FOLIA MEDICA CRACOVIENSIA
Vol. LXI, 4, 2021: 81–92
PL ISSN 0015-5616
DOI: 10.24425/fmc.2021.140006

The effect of root canal rinsing protocol on the push-out bond strength to the dentin cementation of the fiber post

Bartosz Ciapała[1], Krzysztof Górowski[2], Wojciech I. Ryniewicz[2], Andrzej Gala[2], Jolanta E. Loster[2]

[1]Department of Integrated Dentistry, Institute of Dentistry, Jagiellonian University Medical College, Kraków, Poland
[2]Department of Dental Prosthetics and Orthodontics, Institute of Dentistry, Jagiellonian University Medical College, Kraków, Poland

Corresponding author: Bartosz Ciapała, D.D.S.
ul. Montelupich 4, 31-155 Kraków, Poland
Phone: +48 12 424 54 65; E-mail: bartek.ciapala@uj.edu.pl

Abstract: Background: Studies on the effect of root canal rinsing protocols on fiber post bonding to dentin are inconclusive. This study reports investigation of this topic.
Objectives: to determine effects of irrigation protocol by means of a push-out test on the strength of adhesion between the post and dentin in an *in vitro* study.
Materials and Method: Thirty human single-rooted teeth were prepared using hand instruments and the step-back technique, filled with gutta-percha, sealed with AH Plus (Dentsply), and divided into three groups: A: rinsed with NaCl; B: rinsed with 2% chlorhexidine (CHX); C: not rinsed before cementation of posts. The fiber posts were set using RelyX and Built-it. The tooth roots were sliced and the push-out test was performed. The area of contact between the post and dentin was calculated and the destroying force was established. The results were statistically analyzed.
Results: The mean adhesive strength was 10.69 MPa in group A, 16.33 MPa in group B, and 16.72 MPa in C. The adhesive strength in group B and C was statistically significantly higher than in group A ($p = 0.0016$, ANOVA).
Conclusion: Rinsing root canals with CHX seems to be the most effective method prior to setting a fiber post.

Key words: fiber post, rinsing protocols, adhesion, bonding, cementation.

Submitted: 01-Jul-2021; **Accepted in the final form:** 14-Dec-2021; **Published:** 28-Dec-2021.

Introduction

The growing number of patients requiring endodontic treatment, the use of more advanced instruments, the improved effectiveness of therapeutic methods, and the increasing number of positive prognoses for such treatment all conspire to present dentists with the dilemma of choosing the appropriate method of reconstructing the remaining tissue of the clinical crown of the tooth. One of the basic methods of building up the core of the crown is to use standard crown-root posts reinforced with fiberglass [1, 2]. At present, most commonly used posts are bonded by means of adhesive to enhance the strength of the post-dentin connection. According to Schwartz and Robbins, such posts seem to strengthen the roots [3]. The variety of materials and the procedures used to place the posts require from the practitioner a thorough knowledge of adhesive techniques and their proper use in the clinical environment [4]. As with other procedures, various complications can occur. The most common complications during the reconstruction of the crown core using root posts are decementation or fracture of the post, or bacterial microleakage, resulting in the formation of periapical lesions. The most widely used antimicrobial fluid during endodontic treatment is NaOCl [5]. Because of its wide spectrum of action, it has also been used to disinfect root canals [6, 7]. In addition to its antibacterial effect, it can block proteolytic enzymes belonging to the metalloproteinase (MMP) group, which are responsible for the degradation of collagen fibers. These enzymes are also present in dentinal tubules, and their release from dentin probably contributes to the degradation of collagen fibers of the hybrid layer, which weakens the subsequent bond between the post and the dentin. This theory is supported by studies that have examined the long-term effects of 2% CHX solution on the adhesion strength of the root post to the dentin of the root canal [8, 9]. Research by Cecchin *et al.* has shown a positive impact of CHX solution on long-term bonding between the root post and dentin using composite cement [10, 11]. The results of testing samples kept in water for one year showed a statistically significant difference in adhesion strength between the study group and the control group, where CHX had been used prior to the placement of the posts [12, 13]. This means that the use of CHX increases the bond strength between fiber post and dentin, irrespective of CHX application time. According to Ekambram *et al.*, rinsing the root canal with 2% CHX prior to placing the adhesive bonding post does not negatively affect the bonding strength between post and dentine [14]. Similar results were obtained by Gomes *et al.* [15] and by Leitune [16]. Research by other authors has shown no relationship between the use of CHX and improvements in the adhesion strength properties of the system used for bonding [16–18].

The short-term effects of 2% CHX on the bonding strength between the post and the dentin has also been studied. The results are inconclusive, however, as some suggest a positive impact [7, 14] and some indicate a neutral impact on bonding strength [11, 15, 16, 19–22]. The similar results obtained by other authors have encouraged us to carry out our own research in this area, because of the practical clinical importance of this question.

The aim of the study

The objective of the study was to evaluate the effect of root canal irrigation protocol by means of push-out test on the strength of adhesion between the root-canal post and dentin in an *in vitro* study.

Materials and Methods

The study was conducted using thirty single-rooted human teeth. All patients whose teeth were used for the study were informed of its course and purpose, and voluntarily expressed their consent in writing for the use of their biological material for scientific research. The research program was approved by the Bioethics Commission of the Jagiellonian University (Approval No. KBET 122.6120.18.2016). The teeth used had been extracted with no signs of root caries. The criterion for inclusion was a root length of at least 14 mm and a rounded root canal shape on cross-section. The teeth were stored in physiological saline solution and refrigerated for no longer than one year from extraction. In the first phase, the materials were prepared for testing: the clinical crowns were cut off from the roots at the level of the cementoenamel junction. For this purpose, diamond burrs and turbine handpiece with water and air cooling were used [23, 24].

Next, the root canals were prepared with endodontic hand instruments, finishing at MAF up to ISO 40 (Maillefer, Dentsply), with a working length equal to the length of the root canal, by means of step-back technique. During this procedure and before filling, the canals were irrigated with about 2ml each of 2% NaOCl (Cerkamed, Poland) and 40% citric acid (Cerkamed, Poland). The canals were dried using paper points. The prepared root canals were filled with gutta-percha cones using the cold lateral condensation technique with an AH Plus (Dentsply, USA) sealer. The teeth were endodontically treated by two researchers (BC and KG). After the root canals were filled, the teeth were stored in saline solution — 0.9% NaCl (Polpharma, Poland) for one week. After that time, the preparation of the root canals for the dental posts began. For this purpose, tools supplied by the manufacturer of the posts were used (DT-Light posts, VDW GmbH), and the filling material was removed from the root canals at a length about 3 mm shorter than the working length of the canal, as well as from all canal walls. The size of the instruments used was adjusted to the diameter of the canal, and a suitable fiberglass post was selected for adhesive insertion. We used posts of the following magnitude: 1.25, 1.5, 1.8, and 2.2.

Before the posts were placed, the appropriate irrigation protocol was applied. The prepared tooth roots were divided into three equal groups (ten samples per group) based on the irrigation protocol applied prior to cementation of the posts: Group A, the control group, in which the root canals were irrigated with saline (0.9% NaCl); Group B, in which 2% CHX (Cerkamed, Poland) was used; and group C, in which the root canals were not irrigated with any solution. Within each group, two subgroups of five teeth each were defined based on the material used for cementing the fiberglass DT Light Post (VDW, Germany): subgroup 1 used RelyX Unicem (3M ESPE, Germany) while subgroup 2 used Build-It (Pentron, USA). Finally, six groups were analyzed: A1 — control group where root canals were irrigated with saline and RelyX Unicem was used for cementation; A2 — control group where root canals were irrigated with saline and Built-It was used for cementation; B1 — in which 2% CHX was used for canals irrigation and fiberglass was cemented using RelyX Unicem; B2 — in which 2% CHX was used for canals irrigation and fiberglass was cemented using Built-It; C1 — root canals were not irrigated with any solution and RelyX Unicem was used for fiberglass cementation; C2 — root canals were also not irrigated with any solution and fiberglass was cemented using Built-It.

Canals were meticulously dried with paper points prior to cementation (but care was taken not to over dry them). The post placement procedure was performed following the instructions provided by the respective cement manufacturers by two researchers (BC and KG). After the posts were placed, the teeth were kept in a well-controlled container at 100% humidity at 4°C in 0.9% NaCl solution for one week. After that time, each root was cut into slices using a Unimat device (Reitel, Feinwerktechnik) with the procedure described by Goracci *et al.* [19]. Four discs were obtained per tooth.

The contact surface area between the posts and dentin were calculated using the post's diameter and height of the slice with the following equation:

$$A = \pi \cdot d \cdot h \qquad [mm \cdot mm = mm^2]$$

where:
A — contact surface area
d — post diameter [mm]
h — slice thickness [mm]

For this purpose, the prototype measurement bar was photographed (using a Nikon D40X camera with am AF-S VR Micro-Nikkor 105 mm photo lens) next to the samples' slices. Based on this, the measurement grid was calibrated and superimposed (upper layer) on the sample image. Using the projection perpendicular to the long axis of the tooth and as long as the measuring tool, the diameter of the root orifice was calculated. Based on the images oriented in parallel projection to the long axis of the tooth, the cylinder's height was used to calculated the contact surface. All photographs were taken by the same photographer (WIR). The actual dimensions of the portion of the post were calculated using Adobe Photoshop graphical software (Adobe Photoshop CS2 version 9.0), which made it possible to magnify a selected area with an accuracy of up to 10 μm. The thickness of each test slice and the diameter of the post were obtained. An example of some of the calculations are presented in Figure 1. This facilitated the application of above equation and the calculation of the exact surface contact area with the dentin.

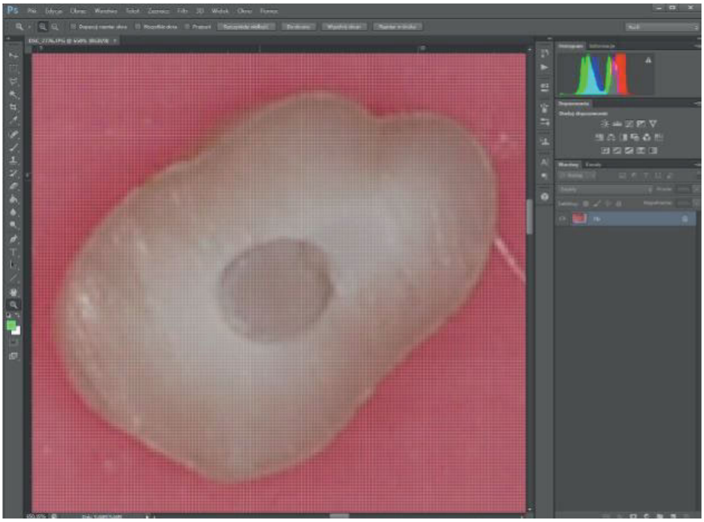

Fig. 1. Sample root cross-section shown in graphics software.

The push-out test was then performed [25] using an Instron 3345 device (Instron) by a single researcher (WIR). The test samples were placed on a specially prepared perforated plate in such manner that the cemented post was situated above the hole in the plate. The testing instrument (plunger) was then placed in the clamp of the device to push the post out from the slice, as it is shown on Figure 2. For each size of the post, the diameter of the plunger in the machine was different: for a sample with a 1.25 post, the plunger with a diameter of 1.0 mm was used; for a 1.5 post, the plunger with a diameter of 1.3 mm was used; for the 1.8 post, the plunger with a diameter of 1.6 mm was used, and for the 2.2 post, the plunger of 2.0 mm was used. The plunger crosshead speed was set to 0.1 mm/s. The destructive force was increased continuously in a static manner, until the post was decemented from the dentine. The results were continu-

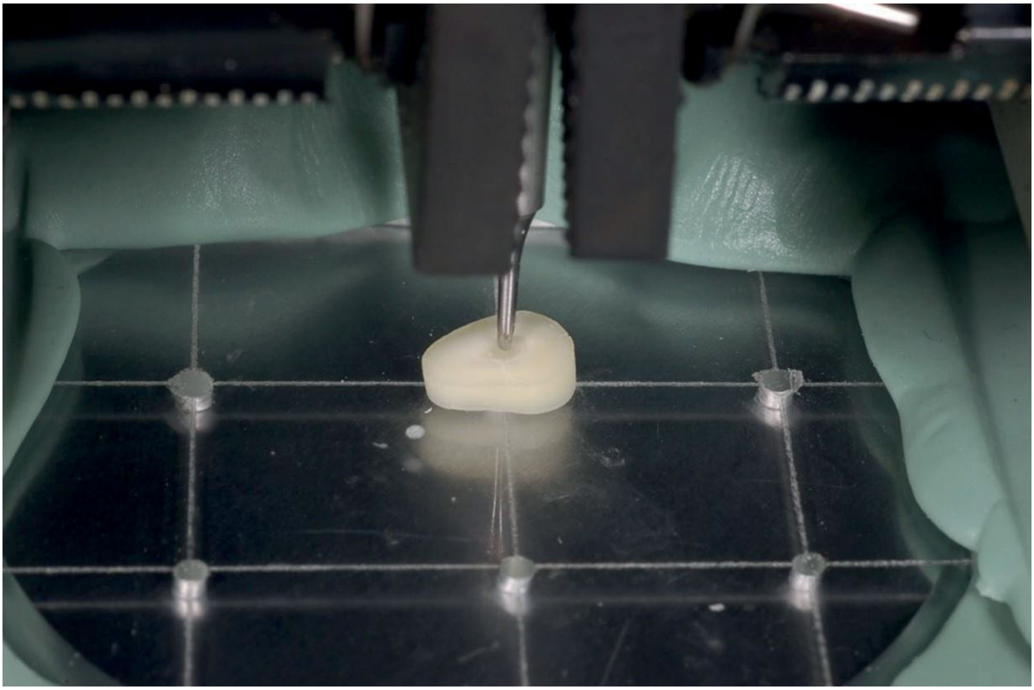

Fig. 2. Push out test of an exemplary sample.

ously recorded. The actual destructive force for each test sample was calculated using the following equation:

$$F_D = \frac{F_L}{A} \qquad \left[\frac{N}{mm^2} = MPa\right]$$

where:
F_D — actual destructive force
F_L — load force obtained from the strength tests [N]
A — surface contact area [mm^2]

The results were analyzed statistically using Statistica 13.3 software (StatSoft). The Shapiro–Wilk test was used to assess the normality of the data distribution. Data analysis was performed using descriptive statistics to determine the minimum and maximum values, standard deviation, and median. Analysis of variance (ANOVA) and Tukey's post-hoc multiple comparison tests were used to assess the relationship between independent variables. The results are presented in tables and in a form of graphical chart. The level of statistical significance was set at p = 0.05. Omega squared was calculated as an estimator of effect size.

Results

Sixty sample slices were obtained for destructive force measurement — thirty samples for each of the tested cements. In each groups, the samples came from teeth in which the space within the canal had been treated with a different irrigating agent prior to the placement of the post. Each of the groups consisted of 10 samples. Results were obtained for the six groups in which different types of cement and irrigation protocols were used.

The average bonding strength between the endodontic posts and the dentin was 10.69 MPa in Group A (with 0.9 NaCl as irrigant); 16.33 MPa in in Group B (with CHX); and 16.72 MPa in Group C (with no irrigant fluid). Figure 3 shows the average values of the force needed to destroy the bond between the posts and the tissue of the tooth roots, by type of canal irrigant fluid used prior to cementation of the posts. According to the ANOVA test ($p = 0.4153$) the difference in destructive force was not statistically significant regarding the cement. Table 1 shows results of descriptive statistics of setting strength, cement and irrigation protocols in six groups.

The assessment was performed of the bond strength between the post and the dentin depending on the canal irrigation protocol, and a statistically significant difference ($p = 0.0016$, ANOVA) was found. The effect size calculated as partial omega squared revealed medium effect size of irrigation factor (0.21). Tukey's HSD post-hoc

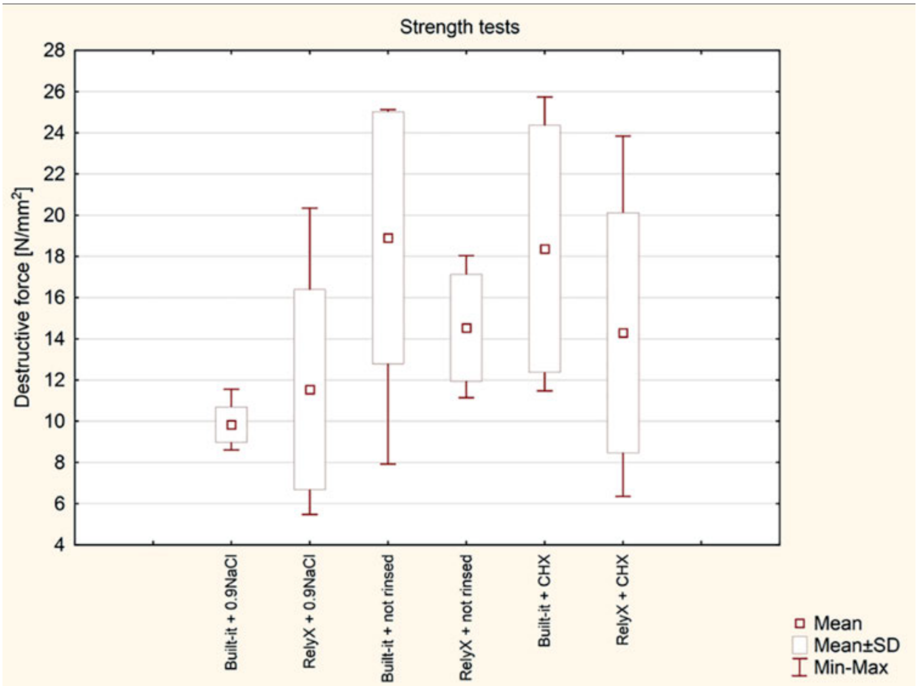

Fig. 3. Average destructive forces necessary to destroy samples by cement and irrigation fluid.

Table 1. Results of descriptive statistics of setting strength, cement and irrigation protocols in six groups.

Group	Cement	Irrigation	N	Mean	SD	Min	Max	Median
A1	RelyX	NaCI	8	11.54	4.850	5.47	20.34	11.57
B1	RelyX	CHX	8	14.29	5.825	6.34	23.83	14.32
C1	RelyX	None	8	14.54	2.587	11.14	18.03	14.22
A2	Built-it	NaCI	8	9.84	0.853	8.60	11.55	9.73
B2	Built-it	CHX	8	18.37	5.988	11.47	25.74	18.07
C2	Built-it	None	8	18.91	6.108	7.92	25.12	20.77

Abbreviations: A1 and A2 — control groups; B1 and B2 — 2% CHX was used for canals irrigation and fiberglass cementation; C1 and C2 — no irrigation before cementation; CHX — chlorhexidine digluconate 2%; NaCl — saline solution.

multiple comparison tests showed a significant statistical difference between bond strength using CHX irrigation (or no irrigation at all) and posts placed after canal irrigation with a 0.9 NaCl (Table 2). Additionally cement (as factor) and cement and irrigation (as interactions) resulted as statistically non-significant.

Table 2. Results of comparison tests between cements and irrigation methods (ANOVA Tukey's HSD post-hoc multiple — statistically significant results are highlighted in bold with asterix).

Cement/Irrigation	RelyX/ NaCl A1	RelyX/ CHX B1	RelyX/ none C1	Built-it/ NaCl A2	Built-it/ CHX B2	Built-it/ none C2
RelyX/NaCl — A1		0.8576	0.8092	0.9801	0.0692	**0.0405***
RelyX/CHX — B1	0.8576		0.9999	0.4421	0.5405	0.4030
RelyX/none — C1	0.8092	0.9999		0.3828	0.6050	0.4634
Built-it/NaCl — A2	0.9801	0.4421	0.3828		**0.0116***	**0.0062***
Built-it/CHX — B2	0.0692	0.5405	0.6050	**0.0116***		0.9999
Built-it/none — C2	**0.0405***	0.4030	0.4634	**0.0062***	0.999922	

Abbreviations: A1 and A2 — control groups; B1 and B2 — 2% CHX was used for canals irrigation and fiberglass cementation; C1 and C2 — no irrigation before cementation; CHX — chlorhexidine digluconate 2%; NaCl — saline solution.

Discussion

Two different generations of cements were used for the study: the self-adhesive cement RelyX Unicem (3M ESPE, Germany), which does not require an etching procedure, and Build-It (Pentron, USA) cement, which requires etching. The results indicate that there is no statistically significant difference between the cements. In particular, our research demonstrates that the type of cement did not affect the bond strength between the post and dentin. Conversely, the irrigation protocol turned out to be statistically significant. This correlates with the results of Casselli *et al.* [22]. The lack of statistical differences between the adhesion forces for self-adhesive cement and the cement that needs a preparatory procedure leads to the conclusion that self-adhesive cements can serve as an alternative to cements that require etching and the subsequent use of an adhesive bonding agents. Additionally, the simpler procedure, which largely eliminates errors in the different stages of work, reveals the advantage of self-adhesive cements. The reduced time required for the self-adhesive procedure is also an important factor.

Analysis of the data shows that the bonding strength of the cement to the dentin depends on the irrigation protocol used for the root canal prepared for the placement of the post. Three groups of samples were prepared for testing: those irrigated with 0.9% NaCl, those irrigated with 2% CHX, and those not irrigated at all prior to cementation of the fiber posts. Our results are similar to those of Bitter *et al.* [21] in terms of the effect of the adhesive strength of the fiber posts to dentin of different types of adhesion process. Our mean bond strengths positively correlated with the values published by those authors [21].

Throughout the literature, there are several tests for determining the strength of dentine-to-post adhesive bonding [2] such as the microtensile bond strength test and push-out or pull-out tests [1, 6, 14, 15, 17, 20, 26, 27]. In our study, we decided to use the push-out test, as it is the most commonly used test and seems to be the most accurate. Using this test, the premature loss of samples during specimen manufacture was reduced, enabling the measurement of bond strength on very small areas such as the interior of the root canal [12].

Our study used the push-out test, which is described in the literature and is a reliable test of the strength of post cementation to root dentin. The results show that a 2% solution of CHX positively affects the bonding strength of the post to the dentin, as compared to the control group. Similar results were obtained by Haragushiku *et al.* [7] who used a 2% solution of CHX and whose push-out test results suggested increased bonding strength between the post and the dentin after CHX was used as an irrigant fluid. This effect was attributed to the bactericidal action of the fluid, which destroyed *Enterococcus faecalis* bacteria present in the root canal. These results, however, contradict those of other authors [11, 15, 20, 27]. The differences in the results may be due to the slightly different irrigation protocols used in the studies. The procedural protocols [11, 25] included an additional irrigation with physiological saline solution or distilled water after the application of CHX. In our study, CHX was removed from the canals using paper points. As a result, different amounts of the irrigation solution may have been left in the prepared canal systems, where they interacted with the bonding agent. The results of the study of Wang *et al.* [26], despite similar handling of the CHX solution, were inconsistent with ours. This may be due to the use of different bonding systems and different cements for post placement. The different types of fiber posts should also be taken into consideration in connection with the bond strength between posts and dentin; for this reason, further investigation of this issue is needed [28, 29].

Conclusions

1. The root canal irrigation protocol affects the adhesion strength of fiberglass posts.
2. The use of 2% CHX or of no canal irrigant fluid (just prior to cementation of fiber posts) significantly positively affects the adhesion strength of posts to dentin.
3. Rinsing root canals with CHX prior to fiber post cementation seems to be the most effective method.

Clinical relevance statement

Our study presents that the root canal irrigation protocol affects the adhesion strength of fiberglass posts to dentin and rinsing root canals with CHX is the most effective method.

Conflict of interest

None declared.

Funding

The study was not funded.

References

1. *Asmussen E., Peutzfeldt A., Heitmann T.*: Stiffness, elastic limit, and strength of newer types of endodontic posts. Journal of Dentistry. 1999; 27: 275–278.
2. *Bateman G., Ricketts D.N., Saunders W.P.*: Fibre-based post systems: a review. Br Dent J. 2003; 195: 43–48.
3. *Schwartz R.S., Robbins J.W.*: Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004; 30: 289–301.

4. *Skupien A., Sarkis-Onofre R., Cenci S., Morales R., Pereira-Cenci T.*: A sys.ematic review of factors associated with the retention of glass fiber posts. Braz Oral Res. 2015; 29: 1–8.
5. *Ryniewicz W., Ryniewicz A.M., Bojko Ł.*: The effect of a prosthetic crown's design on the accuracy of mapping an abutment teeth's shape. Meas. 2016; 91: 620–627.
6. *Bitter K., Aschendorff L., Neumann K., Blunck U., Sterzenbach G.*: Do chlorhexidine and ethanol improve bond strength and durability of adhesion of fiber posts inside the root canal? Clin Oral Investig. 2014; 18: 927–934.
7. *Haragushiku G.A., Back E.D., Tomazinho P.H., Baratto Filho F., Furuse A.Y.*: Influence of antimicrobial solutions in the decontamination and adhesion of glass-fiber posts to root canals. J Appl Oral Sci. 2015; 23: 436–441.
8. *Stape T.H.S., de Souza Menezes M., Aguiar F.H.B., Quagliatto P.S., Soares C.J., Martins L.R.M.*: Long-term effect of chlorhexidine on the dentin microtensile bond strength of conventional and self-adhesive resin cements: A two-year in vitro study. Int J Adhes Adhes. 2014; 50: 228–234.
9. *Toman M., Toksavul S., Tamac E., Sarikanat M., Karagozoglu I.*: Effect of chlorhexidine on bond strength between glass-fiber post and root canal dentine after six month of water storage. Eur J Prosthodont Restor Dent. 2014; 22: 29–34.
10. *Cecchin D., Farina A.P., Souza M.A., Da Cunha Pereira C.*: Effect of root-canal sealer on the bond strength of fiberglass post to root dentin. Acta Odontol Scand. 2011; 69: 95–100.
11. *Cecchin D., de Almeida J.F., Gomes B.P., Zaia A.A., Ferraz C.C.*: Influence of chlorhexidine and ethanol on the bond strength and durability of the adhesion of the fiber posts to root dentin using a total etching adhesive system. J Endod. 2011; 37: 1310–1315.
12. *Cecchin D., Farina A.P., Giacomin M., Vidal C. de M., Carlini-Junior B., Ferraz C.C.*: Influence of chlorhexidine application time on the bond strength between fiber posts and dentin. J Endod. 2014; 40: 2045–2048.
13. *Cecchin D., Giacomin M., Farina A.P., Bhering C.L., Mesquita M.F., Ferraz C.C.*: Effect of chlorhexidine and ethanol on push-out bond strength of fiber posts under cyclic loading. J Adhes Dent. 2014; 16: 87–92.
14. *Ekambaram M., Yiu C.K., Matinlinna J.P., Chang J.W., Tay F.R., King N.M.*: Effect of chlorhexidine and ethanol-wet bonding with a hydrophobic adhesive to intraradicular dentine. J Dent. 2014; 42: 872–882.
15. *Gomes Franca F.M., Vaneli R.C., Conti C. de M., Basting R.T., do Amaral F.L., Turssi C.P.*: Effect of Chlorhexidine and Ethanol Application on Long-term Push-out Bond Strength of Fiber Posts to Dentin. J Contemp Dent Pract. 2015; 16: 547–553.
16. *Leitune V.C., Collares F.M., Werner Samuel S.M.*: Influence of chlorhexidine application at longitudinal push-out bond strength of fiber posts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010; 110: e77–81.
17. *Lindblad R.M., Lassila L.V., Salo V., Vallittu P.K., Tjaderhane L.*: Effect of chlorhexidine on initial adhesion of fiber-reinforced post to root canal. J Dent. 2010; 38: 796–801.
18. *Kang H.-J., Moon H.-J., Shin D.-H.*: Effect of different chlorhexidine application times on microtensile bond strength to dentin in Class I cavities. Restor Dent Endod. 2012; 37: 9–15.
19. *Goracci C., Grandini S., Bossu M., Bertelli E., Ferrari M.*: Laboratory assessment of the retentive potential of adhesive posts: a review. J Dent. 2007; 35: 827–835.
20. *Baldea B., Furtos G., Antal M., Nagy K., Popescu D., Nica L.*: Push-out bond strength and SEM analysis of two self-adhesive resin cements: An in vitro study. J Dental Sci. 2013; 8: 296–305.
21. *Bitter K., Hambarayan A., Neumann K., Blunck U., Sterzenbach G.*: Various irrigation protocols for final rinse to improve bond strengths of fiber posts inside the root canal. Eur J Oral Sci. 2013; 121: 349–354.
22. *Casselli D.S., Borges M.G., Menezes M.S., Faria-e-Silva A.L.*: Effect of cementation protocol on push-out bond strength of fiber posts to root canal. Appl Adhes Sci. 2014; 2: 15.
23. *Cecchin D., de Almeida J.F., Gomes B.P., Zaia A.A., Ferraz C.C.*: Effect of chlorhexidine and ethanol on the durability of the adhesion of the fiber post relined with resin composite to the root canal. J Endod 2011; 37: 678–683.

24. *Kim Y.H., Shin D.H.*: Effect of chlorhexidine application on the bond strength of resin core to axial dentin in endodontic cavity. Restor Dent Endod. 2012; 37: 207–214.
25. *Lima J.F., Lima A.F., Humel M.M., Paulillo L.A., Marchi G.M., Ferraz C.C.*: Influence of irrigation protocols on the bond strength of fiber posts cemented with a self-adhesive luting agent 24 hours after endodontic treatment. Gen Dent. 2015; 63: 22–26.
26. *Wang L., Pinto T.A., Silva L.M., et al.*: Effect of 2% chlorhexidine digluconate on bond strength of a glass-fibre post to root dentine. Int Endod J. 2013; 46: 847–854.
27. *de Araujo D.F., Chaves L.P., Bim O. Jr., et al.*: Influence of 2% chlorhexidine digluconate on bond strength of a glass-fibre post luted with resin or glass-ionomer based cement. J Dent. 2014; 42: 735–741.
28. *Sahinkesen G., Erdemir U., Oktay E.A., Sancakli H.S.*: The effect of post surface silanization and luting agents on the push-out bond strengths of adhesively inserted fiber reinforced posts. Int J Adhes Adhes 2011; 31: 265–270.
29. *Lindblad R.M., Lassila L.V., Salo V., Vallittu P.K., Tjaderhane L.*: One year effect of chlorhexidine on bonding of fibre-reinforced composite root canal post to dentine. J Dent. 2012; 40: 718–722.