RESEARCH ARTICLE

ENAMEL MATRIX PROTEIN AND PERIODONTAL REGENERATION

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Abstract

Failure of a fiber post and composite resin core often occurs at the junction between the 2 materials. This failure process requires better characterization. The present study was aimed to evaluate Shear Bond Strength between Fiber Post and Composite Resin Core Materials. 20 post samples (3 ±0.1 mm in length) each of three different glass fiber posts were surface treated and bonded with the composite cores supplied by the respective manufacturers, namely,FRC Postec Plus with Multicore Flow [IvoclarVivadent AG, Liechtenstein (Group A-PPM)], Radix Fiber Post with Core X Flow [Dentsply, Maillefer, Switzerland (Group B-RFC)] and Rely X Fiber Post with FiltekTM Z350 XT [3M ESPE AG, Germany (Group C-RXF)]. Shear bond strength values were measured using a universal testing machine and data were analyzed by one way ANOVA Test and Post Hoc Test. The results were obtained and it was concluded that the shear bond strength between FRC Postec Plus and Multicore Flow was found to be maximum and hence can be used for restoring an endodontically treated tooth that have insufficient coronal tooth structure to retain a core for the final restoration.

Key Words Fiber Post, Composite Resin Core, Shear Bond Strength.

INTRODUCTION

Restoring endodontically treated teeth is one of the major treatments provided by the dental practitioner. Selection and proper use of restorative materials and methods continues to be a source of frustration for many clinicians. There is controversy surrounding the most suitable choice of restorative material and the placement method that will result in the highest probability of successful treatment[1].Several methods have been proposed to overcome the problems of corono-radicular stabilization, with post-and-core system being the most common treatment.

An important characteristic of fiber posts is a modulus of elasticity similar to dentin, resin cements and resin core materials.This feature is most beneficial in the presence of a homogeneous post-composite-dentin structure that would allow optimal stress distribution whereas metal posts exhibit high stress concentrations at the post dentin interface.[2]

In the past, several different surface treatments have been used to create a reliable bond between the surface of the fiber post and the composite resin core material. McDonough et al and Elsaka et al found that the application of a Silane coupling agent to glass fiber enhanced the interfacial shear strength and flexural properties of fiber reinforced composite resin.[3] Silane coupling agents can achieve chemical bonds with OH-covered inorganic

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Figure 1. Post Sample Embedded in Acrylic Resin

Figure 2. Silane Application

Figure 3.Application of Composite Core

Figure 4. Light Curing of Composite Core

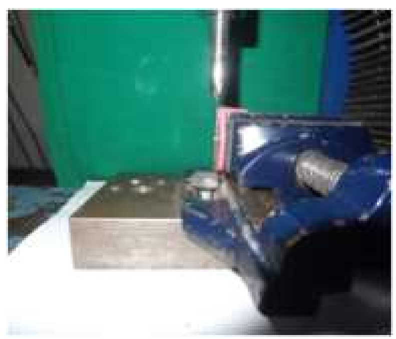


Figure 5. Shear Bond Strength Testing

substrates such as glass. Thus, bonding may be achieved between the core resin matrix and the exposed glass fibers of the post at the interface level.[4]

The present study was conducted to compare the shear bond strength of Fiber Posts with the respective Composite Core materials supplied by three different companies/brands commonly used in day to day clinical practice. This study is an attempt which will help the clinicians to find out which of these materials have the strongest shear bond strength with their respective fiber posts.

MATERIALS AND METHODS

Twenty post samples (3 ±0.1 mm in length) were prepared for each glass fiber posts (FRC Postec Plus, Radix Fiber Post and Rely X Fiber Post). Posts were horizontally embedded in acrylic resin with half of the post diameter exposed (Figure 1). The exposed surfaces were successively ground with #800, #1000 and #1200 grit sized silicon carbide papers, to ensure uniform smoothness. All the samples were then surface treated using silane coupling agent (Silano, Angelus) for 60 seconds (Figure 2). All the post samples were bonded to the composite core supplied by the respective manufacturer namely FRC Postec Plus with Multicore Flow (Ivoclar Vivadent AG, Liechtenstein (Group A-PPM)), Radix Fiber Post with Core X Flow (Dentsply, Maillefer, Switzerland (Gtoup B-RFC)) and Rely X Fiber Post with FiltekTM Z350 XT (3M ESPE AG, Germany (Group C-RXF)). The composite resin was placed in a silicon mold (2.2 mm x 2 mm x 2mm) positioned upon the post specimens (Figure 3) and polymerized for 20 seconds with a light-emitting diode (LED) polymerization unit (Figure 4). The specimens were stored in water at 37°C for 24 hours. Shear bond strength values (MPa) of posts and composite resin cores were measured using a universal testing machine with a crosshead speed of 3 mm/min (Figure5). Data were analyzed by one way ANOVA Test and Post Hoc Test.

Table no. 1: Shear Bond Strength in each group: One Way ANOVA Test:

Group	No of Samples (N)	Mean	Std. Deviation	F value	P value (Significance)
A (PPM)	20	10.12	± 1.32	76.94	0.001
B (RFC)	20	5.22	± 0.99		
C (RXF)	20	7.39	± 0.31		

Table no. 2a: Shear Bond Strength in Group A with other remaining groups: Post Hoc Test (Bonferroni Test):

Group Compared with	Groups Compared to	Mean Difference	Significance
A (PPM)	B (RFC)	4.90	0.001
	C (RXF)	2.73	0.001

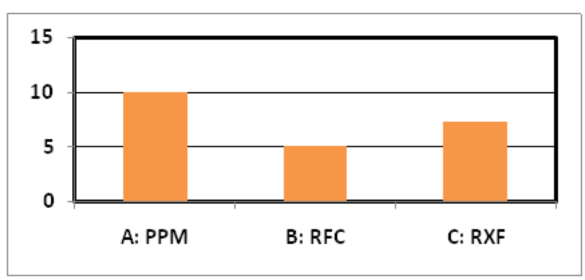
Table no. 2b: Shear Bond Strength in Group B with other remaining groups : Post Hoc Test (Bonferroni Test):

Group Compared with	Groups Compared to	Mean Difference	Significance
B (RFC)	A (PPM)	-4.90	0.001
	C (RXF)	-2.16	0.001

Table no. 2c: Shear Bond Strength in Group C with other remaining groups: Post Hoc Test (Bonferroni Test):

Group Compared with	Groups Compared to	Mean Difference	Significance
C (RXF)	A (PPM)	-2.73	0.001
	B (RFC)	2.16	0.001

Graph 1:Vertical Axis denotes Mean Shear Bond Strength and Horizontal Axis denotes number of Groups



RESULTS AND ANALYSIS

According to Table No. 1, Graph 1 the mean value for the shear bond strength obtained for Group A-PPM was 10.12 with a standard deviation of 1.32. The mean value for shear bond strength test obtained for Group B-RFC was 5.22 with a standard deviation of 0.99. The mean value for shear bond strength test obtained for Group C-RXF was 7.39 with a standard deviation of 0.31. The F value obtained was 76.94 and the P value was 0.001. This indicates a highly significant level of difference existed amongst the mean values of the shear bond strength calculated in the various groups. Once this was established that there was a significant difference between the mean values of the different groups, they were subjected to POST HOC Test to compare each tested group with the other remaining groups.

According to Table No. 2a to 2c the mean difference between Group A and Group B was found to be 4.90 with a P value of 0.001. The mean difference between Group A and Group C was found to be 2.73 with a P value of 0.001. The mean difference between Group B and Group C was found to be -2.16 with a P value of 0.001.

DISCUSSION

Fiber posts are extensively used in clinical practice to restore endodontically treated teeth. The clinical longevity of endodontically treated teeth restored with fiber posts and composite resin cores was recently evaluated by Monticelli F et al (2006).[5] They concluded that satisfactory adaptation at the post/core interface could be achieved using flowable composites as core materials.

In the present study, shear bond strength was compared between the fiber posts with their respective composite resin core material between three different manufacturers. The highest mean shear bond strength value was found in Group A: PPM (10.12 MPa). The second highest mean shear bond strength value was found in Group C: RXF (7.39 MPa). The lowest mean shear bond strength value was found in Group B: RFC (5.22 MPa).

According to Table No. 1, statistically highly significant level of difference existed amongst the mean values of the shear bond strength calculated in the various groups ($f = 76.94$ and $p = 0.001$). The highest mean shear bond strength value was found in PPM when compared with RFC and RXF. Table No. 2a to Table No. 2c clearly depicts that PPM has by far the highest shear bond strength as compared with RFC and RXF. The second highest mean shear bond strength value was found in Group C: RXF. The lowest mean shear bond strength value was found in Group B: RFC.

Similar results showing the best shear strength values of Ivoclar Vivadent were also found by Guler AU et al (2012).[6] In this study, acid etching of FRC Postec Plus posts was done by using 35% phosphoric acid for 60 seconds followed by bonding with Multicore Flow. However, low bond strength values were found by Schmage et al (2009)[7] between FRC Postec Plus and Multicore Flow in which acid etching of the post surface was done using 5% Hydrofluoric acid gel for 60 seconds. The decrease in bond strength was mainly because the Hydrofluoric acid etching resulted in damaging the superficial glass fibers of the FRC posts which decreases the bond strength with the Multicore flow core build up material.

In the present study, although no such acids were used for surface treatment of the FRC Postec Plus posts, similar results with that of Guler AU et al was found. This is probably because of the enhanced bond strength created by the silane coupling agent used to treat all the posts in this study.

The FRC Postec Plus posts used in the present study are fiber reinforced composite post which consists of glass fibers (70%) and dimethacrylates (21%) which formed strong bonds with the methacrylate groups of the composite resin core material Multicore flow. On the other hand Radix Fiber posts and Rely X Fiber posts used in the study have glass fibers (60-70%) which are dispersed in epoxy resin matrix (30-40%) and the methacrylate groups present in the composite core material (Core X Flow and FiltekTM Z350 XT) were unable to form strong bonds with the epoxy resin groups present on the Fiber posts. This might be the reason that higher shear bond strength was seen in case of FRC Postec Plus and Multicore flow than the other two combinations.

The other reason for the low shear bond strength in RFC and RXF might be the absence of surface treatments of the fiber posts with any acid or similar reagents. The bonding of fiber posts with composite resin cores is promoted by various chemical and mechanical surface treatments of posts. Surface treatments are aimed at roughening the post surface, thus enhancing the retention between the post and composite resin core.

Monticelli F et al (2006)[4] found that Silane coupling agents can achieve chemical bonds with OH-covered inorganic substrates such as glass and increases the bond strength of the posts. However, the interfacial strength is relatively low when compared to the values normally achieved with coronal dentin or enamel because of absence of chemical union between the methacrylate based resin composites and the epoxy resin matrix of fiber posts. Similar results were found by Aksornmuang et al (2004)[2] and Goracci et al (2005)[8]. They concluded that Silane agent act as an adhesion promoter at the interface between fiber posts and composite resin cores.

So, for standardization all the glass fiber post samples were treated them with silane coupling agent for bonding with their respective composite resin core materials. The silane was applied in a single layer. According to the results of a study by Vano et al (2006)[9] formation of a multilayer surface could reduce the effectiveness of the silane coupling, as the number of free methacrylate groups is reduced and cohesive failure within the silane coating may occur.

Monticelli et al (2006)[5]in their study found that the flowable composite was able to achieve a satisfactory bond with the fiber posts even in the absence of any surface chemical treatment. So, only the flowable composite core build up materials were included in the study. In the present study, fiber posts and flowable composite cores produced by the same manufacturer were combined together. This was done to avoid pairing of unadvocated combinations in the study thereby incorporating any fallacy.

Clinical Implications:

The present study was aimed to compare the shear bond strengths between three types of fiber posts with their respective composite core build up materials. The shear bond strength between FRC Postec Plus and Multicore Flow was found to be maximum and so can be used for restoring an endodontically treated tooth that have insufficient coronal tooth structure to retain a core for the final restoration.

Scope for further research and limitations of the study:

1. In the present study only silanization of the post surface was done. The different mechanical or chemical surface treatments were not applied. There is a scope in finding out the shear bond strength using various surface treatments of posts.

2. This is an in-vitro study. Similar kind of study can be carried out under oral conditions. Then, the longevity of the bond between the posts and the core materials can be tested when the study is carried out under oral environment.

3. Different bonding procedures have been suggested by different manufacturers for bonding the fiber posts with their respective composite core materials. In the present study, a standardized protocol was followed to achieve a bond between all the post and core combinations. There is a further scope to conduct another study for comparing the bond strengths between the fiber posts and the respective composite cores following the manufacturer recommended procedures for achieving the bonds between each combination.

CONCLUSION

According to the methodology and from the results within the limitations of the study, it can be concluded that the shear bond strength between FRC Postec Plus and Multicore Flow was found to be maximum and so can be used for restoring an endodontically treated tooth that have insufficient coronal tooth structure to retain a core for the final restoration.

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