

Evaluation Of Force Required For Retrieval Of Pre-cementation Silanized Post By Pull Out Test And Electron Microscopic Study Of Surface Changes Of Retrieved Posts : An Original Research

Sourav Bhattacharya¹, Niladri Maiti², Aditya Mitra¹
Anirban Bhattacharyya¹, Asim Bikash Maity¹, Prithwi Bhattacharyy³

¹Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research.

²School of Dentistry, Central Asian University.

³Private Practitioner, Clear Smile Dental Clinic, Tumluk & Kalyani.

Corresponding Author Email: dentex83@gmail.com

KEYWORDS ABSTRACT

Introduction: The aim of the study was to test retentive forces of different adhesive systems after cementation of glass-fiber posts with or without prior silanization of the post by using a pullout test and scanning electron microscope (SEM) observation to detect the mode of failure.

Methods: Forty roots were randomly divided into 6 experimental and 2 control groups: Multilink Speed(Group IA), Multilink Speed + silane (Group IB), Voco Rebulda DC (Group IIA), Voco Rebulda DC + silane (Group IIB), ReluxU200 (Group IIIA), ReluxU200 + silane (Group IIIB), negative control (NEG-CON), and positive control (POS-CON). Tanex posts were placed in the experimental groups (each n = 5) by using an adhesive resin with or without prior silanization. NEG-CON received uncemented posts (n = 5); POS-CON received an active screw post with an adhesive (n = 5). All samples were subjected to a pullout test in a universal mechanical testing machine for pullout tests and SEM to assess the fiber posts and the roots after the tests. Results: Mean failure load values for each ground Group-I-A 11.39Mpa, Group-I-B 11.40Mpa. GRP II-A 14.60N, GRP II-B 14.5N, GRP III-A 13.30 N, GRP III-B 13.80N. The mean failure load (bond strength) of Group-I-A was lower than that of Group-I-B but t-test showed that there was no significant difference between them (p>0.05). with regards to silane application in failure load shows that the mean failure load with silane increased for Voco Rebild The mean failure load (bond strength) of Group-II-A was lower than that of Group-II-B but t-test showed that there was no significant difference between them (p>0.05).Group II (VocoRebild DC),demonstrated greater failure load than Group I (Multilink)and Group III (RelyxU200) between the use of silanization or not. Representative samples for SEM showed ‘debonding’ mainly occurred at the dentine–cement interface.

Conclusions: The results indicated that silanization of fiber posts does not make a difference to prevent dislocation of a post. Dual cure flowable adhesive composite cement was more retentive than self adhesive cements used in the study

Introduction

The restoration of the endodontically-treated teeth has always been a debated topic. As early as 1746 BC, Fauchard proposed the insertion of wooden dowels in canals of teeth to give support to crown retention. Since then, many different materials have been proposed for “reinforcement” and retention of the restorative core.⁽¹⁾

The high demand for esthetic restoration and all ceramic crowns led to the development of variety of tooth colored post. Hence, new glass fiber post systems have been developed which modulus of elasticity is very close to dentin . The adhesive bond of fiber posts can stabilize the tooth substrate. Fractures affecting post restorations could be related to concentration of forces (Sorrentino et al., 2007), Most clinical studies indicated that fiber post restorations might fail via dislodging of the bonded posts or de-cementation(2).

The high bond strength at post-resin cement and resin cement-dentin interfaces is important when the fiber post is used because of their flexibility that allows the post to slightly bend during function. Several studies showed that failures occurred at the resin cement-dentin interface more often than at the post-resin cement interface.(3).

The several surface treatments available for fiber posts can be basically they are three types, Rough surface promotion, Chemical adhesive optimization, combination of both.(4)

The surface treatment of fiber posts with silane coupling agents is characterized as chemical optimization of the post surface and providing increased bond strength.(5)

In recent studies, few investigations have applied pullout testing, which more closely simulates clinical retention loss, in order to investigate the effect of silanization on fiber post systems with modern adhesive cements

A pullout test was used to investigate bond strength between fiber posts and root canal dentin. Pull out tests have several advantages over push-out tests for the investigation of adhesive posts. Which are-

- 1) Pullout tests are an efficient method to assess shear and tensile bond strengths simultaneously.
- 2) In a clinical situation, cohesive failure of fiber posts often occurs as whole fiber post shedding. The situation that a fiber post fractured within the root canal left a segment behind was rarely encountered as well in the clinical situation. (6)

The aim of the study is to evaluate the retentive bond strength of different adhesive systems after cementation of glass fiber-posts with or without prior silanization of the post by using a pull-out test.

The objective of the study is to detect the mode of failure of different adhesive systems by Scanning Electron Microscopy

Material and Methods

Forty human mandibular premolars with straight roots extracted for orthodontic reasons were selected and stored in normal saline. The study was approved by the institutional ethical committee. Roots were closely inspected for cracks External debris removal by ultrasonics.

The roots were cut off at the cemento-enamel junction with a high speed cutting Diamond Disc (Dental Future System, Germany), instrumented to F3 by using a nickel-titanium system Protaper (Dentsply Maillefer, Ballaigues, Switzerland), cleaned with ultrasonically activated 5.25% sodium hypochlorite solution and 17% ethylenediaminetetraacetic acid (EDTA) to remove the smear layer, and filled with F3 gutta-percha and AH Plus (Dentsply, York, PA). A 5-mm-deep space was prepared with a Pizzo reamer #4 (diameter [F] 1.10 mm; Maillefer, Ballaigues, Switzerland) and a twist drill #4 (F 1.30 mm) of the TANEX Taper Lux system following the manufacturer's recommendation. The post space was cleaned with ultrasonically activated 5.25% sodium hypochlorite solution, 17% EDTA, and 75% ethanol before being dried with paper points. Specimens were randomly divided in 2(n=5) control and 6 experimental groups.

Positive control(n=5) Active screw post. (Produits, Dentaires, SAVevey,Switzerland) Post cementation were done with Voco Rebuilda Dc cement .

Negative-control(n=5).Tenax No.2(Coltene Whaledent, Switzerland Lot-MT-F42094) post surface will be treated with alcohol . No adhesive were applied for post cementation.

Experimental groups were - **Group IA** (n=5)Multilink-Speed(Ivoclar Vivadent Lot-TO7962),**GroupIB** (n=5) Multilink Speed +Silane **Group IIA** (n=5)Voco Rebulda DC(VocoLot-13433),**GroupIIB**(n=5)VocoRebuldaDC+Silane,**GroupIIIA**

(n=5)ReluxU200(3MLot503170)**GroupIIIB**(n=5) ReluxU200 +Silane. In non-Silane groups (Gr 1A,Gr2A,Gr3A) the surfaces were washed with 75% ethanol and dried; in the other groups, the surfaces of the posts were coated with the silane coupling agent (Mono bond^R S, Ivoclar VivadentLot-S05675) and dried for 60 seconds. The resected dentin surface of each root was evenly coated with a separating medium, the roots were embedded in an epoxy resin, and then the posts were inserted according to the manufacturer’s specifications of each resin adhesive system and light-cured for 40 seconds. All specimens were immersed in saline at 37C for 24 hours. An universal tester (HEICO, India) was used for the pullout tests at a cross-head speed of 0.5mm/min . Force was applied until the post prolapsed, and the maximum load value (N) was recorded. The specimens were then cut along the long axis by using the dimond disc, stopping just before opening the root canal, and then split by using a chisel. Half pieces were then cut perpendicular to the long axis of the root in sections of 1.0-mm thickness. The sections were ground and polished with 600-grit silicon carbide paper and then demineralized in 37% phosphoric acid for 15 seconds. The collagen was dissolved with 5.25% sodium hypochlorite for 5 minutes, and afterwards the surface was thoroughly cleaned with distilled water. The specimens were placed on an aluminum stub by using a carbon putty and platinum sputter coated for 100 seconds). Then the samples were examined with an SEM (JELOS;JSM-6700F,JELO Tokio, Japan). The fracture interface was classified as adhesive failure (in the resin/dentin interface), cohesive failure (in the internal resin or dentin), or combined failure (both failure modes present). Descriptive statistical analysis was performed to calculate the means with corresponding standard deviations (s.d.). t-test was used to compare the means. One Way Analysis of variance (ANOVA) followed by Tukey’s Test was performed with the help of Critical Difference (CD) or Least Significant Difference (LSD) at 5% and 1% level of significance to compare the mean values. p≤0.05 was taken to be statistically significant.

Results

Maximum load values found for each ground were

Table-: Mean ± s.d., median and range failure load (bond strength) for different adhesive

of descrip							Control	Control
s.d.	.14	.09						
um – Maximum	11.39	1.40	14.60					

Group-I-A 11.39Mpa, Group-I-B 11.40Mpa. GRP II-A 14.60N, GRP II-B 14.5N, GRP III-A 13.30 N, GRP III-B 13.80N. The mean failure load (bond strength) of Group-I-A was lower than that of Group-I-B but t-test showed that there was no significant difference between them (p>0.05). with regards to silane application in failure load shows that the mean failure load with silane increased for Voco Rebuilda The mean failure load (bond strength) of Group-II-A was lower than that of Group-II-B but t-test showed that there was no significant difference between them (p>0.05).

ANOVA showed that there was significant difference in failure load (bond strength) of different adhesives with respect to positive control ($F_{6,28} = 2009.02;p<0.01$). In all specimens ‘debonding’ mainly occurred at the dentine–cement interface and the extracted posts were almost entirely covered with a thin consistent resin cement layer . Nevertheless, very large voids were found in the apical third of some specimen on SEM ANALYSIS. Each sample was seen in 12 different

fields in different magnification. The mode of failure /fracture interface was seen. The fracture interface was classified as

- Adhesive failure (in the resin/dentin interface),
- Cohesive failure (in the internal resin or dentin),
- Mixed failure (both failure modes present). Each type of failure was classified when that failure pattern occupied over 80% of all the area of the field of vision .

Group	Post	Adhesive	Speed	Time	Failure Mode
Group I	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group II	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group III	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group I	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group II	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group III	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group I	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group II	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	
Group III	ReBilda DC	ReBilda DC	1000 (Group1B)	30s	

SEM images of Group I specimens were similar to those of Group II and group III specimens. In all specimens ‘debonding’ mainly occurred at the dentine–cement interface and the extracted posts were almost entirely covered with a thin consistent resin cement layer . Nevertheless, very large voids were found in the apical third of some posts (Fig. 36). SEM evaluation of the specimens after the pull-out test revealed the presence of a little portion of resin cement on the post surface, especially when Group II Voco ReBilda was used. This is in accordance with the presence of a great number of mixed fractures visible on the post surface of the specimens in which –Voco ReBilda was used. Some of the dentinal tubules that were visible on the dentinal walls appear to be obstructed by resin material, while others were open. It was possible to see some glass fibers that probably came off the post surface and were trapped in the cement residue. The interface between the adhesive/ root dentin and adhesive/post were observed. Gaps were visible between the smear layer and the underlying intact dentin in Group II: -this maybe due to the superficial interaction of the adhesive with the smear layer. SEM Analysis On the other hand, self-adhesive

Group III (Relyx U200) has showed evidence of resin tags on post surface. Relyx U200 also showed dense resin tags in coronal region and almost no resin tags in the apical region with a non-uniform thick hybrid layer formation Multilink speed (Group I), several intact resin tags were observed with a well-defined hybrid layer, Furthermore, both groups(silane/ without silane) showed several small bubbles on the cement layer that covered the apical and middle thirds of the posts. Large areas with many fractured resin tags were found on the post surface.

Discussion

The present study evaluated the retentive bond strength of different adhesive systems after cementation of glass fiber - posts with or without prior silanization of the post by using a pull-out test.

Scanning Electron Microscopy is used to detect the mode of failure of different adhesive systems. De Santis et al 2000, and Prisco et al 2003 first proposed that micro mechanical pull out test as a specific design to accurately characterized the post cement interface.(7) . Frictional resistance in pull out test is auto-catalytic by the vertu of poissionian contraction between post and root dentin.(8).

A de-bond propagates up the post, starting at its embedded end in dentin. The pull-out force is directly related to the work of breaking the interfacial bond and the work of stretching the dentin as it becomes detached. As the elastic properties of the dentin are known, the fracture work per unit area of interface can be calculated. Moreover, because the work of fracture is greater for fracture surfaces of greater radius, there is a natural tendency for the failure to remain as close to the interface as possible. Thus, the mechanics of fracture drive the locus of failure towards the interface, even when the bond is strong. (8)

In the present study single rooted teeth with a single root canal were employed. Posts employed were of same length, diameter and taper and post space (5mm). This was done to standardize the length and diameter of posts.

Group II (Voco Rebuilda DC),demonstrated greater failure load than Group I (Multilink)and Group III (RelyxU200). Group II (Voco Rebuilda DC), Group III (RelyXU200) and Group I(Multilink speed) predominantly showed failures associated with the resin dentin interface. Some samples of Voco group showed failures of the post-resin interface.

SEM imaging showed a large number of fiber components in the root canal and even signs of fiber fractures associated with the GroupII (Voco), indicating destruction of the post. The fact that the resin closely bonds with the fiber post is consistent with the study by Akgungor and Akkayan,(9).For Group I (MultilinkSpeed), resin tags were rarely found. In the Group III(RelyXU200), although resin tags were present, the entire tubules were not filled, consistent with the finding of weak bond strengths. Group II (Voco) post surfaces were clean with almost no residue. Large amounts of resin residue were found on the post surfaces of the other 2 groups

In the present study, the resin-dentin inter-diffusion zone observed was a relatively thin layer (1-2 mm) for the Group II (VocoRebuilda). This morphological difference is believed to be due to acidity differences between the bonding systems. (10)

The tested self-etching adhesives resin cement GroupII (VocoRebuilda DC) contain acid monomers, often mixed with water, to make the adhesive systems sufficiently acid to form hybridized complex (similar in thickness), penetrate the smear layer and interact with the underlying dentin about 0.5 mm. (11)

The low bond strengths recorded for the Group III (Relyx U200)and Group I (Multilink Speed) resin cement is probably related to the cements' limited ability to demineralize and infiltrate dentin substrate. SEM analysis revealed that for the Group III (Relyx U200) cements, the predominant type of failure was adhesive between the luting agent and dentin.(12)

Analysis of the failure modes in the present study revealed that most failures occurred between dentin and cement, which was in accordance with the results of Leontine at al 2013.(13)

In the present study, the efficacy of silane with or without the application on bond strength was investigated.

Wang et al.(14) suggested that a silane agent can significantly improve the bonding effect between a fiber post and resin.

According to the results, the application of silane did not show any effect on the failure loads when compared with the non-silanized groups, although this test involved the overall surface area of a post. No differences in pull-out bond strength were found among the groups that used only the silane or without silane.

According to some authors(15) silane treatment did not enhance the bonding between glass fiber posts and different resinous cements. On the contrary, Goracci and colleagues reported an improvement in bond strength between silanized fiber posts and flowable composite cores.(16).

In the present study it is found application of silane does not increase the bond strength. The mean failure load (bond strength) of without silane group was lower than that of with silane group but t-test showed that there was no significant difference between them ($p>0.05$).

The SEM images also demonstrated that the surfaces of the posts before and after the silane treatment were not significantly different.

The fracture modes for Group IA MULTILINK, Group IB MULTI LINK +SILANE, Group III A RELUXU 200, and Group III B RELUX U 200 + SILANE, however, were mainly, yet not exclusively, adhesive (at the resin-dentin interface), and the bond strength at the post-resin interface may have been higher. Therefore, an earlier failure at the resin-dentin interface may have influenced the investigation of the effect of the silanization to a certain extent for these groups. Nevertheless, the Group II (Voco), which demonstrated primarily post-resin interface failures, clearly showed no difference between silanized and non-silanized posts.

Within the limitations and experimental conditions the present study was done to evaluate the effect of surface treatment with silane on the retention of glass fiber posts. The retentive strengths were obtained using universal testing machine. The readings were subjected to statistical analysis. Scanning Electron Microscopy (SEM) was done to detect the mode of failure

Conclusion

The results indicate the following conclusion:

- Treating the surface of the posts with silane produced no statistically significant difference in the retentive strength of all non-silanized posts used in the study.
- The SEM images also demonstrated that the surfaces of the posts before and after the silane treatment were not significantly different
- The fracture modes for all Groups, were mainly, yet not exclusively, adhesive (at the resin-dentin interface), in nature.
- Dual cure flowable adhesive composite cement was more retentive than self-adhesive cements used in the study

Reference

1. 92 Morgano SM, Restoration of pulpless teeth: application of traditional Principles in present and future contexts. J Prosth Dent;75:375-380
2. 57 Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications in fixed prosthodontics. J Prosthet Dent 2003; 90(1): 31-41.
3. 12 Boschian Pest L, Cavalli G, Bertani P, Gagliani M. Adhesive post-endodontic restorations with fiber posts: push-out tests and SEM observations. Dent Mater 2002; 18(8): 596-602.
4. 113 Sahafi, A.; Peutzfeldt, A.; Asmussen, E.; Gotfredsen, K. Bond strength of resin cement to dentin and to surface-treated posts of titanium alloy, glass fiber, and zirconia. J Adhes Dent, New Malden, v.5, n. 2, p. 153-162, 2003
5. 148 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, Copenhagen, v. 24, n. 7, p. 967-977, 2008

- 6 51 Gallo III J.R, Miller T, Xu X and Burgess J.O. In Vitro Evaluation of the Retention of Composite Fiber and Stainless Steel Posts. *Journal of Prosthodontics* March 2002; Vol 11: No 1: pp 25-29
- 7 27 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 Med* 2000;11:201-206.
- 8 107 Peterson, C.G., LOK-TEST and CAPO-TEST pullout testing, twenty years experience, in Proc Conf. on Non-Destructive Testing in Civil Eng., J.H. Bungey, Ed., British Institute of Non-Destructive Testing, 1997, 77
- 9 4 Akgungor G, Akkayan B. Influence of dentin bonding agents and polymerization modes on the bond strength between translucent fiber posts and three dentin regions within a post space. *J Prosthet Dent* 2006;95:368–78
- 10 34 Erhardt MC, Osorio E, Aguilera FS, Proença JP, Osorio R, Toledano M. Influence of dentin acid-etching and NaOCl-treatment on bond strengths of self-etch adhesives. *Am J Dent* 2008;21:44-8
- 11 5 Alberto Albaladejo, Raquel Osorio, Manuel Toledano, Marco Ferrari. Hybrid layers of etch-and-rinse versus self-etching adhesive systems. *Med Oral Patol Oral Cir Bucal*. 2010 Jan 1;15 (1):e112-8
- 12 110 Ronaldo G. Viotti, DDS,aAlline Kasaz, DDS,b Carlos E. Pena et al. Microtensile bond strength of new self-adhesive luting agents and conventional multistep systems. *The Journal of Prosthetic Dentistry* Nov 2009. Volume 102
- 13 33 Emre MUMCU, Ugur ERDEMIR and Fulyatoksoy TOPCU. comparison of micro push out bond strengths of two fiber posts luted using simplified adhesive approaches. *Dental materials journal* 2010; 29(3): 286-296
- 14 143 Wang YJ, Zhang L, Chieffi N, Chen JH, Ferrari M. Combination of sandblasting and silanization on the bond strength between fiber post and resin cement. *International Dentistry SA* 2006;8:22–30.
- 15 16 Bitter K, Meyer-Lückel H, Priehn K, Martus P, Kielbassa AM. Bond strengths of resin cements to fiber-reinforced composite posts. *Am J Dent*.2006Jun;19(3):138-42
- 16 23 Cederlund A, Jonsson B, Blomlöf J. Shear strength after ethylene diamine tetra acetic acid conditioning of dentin. *Acta Odontol Scand* 2001;59:418-22.