Original Article

pISSN, eISSN 0125-5614
M Dent J 2026; 46 (Suppl) : S32-S39

Push-out bond strength of two universal resin cements on fiber post

Thadporn Saovapong[1], **Pipop Saikaew**[1], Titalee Jirathanyanatt[1], Hidehiko Sano[2]

[1] *Department of Operative Dentistry and Endodontics, Faculty of Dentistry, Mahidol University, Thailand*
[2] *Department of Restorative Dentistry, Faculty of Dentistry, Hokkaido University Graduate School of Dental Medicine, Japan*

To evaluate the effect of different universal resin cements under self-adhesive mode on the push-out bond strength of cemented glass fiber posts. Ten extracted mandibular premolar teeth were randomly assigned into 2 groups based on cement types (n = 5): RelyX Universal in self-adhesive mode (RXU) and Panavia SA Luting Multi cement in self-adhesive mode (PSA). Push-out bond strength testing was performed on coronal, middle, and apical root sections. Failure mode was classified under stereomicroscope. Data were statistically analyzed using two-way ANOVA with Tukey HSD post-hoc test (α=0.05). RXU demonstrated a significantly higher push-out bond strength over PSA. RXU failed predominantly at the cement-post interface and as mixed failures, while PSA failed mainly at the cement-dentin interface. However, no statistically significant difference was observed in different root sections. RXU showed significantly better performance over PSA for the cementation of glass fiber post.

Keywords: glass fiber post, push-out bond strength, root canal dentin, self-adhesive resin cement, universal adhesive

How to cite: Saovapong T, **Saikaew P**, Jirathanyanatt T, Sano H. Push-out bond strength of two universal resin cements on fiber post. M Dent J 2026;46(Suppl): S32-S39.

Introduction

The placement of an intraradicular post is frequently indicated for the restoration of endodontically treated teeth. Among the available post systems, glass fiber posts (GFPs) have gained widespread clinical acceptance due to their favorable biomechanical behavior and esthetic properties [1]. However, cementation of GFPs to root canal dentin remains an adhesive challenge to root canal dentin, influenced by canel anatomy, residual endodontic materials and limited light penetration in the apical third.

Self-adhesive resin cements contain functional acidic and hydrophilic monomers that simultaneously demineralize and infiltrate enamel and dentin, enabling both chemical interaction with calcium ions from hydroxyapatite and micromechanical retention through polymerization. SARCs eliminate separate etching, priming and bonding steps, which is advantageous in the confined root canal where moisture control and visibility are limited [2]. Recently, a new generation of self-adhesive resin cements, termed universal resin cements, has been developed and can be used with or without adhesive [3].

In intraradicular dentin, universal resin cements have shown comparable push-out bond strengths in self-etch and self-adhesive modes [4,5]. Recent comparative studies indicate that SARCs achieve bond strengths equal to or higher than conventional resin cements for fiber post

Corresponding author: Pipop Saikaew
Department of Operative Dentistry and Endodontics, Faculty of Dentistry, Mahidol University, Thailand,
6 Yothi Rd., Ratchathewi, Bangkok 10400, Thailand
Tel: +662-200-7825 E-mail: pipop.sai@mahidol.ac.th, pipop045@gmail.com
Received: 1 May 2026 **Revised:** 26 May 2026 **Accepted:** 28 May 2026

cementation in both short- and long-term conditions [6,7].

RelyX Universal (RXU) and Panavia SA Luting Multi (PSA) are widely used universal resin cements with comparable indications but different chemistry: RXU is Bis-GMA-free with DUDMA, an amphiphilic redox initiator and pH 1.7, whereas PSA is Bis-GMA-based with pH 2.8 [3]. RXU has outperformed PSA on coronal dentin and in shear-bond strength [8]. Evidence on intraradicular dentin is limited. The intraradicular substrate differs from coronal dentin in tubule density and orientation, a C-factor exceeding 200, restricted light access and residual irrigant or sealer contamination, none of which can be inferred from shear-bond data [9]. Given these considerations, further investigation of universal resin cements under clinically relevant conditions is warranted. Therefore, the aim of this study was to evaluate the push-out bond strength of different universal resin cements applied in the self-adhesive mode. The null hypotheses were that: (1) there is no significant difference in push-out bond strength of glass fiber posts cemented with different universal resin cements; and (2) there is no significant difference in push-out bond strength among different root sections.

Materials and Methods

Ten extracted human mandibular premolars with a single canal and complete root formation were obtained after approval by the Commission for Medical Ethics Committee, Faculty of Dentistry, Mahidol University (COE.No.MU-DT/PY-IRB 2024/034.2210). Teeth were stored in 0.1% thymol (M Dent, Bangkok, Thailand) at room temperature and used within six months [4]. Inclusion required a root length of 15 ± 1 mm measured from the buccal CEJ to the apical foramen. Teeth with caries, cracks, fractures, prior endodontic treatment, calcification or resorption were excluded. Buccolingual and mesiodistal radiographs were used to exclude canals with a buccolingual/mesiodistal aspect ratio > 1.5 at 5 and 10 mm from the apex [5,9]. Specimens were randomly allocated to two groups (n = 5). Sample size was determined using G*Power 3.1.9.3 (Heinrich-Heine-Universität Düsseldorf, Germany) with alpha = 0.05 and power = 0.80, based on the expected effect size from previous push-out bond strength studies [4].

The CEJ was identified visually and a horizontal reference line was drawn 2 mm coronal to the buccal CEJ served as the sectioning reference. Crowns were sectioned 2 mm above the CEJ perpendicular to the long axis, resulting in 15-mm root segments using a slow-speed cutting machine (IsoMet, Buehler, USA) with water cooling. Root canals were instrumented with a #15 K-file followed by ProTaper Gold rotary files to F5 under irrigation with 2.5% NaOCl. Final irrigation was 5 mL of 17% EDTA for 1 min, 2.5% NaOCl for 1 min and saline for 1 min. Canals were dried with paper points and obturated with a size 50, 0.04 taper gutta-percha cone (Spident, Korea) and AH Plus sealer using warm vertical compaction. Access was sealed with glass-ionomer cement (Fuji VII, GC, Japan) and specimens were stored at 37 °C and 100% humidity for 24 h.

Post space preparation and post cementation

Ten millimetres of coronal gutta-percha were removed with a heated plugger, leaving a 5 mm apical seal. The 10-mm post space was prepared with a #0.5 D.T. Light Post Illusion X-RO finishing drill (RTD, St. Egreve, France) in a low-speed handpiece; depth was confirmed by post try-in and verified radiographically [5]. Canals were irrigated with distilled water and dried with paper points. Fiber posts were cleaned with

alcohol and air-dried for 5 s. RelyX Universal (RXU; Solventum, St. Paul, MN, USA) and Panavia SA Luting Multi (PSA; Kuraray Noritake Dental, Okayama, Japan) were injected from canal floor coronally using the manufacturer-supplied automix elongation tip. Material details are provided in Table 1. DT Light Post Illusion X-RO size 0.5 (RTD) was seated to full depth with sustained finger pressure, excess cement was removed with a disposable microbrush, and then light-cured (Bluephase G2, Ivoclar) at ~1,200 mW/cm² for 20 s. Specimens were stored in distilled water at 37°C for 7 days for complete setting.

Push-out bond strength test

Each root was sectioned into three 1-mm slices using a slow-speed cutting machine (IsoMet) with water cooling, corresponding to the coronal, middle and apical levels at 12-13, 9-10 and 6-7 mm from the apex. Slice thickness was measured using a digital caliper (Mitutoyo, 0.01 mm); slices outside 1.0 ± 0.1 mm were excluded. The apical side was marked with a permanent marker. Push-out testing was performed in a universal testing machine (Instron 5585H, Instron, Canton, MA, USA) at 0.5 mm/min with apico-coronal loading through a cylindrical plunger of 0.7, 0.8 or 0.9 mm diameter for apical, middle and coronal slices respectively [9]. The maximum force at the point of extrusion of the post segment from the test slice was

Table 1 List of materials' classification, manufacturer, lot number and composition.

Type of Material	Materials	Composition
Universal resin cement	Panavia SA Luting Multi (Kuraray Noritake) Lot: A50092	Bis-GMA, TEGDMA, HEMA, 10-MDP, hydrophobic aliphatic dimethacrylate, hydrophobic aromatic dimethacrylate, silane coupling agent, silanated Ba-glass filler, silanated colloidal SiO2, Al2O3 filler, Surface treated NaF, CQ, peroxide, catalysts, accelerators, pigments.
Universal resin cement	RelyX Universal (Solventum) Lot: 10612250	TEGDMA, DUDMA, mixture of mono-, di-, tri- glycerol dimethacrylate esters with phosphoric acid, HEMA, MMA, TAHP, VCPAL, BHT, EDMAB, TPP, Cu (II) acetate monohydrate, MPTMS-silanated silica, MPTMS-and PTMS-silanated glass, YbF3
Endodontic sealer	AH plus (Dentsply Maillefer) Lot: 2411000575	Epoxy-amine resin-based root canal sealer, Opacifier, Zirconium oxide
Glass fiber post	DT Light Post Illusion X-RO 0.5 (RTD) Lot: 667542411	Radiopaque quartz fibers, Epoxy resin matrix, Pigment

BHT: butylated hydroxytoluene; Bis-GMA: bisphenol A glycidyl dimethacrylate; CQ: camphorquinone; DUDMA: diurethane dimethacrylate; EDMAB: ethyl 4-dimethylamino benzoate; HEMA: 2-hydroxyethyl methacrylate; MDP: 10-methacryloyloxydecyl dihydrogen phosphate; MMA: methyl methacrylate; MPTMS: 3-methacryloxypropyl trimethoxysilane; PTMS: phenyl trimethoxysilane; TAHP: tert-amyl hydroperoxide; TEGDMA: triethylene glycol dimethacrylate; TPP: triphenyl phosphite; VCPAL: L-ascorbic acid 6-hexadecanoate; YbF3: ytterbium trifluoride.

recorded as F in Newton (N).

The bonded area (A) of the post was calculated using the following formular [9]:

$$A = \pi(R + r)\sqrt{h^2 + (R - r)^2}$$

Where r is the radius of post at the apical side, R is the radius of post at the coronal side, and h is the thickness of slice in mm. The coronal and apical radius of root was measured using ImageJ software. The push-out bond strengths (MPa) were calculated from F divided by A.

Failure mode analysis

After testing, each slice was examined under a stereomicroscope (DP22, Olympus) at 50x and classified as: adhesive at cement-dentin, adhesive at cement-post, cohesive in cement, cohesive in post, cohesive in dentin, or mixed [7,10].

Statistical analysis

Normality and homogeneity of variance were assessed by Shapiro-Wilk and Levene's tests. Push-out bond strength was analysed by two-way ANOVA to evaluate the effect of cement type and root section, followed by Tukey HSD post-hoc tests. Failure mode was summarized descriptively. Analyses were performed in SPSS 27.0 (IBM Armonk, NY, USA) with significant level at 0.05.

Result

Mean push-out bond strengths and standard deviations are shown in Table 2 and Figure 1. Two-way ANOVA showed a significant effect of cement type ($p < 0.001$): RXU produced a higher mean bond strength than PSA. While, the root sections, however, had no significant effect ($p > 0.05$). No statistically significant interactions were observed among these two factors ($p > 0.05$). Failure mode distributions are shown in Figure 2. No cohesive failures in dentin, post or cement were observed.

Table 2 The mean push-out bond strength (MPa) and standard deviation (SD) of each experimental group.

Group	Root section	Mean push out bond strength (MPa)	SD
RXU	Apical	15.60 a	1.75
	Middle	19.08 a	5.62
	Coronal	12.40 a	6.77
PSA	Apical	4.58 b	2.70
	Middle	2.96 b	1.89
	Coronal	3.95 b	2.15

Statistically non-significantly different groups (Tukey multiple comparisons, $p > 0.05$) are labeled with the same lowercase letter.

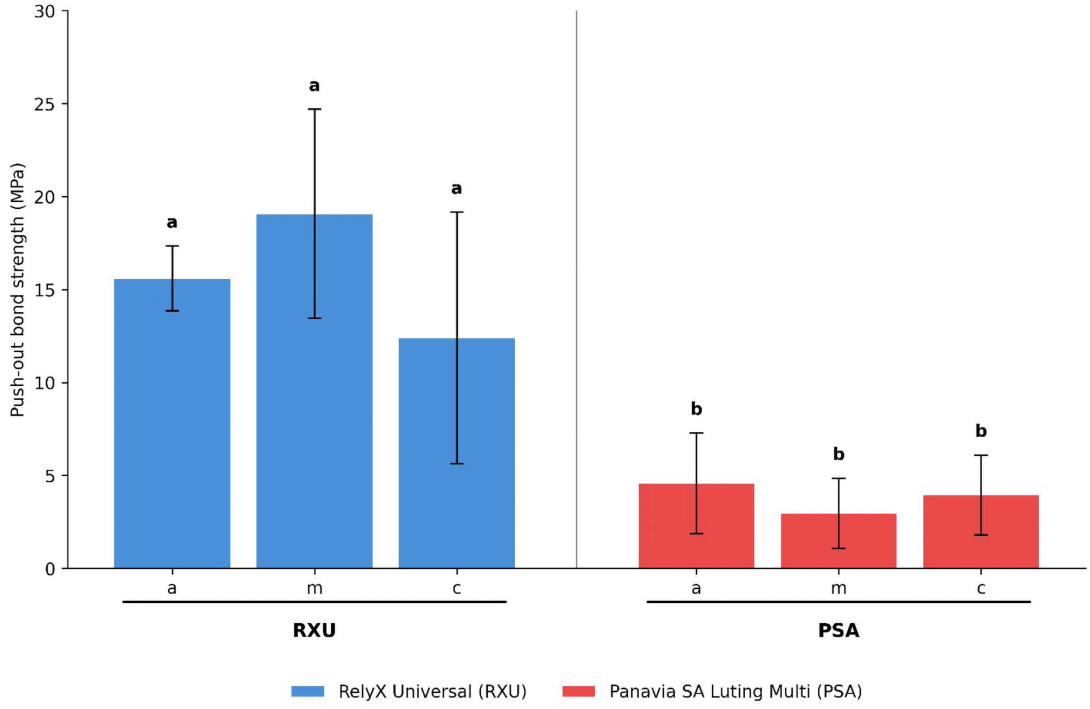


Figure 1 Mean push-out bond strength (MPa) of glass fiber posts cemented with RXU and PSA. Error bars represent standard deviation. The same lowercase letter indicates statistically non-significantly different groups (Tukey HSD post-hoc tests, $p < 0.05$).

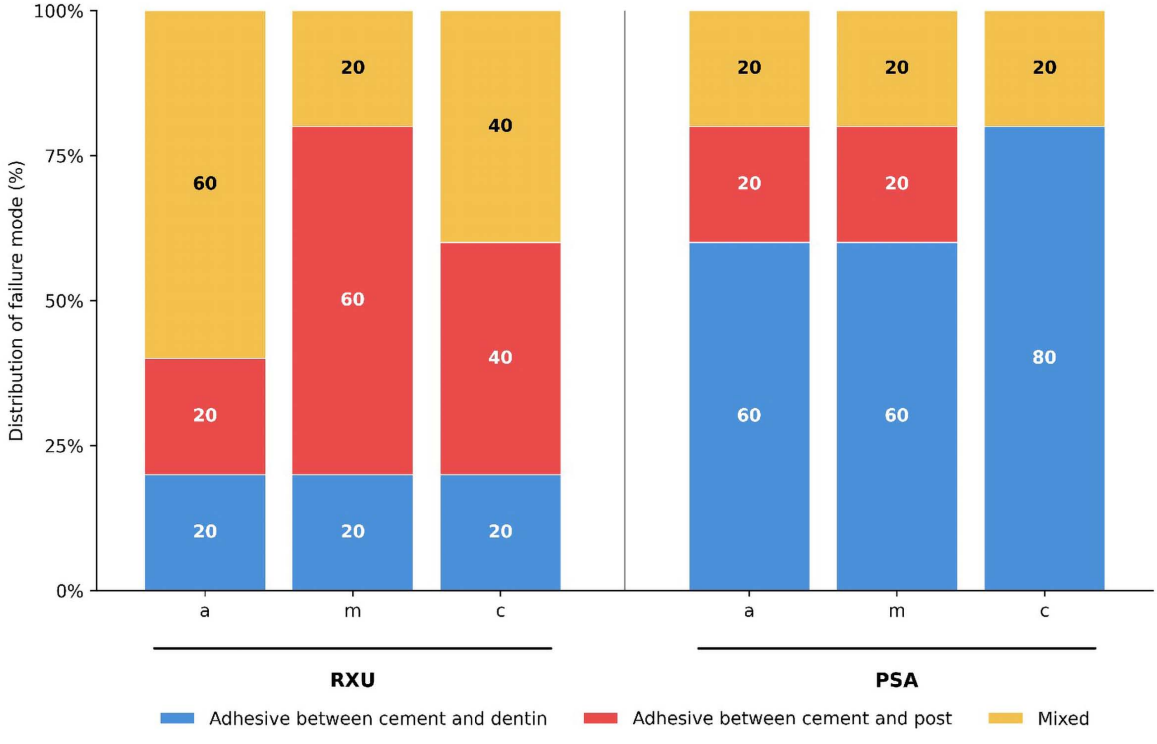


Figure 2 Distribution of failure mode from light-microscopy failure analysis.

Discussion

The present study compared the effect of different universal resin cements, including RXU and PSA on the push-out bond strength of cemented GFPs, under self-adhesive condition. The result indicated that RXU exhibited a significantly higher push-out bond strength than PSA, as presented in Figure 1 [8].

The observed differences may be attributed to compositional variations between the two cements (Table 1). PSA is based on Bis-GMA, whose rigid bisphenol-A backbone and pendant hydroxyl groups restrict chain mobility during polymerization and generate high polymerization stress [11,12]. RXU is Bis-GMA-free and incorporates DUDMA, whose aliphatic urethane backbone permits chain relaxation during gelation and lowers modulus development rate, reducing residual stress [11]. The absence of the two Bis-GMA hydroxyl groups also reduces water sorption and hydrolytic susceptibility of the polymer matrix [12]. RXU further contains an amphiphilic redox initiator that promotes a cross-linked network and higher degree of conversion [3], and its lower pH (1.7 vs 2.8) increases smear-layer dissolution. These mechanisms are consistent with previous coronal and shear-bond data [8].

Previous RXU and PSA comparisons were performed on coronal dentin with shear-bond tests [8]. The intraradicular substrate differs in tubule density and orientation, in C-factor (>200 vs 1-5), in light access and in residual irrigant or sealer contamination, so coronal data cannot be extrapolated [9]. The present study provides direct comparison in intraradicular dentin under self-adhesive mode. These findings are consistent with recent comparative studies indicating that SARCs are effective luting agents for fiber posts [5, 6].

Failure mode supports the bond strength data. RXU failed predominantly at the cement-post interface and as mixed failures, indicating that the cement-dentin bond resisted dislodgement. PSA failed predominantly at the cement-dentin interface, consistent with weaker chemical and micromechanical interaction with intraradicular dentin and with the lower mean bond strength.

Regarding root regions, the present findings showed no statistically significant differences in push-out bond strength among the apical, middle and coronal sections, consistent with previous reports on universal and self-adhesive resin cements [7,9]. The literature on regional variation remains inconclusive: higher bond strengths have been reported coronally due to greater tubule density and improved light transmission [1,4,13], whereas other studies have reported higher values apically [5,14,15]. In the present study, the highest mean bond strength was observed in the middle section of the RXU group and the lowest mean in the middle section of the PSA group, but these regional differences did not reach statistical significance. Also, the space between the post and canal walls can increase cement thickness, which has been associated with reduced bond strength due to greater shrinkage stress and porosity formation, particularly beyond 0.35 mm [16]. Furthermore, universal resin cements applied in self-adhesive mode appear less sensitive to dentin depth and tubular density than etch-and-rinse systems [10], because their bonding relies primarily on chemical interaction with intertubular hydroxyapatite rather than on long resin tags formed within dentinal tubules [15].

Mandibular premolars were selected in this study because of their single, round-shaped root canal, which provides a standardized post space that is well-suited for push-out bond strength testing. However, this represents a limitation,

as the findings may not be generalizable to the full spectrum of tooth morphology encountered clinically. Generalizing the current findings to other tooth types therefore requires caution and warrants further investigation.

Conclusion

Within the limitation of the present study, it was concluded that:

1. RelyX Universal demonstrated significantly higher push-out bond strength than Panavia SA Luting Multi.
2. There was no significant difference of cemented glass fiber post in different root sections.

Acknowledgments

The authors thank to Miss Chayada Teanchai and the teams at the Dental Biomaterials Analysis and Research Center for their essential testing support.

Conflict of interest

The authors do not have any financial interest in the company whose materials are included in this article.

Funding sources

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical approval

All procedures performed in this study were in accordance with the principles of Declaration of Helsinki. Approval was granted by the Commission for Medical Ethics Committee (COE.No.MU-DT/PY-IRB 2024/034.2210)

Declaration of generative AI

During the preparation of this manuscript, the authors employed generative AI (Chat GPT-5) to support language refinement and orgenize preliminary research themes. After using this tool, the authors reviews and edited the content as needed and take full responsibility for the content of the published article.

References

1. Rodrigues RV, Sampaio CS, Pacheco RR, Pascon FM, Puppin-Rontani RM, Giannini M. Influence of adhesive cementation systems on the bond strength of relined fiber posts to root dentin. ***J Prosthet Dent.*** 2017 Oct;118(4):493-499. doi: 10.1016/j.prosdent.2017.01.006.
2. Ferracane JL, Stansbury JW, Burke FJ. Self-adhesive resin cements - chemistry, properties and clinical considerations. ***J Oral Rehabil.*** 2011 Apr;38(4):295-314. doi: 10.1111/j.1365-2842.2010.02148.x.
3. Maravic T, Mazzitelli C, Mancuso E, Del Bianco F, Josic U, Cadenaro M, *et al.* Resin composite cements: current status and a novel classification proposal. ***J Esthet Restor Dent.*** 2023 Oct;35(7):1085-1097. doi: 10.1111/jerd.13036.
4. Detogni AC, Gomes de Araújo Neto V, Felipe de Almeida Nobre C, Feitosa VP, Coelho Sinhoreti MA. Different contemporary resin cements for intracanal luting of glass fiber posts - bonding and polymerization assessments. ***Int J Adhes Adhes.*** 2025 Mar;138:103951. doi: 10.1016/j.ijadhadh.2025.103951.

5. D'Haese R, Vervack V, Hamid I, Vandeweghe S. Effect of two different adhesion modes of a universal resin cement on the retention of glass fiber posts cemented to root canal dentine: an in vitro study. ***Adhesives.*** 2025;1(2):8. doi: 10.3390/adhesives 1020008.
6. Watanabe S, Takamizawa T, Hayashi K, Aoki R, Barkmeier WW, Latta MA, *et al.* Comparing various resin luting cement systems in different etching modes through bond durability and morphological features. ***Oper Dent.*** 2024 Mar;49(2):231-244. doi: 10.2341/23-096-L.
7. Baena E, Escribano N, Fuentes V, Reche I, Ceballos L. Aging effect on push-out bond strength of six resin cements: an in vitro study. ***Materials (Basel).*** 2025 Mar;18(6):1371. doi: 10.3390/ma18061371.
8. Atsavathavornset C, Saikaew P, Harnirattisai C, Sano H. The effect of different adhesive strategies and diamond burs on dentin bond strength of universal resin cements. ***Clin Oral Investig.*** 2025 Jan;29(1):41. doi: 10.1007/s00784-024-06112-4.
9. Patthanawijit L, Yanpiset K, Saikaew P, Jantarat J. Fiber post cemented using different adhesive strategies to root canal dentin obturated with calcium silicate-based sealer. ***BMC Oral Health.*** 2024 Oct;24(1):1290. doi: 10.1186/s12903-024-04963-7.
10. 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 Dec;42(12):1794-1798. doi: 10.1016/j.joen. 2016.08.025.
11. Fugolin AP, de Paula AB, Dobson A, Huynh V, Consani R, Ferracane JL, *et al.* Alternative monomer for BisGMA-free resin composites formulations. ***Dent Mater.*** 2020 Jul;36(7):884-892. doi: 10.1016/j. dental.2020.04.009.
12. Davy KWM, Kalachandra S, Pandain MS, Braden M. Relationship between composite matrix molecular structure and properties. ***Biomaterials.*** 1998 Nov;19(22):2007-2014. doi: 10.1016/S0142-9612(98) 00047-7.
13. Kusumasari C, Margono A, Aditya DR, Abdou A. Effect of etch-and-rinse and self-etch modes in universal adhesives on push-out bond strength of fiber post. ***J Clin Exp Dent.*** 2022 Aug;14(8):e661-e668. doi: 10.4317/jced.59564.
14. Bitter K, Meyer-Lueckel H, Priehn K, Kanjuparambil JP, Neumann K, Kielbassa AM. Effects of luting agent and thermocycling on bond strengths to root canal dentine. ***Int Endod J.*** 2006 Oct;39(10):809-818. doi: 10.1111/j.1365-2591.2006.01155.x.
15. 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-adhesive resin cements. ***Med Oral Patol Oral Cir Bucal.*** 2012 Mar;17(2):e337-e344. doi: 10.4317/ medoral.17429.
16. Özcan E, Çetin AR, Tunçdemir AR, Ülker M. The effect of luting cement thicknesses on the push-out bond strength of the fiber posts. ***Acta Odontol Scand.*** 2013 May-Jul;71(3-4):703-709. doi: 10.3109/00016357.2012.715194.