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ORIGINAL ARTICLE

Comparison of the effects of Sodium Hypochlorite and Chlorhexidine irrigating solutions on push-out bond strength of glass-fiber posts

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ABSTRACT
Reports regarding the effect of root canal irrigating solutions on the bond strength of these posts have been controversial. This study sought to assess the effect of sodium hypochlorite (NaOCl) and chlorhexidine (CHX) on bond strength of glass-fiber posts. This experimental study was conducted on 30 sound single-rooted mandibular premolars in three groups for root canal irrigation with saline (group one), 5.25% NaOCl (group two) and 0.2% CHX (group three). Root canals were instrumented to #60 K-file using the step-back technique and filled with gutta-percha and AH26 sealer one millimeter short of the working length. Post space (10mm length) was prepared by Peeso reamers with a minimum of 5mm distance from the apex. Glass-fiber posts were cemented into canals using Panavia cement. The teeth were mounted in clear acrylic blocks. Each root along with its intracanal post was sectioned into three slices at the apical, middle and coronal levels, and push-out bond strength was measured in each section by an Instron machine. The data were analyzed using ANOVA and Tukey's test. bond strength was not significantly different in the three groups at the three levels of coronal, apical and middle; saline irrigation yielded the highest and CHX yielded the lowest bond strength but the differences were not significant. In the three groups, bond strength was higher in the coronal compared to the apical third. The three irrigating solutions can be used with no adverse effect on bond strength of glass-fiber posts.
Key words: *Push out; Bond strength; Chlorhexidine; Sodium Hypochlorite; Tooth Root*

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INTRODUCTION
Intracanal posts are routinely used for distribution of torque along the roots in endodontically treated teeth to better resist occlusal forces [1]. Glass fiber is an ideal material to benefit from the advantages of carbon fiber, combined with optimal esthetics. However, bond strength of glass-fiber posts has always been a challenge for clinicians. Root fracture and inadequate bond strength are among the most common reasons for failure of fiber post restorations [2]. Most cases of failure of fiber posts have been attributed to debonding of cements and luting resins. At present, several root canal irrigating solutions are used prior to placement of intracanal post in order to enhance bond strength [3]. Some non-invasive mechanical techniques have also been suggested to enhance bond strength such as sand blasting and air abrasion. These techniques can increase bond strength by causing micro porosities and the resultant micromechanical interlocking of resin. Chemical techniques such as the application of hydrogen peroxide and hydrochloric acid have also been tested with controversial results [4].
Use of irrigating solutions is imperative in endodontic treatment. They serve as an adjunct to mechanical debridement and help eliminate the residual pulp tissue and bacterial debris from the root canal system

[5]. Also, irrigating solutions may enhance mechanical bond strength of cements by removing the smear layer from the root canal walls. Following smear layer removal, cement can better penetrate into dentinal tubules and enhance the bond to root dentin [6]. Thus, use of an inappropriate irrigating solution in endodontic treatment can compromise the bond of fiber post to root dentin and lead to subsequent reduction in bond strength and eventual treatment failure.

Most cases of failure of fiber posts are due to the loss of bond strength of cement to root canal dentin [6]. Therefore, many studies have evaluated the effects of different chemical and mechanical factors on bond strength of fiber posts to tooth structure [7]. It is believed that chemical agents enhance the interaction of fiber post and root dentin; however, the exact mechanism of effect of these agents has yet to be fully understood [8].

Sodium hypochlorite is the most commonly used root canal irrigating solution [9]. It mechanically eliminates the debris from the root canal system and is capable of dissolving the vital and necrotic tissues. It also serves as an antimicrobial agent and a lubricant [9].

Chlorhexidine is also commonly used for root canal irrigation. It has a wide spectrum of antibacterial activity as well as favorable substantivity. However, it cannot dissolve the necrotic tissue or eliminate the smear layer, which are among its major drawbacks [10]. Furthermore, it was shown that CHX decreased the bond of self-etch cements to tooth structure over time [11]. However, Zhou et al, in 2013 demonstrated that use of 1% CHX primer increased the bond strength of fiber posts to radicular dentin [12].

Considering the gap of information in this regard and the wide range of irrigating solutions used by clinicians in endodontic treatment, this study sought to assess the effect of three commonly used irrigating solutions namely saline, NaOCl and CHX on push-out bond strength of glass-fiber posts to root dentin. The null hypothesis was that the effects of the three irrigating solutions on retention of glass-fiber posts would not be significantly different.

MATERIALS AND METHODS

This in-vitro, experimental study was conducted on 30 sound human single-rooted mandibular premolars extracted due to orthodontic or periodontal reasons, which were of approximately the same size. The teeth were thoroughly inspected to ensure absence of caries, cracks, root fracture, internal and external root resorption and hypoplasia. The selected teeth had approximately 7-8 mm buccopalatal and 5.5-6mm mesiodistal dimensions (measured by a caliper). The teeth were randomly divided into three groups for assessment of the effect of root canal irrigation with saline (group one), NaOCl (group two) and CHX (group three) on bond strength of glass-fiber posts. Sample size was calculated to be 10 teeth in each group considering $\alpha=0.05$, $\beta=0.2$ and study power of 80%. The teeth were cleaned from debris and calculus by use of an ultrasonic instrument and were then stored in saline until the experiment. Prior to the experiment, the teeth were immersed in 0.1% thymol solution for 24 hours [5] and the tooth crowns were then cut by a metal disc measuring 0.2mm in thickness and a high-speed hand-piece under water coolant at the level of the cementoenamel junction [13] in such a way that the remaining root length was approximately 15±1mm. The teeth were then randomly divided into three groups. Saline (Merckmillipore), 5.25% NaOCl (Golrang) and 0.2% CHX (Behsa) were used for root canal irrigation in groups one, two and three, respectively. The teeth with tug-back of a #20 initial file were chosen and instrumented up to #60 K-file (25mm, Mani) using the step-back technique.

Filing and flaring were performed under copious irrigation with the respective irrigating solution. The master apical file for all root canals was #35 K-file. To remove the smear layer, 17% ethylenediaminetetraacetic acid (EDTA; Ariadent) was used for one minute in all root canals. The root canals were then dried with paper points (Ariadent), and master apical cone #35 (Ariadent) was placed in each root canal. The root canals were further filled with #15 accessory gutta-percha cones and AH-26 sealer (Dentsply Maillefer) using the lateral condensation technique and a #25 finger spreader (Dentsply Maillefer) one millimeter short of the working length [14-17].

Post space was prepared using #1, #2 and #3 Peeso reamers (Ariadent). The post space was prepared with 10mm length with a minimum of 5mm distance from the apex [1,15]. The matching post drill was then used for final preparation. Glass-fiber posts (RTD DT-Light) were tried in the root canals to ensure their easy retrieval. To standardize the lengths, all posts were cut by a 008 diamond bur under water coolant in order to have 10mm post length. Post space was dried by a paper point. For application of Panavia cement (Kuraray Dental), the A and B ED primers were mixed according to the manufacturer's instructions and applied to the root canals using a microbrush. After allowing 30 seconds, the primer was dried by gentle air spray and excess material was removed by a paper point. Next, equal amounts of the A and B pasts of resin cement were mixed and applied to all intracanal post surfaces.

Glass-fiber posts with 1.2mm diameter were placed in the root canals and fixed in place by hand pressure. Excess cement was removed by a microbrush and light curing was performed for 50 seconds using a light curing unit (LED Demetron) with a light intensity of 470 nm. Oxyguard™ II (Kuraray Dental) was then applied at the visible margins for three minutes to ensure complete setting of cement [18]. The teeth were then mounted in clear acrylic resin blocks. The teeth were then sectioned into three slices using a cutting machine (Isomet 1000 South Bay Technology) at the apical, middle and coronal levels of the intracanal post. Each section (1mm in thickness) was coded and subjected to an Instron machine (Canton) for push-out bond strength testing. Load was applied at a crosshead speed of 0.5mm/minute along the longitudinal axis of the tooth (from the apical towards the coronal).

Statistical analysis

The push-out bond strength values in the three groups (nine subgroups for assessment of each group at the coronal, middle and apical levels) were analyzed using SPSS version 22 software. Normality of the data was assessed using Kolmogorov-Smirnov test. The data were analyzed using ANOVA, Kruskal Wallis and Mann Whitney tests. Pairwise comparisons were performed using Tukey's' test.

RESULTS

The push-out bond strength of glass-fiber posts to root dentin was evaluated in 30 samples in three groups of 10 at the three levels of coronal, middle and apical. The mean push-out bond strength values in the three groups and in the three levels are shown in Tables 1 and 2, respectively. Kolmogorov-Smirnov test followed by ANOVA revealed that location of the root section (coronal/middle/apical) significantly affected the push-out bond strength of glass-fiber posts (P=0.001); however, type of irrigating solution had no significant effect on push-out bond strength (P=0.933). The push-out bond strength at each level of the root for each irrigating solution is presented in Table 3.

Based on the results, in the coronal third, the retention was the same in CHX and NaOCl groups and the lowest bond strength was noted in the control group. The difference in this regard between three groups of CHX, NaOCl and control was not statistically significant (P=0.865).

In the middle third, the highest retention belonged to the control group followed by the CHX and NaOCl groups, respectively. This difference was statistically significant (P<0.009). Pairwise comparisons showed significant differences between the control and CHX (P=0.007) and the control and NaOCl groups (P=0.009) but the difference between CHX and NaOCl groups was not significant (P=0.529).

In the apical third, the push-out bond strength was the highest in the control and the lowest in the CHX group. The difference in this respect among the three groups was statistically significant (P<0.001). Pairwise comparisons revealed a significant difference between the control and CHX (P=0.002) and CHX and NaOCl (P<0.001) groups but the difference between the control and NaOCl groups was not significant (P=0.218).

Comparison of the push-out bond strength in the coronal, middle and apical thirds of the control group revealed a significant difference (P=0.01), and the highest retention was noted in the coronal and the lowest to the apical third. Pairwise comparison of root sections in the control group showed that the difference between the coronal and middle thirds was not significant (P=0.218) but the differences between the coronal and apical thirds (P=0.003) and middle and apical thirds were both statistically significant (P=0.000).

Comparison of the three levels in the CHX group revealed a significant difference (P=0.000), and the highest retention was found in the coronal third and the lowest in the apical third. Pairwise comparison of levels showed significant differences between the coronal and apical thirds (P=0.000) and middle and apical thirds (P=0.000) and also coronal and middle thirds (P=0.000).

In the NaOCl group, comparison of the three sections yielded a significant difference (P=0.003), and also coronal section yielded the highest and the apical section yielded the lowest values. Pairwise comparison of levels showed significant differences between the coronal and apical thirds (P=0.000) and middle and apical thirds (P=0.002) and also and also coronal and middle thirds (P=0.001).

DISCUSSION

Retention is among the most influential factors contributing to the success of dental restorations [19]. Intracanal posts are routinely used to provide retention for coronal restorations of endodontically treated teeth with extensive loss of tooth structure. Debonding at the cement-dentin interface is the main cause of failure of glass-fiber posts [20]. Several factors affect the retention and bond strength of intracanal posts to root dentin. Irrigating solutions used in endodontic treatment of teeth may affect the bond strength and retention of intracanal posts [20].

Chemical agents used in endodontic treatment may cause structural changes in root dentin and subsequently impact on its physical and chemical properties. Thus, the current study was undertaken to assess the effect of three commonly used root canal irrigating solutions on the push-out bond strength of glass-fiber posts to root dentin at the three levels of coronal, middle and apical third. The results showed that the retention of glass-fiber posts in all three groups of saline, NaOCl and CHX was significantly different at the apical, middle and coronal thirds and the highest retention was found in the coronal third followed by the middle and apical thirds, respectively.
Search of the relevant literature yielded no study comparing CHX and NaOCl with regard to their effect on push-out bond strength of glass-fiber posts. However comparisons have been made in previous studies between NaOCl and saline in this regard [21]. Our results found no significant difference in the push-out bond strength of glass-fiber posts in the three groups of saline, CHX and NaOCl. Although the retention was the highest in saline and the lowest in CHX group, this difference did not reach statistical significance. These findings were similar to those of Muniz and Mathias. They showed that the retention was lower after a final rinse with NaOCl compared to saline but not significantly [21].
Sodium hypochlorite is among the most commonly used root canal irrigating solutions. The chlorine in its composition dissolves vital and necrotic tissues in the root canal system and kills many of the pathogenic microorganisms [9]. A possible explanation for NaOCl slightly decreasing the bond strength and retention of fiber posts is that it releases free oxygen radicals, which serve as a barrier against penetration and polymerization of the adhesive used [22].
According to Kandil et al, all root canal irrigating solutions decrease root dentin microhardness. In their study, saline caused the lowest and maleic acid caused the greatest reduction in dentin microhardness [23]. Shirvanna in 2014 demonstrated that root canal irrigation with NaOCl increased the push-out bond strength of sealer compared to saline, which was in contrast to our current findings [24].
Type of cement used can also affect the push-out bond strength test results. Faria-e-Silva et al, in 2013 reported that EDTA had different effects on Unicem and Biscem cements. They attributed this finding to the differences in the viscosity of the two cements and consequently different bonding mechanisms [25].
Push-out bond strength test is suitable for quantification of intracanal post retention and has been commonly used in previous studies for this purpose [26, 27]. Thus, we used push-out bond strength test to measure the retention of glass-fiber posts [5]. In this test, sections are made of the root and load is applied to the cross-section of the intracanal post until the intracanal post is extruded from the section. In the current study, three sections were made of each root. The load required for detachment of post from the coronal section was compared from that in the middle and apical sections and the results showed that the load required for detachment of post from the coronal section was higher than that in other sections. This finding was in agreement with that of Zorba et al, [26] and Topcu et al [27]. The difference in bond strength between the coronal and apical sections may be explained by the fact that the cement at the apical section may not set properly due to insufficient light penetration. Thus, perfect curing may not occur.
Also, the diameter of the post (and thus, the bonding surface) is smaller in the apical segment and therefore, lower retention is provided. Considering our findings and those of Zorba et al, [26] and Topcu et al, [27] regarding lower retention in the apical areas, it is recommended to use self-cure or dual-cure resins for cementation of glass-fiber posts in the root canal system. Also, the bonding layer must be thinned with air spray as much as possible prior to curing to enhance its polymerization [28].
Future studies are required to assess the effect of irrigating solutions on retention of glass-fiber posts cemented with the commercially available self-cure and dual-cure cements.

Table 1. The mean push-bond strength of glass-fiber s in the three groups of saline, NaOCl and CHX

Group	Number	Mean	Standard deviation	95% confidence interval		Minimum	Maximum	P value
				Lower bound	Upper bound			
Saline	3	35.0367	10.44537	9.0889	60.9844	23.37	43.52	0.933
CHX	3	30.8867	16.48202	-10.0569	71.8303	14.78	47.72	
NaOCl	3	32.3367	13.78758	-1.9136	66.5869	20.96	47.67	
Total	9	32.7533	12.08478	23.4641	42.0425	14.78	47.72	

Table 2. The mean push-bond strength of glass-fiber posts at the three levels of coronal, middle and apical third

Root section	Number	Mean	Standard deviation	95% confidence interval		Minimum	Maximum	Pvalue
				Lower bound	Upper bound			
Coronal	3	46.3033	2.41057	40.3152	52.2915	43.52	47.72	0.001
Middle	3	32.2533	5.24337	19.2281	45.2786	28.38	38.22	
Apical	3	19.7033	4.43074	8.6968	30.7099	14.78	23.37	
Total	9	32.7533	12.08478	23.4641	42.0425	14.78	47.72	

Table 3. The mean push-out bond strength (retention) values at the three levels of the root for the three irrigating solutions

Groups/Level	Coronal third	Middle third	Apical third
Control	43.5±14.6	36.2±6.5	23.4±5.7
CHX	47.7±6.8	30.2±5.8	14.8±2.7
NaOCl	47.7±11.5	28.4±6.4	21±3.6
P value	P<0.05	P<0.001	P<0.01

CONCLUSION

Within the limitations of this in vitro study, the results showed that the push-out bond strength (retention) of glass-fiber posts to root dentin was not significantly different following irrigation with saline, NaOCl and CHX at the three levels of coronal, middle and apical. Although saline yielded the highest and CHX yielded the lowest bond strength values, this difference did not reach statistical significance. In all three groups, retention was higher in the coronal compared to the apical third.

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CONFLICT OF INTEREST

There is no conflict of interest to declare.

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