Comparative Analysis of the Influence of the Type of Cementation of Co-Cr Alloy Cast Core

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Abstract

There is little in the literature on retention of Co-Cr (cobalt-chromium) cast metal pins cemented with resin or conventional alloy and, although many methods have been tested and used, there is no specific technique or material indicated in all clinical cases. **Objective:** The aim of this study was to evaluate the retention of the molten metal pins cemented with zinc phosphate and resin cement after the root impregnation/treatment with chitosan. **Methods:** A Pull Out was used with a universal test machine, with a speed of 0.5mm / Minute and with a 50kgf load cell. **Results:** The obtained results were submitted to the Kolmogorov-Smirnov test to verify the homogeneity of the data, and it was verified that the values were normal. **Conclusion:** It was concluded that the cementation of the molten metal pins of Co-Cr with resinous cementations agent is more efficient than the action of the zinc phosphate cement when the chitosan is used as an irrigating agent.

Key words: *Chitosan, pull out, metal pins, Cementation, Dental cements.*

Introduction

One the major challenges for oral rehabilitation is restorations in endodontically treated teeth. Although many methods have been tested and many others are constantly launched in the dental market, there is no specific technique or material that is indicated in all clinical cases in order to satisfy the biomechanical, biocompatibility and aesthetic requirements[1].

The first alloys to be used, which were presented in the casting of cast cores, were the noble gold alloys, because they are biocompatible, with low hardness and high resistance to corrosion. On the other hand, these alloys have a higher associated cost[2]. Studies developed in order to find alternative alloys to replace the gold are in progress, consequently, the nickel-chromium (Ni-Cr) and cobalt-chromium (Co-Cr) alloys have reached a large share of the world market[3], due to the economic and mechanical factors close to those of golden alloys[4], besides having advantages like the low weight, high resistance, and low cost[5,6,7].

The chitosan (metalloproteinase inhibitor) is a biopolymer with a unique chemical structure, with high charge density and reactive groups as well as several hydrogen bonds. These characteristics allow it to have excellent biocompatibility and to be easily processed; Regarding the chitosan, among the biological properties described, the antioxidant, antimicrobial, inhibition of biofilm formation, anti-inflammatory and cicatrizing capacities are perhaps the most relevant for Dentistry (new)[8]. For these reasons, it can be an important finding when used together with the fused metal nuclei, aiming at better retention and treatment success.

However, non-noble alloys need to be better understood to be used as cast cores, because the challenge lies in the union between the restorer material and the root canal, which can affect the union forces between the tooth and the cast core. Thus, the clinical success

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of dental restorations is strongly dependent on cement and its cementation procedures[9], and the main functions of cements: to increase retention of restoration and to maintain their integrity[7].

Thus, the aim of this study was to evaluate the tensile strength of two cements (zinc phosphate cement and methacrylate-based dual resin cement) in the retention of cast cores of Co-Cr alloys, when previously impregnated with chitosan.

Materials and Methods

Selection and suitability of the material

Twenty humans' canines from the permanent dentition were selected. They were previously extracted and stored in the laboratory of Dental Materials-UFVJM, being upper or lower teeth, presenting a minimum of 22 mm length, closed apex, no caries, no coronary restorations, and no previous endodontic treatment. Teeth that presented large mesiodistal flattening, length less than 22 mm, root narrowing, or any alteration outside the inclusion patterns were excluded.

Endodontic Treatment and root canal preparation

Root canal access was conducted with an endodontic file size #15 (*Dentsply Mailleifer*, Ballaigues/ Switzerland) until it was viewed at the apical foramen entrance. Of this length, 1mm was subtracted, obtaining the working length of 15mm (obtained in all 20 specimens, radiographically standardized in order to all teeth obtain this working length). The instrumentation of the root canal was conducted from the file size #15 to size #40 (*Dentsply Mailleifer*, Ballaigues/ Switzerland) and it aimed to form the apical stop. Then, files were used sequentially in full working length, stepping back 1mm and 1 larger file at a time (files size #45 to size #80) (*Dentsply Mailleifer*, Ballaigues/ Switzerland), it was used Kerr-type files and from the file size #80 it were used Largo drills (/peeso reamers/?) #2 and #4 (*Dentsply Mailleifer*, Ballaigues/ Switzerland), backing up 2mm for each drill.

Irrigations with Dakin solution (*Biodinamics*, Ibiporã, PR/ Brazil) were performed at each exchange of files and drills in order to remove the debris. After manual instrumentation, the root canal was dried with endodontic absorbent paper points (*Dentsply*, Petrópolis, RJ/ Brazil) and thus, the obturation was performed by the lateral condensation technique, with gutta-percha cones size #40 (*Dentsply,* Petrópolis, RJ/ Brazil) and accessory cones R7 and R8 (*Dentsply*, Petrópolis, RJ/ Brazil).

For root canal filling, a resin-based endodontic cement associated with calcium hydroxide (*Sealer 26, Dentsply*, Petrópolis, RJ/ Brazil) was used, it was proportioned and spatulated according to the manufacturer's recommendations. Prior to the preparation, the teeth were stored in 100% of relative humidity for a period of 72 hours in order to allow the complete hardening reaction of the endodontic cement.

The preparation of the root canal for the core was performed with the Largo drills #2, #4 and #6, in low rotation (*Dentsply Mailleifer*, Ballaigues/ Switzerland). It was adopted 3mm for apical sealing in all teeth, confirmed by periapical radiography of each specimen. When it was finished, a pre-fabricated control post containing an endodontic stop at 10mm length was proven to better visualize the working length. In cases where working length was not confirmed, the Largo drill #6 was reused with 10mm of depth, and again, the control post was tried[10].

Production of resin patterns and casting

For the manufacture of resin patterns, pre-fabricated posts were used for root canal molding (*Pin-Jet, Angelus*, Londrina, PR/ Brazil) and Duralay acrylic resin (*Reliance Dental Mfg Co*, IL/ USA). Each tooth was molded individually, resulting in individual resin patterns. Before casting, the posts received a coronary construction with Duralay resin, with an inverted cone shape in order to adapt the cast core to the traction pull out test matrix. The coronary portion was made by means of a teflon device developed by the Faculty of Dentistry of Ribeirão Preto - USP, with an inverted cone shape.

Therefore, the casting of the cores was performed, with phosphate-agglutinated investment (*Termocast*, Polidental, São Paulo, SP/ Brazil) and subjected to a thermal cycle in automatic oven (*EDG*, São Carlos, SP/ Brazil) according to the manufacturer protocol.

Subsequently, the cast cores were cut in the region of the intersection with the feeding bar, and, in the laboratory, it was used a polishing machine and carborundum discs #43 (*Shelble*, Petrópolis, RJ/ Brazil). The cleaned posts were placed into the canal root to verify the correct adaptation. If the posts presented nodules or irregularities that affected the correct settlement, these were removed by means of careful machining with transmetal drills (*Dentsply Mailleifer*, Ballaigues/ Switzerland).

The teeth in question were included in self-polymerizable acrylic resin (*Dencrilon*, Dencril, Caierias, SP/ Brazil), using a 10x10mm PVC ring, with a modified liner, to allow the posts and root canals to be parallel to the traction of pull out test matrix, avoiding the action of lateral forces. They were then kept in a 100% relative humidity environment, during 48 hours, until the cementation.

After insertion in a self-polymerizable acrylic resin, the cementation of the posts was performed. Cementation was made by means of two luting agents: zinc phosphate cement (*Coltene*, Rio de Janeiro, RJ/ Brazil) and a dual resin cement based on methacrylate-phosphate (*Dentscare*, Joinville, SC/ Brazil). All cements were manipulated according to the manufacturer's instructions.

Impregnation with Chitosan

The powdered chitosan was diluted in pure water (in the proportion of 3 grams for every 200 ml of water) 1 minute before its application. It was added in all root canal with the aid of a syringe and fine thickness needle for better impregnation in the root canal in question, for one minute in each tooth.

In the specimens that would be cemented with zinc phosphate, chitosan was used for cleaning and irrigation of the root canals, which was then dried with absorbent papers and the cast core was cemented immediately.

In the specimens that were cemented with resin cement, the acid conditioner was first made (phosphoric acid 37%) to remove the smear layer and conditioning of the technique and then, impregnation with chitosan solution for 1 minute, drying with the absorbent papers, and application of the appropriate adhesive system for metal (photopolymerization for 20 seconds), and finally, the resin cement (light polymerization for 40 seconds, above the post/tooth).

Grouping and pull out test

At the end of the cementation, the groups were randomized, being 10 samples per group (n = 10). Group 1 was composed of Co-Cr cast cores cemented with zinc phosphate and group 2, Co-Cr cast cores cemented with resin cement.

The pull-out tests were performed 48 hours later (counting from the first cemented post), in a universal test machine *(EMIC DL*. 2000, São Jose DOS Pinhais, PR/ Brazil), with speed of 0, 5mm/minute and load cell of 50KGF.

The data were submitted to the Kolmogorov-Smirnov test to verify their homogeneity and it was possible to verify that they were normally distributed. Therefore, the Student's T-test was selected, with a significance level of 5%.

Results

It was observed that the zinc phosphate group presented the lowest values when compared to the cemented posts with resin cementing agents, after surface treatment with a metalloproteinase inhibitor, Chitosan; It was clear the best performance of the resin cement group when compared by the Pull out test. This test used to evaluate the bond strength between pin and root dentin; The pull-out, which better distributes the stresses, was able to accurately measure the bond strength between the pin and the root dentin[11] and the values of the test performed on the Co-Cr cast metal pins, cemented with the Different cementing agents can be observed in Table 1 and also in Graph 1.

Table 1: Mean and standard deviation of the pull-out resistance of cast metal core.

	Zinc Phosphate Cement	**Resin Cement**
Mean	172.01a	357.70b
Standard deviation	36.26	27.83

Different lowercase letters show significant diferences

Source: Author Data, 2019

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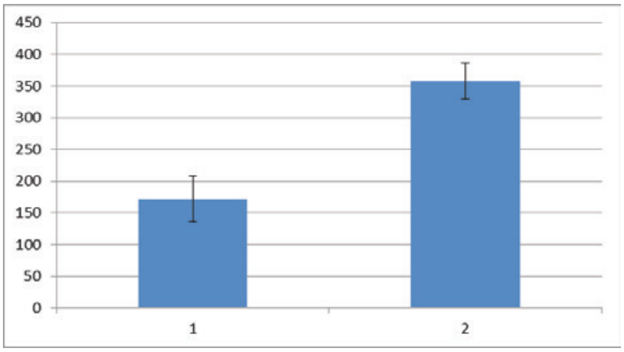
Graph 1: Average and standard deviation of the resistance from the molten metal pins.



Legend: 1- Zinc phosphate-cement; 2 - Resin cement.

Source: Author Data, 2019

Discussion

The zinc phosphate cement has been used in Dentistry for over a century and it still has a greater applicability nowadays, due to the good results regarding its retentive capacity[12] in addition to being one of the most used in cementation of metal-ceramic crowns, due to the low cost, ease of manipulation and good mechanical properties[13].

The cement of zinc phosphate has a role in the fixation of indirect restorations with tooth structures by means of mechanical retention, promoted by the dental surface irregularities and the machined parts of the restoration[14]. However, to restore the function of endodontically treated tooth by means of cementation of cast core remains the aim of several researches[6]. By comparing the means of the cements in this study, it was observed that the zinc phosphate cement presented the lowest resistance to pull out test when compared to the cores cemented with resin cement, after surface treatment with chitosan[7].

The pull out test showed that zinc phosphate cement did not show good results, confirmed by Anusavice[15] (2005), who reported that the zinc phosphate cement does not present adhesion to dental, metallic or ceramics structures and that the original adjustment of the posts before cementation and the surface irregularities contribute as an important factor to improve retention.

Thus, the adaptation of the cast cores in an appropriate way into the root canal previously prepared is a primary factor to provide good retention, because they promote a thin layer of cement, improving the bond strength,[16] because the smaller the cement thickness, greater is the mechanical requirements in order to remove the cast core. However, the present results were different from those found by Shiozawa et al.[17] (2005), because even the core being well adapted to root canal, those one cemented with zinc phosphate were statistically different to those cemented with resin agent.

To compare the zinc phosphate cements with the resin cements is difficult because the behaviors of adhesive cements are differentiated[10]. The main advantages of resin cements are adhesion to metallic, resinous and porcelain structures, very low solubility, high tensile strength and color selection of the luting agent[3]. Thus, the thickness of the cement in the behavior of cast cores is not well defined as for the zinc phosphate cement[5].

It is correct to say that thick layers of resin cements do not interfere negatively in both retention and function of cast core, this may be explained due to the increased surface area for the cement-dentin junction provided by the post-core. However, Shankar et al.[8] (2017) have shown that cementing cast core with resin cements presented better results when compared with zinc phosphate cement, which corroborates with the results found herein.

Another factor, that may have retentive action, was the use of the metalloproteinase inhibitor. The diluted chitosan was used in order to improve the retention of cast core (Co-Cr) and to increase the shear resistance. Kishen et al.[18] (2008) had shown that the incorporation of nanoparticles of chitosan on dental cements does not alter their permeability, but, significantly improve their antimicrobial properties and leaching of antibacterial components. In addition, the importance promoted by the bonding agent is unquestioned, showing the superior performance of the resin cement for cementation of cast core in Co-Cr[11,19]. However, the operative technique of this cement is extremely sensitive, mainly by the presence of moisture in the adhesion interface and the inherent requirements of this resinous material.

In addition, it is important to note that Chitosan as used in this study does not yet have a well-established application in dentistry with regard to pin retention, so further studies on this material are needed for further future conclusions.

Conclusion

It was concluded that cementation of the Co-Cr alloy melt core with resin cement is more efficient than zinc phosphate cement when the chitosan solution was used as root canal irrigant. Further studies are needed to establish a significant contribution of chitosan in retention of fused metal pins. But with this work, we take a first step in what may be an advantage and innovation in rehabilitating treatments with metallic materials.

Declarations

Ethical Clearance - Approved by the Research Ethics Committee of the Federal University of Jequitinhonha and Mucuri Valleys (UFVJM), by protocol 014615/2017.

Conflict of Interest - The authors declare that they have no conflict of interest.

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