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Evaluation of pushout bond strength of surface-treated glass fiber posts using universal adhesives with and without Silanization: an *in vitro* study

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Abstract

Background: Endodontically treated teeth that lack coronal tooth structure may require the placement of a post to provide adequate retention of a core foundation followed by a crown. Glass fiber posts have become one of the most popular because of the similar modulus of elasticity to dentin.

Aim: To evaluate the push-out bond strength of surface-treated glass fiber posts to intraradicular dentin using universal adhesives with and without silanization.

Materials and methods: Thirty single-rooted teeth were prepared up to the working length in a step-back technique and obturated. Post space was prepared to the length of 10 mm. Based on silanization specimens were divided into two groups of 15 each. Clearfil Tri-S bond universal was used as a bonding agent. The two groups including, Group 1 (without Silanization) (CTSBU): post-treatment - only 9%HF, and Group 2 (With Silanization) (CTSBU+S): post-treatment - 9%HF followed by silane. RelyxU200 was used to lute the posts, and the samples were divided into three parts (cervical, middle, and apical) and subjected to push-out bond strength analysis. Overall comparisons were done by analysis of variance (ANOVA), and pairwise comparisons were done by student t-test. The level of significance was set at $p < 0.05$ for all tests.

Results: In all the root regions, group 2 (CTSBU+S) showed the highest pushout bond strength with statistical significance ($p<0.05$) when compared to other groups. In all the groups, the cervical region showed the highest bond strength when compared to the middle and apical regions which were significant ($p<0.05$).

Conclusion: It can be concluded that the Silanization of the glass fiber posts showed to improve the bond strength and the cervical region has better bond strength among the three regions of the post.

Keywords: Glass fiber posts, pushout bond strength, Silanization, Universal adhesive.

1. Introduction

Dentistry has undergone significant evolution since its beginning. With the advancements in restorative dentistry and endodontics, there is a shift towards conservative and effective treatment approaches, promoting the preservation of natural teeth and enhancing patient care [1]. Endodontically treated teeth that lack coronal tooth structure due to severe damage by decay, previous restorations, trauma and excessive wear have increased susceptibility to tooth fracture and may require the placement of a post to provide adequate retention of a core foundation followed by crown [2].

Post can be custom-made and prefabricated. The traditional custom-cast post-core provides a better geometric adaptation and can change the angulation of the crown or core. However, cast metals with their high modulus of elasticity can create stress concentrations at specific regions of the root, causing catastrophic root fractures [3]. Considering the aesthetics of the anterior teeth, using cast metallic posts can result in discolouration and shadowing of the cervical gingival aspect has led to the development of metal-free posts [4].

Prefabricated posts can be metal posts such as titanium and stainless steel or nonmetals such as ceramic, carbon, quartz fiber and glass fiber posts [5,6]. Fiber posts have become popular because they have a similar modulus of elasticity to dentine (approximately 20 GPa) and have comparable bond strength to dentine. They are esthetic and allow easy placement with better bonding to a composite core. A low incidence of root fracture and more repairable situations in the instance of failure have been reported with fiber posts, which subsequently increase the survivability of the tooth as compared to cast post [7]. The durability of the post relies on the development of a strong bond between the luting cement and the intra-radicular dentin, as well as between the luting cement and post material allowing the interface to efficiently transfer stresses under functional loading that reduces the root fractures [2]. Hence bonding between luting cement and post and bonding between luting cement and dentin may be improved through different post-surface treatments, careful choice of adhesives, and resin luting cement [8]. Surface treatments of post surfaces improve adhesion between post and resin-luting cement by allowing micromechanical and chemical retention between different constituents [9]. Hydrofluoric acid in combination with a silane-coupling agent is often employed to enhance the bond strength between composite resins and glass fiber posts [10].

Self-adhesive resin cement presents a less sensitive technique because it eliminates the pre-cementation steps of the resin cement inside the root canal and promotes better bond strength results than conventional resin cements. However, numerous studies have revealed that using self-adhesive resin cement alone does not considerably increase the bond strength of the glass fiber posts, therefore, an additional adhesive is required [3,11]. One of the most recent novelties in adhesive dentistry is the introduction of universal bonding agents. They contain 10 MDP (10- Methacryloyloxydecyl dihydrogen phosphate), a hydrophilic monomer with mild etching properties that enables it to be used with any etching technique (multimode adhesives) [12]. They combine the already existing "all-in-one" concept with the versatility of being adaptable to metals, ceramics, zirconia etc [8]. There are very few studies on the effect of silane application on the bond strength of glass fiber posts. Therefore, the present study aimed to evaluate the effect of universal bonding agent and hydrofluoric acid as surface treatment agents of the posts with and without silane application on push-out bond strength of glass fiber posts cemented with resin luting cement to intra-radicular dentin.

2. Materials and methods

Freshly extracted human maxillary single-rooted teeth were collected and thoroughly cleaned to remove hard and soft tissue deposits. These teeth were radiographed buccolingually and mesiodistally to determine the presence of a single canal. The crown of each tooth was transversely sliced 1 mm coronal to the cementoenamel junction with a low-speed handpiece (Marathon) and diamond disc while being constantly sprayed with water. Finally, 30 roots with cervical canal diameters that are 0.1-0.3 mm greater than the post diameter were selected. This was accomplished by customizing 0.06 taper gutta-percha (Dentsply) in an endo gauge to a diameter of 1.4mm (the manufacturer's post diameter is 1.3 mm). The specimens were then selected by inserting the tailored gutta-percha into the cervical region of the canal.

2.1 Specimen preparation

Root canals were shaped and cleaned up to the working length using K-files #15 to #40 and a master apical file #3 (MANI Tochigi, Japan) in a step-back technique. The root canals were enlarged using Gates Glidden burs #2 to #4 (MANI Tochigi, Japan), irrigated with sodium hypochlorite and rinsed with normal saline. The root canals were obturated with gutta-percha points (Dentsply Maillefer, USA) and sealer (ADSEAL, Meta Biomed) with the lateral condensation technique. The teeth were stored for 24 hours at 37℃ and 100% humidity to allow the sealer to set. Post space was prepared to the length of 10 mm using the special drills provided by the manufacturer (Angelus, Brazil). Clearfil Tri S bond Universal (Kuraray, Noritake, Japan) was directly applied into the canal space and rubbed for 10 seconds. Air dried for 5 seconds and cured using an LED light cure unit (Spectrum 800- Dentsply Maillefer, USA). Based on bonding agents 30 specimens were divided into two groups of 15 each.

Group 1 (without Silanization) (CTSBU): 9% hydrofluoric acid (Ultradent, South Jordan, UT) was used as surface treatment agent for glass fiber post. It was applied on the clean bonding surface for 90 seconds, rinsed and air dried. Silanization was not done in this group.

Group 2 (With Silanization) (CTSBU+S): The post was surface treated with 9% hydrofluoric acid (Ultradent, South Jordan, UT), as described in group I, and then silanized. A puddle coat of silane (Ultradent, South Jordan, UT) was applied to the post for 60 seconds and air-dried without rinsing.

The resin-luting cement (Relyx Unicem 2, 3M ESPE) was spread on the post and was immediately placed inside the canal by rotating slightly to avoid the inclusion of air bubbles. Moderate pressure was applied to hold the post in position. Excess cement was removed, and the post was light-cured for 40 seconds using a QTH light curing unit (Spectrum 800, Dentsply) from the occlusal surface. The specimens were stored at 37°C and 100% humidity for 24 hours. Then the samples were embedded in clear self-cure acrylic resin. After setting the epoxy resin three horizontal sections of 3.0mm thickness each were cut from the cervical, middle, and apical root thirds using a diamond disk.

2.2 Evaluation of push-out bond strength

Each slice was placed in a Universal testing machine (Instron3369, Canton, MA, USA) with its cervical surface facing towards the jig. The cylindrical piston (1 mm in diameter) was placed exactly in the middle of the root without contacting the interface. The loads were applied in an apicocervical direction at a crosshead speed of 0.5 mm/min until the post dislodged. The peak force at the point of detachment of the post segment from the test specimen was considered the point of bond failure and recorded in newtons. Push-out bond strength values in MPa were calculated by dividing the peak force by the bonded surface area (A) of the post segment. The bonded surface was calculated using the following formula [11].

$$A = \pi \times k\,(r_1 + r_2)$$

Where, 'r_1' is the radius of the post in the cervical region, and 'r_2' is the radius of the post in the apical region.
The r_1 and r_2 will be calculated by a digital calliper.
$k = [\, h_2 + (r_1 - r_2)^2 \,]^{0.5}$
Where, 'h' is the thickness of each layer in millimetres.

2.3 Statistical analysis

The data were subjected to statistical analyses using statistical package for social sciences (SPSS) Version 21.0, USA. The data were analysed through one-way ANOVA and student t-test and the p-value less than 0.05 was considered statistically significant.

3. Results

The analysis of the data indicated a notable disparity in the push out bond strengths of glass fiber posts to the root canal, which was influenced by the process of silanization. When comparing the non-silanized group with the silanized group, the latter demonstrated a higher push-out bond strength. The student t-test revealed that there was statistically significant ($p < 0.0001$) result among both the groups (Table 1).

Statistically significant results were obtained for cervical, middle and apical thirds on one-way Anova with a probability value of < 0. 0001. The push-out bond strengths of the cervical third with mean value of 9.52±12.48, without silanization, were found to be greater than those of the middle and apical thirds with mean values of 6.17±7.68 and 3.43±4.71, respectively as seen in table 1 and graph 1.

Similarly, the cervical third had higher mean push-out bond strengths (12.48±0.83) with silanization compared to the middle and apical thirds (7.68±0.66 and 4.71±0.55, respectively).

Table 1. Comparison of push-out bond strength at three different regions in two groups

		Mean ± SD*	F-value	p-value
Group 1 (CTSBU)	Cervical	9.522±1.133	221.565	< 0.0001
	Middle	6.174±0.345		
	Apical	3.439±0.693		
Group 2 (CTSBU+S)	Cervical	12.48±0.84	476.111	<0.0001
	Middle	7.680±0.663		
	Apical	4.716±0.555		

*SD: standard deviation.

4. Discussion

Restoration of an endodontically-treated tooth requires a post-placement as a substitute for lost tooth structure to provide support and retention to the core. Fiber posts are popularly used to restore compromised endodontically treated teeth [7]. The main advantage of fiber post is its closer elastic modulus to (≈20 GPa) that of dentin which produces a favourable stress distribution and high success rates [2].

In this study, Reforpost glass fiber posts (Angelus) were used, and they contain Glass fiber (80%), pigmented resin (19%), and stainless-steel filament (1%). It is a parallel-shaped post with grooves and a conical tip that allows greater retention inside the canal with minimal preparation at the apical end. The metal filament allows radiographic interpretation Literature claims that the polymer matrix of the glass fiber posts is highly crosslinked and does not have functional groups for chemical reaction. This makes it difficult for these posts to bond to the resin-luting agents and tooth structure. It has been estimated that 60% of the fiber post failures occurred between the fiber post and resin cement.

The success of the post depends on the adhesion between the post, resin cement, and dentin interface [13]. So, to improve the bonding of fiber post to resin cement, the application of a silane coupling agent is employed and is characterized as chemical optimization of the post surface. It works by linking the inorganic phase of fiber posts to the organic matrix of adhesive systems/resin cements due to its bifunctional properties [14]. In the present study, therefore, silane (Ultradent) was used as a coupling agent.

The glass fiber posts have unexposed fibers surrounded by a matrix of highly cross-linked epoxy resin, which is unreactive to silane. Therefore, silane coupling agents do not improve the bond strength between fiber posts and resin cements unless their application is preceded by fiber exposure through surface treatments. This was in accordance with previous studies [15-17]. Surface treatment procedures of posts were categorized into mechanical surface roughening, chemical treatments, and a combination of both. This often results in improved adhesion at the post–cement interface by removing the matrix of epoxy resin from the superficial part and exposing the internal glass fibers [9].

Hydrofluoric acid in combination with a silane coupling agent is often employed to enhance the bond strength between composite resins and glass fiber posts, and the results of this study were in accordance with previous studies conducted [6,7,18]. In this study, 9% HF was used as a chemical surface treatment for glass fiber posts in all the groups. Silica and quartz are present in fiber posts and are comparable in chemical structure with ceramic materials. Hydrofluoric acid has recently been proposed for etching fiberglass posts, and it creates a rough pattern on the surface, which is responsible for micromechanical interlocking with the resin cement and composite [10].

Recently, dentin adhesives were modified to produce a new class of universal adhesives that contain nano-fillers with a higher bond strength and the ability for fluoride release [19]. In the present study, Clearfil tri s bond universal (Kuraray) was used. It is a one-step self-etch universal adhesive which contains 10-MDP, bis-GMA, HEMA, phosphate methacrylates, BHT, ethanol, fluorides, CQ and siliciumdioxide nanoparticles. They are capable of bonding to different substrates and can be used in self-etch and total-etch modes. Universal adhesives have undergone significant structural changes compared to older generations of bonding agents and have a complex chemical structure. They have a pH of around 2.7, which is responsible for their self-etching capability. Such a low pH creates adequate acidity and a stable interface between the methacryloyloxydecyl dihydrogen phosphate (MDP) monomer and dentin or enamel. However, the presence of organic solvents and acidic monomers in the composition of universal adhesives has created some concerns regarding their solubility in oral fluids and water sorption. Thus, their bonding durability, structural stability, and mechanical properties in the long term are still questionable [20].

Self-etching adhesive approach offers a shorter adhesive application time and a reduced number of clinical steps. It is considered to be less technique-sensitive because the clinical assessment of optimal dentin wetness after rinsing the phosphoric acid is avoided. However, the simplest one-step self-etching adhesives are also associated with permeability and phase separation that may affect bond durability. Microleakage at the cement root dentin interface was found to be considerably higher when self-etching primer was utilized for fiber post-cementation compared to etch-and-rinse adhesive. Research reported that microleakage at the cement root dentin interface was significantly higher when self-etching primer was used for fiber post-cementation compared to etch-and-rinse adhesive. Likewise, the resin root dentin interdiffusion zone was less pronounced with the self-etching approach than with the etch-and-rinse adhesive approach [21]. Considering the relatively recent introduction of universal adhesives to the dental market, information regarding their properties is still limited.

Self-adhesive resin cements were introduced to simplify luting procedures and have been a good option for fixing fiberglass posts due to their bonding performance and low viscosity with long-standing clinical results [10]. Though, it is claimed that self-adhesive resin cement eliminates the need for the pretreatment of the tooth with adhesives, previous studies show that it cannot be used alone for fiber post-adhesion; it needs an adhesive.[11] In the present study, RelyX U200 was used as self-adhesive resin cement. According to the manufacturer its mechanism is based on acid monomers that demineralize and infiltrate the tooth substrate, resulting in micromechanical retention, and increased adhesion [22].

The retention of the post has been measured with micro tensile and push-out tests in earlier studies [3]. The bond strength in the current study was investigated using a push-out testing method, which has been reported to apply a shear stress parallel to the Fiber post that is comparable to the clinical situation. Push-out bond strength values revealed limited variability which indicated high reproducibility of the measurements [23]. The push-out bond strength of glass fiber posts was evaluated using a universal testing machine. This method allows accurate standardization of specimens and evaluation even when bond strengths are low, and it has the additional advantage of allowing the assessment of bond strength at several root levels [24]. The testing machine was operated at a crosshead speed of 0.5 mm/min, and loading forces were introduced from an apical to coronal direction [11].

The silanization group showed better bond strength when compared to the one without silanization. The contributory factors for this result may be the bifunctional molecules in silane with one end capable of reacting with inorganic fiberglass and the other end capable of copolymerizing with organic resin. Silanization increases surface wettability as intimate contact with the materials is established, creating strong bonds with hydroxyl groups of silane and inorganic substrates of the fiberglass posts. The roughness produced by the combination of treatments exposes the glass fibers, enabling better chemical bonding with silane and micromechanical bonding with resin cements, which might have probably increased bond strength. This was in accordance with the previous studies in which they evaluated the influence of different chemical and mechanical surface treatments, alone and in combination with silane, on the push-out bond strength of glass fiber posts fixed with self-adhesive resin cement, and a significant improvement in bond strength in the posts that received silanization was observed [13,25].

In both the groups, the better bond strength in the cervical region may be the better bonding capacity of dentin substrate in the cervical region and greater access to the cervical portion of the canal for cleaning, humidity control and higher light intensity initiating better resin cement polymerization. The lowest bond strength in the apical region may be because of the thicker and more compacted smear layer, which is difficult to remove even after phosphoric acid etching resulting in nonuniformity of dentin hybridization. This was in accordance with the previous studies where they evaluated the push-out bond strength of glass fiber posts in the three different root regions (cervical, middle and apical) and concluded that the cervical part has better bond strength when compared to the middle and apical thirds.

The study conducted under laboratory circumstances may not accurately replicate the complex and dynamic environment of the oral cavity. Further, in the present study, the limited light penetration would lead to an unequal polymerization mechanism in the middle and apical thirds of the root segments. Also, the study was conducted within a specific time frame, limiting the ability to observe long-term effects as endodontic treatment and fiber posts may exhibit different behaviours over extended periods. Placement of posts in wider canals requires a larger amount of resin-luting cement to fill the void between the post and the root canal. The lesser mechanical strength of resin luting cements, a nonhomogenous cement layer, leads to the compromised bond strength of the post. So, the scope and future directions of the study were to conduct further studies by using multiple fiber posts placement in the anterior tooth with wider canals which may improve adaptation and reduce luting cement volume.

6. Conclusion

From the results of this study, it can be concluded that the application of a silane coupling agent significantly improves the push-out bond strength of surface-treated glass fiber posts and resin cement. In groups with and without Silanization, push-out bond strength was significantly higher in the cervical region compared to the middle and the apical regions.

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References

1. Raman Mishra D, Shetty VS, D'Costa VF, Shetty KH. Evolution of posts-from rigidity to flexibility. Int J Sci Res. 2017; 6:2671-7.
2. Elsaka SE. Influence of chemical surface treatments on adhesion of fiber posts to composite resin core materials. Dent Mater. 2013;29(5):550-8. https://doi.org/10.1016/j.dental.2013.03.004
3. Machry RV, Fontana PE, Bohrer TC, Valandro LF, Kaizer OB. Effect of differentsurface treatments of resin relined fiber posts cemented with self-adhesive resin cement on push-out and microtensile bond strength tests. Oper Dent. 2020;45(4):E185-95. https://doi.org/10.2341/19-108-L
4. Terry DA, Swift EJ. Post-and-cores: Past to present. Dent Today. 2010;29(1):132.
5. Samran A, Najjar MO, Samran A, Al-Akhali M, Al-Maweri SA, Özcan M. Influence of different post luting cements on the fracture strength of endodontically treated teeth: An in vitro study. Eur Endod J. 2018;3:113. https://doi.org/10.14744/eej.2018.03522.

6. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004;30(5):289-301. https://doi.org/10.1097/00004770-200405000-00001
7. Alshahrani A, Albaqami M, Naji Z, Al-Khunein Y, Alsubaie K, Alqahtani A, Al- Thobity AM. Impact of different surface treatment methods on bond strength between fiber post and composite core material. Saudi Dent J. 2021;33(6):334-41. https://doi.org/10.1016/j.sdentj.2020.03.010
8. Spicciarelli V, Ounsi HF, Ferrari M, Corsentino G, Marruganti C, Grandini S. Push-out bond strength of fiber posts cemented using new universal adhesives on etched and nonetched intraradicular dentin. J Contemp Dent Pract. 2020; 21:91-6.
9. Archana CH, Krishna Raju SM, Yadhav SS, Konagala RK, Manthena SR, Teja PR. Effect of Surface Pretreatment and Thermal Activation of Silane Coupling Agent on Bond Strength of Fiber Posts to Resin Cement. J Contemp Dent Pract. 2019;20(11):1293-1296.
10. Valdivia AD, Novais VR, Menezes MD, Roscoe MG, Estrela C, Soares CJ. Effectof surface treatment of fiberglass posts on bond strength to root dentin. Braz DentJ. 2014; 25:314-20. https://doi.org/10.1590/0103-6440201300143
11. Oskoee SS, Bahari M, Kimyai S, Asgary S, Katebi K. Push-out bond strength of fiber posts to intraradicular dentin using multimode adhesive system. J Endod. 2016;42(12):1794-8. https://doi.org/10.1016/j.joen.2016.08.025
12. Sofan E, Sofan A, Palaia G, Tenore G, Romeo U, Migliau G. Classification reviewof dental adhesive systems: from the IV generation to the universal type. Ann Stomatol (Roma).2017;8(1):1. https://doi.org/10.11138/ads/2017.8.1.001
13. Mosharraf R, Ranjbarian P. Effects of post surface conditioning before silanizationon bond strength between fiber post and resin cement. J Adv Prosthodont. 2013;5(2):126-32. https://doi.org/10.4047/jap.2013.5.2.126
14. Choi Y, Pae A, Park EJ, Wright RF. The effect of surface treatment of fiber- reinforced posts on adhesion of a resin-based luting agent. J Prosthet Dent. 2010;103(6):362-8. https://doi.org/10.1016/S0022-3913(10)60078-9
15. Zicari F, De Munck J, Scotti R, Naert I, Van Meerbeek B. Factors affecting the cement–post interface. Dent Mater. 2012;28(3):287-97. https://doi.org/10.1016/j.dental.2011.11.003
16. 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;21(5):437- 44. https://doi.org/10.1016/j.dental.2004.07.012
17. Magni E, Mazzitelli C, Papacchini F, Radovic I, Goracci C, Coniglio I, Ferrari M.Adhesion between fiber posts and resin luting agents: a microtensile bond strengthtest and an SEM investigation following different treatments of the post surface. J Adhes Dent. 2007;9(2):195-202.
18. Vano M, Goracci C, Monticelli F, Tognini F, Gabriele M, Tay FR, Ferrari M. Theadhesion between fibre posts and composite resin cores: the evaluation of microtensile bond strength following various surface chemical treatments toposts. Int Endod J. 2006;39(1):31-9. https://doi.org/10.1111/j.1365-2591.2005.01044.x
19. Kahnamouei MA, Mohammadi N, Navimipour EJ, Shakerifar M. Push-out bond strength of quartz fibre posts to root canal dentin using total-etch and self-adhesiveresin cements. Med Oral Patol Oral. 2012;17(2):337. http://dx.doi.org/doi:10.4317/medoral.17429
20. Valian A, Maghsoudlou M, Roudbari MS. Push-out bond strength of glass fiber posts with two universal adhesives in endodontically-treated teeth. J Res Dent Maxillofoc Sci. 2021;6(3):8-18. https://doi.org/10.52547/jrdms.6.3.8
21. Radovic I, Mazzitelli C, Chieffi N, Ferrari M. Evaluation of the adhesion of fiber posts cemented using different adhesive approaches. Eur J Oral Sci. 2008;116(6):557-63. https://doi.org/10.1111/j.1600-0722.2008.00577.x
22. Sarkis-Onofre R, Skupien JA, Cenci MS, Moraes RR, Pereira-Cenci T. The role ofresin cement on bond strength of glass-fiber posts luted into root canals: a systematic review and meta-analysis of in vitro studies. Oper Dent. 2014;39(1):31-44. https://doi.org/10.2341/13-070-LIT
23. Goracci C, Fabianelli A, Sadek FT, Papacchini F, Tay FR, Ferrari M. The contribution of friction to the dislocation resistance of bonded fiber posts. JEndod. 2005;31(8):608-12. https://doi.org/10.1097/01.don.0000153841.23594.91
24. Valandro LF, Yoshiga S, De Melo RM, Galhano GA, Mallmann A, Marinho CP, Bottino MA. Microtensile bond strength between a quartz fiber post and a resin cement: effect of post surface conditioning. J Adhes Dent.2006;8(2):105-11. https://doi.og/10.3290/j.jad.a11072
25. Prado M, Marques JN, Pereira GD, da Silva EM, Simão RA. Evaluation of different surface treatments on fiber post cemented with a self-adhesive system. Mater Sci Eng. 2017;77:257-62. https://doi.org/10.1016/j.msec.2017.03.141
26. Arcas Leme A, Pinho AL, de Souza Gonçalves L, Correr-Sobrinho L, Coelho Sinhoreti MA. Effects of silane application on luting fiber posts using self- adhesive resin cement. J Adhes Dent. 2013;15(3):269-74. https://doi.org/10.3290/j.jad.a28881
27. Santos LR, Lima DM, Carvalho EM, Rodrigues VP, Alves CM. Effect of glass fiberpost surface treatment on bond strength of a self-adhesive resin cement: an "in vitro" study. Int J Dent. 2021;2021 https://doi.org/10.1155/2021/8856657

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