Need for an alternative method to cement fiber-reinforced posts - A pushout bond strength analysis

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Abstract

Background: The use of dissimilar materials used as posts, luting agents, and the core often makes the restorative procedure quite complicated, as each material demands its own technical process. Furthermore, it may not necessarily result in better collective physical properties.

Aim: The aim of this study was to analyze the pushout bond strength of a zirconia-based core buildup material in cementing two fiber posts.

Methods: Eighty single-rooted mandibular premolars were decoronated, endodontically treated, post space prepared, and randomly assigned to one of the following four groups: carbon fiber post luted with PermaCem 2.0, carbon fiber post luted with LuxaCore Z Dual, glass fiber post luted with PermaCem 2.0, and glass fiber post luted with LuxaCore Z Dual. Pushout bond strength was evaluated in a universal testing machine for each of the 2 ± 0.5 mm sections obtained from the samples (total 160 sections)

Statistical Analysis: One-way ANOVA and post hoc tests were used for statistical analysis.

Results: The glass fiber posts cemented with LuxaCore Z showed significantly higher pushout bond strength (P < 0.001).

Conclusion: LuxaCore Z Dual-core build material was more effective as a luting agent for glass fiber post cementation.

Keywords: Carbon fiber posts; dual-cure resin cement; etch and rinse; glass fiber posts; self-adhesive resin cement

INTRODUCTION

Tooth-colored posts such as zirconium-coated fiber posts, fiber-reinforced light posts, and various glass fiber posts are available today to aid in the retention of the final restoration as well as the distribution of torquing forces within the radicular dentin along the length of the root.1,2 Fiber posts have similar modulus of elasticity to dentin thus absorbing the stresses and preventing root fracture.3,4 Retention of fiber posts relies on the strength of the bond between dentin-cement interface on one hand and post-cement interface on the other. In addition to this, minimizing the number of steps in post cementation followed by core buildup may enhance the longevity of the restoration. Hence, this study was undertaken to evaluate the effect of a zirconia-based core buildup material (LuxaCore Z dual) on the pushout bond strength of glass fiber and carbon posts and further check the viability of using a core buildup material to cement posts.

The mode of analyzing the bond strength still remains the pushout bond strength test, and hence, the same was used in this study.5

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METHODS

Eighty, single-rooted mandibular human premolars, which were extracted for orthodontic reasons were used in this study. The study was approved by the Institutional Ethical Committee (MRDC/IEC/2013/10). These teeth had completely formed roots and closed apices, with no cracks or structural anomalies. The presence of a single-root canal was confirmed by taking radiographs in two angulations (mesiodistal and labiolingual). The teeth were then stored in deionized water after autoclaving until further use. According to the ISO standards, the teeth were used within 1–6 months after extraction. Teeth were decoronated 1.5–2.0 mm coronal to the cementoenamel junction with a diamond disc to obtain standardized length of 15 + 1 mm.

Canal shaping was done using ProTaper Gold rotary files (Dentsply International Inc., TN, USA) up to size F3 as the master apical file with intermittent copious irrigation using 3% sodium hypochlorite (Prime Dental Products, Maharashtra, India), 17% ethylenediaminetetraacetic acid, and normal saline. The warm vertical technique for obturation was carried out using F3 gutta percha master cone with AH plus sealer (Dentsply Maillefer, Switzerland). The access cavity was sealed and samples were stored in distilled water at 100% humidity and 37°C for 24 h.

Gutta percha was retrieved using gates-glidden no.2 (MANI, Inc., Tochigi, Japan) and further refined using the corresponding drill for the post size 2 (1.3 mm) leaving 5 mm of gutta percha at the apex. The specimens were randomly distributed into four study groups (n = 20) using a computer program (www.random.org).

In the two groups, where LuxaCore Z (DMG, Hamburg, Germany), a dual-cure adhesive cement was used as the luting agent, the walls of the post space were etched for 15 s with 37% phosphoric acid. Bonding agent was applied as per manufacturer instructions, and roots were polymerized using a light-curing unit for 20 s with the tip directed toward the post space opening. Carbon fiber-reinforced posts were luted in one of the subgroups, while glass fiber-reinforced posts were cemented in the other subgroup using gentle finger pressure, and the excess was immediately removed. The samples were subjected to an additional light curing for 20 s, with the tip of the light cure unit in close proximity to the coronal end of the posts.

In the two groups, where PermaCem 2.0 (DMG, Hamburg, Germany) dual-cure self-adhesive resin was used as a luting agent, the post space was dried and both the subgroups of carbon fiber post and glass fiber posts were cemented and further light cured for 20 s.

The samples were then mounted in customized steel rings using self-cure acrylic and immersed in distilled water for 1 week at 37°C. Two sections measuring 2 ± 0.5 mm were prepared from each sample using low-speed precision IsoMet cutter (Buehler Ltd., IL, USA) at a speed of 200 rpm with continuous water cooling resulting in a total of 160 sections. The sections were then subjected to the universal testing machine to analyze the pushout bond strength.

A customized jig was assembled, and the pin head was placed directly in the center of the sample. Pushout tests were performed with a cross-head speed of 1 mm/min with a pin diameter of 1 mm being attached to a universal testing machine. Care was taken to center the pushout pin on the post surface without causing stress on the post space walls. The load was then applied to the apical side of the root slice to avoid resistance to movement of the post due to post space taper [Figure 1].

Statistics

The data were subjected to statistical analysis for the calculation of mean and standard deviation and percentages. To find the significance of study parameters, one-way ANOVA test was used to compare the mean values between the groups, followed by post hoc tests for group-wise comparison. P ≤ 0.05 was considered to be statistically significant at 95% confidence interval.

RESULTS

Summarized data are presented in Table 1 and Figure 2. The glass fiber post cemented with LuxaCore Z dual group showed the maximum pushout bond strength of 19.50 ± 6.68 MPa, which was statistically significant compared to the other groups. The lowest mean pushout bond strength of 8.38 ± 3.41 was exhibited by the carbon fiber posts cemented with PermaCem 2.0.

DISCUSSION

The present study clearly showed that glass fiber posts cemented with LuxaCore Dual Z using the etch and rinse technique yielded higher bond strength values. Parallel-sided serrated posts which were used in this study resist tensile, shear, and torquing forces better.[6-7] The findings concur with the results in a recent study by Mayya et al.[8] The type of glass fiber selected in this study is known to chemically bond with the adhesive resin matrix.[9-10] The results of this study are in concurrence with those of Allabban et al.,[11] Vadavadagi et al.,[2] Abduljawad et al.,[1] Turk et al.,[16] and Alnaqbi et al.[12]

A statistically significant difference (P < 0.05) in bond strength values between carbon fiber and glass fiber-reinforced posts probably suggests that the amount of light transmitted by the glass fiber-reinforced post permitted more efficient curing of the luting cement.
A dual-cure core buildup material used to cement the glass fiber posts and carbon fiber posts showed higher bond strength values thus reinforcing the fact that low viscosity core materials which minimize the occurrence of voids make it easier to lute the posts.\cite{8,13}

The etch and rinse technique followed during the cementation with the LuxaCore Z groups yielded higher bond strength and is in agreement with the findings of Malyk et al.,\cite{14} Goracci et al.,\cite{15} and more recently by Shafiei et al.\cite{16} Furthermore, the bond strength between a different core buildup material and luting agent affects the retention significantly.\cite{17} Hence, this study was carried out to check the viability of using a core buildup material to cement the posts and thus create a true monobloc effect.

The pushout bond strength testing continues to be the preferred mode for evaluation as is clearly evident in the systemic review of literature by El Mourad.\cite{5}

Comparison to other available core buildup materials could be considered. Methodologically, static loading was used,
and hence, dynamic loading along with thermocycling should be considered. Furthermore, in vivo studies with substantial follow-up could be done to validate the findings of this study.

**CONCLUSION**

Within the limitations of this study, it can be concluded that glass fiber posts cemented using the etch and rinse technique yielded the best results.

LuxaCore Z Dual, primarily a core buildup material, can be used for post cementation. It represents a promising alternative to the resin cements provided by the post system manufacturers because of simplifying the clinical procedure.

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**Conflicts of interest**

There are no conflicts of interest.

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