Micro push-out bond strengths of four fiber-reinforced composite post systems and 2 luting materials

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Objective. The aim of this study was to compare the bond strengths of 2 types of dual-cured luting agents used for cementation of 4 different fiber-reinforced composite (FRC) posts by using a push-out test and to evaluate the failure modes of these systems.

Study design. Eighty human maxillary central incisors were divided into 8 groups (n = 10), decoronated, and roots filled and restored with one of the following post systems: groups 1 to 4: translucent quartz FRC posts; groups 5 and 6: opaque glass FRC post; and groups 7 and 8: individually formed electrical glass fiber post. Cementation was performed with 2 types of dual-polymerizing resin luting agents: Variolink II (groups 1, 3, 5, and 7) and a new self-adhesive resin cement, RelyX Unicem (groups 2, 4, 6, and 8). Slices with a thickness of 1.00 ± 0.05 mm were prepared from the coronal third of each root by using a low-speed saw. Push-out tests were performed at a crosshead speed of 1 mm/min by using a universal testing machine, and the data was statistically analyzed (analysis of variance [ANOVA] and Duncan tests; $P < .05$). Fracture modes were evaluated at original magnification ×40.

Results. Micro push-out bond strengths were significantly affected by the type of luting agent and the type of post ($P < .05$, 2-way ANOVA). A significant difference was found among the groups (1-way ANOVA, $P < .05$). Fiber-reinforced composite posts luted with Variolink II showed higher bond strengths, and the groups ordered as 5, 1, 3, 7, 6, 2, 4, and 8, with the values (MPa, mean ± SD): 13.80 ± 5.00, 13.77 ± 3.78, 12.20 ± 4.79, 9.39 ± 2.48, 9.21 ± 7.76, 7.25 ± 1.56, 3.89 ± 4.41, and 3.77 ± 1.20, respectively. Adhesive failures between dentin and cement were observed more than cohesive failures in cement or post.

Conclusions. Push-out bond strengths can be affected by luting agent and post type. Variolink II and fiber post combinations resulted in high bond strength values. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105: 121-8)**

Posts made of metal alloys were reported to have less retention, cause serious types of root fractures,[1] compromise esthetics, and have risks of corrosion or allergic reactions.[2] Alternatively, fiber-reinforced composite (FRC) posts have been developing with an intensive research interest.

Current fiber posts are composed of unidirectional fibers embedded in a resin matrix in which resin-forcing quartz or glass fibers are immersed. During the manufacturing process of some of the FRC posts, fibers are prestressed and subsequently resin, as filler, is injected under pressure to fill the spaces between the fibers, giving them solid cohesion.[3,4] Many investigators have suggested that these materials have the advantage of reducing the risk of root fracture[5-7] thanks to comparable modulus of elasticity of composite resins (5.7-25 GPa)[8] and fiber posts (16-40 GPa),[9] which also have high impact resistance, attenuation and softening of vibrations, shock absorption, and increased fatigue-resistance properties. Finite element analyses showed that these materials generate the stresses in the dentin around the central third of the canal, whereas the rigid ones do the same in the interface area.[7]

Bonding capacity of FRC post systems may be influenced by various factors. Different design and composition of FRC posts may affect the restoration quality in terms of retention improvement and microleakage due to bonding capacity. Unfavorable cavity configuration factors encountered within post spaces, and the high wall-to-wall contraction experienced in bonding of posts of thin resin films present challenges in relieving shrinkage stresses generated along canal walls during the polymerization of resin cements.[10-13] The properties of luting materials may also be effective on the bonding quality to dentin and post material.[14,15]

Various luting agents and corresponding adhesive systems have been proposed for bonding FRC posts to root canal dentin. These materials can be divided into

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self-etching adhesives and etch-and-rinse systems.[15] Recently, self-adhesive resin cement RelyX Unicem, which does not require any pretreatment of dentin, was introduced.

Bond strength between post and tooth has been measured through conventional tensile testing on external root dentin[16] or on the post space surface with pull-out[17,18] and push-out methods.[19,20] The push-out test, first used for evaluating bonding to root canal dentin in 1996,[19] provides a better estimation of the bonding strength than the conventional shear test, because with the push-out test, the fracture occurs parallel to the dentin-bonding interface, which makes it a true shear test.[21] In addition, the push-out test has been considered more dependable than the microtensile test for bonded posts because of the high number of premature failures occurring during specimen preparation and the large data distribution associated with microtensile testing.[22] Moreover, the push-out test simulates the clinical conditions more closely.[23] A modification of this technique, by reducing the specimen thickness, is called *micro push-out* and is reported to be more advantageous.[22]

This study aimed to compare the push-out bonding strength of a self-adhesive dual-cured luting agent (RelyX Unicem) with a total etch resin luting agent (Excite DSC/Variolink II) used to cement 4 different FRC posts. Stereomicroscopic evaluation of failure modes of the systems was also performed. The null hypothesis was that push-out bond strengths to root canal dentin are not affected by luting agent and post type.

MATERIAL AND METHODS

Eighty human maxillary central incisors extracted for periodontal reasons, with 15.5- to 16-mm straight root canals, free of cracks, caries, and fractures, and fully developed apices, were selected for this study. External debris was removed with a scaler and all teeth were placed in 2.5% sodium hypochlorite for 2 hours for surface disinfection, and then stored in 0.1% NaN_3 solution until use.

The crown of each tooth was removed 1.5- to 2-mm coronal to the cemento-enamel junction with a 0.15 diamond-wafering blade (Buehler Ltd., Lake Bluff, IL) with a slow speed saw (Minitom, Struers GmBH, Willich, Germany) under water cooling, to achieve a uniform length of 14 mm. The pulp tissue was removed with a barbed broach. Canal patency was determined by passing a size 10 K-file (Dentsply Maillefer, Tulsa, OK) through the apical foramen. Canal working lengths were established 1.0-mm short of the apical foramen. The step-back technique was used for canal instrumentation. The same operator instrumented all root canals. The apical master file was the number 40 K-file (Dentsply Maillefer). During instrumentation, canals were irrigated with 1 mL of 2.5% NaOCl solution after every change of file size. Following the final irrigation, the canal spaces were completely dried with absorbent paper points (Dentsply Maillefer). The obturation was performed using AH Plus (Dentsply Caulk, Milford, DE) and gutta-percha with cold lateral compaction. The roots were stored in gauze dampened with aqueous solution containing 0.1% sodium azide (NaN_3) for 1 week at 37°C to allow the sealer to set.

The gutta-percha was removed from the coronal and middle thirds of each root. Four mm of intact gutta-percha was left behind to preserve the apical seal. The post spaces were all prepared to a depth of 10 mm with special preparation drills (size 3 DT Light-Post drill; Recherches Techniques Dentaires, St. Egreve, France). Post size 3 (DT Light, 1.2-mm diameter apically and 0.02 taper, 2.2 mm coronally and 0.10 taper) was tried to ensure that the posts would reach the bottom of the post space. Following the post space preparations, the canals were irrigated with sterile water and dried with paper points. Presence of any residual gutta-percha in the walls of post space was checked by radiographic evaluation.

The roots were randomly assigned to 8 groups (n = 10), which included 1 of the 4 types of posts and 2 types of dual cements (Tables I and II): group 1: DT Light, Variolink II (Ivoclar Vivadent, Schaan, Liechtenstein), and Excite DSC (Ivoclar Vivadent); group 2: DT Light and RelyX Unicem (3M ESPE, Seefeld, Germany); group 3: DT Light SL, Variolink II, and Excite DSC; group 4: DT Light SL and RelyX Unicem; group 5: FRC, Variolink II, and Excite DSC; group 6: FRC Postec Plus (Ivoclar Vivadent) and RelyX Unicem; group 7: Everstick (StickTech Ltd., Turku, Finland), Variolink II, and Excite DSC; and group 8: Everstick and RelyX Unicem.

In all groups, the posts were cleaned with alcohol as recommended by the manufacturers. In groups using Variolink II as luting agent (groups 1, 3, 5, and 7), the etching gel (35% H_3PO_4) was applied to post space walls with a needle, and after 15 seconds it was washed out with water. Excess water was removed from the post spaces with a gentle stream of air and paper points. Excite DSC, a dual-polymerized single-bottle dentin bonding agent, was applied for 10 seconds via microbrush coated with chemical initiators. Excess bonding agent was removed with paper points and gently air-dried. It was polymerized using a halogen light unit (a halogen light unit with 800-mW/cm^2 intensity (Optilux 501, Sybron-Kerr, Orange, CA) for 20 seconds, with the tip of the light unit directly in contact with the post space opening. Light output was monitored to ensure accurate light intensity before each exposure by using

Table I. FRC posts used in this study

Post	Manufacturer	Post type and design	Post composition
DT Light	Vereinigte Dentalwerke, Munich, Germany	Translucent Double flared Apical diameter, 1.2 mm Apical taper, 0.02 Coronal diameter, 2.2 mm Coronal taper, 0.10	Unidirectional pretensed quartz fibers: 60% volume Epoxy resin: 40% volume Fiber density: 32/mm^2
DT Light SL	Vereinigte Dentalwerke	Translucent Double flared Apical diameter, 1.2 mm Apical taper, 0.02 Coronal diameter, 2.2 mm Coronal taper, 0.10	Unidirectional pretensed quartz fibers coated with primer: 60% volume Epoxy resin: 40% volume Fiber density: 32/mm^2
FRC Postec Plus	Ivoclar Vivadent, Schaan, Liechtenstein	Opaque Apical diameter, 1 mm Apical taper, 0.02 Coronal diameter, 2 mm Coronal taper, 0.02	Unidirectional silane-coated glass fibers (61.5% weight), embedded in a polymer matrix of triethylene-glycol-dimethacrylates and urethane-dimethacrylates in combination with highly dispersed silicon dioxide
Everstick	StickTech Ltd., Turku, Finland	Individually formed Electrical glass-fiber mean diameter, 1.5 mm	Semi-interpenetrating polymer network of Polymethylmethacrylate, Mw 220.000 and 2.2-bis [4-(2-hydroxy-3-methacryloxypropoxy) phenyl] propane)

FRC, fiber reinforced composite.

Table II. Luting cements used in this study

Luting agent	Manufacturer	Bonding agent	Composition of composite resins	Composition of primers	Polymeri-zation mode	Conditioning method
Variolink II	Ivoclar Vivadent, Schaan, Liechtenstein	Excite DSC	Bis-GMA, urethane dimethacrylate, triethylene glycol dimethacylate, ytterbium trifluoride, barium glass, silica	HEMA, Bis-GMA, glycerine dimethacrylate, phosphoric acid acrylate, highly dispersed silica, ethanol, catalysts, stabilizers Microbrush: coated with initiators	Dual	2-step etch (35% H_3PO_4, 15 s) and rinse
RelyX Unicem	3M ESPE, Seefeld, Germany	—	Silica, glass, calcium hydroxide, methacrylated phosphoric ester, dimethacrylate, acetate	No primer	Dual	Self-adhesive resin cement

the digital radiometer built into the light unit. For the investigated posts requiring silane solution according to the manufacturer, Monobond S (Ivoclar Vivadent) was applied with a disposable microbrush for 60 seconds.

For cementation of fiber posts, equal amounts of dual-polymerized resin luting agent's (Variolink II) base and catalyst were mixed and applied onto the surface of the posts and into the orifice of the root canals. The posts were inserted into the canal to full depth by using finger pressure, and excess was immediately removed. Air block gel was applied and light curing was performed for 60 seconds through the posts, the tip of the light unit directly in contact with the coronal end of the posts.

In groups using RelyX Unicem as luting agent (groups 2, 4, 6, and 8), the dual-polymerized self-adhesive resin luting agent was prepared according to the manufacturer's instructions. Cementation and polymerization were performed as mentioned previously. All the post-cemented roots were placed in distilled water at room temperature.

Push-out tests

The coronal portion of each root (n = 80) was sectioned perpendicular to the long axis with a low-speed saw (Minitom, Struers) to create 1.00 ± 0.05-mm-thick slices. The apical portion of each root was

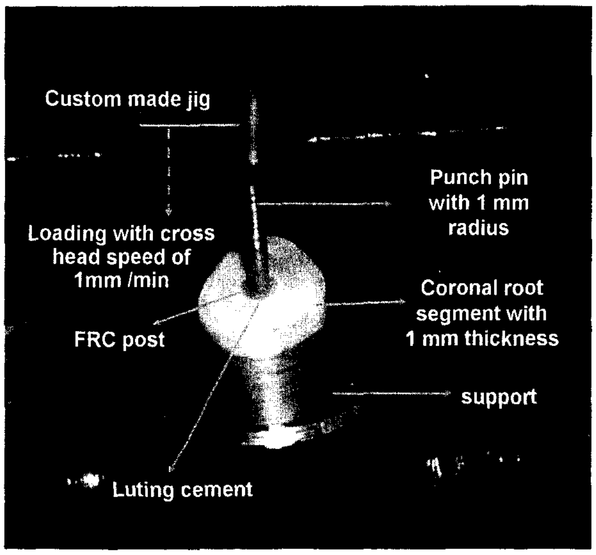

Fig. 1. Micro push-out test design.

preserved for measurement of fracture strength of the posts in another investigation.

Each slice was marked on its coronal side with an indelible marker, and the thickness of the slices and the radius of the canals were measured by using a digital caliper with an accuracy of 0.001 mm. The push-out tests were performed at a crosshead speed of 1 mm/min by using a universal testing machine (Testometric Co. Ltd., Rochdale, Lancashire, UK). The push-out jig was placed on the test machine. Care was taken to center the push-out pin (diameter, 1.0 mm) on the center of the post surface, without stressing the surrounding post space walls. The load was applied to the apical side of the root slice to avoid any limitation of post movement due to post space taper (Fig. 1). The peak force at the point of extrusion of the post segment from the slice was taken as point of bond failure, and the value was recorded in Newton (N). To express the bond strength in MPa, the load value recorded in Newton was divided by the area of the bonded interface. It was calculated as follows:

$$A = 2\pi r h$$

where pi is the constant 3.14, r is the post radius, and h is the thickness of the slice in mm.

Microscopic evaluation of the fracture modes

After testing the push-out bond strengths, samples were analyzed using a stereomicroscope (Olympus SZ 6045 TR Zoomstereomicroscope, Olympus Optical Co., Tokyo, Japan) at originl magnification ×40 to determine the type of failure. The type of failure was classified into the following 5 categories: (1) adhesive failure between post and luting material, (2) adhesive failure between dentin and luting material, (3) cohesive failure of post system, (4) cohesive failure of luting material, and (5) mixed type, a combination of 2 of the aforementioned types.

Table III. Results of 2-way analysis of variance statistical analysis

Source	*df*	*Mean square*	*F*	*Significance*
Luting agent	1	29.405	46.849	.000
Post type	3	2.792	4.448	.006
Luting agent, post type	3	.667	1.063	.370
Error	72	.628		

Table IV. Luting agents and post types*

Luting agents	*Mean ± SD*	*Post types*	*Mean ± SD*
		DT Light	3.18‡ ± 0.66
Variolink II	3.45† ± 0.62	DT Light SL	2.56 ± 1.26
RelyX Unicem	2.24 ± 1.02	FRC Postec Plus	3.16‡ ± 1.27
		Everstick	2.49 ± 0.63

*Mean ± SD values of transformed data and Duncan test results.
†Significantly higher than Rely X Unicem ($P < .05$).
‡Significantly higher than DT Light SL and Everstick ($P < .05$).

Table V. Two-way interaction between luting agent and post type following square root transformation*

Source of interaction	*Variolink II*	*RelyX Unicem*
DT Light	3.68 ± 0.52	2.68 ± 0.28
DT Light SL	3.43 ± 0.68	1.68 ± 1.09
FRC Postec Plus	3.66 ± 0.70	2.66 ± 1.54
Everstick	3.04 ± 0.41	1.94 ± 0.09

*Mean ± SD values.

Statistical analysis

Two-way analysis of variance (ANOVA) was employed to examine 2 factors, luting agent and post type, and their interactions on push-out strength. Because the data was nonparametric, square root transformation was used to fit the data to normal distribution. One-way analysis of variance (ANOVA) and Duncan test were performed for the comparison of the 8 factor levels (2 types of luting agents combined with 4 posts). The significance level was set at $P < .05$.

RESULTS

None of the prepared specimens failed prematurely. Type of luting agent and post was found significantly effective on the micro push-out bond strength ($P < .05$; Table III). Variolink II had higher bond strength than RelyX Unicem ($P < .05$), DT Light and FRC Postec had higher bond strengths than DT Light SL and Ever-

Table VI. Micro push-out bond strength values of original and transformed data*

Group No.	*Groups*	*n*	*Mean ± SD*	*Mean (transformed data) ± SD*
1	DT Light and Variolink II	10	13.77 ± 3.78	3.68 ± 0.52†
2	DT Light and RelyX Unicem	10	7.25 ± 1.56	2.68 ± 0.28‡§
3	DT Light SL and Variolink II	10	12.20 ± 4.79	3.44 ± 0.68†
4	DT Light SL and RelyX Unicem	10	3.88 ± 4.41	1.68 ± 1.09‖
5	FRC Postec Plus and Variolink II	10	13.80 ± 5.00	3.66 ± 0.70†
6	FRC Postec Plus and RelyX Unicem	10	9.21 ± 7.76	2.66 ± 1.54‡§
7	Everstick and Variolink II	10	9.39 ± 2.48	3.04 ± 0.4†‡
8	Everstick and RelyX Unicem	10	3.77 ± 0.34	1.94 ± 0.09§‖

*Values shown are MPa.
†Significantly different from the groups 2, 4, 6, and 8.
‡Significantly different from the groups 1, 3, 4, and 5.
§Significantly different from the groups 1, 3, 4, 5, and 7.
‖Significantly different from the groups 1, 2, 3, 5, 6, and 7.

Table VII. Distribution of the failure modes following the micro push-out test

Failure mode	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*	*Group 7*	*Group 8*	*Total*
1. Adhesive failure between dentin and luting material	—	2	2	2	1	4	—	2	13
2. Adhesive failure between post and luting material	1	—	—	—	—	—	—	—	1
3. Cohesive failure of luting material	—	—	—	—	—	—	—	—	—
4. Cohesive failure of post	—	1	1	—	—	—	6	—	8
5. Mix-type failure									
1 and 2	—		—	—	—	—	—	—	—
1 and 3	—	7	2	3	5	4	3	8	32
1 and 4	—	—	—	1	1	1	1	—	4
1, 2, and 3	1	—	—	—	—	—	—	—	1
1, 2, and 4	2	—	—	1	—	1	—	—	4
1, 3, and 4	—	—	4	2	3	—	—	—	9
3 and 4	2	—	—	—	—	—	—	—	2
2 and 4	1	—	—	—	—	—	—	—	1
Sample cannot be evaluated	3	—	1	1	—	—	—	—	5

stick ($P < .05$; Table IV). Two-way interactions were not statistically significant (Tables III and V).

The results of the 1-way ANOVA and Duncan tests indicated a significant difference among the groups ($P < .05$). The original and transformed mean bond strength value (SD) of each group are shown in Table VI: group 1 (DT Light and Variolink II), group 3 (DT Light SL and Variolink II), and group 5 (FRC Postec and Variolink II) showed the highest bond strength values ($P < .05$).

Adhesive failure between dentin and luting material was the most observed failure type alone (n = 13) or in combination with cohesive failure (n = 32) in luting material. Other failure types were determined as mixed-type failure (n = 53), cohesive failure of post (n = 8), and adhesive failure between post and luting material (n = 1), respectively. Cohesive failure of luting material alone was not observed (Table VII and Fig. 2). Five samples could not be evaluated microscopically because they were lost during the push-out test procedure.

DISCUSSION

In the present study, in most of the Variolink II groups (groups 1, 3, and 5) push-out bond strength values were found significantly higher than those of the RelyX Unicem groups (groups 2, 4, and 8), similar to the study of Goracci et al.[22] The same authors also reported that the bond strength of the autocuring RelyX Unicem was less than that of the dual-cured Variolink II.[22] This contradicts theoretical expectations that chemically cured cements exhibit high bond strengths due to more flow during the slow-setting polymerization process.[24] A possible explanation for the low push-out values of RelyX Unicem could be that the methacrylated phosphoric esters, responsible for substrate conditioning, are not as effective as phosphoric acid

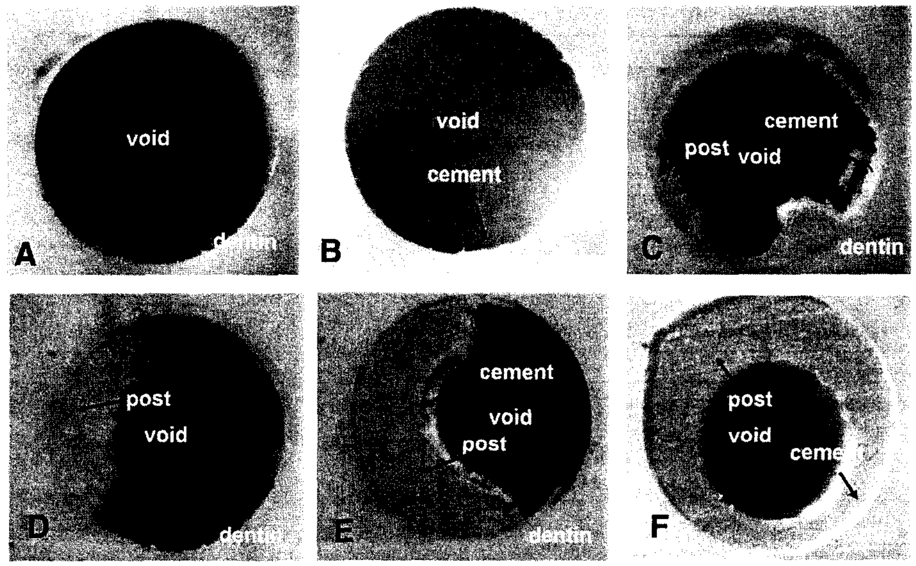

Fig. 2. Failure modes observed following the micro push-out tests. (**A**) Type 1. (**B**) Types 5, 1, and 3. (**C**) Types 5, 3, and 4. (**D**) Types 5, 1, 2, and 4. (**E**) Types 5, 1, 3, and 4. (**F**) Type 4. Voids are the spaces that occurred through the loss of filling material following the push-out loading. Arrows indicate the remaining cement and/or post materials on the slices.

used with Variolink II to dissolve the thick smear layer created on root canal walls during the post space preparation.[22] These findings do not agree with the findings of Bitter et al.,[15] who revealed significantly higher bond strengths for the self-adhesive resin cement RelyX Unicem tested with or without thermocycling. Although the authors noticed that the advantage of RelyX Unicem is having a moisture tolerance in root canals, surface pretreatments of dentin should be more effective according to the present findings. However, further studies are necessary to find out the clinical behavior of this material. Higher acidity of bonding agents can be effective on the hybrid layer thickness, but it was reported that the bond strength depends on hybrid layer mechanical properties rather than the layer thickness.[25,26]

The push-out test is based on the shear stress at the interface between dentin and cement as well as between post and cement,[27] which is comparable to the stresses under clinical conditions.[28] Taking into account relative weakness of the post root bond, Goracci et al.[22] noticed that the push-out test seems to be the most accurate and reliable technique to measure the bonds of fiber posts to root dentin compared with conventional and modified microtensile tests. Nonuniform stress distribution is a drawback of the push-out test when it is performed on the whole post[20] or on thick root sections.[7,23] To overcome this problem, original push-out technique was modified by slicing the posted root into 1-mm-thick specimens.[22,29] It was for this reason that this testing model was preferred for the present study. However, there are speculations that the effect of friction seems to contribute to the bond strengths of fiber posts by using a push-out model.[14]

The reason for the selection of the luting cements used in the present study is their different pretreatment procedures during application to dentin. The null hypothesis of the present investigation cannot be rejected completely. The bond strengths did vary with the type of luting material or the post, whereas some groups did not show significant differences.

There are limited studies investigating the bond strength of fiber posts in conjunction with the luting cements used in the present study. In a microtensile test, Ari et al.[30] reported that Variolink II in combination with Clearfil Liner Bond 2 V had significantly lower bond strength to root canal dentin than the self-cure slow-setting C & B Metabond. Two studies included Variolink II and RelyX Unicem regarding fiber post cementation.[15,22] Push-out and microtensile tests compared by Goracci et al.[22] showed that Variolink II had higher bond strength values than RelyX Unicem, whereas the micro push-out was found more sensitive and showed significant differences between 2 luting cements.

In this study, the post surface was coated with the resin cement and placed into the root canal as recommended by the manufacturers. No voids were observed in the microscopic evaluation of the root slices, but bubbles were present in a few samples. In a similar application procedure of luting cement, Mannocci et al.[31] reported many voids and bubbles. The application of resin luting cement with a lentulo spiral instrument may be an effective technique for reducing voids and bubbles within the luting agent.[32] Also, no sign of premature polymerization prior to post insertion was observed in the present study. This could be related to the fact that the dual-polymerized resin luting agents used in this study provided sufficient working time.

The effects of root canal irrigants on dentin collagen,[11] hydration in root canal dentin as a result of pulp removal, type of agent for conditioning, and the polymerization stress of resin cements with unfavorable cavity configuration factors are the variables that can possibly influence the quality of adhesion.[12,33] Various pretreatment procedures, such as silanization, hydrofluoric acid etching, sandblasting, and tribochemical silica coating, are currently being investigated for increasing the bond strength of the post to the luting cement.[34,35] Silanization is the most used technique to achieve this goal. Some studies reported that this procedure does not have a significant effect on bond strengths of resin cements to FRC posts,[36-38] whereas others reported an increasing effect on microtensile or push-out bond strengths via silanization.[39,40] Bitter et al.[41] noticed that the effects of silanization appeared to be clinically negligible, but the type of fiber post had a significant effect on bond strengths. Almost none of the groups showed adhesive failure between posts and luting materials. Accordingly, silanization had no significant effect on bond strengths in the present study.

Design of the fiber post is also an important factor for retention in the root canal. Parallel FRC posts are reported to have better retention than tapered posts.[42] A finite element analysis study reported that stresses were, in general, higher with tapered dowels than with parallel-sided dowels. Stresses were reduced by bonding and with an increasing modulus of elasticity, increasing diameter, and increasing length of the dowel.[7]

The secondary aim of this study was to investigate the relationship of post and cement or dentin and cement when the applications were made according to manufacturers' instructions. Therefore, silanization was performed on DT Light and FRC Postec by using Monobond S (Ivoclar Vivadent). Variolink II was applied following 35% H_3PO_4 pretreatment of dentin for 15 seconds. According to stereomicroscopic findings, mixed-type failures (type 5) observed in Variolink II groups (1, 3, and 5), except in Everstick combination (group 7), is an indication of homogeneous distribution of stress. The low push-out bond strengths of RelyX Unicem (groups 2, 4, 6, and 8) can be related to the findings of type 1 and 3 failures (Tables VI and VII).

Everstick cemented with Variolink II frequently showed cohesive failures in posts (type 4). In contrast, adhesive failures between dentin and cement together with cohesive failures (types 1, 2, and 3) were the most observed type, when used with RelyX Unicem. This finding correlates with lower push-out bond strengths of RelyX Unicem groups. The structural difference of Everstick from the other FRC posts that have cross-linked polymer phase was that it consisted of both linear and cross-linked polymer phases. The surface of the cross-linked polymer phased post is well polymerized, so that the chance of actual chemical bonding for free radical polymerization decreases. On the other hand, monomers of the adhesive resins and cements can diffuse into the linear polymer phase of Everstick.[43] Everstick groups tested in the present study showed no adhesive failure between post and luting material (type 2), which proved that this material bonds well to the resin cements used.

Under the conditions of this study, it can be concluded that the type of the luting agent and FRC post can be effective on the micro push-out bond strength. Variolink II and fiber post combinations resulted in higher bond strength values than RelyX Unicem combinations.

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