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EFFECT OF IRRIGATION AGENTS, ADHESIVE SYSTEM AND BOND STRENGTH OF COMPOSITE POST

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Abstract

Evaluate the effect of irrigation agents, adhesive system and bond strength of composite post with the dentin.

For this in vitro study, 48 single-rooted teeth were used, (incisions, second premolars with one root) extracted for orthodontic and periodontal reasons. The teeth were then divided into 2 groups of 24 teeth depending on the irrigation agent used, and each group was divided into 2 subgroups of 24 teeth depending on the cementation agent.

After application of the composite post to the root canal and restoration, all samples were prepared in molds to test the strength of the composite post with the dentin.

For this study, a descriptive statistical analysis was used, which was implemented on the obtained results, and was made in a statistical package Excel ANOVA 2016, where the test strength was done with Push-out testing.

The results obtained were in favour of the group where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, where the technique of complete etching with 37% orthophosphoric acid was used, Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and dual-polymerizing cement Variolink II (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing was the highest and was 2,185 MPa, and the weakest bond was obtained when we used only 2.5% sodium hypochlorite as an irrigant using Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement.

From the results obtained from this study we can conclude that the bond between the composite post and the dentin is strongest with the application of the irrigants 2.5% sodium hypochlorite and 17% EDTA and the technique of complete etching with orthophosphoric acid in combination with Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement.

***Key words*:** endodontic treatment, irrigants, dual-polymerizing cements, composite post

Introduction

After endodontic treatment, the tooth should return to normal function. Endodontically treated teeth are usually weakened due to loss of tooth structure. Often most of the crown of the tooth is destroyed so the most common retention for restoration is usually the application of a post in the root canal.

For endodontically treated teeth, there are two main problems in the restorative procedure, and they are: reduced resistance of the remaining tooth structure and the problem of choosing the necessary adequate retention for restoration.

The prognosis of endodontically treated teeth depends not only on the success of endodontic treatment but also on the type of restoration of the teeth, those teeth are weakened by the treatments themselves and by the loss of the tooth structure where not infrequently the crown of the tooth is destroyed, which requires intervention with a post in the root of the tooth as a restorative process.

The resin-based materials used to cement the posts may be affected by the irrigants used during the chemical-mechanical treatment of the endodontic treatment.

Dentin bond usually begins with the etching of the dentin, the removal of the smear layer, and then the placement of a layer of hydrophilic resins that diffuse into the demineralized dentin. The final application of bond resin and its polymerization complete the bond process.

The diffuse surface forms a hybrid layer by penetrating around exposed collagen fibers and by penetrating open dentinal canals [1, 2].

The root canal irrigation plays an important role in the endodontic therapy. Numerous studies, which are conducted in this area confirm that the amount of debris is significantly higher in the root canals that are processed without the use of irrigants. The preparation of the root canals without irrigation leads to a lag of 70% more debris and a smear layer on the walls of the root canals of the teeth. The effectiveness of irrigation in removing the smear layer depends on the type and amount of irrigation solution, the width and morphology of the root canal and the irrigation technique [3,4].

Cleaning and disinfection of the canal system of the tooth during endodontic therapy depends on the physical and chemical effect of the irrigation, i.e. the irrigants [5].

The physical effect of irrigation is based on the flow and return jet of the irrigant through the root canal, which results in the mechanical removal of the debris and the smear layer from the walls of the root canals of the teeth [6,7,8].

The chemical effect of irrigation is based on the decomposition and demineralization of debris, smear layer, remnants of pulp tissue, dentin and is also the most effective way to remove it [9,10].

In endodontic treatment of teeth, the treatment reduces the amount of dentin in the root canal, which reduces the strength of the tooth and increases the possibility of vertical fracture of the root.

To increase the longevity of an endodontically treated tooth, as well as to improve the bond strength of the composite post with the dentin, the irrigation agents and the cementation materials also contribute [11,12].

The use of irrigation agents before the bond process begins may have an effect on the adhesion because it alters the properties of the hydrophilic resins [13].

Depending on the bond method, composite cements can be light-polymerizing, dual-polymerizing or chemical polymerizing. In addition, modern composite cements can be divided into the following three groups according to the adhesive system they use: cements used with Total etch adhesives, cements used with self-etching adhesive and self-adhesive cements [14].

Due to the depth of preparation for the posts, the use of light-polymerizing adhesives and cements is not recommended, but the use of dual-polymerizing or chemical polymerizing materials [15].

Aim: Evaluate the effect of irrigation agents, adhesive system and bond strength of composite post with the dentin.

Material and Methods

For this in vitro study, 48 single-rooted teeth were used (incisions, second premolars with one root) extracted for orthodontic and periodontal reasons. During endodontic treatment, the root canals were prepared manually using the step-back technique up to the apical size of ISO 40.

After changing each instrument, the root canals were rinsed with 2 ml of 2.5% NaOCl solution. The root canals were dried with paper points (Dentsply Maillefer, Tulsa, Okla., USA) and filled with gutta-percha and AH Plus definitive filling material (Dentsply Caulk, Milford, Del., USA) using the cold lateral-compaction technique.

The teeth were then divided into 2 groups of 24 teeth depending on the irrigation agent used, and each group was divided into 2 subgroups of 12 teeth depending on the cementation agent.

For the teeth from Group 1 a, after the preparation of the root canal for application of FRC Postec composite post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) , as an irrigation agent we used sodium hypochlorite and 17% EDTA, then the technique of complete etching with 37% orthophosphoric acid in the root canal was applied, and after rinsing and drying we applied Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented FRC Postec composite post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the Group 1a a subgroup for the preparation of the root canal for application of FRC Postec composite post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) for irrigation we used 2.5% sodium hypochlorite and 17% EDTA. After processing and drying in the root canal we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented FRC Postec composite post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) with SpeedCEM™ dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the group 2a, during the processing of the root canal for the application of FRC Postec composite post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) for irrigation we used 2.5% sodium hypochlorite and 17% EDTA. Then the technique of complete etching with 37% orthophosphoric acid in the root canal was applied, and after rinsing and drying we applied Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein). We cemented the composite post (FRC Postec Ivoclar) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

As a subgroup of Group 2 b, a total of 12 teeth where FRC Postec (Ivoclar Vivadent Inc., Schaan, Liechtenstein) was used as a composite post, sodium hypochlorite was used as an irrigation agent, and SpeedCEM™ (Ivoclar Vivadent Inc., Schaan, Liechtenstein) was used as a cementation agent.

After the application of the composite post in the root canal and the restoration, we first place all the samples in plastic molds (FIXI FORM, STRUCTURES) that have an inner diameter of 25mm, and a height of 25mm and they are made of PVC (polyvinyl chloride) ISO 3698, grade 3.

Two-component transparent acrylate ORTO POLI was used for placing the samples. The placed samples were left to harden for 3 hours at room temperature, then they were taken out of the molds.

Each sample was placed on a specially designed bearing of the universal testing machine, Instron 1122, with the apical, smaller surface facing up.

The diameter bar is 1.2 mm and is positioned so that it only touches the filling. The force is applied in the apical-coronary direction to avoid jamming due to the final sample. The technique used is the Push Out Method for the tissue bond strength, which is used in many other variations but also in medicine or dentistry to prove the bond strength between the post and the dentin after endodontic treatment.

To show the bond strength as a pressure in MPa, the breaking force (F)N is divided by the adhesion surface of the sealers (mm^2) and is represented by the formula:

$$P(MPa) = \frac{F\ (N)}{S(mm^2)}$$

The adhesion surface of the sealers (S) (mm^2) is calculated according to the formula $S=\pi(R+r)h$ where $\pi=3,14$ R is the diameter of the coronary side of the channel filling, r is the diameter of the application side of the filling and h is the thickness of the sample that is 1mm.

The test is performed at a speed of 0.5 mm/min until the moment of termination of bond. The bond is considered to be terminated when there is extrusion of the sample materials. The force that caused the bonds between the fillings and the dentin to break is recorded in dkN on the test machine graph.

For this study, a descriptive statistical analysis was used, which was implemented on the obtained results, and was made in a statistical package Excel ANOVA 2016, where the test strength was done with Push-out testing.

Results and Discussion

The results obtained from this study show us the effect of irrigation agents and cementation materials on the bond strength of the composite post with the dentin and are shown in Table 1.

Table 1: Variations of posts, irrigation agents and cement agents

Group	Subgroups	Irrigation agent	Cementation agent	μTBS (MPa)	Minimum value	Maximum value
	FRC Postec Ivoclar Group 1 a	Sodium hypochlorite and EDTA	Excite and Variolink II (complete etching with acid)	1.598	1.06	2.45
	FRC Postec Ivoclar Subgroup 1b	Sodium hypochlorite and EDTA	Speed cement (self-etching)	1.368	0.88	1.97
2	FRC Postec Ivoclar Group 2 a	Sodium hypochlorite	Excite and Variolink II (complete etching with acid)	1.118	0.72	1.55
	FRC Postec Ivoclar Subgroup 2 b	Sodium hypochlorite	Speed cement (self-etching)	0.761	0.45	1.23

For the first group of FRC Postec post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, where we made complete etching with 37% orthophosphoric acid, and we used Excite adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing is the highest, i.e. 1,598 MPa.

For the first subgroup of FRC Postec post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) where 2.5% sodium hypochlorite and 17% EDTA were used as irrigants, and we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing is lower than the first group, i.e. 1,368 MPa.

The P-value is greater than 0.005, i.e. P> 0.05866, which means that there is no significant difference in the bond strength.

For the second group of teeth of FRC Postec post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) where 2.5% sodium hypochlorite was used as an irrigant +EDTA, where we made complete etching with 37% orthophosphoric acid, and we used Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing is lower than the first and second subgroups, i.e. the strength is 1.118 MPa.

For the second subgroup of teeth of FRC Postec post (Ivoclar Vivadent Inc., Schaan, Liechtenstein) where 2.5% sodium hypochlorite was used as an irrigant and Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and SpeedCEM™ dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) the pressure, i.e. the bond strength obtained by push-out testing is the smallest of all groups by comparison, i.e. the strength is 0,761 MPa.

The P-value is less than 0.005 (P<0,05328), which means that there is a significant difference in the bond strength.

Statistics according to ANOVA

Table 2: SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	4	4.845	1.21125	0.128522
Column 2	4	3.11	0.7775	0.066958
Column 3	4	7.2	1.8	0.2796
Column 4	4	2.441	0.813667	0.15418

Table 3: ANOVA PTEST

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups 1 and 2	2.107029	2	1.053515	6.652648	P > 0.05866	4.256495
Within Groups	1.425242	9	0.15836			
Between Groups 1a and 2a	0.149468	2	0.149468	0.915574	P □ 0.05328	7.708647
Within Groups	1.425242	9	0.15836			
Total	5.106981	22				

According to the statistics between groups 1 and 2, the difference is the largest in terms of the degree of bond, i.e. group 1: FRC Postec Ivoclar post with sodium hypochlorite irrigant and EDTA in combination with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) has a bond value of 1.598 and group 2 FRC Postec Ivoclar post with sodium hypochlorite irrigant in combination with Speed cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) has a bond value of 1.118. The P-value is greater than 0.05 0,05 (P > 0,05866), which means that there is no significant difference in the bond strength.

According to the statistics between group 1a: FRC Postec Ivoclar post with sodium hypochlorite irrigant in combination with Varolink Exite, i.e. (complete etching with acid) has a bond value of 1.118 and group 2b FRC Postec Ivoclar post with sodium hypochlorite irrigant in combination with Speed cement, i.e. (self-etching) has a bond value of 0.761.

The P-value is greater than 0.05, i.e. (P < 0.39282), which means that here also there is no significant difference in the bond strength.

Discussion

In this study, the greatest bond strength shown by FRC Postec Ivoclar posts with sodium hypochlorite irrigant and EDTA in combination with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein) has a bond value of 1.598 and the lowest bond strength shown by FRC Postec Ivoclar with sodium hypochlorite irrigant in combination with Speed cement (self-etching) has a bond value of 0.761.

From the obtained results it can be seen the better results are achieved by the combination of sodium hypochlorite irrigant and EDTA in combination with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

The obtained results showed that the weakest results are achieved by the combination of sodium hypochlorite irrigant and EDTA in combination with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

One group of authors disagrees with this theory, arguing that it is not necessary to avoid eugenol fillings, but to use adhesives with complete etching of enamel and dentin with orthophosphoric acid for cementation of composite posts – total etch adhesives [16].

Application time of sodium hypochlorite is one of the important factors to consider**.** Morris et al. reported that treatment with sodium hypochlorite for 15 to 20 minutes reduces the bond strength with the radical dentin by up to 67% of value. There is probably a connection between the application time of sodium hypochlorite and the bond strength. As the application time increases so the bond strength reduces [17].

For the groups where sodium hypochlorite and EDTA were used as irrigation agents, we obtained a higher bond strength in the totally self-etching adhesive system than in the self-etching adhesive system, which is still in correlation with the study of Zorba et al., who concluded that the application of 17% EDTA with 5.25% sodium hypochlorite after spatial preparation for composite post upgrade increases the strength of self-adhesive cement more than the strength of self-etching cement. The explanation for the reasons was the removal of the secondary residual layer before the cementation of the post and the chemical bond of the self-adhesive cement [18].

In contrast, Ari et al. and Demiryürek et al. concluded that sodium hypochlorite reduces the bond strength of self-etching cement [19].

Similarly, Goracci et al. showed that the extracting bond strength of self-adhesive cement can be compared to that of self-etching cement. [20].

However, Radovic et al. concluded that the self-etching approach has less adhesion compared to the etching, rinsing and self-adhesive approach. Given the fact that sodium hypochlorite is commonly used during root canal treatment to remove remnants of pulp tissue and organic matter, also the same protocol was used in this study [21]

Van Meerbeek and collaborators in their study state that using total each creates the best micromechanical bond between dentin and composite, which we see in the results obtained in this study. [22].

Conclusion

Although it is known that irrigans used in endodontic therapy affect adhesion, however, it is less known how they affect the bond between the tooth and the composite post.

From the obtained results we can conclude that irrigation agents and cements significantly affect the bond strength between the composite post and the tooth and that the self-etching approach has less adhesion compared to the complete etching of the dentin in the root canal. The combination of 17% EDTA with 2.5% sodium hypochlorite during the preparation for application of FRC Postec composite post had a positive effect on bond strength, however, no differences were found between the other groups.

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