

Research Article

The effect of different cementation strategies on the pull-out bond strength of fiber post: an ex-vivo study

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ABSTRACT

Background: The purpose of this study was to evaluate the influence of dual cure resin with total etch and self-etch adhesive systems, conventional glass ionomer and zinc phosphate cementing media on the retention of fiber posts.

Methods: 60 freshly extracted bovine mandibular incisors were biomechanically prepared. Post space was created. The specimens were divided into four groups of 15 teeth each according to the material used for luting of posts. Group Z had zinc phosphate cement as luting agent, group R had dual cure resin cement with total etch adhesive (Relyx ARC cement), group G had conventional glass ionomer cement (GC Fuji) and group P had dual cure resin cement with self-etch adhesive (Panavi F). The posts were luted. Prepared samples were tested on the Universal testing machine for pull out strength.

Results: Among the various cemented media tested best pull out bond strength was obtained with Relyx ARC and Panavia F followed by conventional glass ionomer cement. The pull-out strength of glass ionomer cement was slightly higher than zinc phosphate cement but the difference was statistically insignificant.

Conclusions: Based on the results of this study it can be concluded the dual cure resin cement showed the best retention of the fibre glass posts followed by conventional glass ionomer.

Keywords: Dual cure resin cement, Fiber post, Glass ionomer cement, Pull out strength, Zinc phosphate cement

INTRODUCTION

The restoration of endodontically treated teeth often gets complicated due to loss of tooth structure by caries, restorative procedures, fractures and endodontic access preparation. In addition, the loss of water content in dentin after endodontic therapy can reduce tooth resilience and, consequently increase the probability of fracture. The use of post and core in root canal treated teeth having insufficient remaining coronal tooth structure is a universally acceptable procedure.

Glass fiber posts have gained importance because of their purported favorable biomechanical properties,¹ increased

transmission of light within the root and overlying gingival tissues and Young's modulus similar to dentin.

Cement selection for luting of posts is also critical for retention of all types of posts. Resin cements can increase retention, tend to leak less than other cements, and provide strengthening of the root.² Glass ionomer type water based cements have also been suggested as alternatives for the luting of fiber posts. However, the biggest drawback of GIC is their weak bond strength.³

Judicious selection of luting cement is crucial for stability and retention of the rehabilitative complex. The aim of this study was to evaluate the ability of resin,

conventional glass ionomer and zinc phosphate cementing media to retain fibre posts in the tooth.

METHODS

Sixty freshly extracted bovine mandibular incisors with straight roots and root length more than 16 mm were selected for this study (Figure 1). The specimens were stored in normal saline solution till they were used in the study. Coronal and cervical portions of each tooth were sectioned using a, single faced diamond disk (Microdont technology, Germany) at low speed, to standardize the size of the specimens at 16 mm. Thereafter the coronal diameters of the canals were measured with a digital caliper and specimens presenting diameter greater than the diameter of the post (1.5 mm) were discarded. The working length was established 1mm short of the apex. Irrigation of the root canal was done with 0.5% sodium hypochlorite after each instrumentation. The canals were dried with paper points. Protaper rotary files were used for biomechanical preparation. Subsequently the apices of the specimen were sealed with composite. The preparation bur of a tapered glass fiber reinforced post (of diameter 1.5 mm) was selected for post space preparation. 4 mm of the canal in the apical third of the specimen was left out to simulate root canal filling. Upon completion of the preparation, each specimen was embedded into chemically cured acrylic resin leaving 3mm of the most coronal portion of the specimen (Figure 2).

After preparation, all the 60 specimens were randomly divided into four groups considering the strategies for post cementation.

Group Z: 15 posts luted with zinc phosphate cement (control group).

Group R: 15 Posts luted with dual cure resin cement (Relyx ARC cement).

Group G: 15 Posts luted with conventional glass ionomer cement (GC Fuji).

Group P: 15 Posts luted with dual cure resin cement (Panavia F).



Figure 1: Bovine mandibular incisor teeth.

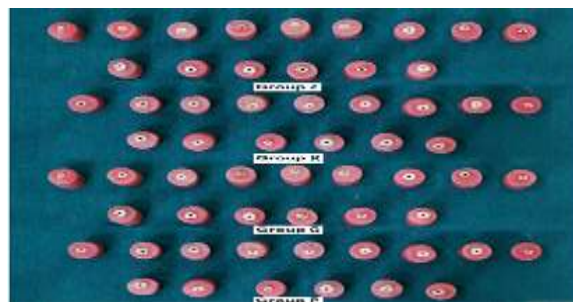


Figure 2: Samples mounted in acrylic.

Table 1: Different cements used in the study.

Materials	Component	Steps of application	Manufacturer
Panavia F	Two pastes, self-etching primer (ED primer) co-initiators	Mixing of equal amounts of ED primer II A and B, applied to post space, left as such for 30 seconds, gently air dried, excess primer removed with paper points. Equal amount of Panavia paste A & B then dispensed and mixed. Cement paste applied onto post and in the canal and then post seated with pressure.	Kuraray
Relyx ARC	Paste, etchant, bonding agent	Etching, rinsing, drying, application of bonding agent, light curing, mixing of two pastes. Cement paste applied onto post and in the canal and then post seated with pressure	3M ESPE
Glass ionomer cement	Powder liquid	Liquid and powder dispensed onto a mixing pad, mixed with the help of a plastic spatula. Cement paste applied onto post and in the canal and then post seated with pressure.	GC AMERICA
Zinc phosphate	Powder liquid	Liquid and powder dispensed onto a mixing pad, mixed with the help of a plastic spatula. Cement paste applied onto post and in the canal and then post seated with pressure.	Harvard

The fibre glass posts were tested inside the post spaces for their fit in the post spaces. The posts were then cleaned with 70% isopropyl alcohol. It was allowed to dry for 1 minute and then a gentle blast of air was applied with the help of three way syringe. Posts were then luted in the canal following the manufacturer’s instructions (Table 1, figure 3).



Figure 3: Sample after luting of post.

After cementation, specimens were stored in distilled water at 37°C for 24 hours in Humidor. Universal testing machine was used for this study to determine the pull out bond strength of glass fiber post (Figure 4). The obtained data were analysed statistically.



Figure 4: Pull out bond strength being tested in universal testing machine.

RESULTS

Among the various cementing media the best pull out strength was obtained with group R (dual cure resin cement with total etch, Relyx ARC) and group P (dual cure resin cement with self-etch, Panavia F) followed by group G (conventional glass ionomer cement). The pull out bond strength of zinc phosphate was lower than glass ionomer cement but the difference was statistically insignificant (At 1% level of significance).

The bar chart of mean values of pull-out bond strength (KgF) for the four groups and comparison of pull-out bond strength of each sample has been shown in graph 1 and 2 respectively. ANOVA (Table 2), t-test (Table 3) and Dunnet’s test were used for statistical analysis.

Table 2: ANOVA table.

Source of variation	Degree of freedom	Sum of squares	E (S.S)	F-ratio calculated	F-ratio tabulated	P value
Groups	3	659.85	219.95	562.96	(3, 56,.01) 4.15	(S)
Error	56	21.88	0.3907	-		
Total	59	681.73	-	-		

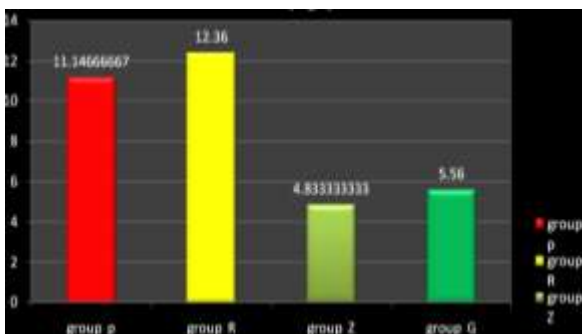


Figure 5: The bar chart of mean values of pull-out bond strength (kgf) for four groups.

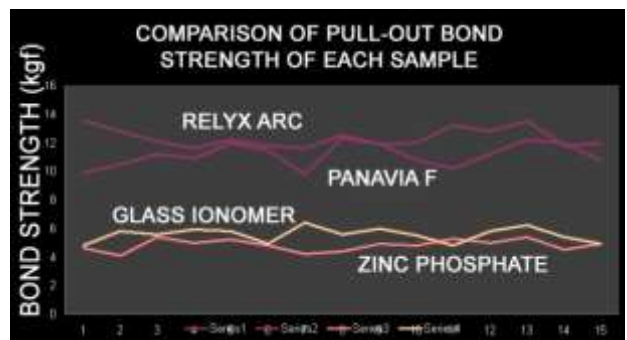


Figure 6: The bar chart of mean values of pull-out bond strength of each sample.

Table 3: t-test table.

Groups	t-test results	S/NS (0.01)
Gr Z-R	0.0000	S
Gr Z-G	0.00189	NS
Gr Z-P	0.0000	S
Gr R-G	0.0000	S
Gr R-P	0.0014	NS
Gr G-P	0.0000	S

DISCUSSION

The quality of the cement is fundamental for post retention. Selecting a reliable luting agent for cementing post is crucial to preventing premature failure of restorations caused by dislodgement of posts and to increase the stability and retention of the rehabilitative complex.

Resin cements can increase retention, tend to leak less than other cements, and provide strength to the root.² However, these cements are highly technique-sensitive, are affected by moisture and require extended chair time, have shorter working time, high viscosity and possibility of accumulation of adhesive may preclude its application in narrow root canals, with risk of incomplete fitting of the post. Bonding of resin cements is mainly impaired by unfavorable root canal configuration, related to a high C factor (cavity configuration factor), which may be up to 40 times higher compared to direct intracoronal restorations with similar cement thickness. From mechanical viewpoint, resin cements generally exhibit a better performance. Saupe et al (1996) emphasized their strengthening effect on roots with thin walls.⁴ Junge et al (1998) reported that posts cemented with resin were more resistant to cyclic loading than posts cemented with zinc phosphate and glass ionomer cements.⁵

Conventional glass ionomer cements (GIC) may be alternatively indicated for the luting of fiber posts. These cements present bonding to dentin by micromechanical mechanisms and chemical bonding, and, despite the polymerization shrinkage they present, their more favorable viscoelastic properties (viscosity and modulus of elasticity), compared to those of resin cements (which are more rigid), and their longer setting time allow a better maintenance of the bonding. Moreover, the hygroscopic expansion occurring after maturation of GIC partially compensates for shrinkage, thus reducing the stress and providing a closer adaptation between cement and dentin at completion of maturation.⁶ The biggest disadvantage of GIC is their weak bond strength, well documented in several studies.³

Bovine teeth have been accepted for in vitro studies earlier. It has been reported that the shear bond strength in human dentin did not present statistically significant differences in relation to bovine enamel. Bovine teeth are accepted as possible substitute for human teeth in either

dentin or enamel bond strength tests.⁷ Compared to human teeth bovine teeth are more easily collected, enable age standardization and reduce the risk of transmitting infectious-contagious diseases.⁸

Obturation of the root canal is controversial. It was not done in our study. According to Khalid A. Al Wazzan & Khalil Al-Ali (2005) leaving the root canal unobturated helps to eliminate a possible variable from the study as the endodontic sealer may affect retentive strength of cemented posts.⁹ Similarly according to Karin Kremer et al (2008) leaving the root canal unobturated eliminates a possible confounding factor. It aids in determining bond strength in the entire root canal extension, including the deepest regions, such as the apical third.¹⁰

Dual cure resin cements used in this study for luting of posts were Panavia F and Relyx ARC luting cement. Panavia F dental adhesives those are self-etch in nature. Relyx ARC utilizes total etch adhesives. Total-etch resin cements utilize phosphoric acid etching that completely dissolves the smear layer and creates a zone of partially demineralized dentin. Conversely, self-etch resin cements utilize adhesives containing increased concentrations of acidic resin monomers to simultaneously demineralize and infiltrate the smear layer covered dentin. It also helps to reduce the number of working steps.¹¹

In the present study, bond strengths of various luting agents to fibre posts were evaluated using a pull out bond strength test. The pull out methodology used in this study is considerably different from the more commonly used push-out method. In the push-out method the tooth is sectioned into thin slices and the post is pushed out of the slice. The push-out force is compressive in nature and unlike the pull-out force which is tensile. These two forces would be largely equivalent if the post were infinitely rigid; however fibre posts can and do flex in response to forces.¹² Push-out tests tend to exaggerate the effects of frictional retention whilst pull-out testing tends to minimize them.

According to results of this study the pull out bond strength for dual cure resin cement with total etch and self-etch adhesive was similar.

As with the current study Y Shimada et al (2002) observed that the bond strength was similar for resin cement with total etch adhesive system and self-etch adhesive cement.¹³⁻¹⁵

According to Bitter et al (2004) Hybrid layer was detected in etch and rinse as well as in self-etch adhesives though the thickness of the hybrid layer may vary.¹⁶ According to Inoue et al thickness of hybrid layer is of minor importance for effectiveness of bonding.¹⁷⁻²⁰

Alberto Albaladejo et al (2010) reported that hybrid layers created by the two step etch-and-rinse self-priming adhesives were thicker than those observed in the

specimens bonded with self-etching adhesive system. Despite the physical appearance of thin hybridized complex, high immediate bond strength has been reported for these self-etching systems. This suggests the absence of correlation between hybrid layer thickness and bonding efficacy as long as a uniform demineralization front is created at the underlying dentin and it is fully impregnated by resin.²¹

In contrast to the present study in one study higher dentin bond strengths was reported when adhesive cements were combined with total-etch adhesives compared to the use of self-etch adhesives.²²

In the present study resin cements exhibited higher bond strength when compared to zinc phosphate and Glass ionomer cement. According to Alvaro H. Cury et al (2006) hygroscopic expansion occurs within the water based cements.²³ A possible reason for the low bond strength of glass ionomer cement may be due to the fact that glass ionomer requires time to attain the maximum strength. According to Timpawat et al (2001) voids were present in glass ionomer cements due to air entrapment. This factor may cause a weak cohesive bonding within the material.²⁴ As per the present study it was reported that micro tensile bond strength for resin cement was greater than that for glass ionomer cement. Findings are reported in the literature showing composite cements to be superior to those of conventional cements.²⁵

According to Smith DC zinc phosphate (1988) cements lack adhesion to tooth structure and exhibit a high degree of solubility, a low compressive strength, and a low tensile strength compared with glass ionomer cement.²⁶ In another study retentive strength of glass ionomer cement was found to be similar to zinc phosphate.²⁷

CONCLUSION

Within the experimental condition of this study it is concluded that among the cementing media tested, the dual cure resin cement with total etch as well as self-etch showed the best retention of the fiber glass posts followed by conventional glass ionomer. The bond strength was slightly higher for the glass ionomer group compared with zinc phosphate cement though it was statistically insignificant.

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Ethical approval: The study was approved by the institutional ethics committee

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