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THE EFFECT OF IRRIGATION AGENTS ON THE BOND STRENGTH OF THE COMPOSITE POST WITH THE DENTIN

ЕФЕКТОТ НА СРЕДСТВАТА ЗА ИРИГАЦИЈА ВРЗ ЈАЧИНАТА НА ВРСКАТА НА КОМПОЗИТНОТО КОЛЧЕ СО ДЕНТИНОТ

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Abstract

Aim: Evaluate the effect of irrigation agents and cementation materials on the bond strength of composite post with dentin. **Material and method:** 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 applying 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 Excel ANOVA 2016 statistical package, where the test strength was performed with Push-out testing. **Results:** The obtained results 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. **Conclusion:** 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, dual-polymerizing cements.

Апстракт

Цел: Да се евалуира влијанието на средствата за иригација и материјалите за цементирање врз јачината на врската на композитното колче со дентинот. **Материјал и метод:** За ова е ин витро испитување беа користени 48 еднокорени заби (инцизиви, втори премолари со еден корен) екстрахирани од ортодонтски и пародонтолошки причини. Потоа забите беа поделени во 2 групи од по 24 заби зависно од користеното средство за иригација, а секоја група беше поделена на 2 подгрупи од по 24 заби зависно од средството за цементирање. По апликацјата на композитното колче во коренскиот канал и реставрацијата сите примероци беа припремени во калапи за испитување на јачината на врската на композитното колче со дентинот. За ова испитување користена е дескриптивна статистичка анализа која е имплементирана на добиените резултати, а е изработена во статистички пакет Excel ANOVA 2016, при што јачината на тестот е работена со Пуш -аут тестирање. **Резултати:** резултатите кои се добија беа во прилог групата каде како ириганси се употребени 2.5% натриум хипохлорид и 17% EDTA, каде се примени техниката на комплетно нагризување со 37% ортофосфорна киселина, атхезивот Excite (Ivoclar Vivadent Inc., Schaan, Liechtenstein) и двојнополимеризирачкиот цемент Variolink II (Ivoclar Vivadent Inc., Schaan, Liechtenstein) притисокот односно јачиината на врската добиена со пуш аут тестирањето беше најголема и изнесуваше 2,185 MPa, а најслаба врска се доби кога како ириганс го користевме само 2.5% натриум хипохлориддот со примена на самонагризувачкиот атхезив Excite и двојнополимеризирачкиот цемент SpeedCEM™. **Заклучок:** Од добиените резултати од ова испитување можеме да зклучиме дека врската помеѓу композитното колче и дентинот е најцврста со примена на иригансите 2.5% натриум хипохлорид и 17% EDTA и техниката на комлетно нагризување со ортофосфорна киселина во комбинација со самонагризувачкиот атхезив Excite и двојнополимеризирачкиот цемент Variolink II. **Клучни зборови:** ендодонтски третман, ириганси двојно полимеризирачки цементи.

Introduction

The prognosis for 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 as well as 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[3,4]. 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[5,6]. 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[7].

The physical effect of irrigation is based on the flow and return jet of the irrigant through the root canal, which results in mechanical removal of the debris and the smear layer from the walls of the root canals of the teeth[8,9,10].

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 the same[11,12].

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. The irrigation agents and the cementation materials also contribute to increasing the longevity of an endodontically treated tooth, as well as to the improvement of the bond strength of the composite post with the dentin[13,14].

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.

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[15].

Due to the depth of preparation for the posts, the use of dual-polymerizing or chemical polymerizing materials is recommended, instead of light-polymerizing adhesives and cements[16].

The advantage of dual-polymerizing cements is the sufficiently long working time and the possibility for faster bonding with light-polymerization in clinically unfavourable situations, i.e. in places, in regions where light-polymerization is not available, the material bonds chemically.

Aim

Evaluate the effect of irrigation agents and cementation materials on the bond strength of the 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 the first group, and a subgroup after the preparation of the root canal for application of the composite post (GC EverStick), we used 2.5% sodium hypochlorite and 17% EDTA for irrigation, 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 the composite post (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the first group, subgroup 1 b, after the preparation of the root canal for application of the composite post (GC EverStick we used 2.5% sodium hypochlorite and 17% EDTA) for irrigation. After processing and drying the root canal we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented composite post (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the teeth from the 2 group, subgroup a, during the processing of the root canal for application of the composite post (GC EverStick) we used 2.5% sodium hypochlorite for irrigation.

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 (GC EverStick) with Variolink II dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

For the second subgroup 2 b on 12 teeth, after the preparation of the root canal for application of the composite post (GC EverStick) we used 2.5% sodium hypochlorite for irrigation, then the technique of complete etching within the root canal was applied, and after drying the root canal we applied Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein), and cemented the composite post (GC EverStick) with SpeedCEM™ dual-polymerizing cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein).

After the application of the composite post in the root canal and the restoration, we first placed all the samples in plastic molds (FIXI FORM, STRUCTURES), that have an inner diameter of 25 mm, and a height of 25 mm 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 (mm2) and is represented by the formula:

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

The adhesion surface of the sealers (S) (mm2) 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 Excel ANOVA 2016 statistical package, where the test strength was done with Push-out testing.

Results

The results obtained from this study show us the effect of irrigation agents and cementation materials on the bond

Table 1

Groups	Irrigation agent	Cementation agent	μTBS (MPa)	Minimum value	Maximum value
GC Ever stick Group 1 a	Sodium hypochlorite and EDTA	Excite and Variolink II (complete etching with acid)	2.185	1.09	3.12
GC Ever stick Subgroup 1b	Sodium hypochlorite and EDTA	Excite and Speed cement (self-etching)	1.536	0.96	2.27
GC Ever stick Group 2 a	Sodium hypochlorite	Excite and Variolink II	1.383	0.86	2.19
GC Ever stick Subgroup 2 b	Sodium hypochlorite	Excite and Speed cement (self-etching)	1.11	0.55	1.54

strength of composite post with dentin and are shown in Table 1.

For the first group, 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. 2,185 MPa.

For the first subgroup, 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 result obtained in the first group, i.e. 1,536 MPa.

For the second group of teeth, where 2.5% sodium hypochlorite was used as irrigant, 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 those obtained in the first and second subgroups, i.e. the strength is 1,383 MPa.

For the second subgroup of teeth, where 2.5% sodium hypochlorite was used as irrigant and Excite self-etching adhesive (Ivoclar Vivadent Inc., Schaan, Liechtenstein) and SpeedCEM™ dual polymerizing

Statistics according to ANOVA

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	4	6.214	1.5535	0.208287
Column 2	4	3.46	0.865	0.052967
Column 3	4	9.12	2.28	0.420467
Column 4	4	6.214	1.5535	0.208287

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups 1a and 2b	4.005894	3	1.335298	6.00129	P<0.05155	P<3.490295
Within Groups	P<2.670022	P<12	P<0.222502			
Between Groups 1b and 2a	P<1.33101	P<3	P<0.001212	P<2.11010	P><0.05578	P<1.230453
Within Groups	P<2.670022	P<12	P<0.222502			
Total	P<6.675916	P<30				

cement (Ivoclar Vivadent Inc., Schaan, Liechtenstein), the pressure, i.e. the bond strength obtained by push-out testing is the lowest of all groups by comparison, i.e. the strength is 1,110 MPa.

According to the statistics, the difference is the largest between groups 1 and 4 in terms of the degree of bond, i.e. group 1: Sodium hypochlorite and EDTA in combination with Excite and Variolink II (complete etching with acid) have a bond value of 2.185, and group 4: Sodium hypochlorite in combination with Excite and Speed cement (self-etching) has a bond value of 1.11. The P-value is less than 0.05 ($P < 0.05155$) which means that there is a significant difference in the bond strength.

According to the statistics, the lowest significant difference is between the second and third group, which can be seen from the summary ANOVA table. Here the R-value is greater than 0.05 ($P>0.05578$).

Discussion

In our study, the highest bond strength is shown by the root canals where 2.5% sodium hypochlorite and 17% ETDA are used as irrigation agents, and adhesive technique of complete etching, and the lowest is shown by those where 2.5% sodium hypochlorite is used in the preparation of the root canal of the tooth as an irrigation agent, and an adhesive technique of etching.

From the obtained results, we can see that EDTA as an irrigant has a tendency to remove more smear layer from the tooth canal, and with increased removal of the smear layer, a greater bond strength is obtained.

The obtained results show that the use of sodium hypochlorite as an irrigation agent reduces the bond strength by applying self-etching adhesive and SpeedCEM™ dual polymerizing cement, in comparison with the first group where 2.5% sodium hypochlorite and 17% EDTA were used as irrigation agents, which correlates with the study of Elnaghy et all. which showed that the use of 5.25% sodium hypochlorite during spatial preparation for placement of the composite post reduces the bond strength in comparison with complete etching with 37% orthophosphoric acid.

The 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. It is likely that there is a connection between the application time of sodium hypochlorite and the bond strength, and as the application time increases the bond strength reduces[26].

For the groups where 2.5% sodium hypochlorite and 17% EDTA were used as irrigation agents, we obtained a higher bond strength in the total 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 composite post and the chemical bond of the self-adhesive cement.

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

Conclusion

In endodontic treatment, the processing of the root canal of the tooth reduces the strength of the tooth, which increases the possibility of vertical fracture of the root. Irrigation agents and cementation materials have a very important role in this treatment, as they have a significant impact on the bond strength of the composite post with the dentin. From the results obtained from this study we can conclude that the bond between the composite post and the dentin is the strongest with the application of 2.5% sodium hypochlorite and 17% EDTA as irrigation agents, and complete etching with orthophosphoric acid in combination with Excite self-etching adhesive, and Variolink II dual-polymerizing cement; and the weakest bond was obtained when we used only 2.5% sodium hypochlorite as an irrigant, applying Excite self-etching adhesive and SpeedCEM™ dual-polymerizing cement.

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