Marmara Dental Journal (2013) 1: 35-38
DOI:10.12990/MDJ2013127

ORIGINAL ARTICLE

The Effect of Surface Treatments on the Bond Strength of Fiber Post to Root Canal Dentin

Nimet Gençoglu[1], Pelin Sezgin[1], Mustafa Gündoğar[2], Can Şivet[1]

Abstract

It's known that many factors such as root canal dentin or post surface treatment may effect the retention of post. The purpose of this in vitro study was to evaluate the effect of different surface treatments on the bond strength of fiber post with luting agent to root canal dentin. 75 extracted single root teeth were used in this study. The canals were prepared with rotary instruments and obturated by AH Plus and lateral condensation technique. After post space preparation, 75 fiber-posts (Rebilda, Voco) were divided into 5 groups and treated with one of the following surface treatment procedures: no treatment (control), silanization, etching by % 9.6 hydrofluoric acid, sand blasting with 50 milimicron Al2O3 and bonded (15 of each). After that, posts were bonded with dual polimerizing resin based luting material. The specimens were embedded in acrilic resin blocks and sliced from the apical, middle, coronal part of the roots. A push out bond strength test was performed by a universal testing machine at across head speed of 1mm/min. Data were analyzed with one-way Anova and Tukey tests. Although silanization showed the least and sanding the best bond strength, only statistical difference was found between silanization and etching ($p<0.05$) and between sanding and bonding ($p<0.05$). Bonding group showed the highest bond strength in coronal section, and sandblasted group in middle and apical section ($p<0.05$). The different surface treatment affected the bond strenght of fiber post to root canal dentin.

Keywords: Fiber post, push-out test, sanding, silanization, bonding

Introduction

Endodontically treated teeth may often require post and core restoration to restore the missing tooth structure (1). Traditionally used prefabricated or costumized metal posts weaken roots and may lead to root fracture (1, 2). The rigidity of the post should be close to that of the root to distribute the occlusal forces along the length of the root (2, 3). Fiber posts are introduced as an alternative to cast posts and metal dowels due to their modulus elasticity being closer to that of dentin and this feature reduces the risk of root fracture (4-6). Fiber based posts are essentially composite materials and composed of fibres of silica surrounded by a matrix of polymer resin, usually an epoxy resin (7).

Studies have shown that the failure ratio of fiber posts systems are lower than metal post-cores due to their physical and mechanical properties similar to the tooth structure (8, 9). Also, they have some other advantages such as biocompatibility, improvement of light transmission and the optical effects of esthetic restoration (7, 10) Since most failures of fiber posts are because of decementation, the bonding effectiveness into the root canal is crucial for the retention of these posts.

In literature, many studies have focused on the dentin-cement interface or on the combined sandwich dentin-cement-post assembly (11). It's been suggested that applications performed on dentin surface or post surface treatment possibly enhance the bonding ability (12). Irrigants such as sodium hypoclorite (NaOCI), hydrogen peroxide, EDTA, chlorexidine digluconate, citric asid (10%, 20%, and 50%) orthophosphoric acid and their combinations are used to increase the micromechanical retention of the cement by removing the smear layer. As a result of smear layer removal, the cement can penetrate into the dentinal tubules (13, 14). Meantime, dentin tubul densities and root canal orientation may affect the adhesion quality on root dentin.

Regarding surface pre-treatment of fiber posts, both chemical and micro-mechanical treatment protocols have been proposed to enhance the bond strength at the post-cement interface (12). Chemical post-surface treatment that are employed clinically, involve coating of the post with a silane primer, and with an adhesive resin, this is potentially combined with beforehand acid-etching of the post surface (7, 15-18). Although it's indicated that silane application may improve the bonding ability of fiber post, Wrbas et all. (19) did not find any significant effect. Most common micro-mechanical post surface pre-treatment is sandblasting which is intended to remove the top layer of resin and make the glass fiber reachable for chemical interaction (20, 21). Silicate-coated alumina particles are used for sandblasting in Cojet system (3M ESPE, Germany).

[1] Department of Restorative Dentistry, Faculty of Dentistry, University of Marmara, Istanbul, Türkiye.
[2] Department of Endodontics, Faculty of Dentistry, University of Medipol, Istanbul, Türkiye.

Correspondence Address:
Nimet Gençoğlu
Marmara University, Faculty of Dentistry, Restorative Department, Istanbul, Türkiye.
Tel : +90 212 2319120 / 555
Fax : +90 212 2465247
E-mail : ngencoglu@marmara.edu.tr

Considering the literature, studies on that matter are limited and quite contradictious.

The aim of this study was to evaluate the effects of various surface applications on fiber post system by using push-out test.

Materials and Methods

Seventy five extracted human maxillary central incisors were used in this study. The teeth were stored in distilled water at room temperature until used. The inclusion criteria were absense of caries, root crack or fracture. External debris was removed using a ultrasonic scaler. The crown of each tooth was removed to the cemento-enamel junction, using a slow-speed diamond bur under copious water cooling, to standardize root canal length to 18 mm. The roots were endodontically instrumented at a working length of 1 mm from the apex using Ni-Ti rotary instrument of Protaper universal system (Dentsply, Maillefer, Switzerland). Irrigation was performed using a 1ml. 5 % solution of sodium hypoclorite after each change drill through the shaping process. The canals were rinsed with distilled water, dried with paper points and then obturated with gutta-percha cones and AH Plus sealer (Dentsply, Maillefer, Switzerland) using a llateral condensation technique.

Post Space Preparation

Root canal filling was removed by using # 2 Rebilda post drill (Rebilda post system, Voco, Germany) and 4 mm of filling was left in the root canal. Post space was irrigated by using 5 % NaOCI and %17 EDTA, then rinsed by distilled water. After that, the canals were dried with paper points. Seventy five, # 2 Rebilda posts were divided into 5 groups 15 of each.

Group1 (Control group): No surface treatment was performed on post surface.

Group 2 (Silan group): Posts were treated with a silane coupling agents for 60 seconds using a disposable brush and then dried.

Group 3 (Bonding group): Posts surface treated with bonding agent (Fütura Bond DC, Dual curing self etching bond, Cuxhaven, Germany).

Group 4 (Sandblasting group): Posts surface was coated with sandblast using Cojet system (3M ESPE, Seefeld, Germany) at 2-3 bar for 15 seconds from 10 mm. distance.

Group 5 (Etching group): Posts surface treated with 9.6 % hydrofluoric acid for 15 seconds.

Specimen Preparation and Push Out Test

Fiber posts were luted using dual polimerize resin cement (Rebilda DC, VOCO, GmbH, Cuxhaven, Germany) to post space. Specimens were stored at % 100 humidity at 37o C for 1 week. Tooth were embedded in acrylic resin mold. Resin blocks were attached to the arm of a low-speed saw and sectioned perpendicular to the long axis under water cooling by Isomet device (Isomet, Buehler, USA). Three slices (each 1-0.06 mm thick) were obtained from apical, middle and coronal sections of each root.

Push out bond strengths were measured with a Universal testing machine (Shimadzu Corporation AutoGraph AGS-X Series, Kyoto-Japan) at a crosshead speed of 1mm/min. The peak force, which was the force applied at the point of extrusion of the post segment from the test specimen, was taken as the point of bond failure and was recorded in Newtons (N). Then all data were converted to MPa and analyzed using 1 way ANOVA and Post Hoc Tukey HSD tests ($p < 0.05$) using Graphad prism 5.0 program.

Results

The result of this study showed that sanding and bonding procedure enhanced bonding ability. However, statistically no difference was found between control and experimental groups ($p>0.05$). When the experimental groups were compared, silanization showed the least and sanding the best bond strength, but only statistical difference was found between silanization and etching and between sanding and bonding groups ($p<0.05$).According to the location, bonding group showed the highest bond strength in coronal section and sandblasted group in middle and apical section ($p<0.05$) (Table1, 2).

Table 1. Mean and standard deviation values for all groups (MPa).

	Control Mean SD	Etching Mean SD	Silan Mean SD	Bonding Mean SD	Sandblasting Mean SD
Coronal	9.79 ± 5.8	12.16 ± 4.2	9.81 ± 4.9	15.49 ± 8.3	12.91 ± 5.25
Middle	10.53 ± 4.6	9.3 ± 4.5	9.36 ± 2.8	14.17 ± 8.9	13.20 ± 4.31
Apical	10.63 ± 3.8	9.84 ± 7.62	9.97 ± 5.8	9.79 ± 5.8	13.23 ± 8.02

p<0.05

Table 2. Tukey's Test Results

Tukey's Multiple Comparison Test	S.(p < 0.05)	N.S(p>0.05)
Silan versus Sanding	X	
Control versus etching		X
Control versus Silan		X
Control versus Sanding		X
Control versus Bonding		X
Etching versus Silan		X
Etching versus Sanding	X	
Etching versus Bonding		X
Silan versus Bonding	X	
Sanding versus Bonding		X

Discussion

The results of the present study showed that the post surface treatments affected bond strength of fiber-post system to dentin. It's found that bond strength of bonding or sanding groups were significantly better than other groups. Beside that, silane or acid treatment had no significant effect on bond strenght ($p<0.05$).

In literature, contradictory results have been demonstrated with regards to the bonding effect of post surface treatments. Vano et al.(22) found hydrofluoric acid enhancing in post-to composite bond strength and remarkable surface alteration in their study. Albashaireh et al. (23) demonstrated hydrofluoric acid application had no significant effect on bonding ability. In the present study,

also, hydrofluoric acid (9.6 %) treatment was not found effective. D'Arcangelo et al. (24), found that hydrofluoric acid and sandblasting treatment enhanced bond strength of post. Valandro et al.(2) reported that hydrofluoric acid or phosphoric acid treatment had lower bond strength than sanding in their study. In the present study, sanding group also showed the highest bond strength. Contradictory results of the studies may be related to the type of etching or fiber post used. As regards to silanization, our findings collaborated to Wrbas et al's (19) findings which found no significant effect of silanization (19). However, Goracii et al. (17) found significant bond strength of silanization. Matinlinna et al. (25) stated that mechanical and chemical adherence by silanization could not have been clarified yet. Cross-linked polimer matrix on fiber post has no chemical reaction with silane molecule. With this mechanism, the effect of silane can easily be seen on the surface of fiber post and post types having intensive superficial fiber (25). Monticelli et al.(12) announced that there was not any chemical bonding between epoxy resin and methacrylate-based resin within the post material regard to different chemical structure. The compositon of silan (ph, solvent content, molecule size), application mode may affect the results (12,26). On the other hand, Ozcan et al.(26) used H_2O_2 to solve epoxy resin matrix for increasing silanization effect and found successful results. However, H_2O_2 was not used in the present study.Choi et al. (27) evaluated the effect of different treatments on DT Light fiber post surface and found that sanding was more effective than silanization. Soares et al. (28) compared sanding, H_2O_2 application, and hydrofluoric acid treatment on post surface and they observed sanding procedure was the most effective. Collaborate to these finding, Prithvaraj et al. (29) also found sanding procedure more effective than ethyl alcohol and resin primer application. Amaral et al.(30) anounced that none of any silane, hydrofluoric acid and H_2O_2 applications were effective in adherence of fiber post and considered etching application as inadequate. Albarshaireh et al. (31) investigated artificial aging, phosphoric acid or air bone particule abration on post surface and found only the air abration procedure was effective. Shmage et al.(32) compared silane, etch (hydrofluoric acid) and CoJet systems with different composite materials on post surface and observed that CoJet system was found to be effective when used with only RelyX Unicem or MultiCore Flow composites. So they stated that besides surface treatments, the type of luting cements and composite are all important for bonding. Cleleux et al.(33) applied chloroform, sanding or silan on fiber posts and found that chloroform application and sanding procedure enhanced bonding ability and also they stated that sanding was more effective when used after silan. In the present study, sanding and bonding procedure increased the bonding effect although the difference was not signifficant. Ferrari et al.(10) reported no substantial improvement in bond strength by the separate application of silane and a different formulation of dentin adhesives on methacrylate-based quartz fiber posts .Studies have shown that, beside post surface treatment, dentin surface treatment also affected bond strength of post system. Different irrigation solutions were used to clean dental wall for better adaptation. Usage of NaOCl with EDTA can remove smear layer and removing the smear layer provides better adaptation of material into dentin tubules (34, 35).It's demonstrated that canal sealers and residuals disappeared during smear layer removal but inter-tubular and peri-tubular dentin were also demineralized. Irriagation solution can dehydrate dental wall during cleaning procedure and dehydratation might affect the bonding strength (14, 32). Demiryürek et al.(14) investigated the effect of different irrigation solutions on bond strength of fiber post and found that different acids (citric, orthophosporic or EDTA) and acetone based cleansing agent (Sikko Tim) increased bonding strength.The type of adhesive system can also affect the adherence of fiber post (13). Previous studies stated that adhesion to root canal dentin can be obtained with each of the tested luting strategies, but revealed controversial results. Wang et al.(36) analyzed the post bond strength in different adhesive systems and found that the total etch system provides better luting than self etch system. In contradiction to this finding, Zicari et al.(6) found self adhesive system more effective than the multi-step composite cements. In collaboration to this, Bıtter et al.(16) also demonstrated higher bond strength with self adhesive system (RelyX Unicem) than total etch system (Panavia F,Variolink II). In the present study, self adhesive system (Rebilda DC, VOCO, GmbH, Cuxhaven, Germany) was used and not compared with other adhesive systems. According to the present study, bonding and sanding procedure on fiber post increased bond strength to dentin. Beside in vitro studies, clinical studies are needed to confirm this study results.

Acknowledgements

This study is supported by Marmara University's Scientific Research Projects Committee (Project no: SAĞ-A-080410-0067)

References

1. Guzzy G E,Nicholls J I. In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement.J. Prosthet Dent 1979;42:p.39-44.
2. Valandro LF, Zardin LW, de Villa MA, Amaral M, Galhano G, Baldissara P, Bottino MA.Fatigue resistance of teeth restored with fiber posts and different post cementation strengths. Gen Dent.2009 May-Jun;57(3):264-9.
3. Standlee JP, Caputo AA, Hanson EC.Retention of endodontic dowels: effects of cement, dowel length, diameter, and design.J Prosthet Dent.1978 Apr;39(4):400-5.
4. Deutsch AS, Musikant BL, Cavallari J, Lepley JB.Prefabricated dowels: a literature review.J Prosthet Dent.1983 Apr;49(4):498-503
5. Sorensen JA, Martinoff JT.Intracoronal reinforcement and coronal coverage: a study of endodontically treated teeth.Prosthet Dent 1984 Jun;51(6):780-4.
6. Zicari F, Couthino E, De Munck J, Poitevin A, Scotti R, Naert I, Van Meerbeek B. Bonding effectiveness and sealing ability of fiber-post bonding. Dent Mater. 2008 Jul;24(7):967-77.
7. Bateman G, Ricketts DN, Saunders WP . BR Dent J.Fibre-based post systems: a review 2003 Jul 12;195(1):43-8; discussion 37.
8. Cormier CJ, Burns DR, Moon P. In vitro comparison of the fracture resistance and failure mode of fiber, ceramic, and conventional post systems at various stages of restoration.J Prosthodont . 2001 Mar;10(1):26-36.
9. Foxton RM, Nakajima M, Tagami J, Miura H. Adhesion to root canal dentine using one and two-step adhesives with dual-cure composite core materials.J Oral Rehabil . 2005 Feb;32(2):97-104.

10. Ferrari M, Cagidiaco MC, Goracci C, Vichi A, Mason PN, Radovic I, Tay F. Long-term retrospective study of the clinical performance of fiber posts.Am J Dent. 2007 Oct;20(5):287-91.

11. De Santis R, Prisco D, Apicella A, Ambrosio L, Rengo S, Nicolais L. Carbon fiber post adhesion to resin luting cement in the restoration of endodontically treated teeth. J Mater Sci Mater İn Med.2000 Apr;11(4):201-6.

12. Monticelli F, Ferrari M, Toledano M. Cement system and surface treatment selection for fiber post luting.Med Oral Pathol Oral Cir Bucal 2008 Mar 1;13(3):E214-21.

13. Serafino C, Gallina G, Cumbo E, Ferrari M. Surface debris of canal walls after post space preparation in endodontically treated teeth: a scanning electron microscopic study.Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004 Mar;97(3):381-7.

14. Demiryürek EO, Külünk S, Saraç D, Yüksel G, Bulucu B. Effect of different surface treatments on the push-out bond strength of fiber post to root canal dentin. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009 Aug;108(2):e74-e80.

15. Hudis SI, Goldstein GR. (1986). Restoration of endodontically treated teeth: a review of the literature. J Prosthet Dent, 55(1): 33-38.

16. Bitter K, Noetzel J, Neumann K, Kielbassa AM.Effect of silanization on bond strengths of fiber posts to various resin cements. Quintessence Int. 2007 Feb;38(2):121-8.

17. Goracci C, Raffaelli O, Monticelli F, Balleri B, Bertelli E, Ferrari M.The adhesion between prefabricated FRC posts and composite resin cores: microtensile bond strength with and without post-silanization.Dent Mater. 2005 May;21(5):437-44.

18. Perdigão J, Gomes G, Lee IK.The effect of silane on the bond strengths of fiber posts.Dent Mater. 2006 Aug;22(8):752-8. Epub 2006 Jan 19.

19. Wrbas KT, Schirrmeister JF, Altenburger MJ, et al.(2007).Bond strength between fibre posts and composite resin cores: effect of post surface silanization.Int Endod J. ;40(7):538-43.

20. Kern M, Thompson VP.Effects of sandblasting and silica-coating procedures on pure titanium.J Dent. 1994 Oct;22(5):300-6.

21. Sahafi A, Peutzfeld A, Asmussen E, Gotfredsen K.Effect of surface treatment of prefabricated posts on bonding of resin cement.Oper Dent. 2004 Jan-Feb;29(1):60-8.

22. Vano M, Goracci C, Monticelli F, Tognini F, Gabriele M, Tay FR, Ferrari M. The adhesion between fibre posts and composite resin cores: the evaluation of microtensile bond strength following various surface chemical treatments to posts. Int Endod J. 2006 Jan;39(1):31-9.

23. Albashaireh ZS, Ghazal M, Kern M. Effects of endodontic post surface treatment, dentin conditioning and artificial aging on the retention of glass fiber-reinforced composite resin posts. J Prostet Dent 2010;103:31-39.

24. D'Arcangelo C, D'Amario M, Vadini M, De Angelis F, Caputi S. Influence of surface treatments on the flexural properties of fiber posts. J Endod. 2007 Jul;33(7):864-7. Epub 2007 Apr 17.

25. Matinlinna JP, Lassila LV, Ozcan M, et al. An introduction to silanes and their clinical applications in dentistry.Int J Prosthodont. 2004 Mar-Apr;17(2):155-64. Review.

26. Ozcan M, Vallittu PK.Effect of surface conditioning methods on the bond strength of luting cement to ceramics.Dent Mater. 2003 Dec;19(8):725-31.

27. Choi Y, Pae A, Park EJ, et al. (2010). The effect of surface treatment of fiber-reinforced posts on adhesion of a resin-based luting agent. J Prosthet Dent, 103(6):362-368

28. Soares CJ, Santana FR, Pereira JC, et al. (2008). Influence of airborne-particle abrasion on mechanical properties and bond strength of carbon/epoxy and glass/bis-GMA fiber-reinforced resin posts. J Prosthet Dent, 99(6):444-454.

29. Prithviraj DR, Soni R, Ramaswamy S, Shruthi DP. Evaluation of the effect of different surface treatments on the retention of posts: a laboratory study. Indian J Dent Res. 2010 Apr-Jun;21(2):201-6. doi: 10.4103/0970-9290.66637.

30. Amaral M, Favarin Santini M, et al. Effect of coronal macroretentions and diameter of a glass-FRC on fracture resistance of bovine teeth restored with fiber posts. Minerva Stomatol. 2009 ; 58(3):99-106.

31. Albashaireh ZS, Ghazal M, Kern M (2010).Effects of endodontic post surface treatment, dentin conditioning, and artificial aging on the retention of glass fiber-reinforced composite resin posts.J Prosthet Dent. ;103:31-9.

32. Schmage P, Cakir FY, Nergiz I, et al.Effect of surface conditioning on the retentive bond strengths of fiberreinforced composite posts.J Prosthet Dent. 2009 ;102(6):368-77.

33. Cheleux N, Sharrock P, Degrange M.(2007).Surface treatments on quartz fiber post: influence on adhesion and flexural properties.Am J Dent. ;20(6):375-9.

34. Morris MD, Lee KW, Agee KA, et al. (2001).Effect of sodium hypoclorite and R-C prep on bond strenght of resin cement to endodontic surface. J.Endod; 27:753-7.

35. Arı H, Yaşar E,Belli S.(2003).Effect of NaOCl on bond strenght of resin