post Using The Push Out Test- An Invitro Study

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ABSTRACT

Background: Post and cores contribute in providing predictable restorative options for endodontically treated teeth. The clinician should be knowledgeable in selecting the right type of post and core systems to meet the biological, mechanical, and esthetic needs for each individual tooth.

Objectives: The objective of this study was to evaluate regional post retention of a pre-fabricated fiber post and custom made cast post using the push-out test.

Method: The crowns of 20 recently extracted sound maxillary central incisors were sectioned transversely 2mm coronal to the labial cemento-enamel junction and the roots were treated endodontically. Fiber posts (Reforpost, Angelus) and custom made posts were luted using resin cement (RelyX Unicem, 3M-ESPE). Push-out bond strength tests were performed using a Universal Testing Machine. Bond strength at failure for each section was recorded.

Results: Results of the One-way ANOVA test indicated that the bond strength at the coronal sites was highest and the apical sites were least for both, glass fiber reinforced posts and custom posts. Comparison between the two post types using unpaired student's t test showed that custom posts were significantly more retentive in the coronal section while the glass fiber posts were more retentive in the middle and apical sections. The overall bond strength was higher for glass fiber posts but the difference was statistically insignificant.

Conclusion: The study showed that coronal dentin gave higher bond strength values when compared to the middle and apical dentinal sites, while the apical dentin was least favorable to offer good bond strength irrespective of the type of post used.

KEYWORDS : Bond strength , custom made posts, fiber posts, push out test, resin cement.

INTRODUCTION:

Traditionally, custom-made cast tapered post and cores procedures have been the method of choice to restore endodontically treated teeth. However they increase the risk of root fracture, need more time to be fabricate and need adjustment to achieve an adequate fit. [1]

Pre-fabricated post systems have recently become more popular as they provide satisfactory results, reduce cost of treatment [2], better corrosion resistance, non-hypersensitivity, esthetic appeal, easier removal if needed and single visit treatment. They also match the elastic modulus of the root dentin closely therefore, distribute stresses well thereby leading to reduced and more favorable root fractures.[3]

Most clinical failures involving endodontically treated teeth which have been restored with posts are due to cementation failure which is regarded as a relative failure as it can be re-cemented whereas root fracture is the most serious complication which is also the least common problem.[4]

De-bonding is a problem that clearly needs to be addressed to ensure long-term success of post and cores. Various studies have been carried out in this respect to study the bond between the post and root canal dentin and various factors have been found to contribute to the success and failure of the same.[5] Bond strength of the post to the dentin has been investigated employing the microtensile, pull-out and push-out tests. The push-out test has been found to be most consistent and is used frequently to test the push-out bond strength between the dentin-post complex.[6,7,8]

This study aims to compare and evaluate the regional bond strengths between the root canal dentin and a pre-fabricated fiber-reinforced post and custom-fabricated post cemented using a resin cement using the push-out test.

OBJECTIVES

The objective of this study was to evaluate and compare the push out

bond strengths in the coronal and apical root canal dentin sites for a prefabricated fiber-reinforced post and custom made cast post and to compare the push-out bond strengths of the fiber reinforced post and custom made cast post.

METHODOLOGY

Specimen preparation :

20 maxillary central incisors with fully developed apices extracted for periodontal reasons were collected and the root lengths, mesio-distal and labio-palatal widths of the teeth were measured. Diamond disks (DFS, Germany) were used to section the crowns transversely 2mm coronal to the labial cemento-enamel junction under constant water cooling.

The twenty roots were then divided into two equal groups randomly – Group A and Group B. Standardized root canal preparations were completed with size# 4 Gates-Glidden drills (Mani, India). K-files (Mani, India) were used along-with sodium hypochlorite to carry out the biomechanical preparation of the root canals. Root canals were then dried using absorbent paper points (Dentsply, USA). Gutta percha points (Dentsply, USA) coated with root canal sealer

(AH Plus, Dentsply, Germany) were condensed using spreaders (Mani, India) into the canals. The endodontically treated teeth were then stored at 37°C in normal saline solution for a week.

Post spaces, 10mm deep were prepared using the size# 4 paeso reamers (Mani, India) using a micro-motor (Kavo, Germany) at low speed and under constant water cooling. The post spaces were then rinsed with sodium hypochlorite solution and dried with paper points.

Specimens restored with fiber posts – Group A (Fig 1) :

Pre-fabricated glass fiber reinforced posts (#2 Reforpost, Angelus, Brazil) were placed into the prepared post spaces in Group A. Resin cement (RelyX Unicem, 3M-ESPE, USA) was hand mixed according to the manufacturer's instruction, coated onto the post and carried into prepared post spaces using lentulo spirals (Mani, India). The posts were

then cemented into the canals using finger pressure .

Specimens restored with custom fabricated post – Group B (Fig 2) :

The prepared post spaces were lubricated with vaseline and acrylic pattern resin (GC company, Japan) was coated onto wooden wedges and carried into the post spaces and patterns of prepared post spaces were prepared. The prepared acrylic patterns were invested (Begosol, Bellavest, Bego, Germany), burned out and cast in nickel chromium alloy (Wiron 99, Bego, Germany). The posts were retrieved and adjusted using metal trimmers (DFS, Germany) until a passive fit was achieved within the post spaces. Resin cement (RelyX Unicem, 3M-ESPE, USA) was hand mixed according to the manufacturer's instruction and coated onto the post and carried into prepared post spaces using lentulo spirals (Mani, India). The posts were then cemented into the canals using finger pressure .

All the restored roots were stored in normal saline solution at 37°C for 1 week in an incubator.

A surveyor (Dentaurem, Germany) was used to place each restored root into a cylinder of self cured clear acrylic resin (DPI, India) . Diamond disk was then used to section each root transversely into three sections of 2mm thickness each located 5mm coronal to the apex of the root. The segments were labeled as apical, middle and coronal (Fig 3,4) .

Bond strength assessment :

The coronal surface of the sectioned segments was secured on the platform of the Universal testing machine (HT400, Hounsfield, Germany) and a vertical load was applied at a crosshead speed of 0.5mm/min (Fig 5). The maximum push-out force(N) at bond failure was recorded . The bond strength was calculated by using the formula :

$$\text{Bond strength (MPa)} = N/2 \pi r h$$

Where $\pi = 3.14$, r is the radius of the post segment (mm) and h is the thickness of the post segment. Each dimension was measured using a vernier's caliper .

STATISTICAL ANALYSIS:

Data collected was computerized and analyzed using Statistical Package for Social Sciences (SPSS 14.0) Mean and Standard Deviation (SD) were calculated. One way Analysis of Variance (ANOVA) test was used followed by Tuckey post hoc test for intra-group comparisons. Students unpaired 't' test was employed for group wise comparisons. p-value <0.05 was considered statistically significant.

RESULTS:

Table 1:

Shows the mean bond strength (MPa) of Group A – glass fiber post specimens for the coronal, middle and apical sections which were 12.90 (S.D. \pm 1.43), 11.44 (S.D. \pm 0.76) and 9.19 (S.D. \pm 0.62) respectively. For Group B - custom posts, the mean bond strength values (MPa) were 16.07 (S.D. \pm 1.63) for coronal, 8.75 (S.D. \pm 1.11) for middle and 4.59(S.D. \pm 0.72) for apical.

Table 2 :

Shows the difference between the coronal /middle, coronal / apical and middle/apical sites for Group A specimens which was 1.47, 3.72 and 2.25 MPa respectively and was statistically significant (p<0.05).

Table 3 :

Demonstrates the difference between the coronal/middle, coronal/apical and middle/apical sites which was 7.32, 11.48 and 4.15 MPa respectively and was statistically significant (p<0.05).

Table 4 :

Shows the difference between the mean bond strengths for coronal, middle and apical sections of Group A and Group B. The mean bond strength for coronal sections was higher for Group B (custom posts) when compared to Group A (glass fiber posts) by 3.16 MPa and was highly significant (p<0.001). The glass fiber posts had higher values in the middle and apical sections when compared to custom posts with the difference being 2.69 and 4.59 MPa respectively which was also statistically significant.

Table 5 :

Shows the overall mean bond strength for Group A as 11.18 \pm 1.83 MPa and for Group B which as 9.80 \pm 4.96 MPa. The difference between the overall mean bond strengths of Group A and Group B was 1.37 MPa and was not statistically significant.

TABLES:

Table 1 : Mean bond strengths for Groups A and B.

Custom posts			
Parameter	Coronal	Middle	Apical
Mean	16.07	8.75	4.59
SD	1.63	1.11	0.72
Glass fiber posts			
Mean	12.90	11.44	9.19
SD	1.43	0.76	0.62

Table 2 : Group A (Glass fiber posts) – Intragroup comparisons between the apical, middle and coronal section.

Parameter	Mean Values	P* Value, sig	Coronal	Middle	Apical
Coronal	12.90	P<0.001 HS	-	1.47 S	3.72 S
Middle	11.44		-	-	2.25 S
Apical	9.19		-	-	-

* Oneway ANOVA test

** Tukey's post hoc test

Table 3 : Group B (Custom posts) – Intragroup comparisons between the apical, middle and coronal segments.

Parameter	Mean Values	P* Value, sig	Coronal	Middle	Apical
Coronal	16.07	P<0.001 HS	-	7.32 S	11.48 S
Middle	8.75		-	-	4.15 S
Apical	4.59		-	-	-

* Oneway ANOVA test

** Tukey's post hoc test

Table 4 : Intergroup comparisons between apical, middle and coronal segments of Group A and Group B.

Parameter	Custom posts	Glass fiber posts	Mean difference	p* Value, sig
Coronal	16.07	12.90	3.16	p<0.001 HS
Middle	8.75	11.44	-2.69	p<0.001 HS
Apical	4.59	9.19	-4.59	p<0.001 HS

*Student's unpaired t test

Table 5 : Intergroup comparisons between the overall mean bond strengths of Group A and B.

Parameter	Custom posts	Glass fiber posts	Mean difference	p* Value, sig
Mean	9.80	11.18	1.37	0.16 NS
SD	4.96	1.83		

*Student's unpaired t test

DISCUSSION:

Post and cores contribute in providing predictable restorative options for endodontically treated teeth. The clinician should be knowledgeable in selecting the right type of post and core systems to meet the biological, mechanical, and esthetic needs for each individual tooth.

In this study custom posts and glass reinforced fibre posts were used. Despite their disadvantages the custom made posts are still regarded as the established technique or gold standard for restoring endodontically treated teeth1. On the other hand, the use of fiber reinforced

posts has become increasingly common due to their obvious advantages.[3,9,10]

The timing of post space preparation and cementation may influence the development of high bond strength values between an endodontic post and radicular dentin. Concerns on the immediate procedure were aroused because of the possible negative effect of the unset sealer on post retention. Contamination of the post space with the sealer may impede the set of the luting resin cement during post cementation. The effect of eugenol sealers on the retention of resin-cemented posts has been studied and it has been indicated that the presence of eugenol on the canal walls appears to have an adverse effect on post retention. To avoid this problem epoxy resin root canal sealers have been recommended.[11] In this study for all the samples post space preparation was carried out after 24 hrs of root canal obturation and an epoxy-resin root canal sealer (AH Plus) was used as .

It has also been demonstrated that bond strength is affected by the method of cement application. The best results with the push-out test were obtained when the luting agent was brought into the post space with flexible root canal shaped application aids like lentulo spirals or specific syringes.[5,12,13] In the present study cement application into the canal was done using lentulo spirals.

Deminerlization by phosphoric acid leads to deeper penetration of the adhesive than does a self-etch system, which cannot completely penetrate the smear layer.[10] In the present study the root canals were separately acid etched with 37% phosphoric acid (Scotchbond, 3M ESPE) for 15 seconds for the same reason.

Three types of tests have been used for assessing bonding to root canal dentin: the micro-tensile bond strength test, the push-out test, and the push-in test. The push-out test was first advocated by Roydhouse and measures the shear bond strength of relatively thick cross-sectional specimens.[3] The micro-push-out method has shown to have fewer premature specimen failures and a lower data distribution variability compared to both trimmed and untrimmed micro-tensile specimens during the bond strength evaluation of glass fiber posts to intra-radicular dentin and has been suggested to more closely simulate the clinical conditions. Finite element analysis results also demonstrate that micro-push-out is a more appropriate methodology for the evaluation of glass fiber posts bonded to intraradicular dentin. [8] Therefore in the present study the push-out test was employed to test the bond strengths between the root canal dentine and custom posts and glass fiber reinforced posts. This was carried out using a universal testing machine (Housenfield, Germany).

Different root regions show different distributions and densities of dentinal tubules. A higher bond strength in the coronal section of the root canal is most commonly explained by the higher density of dentinal tubules and the longer resin tags formed in this area .[14]

The push-out bond strength (MPa) was recorded at bond failure for all sixty sections. It was observed that the bond strength for the coronal sections were higher than either the middle and apical sections while the apical segments had least bond strength for both groups A and B and the difference in bond strengths was statistically significant. This finding was consistent with other studies.[3,15,16]

When comparing group A and group B, the coronal sections of custom posts showed higher bond strengths than those of the glass fiber reinforced posts whereas, the glass fiber reinforced posts had higher bond strengths in the middle and apical regions and the differences were statistically significant . When comparing the overall mean bond strengths for groups A and B, it was found that the values for glass fiber reinforced posts was higher than the custom post group but was found to be statistically insignificant. The metal posts were sand blasted as this has demonstrated to enhance retention by increasing the mechanical interlocking[17] and may explain the higher values in the coronal segments. Investigators have suggested that lower values obtained with the resin cements when compared with zinc phosphate are due to the stresses generated during the polymerization shrinkage of the resin cement causing dislocation of the cement from the dentinal surface and leading to incomplete dentin bonding. Additionally, difficulties in achieving adequate conditioning of the dentin surface of the intra-radicular space, lower density of dentinal tubules, and a high configuration factor (C factor) are

obstacles to producing a strong, defect-free dentin bond, and polymerization shrinkage of the resin luting agent may exceed the bond strength to the radicular dentin.[16] This maybe an explanation to the lower values of bond strengths achieved with custom posts in comparison to the glass fiber reinforced posts in the middle and apical sections. It has been suggested that in case of fiber posts the mechanical interlocking of the cement is further improved by a chemical bond to the dentine and the matrix of the fiber reinforced posts. [10,19] However such a penetration of bond resins into the surface of the fiber posts has been reported only for posts featuring a matrix partially based on PMMA resin. [14] Other studies have pointed out a poor penetrability of the methacrylate-based resins into the epoxy-resin matrix of the fibre reinforced posts leading to low mechanical interlocking.[3]

Different surface treatments may provide an opportunity to increase bond strength to fiber posts. Air-borne particle abrasion has shown to increase the bond strength of fiber reinforced posts in some studies [3,22] while other studies have suggested that abrasion may actually degrade the surface properties of these posts.[20,21] Application of a silane coupling agent was observed to improve bond strength to quartz fiber posts but not to glass fiber posts .[14,21] However, the use of silanes to improve resin bonding to fiber posts is a controversial subject as in one in vitro study the placement of a silane coupling agent gave the highest and most uniform bond strengths for a translucent quartz fiber post but this procedure did not improve the bond strengths at any region of the same translucent quartz fiber post in another study.[3] Combined application of a silane coupling agent and dentin adhesives was superior to the application of a silane coupling agent alone when the posts had been etched using sodium ethoxide and when a high viscosity resin composite was used as a core material. Etching using different concentrations of hydrogen peroxide, potassium permanganate and sodium ethoxide has been found to improve bond strength to quartz fiber posts .[3,14,22]

CONCLUSION:

Within the limitations of this study the following conclusions can be drawn,

- Push-out bond strength was significantly higher for coronal sections followed by middle sections and was least for a apical sections for roots restored with glass fiber posts (Group A)
- Push-out bond strength was also significantly higher for coronal sections followed by middle section and was least for a apical sections for roots restored with custom posts (Group B)
- When comparing glass fiber posts (Group A) and custom posts (Group B), custom posts were significantly more retentive in the coronal section while the glass fiber posts were significantly more retentive in the middle and apical sections.
- When comparing the overall mean bond strength between Groups A and B, it was higher for glass fiber posts but the difference was statistically insignificant.

FIGURES



FIG 1: GLASS FIBRE POSTS (GROUP A) CAMANTED INTO PREPARED POST SPACES



FIG 2: GLASS FIBRE POSTS (GROUP A) CAMANTED INTO PREPARED POST SPACES



FIG 3: SECTION GROUP A (GLASS FIBRE POST) SPECIMENS



FIG 4: SECTION GROUP B (CUSTOM POST) SPECIMENS



FIG 5: SECTION PLACED ON THE UNIVERSAL TESTING MACHINE FOR 'PUSH OUT TEST'

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