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Comparing the Retention of Cast Posts Cemented with Three Different Kinds of Cement

Comparação da Retenção de Pinos Fundidos Cimentados com Três Tipos de Cimento

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RESUMO

Objetivo: Verificar e comparar a retenção de pinos fundidos cimentados com três diferentes tipos de cimento.

Método: Quarenta e cinco incisivos superiores permanentes humanos foram divididos aleatoriamente em três grupos de 15 dentes cada um. Os canais radiculares foram preparados para receberem pinos fundidos de até 8.5 mm de comprimento. Os pinos foram cimentados com um dos três tipos de cimentos a seguir: cimento de fosfato de zinco, cimento de ionômero de vidro e cimento de ionômero de vidro modificado por resina (híbrido). Após a cimentação, as amostras foram armazenadas em solução salina durante 7 dias e então submetidas à análise da força de retenção em máquina universal de ensaios (Zwick num. 112627, Ulm-Germany).

Resultados: O cimento híbrido apresentou o maior valor médio de retenção (312.90 N), seguido do cimento de ionômero de vidro (272.40 N) e do cimento de fosfato de zinco (312.90 N). A análise estatística mostrou diferença estatisticamente significativa nos valores de retenção entre o cimento de fosfato de zinco e o cimento de ionômero de vidro ($p<0,01$), e entre o cimento de fosfato de zinco e o cimento híbrido ($p<0,01$).

Conclusão: Não houve discrepância significativa entre o cimento de ionômero de vidro e o cimento híbrido, embora a diferença na força de retenção entre os dois materiais tenha sido de aproximadamente 40 N.

ABSTRACT

Objective: To check and compare the retention of cast posts cemented with three different kinds of cement.

Method: Forty five 45 human permanent maxillary incisors were randomly divided into three groups of 15 teeth. Root canals were prepared for the cast posts up to 8.5mm in length. The cast post obtained randomly were cemented with the help of the three cements (Zinc Phosphate, Glass-ionomer and resin modified Glass-ionomer [hybrid] cement). After cementation, the samples were stored in a physiological solution for seven days, after which we concluded the measure of retentive strength with the help of the universal testing machine (Zwick num. 112627, Ulm-Germany).

Results: The hybrid cement has the greatest means value for retention and it is 312.90 N. It is followed by the Glass-ionomer cement with 272.40 N, while the Zinc Phosphate has the least, at 312.90 N. The statistical analysis shows that there is a statistical difference in the retention strength between the Zinc Phosphate cement and the Glass-ionomer ($p<0.01$), between the Zinc Phosphate cement and the hybrid cement ($p<0.01$).

Conclusion: A significant statistical discrepancy was not manifested between the Glass-ionomer cement and the hybrid cement even though the difference in retention strength for these two cements was around 40 N.

DESCRIPTORES

Cimentos de ionômeros de vidro; Cimento de fosfato de zinco; Técnica para retentor intra-radicular.

KEYWORDS

Glass ionomer cements; Zinc phosphate cement; Post and core technique.

INTRODUCTION

A dentist is often confronted with the problem of restoring endodontically treated teeth. Adequate restoration is just as important as the success of the endodontic treatment itself. The development of new materials and technology concerning them has made new approaches possible in treating lost or significantly damaged tooth tissue. Previous authors identified the following ideas and views in literature concerning the restoration of endodontically treated teeth: [a] restoring form and function, [b] preventing fractures in root residue, [c] aesthetics, [d] preventing caries and [e] retaining final restoration¹.

If a crown is required because of extensive coronal destruction, a dowel core is needed. A dowel is placed to provide the retention for a crown that ordinarily would have been gained from coronal tooth structure².

Cast dowel cores have been reported to provide excellent service for endodontically treated teeth with moderate to severe damage³. Cast dowel lies intimately in the root canal where it follows the root canal's morphology and evenly transfers occlusal forces on the remaining part of the root and periodontal apparatus⁴.

Laboratory studies that researched the retention of various posts stress that the following factors influence retention: length, diameter, post design, canal shape and preparation, position in the dental arch and finally, cement and cementing technique⁵.

All posts reach their ultimate retention with cement in the prepared root canal^{6,7}. The cement's ability to strengthen the post can influence the prosthodontic restoration prognosis^{1,8}. Concerning the post retention efficiency, there are controversial opinions about the various kinds of cements. A large number of researchers have questioned the bond strength of the different cements that are commonly used in fixed prosthodontics^{3,5,9-14}. Every category of cement has distinct advantages and inherent disadvantages³. The ability for post retention of different cements is connected to its mechanical attributions and the durability of the cement, the ability of the cement to bond to the surface with which it is inoculating, post configuration, canal preparation and the dentin structure⁹.

For the cementation of the endodontical post the following is used: Zinc Phosphate cement, Glass-ionomer cement, Resin modified Glass-ionomer cements (hybrid cement) and resin cements. With the overview of various studies that have dealt with the correlation of post retention and the type of cement used it can be noted that results are different. No cement manifested a significant advantage. Such results of course leave room

for further research with the goal of achieving greater success in prosthodontic therapy.

The aim of this research is to examine and compare the retention of cast posts cemented with three different types of cement: Zinc Phosphate, Glass-ionomer, and Resin modified Glass-ionomer (hybrid) cement.

MATERIAL AND METHODS

For experimental material, freshly extracted human permanent maxillary incisors with similar root lengths are used. The teeth are extracted due to periodontal reasons, according to the dental specialist's directions. The teeth are kept in a physiological solution at a temperature of 22° C until the carrying out of the experiment. In total, 45 teeth are chosen at random and divided into three experimental groups, each having 15 teeth.

The tooth crowns are separated from the roots with diamond disk under water spray, 1 mm above cemento-enamel junction at 90° to the long axis of the root. After that, root canals are prepared using a step-back method. All canals are filled with the technique of lateral gutta-percha condensation in the customary clinical way. After being filled, the samples are kept dry for 48 hours.

The root canals are prepared for cast post up to 8.5mm deep from the cut surface using a bevel drill (39, RA L, ISO 310205210002, Hager & Meisinger, GmbH, Germany) with a new drill used for every 10 specimens. The canal is prepared in the shape of a cone, having a narrower apical part (1mm), and a wider coronal part (1.6 mm). After that, they are washed with water and dried with compressed air. The impression of every prepared root is taken. By pouring the impression into a firm cast, we get a working model on which, with the help of blue modeling wax, (Modeling wax, Interdent, Celje) we model the cast post. On the tip of the crown part of the restoration, a loop is made from the same wax, which is crucial for measuring.

After it is cool, the wax model is taken from the model in the most convenient way. The wax model is put in with a one-phase method of investing using investment material (Investment K+B speed, Interdent, Celje). The investment material is prepared with the help of a vacuum mixer (Motava SI; BEGO). The samples are cast using an induction machine for casting (Fornax 35K-F; BEGO). For casting a metallic alloy composed of 60.5 %Co, 28%Cr and 9%W (Remanium star, Dentauro, Germany) is used. After that, the castings are cooled at room temperature while the object is emptied of the investment material by abrasion with small particles of aluminum oxide (250 µm). The finished cast posts are tried in root canals.

Before cementing the post, micro retentions are made on the tooth root for the auto polymerizing acrylic resin with the aide of a double-sided diamond washer (919, ISO 806 104346524, GEHR. BRASSELER GmbH & Co. KG, Germany). The micro retaining grooves are turned under the opposite corner of the towing force. The cast posts are cemented with one of the three kinds of cement.

In the first group, the 15 cast posts are cemented with Zinc Phosphate cement (Harvard Cement, Richter & Hoffmann Harvard Dental-gesellschaft, Berlin, Germany). In the second group the 15 cast posts are cemented with Glass-ionomer cement (Ketac-Cem radiopaque 3M Espe AG, Germany). In the third group the 15 cast posts are cemented with Resin modified Glass-ionomer-hybrid cement (GC Fuji Plus Radiopaque reinforced Glass-ionomer cement GC Corporation Tokyo, Japan).

The root canals are washed with water and dried with compressed air before cementation. The cast posts are disinfected with alcohol and dried. The cements are prepared and used in accordance with the directions from their producer. The mixed cement is put in the root canal with a lentulo spiral (Dentsply Maillefer) on a low

speed. Each cast post is coated with cement and seated to the root canal. During the time the cement hardens, the post is pressed by fingers. The same procedure for cementation is repeated for every post. Excess cement is removed with a dental probe. After cementation, the samples are kept in a physiological solution for seven days after their measurements are completed.

All samples are prepared for measurement in the following way: auto polymerizing acrylic resin (ProBase Cold, Ivoclar Vivadent AG Liechtenstein) is dripped into a cylinder cast with dimensions $r=0.7$ mm and $l=15$ mm in which the tooth root with its cemented post up to the cemento-enamel border is put. For the measuring of the retention value universal testing machine (Zwick num.112627, Ulm-Germany) is used to apply a tensile force parallel to the long axis of the post. The force in N (Newton) required to dislodge each cemented post is recorded in the universal testing machine.

To process the recorded data we used the statistical program SPSS and the following: Descriptive Statistics, One-sample Kolmogorov-Smirnov Test, Parametric test (One-way Analysis of Variance ANOVA) and Sheffe's Test.

RESULTS

The maximal, minimal and mean values of retention for the analyzed cements are shown in Table 1.

The statistical analysis showed that there is a significant statistical difference in the strength of retention

between Zinc Phosphate cement and Glass-ionomer cement ($p<0.01$) while between Glass-ionomer cement and the hybrid cement, there is essentially no significant statistical difference (Table 2.), even if the mean value for strength retention for these two cements is about 40 N.

Table 1. Descriptive statistic values for the types of cements.

Type of Cement	N	Arithmetic Mean (N)	Standard Deviation	Minimum Value	Maximum Value
Zinc Phosphate cement (Harvard)	15	182.20	31.03	120	240
Glass-ionomer cement (Ketac-Cem)	15	272.40	66.05	208	440
Hybrid cement (Fuji Plus)	15	312.90	60.76	198	420

Table 2. Results for the One-way Analysis of Variance (ANOVA).

Variance	Quadrant Sum	Df	Average Quadrant	F- ratio	Significance
Between groups	132762.744	2	66381.372	22.086	.000
Within a group	126237.263	42	3005.649		
Total	259000.006	44			

DISCUSSION

Adequate restoration of endodontically treated teeth is just as important as the success of the endodontic

treatment itself. Until now, work has drawn attention to the necessity of a responding post and crown that would enable optimal results^{15,16}. Retention of the post in the tooth root is critical for the success and durability of

the final restoration. The ability of the cement to retain the post can significantly influence the prognosis for complete restoration¹⁷⁻²⁰. The retention value is used as a conventional method for comparing posts. Posts that have a greater retention are less functional concerning normal chewing functions²¹.

The wearing away of cement occurs as a result of the constant burden of tension. The clinical post and crown are put under repeated tension, compression, torsion and torque. The posts will be dislocated when the cement wears away and the connection with the dentin is finally lost.

Unfortunately, there is not a practical method that can simulate the conditions in the mouth cavity. Though this study does not directly reflect an intra-oral strength which leads to the dislocation of a post, it can address their retentive value.

Although many authors have conducted studies of the retention strength of different cements, the ideal retentive strength for cementation posts in endodontically treated teeth is yet to be found.

In this experimental study, the hybrid cement showed the greatest means of retention value, followed by Glass-ionomer cement, while the Zinc Phosphate cement had the least retention value.

The significant difference in the retention value between the Zinc Phosphate, the Glass-ionomer and the hybrid cement can be attributed to the fact that the Zinc Phosphate cement does not connect chemically to even one substrate and achieves retention only mechanically²². On the other hand, the cements with a base of Glass-ionomer have adhesive material since they create a chemical connection with the surface of the tooth tissue and the surfaces of high-noble alloys and base metal alloys. Adhesion of Glass-ionomer for tooth tissue has similar bond strength as adhesion of composite for dentin, with the aid of the third generation of dentin adhesives²³.

The retention value of Zinc Phosphate cement in our research corresponds to the results obtained by other investigators in their in vitro researches^{19,24-26}.

The average retention value obtained in other study which it was compared the retention of cast posts made of gold alloys and four kinds of cement was significantly less than our results¹⁹; that can be explained by the better chemical cement connection with base metal alloys used in our research than for gold alloys used in his mentioned research. The stronger connection is formed with base metal alloys and after sand blasting, is enhanced with the help of Smelter-grade particles, 50 µm in size. Remaining evenly distributed layer cement is often noticed on the uncemented crown²³. It should be kept in mind that after

cementation, the authors kept their sample in damp surroundings for 24 hours while our samples were kept in a physiological solution for 7 days. Glass-ionomer needs more days or weeks to reach its maximal strength^{3,8}; that is another possible cause for the greater retention value of Glass-ionomer in our research.

Previous research²⁵ compared the strength connecting post products cemented with three different kinds of cement; for Glass-ionomer and hybrid cement he got lower values than we did. The way of keeping the cementation samples differed, which probably influenced the difference in the retention values of these cements. Others authors got results for Glass-ionomer which matched ours^{6,7,20,26}.

On the other hand, for the hybrid cement it was found a low average retention value²⁰ (Vitremar 53.90 N and Fuji DUET 25.97 N) compared to our results, which is hard to explain. The cements were mixed according to their producers' instructions, but there is a possibility for inaccuracy or inconsistency concerning the quantity of powder and liquid needed and distributed with a little spoon and drops. One other possibility is that producers lessened the ratio of powder and liquid in the material products responding to the consistency for cement and thus, they got weaker cement compared to the relatively thick cement for fillings. The cement stayed on the post before cementation with Fuji DUET and Vitremar, which supports the hypothesis suggesting that the cohesion failure occurred truly because of the cement. In order to lessen the quantity of powder in the hybrid cement, increasing the proportion of HEMA would be necessary, which further implies that this hydrophilic material absorbs more water and generates a weaker cement structure²⁷. The samples of this experiment were kept in water for six weeks, which could cause a lower retention value of these cements.

Even though the statistical analysis showed significant differences in retention value between the Zinc Phosphate and other tested cements, that does not lessen the clinical importance of using this cement. Its adaptable retention value, along with effectual preparation principles and adequate technical cementation still keeps it as the cement of choice in many clinical situations. In addition, its affordable price and simple technical work and manipulation should be mentioned. It should also be mentioned that the standard deviation in our research was the least for Zinc Phosphate cement, which demonstrates the reliability of this cement and its ability to secure consistent retention.

Glass-ionomer and hybrid cement showed a greater range of retention value in our research, as well as a greater variability in different studies, which brings us to

the conclusion that these two cements are technically much more sensitive than Zinc Phosphate cement.

On the other hand, there are numerous factors that are on the side of the new cements, such as the continuous release of fluoride, thus giving protection to caries, the ability of chemical connection with adamantine, dentin and metal posts, as well as having greater retention value.

CONCLUSIONS

- 1) The hybrid cement (Fuji Plus) manifested the greatest retention value;
- 2) The Zinc Phosphate Cement had the lowest means of retention value;
- 3) The statistical analysis proved that there is a significant statistical difference in retention strength between the Zinc Phosphate cement and the Glass-ionomer cement ($p < 0.01$), and between the Zinc Phosphate cement and the Hybrid cement ($p < 0.01$);
- 4) A significant statistical difference between the Glass-ionomer and the hybrid cement was not proven; the difference in retention strength of these two cements is around 40N.

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