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Analysis of bacterial infiltration in cast post cores, cemented with different types of cement

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Abstract

Objective: The aim on this study was to evaluate the coronal infiltration of restored samples with cast post cores, cemented with different types of cement.

Methods: Forty-eight rooted samples extracted from humans were instrumented with rotatory system and prepared dentist's drill wide to the confection of the molten core. The samples were divided in three experimental groups and two control groups. Group 1 was cemented with zinc phosphate cement; group 2 with glass ionomer cement, and group 3 with resin cement. The samples were assembled in a double chamber model system, and their leakage detector was the *Enterococcus faecalis*. The inoculation was renewed every three days during 60 days. The microleakage was daily evaluated through the observation of the culture medium regarding its turbidity.

Results: Microleakage occurred in positive group. There was no microleakage in the negative group. It was detected 66, 66%, 25%, and 41, 66% of microleakage in groups 1, 2 and 3. The statistical analysis carried out by the Wilcoxon-test, revealed a considerable difference between cements, being the zinc phosphate cement the one with the worst results.

Conclusion: The cementation procedure of molten metallic cores can be important to delay the contamination of teeth in need of coronal reconstruction.

Key words: Dental cement; Microleakage; Cast post core

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Análise da infiltração bacteriana em dentes restaurados com núcleos metálicos fundidos e cimentados com diferentes tipos de cimento

Resumo

Objetivo: O objetivo deste estudo foi avaliar a infiltração bacteriana por via coronária de espécimes restaurados com núcleos metálicos fundidos e cimentados com três diferentes tipos de cimento.

Métodos: 48 espécimes extraídos de humanos, que foram instrumentados com o sistema rotatório e preparados com broca para a confecção do núcleo metálico fundido. Os espécimes foram divididos em três grupos experimentais e dois grupos-controle. Grupo 1 foi cimentado com cimento fosfato de zinco; grupo 2 cimentado com cimento de ionômero de vidro e grupo 3 com cimento resinoso. Os espécimes foram montados em um sistema modelo de câmara dupla, e tiveram como indicador da infiltração o *Enterococcus faecalis*. A inoculação foi renovada a cada três dias, durante sessenta dias. A avaliação da infiltração foi realizada diariamente pela observação do meio de cultura quanto à turvação.

Resultados: Em todos os espécimes do grupo-controle positivo, observou-se a presença de infiltração. No grupo-controle negativo, não ocorreu infiltração. Detectaram-se 66,66%, 25% e 41,66% de infiltração nos grupos 1, 2 e 3. A análise estatística realizada pelo Teste-Wilcoxon, mostrou haver diferença significativa entre os cimentos, com o cimento fosfato de zinco apresentando os piores resultados.

Conclusão: O procedimento de cimentação de núcleos metálicos fundidos pode ser importante para retardar a contaminação em casos de dentes que necessitem de reconstrução coronária.

Palavras-chave: Cimentos odontológicos; Microinfiltração; Núcleos metálicos fundidos

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Introduction

The endodontic therapy fail is related with the coronal microleakage inside the root canal [1-7]. The coronal microleakage can happen after the loss of the coronal sealing [8-10].

The relation between the quality of the coronal restoration and the filling of the root canal with the presence of periapical pathology has been evaluated [11]. Some authors concluded that the technical quality of the coronal restoration was more important than the endodontic treatment to the periapical health of the teeth endodontically treated [2,12]. On the other hand, other authors emphasize that quality of the endodontic treatment is more important than the restoration quality [3,13]; in the meantime, the majority of the studies had highlighted the association of a good endodontic treatment to an adequate coronal restoration [1,3,5,7,11,14].

Since 1965 it has been established [15] the importance of the microorganisms role as the etiological coefficient of the pulp and periapical alterations, demonstrating that the exposition of the root canal system to the oral microbiota can be a great risk for the success of the endodontic treatment [11,16].

A special attention must be emphasized in cases that great part of the filling material has to be removed for the confection of the molten metallic cores [17]. Several studies demonstrate that partially filled roots present a poor sealing for the placement of an intra-radicular retainer, once compared with completely filled roots [2,18-22]. According with Shibayama at al. [7] the provisory restoring materials, the remaining filling material, as well as the endodontic types of cement are important and must be associated to the quality of the retainers and also to a good cementing agent.

Maniglia et al. [20] verify *in vitro*, the capacity of the coronal sealing provided by different fastening agents of intraradicular retainers, using the nanquin dye as a marker agent. The analysis of the results pointed a significant difference among the evaluated materials, in such a manner, that both the zinc phosphate and the resin cements presented a better capacity of coronal sealing, with no significant statistical difference between them, nevertheless, they are considerably superior to the glass ionomer cement. However, a literary in depth study in this matter has proven the importance of the biological marker in the evaluation of the sealing capacity post endodontic treatment, which can possibly relate to the everyday clinical reality.

Therefore, the set tooth/core/quality of the endodontic treatment associated to a good restoration seems to be the golden pattern for the success of the dental treatment. Due to insufficiency of the studies, it seems convenient to evaluate the real role of the cementation of a molten metallic retainer, also evaluating if the kind of cement used in such procedure can delay the microbial contamination of the system of the root canals.

Method

Selection, Preparation and Distribution of the Samples

The Ethics Committee in Research, Protocol CAAE 01019012.7.0000.5137, has approved this work. Forty-eight single rooted human teeth, provided by the teeth bank were used in this experiment, the teeth with more than one canal, not completely formed apex, reabsorption and massive cavities were excluded.

The samples were kept in a solution of distilled water and sodium hypochlorite 2,5% in a proportion of 10:1 until the time of the experiment.

Criteria of the Standardization of the and Instrumentation of the Root

The teeth had the apex cut at 3mm from the apical vertex, and the coronal amount was removed to the cement/ enamel junction level with the aid of the carborundum disc (SS White, Rio de Janeiro, Brazil), the samples were standardized in 10 mm. The length of the work was settled by introducing a file Model k#15 up to the beginning of its viewing in the apex area. The cleaning procedure and formatting of the System Root Canals (SCR) were accomplished by a rotatory instrumentation Nickel-Titanium *Pro Taper* system (Dentsply-Maillefer, Ballaigues, Switzerland), using sequentially the files S1, S2, F1, F2 and F3 associated with the final standardization of the apical foramen with the file Type k#30. In each change of the files, the channels were irrigated with 1ml of hypochlorite of Sodium 2,5%.

The molten metallic core was prepared after the root canal preparation, with the aid of a Largo n° 4 file (Dentsply-Maillefer, Ballaigues, Switzerland) with the standard length in 7 mm.

Preparation of the Cores

A canal lubrication with the hydro soluble paste KY (Johnson & Johnson do Brasil, Sao Paulo, Brazil) was previously made. The modelling of the root channel was made in red acrylic resin (Duralay, Illinois, USA). The shape of the coronal segment was made by Nealon technique, and its preparation and finishing touches were accomplished with high rotation drills nº 2136G (KGS, Sao Paulo, Brazil).

In order to check their adaptation with the remaining root, the cores were reset in position and observed with front magnifying glasses 4X enlargement (Bioart, Sao Paulo, Brazil). Whenever required, the pins were rebased with the acrylic resin. Afterwards, the cores were fused with the alloy CuZn (Goldent-LAJE Comercio e Representacão, Sao Paulo, Brazil). Subsequently, the molten cores and its respective samples were aleatory divided in three experimental groups, according to the cement used (Table 1). There were twelve samples in each experimental group, apart from the two control groups, a positive and a negative one, with six samples each.

Table 1. Group Distribution.

Group	Material	Commercial Name	n
Group 1	Zinc Phosphate	Zinc Phosphate	12
Group 2	Glass Ionomer	Vidrion C	12
Group 3	Resin Cement	Multilink	12
Control	Positive		6
Control	Negative		6

Cementing of the Cores

Before the cementing process, the samples received an irrigation of sodium hypochlorite and were dried with hints of absorbent paper number 80 (Dentsply-Maillefer, Ballaigues, Switzerland). The cements were manipulated according to the manufacturer's recommendations and in the room temperature.

In the group 1, the Zinc Phosphate cement (SS White, Rio de Janeiro, Brazil) was taken with the aid of a Hollembeck (SS White, Rio de Janeiro, Brazil) to the surface of the cores, and adapted to the correspondent sample.

In the group 2, the core was cemented with glass ionomer cement Vidroin C (SS White, Rio de Janeiro, Brazil). After being tooled with a spatula, the cement was taken by a hollembeckto the core surface and settled in the correspondent sample.

In the group 3, the resin cement was used – Multilink (Ivoclar/Vivadent, Schaan, Liechtenstein, Germany). The root canal and the occlusal surface of the preparation were completely covered with the mixture Multilink Primer A/B using the thin *Microbrush* (Vigodent SA Industria e Comércio, Rio de Janeiro, Brazil). After 15 seconds, the excess of material inside the root canals was removed using absorbent paper cones. The manipulation of the Multilink cement was made by the agglutination of the mixture base/catalyst. In the metallic core was applied the phosphoric acid (37%) for cleaning and degreasing purposes, it was also applied a primer (Metal/zirconia, Ivoclar/Vivadent, Schaan, Liechtenstein, Germany) for a 20 seconds period. It was cemented in a similar way of the previous groups.

Preparation of the test apparatus

The test apparatus from the confection of the double chamber experimental model consisted of a structure made of 10 ml glass phials (Wheaton do Brasil S.A., São Bernardo do Campo, Brazil), rubber lids with 20 mm of diameter (Adnaloy Artefatos de Borracha, Ltda, São Paulo, Brazil), and *Eppendorf* kind of tubes 1,5 ml [24]. In order to grant a proper impermeability, a layer of epoxy resin was applied in the tube-tooth junction, subsequently, a layer of cyanoacrylate was applied on the epoxy resin surface as well as on the root surface, which was made impermeable already, besides, a new layer of nail enamel was used to grant the best possible sealing of the junction tube-teeth and impermeability of the samples. The teeth of the positive control group had the same process of impermeability as the experimental groups, meanwhile, the negative control group had the complete impermeabilization of the root structure, including the 3 apical mm, besides all the internal and external coronal structure, with the same sealing agents. After drying the sealing agents for no less than 24 hours at room temperature, all the apparatus of the test, which consisted of an *Eppendorf-dente* tube, a 10 ml glass phial, and a perforated rubber lid; all these items were properly identified, and the sets were individually numerated and taken to sterilization in Ethylene Oxide Gas (Curar Centro de Esterelização, Ltda, Belo Horizonte, Brazil), to ensure the absence of any microorganism. The sterilization process was carried out for a period of 240 minutes of exposition to the agent, to a 55° *set point* temperature, and a relative humidity of 60% followed by an aeration process of 180 min.

Microorganism Indicator

According to the protocol advocated by Valadares et al. [23], a microorganism indicator issued by the *American Type Culture Collection* (ATCC) – *Enterococcus faecalis* (ATCC 29212) was used.

Preparation of the Fixing Platform and allotment of the Culture Medium in the Revealing Phial

The culture medium *Brain Heart Infusion* (BHI), broth (BHI Difco Laboratories, Detroit, MI, USA), was sterilized in autoclave after being prepared according to the manufacturer instructions.

The container with sterile medium, along with the individual packaging of the apparatus of the test, which were sterilized in Ethylene Oxide Gas, was opened in a Laminar Flux Chamber, where the fixing platform was assembled and the culture phials were allotted. 6, 5 ml of BHI broth were set in each phial, later such phials were adjusted to the perforated lids, and an *Eppendorf-dente* set was inserted up to approximately 3 root mm immersion of the culture medium.

Microbial Inoculation of the Samples and Contamination Control

The microbial inoculation was held each three days, always with a 24 hours culture, during 60 days. The presence or the absence of turbidity in the culture medium inside the glass phial was evaluated in each day of the experimental period, since the clouding indicated the presence or absence of microorganisms, which distinguished the complete microbial infiltration through the set: teeth, post and cement.

The data gathered during the experimental period were tabulated and displayed in survival curves. The difference among the groups were analysed through the Long – Rank (Mantel – Cox) test. The significance level was established in 5%. The tests were held using the GraphPadPrism 5.00 software (GraphPad Software, San Diego, California, USA).

Results

The Table 2 summarizes the amount of samples infiltrated in each experimental group, the time of the infiltration, and the percentage of infiltration can also be verified in Figure 1.

Table 2. Time of the infiltration.

Group	Day of the clouding	Turbid samples	%
Phosphate	1 (4°); 3 (6°); 1 (8°); 1 (10°); 1 (11°); 1 (13°)	8 in 12	66,66%
Ionomer	1 (1°); 1 (26°); 1 (41°)	3 in 12	25%
Resin	2 (7°); 1 (8°); 1 (13°); 1 (48°)	5 in 12	41,66%
Positive	5 (1°); 1 (8°)	6 in 6	100%
Negative	No samples	Zero	0%

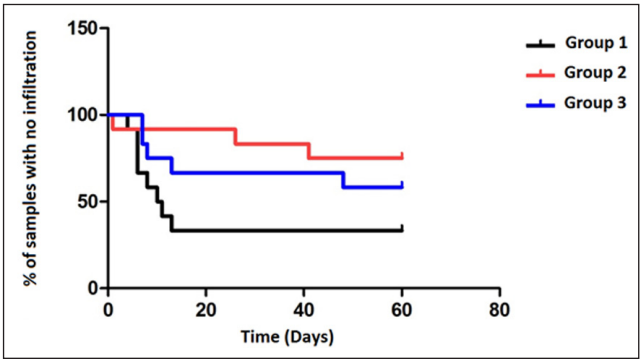

Figure 1. Results from the Comparison of Frequency among the groups.

Comparison between groups

A comparison of dispersion of frequency was held using the Mantel-Cox Test with 5% significance level. There was a significant difference (p=0.02) from group 1 in relation to group 2. However, comparing groups 1 and 3 (p=0,14), or groups 2 and 3(p=0,39) the results do not present any significant statistic difference.

Discussion

It seems established in the literature the importance of the coronal sealing after the accomplishment of the endodontic treatment, whereas several authors quote its importance to the success of the treatment [2-7]. The actual study was based in the efficiency of different kinds of cement in the fastening of molten metallic root posts. The cements used in this experiment were tested according to their efficiency to block an *Enterococcus faecalis* culture, which is a very resistant gran-positive coccus in the oral cavity, such coccus was chosen as a biological pointer in the actual study for being constantly involved in persistent endodontic infections, therefore, it can be responsible for a great amount of endodontic failures.

Ricucci et al. [5] concluded that the failure of the endodontic therapy is related with coronal microleakage inside the root canal, which can be worsen whenever the removal from part of the filling material is needed for the installation of the post.

Demarchi and Sato [24] compared the coronal microleakage in two different circumstances for the core cementation: the teeth cemented with permanent cement, and the ones with the core cemented with temporary cement. The teeth were thermocycled, immersed in Nanquin ink for a week, and after that, they were included in acrylic and cut into thin plates for observation. The results revealed that the group with the permanent cement produced a better sealing than the group with temporary cement, and also the microleakage was significantly bigger in the group with temporary cement. Besides, Maniglia et al. [20] verified *in vitro* the capacity of coronal sealing provided by different fastening agents of intraroot retainers using the microleakage produced by Naquin. The zinc phosphate and Enforce cements presented a better coronal sealing capacity, with no significant statistical difference between them; however, they were significantly superior to the Vidroin C and the Filmagic ones. On the other hand, the actual study used the *Enterococcus faecalis* as a biomarker, which is largely used in studies to evaluate the sealing capacity post endodontic treatment [25].

Considering that the majority of the studies refer to previously filled teeth, in this study the proposal of verifying the best kind of cement for metallic cores underwent by the non-filling of the canal systems, in order to have a closer answer in relation to the real efficiency of the cements available in daily practice, in this sense, making this comparison harder due to the lack of similar studies.

The chosen cements for this experiment were the zinc phosphate cement, the glass ionomer cement, and a third group with resin cement.

The model utilized for this experiment was the one used by Valadares et al. [24]. The absence of clouding in the culture medium of the negative control group, and its presence in the samples of the positive control group proved it to be a trustful system, in which the information reproduced objectively the existence or the non-existence of clouding, being the *Enterococcus faecalis* chosen as the biomarker of this study. After the cementation of the cores in the samples with the cements mentioned above, their behaviour was evaluated during 60 days in the broth culture medium (BHI). Once the clouding occurs, the specimen was taken from the sample and registered in a spread sheet for post statistic studies, and according to it, there was no significant statistical difference among the 3 groups. If we evaluated 2 to 2, there was a difference between the phosphate cementation and the glass ionomer one, in which the second presented a more stable behaviour in relation to the first, however, comparing the groups phosphate/resin and ionomer/resin, it was not possible to assure that there was any change among the given cements; concluding that the cement with less leakage during the 60 days was the glass ionomer, the second one was the resin, and finally the zinc phosphate one.

Therefore, given the experimental conditions of the actual study, a given cement, which presents a better sealing quality of the pin fastening associated to a filling remain, probably will help to delay the leakage of toxins and microorganisms to the periapical area, and thus, probably increasing the level of success of the endodontic treatment.

In this sense, the professional must be constantly observant to the literature, since new studies appear to be advisable to attempt increasing the level of success of the dental treatment throughout time.

Conclusion

According to the consideration of the actual study, considering the given results:

a) No cement prevents totally the microleakage during the experimental period.
b) The zinc phosphate cement presented the smallest capacity of apical sealing.

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