

Evaluation of the apical seal after intraradicular retainer removal with ultrasound or carbide bur

Avaliação do selamento apical após remoção de retentor intra-radicular com ultra-som ou instrumento cortante rotatório

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Abstract: There are situations in which intraradicular retainers have to be removed and replaced. The objective of this research was to evaluate the apical seal after the removal of a custom cast post and core with a carbide bur or with an ultrasound apparatus. Twenty five roots of extracted human incisors were used. They were endodontically treated and prepared to receive the posts. The posts and cores were cast with 2 types of dental alloys, CuAlZn and PdAg, and were cemented with zinc phosphate cement. After 24 hours, they were removed using the two above mentioned techniques. Then, the roots had their external surface made impermeable by two layers of cyanoacrylate adhesive, leaving only the cervical area for dye penetration. The teeth were immersed in rhodamine for 24 hours. They were then cut and observed under an optical microscope and analyzed with appropriate software (Imagelab). The results were submitted to ANOVA, and they evidenced that, regarding the alloy factor, PdAg posts presented a larger mean infiltration value (2.23 ± 0.48 mm) as compared to the posts made of CuAlZn (1.39 ± 0.48 mm) ($p = 0.025$). Regarding the technique factor, there was no significant difference ($p = 0.9$) between the removal of the intraradicular retainer using ultrasound (1.99 ± 0.62 mm) or using a rotating cutting instrument (1.62 ± 0.62 mm). Under these experimental conditions, it was possible to conclude that the degree of apical leakage was directly related to the alloy type, and it was present in both techniques used.

Descriptors: Dental leakage; Post and core technique; Dental alloys; Dental instruments; Ultrasonics.

Resumo: Há situações que exigem a remoção ou substituição de retentores intra-radiculares. O objetivo deste trabalho foi avaliar o selamento apical do material obturador após a remoção de pino intra-radicular metálico fundido com instrumento cortante rotatório ou com aparelho de ultra-som. Utilizaram-se 25 raízes de incisivos humanos extraídos, que foram endodonticamente tratadas e preparadas para receberem os pinos. Os retentores intra-radiculares foram fundidos com 2 tipos de ligas odontológicas, CuAlZn e PdAg, e foram cimentados com cimento de fosfato de zinco. Após 24 horas, foram removidos com as 2 técnicas citadas. Em seguida, os dentes foram impermeabilizados com cianoacrilato de etila, permitindo a entrada do corante apenas por via cervical. Os dentes foram imersos em rodamina por 24 horas, depois foram clivados e observados em microscópio óptico de luz e analisados em “software” próprio (Imagelab). Os resultados foram submetidos à análise de variância e mostraram que, para o fator liga, os pinos de PdAg geraram uma média de infiltração maior ($2,23 \pm 0,48$ mm) do que os pinos de CuAlZn ($1,39 \pm 0,48$ mm), com $p = 0,025$; para o fator técnica, não houve diferença significativa, com $p = 0,9$, entre a remoção com ultra-som ($1,99 \pm 0,62$ mm) e a remoção com instrumento cortante rotatório ($1,62 \pm 0,62$ mm). Nestas condições experimentais, foi possível concluir que o grau de infiltração apical está relacionado com o tipo de liga, e a infiltração esteve presente em ambas as técnicas utilizadas.

Descritores: Infiltração dentária; Técnica para retentor intra-radicular; Ligas dentárias; Instrumentos odontológicos; Ultra-som.

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Introduction

One of the objectives of endodontic treatment is to obtain an adequate root seal, to avoid communication between the external environment and the lateral and apical periodontal tissues, creating favorable conditions for repair. Several researches have evaluated this aspect, comparing the materials and methods for root sealing.^{7,14,17}

The apical seal obtained after endodontic therapy can be disturbed during preparation of the dowel space and cementation of an intraradicular retainer. Leakage after dental preparation can be compensated for by cementation of an intraradicular retainer, according to Wu *et al.*²³ (1998). On the other hand, Usumez *et al.*²¹ (2004) assessed microleakage in endodontically treated teeth with different dowel systems and concluded that some systems should be further evaluated because of their unacceptable level of leakage.

There are situations in which the intraradicular retainer needs to be removed and replaced due to incorrect prosthetic procedures, resulting in marginal infiltration, or because of inadequate planning.

Removal of the intraradicular retainer is a delicate procedure and it should be done carefully to avoid such problems as root fracture or perforations. The most commonly employed techniques are the use of rotating cutting instruments;⁹ the application of traction forces to the retainer with devices like bag-posts;¹⁹ trepan burrs;²² and the small giant.² These methods produce excessive stress on the dental structure as a result of the use of strong forces, making the retainer removal a risky procedure in some situations.¹³ Nowadays, many researches have been focusing on the ultrasound technique for the removal of intraradicular posts.^{1,3,8,10}

Frequently, there are cases in which the endodontic treatment is considered acceptable based on an X-ray exam presenting no periapical lesion. The question is whether it would be necessary to perform endodontic treatment again, after post removal.

The hypothesis is that the heat generated by the removal of the intra-radicular retainer by means of a bur could compromise the apical seal, and the vibration added to the heat produced by ultrasound could worsen the damage. There were no studies in

literature focusing on this aspect. Hence, the aim of the present study was to determine the direct relationship between the use of two techniques of intraradicular retainer removal, bur or ultrasound, and their effects on the apical seal of endodontically treated teeth.

Material and Methods

Samples were distributed in 5 groups:

1. control: root filling, preparation for intraradicular retainer, and sealing of the apical ends of the roots by means of two layers of cyanoacrylate adhesive;
2. intraradicular retainer (Goldent) removed with carbide burs;
3. intraradicular retainer (Goldent) removed with ultrasound;
4. intraradicular retainer (Pors-on 4) removed with carbide burs;
5. intraradicular retainer (Pors-on 4) removed with ultrasound.

Twenty five human superior central incisors were selected from the teeth bank of the School of Dentistry, University of São Paulo (FOUSP). After being cleaned, the teeth were submersed in physiological solution (0.9% NaCl) during 72 hours to hydrate.

A coronal section of the teeth was removed using a carborundum compound disk under water irrigation, thus producing a root of 15 mm in length.

The samples were cleaned and shaped up to file size 50 at the apex with 0.5% sodium hypochlorite irrigation, K files (Dentsply, Petrópolis, RJ, Brazil) and endo-PTC (Polidental, São Paulo, SP, Brazil). The canals were dried with paper points and sealed with gutta-percha points and N-rickert cement (Biodinâmica, Ibiporã, Paraná, Brazil).¹⁶

The canals were prepared with a Gates-Glidden drill (Maillefer, Ballaigues, Switzerland) and a #3 Peeso drill (Maillefer, Ballaigues, Switzerland) to receive a post of 10 mm in height. The final preparation was executed with a drill (#302302, Edenta, Hauptstrasse, Switzerland). Cotton pellets were placed inside the root preparations and the teeth were closed with Cimpat® (Septodont, São Paulo, SP, Brazil), a temporary filling. The specimens were stored under 100% humidity and at 37°C, during 10 days.

The root preparations were washed with a 0.5% sodium hypochlorite solution, dried with paper points and isolated with solid Vaseline. The intraradicular retainers were cast in a CuAlZn alloy (Goldent, L.A., AJE, São Paulo, SP, Brazil) or in a PdAg alloy (Pors-on 4, Degussa, Hanau, Germany). The teeth were washed and dried again. The cast posts were adapted and cemented with zinc phosphate cement (S.S.White, Rio de Janeiro, RJ, Brazil).

The samples were stored at a temperature of 37°C under 100% humidity for 24 hours.

The posts were removed using 2 methods:

- a. posts cut with a carbide bur (#329, JET, Wheeling, IL, USA) and high speed rotation;⁴
- b. cement around the posts removed with tips connected to an ultrasound device (ENAC ultrasonic unit, Osada Electric Co., Tokyo, Japan)*.

Both of them used water refrigeration. Every tooth had their external surface made impermeable by two layers of cyanoacrylate adhesive (Super Bonding – Loctite Brasil Ltda., São Paulo, SP, Brazil).

The teeth were submerged in a rhodamine solution for 24 hours. They were washed and longitudinally cut. Leakage was observed under an optical microscope and analyzed with appropriate software (Imagelab, Softium, São Paulo, SP, Brazil).

Variance analysis including principal factors (alloy *versus* technique) was performed to evaluate differences between the material of the retainer and the removal technique.

Results

Table 1 shows leakage means and variance data for the experimental and control groups. Disagreement between the variance data for groups 1 and 2 can be observed as compared to groups 3, 4 and 5. Group 1 presented the lowest leakage mean, followed by groups 2, 4, 3 and 5.

Variance analysis including principal factors (alloy *versus* technique) showed that there was no statistical significance ($p = 0.535$) between the material of the retainer and the removal technique. After

Table 1 - Descriptive analysis of leakage in the experimental and control groups (mm).

Groups		n	Mean	Standard Deviation	Standard Error
Control	1	5	0.97	0.05	0.03
Carbide bur	2 CuAlZn	5	1.14	0.09	0.04
Carbide bur	3 PdAg	5	2.11	0.54	0.24
Ultrasound	4 CuAlZn	5	1.64	0.61	0.27
Ultrasound	5 PdAg	5	2.34	0.45	0.20

Table 2 - Mean leakage (mm) according to alloy and removal technique**.

Factors	Groups	N	Mean#	Standard Deviation	Standard Error
Alloy	CuAlZn	10	1.39 a	0.49	0.15
	PdAg	10	2.23 b	0.48	0.15
	control	5	0.9 a	0.05	0.03
Technique	Carbide bur	10	1.62 c	0.62	0.20
	Ultrasound	10	1.99 c	0.61	0.20
	Control	5	0.97 d	0.05	0.03

**Multiple comparisons with Bonferroni's correction ($p = 0.05$). #Different letters indicate significant difference.

the interaction factor was excluded, the alloy factor was significant in the results ($p = 0.001$). PdAg post removal caused higher mean leakage values as compared to those of CuAlZn post removal. The technique factor showed no significant difference ($p = 0.9$) between the use of ultrasound and the use of a carbide bur in the post removal process. Therefore, the Two-Sample *t*-Test was performed by the MINITAB software, release 13.0 (Minitab Statistical Software, Minitab Inc., State College, Pennsylvania, USA).

Table 2 presents a comparative analysis of the mean values for the principal factors *versus* the control group. This analysis showed that, regarding the alloy factor ($p = 0.025$), PdAg post removal caused higher leakage values as compared to those of the control group. Regarding the technique factor, both

* Campos TN, Yamamoto E, Araki AT, Takahashi CU, Veiga JAL, Contin I. Temperature evaluation during the cast post removal with ultrasonic vibration. Rev Odontol UNICID. *In press* 2006.

techniques increased leakage as compared to the control group ($p = 0.025$).

Discussion

The apical seal of an endodontically treated tooth is an important factor for a successful restorative treatment. Concern with apical sealing has been the object of many researches investigating techniques and materials of endodontic filling, as well as the possibility of apical contamination during root preparation and with the use of a temporary restoration.

Coronal leakage is the main cause of failure of endodontic treatment.¹⁸ This leakage can progress and extend itself along the intraradicular post.²⁰ The following are other reasons that may lead to the removal of an intraradicular retainer: presence of caries, inadequate design of the post (length and diameter) in relation to the dimensions of the canal, poor retention of the post or the core, badly executed endodontic treatments, among others. The latter requires that an adequate filling be redone.

However, when the endodontic treatment is considered clinically and radiographically acceptable, what should be the next step after removal of the intraradicular retainer?

Removal of the intraradicular retainer is a procedure that requires care, since it can cause perforations, cracks or root fractures. This procedure generates heat and vibration that can disturb the apical seal without changing the radiographic image.

The results of the present research showed that statistically significant leakage occurred in all of the experimental groups. Comparisons between the experimental groups and the control group were made to discard leakage due to procedures made before cementation and removal of the intraradicular retainers. According to Table 1, there was higher leakage in Group 5 (PdAg-ultrasound), followed by Group 3 (PdAg-carbide bur), Group 4 (CuAlZn-ultrasound) and Group 2 (CuAlZn-carbide bur) consecutively.

In a previous research, removal of a CuAlZn intraradicular retainer with burs produced higher

temperatures than those produced by the removal of a PdAg one. The pressure on the handpiece was not standardized because the objective was to reproduce a clinical situation. The pressure developed was related to the hardness of the material. Cutting was intermittent but, because the CuAlZn alloy was softer, an extended length of the working time and more heat were produced. The PdAg alloy was more resistant to wear and required more pressure, so it was expected to generate higher temperatures than CuAlZn. However, the hardness made controlling of the handpiece more difficult and caused more dental wear, thus enlarging the canal and making refrigeration easier.⁴

In another study, removal of the same alloys following the same method and with an ultrasound device generated a significant amount of heat, and the PdAg alloy showed much higher temperature values.*

The results of the previously mentioned articles did not present high temperatures on the internal surface of the canal maybe because the authors measured it on the external surface of the teeth, and because of refrigeration. It is to be supposed that the apical seal was disturbed mainly by vibration.

Ultrasound fractures the cement in the coronal area, leading to a migration of the fulcrum to the apical portion of the post. Ultrasonic vibration starts the moving of the post and generates stresses in the apical area, consequently moving the retainer.⁶

In the present research, two different alloys were selected with visibly different characteristics, mainly in relation to their hardness. Materials with higher hardness tend to conduct vibration better. Soft alloys do not conduct ultrasound adequately.^{12,13} The dowel material thus influences ultrasound action.¹⁵ Our results fortify these assertions as we observed higher leakage values with the harder alloy (PdAg) and with ultrasound.

Cardoso *et al.*⁵ (1995) stated that a root filling of at least 4 mm is necessary because, in their experiment, the post space preparations previously showed

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a maximum leakage value of 3.23 mm.

In the present research, the external surface of the root was isolated to evaluate the influence of post removal on the apical seal. Leakage was measured in the cervico-apical direction, and the maximum leakage mean value was 2.34 mm. Besides, an inverse leakage may be observed, as described by Habitate *et al.*¹¹ (1989) who obtained smaller leakage values with the apical preparation technique, varying from 0.83 to 1.85 mm.

Therefore, from a clinical standpoint, in relation to the removal of radicular posts, and based on the results obtained here, endodontic re-intervention is recommended especially when there is a root filling of less than or equal to 4 mm. It must also be considered that, in most cases, the replaced posts had been in place for some time, and the age of the root filling is an important factor in terms of quality of the apical seal.

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Conclusions

Based on the method used, it can be concluded that removal of the posts increased leakage through the apical seal both by means of the carbide burs and by means of ultrasound.

The degree of leakage was dependent on the type of alloy and on the removal technique, thus being directly related to the difficulty involved at the time of removal.

As a clinical guideline, it is suggested that endodontic intervention should be repeated mainly in situations of difficult access.

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