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Effect of the action of diamond burs with high speed on the tensile strength of cores cemented with zinc phosphate at different preparation times

Efeito de pontas diamantadas com alta rotação na resistência à tração de núcleos cimentados com fosfato de zinco em diferentes tempos de preparação

Vanilde Rocha RODRIGUES[1]

ABSTRACT

Objective
To know the finishing effect, in order to be able to safely proceed with the cores preparation in the daily clinic, without compromising the prosthetic restoration longevity.

Methods
This study used 48 human single-rooted premolars, which after the section of its crowns, were endodontically treated, and its root canal prepared 8 mm deep to receive cores casting in cobalt-chrome alloy. Cementing was made with zinc phosphate and the tensile test performed at different preparation times: G1 - without re-preparation after cementation (control); G2 - re-prepared 24 hours after cementation, and G3 - re-prepared 15 minutes after cementation.

Results
Statistical analysis showed no significant difference in the tensile strength values in the different groups (p = 0.233), in other words, the core re-preparation 15 minutes or 24 hours after the cementation caused no significant reduction in tensile strength between the core and the root remaining when using the zinc phosphate cement.
Conclusion
The metallic core re-preparation cast 15 minutes or 24 hours after cementation caused no significant reduction in tensile strength between the cast metallic core and the root remaining, although in absolute values there was an important difference.

Indexing terms: *Cementing film. Core re-preparation. Post and core. Posts retention. Zinc phosphate cement.*

RESUMO

Objetivo
Saber o efeito desse acabamento, para que se possa prosseguir com a preparação desses núcleos na clínica diária de forma segura, sem comprometer a longevidade da restauração protética.

Métodos
Utilizou-se neste estudo, 48 pré-molares unirradiculares humanos, que após a secção de suas coroas, foram tratados endodonticamente, e seus condutos radiculares preparados com 8 mm de profundidade para receber núcleos fundidos em liga de cobalto-cromo. A cimentação foi feita com fosfato de zinco e o teste de tração realizado em diferentes tempos de preparação: G1- sem repreparo após a cimentação (controle); G2- repreparados 24 horas após a cimentação e G3- repreparados 15 minutos após a cimentação.

Resultados
A análise estatística revelou não haver diferença significativa nos valores de resistência à tração nos diferentes grupos (p = 0,233), ou seja, o repreparo do núcleo após 15 minutos ou 24 horas da cimentação não causou redução significativa na resistência à tração entre o núcleo e o remanescente radicular quando se empregou cimento de fosfato de zinco.

Conclusão
o repreparo do núcleo metálico fundido após 15 minutos ou 24 horas da cimentação não causou redução significativa na resistência à tração entre o núcleo metálico fundido e o remanescente radicular, embora em valores absolutos tenha havido uma diferença importante.

Termos de indexação: Película cimentante. Repreparo de núcleo. Pino e núcleo. Retenção de pinos. Cimento de fosfato de zinco.

INTRODUCTION

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Cast metallic cores have been used over the years as a means to reconstruct teeth with large coronary destruction, in cases where the remaining no longer offers structural strength to support the filling material, in order to make on them, prosthetic crowns.

Sometimes, there is a finishing requirement on the coronary portion of these cores once cemented, in order to correct their shape, improve the future crown insertion axis and promote a better esthetics. The cast metallic core positioning in the dental remaining without cementing makes its coronary portion finishing difficult, because the diamond burs action in high rotation tends to displace it. For this reason, some professionals do this finishing in the same session, after cementation.

In order to fix the cast metallic cores to the remaining root, a sealing cement is required, which increases its retention, and helps the sealing along the root canal and in the strength distribution between the retainer post and the canal[1].

Zinc phosphate is the pattern cement, used for the intraradicular posts fixation with great success for over 100 years, supported by numerous scientific papers. This does not show adhesion to the dental structure or to the post, but provides the retention by the mechanical imbrication in the roughness of the surfaces to be cemented[2].

According to Al-Ali et al.[3], there is a correlation between the vibration generated by the ultrasound machine in removing intraradicular retainers and the vibration generated by the high rotation instruments during the core preparation after cementation. Several authors claim that ultrasonic vibration decreases the retention of cores fixed with conventional cements[4-7].

The dentistry literature does not explain clearly the diamond burs effect in high rotation in cemented cast cores on the cementing agent. The purpose of this research, therefore, is to know this finishing effect, in order to be able to safely proceed with such cores preparation in the daily clinic, without compromising the prosthetic restoration longevity.

METHODS

The experimental units were 48 roots of human endodontically treated premolars and randomly divided into three groups (n = 16) to receive the cast metallic cores, which have been re-prepared 15 minutes or 24 hours after cementation with zinc phosphate, re-prepared or not. The response variable was the tensile strength measured in Kgf. Teeth crowns were sectioned under refrigeration, with a diamond bur No. 3203 (KG Sorensen) in high rotation, approximately 1 mm below the teeth cervical limits, in order to standardize the roots size in 13 mm. The endodontic treatment was performed by the side condensation technique, using gutta percha cones and accessories, and zinc oxide and eugenol-based cement. The gutta percha cones excesses were cut below the cervical level with heated tool, making the vertical condensation and sealing with heated pink wax for waterproofing the canal entrance. Roots were stored in 100% humidity environment in a plastic container with saline. Perpendicular grooves were made to the roots long axis before the inclusion in acrylic resin with carborundum disc in the labial and palatal sides, to increase retention, avoiding its displacement during the tensile test. Roots were included in PVC tubes with 20 mm height and 15 mm diameter in chemically activated acrylic resin. Roots were positioned in a pink wax plate and pressed until touching the bench. The PVC tube was positioned so that the root was centered, and acrylic resin was poured into its sandy phase. After the resin polymerization, the pink wax was removed, leaving the root included approximately 1 mm above the resin level, corresponding to the pink wax plate thickness. Canals were prepared with standardized diameter, using Largo No. 3 (Maillefer) drills, being approximately 1/3 of the mesial-distal distance at the root top, and while it was deepening it was getting thinner, achieving 1mm diameter in the most apical part, at a depth of 8 mm. During the root preparation, from 3 to 4mm of endodontic filling was left in the apical third[8], in order to avoid the gutta percha cone displacement. The patterns were modeled in Duralay® acrylic resin, by the direct technique. After the cores modeling, a handle was made with the wax fixed in its coronary portion, were the modified hook would enter, adapted to a screw and attached to the tensile machine. Resin patterns were included in the coating and then casted into cobalt-chrome alloy (Figure 1). After the cores casting, their adaptation was detected in the corresponding root remaining, using condensation silicone fluid, until a passive adaptation and a full layer to the root was obtained. Root canals were cleaned with a detergent solution to remove any material remnant that could interfere in the cementing, and all cores were treated with jets with aluminum hydroxide particles of 50 μm to increase its retention. Cementing was made with Zinc Phosphate (SSWhite Artigos Dentários Ltda., Rio de Janeiro, Brazil), according to the manufacturer's instructions. Before storage, the core/root interface was protected with cast pink wax No. 7, avoiding exposure to the liquid in which they were stored, because the high solubility soon after cementation is a feature of zinc phosphate[9-10]. The storage was done in a sodium chloride solution at 0.9% for 48 hours.

Division into groups

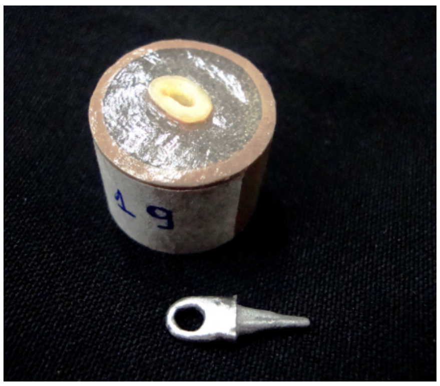

Figure 1. Casting cobalt-chrome alloy.

Group 1: cemented cores without re-preparation

Table 1. CPs were divided into 3 groups (n = 16)

Group	Cement	Time
G1	Zinc Phosphate	Control: cemented without re-preparation
G2	Zinc Phosphate	Cemented and re-prepared 24 hours after cementation
G3	Zinc Phosphate	Cemented and re-prepared 15 minutes after cementation

(control) - 3 minutes after cementing, the excesses were removed and the root/core interface protected with cast pin wax No. 7, and the specimens immersed in sodium chloride 0.9% solution for 48 hours. Group 2: cores cemented and re-prepared 24 hours after cementation, and the excesses were removed and stored as in Group 1, but for 24 hours. After this time, the re-preparation was done with diamond burs in high rotation (KG Sorensen No. 3216), using a new diamond bur for each re-reparation. Wearing for 2 minutes in the cervical region, close to the cementation line on all sides, simulating the cervical end preparation (Figure 2), and in the 2 final minutes, at the coronary core portion, simulating shape and inclination hits. Core/root interface was protected with melted pink wax and test specimens were stored for another 24 hours. After this time, the tensile test was performed. Group 3: metal casting cores cemented with zinc phosphate and prepared 15 minutes after cementation - 3 minutes after cementing, the excesses were removed and the re-preparation was performed as described for Group 2. Another 15 minutes rest was given, simulating the temporary restoration preparation time, for then performing the tensile test.

In order to position the test specimens in the

Figure 2. The cervical end preparation of metal casting cores.

testing machine, these were fixed in a base, and a hook was adapted with some modifications to a screw with chemically activated acrylic resin (Figure 3). This screw was positioned in the machine to enable the tensile tests of cast metallic cores, which had a handle on the coronary portion, where the modified hook was fitted. Tests were carried out on universal testing machine, at a speed of 0.05 mm/min with 2000 Kgf load cell. At the time there was a post displacement, the test was stopped and the displacement tensile value was registered in the software. Tensile strength values were obtained in Kgf. Data was submitted to statistical analysis.

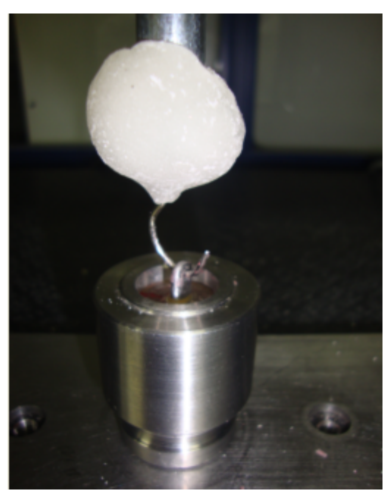

Figure 3. A hook adapted was positioned in the machine to enable the tensile tests of cast metallic cores.

RESULTS

The roots allocated in different groups did not differ among themselves regarding their vestibule-lingual dimensions (ANOVA: p = 0,287) and mesial-distal (ANOVA: p = 0.978), revealing that, prior to the experimental steps, when they were allocated in different groups, all experimental units were equivalent regarding the analyzed measures.

A specimen belonging to the group which cast metal cores were prepared 15 minutes after cementation with zinc phosphate became loose during the preparation. Therefore, in that group there were fifteen experimental units, while in the others, there were sixteen samples.

The ANOVA to a criterion revealed that there was no significant difference in the tensile strength values in different groups (p = 0.233), that is, within the conditions of this study, the cast metallic core preparation after 15 minutes or 24 hours has caused significant reduction in the tensile strength between the cast metallic core and root dentin when using zinc phosphate cement, as noticed in Table 2 and Figure 3. A reduction trend may be noticed, however, in tensile strength values compared to the control group in test specimens, in which the cast metallic preparation was performed 15 minutes after cementation with zinc phosphate.

Table 2. Mean values and standard deviation of the tensile strength values, in Kgf, of cast metallic core according to the achievement or not of its re-preparation after cementation.

Re-preparation	Mean	Standard deviation	Minimum value	Maximum value
Absent	5.88 A	4.33	1.52	18.48
24 hours*	5.20 A	2.20	2.40	10.13
15 minutes*	3.88 A	2.85	0.17	10.19

* After cementation of cast metal core with zinc phosphate.
Means followed by equal letters denote the absence of significant difference between the groups.

DISCUSSION

Studies have reported that the finishing procedures with handpieces and diamond burs in high speed produce vibration that can be compared to those produced by ultrasound devices. Through these mechanical waves, intense mechanical vibrations reach the cement layer between the metal post and the root canal wall, and may result in retention loss of cemented cores. Therefore, some authors recommend that the preparation is not performed immediately after the cementing of intraradicular retainers[3,7,11-12].

According to the records of Craig[10], Berbet et al.[4], Contin[12], Van Noort[13], Al-Ali et al.[11], Anusavice[2], and Soares et al.[7], the zinc phosphate cement is considered friable. It is recommended, therefore, to wait a while to start the nucleus re-preparation after cementation. The setting reaction of this cement, and also the time of its final setting, is not fully known yet. This setting time varies in the literature from 5 and 9 minutes. Even so, some authors have shown that at least 24 hours are required for this cement achieving its maximum strength. According to Van Noort[13] this cement achieves 50% of its strength in the first 10 minutes, gradually increasing, until reaching its final strength after 24 hours.

In results of the tensile tests performed in this study, no statistically significant differences have been found between the groups, which generally occur due to significant variability between the values found within each group. A reduction trend may be noticed, however, in the tensile strength absolute values regarding the control group in test specimens, in which the cast metallic core preparation was performed 15 minutes after cementation with zinc phosphate. This variability is common in studies testing the tensile strength of cast metallic core cemented with zinc

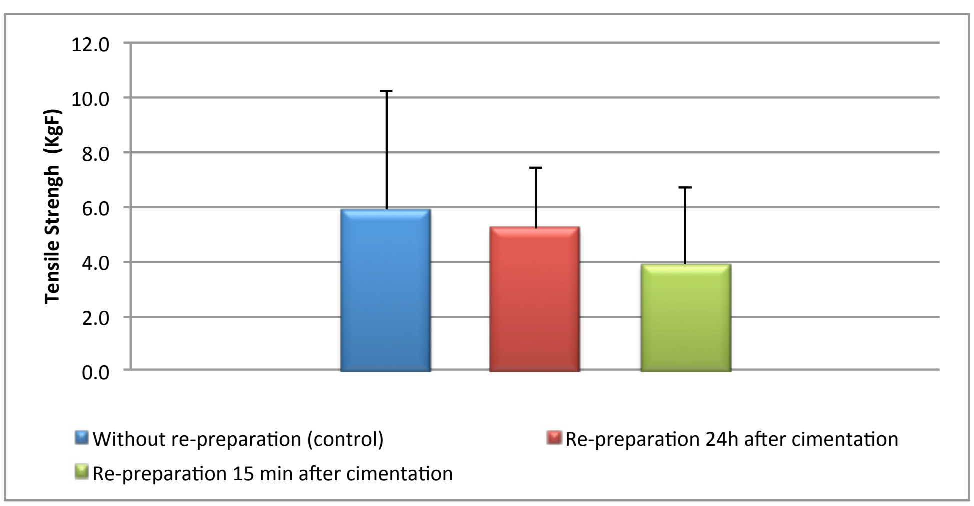

Figure 4. Mean values diagram of tensile strength values columns, in Kgf, of cast metallic core according to the achievement or not of its re-preparation after cementation.

phosphate cement. Small variations must be considered in some factors such as room temperature, cement time and handling speed, time spent to be taken to the canal and core, pressure from the operator hand at the preparation time, among others, may have interfered in the results, since the other conditions had been fully satisfied

Results similar to this study were found in the studies of Lund & Wilcox[14], Rocha et al.[15], Domingos et al.[16], Iglesias[17] and Oliveira et al.[18], concluding that the preparation time after cementation does not interfere with the retention of cores cemented with zinc phosphate cement.

It can be seen in some studies, that differences in the methodology employed may have led to results that showed that there was no negative effect on the re-prepared core retention soon after cementation. Domingos et al.[16] in his discussion, reports that different results would have been obtained if the group of re-prepared 10 minutes after cementing, tensile was made shortly after this re-preparation, in a time less than 24 hours. The author assumes that areas disrupted by the vibration generated by the preparation had time to recover, since the cement has not reached its maximum strength, and test specimens have been free of load, unlike what happens in the clinical situation. He also mentioned that, although there was no statistical difference between the groups, the vibration induced by the core preparation soon after retainer cementation seems to have a negative influence on its retention inside the canal, as elucidated by other researches.

Dissonant studies stated that there is a negative effect on the tensile strength of the cores prepared after cementation with zinc phosphate. Al-Ali et al.[11] found significant differences in the results between the tested groups, stating that there is a negative effect on the retention of cores prepared 15 minutes and 1 hour after cementation. Brito Júnior et al.[6], demonstrated the negative effect of diamond burs, when they found that the time for removing posts was quite reduced when wear was made in the cores with diamond burs in cementing line, prior to ultrasonic action, making its removal surprisingly fast, which had already been proved by Berbert et al.[4].

When using zinc phosphate cement on cast metallic cores regarding the waiting time for its re-preparation, one must be aware that, even if the core is not released when subjected to the diamond burs action, remaining in the position despite the imperceptible cracks in cementation line resulting from the re-preparation, it can be released at any time after the final crown cementation. And in case these are partial fix prostheses, due to being attached to other pillars, the retention loss in time is not noticed, but with the incidence of functional or non-functional loads generated over time, the already cracked cement film, can fully break, causing the core full rupture and, consequently, the crown or fixed prosthesis failure.

It should be considered that the first hours following the cementing constitute a critical stage, whatever the cement used, when the material strength must be examined.

In the case of zinc phosphate, it would be wise to wait a while after cementation, until the setting reaction is completed, and then use the diamond burs for the core preparation, thus avoiding damages to the cementing film and ensuring the prosthesis success[7,11-12].

CONCLUSION

It is important that the professional knows the particularities of each cement offered by the dental market and adopts the right procedure, waiting the time required for the material total setting, regardless of the material choice, avoiding problems in the daily clinical practice. In addition, we have a wide variety of fixing agents, not requiring that the professional uses a unique cement for all cases, enabling to select the technique and the material indicated for each clinical situation.

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