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EVALUATION OF PUSH-OUT BOND STRENGTH BETWEEN DIFFERENT SURFACE TREATED GLASS FIBER POSTS AND COMPOSITE.

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ABSTRACT:

Aim: To evaluate the effect of push-out bond strength between different surface treated glass fiber posts and resin composite.

Materials and Methods: Four Cylindrical Glass fiber post (GFP) of 1.3mm diameter were divided into four groups depending on the surface treatment of glass GFP. Group I– no surface treatment done for GFP, group II - silane coupling agent was applied to GFP, then coated with bonding agent, group III – GFP was etched with 37% phosphoric acid, then treated with silane coupling agent and later coated with bonding agent and group IV - GFP was etched with 5% hydrofluoric acid then treated with silane coupling agent and later coated with bonding agent. The surface treated posts were vertically stabilized in the centre of a matrix. Composite was filled circumferentially and incrementally and photo cured. It was then sectioned perpendicular to the vertical axis yielding ten 1.0mm thick discs per fiber post. Ten specimens per group were obtained. They were subjected to push-out bond strength using universal testing machine. One - way analysis of variance and Tukey's test were performed to verify statistical differences between groups ($P < 0.01$).

Results: Superior bond strength was seen in 5% hydrofluoric acid etched group. Etching with 37% phosphoric acid or silane coupling agent alone did not show significant difference. GFP without surface treatment showed least bond strength.

Conclusion: Glass fiber posts should be etched with 5% hydrofluoric acid and treated with silane coupling agent before applying bonding agent for a better bond strength between composite and the GFP.

Keywords: Glass fiber post, push-out bond strength, custom made glass fiber post.

INTRODUCTION

The clinical success of endodontically treated tooth depends frequently on post endodontic restoration. Often endodontically treated teeth require use of intra-radicular post to support the coronal restoration and crown root fracture resistance. The post used must show physical properties similar to dentin in order to achieve long term clinical success.[1] Fiber posts have physical properties amenable to the properties of the dentin and are common choice.[2] Fiber posts are available as carbon fiber, quartz fiber, glass fiber and silicon fiber. Huber et al, Rathke et al and Balbosh et al have demonstrated the advantages of GFP over other posts.[3-5]

Certain teeth with large canal spaces pose challenge during post retained endodontic restorations. Developmental anomalies like taurodontism, oval shaped canals, internal resorption, iatrogenic errors such as over instrumentation and previous restorations with excessive post and core diameters may lead to wider canal spaces.[6] Several techniques are reported in literature for treatment of widened canal spaces, such as root reinforcement with composite resin, usage of accessory posts and direct anatomical post[7]. Direct anatomical posts or customization of prefabricated post with composite produced optimum fit to the canal. It resulted in closer adaptation of the post to the canal forming a monoblock. It also reduces the resin cement thickness, thus improving the retentive properties of post to the canal. This technique is easy and may solve some problems associated with cementation of fiber post in a widened canal space. [8]

In spite of the above mentioned advantages, one of the main causes for failure is debonding of post.[9] This is because of poor adhesion of fiber reinforced post to composite. Optimal post surface treatment may increase the bond strength between GFP and composite resin and help overcome the problem. Wang et al has suggested surface treatment of GFP facilitate chemical and micro mechanical retention between the constituents [10] Valdivia et al and Monticelli et al have suggested chemical bonding between post and composite, surface roughening, and combination of chemical and surface roughening. For achieving this, pretreatment of GFP with various agents like ethanol, phosphoric acid, hydrofluoric acid, hydrogen peroxide have been proposed.[11] The aim of this study was to evaluate the push-out bond strength between glass fiber posts surface treated by various techniques and composite.

MATERIALS AND METHOD:

Materials Used:

1. **Glass Fiber Post** (Tenax Fiber Trans, Coltene/Whaledent, USA, MT-H87369)
2. **Silane coupling agent** (Angelus, Silano Angelus, Europe, 42115)
3. **Etchant:** 37% phosphoric acid (Total etch, Ivoclar Vivadent Schaan / Liechtenstein, 0922) 5% hydrofluoric acid (IPS ceramic, Atzgel, Ivoclar Vivadent, Europe, NL9202)
4. **Bonding agent** (Tetric N- Bond, Ivoclar Vivadent Liechtenstein, Europe, R52704)
5. **Composite** (SwissTEC Dentin A2, Coltene/ Whaledent, Switzerland, H44835)
6. **Light cure unit** (Bluephase G-2 LED curing light, Ivoclar Vivadent, Mississauga, Canada)
7. **Universal testing machine** (FIE-UTM-Computerized 81/16, Poona, India)

Methodology:

Cylindrical GFP of 1.3mm diameter were randomly grouped according to the surface treatment of GFP.

Group I (n=10): No surface treatment was done for GFP. GFP was coated with bonding agent

Group II(n=10): Silane coupling agent was applied to GFP and coated with bonding agent

Group III (n=10): GFP was etched with 37% phosphoric acid, then treated with silane coupling agent and later coated with bonding agent.

Group IV (n=10): GFP was etched with 5% hydrofluoric acid, treated with silane coupling agent and later coated with bonding agent.

Fabrication of composite disc (to simulate the custom fabricated post):

All the GFP used in this study were vertically stabilized with addition silicone. A single thin walled polytetrafluoroethylene matrix was placed and secured above the addition silicone. Composite was built in 2mm increments within the matrix and light cured for 20 seconds. Cylindrical composite blocks of height 13mm and diameter 10mm were obtained. They were light cured externally from four directions, for 20seconds in each direction. They were subjected to sectioning with a diamond disc to get ten 1mm thick discs (Figure1). Standardization of thickness was done with a metal caliper.

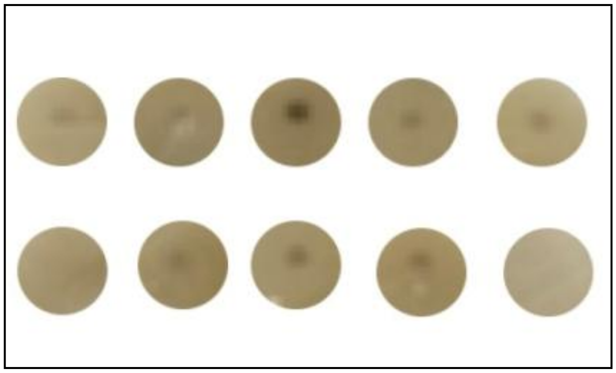

Figure 1: Specimens of diameter 10mm and thickness 1mm

Push-out bond strength evaluation:

Each specimen was placed on the Universal testing machine with a pin head diameter 0.8mm centered on the sectioned GFP in the center of the composite disc. Specimens were loaded with crosshead speed of 1.25mm/min. The force was applied in increasing gradient until the post extruded from the disc (Figure 2a and 2b). *The push-out strength values were recorded in MegaPascal (MPa).*

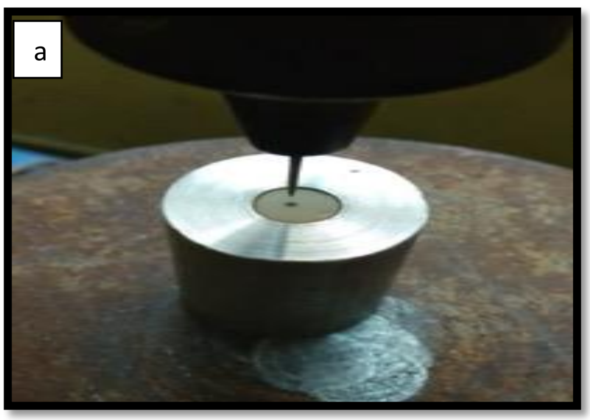

Figure 2: (a) Specimen on Universal testing machine (b) extruded post from the disc

RESULTS:

*Statistical analysis of the data was evaluated using one-way analysis of variance (ANOVA) and Tukey's test to compare the effect of surface treatment on the push out bond strength of custom fabricated GFP (SPSS version 21, Chicago, IL, USA)**.** The mean and standard deviations of the push-out bond strength are shown in Table1. The highest push-out bond strength values were seen for group IV. Group II and III did not show statistically significant difference in bond strength. Group I showed the least bond strength.*

Table 1. Descriptive Statistics (Mean group Push-Out bond Strength [MPa]± Standard Deviation [MPa]

Groups	N	MEAN and SD
I (B+C)	10	10.74±2.99
II(S+B+C)	10	16.93±3.72
III(E+S+B+C)	10	17.69±3.72
IV(HF+S+B+C)	10	20.77±5.19

DISCUSSION:

Wider canals exhibit thin remaining dentin in endodontically treated teeth. Hence, in these kind of clinical situations, the selection and execution of the post placement is important to reinforce the remaining tooth structure[7] Various methods have been proposed in literature for the same. Silva et al reported multiple GFP and GFP reinforced composite has higher fracture resistance than single fiber post and cast metal single post, but when these accessory posts are placed, large lacunae and thicker cement layer were formed.[7] They also have been reported to reduce the cohesive strength of resin cement and leading to debonding of post.[12]. According to Rocha et al, an increase in bond strength values was observed in the customized post group compared to prefabricated groups. [13] This technique reduces the resin cement thickness by allowing close adaptation of the post to the root canal. Thus, the retentive property of the customized post increases. [14]

One of the main disadvantages faced with the customized post is adhesive failure between the post and composite. Hence the longevity of the customized post depends on the adhesive ability.[15]

The matrix present in GFP has epoxy resin[16], owing to their highly cross linked structure, they cannot chemically bond with composite.[17] According to Valdiviya et al, surface treatment of GFP increased the bond strength of GFP to root dentine. [11] Various agents have been proposed in literature for the surface treatment of GFP's. In this study, silane coupling agent, 37%phosphoric acid and 5% hydrofluoric acid were used. Silane coupling agent increases the surface wettability and can chemically bond to GFP. It forms a chemical bridge with hydroxyl covered substrates, such as glass.[28, 39,30] Studies have reported phosphoric acid [11,18-21]. has the ability to remove epoxy layer with intact glass fibers. So exposed glass fibers aid in improving the bond strength both by micromechanical interlocking and by chemical means.[11] Hydrofluoric acid is used for etching ceramic. It creates rough surface that allows micromechanical interlocking with the resinous cement.[22] It has been recently proposed for etching glass-fiber posts.[23]

The push-out test is considered more appropriate to assess the adhesion of post to composite. Specimen of thickness 1mm, allows a more uniform distribution of the load applied throughout the bonded interface.[24] Failure occurs parallel to the post-cement-dentin interface, which is similar to clinical condition.[25]

Result interpretation:

The least bond strength was seen in group I where the samples were subjected to no surface treatment. Group II where the GFP's were treated with silane coupling agent, increased the surface wettability of the GFP, but did not have any effect on epoxy resin. Whereas group III showed higher bond strength than group II, because 37% phosphoric acid has the ability to etch epoxy resin. Bond strength between group II and III was not statsistically significant, might be due to the insufficient etching by phosphoric acid on the GFP. This would have lead to insufficient mechanical interlocking between GFP and composite.[9] Group IV had the highest bond strength. It is proposed that 5%hydrofluoric acid might attack both the fiber and epoxy resin matrix, which produces a corrosive effect on the glass phase of the post, while other chemical conditioning methods only affect the epoxy resin matrix.[26]

CONCLUSION:

Within the limitations of this study, when customized composite reinforced GFP was used especially in wider canal spaces, it was observed that GFP's which was etched with 5% hydrofluoric acid and treated with silane coupling agent before applying bonding agent exhibited better bond strength between composite and GFP. Hence this technique might reduce the debonding of post from the composite, thus increasing adhesive ability and longevity of the post endodontic restoration.

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