

Bond Strength of Resin Composites used as Core Materials around Different Types of Fiber Posts

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ABSTRACT

The purpose of this study was to evaluate the shear bond strength of two resin composites around different types of fiber posts. Twenty post specimens were prepared for three types of fiber posts. Posts were embedded in acrylic resin blocks with half of the post diameter exposed. The exposed portions of the posts were successively ground with silicon carbide paper until flattened flush with the acrylic resin, to create a standard smooth surface. All the posts were treated with a single silane coupling agent layer. After silane application, the posts were gently air dried. Three types of fiber posts were randomly divided into two groups, according to the resin composite used. The light-cured composite resins were placed in a polytetrafluoroethylene mold positioned over the post specimens and they were polymerized. Shear bond strength values (MPa) of posts and composite resin cores were measured using an universal test machine. Two-way analysis of variance (ANOVA) and Tukey's test were used for statistical analysis. The result of two-way ANOVA showed that the difference between the post groups was not significant ($p = 0.59$). But significant differences were observed between the core materials ($p = 0.018$). The shear bond strength values were not affected by the type of the fiber post. The type of the composite core material affected the bond strength values between the fiber post and composite core.

Keywords: Light-cured composite, Post-core, Shear bond strength.

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INTRODUCTION

The restoration of endodontically treated teeth with metal-free and physiochemically homogenous materials that have mechanical properties similar to dentin has become a major objective in dentistry.¹ Reconstructing endodontically treated teeth with prefabricated fiber post and core systems has been widely accepted as a treatment option offering both esthetics and function.² These systems can reduce the incidence of nonretrievable root fractures when compared to prefabricated metallic posts or conventional cast posts.³ Fiber posts are currently perceived as promising alternatives to cast metal posts, as their elastic moduli are similar to that of dentin, producing a favorable stress distribution and providing more esthetic outcomes for endodontically treated anterior teeth.⁴ Fiber reinforced post systems contain a high volume percentage of continuous fibers embedded in

polymer matrixes, which are commonly epoxy polymers that keep the fibers together.⁵ Glass fiber posts can be made up of different types of glass, such as e-glass (electrical glass), in which the amorphous phase is a mixture of SiO_2 , CaO , B_2O_3 , Al_2O_3 and some other oxides of alkali metals and s-glass (high-strength glass), which is also amorphous, but differs in composition. Additionally, glass fiber posts can also be made up of quartz fiber, which is pure silica in a crystallized form.⁶

The use of tooth-colored fiber posts, together with the wide choice of composite resins available for core foundation restorations, allows better reproduction of the underlying natural tooth shade, resulting in a more esthetic solution.⁷ Although composites that are specifically designed for core buildups are available,⁸ a large variety of composite resin materials are available to the clinician, from packable to microhybrid to flowable composites.⁹ These nonspecific composite materials achieved good results in terms of microscopic structural integrity and surface adaptation around fiber posts.¹⁰

It is not known whether the bond between fiber posts and hybrid resin composites are as good as the different core buildup composites that are currently available in the market. Therefore, the purpose of this *in vitro* study was to evaluate shear bond strengths between glass and quartz fiber posts and different resin composites used as core buildup materials. The research hypothesis was that different resin composites and fiber posts would affect the shear bond strengths.

MATERIALS AND METHODS

The materials used and compositions are presented in Table 1. Twenty post specimens in 2 ± 0.1 mm post length were prepared for three types of fiber post, including Exacto (Angelus, Londrina, PR, Brazil), DT light post (Bisco Dental Products, Schaumburg, IL, USA) and Reforpost (Angelus, Londrina, PR, Brazil), which were in 1.5 mm diameter. Nonparallel apical parts of the posts were cut with a diamond rotary instrument using a high-speed handpiece under water spray to obtain parallel posts. Posts were embedded in acrylic resin blocks (Meliodent; Heraeus Kulzer, Armonk, NY) with half of the post diameter exposed. The exposed portions of the posts were successively ground with 400-, 800- and 1,200-grit silicon carbide paper (English

Table 1: Materials used in the study

Material	Product	Composition	Code
Fiber post	Exacto	86% glass fiber, 8.5% epoxy resin, 5.5% stainless steel	E
	DT Light post	62% quartz fiber, 38% epoxy resin	B
	Reforpost	57% unidirectional glass fiber, 43% epoxy resin	R
Composite resin	Light-core	7.8% fiber, Bis-GMA, glass filler (>60%), ethoxylated bisphenol A dimethacrylate	C
	Aelite all purpose body	Ethoxylated bisphenol A dimethacrylate, triethylene glycol dimethacrylate, glass fiber, amorphous silica	A

Abrasives, English Abrasives Ltd., England) under running water until flattened flush with the acrylic resin, to create a standard smooth surface. The specimens were ultrasonically cleaned for 3 minutes in deionized water and air dried. All the posts were treated with a single silane coupling agent layer (One-step plus, Bisco Dental Products, Schaumburg, IL, USA) for 20 seconds according to the manufacturer's instruction. After silane application, the posts were gently air dried. Three types of fiber posts were randomly divided into two groups, according to the resin composite used. Light-core (Bisco Dental Products, Schaumburg, IL, USA) is a light-cured composite specially developed for core buildup and Aelite all-purpose body (Bisco Dental Products, Schaumburg, IL, USA) is a light-cured universal microhybrid composite. The light-cured composite resins were placed in a polytetrafluoroethylene mold (Isoflon, Diemoz, France) with a hole in the center (1.5 mm diameter \times 2 mm thickness) positioned over the post specimens and they were polymerized for 40 seconds with a light-emitting diode (LED) light-curing unit Elipar FreeLight 2 (3M ESPE, St Paul, MN, USA). The tip of the polymerization unit was placed in contact with the mold. The specimens were washed with air-water spray and then were stored in distilled water at 37°C for 24 hours before shear bond strength test.

A universal test machine (Instron, L-Loyd Instrument LRX, Segensworth East, UK) was used for shear bond strength test at a crosshead speed of 0.5 mm/min. Each specimen surface was parallel to the direction of the force during the shear strength test. Force was applied to the composite core–post interface. The shear bond strength values of posts and composite resin cores in megapascal (MPa) were measured using an universal test machine by dividing the load used until a fracture occurred (N) to the area of the composite resin ($N/\pi r^2$). The shear bond strength values were calculated from the recorded failure loads, with a bonding area of 1.5 \times 1.5 mm for all specimens. Data was analyzed by two-way analysis of variance (ANOVA; SPSS 13.0; SPSS Inc., Chicago, IL, USA) according to the type of fiber posts, composite cores and their interactions and the mean values were compared by the Tukey HSD test ($\alpha = 0.05$).

RESULTS

The mean shear bond strength values and standard deviations are listed in Table 2. The result of two-way ANOVA showed that the difference between the post groups was not significant ($p > 0.01$). However, significant differences were observed between the core materials ($p < 0.01$). In all post groups, the shear bond strength value of group C was higher than group A. There was no significant difference between the shear bond strength values of the post and core groups ($p > 0.01$).

Table 2: Mean shear bond strength values (in MPa) and standard deviations (SD)

Core	Post		
	B	E	R
A	22.15 \pm 7.32	16.80 \pm 6.33	15.52 \pm 5.76
C	24.35 \pm 11.93	28.51 \pm 11.41	24.08 \pm 15.12

DISCUSSION

The data partially supports the hypothesis that the bond strength was affected by the type of the resin composites but not affected by the type of the fiber posts. The type of the resin composite affected the shear bond strength values significantly.

The mechanical properties of fiber-reinforced composite posts depend on factors, such as the direction¹¹ and volume fraction of the fibers, impregnation of the fibers by the resinous matrix, polymerization shrinkage of the resin, individual properties of fibers and matrix,¹² and the bonding between the resinous matrix and fibers, which is one of the most important factors that may influence the post strength.¹³ If interfacial bonding between the fiber and the matrix is not adequate, no improved mechanical properties are acquired.⁶ The efficacy of silane coupling agents increasing bond strength between fiber post and composite core restorations have been reported.⁴ For all groups, the silane coupling agent was applied to the posts in a single layer in the study.

Although it has been reported that the bond strength between fiber post and dual-cure resin core material depends

upon glass and quartz fiber post, the glass fiber post (E) showed no difference in bond strength with the core materials in comparison with the other glass fiber post (R) and quartz fiber post (B) in the study, rejecting the hypothesis tested. This result may be explained by similar mechanical characteristics of glass and quartz fiber.¹³

While it was assumed that the bond strength between the fiber post and core composite is the most important factor, it is worth mentioning that one of the main problems with fiber posts is that the polymer matrix between fibers is too crosslinked and inactive, thereby leading to a weak adhesion between the post and the composite core material.¹⁴ In the present study, light-core composite that has fiber content like the fiber post showed more bond strength than the microhybrid composite. The type of the composite core material plays an important role in improving the performance of post/core-based restorations.¹⁵

Core buildup materials should exhibit good adaptation, and a reliable bond to the post surface. Ideally, minimal voids should be present along the interface between the post and the composite, as these voids may act as stress raisers and initiate mechanical failure.¹⁶ Stress from shrinkage-strain can weaken the interfacial bond, affecting bond strength to the post surface. Lower shrinkage is expected to occur in composites with a superior filler content.¹⁷ Following this hypothesis, light-core composite that has more filler content showed the highest bond strength to fiber post.

Within the limitations of this study, considering the bond strength of glass and quartz fiber posts with the core materials, shear bond strength values were not affected by the type of the fiber post. On the other hand, the type of the light-cured composite resin affected the bond strength values between the fiber post and composite core. In this *in vitro* experimental study, three types of fiber posts and two types of composite core materials were evaluated. Hence, further studies are required on different types of core materials and fiber posts.

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