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ORIGINAL ARTICLE

Effect of different methods of fiber post cleaning on post resistance to dislodgement from the root canal

ABSTRACT

Aim: *To evaluate the effect of different methods of fiber post cleaning on post resistance to dislodgement after cementation.*
Methodology: *Sixty bovine incisors were divided into six groups according to the cleaning method applied to the fiber posts. GC: no cleaning; GES: autoclave sterilization; GHP: 2.5% sodium hypochlorite; GCL: 2% chlorhexidine digluconate; GAL: 70% alcohol; GAF: 35% phosphoric acid. The posts were cemented in the canals using a self-adhesive resin cement. The specimens were sectioned perpendicularly along the long axis of the root with an average thickness of 1.61 mm at the cervical, middle, and apical root thirds and subjected to the push-out test. After the test, they were examined under a stereomicroscope to determine failure mode. Data were analyzed using one-way ANOVA and the Tukey test (α=0.05).*
Results: *The comparisons with the GC group revealed statistical differences only in the middle and apical thirds of the GCL group and in the apical third of the GHP group. Only the apical thirds were different from the middle and cervical thirds in the GC group, and the cervical thirds, from the middle and apical thirds of the GES group.*
Conclusions: *The resistance to dislodgement of fiber posts cemented in root canals was not affected by the different cleaning methods under study.*

Vanessa Mallmann Weschenfelder[1]

Vicente Castelo Branco Leitune[2]

Tiago André Fontoura de Melo[2]

[1]Dentistry College, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil

[2]Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil

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Corresponding Author
Tiago André Fontoura de Melo | Federal University of Rio Grande do Sul, Porto Alegre, RS | Brazil
Tel. +55 (51) 3308-5430 | Email: tafmelo@gmail.com

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Introduction

Resources for a direct restoration of weakened and endodontically treated teeth include fiber posts, which have an elasticity module similar to that of dentin, and restorative materials (1, 2). The cementation protocols for this type of post include numerous pre-placement clinical procedures, of which the operator should have a sound knowledge and technical mastery, conducted under strict biosafety control. Handling and clinical adjustment of the post by the manufacturer or the dentist without proper biosafety care before cementation may result in the accumulation of microorganisms on the surface of the post, which may initiate and perpetuate contamination of the root canal system (3). Correct cleaning of the post before cementation reduces the risk of reinfection and endodontic treatment failure.

Although fiber posts are manufactured under aseptic conditions, they can be contaminated through manual contact, or by aerosols. Furthermore, in routine clinical procedures, it may be necessary to change the size of the fiber post that has been tried in a root canal. Therefore, cleaning is required to use the fiber post again (4). Some substances such as sodium hypochlorite (5) and chlorhexidine (6) may be used to clean intraradicular posts. They are excellent antimicrobial irrigants to be used during endodontic treatments. Alcohol, already used to clean posts before cementation, also has a bactericidal and virucidal action against certain strains (7). Phosphoric acid, in contrast, reduces the microbial load on surfaces, but does not eliminate it completely (8). However, no studies have yet examined whether the use of these substances has any deleterious effects, such as the presence of residual oxygen, the formation of precipitates, or changes in the surface roughness of posts, which may compromise the adhesive bonding of posts cemented in root canals. There are only studies that directly assess the effect of these substances on the dentin substrate (9-11).

This study evaluated the effect of different methods of fiber post cleaning on post resistance to dislodgement after cementation. The null hypothesis is that the different methods of fiber post cleaning do not cause changes in the bond strength of fiberglass posts within the intraradicular dentin.

Materials and Methods

Sample selection and preparation

This study included 60 bovine primary incisors with root canals that had an apical diameter equivalent to that of a #20 K-file (Dentsply/Maillefer Instruments S.A., Ballaigues, Switzerland). After cleaning, the teeth had their crowns sectioned at the cementoenamel junction using a low-speed carbide disc. Roots were standardized to a length of 17 mm, and working length (WL) was set at 1 mm short of root length (WL=16 mm). All samples were prepared manually with first and second series K-type stainless steel endodontic instruments (Dentsply/Maillefer Instruments S.A., Ballaigues, Switzerland). Chemomechanical preparation was carried out in the following sequence of K-type instruments: #20, #25, #30, #35, #40, and #45 (Dentsply/Maillefer Instruments S.A., Ballaigues, Switzerland). All instruments were used along the WL.

At each instrument change, the canals were irrigated with 2 mL of 2.5% sodium hypochlorite (Iodontec Indústria e Comércio de Produtos Odontológicas Ltda., Porto Alegre, Brazil) using a plastic syringe (BD Solumed, São Paulo, Brazil) and 25-mm 30-ga NaviTip needles (Ultradent, Indaiatuba, Brazil).

After the preparation, the canals were irrigated with 17% trisodium EDTA (Biodinamica, Ibiporã, Brazil) for three minutes under agitation using #45 files. After that, they were rinsed with distilled water (Iodontosul-Industrial Odontológica do Sul LTDA, Porto Alegre, Brazil) and dried with absorbent paper cones (Tanari Indústria Ltda., Manaus, Brazil).

All canals were filled with gutta-percha cones and a resin-based sealer (AH Plus®,

Table 1
Experimental groups

Groups	n	Disinfection method
GC	10	None
GES	10	Autoclave sterilization
GHP	10	2.5% sodium hypochlorite (Iodontosul, Industrial Odontológica do Sul LTDA, Porto Alegre, Brazil)
GCL	10	2% chlorhexidine digluconate (Maquira Indústria de Produtos Odontológicos S.A., Maringá, Brazil)
GAL	10	70% alcohol (LBS Laborasa Indústria Farmacêutica Ltda., São Paulo, Brazil)
GAF	10	35% phosphoric acid (FGM, Joinville, Brazil)

Table 2
Disinfectants and application method according to fiber post group

Groups	Disinfectant	Application method
GHP	2.5% sodium hypochlorite	Posts were immersed in 10 mL of the solution
GCL	2% chlorhexidine digluconate	Posts were immersed in 10 mL of the solution
GAL	70% alcohol	Posts were immersed in 10 mL of the solution
GAF	35% phosphoric acid	Gel was applied to posts in a Petri dish

Dentsply/Maillefer Instruments SA, Ballaigues, Switzerland) using a #60 McSpadden® condenser (Dentsply/Maillefer Instruments SA, Ballaigues, Switzerland) and the hybrid technique developed by Tagger. All samples were restored using a temporary filling paste (Cimpat®, Septodont, Saint-Maur-des-Fossés, France) and then kept in distilled water for two days until the paste set completely.
After that, the canals were cleaned with 2 mL of distilled water and dried with absorbent paper points (Dentsply Maillefer Instruments SA, Ballaigues, Switzerland) to prepare the space for the post to be cemented.
The drill that comes with the post and has the same diameter was used to remove 13 mm of the obturation, leaving 3 mm of apical sealing.

Division of experimental groups
The teeth were divided into six groups (Table 1), using simple random sampling and the Excel software (Microsoft Excel, Microsoft Corporation, Redmond, WA).

Protocols for fiber post cleaning
Sixty #1 tapered Exacto® fiber posts (Angelus, Londrina, Brazil) were used in the study (10 per group). The posts in GC did not receive any antimicrobial treatment. The samples in GES were sterilized in an autoclave: they were placed in a sterilization pouch (Medstéril, São Paulo, Brazil), sealed using a sealing machine (RSR 2000, RON Micromecânica Ltda., São Paulo, Brazil) and placed in a Vitale 12 autoclave (Cristófoli, Curitiba, Brazil) for a 40-minute cycle at a temperature of 240 ºF (126 ºC) and 20 psi of pressure.
The posts in GHP, GCL, GAL and GAF were kept in contact with the disinfectant for 5 minutes (Table 2). After that, all were rinsed with 20 mL of saline and dried at room temperature.

Post cementation and specimen preparation
All posts were cemented according to the manufacturer's directions. An adhesive (Single Bond Universal®, 3M ESPE, St Paul, MN) was applied to the posts for 20 seconds using a microbrush, and posts

Table 3
Bond strength values in the push-out test according to root thirds in the different groups

Experimental Group	Root thirds			P
	Cervical	Middle	Apical	
	MPa (± SD)	MPa (± SD)	MPa (± SD)	
GC	9.87[Aa] ± (4.18)	6.89[Aab] ± (3.30)	4.37[Ab] ± (4.42)	P<0.05
GES	12.12[Aa] ± (3.28)	9.28[ABb] ± (3.01)	7.66[ABb] ± (2.40)	P<0.05
GHP	10.5[Aa] ± (2.56)	10.17[ABa] ± (3.71)	9.96[Ba] ± (4.62)	P=0.949
GCL	11.29[Aa] ± (2.56)	13.46[Ba] ± (6.06)	10.23[Ba] ± (4.80)	P=0.309
GAL	10.64[Aa] ± (3.53)	11.53[ABa] ± (4.46)	8.96[ABa] ± (4.40)	P=0.386
GAF	11.96[Aa] ± (4.43)	10.29[ABa] ± (3.83)	8.29[ABa] ± (4.08)	P=0.158
P	**P=0.676**	**P<0.05**	**P<0.05**	

Means followed by different uppercase letters in the column and means followed by different lowercase letters in the line differ significantly in the analysis of variance at the 5% significance level.

were then dried with air spray for 5 seconds. The posts were cemented using a self-adhesive resin cement (RelyX U200®, 3M ESPE, St. Paul, MN) applied to the root canal with a syringe (Sistema Centrix, DFL, Rio de Janeiro, Brazil) and a fine metal tip to fill the 13 mm of unobstructed canal. The posts were inserted into the root canal and light-cured using an EC450 unit (ECEL, Ribeirão Preto, Brazil) at an irradiance greater than 400 mW/cm^2 for 20 seconds; chemical curing took six more minutes.

The roots were kept in distilled water after cementation, and, 15 days later, were sectioned perpendicularly along the long axis of the root in three 1.61-mm ± 0.30-mm-thick slices using a diamond saw (Labcut 1010, Extec Corp., Enfield, CT). The slices were standardized to 4 mm in the cervical third, 8 mm in the middle third and 12 mm in the apical third (Figure 1). They were labeled and stored in an oven at 37° C and 100% relative humidity for seven days.

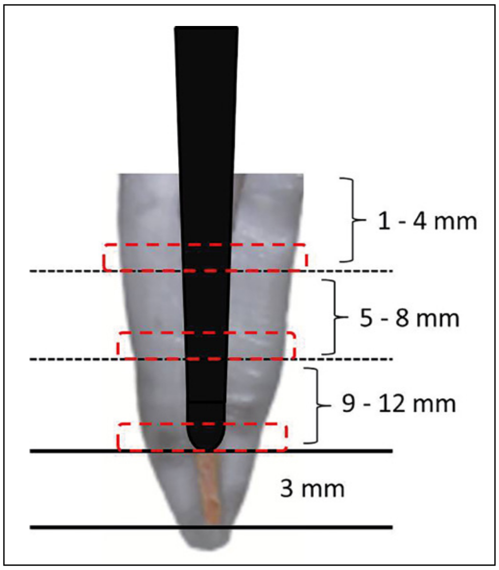

Figure 1
Schematic diagram of root slices.

Push-out test

The specimens were placed on a stainless steel support that had a central perforation 2 mm in diameter. As the posts were conical, the load was applied to the apex in the direction of the cervical third, so that the post was pushed towards the widest portion of the root canal.

The load was applied only to the post surface using a pin measuring about 1 mm in diameter in a universal testing machine (EZ-SX, Shimadzu, Kyoto, Japan). The load cell was 500 N, and the crosshead speed, 1 mm/min. The values were recorded in N and later converted to MPa.

The internal upper and lower diameters of the canal and the thickness of the sections (cone trunk area) were measured to estimate the canal area used for the calculation of bond strength values.

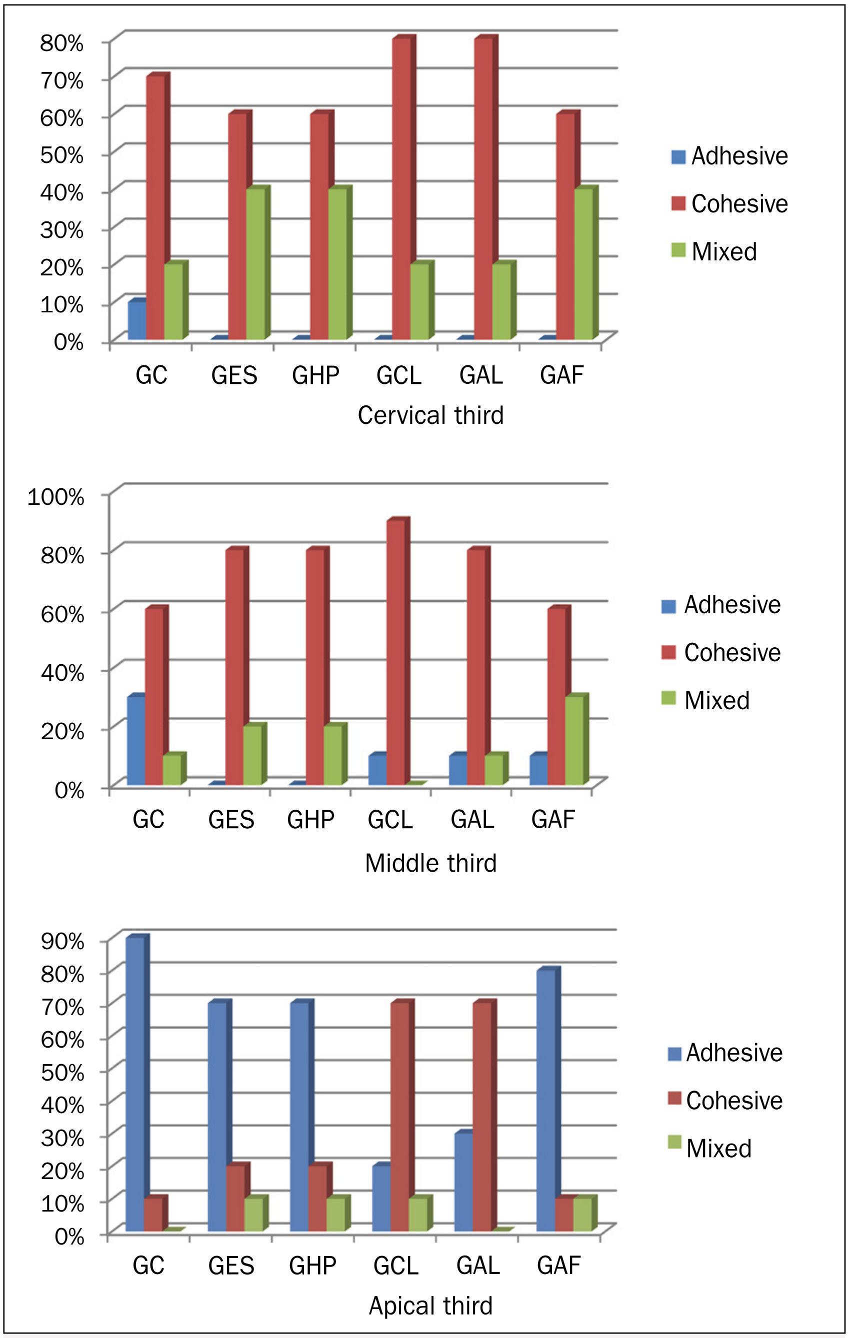

Figure 2
A graph showing failure patterns (%) after tested protocols.

After the push-out test, the fractured specimens were analyzed under an X20 stereomicroscope (Stemi 2000, Karl Zeiss, Germany) to determine the adhesive, cohesive, or mixed failure pattern.

Statistical analysis
The Shapiro-Wilk test was used to check for data normality. One-way ANOVA and the Tukey test for multiple comparisons were used to analyze the results of resistance to dislodgement. The level of significance was set at 5% ($P \leq 0.05$). Statistical analyses were performed using the GraphPad Prism 7 program (GraphPad Software Inc., San Diego, CA).

Results

Mean values of resistance to dislodgement (MPa) in the different groups and canal thirds are shown in Table 3. There was a statistical difference between the GC group and the groups disinfected with chlorhexidine (GCL) in the middle and apical thirds and with sodium hypochlorite (GHP) in the apical third. The comparisons of canal thirds in each group revealed a statistical difference only in GC when the apical third was compared with the middle and cervical thirds, and GES, in the comparisons of cervical thirds with the middle and apical thirds.
Graph in figure 2 shows the percentage of failure in the samples for each root third. There was a higher percentage of cohesive failures in the cervical and middle thirds in all groups. However, most failures in the apical third were of the adhesive type at the post-cement interface, except in GCL and GAL, in which samples had a higher percentage of cohesive failures.

Discussion

In the analysis of factors that may determine the endodontic and restorative success of a tooth, one must take into account, in addition to the choice of the best material to functionally and aesthetically replace the lost structure, the decontamination of this material before being inserted into the root canal. It is prudent to have a biosafety protocol on intraradicular pins so that they are effective in their functions and that at the same time they do not recontaminate the canal.
Although some disadvantages have been reported in the literature, such as the

distribution of non-uniform tensions, the push-out test was chosen in this study because it is more reliable than other techniques for the evaluation of resistance to dislodgement of fiber posts from root canal dentin (12). All root thirds were tested to understand, after excluding other variables, the mechanism of changes during the interaction between the post and the cement. According to the results obtained, the null hypothesis of the present study was accepted, the methods used to clean posts did not have a negative effect on the resistance to dislodgement of fiber posts cemented in root canals. In fact, the comparison of the GC group with the other groups revealed a statistically significant increase in bond strength in the middle and apical thirds of GCL, and in the apical third of GHP. So far, studies in the literature have only investigated the treatment of dentin surfaces with disinfectants and their effect on cemented posts. Although treatments applied to dentin cannot be compared with dentin treatments, their results revealed some differences. The use of chlorhexidine as a root canal irrigant before post cementation seems to increase the bond strength of the posts. Farina et al (13) found that the bond strength of a self-etching adhesive to dentin was greater in the group that received 2% chlorhexidine followed by 17% EDTA as intracanal irrigation than in the groups that was irrigated with different concentrations of sodium hypochlorite. Durski et al (14), in a study that pretreated all samples with 2% chlorhexidine, found that the posts cemented with the RelyX Unicem® self-adhesive system had greater bending forces in all thirds than those that received the RelyX ARC® total-etch cement, in both immediate and long-term analyses. According to a study analyzing the use of sodium hypochlorite conducted by Ertas et al (15), 5 mL of 5.25% sodium hypochlorite for five minutes in the root canal prepared to receive a post did not decrease the bond strength of the cemented post. Cecchin et al (16) found that sodium hypochlorite does not affect post bond strength immediately after bonding and for 12 months.

Sterilization is the best resource to eliminate all forms of microorganisms (17). Post sterilization in an autoclave did not affect the bond strength of post to root canal. Yagci et al (4) analyzed the effect of sterilization using ethylene oxide and autoclave sterilization on the tensile strength, flexion and elasticity modulus of fiber posts. Results revealed that that type of sterilization did not affect the three criteria negatively, which somewhat corroborates our findings. In contrast, Canelas et al (18) found that autoclave sterilization and the application of a disinfectant containing glutaraldehyde resulted in a statistically significant decrease in fiber post strength and a greater risk of fracture than in the control group. According to those authors, the exposure to high-pressure steam during autoclave sterilization might compromise the physical properties of the fiber posts because of the degradation of the bond between the resin matrix and the fibers. According to their manufacturer's instructions, Exacto® posts may be autoclaved up to two times, as more times may affect the strength of their material. In addition, questions remain about how long a patient should wait for autoclave sterilization to be completed. Posts should be disinfected before intraradicular cementation, as well as after their necessary adjustment to the tooth structure. Posts are adjusted to the desired length usually using drills and tips at high rotation under refrigeration. Therefore, there is a considerable increase in clinical time when transoperative autoclave sterilization is used, and this time should be included in treatment plans.

Cleaning with alcohol and phosphoric acid did not compromise post bond strength in the canal. Many manufacturer's protocols for the cementation of fiber posts call for cleaning the posts with alcohol before the application of silane to degrease their surface, and not to disinfect them. According to the Center of Diseases Control and Prevention, 70% alcohol is an intermediate level germicide (19). In our study, the posts were immersed in alcohol for five minutes for cleaning, and this clinical protocol seems to suggest that post bond strength in the canal is not compromised. The five-minute immersion time was defined to standardize all study protocols.

Moreover, alcohol is a volatile substance and would have to be replaced if a longer time had been used. Baldissera et al (20) found that 70% alcohol remained active and eliminated all microorganisms on periapical radiographic film when a minimum immersion time of three minutes was used. The application of phosphoric acid to post surfaces improves the chemical interaction between the post surface and the restorative material (21, 22). However, the decrease in adhesive strength of intraradicular posts seems to be associated with the degradation of dentin collagen fibrils after intracanal acid etching (23). In our study, phosphoric acid was applied to the fiber post to reduce superficial microbial contamination (8), and post bond strength in the canal was not affected. Albashaireh et al (24) found that pretreating fiber posts with 37% phosphoric acid for 15 seconds had no significant effect on fiber post resistance to dislodgement.

The comparison of resistance to dislodgement of cemented posts from root thirds revealed differences in the thirds closest to the root apex from those located in the cervical third only in GC and GES. This finding is in accordance with reports in the literature (25, 26). Durski et al (14) also found that the use of total etching and self-adhesive resin cements resulted in higher fiber post bond strength in the cervical third, whereas the apical third had significantly lower push-out values. Root dentin has morphological differences along the canal (27), as the density of dentinal tubules is reduced (28) and its diameter is smaller (29) in the apical region, which may justify the difference between root thirds. The other groups did not show any differences in bond strength between the root thirds, although their values (Table 3) decreased from the cervical to the apical third. In the studies conducted by Faria and Silva et al (30), with fiber posts, and by Kahnamouei et al (31), with quartz posts, resistance to dislodgement was the same in the comparisons between root thirds. In both studies, the posts were cemented in the root canal with self-adhesive systems.

The analysis of predominant failure mode revealed a higher percentage of cohesive failures in the middle and cervical thirds than of mixed and adhesive failures in all groups. These results are in agreement with findings by Lindblad et al (32), who evaluated the effect of chlorhexidine as a root canal irrigant before fiber posts were cemented using different types of cements. They found that chlorhexidine had no negative effect on the resistance to dislodgement of cemented posts. In contrast, the examination of the apical third in our study revealed a predominance of adhesive failures, except in the groups of samples disinfected with alcohol and chlorhexidine, which had a higher percentage of cohesive failures. Lindblad et al (32) also found a higher percentage of cohesive and mixed failures, except in the group that received everStickPOST for cementation and chlorhexidine as an intracanal irrigant. No plausible explanation was found in the literature for the fact that cohesive failures were predominant in the apical third when these substances were used.

The use of a disinfectant on the fiberglass posts before their cementation in the root canal is necessary to ensure the biosafety of the operative field. Our study found that bond strength of posts cemented in the canal was not affected by the cleaning methods under evaluation. However, further studies should examine other clinical protocols with varying disinfectant concentrations and times to evaluate whether they affect post properties and function after restorations.

Conclusions

The cleaning methods examined in this study did not have a negative effect on the resistance to dislodgement of fiber posts cemented in the root canal.

Clinical Relevance

The cleaning methods examined not influence intraradicular posts adhesion.

Conflict of Interest

The authors declares that there is no conflict of interest.

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None.

References

1 Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004;30:289-301.
2 Al-Omiri MK, Mahmoud AA, Rayyan MR, et al. Fracture resistance of teeth restored with post-retained restorations: an overview. J Endod. 2010;36:1439-49.
3 Berger CR, Cavina DA. Pinos intrarradiculares não metálicos. In: Gomes JC et al. Estét Clín Odontol. 1 ed. Curitiba: Ed Maio. V 1, p. 395-426, 2004.
4 Yagci F, Ustun Y, Zortuk M, et al. Effect of sterilization on bond strength and mechanical properties of fiber posts. J Adhes Dent. 2019;21:143-148.
5 Gazzaneo I, Vieira GCS, Pérez AR, et al. Root canal disinfection by single- and multiple- instrument systems: effects of sodium hypochlorite volume, concentration, and retention time. J Endod. 2019;45:736-741.
6 Zandi H, Rodrigues RC, Kristoffersen AK, et al. Antibacterial effectiveness of two root canal irrigants on root-filled teth with infection: a randomized clinica trial. J Endod. 2016;42:1307-13.
7 Venturelli AC, Torres FC, Rodrigues RAP, et al. Avaliação microbiológica da contaminação residual em diferentes tipos de alicates ortodônticos após desinfecção com álcool 70%. Rev Dent Press Ortodon Ortop Facial. 2009;14:43-52.
8 Luglié PF, Delitala PP, Zanetti S, et al. An in vivo bacteriological study on the effects of acid etching at the bottom of cavities. Minerva Stomatol. 1998;47:19-26.
9 Breschi L, Gobbi P, Falconi M, et al. Effect of dentinal pretreatments on coronal dentin primary carious lesions: a field emission SEM study. Clin Oral Investig. 2003;7:140-7.
10 Gandolfi MG, Taddei P, Pondrelli A, et al. Demineralization, collagen modification and remineralization degree of human dentin after EDTA and citric acid treatments. Materials (Basel). 2018;12:25.
11 Suzuki TYU, Pereira MA, Gomes Filho JE, et al. Do irrigation solutions influence the bond interface between glass fiber posts and dentin? Braz Dent J. 2019;30:106-116.
12 Goracci C, Sadek FT, Monticelli F, et al. Influence of substrate, shape, and thickness on microtensile specimens' structural integrity and their measured bond strengths. Dent Mater. 2004;20:643-54.
13 Farina AP, Cecchin D, Barbizam JV, et al. Influence of endodontic irrigants on bond strength of a self-adhesive. Aust Endod J. 2011;37:26-30.
14 Durski M, Metz M, Crim G, et al. Effect of chlorhexidine treatment prior to fiber post cementation on long-term resin cement bond strength. Oper Dent. 2018;43:E72-E80.
15 Ertas H, Ok E, Uysal B, et al. Effects of diferente irrigating solutions and disinfection methods on push-out bond strengths of fiber posts. Acta Odontol Scand. 2014;72:783-7.
16 Cecchin D, Almeida JF, Gomes BP, et al. Deproteinization technique stabilizes the adhesion of the fiberglass post relined with resin composite to root canal. J Biomed Mater Res B Appl Biomater. 2012;100:577-83.
17 Rutala WA. APIC guideline for selection and use of disinfectants. 1994, 1995, and 1996 APIC Guidelines Committee. Association for professional in infection control and epidemiology, Inc. Am J I nfect Control. 1996;24:313-42.
18 Canelas R, Salgado H, Vaz M, et al. Flexural strength of glass fiber posts after sterilization by two different methods. Rev Port Estomatol Med Dent Cir Maxilofac. 2014;55:227-231.
19 Rutala WA, Weber DJ, HICPAC. Guideline for disinfection and sterilization in healthcare facilities, 2008.
20 Baldissera EZ, Fontanella V, Torriani MA. Avaliação da desinfecção de filmes radiográficos periapicais utilizando diferentes soluções. Rev Odonto Ciênc. 2006;21:153-7.
21 Valandro LF, Yoshiga S, de Melo RM, et al. Microtensile bond strength between a quartz fiber post and a resin cement: effect of post surface conditioning. J Adhes Dent. 2006;8:105-11.
22 Monticelli F, Osorio R, Sadek FT, et al. Surface treatments for improving bond strength to prefabricated fiber posts: a literature review. Oper Dent. 2008;33:346-55.
23 Malacarne J, Carvalho RM, de Goes MF, et al. Water sorption/solubility of dental adhesive resins. Dent Mater. 2006;22:973-80.
24 Albashaireh ZS, Ghazal M, Kern M. Effects of endodontic post surfasse treatment, dentin conditioning, and artificial aging on the retention of glass fiber-reinforced composite resin posts. J Prosthet Dent. 2010;103:31-9.
25 Zicari F, De Munck J, Scotti R, et al. Factors affecting the cement-post interface. Dent Mater. 2012;28:287-97.
26 Chang HS, Noh YS, Lee Y, et al. Push-out bond strengths of fiber-reinforced composite posts with various resin cements according to the root level. J Adv Prosthodont. 2013;5:278-286.
27 Mumcu E, Erdemir U, Topcu FT. Comparison of micro push-out bond strengths of two fiber posts luted using simplified adhesive approaches. Dent Mater J. 2010;29:286-96.
28 Akgungor G, Akkayan B. Influence of dentin bonding agentes and polymerization modes on the bond strength between translucent fiber posts and three dentin regions within a post space. J Prosthet Dent. 2006;95:368-78.
29 Ferrari M, Mannocci F, Vichi A, et al. Bonding to root canal: structural characteristics of the substrate. Am J Dent. 2000;13:255-60.
30 Faria-e-Silva AL, Menezes MS, Silva FP, et al. Intra-radicular dentin treatments and retention of fiber posts with self-adhesive resin cements. Braz Oral Res. 2013;27:14-9.
31 Kahnamouei MA, Mohammadi N, Navimipour EJ, et al. 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;17:337-44.
32 Lindblad RM, Lassila LV, Salo V, et al. Effect of chlorhexidine on initial adhesion of fiber-reinforced post to root canal. J Dent. 2010;38:796-801.