Rama Univ. J. Dent. Sci. 2023 March; 10(1):-12-15 ISSN No. 2394-417X (print), 2394-4188(online)

Evaluation of the shear bond strength of two resin composites 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. To produce a uniformly smooth surface, the exposed sections of the posts were successively ground with silicon carbide paper. All the posts were treated with a single silane coupling agent layer and 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

Introduction

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]. Prefabricated fiber post and core systems has been widely used for reconstruction of endodontically treated teeth[2].It reduces the incidence of non retrievable root fractures when compared to prefabricated metallic posts or conventional cast posts[3]. Fiber posts are now viewed as viable substitutes for cast metal posts because their elastic moduli are comparable to those of dentin, resulting in a favourable stress distribution and providing more esthetic outcomes for endodontically treated anterior teeth [4].

Fiber reinforced post systems have a high volume of continuous fibers embedded in polymer matrixes, often epoxy polymers, which hold 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, quartz fiber, which is pure silica in a crystallised form, may be used to create glass fiber posts [6].

With the use of tooth-colored fiber posts, and the variety of composite resins available for core foundation restorations, it allows better reproduction of the underlying natural tooth shade, resulting in a more esthetic solution [7].Although there are composites especially made for core buildups, a large variety of composite resin materials are available to the clinician from packable, microhybrid, and flowable composites [8, 9].

These generic composite materials performed well in terms of surface adaptability around fiber posts and microscopic structural integrity [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 aim of this study was to evaluate shear bond strengths between glass and quartz fiber posts and different resin composites used as core buildup materials.

Materials and methods

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 1.5mm diameter. To create parallel posts, nonparallel apical portions of the posts were cut with a diamond rotary instrument using a high-speed handpiece under water spray.Posts were embedded in acrylic resin blocks (Meliodent; Heraeus Kulzer, Armonk, NY) with half of the post diameter exposed. To produce a uniformly smooth surface, the exposed sections of the posts were successively ground with 400-, 800-, and 1,200-grit silicon carbide paper (English Abrasives, English Abrasives Ltd., England) under running water. The samples were ultrasonically cleaned in deionized water for three minutes before being air dried. According to the manufacturer's instructions, all of the posts were coated with a single coating of silane coupling agent (One-step plus, Bisco Dental Products, Schaumburg, IL, USA) for 20 seconds.

The posts were delicately air dried after being coated with silane. Three types of fiber posts were randomly divided into two groups, according to the resin composite used. Tetric Evoceram (Ivoclar vivadent,Liechtenstein) is a light-cured universal microhybrid composite, and Clearfil Photocore (Kuraray,Japan) is a light-cured core buildup composite. The polymerized light-cured composite resins were placed in a polytetrafluoroethylene mould (Isoflon, Diemoz, France) with a hole in the center (1.5 mm diameter × 2 mm thickness) 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).

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
	D T light post	62% quartz fiber, 38% epoxy resin	B
	Reforpost	57% unidirectional glass fiber, 43% epoxy resin	R
Composite resin	Clearfil Photocore	Silinated silica filler, Silinated barium glass filler, triethylene glycol dimethacrylate, bisphenol-Adiglycidylmethacrylate(Bis-GMA), dicamphoroquinone, catalysts, accelerators and other filler contents	C
	Tetric evoceram	Bis-GMA 3-7 %, UDMA 5-<10 %,Ethoxyl Bis A Dimethacrylate 3-5 % Fillers (48.5% Wt). Barium glass filler. Ytterbium trifiuoride 1-5 %,mixed oxide, pre-polymers 34 % Wt. silica	A

The tip of the polymerization unit was placed in contact with the mold. Before the shear bond strength test, the specimens were cleaned with an air-water spray and then kept in distilled water at 37°C for 24 hours. Shear bond strength tests were conducted using a universal testing device (Instron, L-Loyd Instrument LRX, Segensworth East, UK) at a crosshead speed of 0.5 mm/min. During the shear strength test, each specimen surface was perpendicular to the direction of the force. Force was applied to the composite core–post interface. Using a universal test machine, the shear bond strength values of the posts and composite resin cores were calculated in megapascal (MPa) by dividing the load used until a fractured occured (N) to the area of the composite resin (N/r□2).The shear bond strength values were calculated from the recorded failure loads, with a bonding area of 1.5 × 1.5 mm for all specimens. According to the type of fiber posts, composite cores, and their interactions, the data was analysed using two-way analysis of variance (ANOVA; SPSS 13.0; SPSS Inc., Chicago, IL, USA), and the mean values were compared using the Tukey HSD test.

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	22.16 ± 7.31	16.80 ± 6.30	15.52 ± 5.75
C	24.39 ± 11.91	28.51 ± 11.40	24.08 ± 15.21

Conclusion

The data partially supports the hypothesis that the type of resin composites and not the type of fiber posts had an impact on the bond strength. The values of the shear bond strength were greatly influenced by the type of resin composite. The mechanical properties of fiber-reinforced composite posts depend on factors, such as the direction 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, and the bonding between the resinous matrix and fibers, which is one of the most important factors that may influence the post strength[11.12.13].Lack of interfacial bonding between the fiber and matrix prevents the acquisition of better mechanical properties[6]. It has been demonstrated that silane coupling agents effectively increase the bond strength between fiber post and composite core restorations4.In the study, the silane coupling agent was applied to the posts in a single layer for all group. The glass fiber post (E) showed no difference in bond strength with the core materials in comparison to the other glass fiber post (R) and quartz fiber post (B), rejecting the tested hypothesis even though it has been reported that the bond strength between fiber post and dual-cure resin core material depends upon glass and quartz fiber post. This result may be explained by similar mechanical characteristics of glass and quartz fiber[13].

Although the bond strength between the fiber post and core composite was previously thought to be the most crucial factor, it is important to note that one of the main issues with fiber posts is that the polymer matrix between the fibers is too crosslinked and inactive, which results in a weak adhesion between the post and the composite core material [14].

In the present study, the bond strength of the Clearfill photocore composite, which contains fibres like the fibre post, was higher than that of the microhybrid composite. The type of the composite core material plays an important role in improving the performance of post/core-based restorations [15].

Materials used for the core buildup should adapt well and adhere firmly to the post surface. The interface between the post and the composite should ideally have a minimum amount of voids since these voids might cause mechanical failure by acting as stress raisers [16]. The interfacial connection can become weaker under stress from shrinkage strain, reducing the bond's strength to the post surface. Lower shrinkage is expected to occur in composites with a superior filler content[17].Following this hypothesis , Clearfill photocore 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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To cite this article: Evaluation of the shear bond strength of two resin composites around different types of fiber posts: Rohit Kumar, Richa Singh, Asheesh Sawhny, Baljeet Singh Hora, Mukta Bansal, Virginia Vizo6, Rama Univ. J. Dent. Sci. 2023 March; 10 (1): 12-15