Article published online: 2021-11-01

Original Article

Influence of Irrigating Solutions and Post Luting on Bond Strength of Fiber Posts after Aging

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Abstract

Aim: The study aimed to evaluate the influence of irrigating solutions on bond strength (BS) of fiber posts using different luting systems after aging. **Methods:** Bovine teeth ($N = 96$) were randomly (8 groups, $N = 12$), sectioned, endodontically treated and root canals were prepared. The 96 bovine teeth were divided into four groups according to luting systems as conventional light-cure (RelyX ARC), self-adhesive (RelyX U200 and Panavia F),dual - cure self - etch, and self - adhesive (SeT PP). Each of the four groups was further divided into two subgroups using 2% chlorhexidine (CHX) gel or 5.25% sodium hypochlorite (NaOCl) as the irrigating solution. After post cementation, the metal-ceramic crowns were positioned. After 48 h, all samples were submitted to 1,000,000 thermal cycles. After water storage, push-out test was performed. The data were analyzed using two-way ANOVA and Tukey's test ($P = 0.05$). **Results:** CHX gel BS means were statistically higher than NaOCl means when posts were cemented with the conventional or dual-cure self-etch and self-adhesive resin cements; no significant statistical differences were observed between groups CHX gel or NaOCl treatments for the dual-cure self-adhesive resin cements. **Conclusion:** The irrigation solution used on endodontic treatment before luting procedures with conventional or dual-cure self-etch and self-adhesive resin cements of glass fiber posts improved long-term BS after aging.

Keywords: Chlorhexidine, dental pins, sodium hypochlorite

Introduction

In the 1990s, the fiber posts were introduced in dentistry. It composition includes fiber glass added in an epoxy resin matrix with a high degree of conversion, which provides a flexible structure with high resistance, ideal to be used as intra-root posts.[1] Further, the possibility of adhesion to composite resins, then being possible to be used in association with adhesive systems to luting cementation.[2]

The post setting to the dentin substrate with a resin-luting cementation can be affected by different connected factors, as the irrigating solution used during the root canal treatment (RCT).[3] Sodium hypochlorite (NaOCl) that has been widely used in RCT causes the degradation of collagen fibers of dentin, such as the genesis of protein radicals, that competes with the polymerization reaction of the resin materials such as the resin-luting systems.[4]

The chlorhexidine (CHX) has been used as an alternative irrigating solution, once its capable to inhibit the metalloproteinases of the collagen dentin which would cause the hybrid layer degradation.[5,6] The studies[7,8] show that bond strength (BS) between fiber posts luting cementation and the root canal dentin is similar or higher using the CHX as the irrigating solution on the RCT compared to NaOCl or no irrigating solution.

All adhesive bond techniques used to intra-root luting cementations are based on the knowledge of coronal dentin bond techniques.[9] I Indeed, the real clinical consequences of the RCT on the bond strength of the fiber posts are only

Access this article online

Quick Response Code:

Website: www.ejgd.org

DOI: 10.4103/ejgd.ejgd_95_19

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How to cite this article: de Oliveira DC, Prieto LT, Pierote JJ, de Araújo CT, Coppini EK, Paulillo LA. Influence of irrigating solutions and post luting on bond strength of fiber posts after aging. Eur J Gen Dent 2020;9:7-10.

Received: 12th July, 2019 **Revision:** 21st August, 2019
Accepted: 30th August, 2019 **Publication:** 02nd January, 2020

theorical, but scientifically unknown Despite the favorable clinical results of fiber posts cementation, the fail percentage occurs due to the resin-luting cementation failure and posts displacement.[10]

Thus, the aim of this this study was to evaluate the influence of irrigating solutions application on BS of glass fiber posts to root dentin using different luting systems after aging. The tested hypothesis were (1) the irrigating solution used on the RCT affects the BS of glass fiber posts after aging and (2) the BS degradation of auto-adhesive resin-luting cements is similar to the conventional resin-luting cements, regardless the irrigating solution used on the RCT.

Methods

Specimen preparation

A total of 96 freshly extracted bovine anterior teeth were selected and stored into 0.1% thymol for 24 h. External debris was removed using a hand scaler. The crowns were removed 1 mm above the cement-enamel junction (root length 17 mm) using a water-cooled low-speed diamond saw (Isomet 1000; Buehler, Lake Bluff, IL, USA).

Root canal treatment

The RCT was performed using ProTaper Universal NiTi rotary files (Dentsiply Maillefer, Baillaigues, Switzerland). During instrumentation, the canals were irrigated with 2% CHX (Biodinâmica, Ibiporâ, PR, Brazil) or 5.25% NaOCl (Asfer, São Caetano de Sul, SP, Brazil), followed by rinse with a saline solution (Laborasa, São Paulo, SP, Brazil). After the RCT, all the canals were irrigated with 2 mL of 17% Ácido etilenodiamino tetra acético - EDTA (Biodinâmica) (Biodinâmica) for 3 min, followed by rinse with 5 mL of a saline solution and dry with absorbent paper points (Dentsply Maillefer).[11] The canals were filled with gutta-percha points (Gutta Percha Dentisply Maillefer).

Post luting cementation

A post space of 12 mm in depth was prepared in each root with Gates Glidden #5 drills (Dentsply Maillefer), and the root canals were prepared with the corresponding low-speed drills provided by the post manufactures (Ângelus) respecting the limit of 5 mm of apical root canal filling.

Following the manufacturer's instructions, the glass fiber post (Exacto, Ângelus, Londrina, PR, Brazil) surface was cleaned with 70% alcohol (Asfer) and treated with a salinization agent (Angelus) for 1 min before luting.

A previous etch-and-rinse was performed to the Adper ScotchBond Multi-Purpose/RelyX ARC group with a 37% phosphoric acid (Super Etch, SDI, Victoria, Australia) for 15 s and 30 s of rinse. Rather the luting cementation, the canals were dried with absorbent paper points. The Adper ScotchBond Multi-Purpose Bond System was sequentially placed on root canals following the manufacturer sequence primer activator, primer, and primer catalyst. Immediately, the RelayX ARC luting cement (3M ESPE, St Paul, USA) was mixed according to the instructions of the manufacturer.

The remaining resin-luting cements were mixed according to the instructions of each manufacturer. All luting cementation procedures were performed with the Centrix syringe system (DFL, Rio de Janeiro, RJ, Brazil) and light cured using a light-curing unit (Radii, SDI, Victoria, Australia) with 16J on the vestibular and lingual teeth surfaces. Table 1 shows all products used for cementation.

Core buildups and ceramic crowns

After posts cementation, core buildups procedures were performed on the teeth before placing a metal-ceramic crown on each tooth. Standardized core buildups were performed with the Filtek Z350XT A3 Body composite resin (3M ESPE, St Paul, USA) using a prefabricated pattern. The photo activation was performed using a light-curing unit with 16J on the vestibular and lingual teeth surfaces. The metal-ceramic crowns were cemented in place with zinc phosphate cement (DFL).

Thermal aging

After 48 h, the cemented specimens were subjected to 1,000,000 thermocycles with 37°C, between two water baths of 5°C and 55°C with a dwell time of 2 min at each temperature (Elquip, São Carlos, SP, Brazil).

Bond strength test

After thermocycling aging, the roots were transversely sectioned into 1-mm thick slices using a water-cooled low-speed diamond saw (Isomet 1000). The first section was made at a distance of 1 mm from the cement-enamel junction. The push-out test was performed using a universal testing machine (Shimadzu, São Paulo, SP, Brazil), operating at a crosshead speed of 0.5 mm/min at break. Slices were positioned

Table 1: Material, product, manufacturer and composition

Material	Product	Manufacturer
Phosphoric acid	Super Etch	SDI, Victoria, Australia
Conventional 3-steps adhesive system	Adper ScotchBond MP	3M-ESPE, St Paul, USA
Conventional light-cure resin cement	RelyX ARC	3M-ESPE, St Paul, USA
Dual-cure self-adhesive resin cement	RelyX U200	3M-ESPE, St Paul, USA
Dual-cure self-etch self-adhesive resin cement	Panavia F	Kuraray, Okayama, Japan
Dual-cure self-etch self-adhesive resin cement	SeT PP	SDI, Victoria, Australia
Resin Composite	Filtek Z350XT	3M-ESPE, St Paul, USA

to assure application of the loading force in the apical-coronal direction. The BS (N/mm^2) was calculates using the formula $A = (\pi_x [R + r]) \times (h^2 + [R - r]^2)^{0.5}$, where A represents the area of the bonded interface, π is 3.1416, R is the larger radius (coronal post radius), r represents the smaller radius (apical post radius), and h the thickness of the slice (in mm).

Statistics analysis

The slices were considered as independent statistical unit within each experimental group. Data were submitted to ANOVA to find means that are significantly different and Tukey's test for multiple comparisons ($P = 0.05$) using the SAS 9.1 software (SAS Institute, Cary, USA).

Results

Descriptive statistics of the post push-out strengths are reported in Table 2. Statistically significant differences were observed among the groups. The dual-cured resin cement RelyX ARC with CHX and dual-cured resin cements Panavia F with NaOCl application achieved the highest BS values 8.73 and 6.33 MPa, respectively.

Table 2: Tukey's test outcomes for bond strength (N/mm^2) after aging according to each irrigating solution and luting cement evaluated

Luting cements	Irrigating solutions	
	Chlorhexidine	Sodium hypochlorite
RelyX ARC	8.73 (0.4)^{Aa}	7.14 (0.0)^{Ba}
Panavia F	6.76 (0.1)^{Ab}	6.33 (0.1)^{Aa}
Set PP	3.94 (0.3)^{Ad}	2.70 (0.4)^{Bc}
U200	5.61 (0.0)^{Ac}	5.07 (0.1)^{Ab}

Different superscript uppercase letter indicate statistical significance in columns ($P < 0.05$); Difference superscript letters indicate statistical significance in rows ($P < 0.05$)

Discussion

The fiber posts have been wildly used in dentistry in association to resin-luting cements to provide an adhesive cementation.[2] The adhesive technique provided better retention and lower solubility compared to the zinc phosphate cements.[12] Still, the bond interface between the post and the root canal dentin can be compromised in apical due the difficulty in moisture control and also lower light-curing irradiance.[13] That is also a fact to the dual-curing luting cements, besides its self-curing, it depends on light curing to reach a high degree of conversion and reasonable mechanical properties. Thus, that study used the mean average of the slices of each tooth to evaluate the BS by the push-out test, regardless the slice cut region.

Other important studied factor is the irrigating solution used on the RCT on BS between the post luting cement and the root canal dentin, as the purpose of this study. The NaOCl each is used into RCT's causes the degradation of the collagen fibers of root canal dentin[4,5,14] and it causes the genesis of protein radicals which competes with the polymerization reaction of the resin materials such as the resin -luting systems.[4,5,14]

Still, CHX has been used as an alternative irrigating solution, once it is capable to inhibit the metalloproteinases of the collagen dentin that would cause the hybrid layer degradation.[6] It provides a similar or better antibacterial activity,[15-20] as well as BS between the cemented post and the root canal dentin compared to NaOCl.[21]

As observed in this study, the groups irrigated with CHX during the RCT showed similar or higher BS results compared to the groups irrigated with NaOCl. Thus, the first hypothesis of the study that the irrigating solution used on the RCT would affect posts BS after aging was accepted.

This outcome agrees to previous literature;[14,21] moreover, the results of the present study were obtained after 1,000,000 thermal aging cycles, which corresponds nearly 5 *in vivo* years.[21] Thus, these outcomes show that CHX ensures better resin BS longevity and not only resin BS initial results as previously established in literature.

Other discussed factor in the literature is the negative effects of the CHX as an irrigating solution on self-adhesive luting cements.[22] As observed in this study, the self-adhesive luting cements (RelyX U200 and SeT PP) indeed had lower BS results compared to the conventional-luting cements (RelyX ARC and Panavia F). However, these outcomes were similar in both irrigating solution groups, and further, the means of the self-adhesive-luting cement groups irrigated with CHX were respectively superior to the same groups irrigated with the NaOCl, as observed in Table 2. Thus, the second hypothesis that the BS degradation of auto-adhesive resin-luting cements would be similar to the conventional resin-luting cements, regardless the irrigating solution used on the RCT was denied.

The adhesive bond technique used on root canal dentin was based on coronary dentin knowledge.[9] However, it can be established a correlation ship between that knowledge and the outcomes of the present study. Regardless the difficulty of visualization and access to the dentin surfaces of root canal walls and the differentiated morphology and histology, the BS in both coronary and root canal dentins was similar affected besides the lower values comparing to the coronary dentin values in literature. Thus, as observed in that study, the irrigating solutions used on RCTs can affect the bond procedure and, as consequence, affect the cementation success.

Besides the favorable clinical results of the fiber posts using, the fails usually occur because of the fiber post owing to bond failure.[10] Thus, is of importance to evaluate the RCT procedure and the chooses bond system for a most appropriate post cementation.

Conclusion

Within the limitations in the experimental design, the following conclusion can be drawn: The irrigating solution used on the RCT can affect BS between post cementation and root

canal dentin after aging. CHX shows greater efficacy for BS longevity compared to the NaOCl. The self-adhesive luting cements showed lower BS after aging compared to the conventional luting cements, regardless the irrigating solution used on the RCT.

Financial support and sponsorship

The study was supported by grant no. 2011/11,937-8 from the São Paulo State Research Foundation (FAPESP).

Conflicts of interest

There are no conflicts of interest.

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