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Comparative evaluation of push out bond strength for a fiber post system using six different resin cements: An *in-vitro* study

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Abstract:

Successful restoration of endodontically treated teeth with extensive coronal loss depends on durable adhesion between the fiber post, resin cement, and root dentin. Therefore, it is of interest to compare the push-out bond strength of fiber posts cemented with six different resin cements: Calibra Universal, RelyXTM U200, seT PP resin cement; Hy-Bond Resiglass resin cement, SelfCem dual-cure resin cement and Fusion Ultra D/C resin cement. Hence, sixty extracted single-rooted human teeth underwent standardized endodontic treatment, post space preparation, and fiber post cementation. Push-out bond strength was evaluated at the cervical, middle, and apical root levels using a universal testing machine, followed by MANOVA and Scheffé post hoc analysis. Thus, we show resin cement providing high bond strength and retention, supports evidence-based selection for fiber post cementation.

Keywords: Fiber post, push-out bond strength, resin cement, root dentin, adhesion, fiber-reinforced post system, endodontically treated teeth.

Background:

One of the biggest challenges in endodontics and restorative dentistry is the restoration of endodontically treated teeth. The biomechanical integrity of teeth with root canal treatment is often compromised by extensive caries, trauma, previous restorations, and access cavity preparation, which makes the rehabilitation of these teeth challenging, requiring not only successful endodontic therapy but also the proper selection of an appropriate post-endodontic restorative system that can restore function, retention, and aesthetics [1, 2]. Traditionally, cast metal posts and prefabricated metallic posts were widely used for reinforcing endodontically treated teeth. The use of metallic posts, however, has a high modulus of elasticity compared with dentin, which can result in an unfavourable stress concentration and catastrophic root fracture, especially in anterior teeth, and may also cause discoloration and shadowing through all-ceramic restorations [3, 4]. These restrictions have been overcome with the development of fiber-reinforced post systems, which are gaining in popularity in current restorative dentistry [5]. Fiber posts consist of reinforcing fibers in a resin matrix that have a modulus of elasticity similar to dentin. Furthermore, fiber posts offer superior aesthetics, biocompatibility, and corrosion resistance and retrieval properties over metallic posts. Because of these benefits, fiber posts are now regarded as an ideal choice for the restoration of endodontically treated teeth with extensive coronal loss [6]. Failure of bond between the post, resin cement, and root canal dentin can result in debonding, microleakage, secondary caries, and ultimately failure of the fiber post restoration [7]. However, the technical difficulty of achieving reliable adhesion within the root canal is still a challenge due to limited access, unfavourable cavity configuration factor (C-factor), incomplete polymerization of resin materials, smear layer, and dentinal tubule density variations along the root canal [8]. Several adhesive resin cements have been developed to address these challenges, each having different chemical composition and bonding mechanisms. Self-adhesive resin cements have been the subject of much attention due to the fact

that they do not require separate etching and bonding steps, which makes the cementation procedure less technique sensitive and chairside time efficient, but they can vary in viscosity, polymerization shrinkage, hydrophilicity, filler content, and chemical interaction with dentin, which may affect their bonding properties [9]. Calibra Universal, RelyX U200, seT PP resin cement, Hy-Bond Resiglass resin cement, SelfCem dual-cure resin cement, and Fusion Ultra D/C resin cement are all different adhesive formulations and curing mechanisms for luting fiber posts that are currently available. Comparative evaluation of these materials is important to determine their clinical reliability and retention performance under standardized conditions. The bond strength of resin cements has been shown to vary among different cements, depending on the type of monomers used, degree of conversion, and interaction with root dentin, as seen in previous investigations [10, 11]. Therefore, it is of interest to determine the best resin cement to enhance retention and long-term clinical performance of fiber post restorations.

Materials and Methodology:

Study design:

The present study was conducted as an *in vitro* experimental comparative study to evaluate and compare the push-out bond strength of a fiber-reinforced post system using six different resin cements. The study was carried out under standard laboratory conditions to reduce the experimental variability and to obtain the reproducibility of the results. Push-out bond strength testing was chosen as the evaluation method because it is a reliable method to assess the adhesive interaction between root canal dentin, resin cement, and fiber post.

Study setting:

The study was carried out in the Department of Conservative Dentistry and Endodontics, New Horizon Dental College and Research Institute, Sakri, Bilaspur, Chhattisgarh. All laboratory work such as specimen collection, cleaning, root canal

preparation, post space preparation, cementation, specimen sectioning, etc. were carried out in the departmental research laboratory using standard instruments and equipment.

Study duration:

The whole study lasted for one academic year. The time period was from the time of specimen collection until the end of the post cementation, storage of specimens, push-out testing, data recording, and statistical analysis.

Sample selection:

Sixty freshly extracted human permanent single-rooted teeth with a single canal were included in the study. Teeth were collected from the outpatient department of Oral and Maxillofacial Surgery and dental outreach camps organized by the Department of Public Health Dentistry. All specimens were carefully evaluated clinically and radiographically before being included.

Inclusion criteria:

The following teeth were included in the study:

- [1] Teeth with a single root and a single root canal that are not fractured.
- [2] Single-rooted teeth with a single root canal that are not fractured.
- [3] Complete root formation is present in teeth.
- [4] Teeth have a fully formed root.
- [5] Teeth with open root canals
- [6] No caries, restorations, cracks or fractures in teeth
- [7] No abnormalities in the teeth

Exclusion criteria:

- [1] The following teeth were not included:
- [2] Teeth with open apices
- [3] Calcified canals in teeth are a risk factor.
- [4] Multi-rooted teeth
- [5] Internal and external resorption of teeth
- [6] Teeth with root cracks, fractures or structural deformities

Storage and disinfection of specimens:

Immediately after extraction, soft tissue and calculus deposits that adhered to the tooth surface were removed with ultrasonic scalers. The teeth were disinfected and kept in thymol solution to avoid dehydration and microbial contamination. All handling procedures were carried out in accordance with recommended biosafety procedures.

Group allocation:

The selected specimens were randomly allocated into six experimental groups (10 teeth per group) based on the type of resin cement used for fiber post cementation.

- [1] Group I: Fiber posts with Calibra Universal Self-Adhesive Resin Cement.
- [2] Group II: Fiber posts with RelyXTM U200 Automix Self-Adhesive Resin Cement.
- [3] Group III: Fiber posts cemented using seT PP Resin Cement.

- [4] Group IV: Fiber posts with Hy-Bond Resiglass Resin Reinforced Glass Ionomer Cement.

- [5] Group V: SelfCem Dual-Cure Resin Cement cemented fiber posts.

- [6] Group VI: Fusion Ultra D/C Resin Cement cemented fiber posts.

Access preparation and working length determination:

Standardized endodontic access cavities were prepared with water-cooled high-speed aerator hand piece fitted with round burs and Endo-Z burs. Barbed broaches were used to remove the pulpal tissue remnants. The No. 10 K-file was inserted into the root canal until the tip was seen at the apical foramen. The working length was determined by subtracting 1 mm from the measured canal length.

Biomechanical preparation:

The conventional step-back technique was used for instrumentation of the root canals with stainless steel K-files and H-files. The cleaning and shaping were performed up to the master apical file size of 30. In the instrumentation, canals were flushed with 5.25% sodium hypochlorite solution between each file change. Smaller files were used for recapitulation to keep the canals patent and to avoid blockage, as this was done intermittently.

Smear layer removal:

After the biomechanical preparation, the removal of smear layer was performed with:

- [1] 10ml sodium hypochlorite solution
- [2] 10 ml of 17% EDTA solution for 3 minutes

The last irrigation was done with sterile distilled water. The canals were then dried with absorbent paper points.

Obturation procedure:

All root canals were obturated using gutta-percha cones and AH Plus sealer employing the cold lateral condensation technique. A heated plugger was used to remove excess gutta-percha and vertical compaction was done.

De-coronation:

All specimens had their crowns cut horizontally about 1 mm above the cemento-enamel junction with a water-cooled diamond disc, to standardize the root lengths.

Post space preparation:

Post space preparation was started following obturation with Peeso reamers. All specimens had a standardized post space depth of 10 mm and an adequate apical seal. The prepared roots were placed in blocks of plaster for ease of handling and to stabilize them for the following procedures.

The removal of smear layer in post space:

After post space preparation, canals were flushed with 17% EDTA solution to remove the smear layer formed during post space preparation. The canals were then rinsed with distilled

water and dried using paper points. Fiber posts that are cemented. All specimens were constructed with prefabricated fiber-reinforced posts of fixed size. Each resin cement was used for cementation following the manufacturer's instructions. The cement was prepared and poured into the post hole with the proper applicators. Finger pressure was used to seat the fiber post in the canal, ensuring that the post was fully seated in the canal with cement. The coronal area was cleaned up of excess cement with care. Light curing was done using an LED curing unit for the recommended period, as suggested by the manufacturer, depending on the cement system. Dual-cure systems were allowed to complete polymerization chemically as well.

Storage of specimens:

All specimens were then placed in distilled water at 37°C for 1 week to simulate oral conditions and allow full setting and polymerization of the resin cements.

Sectioning of specimens:

Root samples were cut with a low-speed diamond saw with water irrigation to prevent overheating and damage to the roots. Each specimen was cut into 3 sections of ~2.2-2.5 mm thickness representing:

- [1] Cervical third
- [2] Middle third
- [3] Apical third

A digital Vernier calliper was used to check the thickness of each slice.

Push-Out bond strength testing:

The specimens were cut into sections, and each section was attached to a specially designed metal jig and tested on a universal testing machine. The plunger was a cylindrical piece of metal with a diameter of 1 mm that was placed in the center of the fiber post but not touching the dentin. The load was applied in an apico-coronal direction at a crosshead speed of 0.5 mm/min until bond failure and displacement of the post occurred. The force needed to pull the post out of the ground was measured in Newtons (N). The push-out bond strength was calculated in megapascals (MPa) using the formula:

$$\text{Push-out Bond Strength (MPa)} = \frac{\text{Force at Failure (N)}}{\text{Bonded Surface Area (mm}^2\text{)}}$$

Bonded surface area of each specimen was determined from the size of the post and thickness of the section cut.

Data collection:

The push-out bond strength values recorded for the cervical, middle and apical sections were tabulated separately for all experimental groups. The mean values and standard deviations were determined for each group.

Statistical analysis:

The data obtained were analyzed with a computer-based statistical software package. Statistical evaluation included – descriptive statistics: mean and standard deviation; Multivariate Analysis of Variance (MANOVA) for comparison between groups; The post hoc Scheffe test was used for pairwise intergroup comparison; The p value of < 0.05 was statistically significant.

Ethical considerations:

The present study was an in vitro study performed on extracted human teeth. No living human subjects or animals were used in procedures. Ethical clearance was taken from the Institutional Ethical Committee, New Horizon Dental College and Research Institute before the study was started. All teeth extracted were retrieved according to institutional protocols and recommended biosafety procedures such as OSHA and CDC guidelines were adhered to in specimen handling, storage and laboratory procedures.

Results:

The present *in-vitro* investigation comparatively evaluated the push-out bond strength of fiber-reinforced post system cemented using six different resin cements. A total of 60 extracted single-rooted teeth were equally distributed into six experimental groups comprising 10 specimens each. Push-out bond strength was evaluated at cervical, middle, and apical root levels and the obtained values were statistically analysed using one-way ANOVA, Scheffe post-hoc test, and Chi-square analysis. All six experimental groups contained equal numbers of specimens (16.7%), ensuring uniform comparison and minimizing sampling bias. RelyX™ U200 demonstrated the highest mean push-out bond strength, followed by Fusion Ultra D/C and SelfCem dual-cure resin cement. Hy-bond Resiglass showed the lowest bond strength values, indicating comparatively weaker adhesion to root dentin. One-way ANOVA analysis demonstrated a highly significant difference among the resin cement groups ($F = 11.62$, $p < 0.001$), confirming that the type of resin cement significantly influenced fiber post retention and bonding performance (**Table 1**). RelyX™ U200 demonstrated the highest push-out bond strength and showed approximately 41.7% greater bond strength than Hy-bond Resiglass. Fusion Ultra D/C also demonstrated superior bonding performance with values nearly 38.4% higher than Hy-bond Resiglass. The statistically significant p value (< 0.001) indicated that the differences observed among the resin cements were highly significant and not due to random variation (**Table 2**). The cervical region demonstrated the highest push-out bond strength values for all resin cements, while the apical region showed the lowest values. RelyX™ U200 exhibited superior bonding performance across cervical and middle levels, whereas SelfCem dual-cure demonstrated slightly better apical bond strength. Hy-bond Resiglass consistently showed the weakest bonding performance. Statistical analysis revealed a highly significant difference among root levels ($p < 0.001$), indicating that root canal level significantly influences adhesive bond strength (**Table 3**). RelyX™ U200 demonstrated the highest

overall push-out bond strength with the greatest maximum value (22.6 MPa), while Fusion Ultra D/C showed comparable high bond strength and greater cohesive failure patterns, indicating superior internal integrity. SelfCem dual-cure demonstrated relatively stable bonding with the lowest variability. Hy-bond Resiglass consistently showed the lowest bond strength values and the highest number of adhesive

failures, suggesting weaker adhesion to root dentin. Bond strength progressively decreased from cervical to apical regions in all groups. Adhesive failure was the predominant failure mode overall (46.7%), and statistical analysis revealed significant associations between resin cement type and failure mode distribution ($p = 0.041$) as well as between root level and failure pattern ($p = 0.036$) (**Table 4**).

Table 1: Distribution of specimens and comparative analysis of Push-Out bond strength among Resin Cement Groups

Resin Cement Group	Specimens (n)	Percentage (%)	Mean Bond Strength (MPa)	SD	Rank
Calibra Universal	10	16.7	16.82	1.92	4
RelyX™ U200	10	16.7	19.18	1.73	1
seT PP resin cement	10	16.7	15.96	1.85	5
Hy-bond Resiglass	10	16.7	13.54	1.78	6
SelfCem dual-cure	10	16.7	17.92	1.67	3
Fusion Ultra D/C	10	16.7	18.74	2.01	2
Total	60	100	—	—	—
ANOVA (F value)	—	—	11.62	—	—
p value	—	—	<0.001	—	—

Table 2: Mean Push-Out bond strength among Resin Cement Groups

Resin Cement	Mean Bond Strength (MPa)	SD	Rank
RelyX™ U200	19.18	1.73	1
Fusion Ultra D/C	18.74	2.01	2
SelfCem dual-cure	17.92	1.67	3
Calibra Universal	16.82	1.92	4
seT PP resin cement	15.96	1.85	5
Hy-bond Resiglass	13.54	1.78	6

Table 3: Comparison of Push-Out bond strength among root levels and Resin Cement Groups

Resin Cement	Cervical Mean ± SD (MPa)	Middle Mean ± SD (MPa)	Apical Mean ± SD (MPa)
Calibra Universal	18.9 ± 1.8	16.4 ± 1.7	15.1 ± 1.6
RelyX™ U200	22.0 ± 1.6	19.4 ± 1.6	16.1 ± 1.4
seT PP resin cement	17.4 ± 1.6	15.2 ± 1.5	14.3 ± 1.4
Hy-bond Resiglass	15.2 ± 1.4	13.1 ± 1.3	12.3 ± 1.3
SelfCem dual-cure	19.8 ± 1.5	17.6 ± 1.4	16.4 ± 1.5
Fusion Ultra D/C	21.3 ± 1.7	18.9 ± 1.8	16.0 ± 1.5
Overall Mean ± SD	19.1 ± 2.3	16.7 ± 2.1	15.0 ± 1.9
ANOVA p value	<0.001		

Table 4: Combined analysis of bond strength distribution, variability, and failure modes among Resin Cement Groups

Resin Cement	Cervical (MPa)	Middle (MPa)	Apical (MPa)	Minimum	Maximum	Median	SD
Calibra Universal	18.9	16.4	15.1	13.5	20.1	16.7	1.92
RelyX™ U200	22.0	19.4	16.1	16.4	22.6	18.5	2.01
seT PP resin cement	17.4	15.2	14.3	12.9	19.2	15.8	1.85
Hy-bond Resiglass	15.2	13.1	12.3	10.8	16.7	13.2	1.78
SelfCem dual-cure	19.8	17.6	16.4	15.1	21.0	17.8	1.67
Fusion Ultra D/C	21.3	18.9	16.0	15.6	22.5	19.0	1.73
Overall Findings	Highest at cervical level	Moderate at middle level	Lowest at apical level	10.8	22.6	—	—

Discussion:

The retention and durability of the post system placed in the root canal is a critical factor in successful restoration of endodontically treated teeth. Fiber-reinforced posts have become increasingly popular because of their elastic modulus similar to dentin, improved aesthetics, and favourable stress distribution characteristics [1]. The present *in-vitro* study comparatively evaluated the push-out bond strength of a fiber post system using six different resin cements and assessed the influence of root level on bonding performance. The results of the present study showed statistically significant differences between the tested resin cements. RelyX™ U200 exhibited the highest overall push-out bond strength followed closely by Fusion Ultra D/C and SelfCem dual-cure resin cement. Hy-bond Resiglass had the

lowest bond strength values. The results indicate that the self-adhesive and dual-cure resin cements are more retentive and adhesive than resin-reinforced glass ionomer cements. The better performance of RelyX™ U200 in the present study could be explained by the self-adhesive chemical composition of the material and its improved interaction with dentinal hydroxyapatite. The acidic functional monomers of self-adhesive resin cements have been reported in previous studies to be able to demineralize and infiltrate dentin simultaneously, resulting in micromechanical and chemical bonding. The dual-curing mechanism of RelyX™ U200 also helps to enhance polymerization in deeper areas of the root canal where light penetration is less [4]. Bond strength values for Fusion Ultra D/C were similar to RelyX™ U200. The dual curing resin components and better flow properties may have contributed to

better adaptation in the root canal space. Pereira et al. reported the same, showing that dual-cure resin cements had better push-out bond strength as a result of better polymerization and lower polymerization stress [6]. SelfCem dual-cure resin cement also exhibited good bonding properties, especially in the apical area. This could be associated with its self-curing property that helps to make up for the lack of light in the deeper sections of the canal. During post cementation, polymerization in the apical regions is still a significant challenge due to limited accessibility and limited transmission of curing light in these areas [8]. The lowest bond strength values were obtained with Hy-bond Resiglass in all root levels. The reduced bonding performance of the resin modified glass ionomer systems compared to modern resin cements may be attributed to the lower adhesive properties and lesser mechanical interlocking of the resin modified glass ionomer systems. Previous studies have also found that glass ionomer based cements have lower bond strength values because of their lower fracture toughness and micromechanical retention [10]. The present study also showed that the bond strength values gradually decreased from the cervical to the apical region. The highest mean bond strength was found in the cervical region and the lowest in the apical region. This trend has been consistently reported in previous literature. This result may be attributed to a number of factors. The cervical region has a higher number and diameter of dentinal tubules and better access to the dentinal tubules, allowing better penetration of adhesive monomers and formation of a stronger hybrid layer, while the apical region has fewer dentinal tubules, smaller canal diameter, and less access to the dentinal tubules, which limits penetration of adhesive monomers and cement adaptation [12, 13]. The high configuration factor (C-factor) inside the root canals is another factor that helps to decrease the apical bond strength. The polymerization shrinkage stresses created during curing can be higher than the bond strength in the deeper areas and may cause debonding or micro gap formation, and the limited visibility and the difficulty in controlling moisture in the apical region may further affect the adhesion [14]. The push-out bond strength test used in the present study is one of the most reliable tests for post retention, which is more uniformly distributed along the bonded interface than tensile tests, and which better mimics clinical dislodgement forces and minimizes premature specimen failure during testing. Thus, the results obtained could have significant clinical implications [15, 16]. Adhesive failure was the most common failure mode identified during failure mode analysis. Adhesive failure between dentin and resin cement was observed in almost 46.7% of the specimens. This result suggests that the dentin-cement interface is still the weakest link in the bonded complex. Wang et al. reported similar results, showing that debonding is often found at the adhesive interface due to incomplete infiltration and polymerization defects [17]. The number of cohesive failures was higher in Fusion Ultra D/C, indicating better adhesion and better internal mechanical properties of the cement. Generally, cohesive failure suggests that the bond between dentin and the cement is stronger than the bond between the cement and the material itself, which is the case with Hy-bond Resiglass, as it

had the most cohesive failures [18]. The ANOVA and Scheffe post-hoc statistical analysis showed that the differences between the experimental groups were very significant. The p values that were significant in the present study validate the fact that the type of resin cement has a significant effect on the retention of fiber posts. The same findings have been described in recent studies that have compared self-adhesive resin cements to conventional luting materials [19]. The results of the present investigation have clinical implications as post debonding is one of the most frequent failures in post-retained restorations. The choice of suitable resin cement is critical to achieve better retention, microleakage, and longevity of endodontically treated teeth with fiber posts [20]. The present study had some limitations, although it was carefully standardized. The study was an *in-vitro* investigation and was not able to fully simulate the complex oral environment, such as thermal changes, occlusal loading, and long-term aging conditions. Further studies are recommended that include thermocycling, fatigue loading and long term clinical evaluation to further validate the findings. In general, the present study showed that the push-out bond strength of self-adhesive and dual-cure resin cements was found to be better than the resin-modified glass ionomer cement systems. The RelyX™ U200 material had the best bonding results, with Fusion Ultra D/C resin cement closely following.

Conclusion:

The push-out bond strength of fiber-reinforced post systems is significantly affected by the type of resin cement. RelyX™ U200 performed best overall in terms of bond strength, followed by Fusion Ultra D/C and SelfCem dual-cure resin cement. The lowest bond strength values were obtained for the group of Hy-bond Resiglass. The bond strength was always higher in the cervical area and decreased gradually towards the apical area. Adhesive failure was the most commonly observed mode of failure. The results indicated that self-adhesive and dual-cure resin cements offer better retention, and may enhance the long-term clinical performance of fiber post restorations.

References:

- [1] Andrade GS et al. *Dentistry Review*. 2023 **3**:100067. [DOI: 10.1016/j.dentre.2023.100067]
- [2] Keles ZH et al. *Appl Sci*. 2026 **16**:57. [DOI: 10.3390/app16010057]
- [3] Turp V et al. *J Adv Prosthodont*. 2013 **5**:226. [PMID: 24049562]
- [4] Zhang CY et al. *J Spectrosc*. 2018 **2018**:8684245. [DOI: 10.1155/2018/8684245]
- [5] Kosan E et al. *Clin Oral Investig*. 2021 **25**:6419. [PMID: 34125299]
- [6] Pereira JR et al. *Saudi Dent J*. 2021 **33**:22. [PMID: 33473238]
- [7] Amiri EM et al. *J Dent (Tehran)*. 2017 **14**:153. [PMID: 29167687]
- [8] Karobari MI et al. *PLoS One*. 2023 **18**:e0294076. [PMID: 37956149]
- [9] Reddy THS et al. *Indian J Dent Res*. 2021 **32**:485. [DOI: 10.4103/ijdr.ijdr_603_21]

- [10] Irie M *et al.* *Polymers (Basel)*. 2026 **18**:810. [DOI: 10.3390/polym18070810]
- [11] Kahyaie Aghdam M *et al.* *Front Dent*. 2024 **21**:24. [PMID: 39104788]
- [12] Lee Y *et al.* *Materials (Basel)*. 2021 **14**:3639. [PMID: 34209908]
- [13] Alovisei M *et al.* *J Adhes Dent*. 2024 **26**:231. [PMID: 39397758]
- [14] Chanapairin B *et al.* *BMC Oral Health*. 2024 **24**:3. [PMID: 38167313]
- [15] Hatayama T *et al.* *Polymers (Basel)*. 2024 **16**:3389. [PMID: 39684134]
- [16] Özer H *et al.* *Front Dent Med*. 2023 **4**:1140794. [PMID: 39916894]
- [17] Wang Y *et al.* *Eng Fract Mech*. 2007 **74**:1838. [PMID: 18670583]
- [18] Desai K *et al.* *Cureus*. 2024 **16**:e55009. [PMID: 38550459]
- [19] Bansod S *et al.* *Int J Sci Res*. 2020 **9**:18 [DOI: 10.36106/ijsr/1208964]
- [20] Silva RR *et al.* *Int J Adhes Adhes*. 2026 **145**:104211. [DOI: 10.1016/j.ijadhadh.2025.104211]
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