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To Evaluate the Influence of Pre-Treatment of Fiber Post on Bond Strength Between Fiber Post and Root Dentin in Push out Test-An Invitro Study.

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ABSTRACT

Background: Restoration of the endodontically treated teeth is complicated by the fact that much or all of the coronal tooth structure has been destroyed by caries, previous restorations and the endodontic access preparation. Post-and-core has been most commonly used when insufficient dentin remains. **Methods**: Fourty translucent glass fiber post (Tenax fiber Trans Coltene Whaledent) of diameter 1.3 mm and 40 extracted premolars were used. Post were divided into 4 groups of 10 each depending on the pre –treatment of post surface.In Group 1: Multilink N primer A & B was applied on post surface and root dentin for 15 sec, (Control group), group 2 : Monobond S primer was applied for 60 sec, followed by multilink N primer A & B, Group 3: Immersion in 30% H_2O_2 for 5min, rinsing and application of Monobond S Primer (silane) and multilink N primer A & B and Group 4: application of 25% polyacrylic acid for 5 sec, rinsing, silane and multilink N primer A & B dual cure adhesive. The specimens were then sectioned horizontally into 1-mm-thick post-dentin sections. The post space (9mm) were divided into 3 halves: the coronal, middle and the apical third.The push out bond strength (MPa) were measured using a universal testing machine at a crosshead speed of 0.5mm/sec.Failure mode of each debonded specimen were analyzed using a stereomicroscope. Maximum failure mode were adhesive failure between post and resin cement. **Results**: The bond strength values were higher in group 3 and group 4 compared to group 2 and group 1. **Conclusion**: The pre-treatment of fiber post increases bond strength between fiber post and root dentin.

Keywords: Fibre post, Surface treatment, failure modes.

INTRODUCTION

The maintenance of teeth in the mouth is the primary goal of dentistry. Restoration of endodontically treated teeth are designed to protect the remaining tooth structure, prevent reinfection of root canal system and replace the missing tooth structure.[1] The extent of the destruction is an important determinant factor in deciding on the restorative techniques and materials to be used.[2]

When there is excessive destruction of the coronal structure, the cementation of a post inside the root canal is used to provide retention.

Some clinicians believe that a post placement strengthens or reinforces teeth. However, some indicate that posts do not strengthen teeth, but instead preparation of a post space may increase the risk of root fracture and treatment failure.[3,4] The main function of a post is the retention of a core to support the coronal restoration.[5]

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Cast post-and-core has been the most commonly used post type. Unfortunately, cast post-and-cores have disadvantages, such as loss of post retention, root fractures, and risk of corrosion. Since the advent of carbon fiber, glass fiber and fiber reinforced composite posts, these have become more popular.

FRC (fiber reinforced composite) posts are aesthetic, they bond to tooth structures, have a high tensile strength and modulus of elasticity similar to that of dentin (20 GPa). FRC posts require minimal preparation of the root canal as the post utilizes the undercuts and surface irregularities to increase the surface area for bonding.[6-9]

The most important limitations of these posts is failure of adhesively luted fiber post often occuring due to debonding of post. A properly bonded post –

dentin unit would have a monoblock like effect. The durability of a composite core restoration depends on the formation of a strong bond between the resin composite and the residual dentin,[10] as well as between the composite and the fiber post, enabling the interface to transfer stress under functional loading.[11]

Several pre – treatment procedures of fiber post have been investigated to enhance the bond between fiber post and root dentin such as silianization. Hydrogen peroxide and sodium ethoxide are commonly employed for conditioning epoxy resin surfaces. The etching effect of these chemicals depends on partial resinous matrix dissolution, breaking epoxy resin bonds through substrate oxidation.[12] Pretreatment with 24% H_2O_2 for 10 minutes, followed by silane application, seems to be an inexpensive, and effective method for enhancing interfacial strengths between both methacrylate-based and epoxy resin-based fiber posts and resin composites.[13]

The purpose of our study was to evaluate the effect of surface pre-treatment using silane, 30% H_2O_2 and 25% polyacrylic acid on the bond strength between fiber post and root dentin and to evaluate failure mode of each debonded specimen using stereomicroscope.

MATERIALS AND METHODS

Tooth Prepartion

40 freshly extracted single rooted teeth having straight roots, absence of root decay, defects, cracks and /or previous endodontic treatment and root length of at least 14 mm were selected. Crowns were sectioned to obtain 14 mm of root length.[14]

Prepartion of the root canal was done using protaper instrument upto size F2. The prepared root canals were obturated with F2 gutta percha (Densply) and AH Plus endodontic sealer. Down packing and back filling was done using E and Q plus heat source.[14,15]

The canal was sealed using glass ionomer cement and stored for 2 weeks in physiologic saline. Then the post space was prepared using pesso reamer drill no. 1and 2 and Tenax Fiber White Drills (Coltène/Whaledent, Cuyahoga Falls, OH, USA). Post space had a depth of 9 mm[16] leaving behind 5 mm of gutta percha apical seal.

Post surface conditioning method: 40 glass fiber reinforced composite post (Tenax fiber White Coltene Whaledent) diameter 1.3 mm, cylindrical with tapered end were used in the study.

Posts were divided into 4 groups, of 10 each, depending on the surface treatment performed.

In Group 1 – Dentin bonding agent (Multilink N Primer A and B; ivoclar vivadent), was applied. Generous amount of mixed adhesive/ activator were applied to post space dentin with microbrush for 15 sec. Mixed adhesive/ activator were also applied to the post surface and gently air dried for 15 sec. Then a multilink N self – curing resin based luting material with light – curing option(ivoclar vivadent), were applied to the post and post was cemented. It was cured for 40 sec using blue visible light.

In Group 2 – A single layer of monobond – S primer agent (ivoclar vivadent) was applied and left to dry for 60 sec. Application of multilink N primer A and B(ivoclar vivadent) was done, similar to group 1, followed by application of multilink N luting agent to lute the post in canal.

In Group 3 –posts were immersed in 30 % H_2O_2 for 5 min, then rinsed with distilled water and air dried. Monobond – S primer was applied, then multilink N primer A and B and multilink N luting agent same as in group 2.

In Group 4 – 25% polyacrylic acid (3M ESPE Seefeld- Germany) was applied on the post surface for 5 sec and rinsed with distilled water, air dried and silanization of post surface for 60 sec were done. Self cure adhesive/ activator were applied, followed by multilink N luting agent same as in group 3.

Push out bond strength evaluation: The specimens were sectioned horizontally with a diamond disk to produce nine 1-mm-thick post-dentin sections. The post space (9mm) was divided into 3 halves: the coronal, middle and the apical third. The middle section of the coronal third ,middle third and of the apical third were standardized for the study [Figure 1]. The thickness was confirmed with the aid of digital calliper.

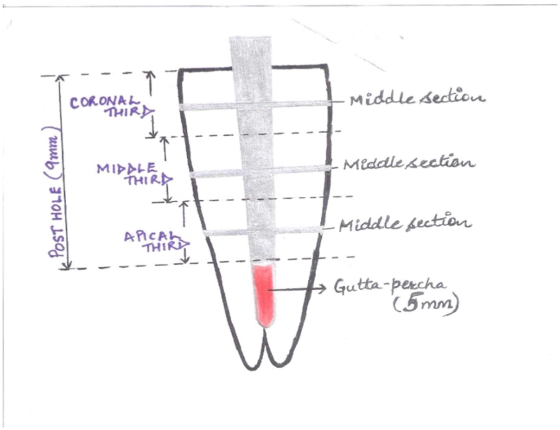

Figure 1: A diagram showing the post space of 9mm were divided into coronal, middle and apical third. The middle section of each were standardized for the study.

A push out jig was constructed using a metal base of 3x3 inches, a hole (1.5mm) was made at the center of the jig for the dislodgement of the post. Each section was attached to a push-out jig with a cyanoacrylate adhesive, whereby the coronal surface faced the jig and the post was centered over the hole of the jig.[16]

The push out bond strength (MPa) was measured using a universal testing machine; equipped with a 1mm diameter cylindrical plunger acting at a crosshead speed of 0.5mm/sec until failure. Results obtained from tensile bond testing for all groups were analysed with one – way ANOVA (SPSS version) and post hoc – student test for multiple comparison with statistical significance set at p = 0.05

Microscopic evaluation

The failure mode of each debonded specimen was analyzed by two independent operators using a stereomicroscope at 2X and 10X magnification. The failure modes were classified as : (1) Adhesive failure between dentin and luting cement; (2) Adhesive failure between luting cement and post; (3) Mixed failure.[17]

RESULTS

The type of surface treatment had a significant influence on the bond strength ($p < 0.05$). Significantly higher bond strength were observed in Group 3 and Group 4 followed by Group 2 and Group 1($p < 0.05$). Group 1- Multilink N primer A and B surface treatment achieved lowest interfacial bond strength compared to all other groups. The mean bond strength values of Group 2 (C: 15.85, M: 11.36, A: 5.27) were higher than in Group 1 (C: 11.83, M: 8.29, A: 2.80) but it was statistically not significant. The mean bond strength value of Group 3 (C: 20.44, M: 14.43, A: 6.03) were slightly higher compared to Group 4 (C: 19.52, M: 13.44, A: 5.47) but it was statistically not significant.

The bond strength were significantly affected by the region of the root canal. the coronal third had highest bond strength followed by middle and least in apical third($p < 0.05$).

[Table 1,2 and 3] shows comparison of mean push out bond strength values in the coronal, middle third and apical third sections of all groups.

Table 1: Strength values in all the groups, comparison of mean strength values in the coronal region.

Coronal	Number	Mean	S. D.	P-value
Group 1	10	11.83	1.01	0.000
Group 2	10	15.85	0.67	
Group 3	10	20.44	0.88	
Group 4	10	19.52	0.87	

Table 2: Strength values in all the groups, comparison of mean strength values in the middle region

Middle	Number	Mean	S. D.	P-value
Group 1	10	8.29	0.48	0.000
Group 2	10	11.36	0.68	
Group 3	10	14.43	0.94	
Group 4	10	13.44	0.61	

Table 3: Strength values in all the groups, comparison of mean strength values in the apical region

Apical	Number	Mean	S. D.	P-value
Group 1	10	2.80	0.80	0.000
Group 2	10	5.27	0.60	
Group 3	10	6.07	0.64	
Group 4	10	5.47	0.86	

DISCUSSION

The loss of tooth structure created by endodontic access (5% loss in structural stability) accompanied by a mesio-occluso-distal cavity can result in an approximately 63% loss of stability.[18\ Fibre posts simplify the post-endodontic restoration procedure in comparison with the use of cast posts, by eliminating the laboratory steps.

Prominent among the advantages of FRC posts is the fact that the flexural and tensile strength is similar to that of the root structure. Also, the mechanical properties of the post ensure that in case of excess loading, the post will fracture prior to the root, thus protecting the tooth from catastrophic root fracture. The FRC posts also display an excellent biocompatibility and are easy to retrieve.[19,20] Although fiber posts offer several advantages, they do have limitation. The failure of adhesively luted fiber post often occur due to debonding of post. The retention of fiber posts relies mainly on mechanical (frictional) retention rather than bonding, similar to metal posts. Clinical studies observed that 1.7% and 4.3% of fiber posts debonded within 30 months, respectively (Malferrari et al. and Cagidiaco et al),[21] and 6.2% of debonding occured after 2-3 years. (Monticelli et al).[22]

Surface conditioning of posts is a treatment of a surface that increases the surface roughness, i.e., the surface energy hence improves wetting and the bond strength between post and resin cement. Surface treatments also create micropores for infiltration of silanes and resin cements.[23]

The use of agents such as hydrogen peroxide,[12, 24] silane[15], adhesive agent and phosphoric acid have been advocated for post surface conditioning. Our results have shown that pre – surface treatment with 30% hydrogen peroxide and 25% polyacrylic acid (Group 4 and 3) statistically significantly improved bond strength when compared to dentin bonding agent alone (Group 1) and silane (Monobond S primer) with dentin bonding agent (Group 2).

Therefore, the results stated that the use of silane and adhesive did not result in improved bond strength. Whereas, surface treatment with 30% H_2O_2 and 25% polyacrylic acid resulted in significantly higher bond strength values. These results are in agreement with the previous studies.[13,24]

Mallmann et al 2007,[17] evaluated the microtensile bond strength of 2 adhesive system Scotchbond

Multi- Purpose Plus (SBMP) and Single Bond (SB) to root dentin and 2 fiber reinforced composite resin posts -Light post and Aesthetic Post . The coronal third presented higher mean bond strength values, especially for SBMP. While as Middle and apical regions demonstrated lower values. This is in agreement with our study. Highest bond strength values were observed in the coronal root section. The bond strength values of middle third were significantly higher compared to apical root section.

We also found that the failure modes in each group were different. This is important because it indicates the quality of bonding between post and cement–dentin and therefore, it can apparently influence the clinical longevity.

Mallmann et al 2007,[17] evaluated the microtensile bond strength of 2 adhesive cement and 2 fiber – reinforced composite post. Fractured specimens were examined under a 25X stereomicroscope to determine the failure mode. Most failure occurred between resin cement and fiber reinforced composite post.

The failure modes in our study found were predominantly adhesive failures between post and resin cement and adhesive failure between root dentin and resin cement and only some mixed failures.

Adhesive failure between post and resin cement occur, due to an absence of chemical union between the epoxy resin based post and the methacrylate – based resin, thus leading to a proposed use of surface treatment to improve the bonding mechanism. In our study most failure occurred were between post – resin interface. Adhesive failure between post and resin cement was seen maximum in group I (Multilink N Primer A& B) and group 2 (monobond S + Multilink N Primer A & B) because the surface treatment used in these groups are not as effective compared to group3 and group 4. The next frequent failure mode seen were adhesive failure between root dentin and resin cement. Seen more in group 3 and group 4 as surface treatment of posts used in these groups was more effective, than in group 1 and 2.

CONCLUSION

Within the limitation of the study, the following conclusion were drawn.

Bond strength value of Group 3 (30% H2O2) and Group 4 (25% polyacrylic acid) was significantly higher than group 1(Multilink N Primer A and B – dentin bonding agent) and group 2(Monobond S primer + Multilink N primer A & B) with coronal dentin showing the highest bond strength as compared to middle and apical root sections in all the groups.

REFERENCES

1. James B Summit, J.Willam Robbins, Richard S Schwartz. Fundamental of Operative Dentistry: A Contemporary Approach Quinessence Publishing: Second Edition; 2001.
2. Sahar A. Sabbak. Prefabricated post and core material versus custom cast post and core in a maxillary first premolar tooth. Review of literature and management of a clinical case. Cairo dental J. 1988 ;14(1)23-26.
3. Guzy GE, Nicholls JI. Invitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. J Prosthet Dent. 1979;42:39-44.
4. Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. Endod Dent Traumatol. 1985;1:108-11.
5. Willam Cheung. A review of the management of endodontically treated teeth. Post, core and the final restoration. JADA 2005;136:611-61.
6. Adanu N, BeliS. Stress analysis of a maxillary central incisor restored with different posts. Eur J Dent. 2007;1:67-71.
7. AlbunquerqueRde C, Polleto LT, Fontana RH et al. Stress analysis of an upper central incisors restored with different posts. J Oral Rehabil. 2003;30:936-943.
8. Lanza A, Aversa R, Rengo Set al. 3D FEA of cemented steel, glass and carbon posts in a maxillary incisors. Dent Mater 2005;21:709-715.
9. Okamotok, Ino T, Iwase N, et al. Three dimensional finite element analysis of stress distribution in composite resin cores with fiber posts of varying diameters. Dent Mater J 2008;27:49-55.
10. O' Keefe KL, Powers JM. Adhesion of resin composite core materials to dentin. Int J prosthod. 2001;14:451-6.
11. Iglesias JG, Gonzaˊles-Benito J, Aznar AJ, Bravo J, Balsega J. Effect of glass fiber surface treatment on mechanical strength of epoxy based composite materials. J Coll Inter Sci. 2002;250:251-60.
12. F Monticelli, R Osorio, FT Sadek I Radovic, M Toledano, M Ferrari. Surface treatment for improving bond strength to prefabricated fiber posts: A literature review. Operative Dentistry 2008;33-3:346-355.
13. M. Vano, C. Goracci, F. Monticelli, F. Tognini, M. Gabriele, F. R. Tay & M. Ferrari. The adhesion between fibre posts and composite resin cores: the evaluation of microtensile bond strength following various surface chemical treatments to posts. International Endodontic Journal; 2006(39):31-39.
14. Camillo D' Arcangelo, Maurizio D'Amario, Francesco De Angelis, Simone Zazzeroni, MircoVadini and Sergio Caputi. Effect of application technique of luting agent on the retention of three types of fiber – reinforced post systems. Journal of Endodontics 2007; 33(11):1378-1382.
15. Camillo D' Arcangelo, Maurizio D' Amario, Francesco De Angelis, Simone Zazzeroni, MircoVadini and Sergio Caputi. Effect of surface treatment on tensile bond strength and on morphology of quartz – fiber posts. Journal of Endodontics 2007;33(3):264-267.
16. Emre MUMCU, Uger ERDEMIR and FulyaToksoy TOPCU. Comparsion of micro push out bond strength of two fiber posts luted using simplified adhesive approaches. Dental Material J 2010;29(3):286-296.
17. Andre Mallmann, Leticia Borges Jacques, Luis Felipe Valandro, and Antonio Muench. Microtensile bond strength of photoactivated and autopolymerized adhesive systems to root dentin using translucent and opaque fiber – reinforced composite posts. The J of Prosthetic Dentistry 2007;97(3):165-172.
18. Varvara G, Perinetti G, Dilorio D, et al. In vitro evaluation of fracture resistance and failure mode of internally restored endodontically treated maxillary incisors with different

heights of residual dentin. J Prosthet Dent. 2007;98(5):365-372.
19. Grandini S, Geracci C, Monticelli F, Tay FR, Fatique resistance and structural characteristics of fiber post: three point bending test and SEM evaluation. Dent Mater.2005;121:75-82.
20. Bateman G, Ricketts DNJ, Saunders WP. Fiber base post system: A review. British Dental Journal 2003;195:43-8.
21. Caqidiaco MC, Goracci C, Garcia – Godoy, Ferrari – M. Clinical studies of fiber posts: a literature review. Int j prosthodont. 2008;21(4):328-36.
22. Monticelli F, GrandiniS,Goracci C, Ferrari M. Clinical behaviour of translucent fiber posts. J Prosthodont. 2003;16:539-596.
23. Lunq CY, Matinlinna JP. Aspects of silane coupling agents and surface conditioning in dentistry: An overview. Dental material 2012;28(5):467-777.
24. Monticelli F, Toledano M, Tay FR, Sadek FT, Goracci C, Ferrari M. A simple etching technique for improving the retention of fiber posts to resin composites. J Endod 2006;32(1):44-47.

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