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The modern endodontic therapy

With the avalanche of new concepts, techniques and materials, the modern endodontic therapy — increasingly modern — suggests a single path to be followed so that one can achieve bigger recognition and distinction in the dental field: Professional updating. To be considered competent, a professional must have both scientific knowledge and technical skills; but it is not enough to give attention to the disease only, it is necessary to understand the patient as a whole. A dignified Endodontics practice involves taking positions and attitudes.

This professional updating occurs by reading periodicals, which aims at preserving science history, pointing results of scientific research and disseminating innovative materials and techniques to allow its clinical applicability. However, certain demands force the authors to publish quality papers in international journals, a fact contested by professionals, considering that the disseminators of knowledge must also have credibility in national periodicals, benefiting the endodontic class. In Brazilian Endodontics, this vehicle is the Dental Press Endodontics journal, which aims to be the responsible for knowledge transfer. Given the difficulties of publishing abroad, it is necessary that our researchers focus on the internal market and direct many of their studies to here, since it is the Brazilian endodontic professionals that subscribe to this dissemination vehicle and this is their demand.

The other way of being updated is to take part in events specific to the Endodontics area. Among these, the NATIONAL CIRCUIT OF ENDODONTICS aims to discuss current issues, important to the clinical practice of Endodontics, with renowned professors. In 2013, in its 5th edition, the event will be in Curitiba/PR - Brazil, from 25th to 27th of April. Seeking for clinical solutions, “The reason why I changed the technique” promises to show that the best option not always is the one proposed by the manufacturer. “Treatment of endodontic infection” with Profs. Helio Pereira Lopes and José Siqueira Jr. will be the main attraction. But “Why failures happen and how to solve them” promises a great debate in the search for solutions and on the various factors involved. We have no doubt that we will witness and take part in important moments for our professional growth. In today’s world, the scientific improvement is more than a fad, it is a must for professional’s survival.

Done. Now you have in your hands the two most important vehicles for your updating. Your patient deserves it!!

Gilson Blitzkow Sydney
Editor-in-chief

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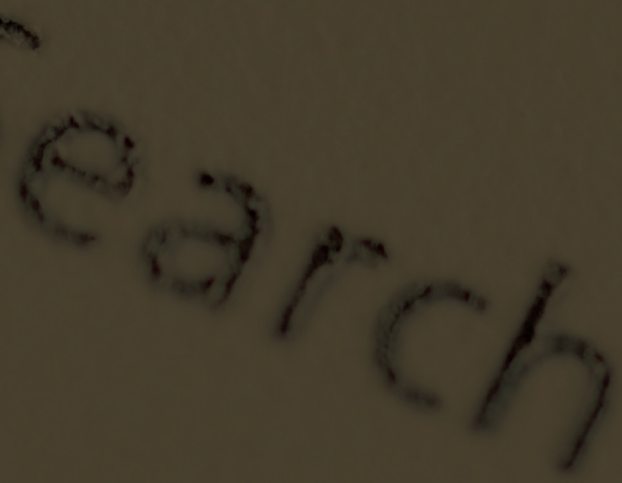
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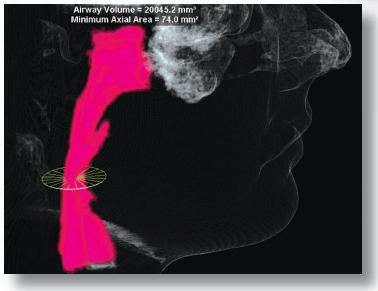
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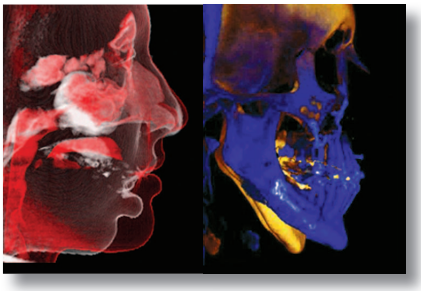
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The waiting time for inducing orthodontic movement after endodontic treatment, even with perforations

Alberto **CONSOLARO**[1]

ABTRACT

The delay period required to start orthodontic movement after endodontic therapy has always raised many questions. This study aimed to reduce these questions, add some considerations into these discussions and suggest a delay period that agrees with the periodontal tissues biology. When the main goals of endodontic treatment are reached, regardless if the tooth presents pulp vitality, pulp necrosis, chronic root lesions or root perforations; 30 days after endodontic treatment, the periodontal tissue is in final repair stages, reorganizing the tissue to restore its physiology and anatomy, even though this process does not occur in such manner, since mineralization is incipient. Orthodontic forces should not biologically interfere with tissue repair, with the pathogenic and virulent microbes involved in pulp necrosis, with chronic periapical lesions and with perforated roots due to endodontic treatment.

Keywords: Endodontics-Orthodontics. Orthodontic movement. Periapical repair. Endodontic repair.

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Introduction

In discussions and planning of clinical cases, several questions arise and the literature does not provide precise answers or well-defined guidelines. It may be the lack of experimental data to substantiate stronger assumptions, or the lack of reports of a large sample with a standardized protocol.

While these two circumstances are not resolved, our conduits and protocols must be based on clinical experience and knowledge acquired by the similarity of biologically correlated scenarios.[1,2] Another way to define guidelines in the absence of experimental data and large sample reports is by applying the basic knowledge of general principles[1,2] to a specific situation.

To understand what would be the delay period required to move a tooth that has been endodontically treated — regardless of pulp vitality, pulp necrosis, perforation or chronic periapical lesions — it is necessary to review how the periodontal healing occurs.

The periodontal repair of the lateral root surface in teeth with pulp vitality

Like other tissues, the periodontal ligament remodeling happens by the mechanism of tissue repair, which can be have smaller or greater extent depending on the damage. The granulation tissue, after filling in the injured area, differentiates into mature connective tissue, restoring its previous anatomy and physiology.

This occurs when:

1. A periodontal surgery on a lateral root surface with no involvement of the gingival or pulpal tissues, and scaling of the root are performed.
2. An orthodontic mini-implant have pierced or slipped onto the root surface, thus forming a blood clot, which will fill the injured wall with a fibrin net, which will bond platelets and inflammatory cells.

The platelets and macrophages in the clot are the main sources of mediators that stimulate adjacent cells to proliferate. Simultaneously:

a. The adjacent endothelial cells form buds and form new blood vessels, which infiltrate the blood clot in a similar to a blood supply network manner.
b. The surrounding bone cells, as young osteoblasts and osteoblast forming cells, proliferate and migrate to infiltrate the clot.
c. The cementoblasts and cementoblast forming cells, differentiate and migrate toward the center of the uncovered root surface.
d. Epithelial cells rests of Malassez proliferate and form new filaments and islets at the area.

Three to four days into maturation, the blood clot was been replaced by granulation tissue rich in blood vessels, young differentiated cells and extracellular matrix. The osteoblasts deposit alveolar bone, the fibroblasts release organized collagen fibers and the peptidoglycans matrix of the periodontal ligament, and the cementoblasts restore the cells layers of the uncovered portion of the root, depositing new cementum layers to attach the new periodontal fibers being produced.

In one to two weeks, depending on the size of the lesion, the full restoration of periodontal tissues happens and the tissue has regained its physiologic functions. In most cases, radiographic images of the repair cannot yet be obtained, because the level of mineralization may not be sufficient at this point.

During the period when the tooth root becomes exposed to the blood clot and granulation tissue, some clasts migrate and settle to reabsorb the cementum and/or dentin surface. Once the cell migration and differentiation happens in the granulation tissue, the pH returns to normal and the area is no longer an acid environment, such as in acute inflammation. In normal or basic pH, these clasts demobilize and migrate from the area, leaving the binding protein surfaces, which stimulate the migration and synthesis of new cementoblastic cells.[1,2]

Following the complete periodontal repair of the resorption area, especially by a tomographic and microscopic standpoint, one can observe small contour defects on the root surface and the periodontal space, which does not affect the physiology of the area.

The periodontal repair of the root surface at the apical foramen region after endodontic therapy

The following factors should be considered in the proposed situation:

» Endodontic treatment was performed after a bio pulpectomy, or
» Pulp necrosis with root canal contamination, but controlled infection and no evident lesion, or

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» Existing chronic periapical lesions and controlled or eliminated infection by root canal therapy and / or medication, or
» The majority of canals adequately treated develop to cure. In some cases, the repair happens in approximately 90% of endodontically treated cases, even with chronic periapical lesions associated.

If the infection was controlled and the endodontic technique was properly performed, with no chemical irritation or periapical residues, the apical periodontal tissues tend to respond through the same process described on the topic above, where there wasn't an apical foramen.

However, some filling materials do not allow for cementoblast colonization on its surface, due to their toxicity and/or physicochemical characteristics. In such cases, macrophages and multinucleated giant cells will accumulate on their surface, which will try to slowly phagocyte these materials indefinitely. This macrophage accumulation around the filling material in the apical region is called a foreign body granuloma, and it is restricted to that specific area of the surface, allowing the repair to continue normally at the adjacent areas.

Some dental materials, however, such as those with a calcium hydroxide and MTA base, allow the cementoblasts to colonize their finely coagulated proteins coated surface due to their basic pH. In this scenario, the cementoblastic layer deposits cementum with different organization levels, allowing the reinsertion of the periodontal collagen fibers. A few weeks later it is possible to microscopically observe a mineralized barrier of cementum "sealing" or covering what was once the opening of the apical foramen. The cementum is often cellularized, rich in blood vessels canals, and irregularly deposited. In such cases, it is commonly called osteocementum, cementoid or neocementum, and its primary functions are to line the dentin surface and to serve as attachment to the periodontal collagen fibers.

The periodontal repair of the root surface after root canal perforation

When there is a root canal perforation, we can biologically compare it with an apical foramen.

In those cases, there are some questions that must be answered, such as the following.



1. Is the structure (dentin, cementum and periodontal ligament) in the perforated area contaminated?
2. Has the removal of foreign bodies, tissue micro fragments and materials been performed?
3. Was the decontamination of the entire area performed by appropriate therapeutic techniques?
4. Has calcium hydroxide or MTA been used?
5. Has no communication with the outer surface, especially in the furcation region, been achieved?

If the answers to those questions are positive, the clinician may think; "I did my best and in 2 to 4 weeks the region will be fully repaired". The periodontal ligament will behave as it does in the apical foramen area, after canal obturation and after eliminating the infection causes, as we described in the previous section.

The timeline of periodontal repair after endodontic therapy and the orthodontic movement

The granulation tissue develops into mature connective tissue very quickly in small areas. One month after the repair process is established is a long time considering the dimensions of these structures. During this period, the activity in the area is limited to tissue synthesis and reorganization, provided that the infection causes, foreign bodies and necrotic tissues are eliminated or controlled.[1,2]

The forces of the orthodontic movement do not compare to those of a dental trauma or to occlusal trauma forces. They are much lighter, gently applied

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and distributed. For that reason, professionals can smoothly move a tooth 30 days after a proper executed endodontic treatment. It is not necessary to wait until the bone and periodontal repair are visually noticeable, as it was previously suggested.

The orthodontic forces do not have influence on microbial colonies or on the repair process, because they are slow and light forces.[1] If chronic periapical lesion or a perforation does not repair, one should not attribute the failure to the forces applied. The cause of the failure should be considered periodontal or endodontic, not orthodontic. In fact, orthodontic treatment could be initiated directly after endodontic therapy, but it is always wise to wait for a month period to assure that the repairing process occurs and is in its final maturation stage.

In clinical endodontic practices, everyone recognizes that the failure rate in the treatment of teeth with chronic periapical lesions is higher than in other scenarios. This occurs:

1) Due to the greater likelihood that microbial biofilms are located in the external apical surfaces, where the access is more difficult to mechanical decontamination and endodontic medication.
2) Due to the presence of frequent external apical resorption, which increases the inaccessibility of instruments and drugs to the microbial biofilm.

In cases of teeth with chronic periapical lesions that were treated endodontically and also orthodontically moved, failures must be attributed to endodontic and morphological factors, and not the fact that the teeth were subjected to light and dissipating orthodontic forces.

There is a very important factor should be emphasized: when a tooth is moved, a lateral root dentin-cementum resorption may occur, including in areas of repaired perforations. In this process, there may be a rearrangement in the region or even a reactivation of the inflammatory process, due to the exposure of hidden bacteria and/or their products by this lateral resorption. In general, after the movement is ceased, this condition goes back to normal, because the required sealing reoccurs. In rare cases, in which this may happen without a subsequent repair, even after the orthodontic movement has ceased, one should repeat the endodontic treatment. Although it rarely happens, the patient should be warned of this possibility.

Final consideration

When the main goals of endodontic treatment are reached:

1) Control and elimination of infectious agents.
2) Absence of foreign bodies.
3) No chemical irritation of the area by used dental materials.

Regardless if the tooth presents pulp vitality, pulp necrosis, chronic root lesions or root perforations; 30 days after endodontic treatment, the periodontal tissue is in final repair stages, reorganizing the tissue to restore its physiology and anatomy, even though this process does not occur in such manner, since mineralization is incipient.

The orthodontic forces are very light and dissipating, and incomparably smaller and different from those found in dental trauma and occlusal trauma. Orthodontic forces should not biologically interfere with tissue repair, with the pathogenic and virulent microbes involved in pulp necrosis, with chronic periapical lesions and with perforated roots due to endodontic treatment.

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Effectiveness of 2% chlorhexidine gel compared to two solvents commonly used in endodontic retreatment

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ABSTRACT

Objective: The present study has compared the action of 2% chlorhexidine gel to two solvents commonly used in endodontic retreatment, xylol and eucalyptol, regarding the cleaning of the root canal walls. **Methods:** Forty-five human single-rooted teeth were randomly divided into three groups. The teeth were instrumented, filled and radiographed before being stored in an oven at 37°C for 60 days. The filling material was removed from root canals according to the following techniques: Kerr and Hedströem files with xylol (G1), eucalyptol (G2), and 2% chlorhexidine gel (G3). After removing the filling material, the teeth were radiographed in ortho- and mesio-radial directions. The radiographs were analyzed by three double-blinded examiners for the presence of remaining filling material. Next, the teeth were longitudinally fractured and the resulting faces were digitally scanned. The Image Tool software was used to assess the amount of remaining filling material, and data were statistically analyzed. **Results:** With regard to the radiographic analysis, no statistically significant differences were observed between the groups studied (i.e. chlorhexidine, xylol and eucalyptol). However, when digitalized images were analyzed, xylol was found to be significantly more efficient for cleaning the root canals compared to 2% chlorhexidine gel. **Conclusion:** It can be stated that xylol was the most effective solution for removal of filing material compared to 2% chlorhexidine gel and eucalyptol.

Keywords: Retreatment. Chlorhexidine. Solvents. Root canal preparation.

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Introduction

Removal of filling material and cleaning of root canals are considered important procedures for a successful endodontic retreatment.[1,2] In order to remove the filling material from the root canals, different techniques have been proposed by the literature. These techniques include the use of rotary or manual instruments in association or not with solvents.[3]

Different solvents have been proposed for aiding in the removal of filling material from root canals, among them one can cite chloroform, eucalyptol and xylol.[3,4] Although effective, most endodontists do not use solvents because of the toxic action of such substances on periapical tissues.[5,6]

According to Oliveira,[7] chlorhexidine gel can be an alternative to the use of solvents. In fact, this substance has low toxicity[8] and allows the root canal walls to be mechanically cleaned due to its viscosity, thus compensating the action of solvents.[8] In addition, chlorhexidine has a wide-spectrum antibacterial activity.[9,10,11] According to Gomes et al,[10] 2% chlorhexidine gel has shown to be highly effective against Enterococcus faecalis, which is a relevant fact as Sundqvist et al,[12] Molander et al[13] and Pinheiro et al[14] reported that this microorganism is associated with cases of endodontic failure.

The objective of the present study was to compare the action of 2% chlorhexidine gel to two solvents largely used in endodontic retreatment, xylol and eucalyptol, regarding the cleaning of the root canal walls.

Material and Methods

The Human Research Ethics Committee of the Federal University of Pelotas, Dentistry School (process number 012/2006) has approved this study. A total of 45 human single-rooted teeth (incisors and canines) with complete apices were used for study, all being stored in saline solution (Basa – Indústria Farmacêutica Basa Ltda, Caxias do Sul, RS, Brazil) and kept at constant temperature of 37°C in an oven. By using a digital calliper, the roots had their length standardised to 15 mm. Double-faced diamond discs (KG Sorensen, São Paulo, SP, Brazil) mounted on a micro-motor and straight handpiece (Kavo Extra –Torque 605C, Brazil) were used for this standardization.

The foramens were standardised by using a Flexofile #15 file (Dentsply Maillefer, Petrópolis, RJ, Brazil) and the working length was set at 1 mm short of the apex.

The root canals were instrumented according to the step-back technique, which consisted in preparing the coronal third with Gates-Glidden burs #2 and #3 (Dentsply Maillefer, Petrópolis, RJ, Brazil). For apical preparation, the apical stop was standardised to calliper #35 and step back performed in 1 mm increments until #55 file. During instrumentation, the root canals were irrigated with 2.5% sodium hypochlorite solution (Vida Nova Farmácias de Manipulação). After instrumentation, EDTA (Iodontosul Indústria Odontológica do Sul) was used for 3 minutes for removal of the smear layer and then a final irrigation with saline solution was applied.

Root canals were dried with paper tips (Endopoints) and filled according to the lateral condensation technique by using gutta-percha cones and Endofill sealer (Dentsply). The teeth were radiographed in the mesial-distal and buccal-lingual orientations for analysis of the quality of the obturation.

Next, the root canal entry was temporarily restored with intermediate restorative material (Dentsply) and the teeth were stored in an oven at 37°C during 60 days to allow the sealer to set.

After 60 days, the restorative material was removed, including a coronal 5 mm of filling material (gutta-percha + sealer) by using Gates-Glidden burs #2 and #3 in order create a reservoir for the auxiliary chemical agent being used.

The teeth were divided into 3 groups (n = 15) depending on the auxiliary chemical agent used during the preparation:

- Group 1: Manual instrumentation with #15 to #45 K-files (Dentsply Maillefer) followed by #15 to #45 Hedströem files (Dentsply Maillefer) in association with the use of 0.5 mL of 2% chlorhexidine gel at each instrumentation and abundant irrigation with 3 ml of saline solution (Basa).
- Group 2: Manual instrumentation with #15 to #45 K-files (Dentsply Maillefer,) in association with #15 to #45 Hedströem files (Dentsply Maillefer), adding 0.5 mL of xylol (Merck at each instrumentation and final irrigation with 3 ml of saline solution (Basa).
- Group 3: Manual instrumentation with #15 to #45 K-files (Dentsply Maillefer) in association with #15 to #45 Hedströem files (Dentsply Maillefer), adding 0.5 mL of eucalyptol (Biodinâmica) at each instrumentation and final irrigation with 3 ml of saline solution (Basa).

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The maximum time for removing the filling material from each root canal was defined in 30 minutes. Removal of the filling material was considered complete when remnants of gutta-percha or filling material recovering the instruments were no longer observed, with these criteria already being proposed by Hulsmann, Stotz[15] and Imura et al.[16]

After removing the filling material, the teeth were radiographed (Spectro 70X-Dabi-Atlante) at a focal distance of 200 mm with an X-ray unit operating at 70 KVp, 8mA, and exposure time of 0.5 seconds. The radiographs taken were in the mesial-distal and buccal-lingual directions.

The radiographs were evaluated by three double-blinded examiners for the presence of remnants of gutta-percha, attributing scores described by Ferreira et al[17] (Table 1) for the different thirds (coronal, middle and apical) regarding the amount of radiopaque debris.

After the radiographic analysis, the teeth were longitudinally sectioned in the buccal-lingual direction by using double-faced diamond discs (KG Sorensen) and surgery chisel (Neumar). Image of the segments were taken in pairs (semi-parts) by digitalizing the image with a scanner device HP Deskjet F300 All-In-One Series (HP-Brasil) operating at a 1200 dpi resolution and presence of a stainless steel ruler for image standardization. Next, the software Image Tool was used to analyze the images and helped calculate the sum of all areas (regions) where remnants of the filling material were present. For this analysis, the measurements were in mm^2.

Kruskall-Wallis' test was used ($p < 0.05$) for statistical analysis of the amount of radiopaque debris (radiographic analysis of the scores), whereas ANOVA ($p < 0.05$) and Tukey's tests ($p < 0.05$) were used to analyze the sum of the areas containing remnants of filling material.

Results

With regard to the radiographic analysis of the scores, no statistically significant difference was observed between the three groups studied, that is, chlorhexidine, xylol, and eucalyptol (Table 2). However, when the total area of remaining filling material was assessed with the Image Tools software, one could observe a statistically significant difference between the chlorhexidine and xylol groups, with the latter being more efficient than 2% chlorhexidine gel for cleaning the root canals. No statistically significant difference was found regarding the use of eucalyptol and 2% chlorhexidine gel.

With regard to the analysis of the thirds, Figure 1 shows the scores obtained from each of them. It was observed a higher degree of cleaning efficiency in the coronal third, followed by middle and apical thirds.

Discussion

According to Wilcox and Swift,[18] a successful endodontic retreatment is strongly associated with the cleaning of the root canal walls. The present study has evaluated the root canal cleaning with different substances by means of radiographic analysis and digital imaging.

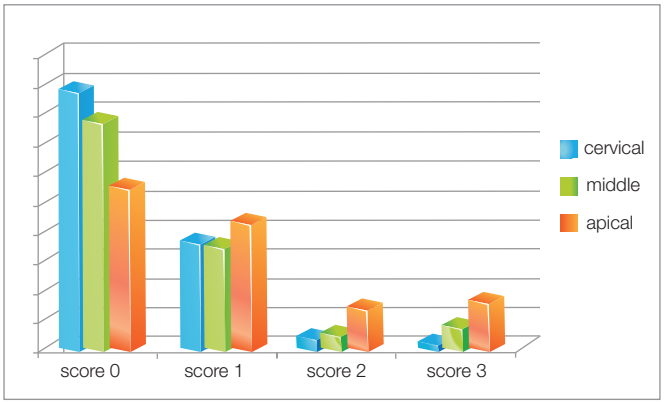


Figure 1. Scores attributed to the different thirds.

Table 1. System of scores attributed to radiographic analysis according to the amount of radiographic debris.

Scores	Significant
0	Absence of radiopaque debris
1	*Less than 25% of debris*
2	*Between 25% and 50% of debris*
3	*More than 50% of debris*

Table 2. Values of the sum of remaining filling material present in the root canals in the three groups.

Groups	Radiographic analysis (scores)	Image analysis (Area of remaining material)
Chlorhexidine	0.8 ± 1.1^a	6.1 ± 4.2^b
Xilol	0.3 ± 0.5^a	2.5 ± 3.0^a
Eucalyptol	0.8 ± 0.9^a	5.4 ± 4.9^b

Notes: Letters a and b mean statistically significant differences.

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In the present work, the root length was standardised to 15 mm with the removal of the coronal portion of the teeth. This procedure was performed according to Al-Omari and Dummer,[19] who state that such a removal allows the root canal to be better viewed morphologically and possible interferences eliminated during the retreatment procedures.

Although several previous studies had shown that the time required for removing the filling material is around 20 minutes, regardless of the technique used,[2,16] we have opted to define a time of 30 minutes.

With regard to the different analyses used in the present study, the radiographic one was used because it is a methodology already established in the literature. According to Tanomaru Filho et al,[20] the conventional radiographic technique using periapical films in two radiographic orientations provides good conditions for analysis. However, according to Ferreira et al,[17] it is not possible to assess the amount of remaining filling material existing on the root canal walls by using periapical films.

In the present study, according to such a technique, it was observed a better cleaning of the coronal third compared to the middle and apical ones. This finding may be associated to the use of Gates-Glidden burs for this third, enabling better cleaning compared to the middle and apical thirds as these were cleaned with manual instruments only.[7] Despite also being described by Wilcox[21] and Ferreira et al,[17] these burs were used here to prepare a reservoir for storing the chemical substances used.

With regard to the analysis of the root canal cleaning using digital imaging, this technique was shown to be efficient for quantifying the amount of remaining filling material, which was also reported by Bramante and Betti.[22]

In the present work, when this technique was employed it was observed a better cleaning of the dentinal walls in association with the use of xylol compared to 2% chlorhexidine gel and eucalyptol. In addition, in the case of the former substance, it was difficult to reach the entire working length in some of the teeth, as higher pressure was applied to the files in order o remove the filling material from the root canals. This happened because chlorhexidine does not act directly on the filling material, that is, it does not alter the properties of this material by causing its dissolution. In fact, because of its viscosity, this substance only allows the filling material to be removed in fragments, which are dislocated from the inside of the root canals. Also, due to the need to exert higher pressure to the instrument, the use of manual files in association to 2% chlorhexidine gel might cause a deviation of the root canal, which did not occurred in the present study as the teeth being used already had wide and straight root canals.

The findings reported in the present study are in accordance with Oyama et al,[23] who evaluated the properties of several solvents by assessing the weight loss of gutta-percha cones following the action of the substances at different times, concluding that xylol was the most effective. Additionally, Bueno and Valdrighi[24] reported better results with the use of xylol compared to eucalyptol. However, our findings differ from those found by Oliveira,[7] who reported that chlorhexidine was better than the other solvents studied. This discrepancy may be associated to the type of instrumentation, since Oliveira[7] had used rotary instruments that soften the gutta-percha by heating it, whereas in the present study manual files were used instead.

Conclusion

According to the methodology used and the results found in the present work, one can conclude that the use of xylol has favoured the removal of filling material as well as the cleaning of dentinal walls compared to the use of eucalyptol and 2% chlorhexidine gel.

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In vitro evaluation of dentin marginal adaptation of three root-end filling materials inserted with and without surgical microscope

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ABSTRACT

Objective: Periradicular surgery is the procedure of choice when one aims to solve problems or complications which conventional endodontic therapeutics has not been able to solve. Surgical therapy comprises a number of procedures, among which retrofilling. The aim of this study was evaluating the degree of dentin marginal adaptation of root-end filling materials, as well as ascertaining the effectiveness of optical microscopic usage in the insertion of these materials. **Methods:** Sixty upper canine teeth were selected, apicectomized and then rood-end cavities were prepared with the help of ultrasonic tips. The specimens were divided according to the material used: White MTA Angelus®, Super-EBA® and Sealapex® + White MTA Angelus®, it being that optical microscope was used in half of the samples of each group. All samples were processed and evaluated by scanning electronic microscopy (SEM). **Results:** The three materials tested presented satisfactory marginal adaptation. The use, or not, of the optical microscope, did not change the degree of adaptation of root-end filling materials evaluated in the present study. **Conclusion**: All materials tested (White MTA Angelus®, Super-EBA®, and Sealapex® cement added to White MTA Angelus®) proved efficient regarding the issue evaluated, dentin marginal adaptation. The use of the optical facilitated insertion of root-end filling materials, due to better illumination and magnification. However, it did not promote any difference in the materials marginal adaptation to root-end cavities, when compared with its non-utilization.

Keywords: Retrograde obturation. Scanning electron microscopy (SEM). Endodontics. Oral surgery.

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Introduction

Surgical therapy is the procedure of choice when one aims at the resolution of endodontic problems with repercussion on adjacent periapical tissues. Thus, it should be seen as an extension of the endodontic treatment, not as an independent entity. All principles of conventional endodontics, such as cleaning, modeling, disinfecting, filling and canal sealing should be followed, it being that such procedures are carried out via root apex rather than by access cavities in surgical treatment.[1]

Materials used in root-end fillings are, among others, determining factors for the success of periradicular surgery.[3] It should be emphasized that the ideal root-end filling material to be used should provide adherence, promote tridimensional sealing of the root canal system, be biologically tolerated by the periradicular tissues, non-absorbable, easy to handle and radio-opaque, in addition to allowing for a conducive environment to tissue regeneration.[2,3,4]

The most-used materials include amalgam, gutta-percha, zinc oxide and eugenol cement, IRM® (Intermediate Restoration Material), Super-EBA®, glass ionomer cement, composite resin, consistent Sealapex® and MTA (Mineral Trioxide Aggregate).[5]

Use of optical microscopy for performing surgical procedures involving the periapex has rendered prognosis more predictable. A great number of failures stems from poor visualization of root apex anatomical structures.[6,7]

The degree of adaptation and the quality of apex sealing provided by the filling materials used in root-end cavities have been evaluated by the use of dies, radioisotopes, bacterial penetration measures, scanning electron microscopy, electrochemical means and fluid filtering techniques.[8]

Continuous search for an ideal root-end filling material, which remains unknown, may be materialized as from the use of a surgical protocol, with or without the use of an optical microscope.

The present study aims to evaluate the degree of dentin marginal adaptation for three root-end filling materials: White MTA Angelus® (Mineral Trioxide Aggregate), Sealapex® added to White MTA and Super-EBA®.

Concomitantly, the study shall ascertain the efficacy of the use of optical microscopy in periradicular surgery, more precisely in the adaptation of the root-end filling material to root-end cavities.

Material and Methods

Sixty upper and lower canine teeth extracted from humans, with fully-formed apexes, single rooted and straight, conditions which have been proven by visual and radiographic examination. The present study had its research project approved by the Committee of Ethics in Research of the Estácio de Sá University.

The sample was preserved for 24 hours in a sodium hypochlorite solution at 2.5% for disinfecting and dissolving organic matter, being later washed in running water for 15 minutes and then sterilized.

Access to cavities was performed under constant refrigeration, with spherical bur #1013 (KG Sorensen, São Paulo, Brazil), burs #3083 (KG Sorensen) and Endo-Z (Dentsply-Maillefer, Ballaiguess, Switzerland). Apical foramen for each canal was ascertained with a Kerr # 10-type file (Dentsply-Maillefer), by visual method, apical limit being considered 1 mm beyond apex for keeping the instrumentation standard. Instrumentation was carried out up to Kerr # 40 (Dentsply-Maillefer) file, by the MRA (alternate rotation movement) technique. Irrigation was done at every file change with 2 ml of a sodium hypochlorite solution at 2.5%.

Instrumentation being completed, the canals received irrigation with 5 ml of EDTA 17% in solution, which remained in the canal for 5 minutes, followed by new irrigation with sodium hypochlorite 2.5%. Canals were dried with cones of absorbent paper 0.40 mm caliber (Dentsply-Maillefer, Petrópolis, RJ, Brazil) and then filled with calibrated gutta-percha cones (Dentsply-Maillefer, Petrópolis, RJ, Brazil) by the lateral condensation technique using Sealer 26 epoxy cement (Dentsply-Maillefer, Petrópolis, RJ, Brazil).

Apical resection of the teeth was performed in the apical 3 mm roots, following marking off with an overhead projector, in a 90° angle, with the long axis of the root, using a Zecrya bur (Dentsply-Maillefer, Ballaiguess, Switzerland) under high rotation with constant cooling. The teeth were fixed in acrylic tubes with wax 7 and acrylic resin leaving only 10 mm of its most apical position outward. Upon resection, the assembly was attached to a lathe, thereby avoiding unforeseen movements during this procedure.

The samples were randomly divided into three groups according to the root end filling material: Group I – White MTA (Angelus, Paraná, Brazil), Group II – Super-EBA® (Bosworth, Illinois, USA), and

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Group III – Sealapex® (SybronEndo, California, USA) + White MTA. Later, groups I, II, and III were divided into subgroups: with the help of a surgical microscope and without a surgical microscope.

In experimental groups, root-end cavities were made with diamond burs, model TU21 (Trinity, São Paulo - Brazil), coupled to an ultrasonic unit ENAC model OE3 (Osada, Japan), adjusted to level 5 (average). This stage was carried to a total time of 90 seconds, with the 15 first seconds without cooling so that removal occurs, by plasticization, of the gutta-percha present therein and the last 75 seconds under cooling with distilled water spray. The root-end cavities were made to a depth of 3 mm, and immediately afterwards, were irrigated with saline, and dried with paper cones. Twelve points were used for the making of root-end cavities, with 1 point for every 5 teeth of groups I, II, and III.

After completion of root-end cavities, the teeth were submitted to retrofilling, manufacturers' recommendations being used regarding the proportion and form of mixing. Each group with its respective material and each subgroup either using, or not, a surgical microscope (M-900 DF Vasconcelos) to a magnification of 25 times. The root-end filling material was taken to the operating field with the help of a child's amalgam carrier and condensed with the help of Bernabé instrumenting #2, #4, and #6.

The retrofilling, the 10 mm portion of the teeth was cut from the acrylic tubes by means of a diamond-coated cutting disc inserted in the precision cutter (Labcut 1010 – Extec Corp, Enfield, USA), an average speed of 150 rpm under constant irrigation with distilled water.

The specimens were fixed on a wax 7 so that surface with retrofilling be turned to the wax. The same were separated according to their pertinent subgroups and captured with an epoxy resin which was contained up to its total holding with 10 mm-high PVC cylinders.

The finishing of epoxy resin cylinders was performed on a Universal APL – 4 Sander and Polisher (Arotec, Rio de Janeiro, Brazil). Fine sandpaper with increasing granulation of 600, 1200, 1500, and 2000, at a low speed and under constant cooling. Alumina suspension (Arotec, Rio de Janeiro, Brazil) #4, #3, and #2 with a felt disk was used for polishing.

Following final polishing, samples were immersed in distilled water and placed in an ultrasonic basin (Cristófoli Equipamentos de Biossegurança, Paraná, Brazil) for 10 minutes for removal of debris. The demineralization procedure was started for removal of the dental inorganic matrix for later observation in SEM. A phosphoric acid solution at 37% (Condac – FGM, Santa Catarina, Brazil) was applied, for 3 minutes, for demineralization. Later, the samples were dehydrated in absolute ethylic alcohol in growing concentrations (25%, 50%, 75%, and 100%) for 15 minutes in each concentration.

Specimens were mounted on steel plates, of 45 mm diameter, with double face adhesive tape, to be submitted to metal-coating. Sample coating was done in gold and the latter stored in the desiccators until processing in SEM.

Processing was performed under variable-pressure (self-vacuum), scanning electron microscope, LEO model VP1450 (Carl Zeiss do Brasil, São Paulo, Brazil), under EHT conditions: 15.00 kV, chamber pressure: 1.2 ± 0.04mBar, detector: QBSE and WD 12/15 mm. All samples were analyzed and photographed with a magnification of 70x and then divided into four quadrants. Each quadrant was amplified by 500x and analyzed by two examiners who did not know the root-end filling material used, and the form of insertion of the latter, with or without the help of a surgical microscope.

Results

In the analysis of dentin marginal adaptation, with the aid of SEM, it was ascertained that there are no points of failure of adaptation at any of the three groups evaluated; thus, a statistical analysis is unnecessary at this stage of the experiment. Groups I, II, and III displayed total adaptation to the surface of the root-end cavities, there being no presence of cracks between dentin walls and the filling material, indicating that the MTA Angelus®, Super-EBA®, and the combination of the Sealapex® + MTA Angelus®, displayed a similar behavior in the marginal adaptation item (Fig 1).

It is important to point out that all specimens were submitted to previous procedures, related to the methodology of the present study, so that they would be appropriate for SEM evaluation. The presence of cracks, stemming from apical resection or ultrasonic root-end cavities, is evident in some images. In other images, we can ascertain dark regions under the retrofilling, which are the burns occurring during test sample metal-coating. Both the cracks and the burns are deemed technical artifacts for preparing specimens.

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In analyzing optical microscope effectiveness during root-end filling material insertion, it was determined that the use of the latter rendered control of the retrofilling phase easier, due to the excellent illumination and the magnification provided. However, this did not change adaptation of material to root-end cavities. Independently of optical microscopic use, all specimens referring to Groups I, II, and III presented perfect adaptation to root-end cavity surface. Thus, there is no need either of statistical evaluation at this stage of the research (Fig 2).

Discussion

The specific objective of this study consisted in comparing the dentin margin adaptation capacity of three root-end filling materials: White MTA Angelus®, Sealapex® added to White MTA Angelus®, and Super-EBA®. Additionally, performance of the optical microscope as surgical material, in helping the performing of root-end filling material insertion.

Proven techniques, such as apicectomy at 45°, root-end cavities with burs and retrofilling with amalgam, have been gradually replaced by new procedures such as using ultrasounds in root-end cavities and the employment of new odontological materials for retrofilling, for example. These important innovations increase surgical benefits and provide for better clinical prognosis in cases deemed as of difficult therapeutical solution.[9,10]

Apical resection may be performed with different types of burs and different angles. In this research, option was made for apical resection at 90°, at 3 mm of the

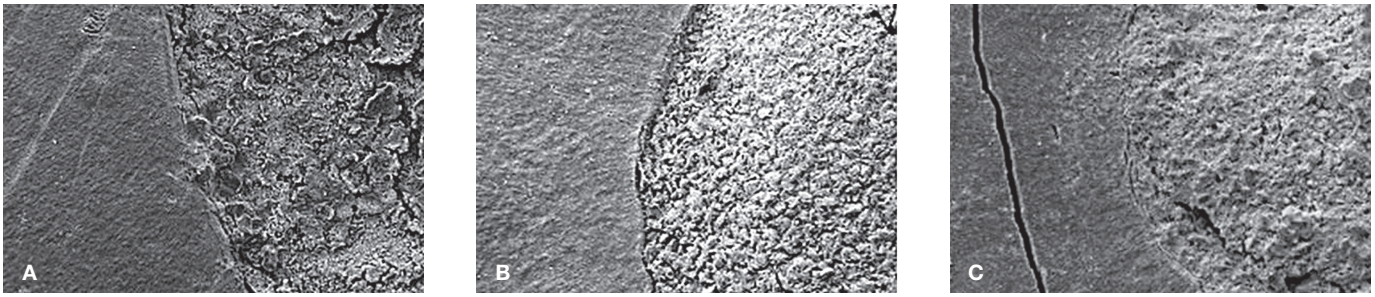


Figure 1. Evaluation of marginal adaptation to dentin of retrograde obturation materials. (**A**) MTA 500x; (**B**) Super-EBA 500x; (**C**) Sealapex + MTA 500x.

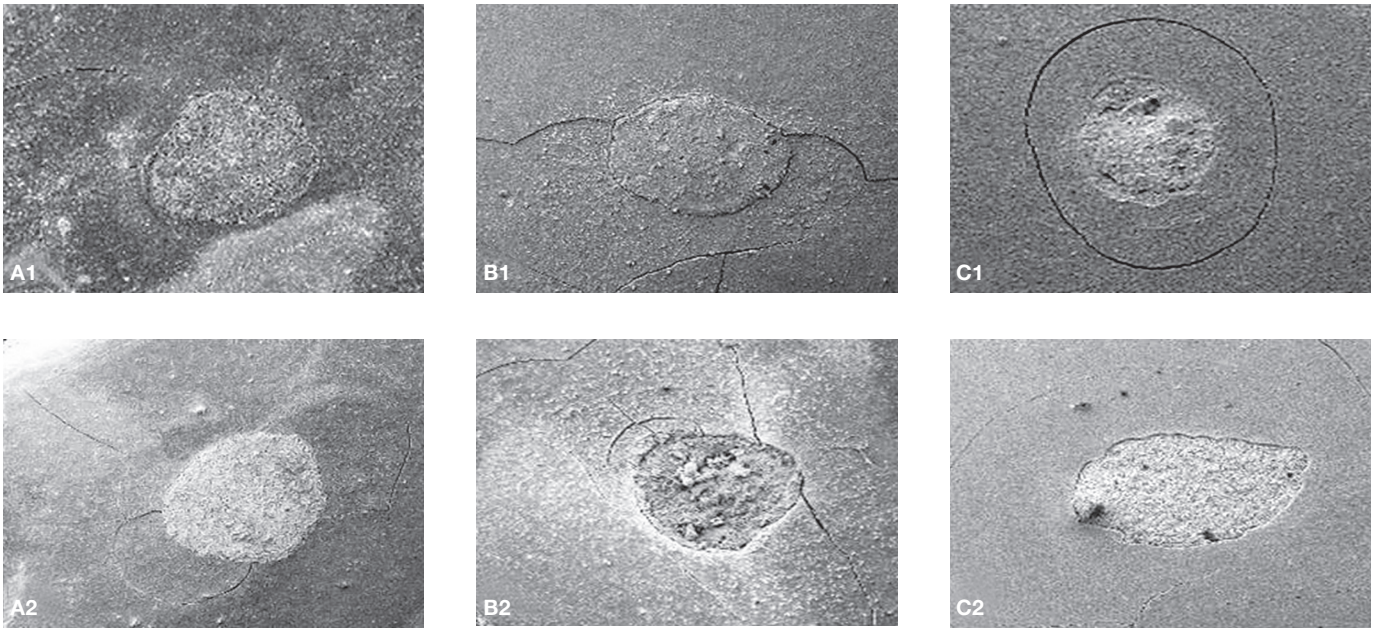


Figure 2. Evaluation of surgical microscope use in the insertion of retrograde obturation materials: **A1**) MTA with microscope 70x; **A2**) MTA without microscope 70x; **B1**) Super-EBA with microscope 70x; **B2**) Super-EBA without microscope 70x; **C1**) Sealapex + MTA with microscope 70x; **C2**) Sealapex + MTA without microscope 70x.

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root apex, as these are the apicectomy techniques most recommended in literature.[9,10,11]

In the cases in which apicectomy at 90° is performed, more security is found in removing root canal ramifications. Thus, one of the causes of failure in periradicular surgery, the possibility of the passage of bacteria and irritating agents via root apexes, is prevented.[12,13]

Option was made in the present research for using the diamond-covered ultrasonic point was based on three main criteria: preserving dental structure, capacity of performing duper and more appropriate preparation for inserting the root-end filling material and its capacity of providing cleaner and smoother root-end cavities.[14,15,16]

However, studies warn on the possibility of occurring microcracks and microfractures when ultrasonic points are used in making root-end cavities. It was possible, in this study, it was possible to ascertain the presence of these injuries following the use of ultrasonic points in a number of specimens.[17,18]

The presence of cracks was also ascertained in the SEM of apex surfaces of specimens following placement of root-end filling materials. In these authors' view, the occurrence of cracks may be associated to the preparation of samples for SEM observation, this hypothesis being the one with which our study agrees.[19]

The capacity of marginal adaptation and the apical scaling of the main materials in retrofillings are approached by countless works in the literature.[5,11,19-28]

In selecting the materials tested in the present study, it was attempted to comparatively evaluate those which were object of biological experiments and those which displayed more favorable results.

It was ascertained, upon comparing the capacity of dentin marginal adaptation of MTA Angelus®, Super-EBA®, and Sealapex® + MTA Angelus® in this research, which bore scanning electron microscopy as tool, it was found out that all materials displayed similar behaviors from the point of view of adaptation, which differs from the work of Torabinejad et al,[19] in which the authors report that the MTA displayed better adaptation when compared with Super-EBA® and amalgam.

The present research was made according to the findings of Bernabé et al,[5] when the authors compared four root-end filling materials: MTA Angelus®, ProRoot® MTA, Portland cement and consistent Sealapex®. No statistical difference was found regarding seepage by dye on the interface between the filling material and exposed dentin surface on the cavity wall, which justifies a satisfactory material adaptation.

In another studio, the authors evaluated the marginal sealing capacity of a combination proposed by them, in which MTA Angelus® (powder) was added in the mixing of the Sealapex cement. The authors compared this combination with the MTA Angelus® cement and with the consistent Sealapex® cement.[27]

The aim of investigation by the present study whether such combination would provide a better marginal adaptation, as the other authors have reported better consistency and consequently a better insertion of this material when compared with the other groups. The authors did not find statistically significant differences between the groups studied.

As from this finding, we have compared the combination proposed with two already-known materials, previously tested: MTA Angelus® and Super-EBA. No difference was found in marginal adaptation between the materials; it was not ascertained that the combination between Sealapex® and MTA Angelus® promotes a better insertion of the material or a better consistency. The materials displayed themselves in a similar fashion, in the item consistency, insertion and adaptation.

It is important to point out that the present study evaluated only the dentin marginal adaptation of this combination; new studies need to be developed. However, one can say that all materials tested displayed potential to be indicated as root-end filling materials.

The use of optical microscopy for the performing of surgical procedures involving the periapex has been emphasized by other authors, which justifies the protocol adopted in this work.[7,29]

We are able to confirm, with the results of the present research, that the surgical microscope provides better lighting and magnification of the operating field, thereby rendering the surgical phase easier. However, we have determined that it is also possible to perform satisfactory retrofilling without the use of the microscope, as results were similar in the groups aided by the microscope and not aided by the optical microscope. Thus, the presence of the optical microscope in the endodontic surgical protocol is not a mandatory factor.

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Eugenol influence on the bond strength of intracanal metallic cast posts bonded with resinous cement

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ABSTRACT

Objective: To verify the influence of the eugenol on the bond strength of cast intracanal posts using resinous cement. **Methods:** Root canal shaping of 33 human maxillary central incisors with 15 mm was performed standardizing the apical shaping at #55 file, 1 mm below de apical foramen. The teeth were divided in 3 experimental groups and 1 control. Group I (Control group) was composed by 3 teeth with root canal filling. The experimental groups were composed by 10 teeth each, filled by gutta-percha associated to 3 types of root canal sealers, used according to the group: Group II – epoxy resin based root canal sealer (AH Plus); Group III – calcium hydroxide based root canal sealer (Sealapex); Group IV – zinc oxide and eugenol based root canal sealer (Endofill). After the root canal preparation, 10 mm for the intracanal post, and the cast posts were adjusted and cemented with resinous cement (RelyX ARC). Every specimens were submitted to the mechanical test in the Universal Testing Machine Kratos 5002, at 0,5 mm/min speed and the values of the higher strength needed to dislocate the posts were registered and submitted to statistical analysis by the tests ANOVA and Tukey with 5% significance level. **Results:** The control group presented mean of 598.05 kgf/cm^2, AH Plus 475,43 kgf/cm^2, Sealapex 358,03 kgf/cm^2 and Endofill 213,70 kgf/cm^2. **Conclusion:** The eugenol influenced the bond strength of intracanal cast posts using resinous cement decreasing tensile resistance.

Keywords: Dental materials. Endodontics. Intracanal posts. Cementation and bond strength.

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Introduction

The restoration of endodontically treated teeth, despite the high technical and scientific advance, is considered a challenge when comes to the oral rehabilitation, once the retention of the restorative material is compromised by the loss of coronal dentinal structure.[1,2,3] Thus, the use of intracanal posts is required in teeth with partial or total destruction of the crown and need prosthetic rehabilitation treatment.[2,4]

Retention and stability of intracanal posts depends on the anatomical features, intracanal post preparation, which will limit post length and width, and the physicochemical features of the used cement.[1,5,6] Therefore, the adhesion ability of the used cement, linking the intracanal post to the dentin, is essential to the rehabilitation treatment success.[7,8]

The main cause of failure of restorations with intracanal posts is loss of the post adhesion.[9] Therefore, the cement type is a decisive factor to the treatment success. The zinc phosphate cement has been widely used to cementation of intracanal posts.[10] However, this material does not present chemical bond to dentin. The development of resinous cements introduced a new perspective to enhance retention, since these cements adhere to both the retention material and dentin.[11]

Another determinant factor for the rehabilitation of endodontically treated teeth is the type of endodontic cement used for root canal filling, which could interfere in the adhesion of the intracanal post to dentin, especially zinc oxide and eugenol based sealers. The eugenol seems to modify the resinous cement polymerization, which could result in bond failure on the intracanal post cementation.[10,12,13]

Thereby, the present study had the aim to verify the influence of the eugenol on the bond strength of cast intracanal posts using resinous cement.

Material and Methods

This study was approved by the Research Ethics Committee (protocol 149/09) of the Lauro Wanderley University Hospital.

The sample was constituted of 33 human maxillary central incisors, with similar dimensions and root without curvature, and without previous endodontic treatment. After extraction, the teeth were stored in sodium hypochlorite 1% (Dilecta, João Pessoa, PB, Brazil) for 30 seconds to disinfection and were submitted to prophylaxis with pumice (SS White, Rio de Janeiro, RJ, Brazil), using Robinson's brush (KG Sorensen, Cotia, SP, Brazil). Later, the teeth were cleaned in running water and stored in saline solution renewed weekly, under refrigeration until the experiment period, which had not exceeded a maximum period of six months, according to the standardization ISO / TR 11405:2003.[14]

The selected teeth were identified by number and standardized in size after the removal of coronal portion, keeping 15 mm length, measured in the apex-crown axis using a digital caliper with resolution of 0.01 mm (Mitutoyo MTI Corporation, Tokyo, Japan). The sectioning was performed using a double face diamond disk (Discoflex, KG Sorensen, Cotia, SP, Brazil), under constant water irrigation.

The endodontic treatment of the samples was performed by one professional, with the apical preparation standardized 1 mm below the apical foramen, using the crown-down technique, as described by Estrela.[15] The tooth length determination was performed by visual method, standardized 14 mm length, 1 mm below the apical foramen.

The root cervical portion was prepared with a LA Axxess bur (SybronEndo, Orange, CA, USA) and the cervical and middle portions were enlarged by Gates-Glidden burs (Dentsply Maillefer, Ballaigues, Swiss) #3 and #4 until 10 mm. Sodium hypochlorite 1% was used for the irrigation of root canals during the preparation. The apical shaping was performed until K-file #55 (Dentsply Maillefer, Ballaigues, Swiss). After biomechanical preparation, the root canals were dried with paper points (Dentsply, Petrópolis, RJ, Brazil) and, posteriorly, irrigated with 10 ml of EDTA 17% (Dilecta, João Pessoa, PB, Brazil) for 3 minutes and followed by 10 ml of sodium hypochlorite 1% and 10 ml of distilled water.

The teeth were randomly allocated to 4 groups: 3 experimental with 10 teeth each and 1 control group with 3 teeth. The groups were divided accordingly to the used cement: Group I (control) – without root canal sealer; Group II – epoxy resin based cement AH Plus (Dentsply, De Tray, Konstanz, Germany); Group III – calcium hydroxide based sealer Sealapex (SybronEndo, Orange, CA, USA); Group IV – zinc oxide and eugenol based sealer Endofill (Dentsply, Petrópolis, RJ, Brazil).

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The root canal fillings were performed by the lateral condensation recommended by Estrela.[15] After confirmation of master gutta-percha cone #55 (Dentsply, Petrópolis, RJ, Brazil) clamping, the root canal sealers were manipulated according to the manufacturer's instructions, except for Group I, which did not used root canal sealer, and the condensation was performed with spreaders (Dentsply Maillefer, Ballaigues, Swiss) and pluggers (Odous de Deus, Belo Horizonte, MG, Brazil).

Following, the root canal post space was prepared using hot pluggers properly delimited at 10 mm, intercalated by cold plugger condensation, as recommended by the Schilder's technique. The presence of 4 mm reminiscent of root canal filling was confirmed radiographically.

After this procedure, root canal modeling was performed with pinjet (Angelus Soluções Odontológicas, Londrina, PR, Brazil) and Duralay resin (Reliance Dental Mfg., Worth, IL, USA) with the root canal space properly isolated with topic anesthetics (DFL, Rio de Janeiro, RJ, Brazil). After the modeling of the posts, they were sent for foundry with NiCr alloy. The root cavities were sealed with temporary restorative material (Coltosol, Vigodent, Rio de Janeiro, RJ, Brazil), and the teeth were stored in a chamber at 37°C for 48 hours.

The posts cementation was performed by the sequence: 1 – Verification of post adaptation in the root canal; 2 – The posts were cleaned with alcohol and left to dry for 1 minute; 3 – The internal root canal walls were cleaned using a microbrush (Vigodent, Rio de Janeiro, RJ, Brazil); 4 – The root canals were dried with paper points and conditioning with phosphoric acid 37% was performed for 15 seconds and then removed using water spray. After, the root canals were dried with aspiration cannula and paper points #50, preventing dentin dehydration; 5 – Single Bond (3M ESPE, St. Paul, MN, USA) adhesive system was applied to the root canal walls using a microbrush. After 15 seconds, and the excesses were removed using a paper point. This procedure was followed by photo polymerization for 40 seconds; 6 – The cement RelyX ARC (3M ESPE, St. Paul, MN, USA) base and catalyzer were manipulated under the same lengths according to the manufacturers specifications; 7 – After manipulated, the cement was applied to the surface of the metallic post and then placed in the pre-prosthetic space, kept initially by compression; 8 – The cements excesses were removed with a microbrush; 9 – The cement was photo polymerized according to the manufacturer's specifications.

Subsequently, the specimens were properly identified and kept in a chamber until their inclusion.

PVC tubes (Tigre, Joinville, SC, Brazil) with internal diameter of 21 mm were cut with 22 mm height, according to the mechanical test machine. The exact location of the PVC tube was standardized in the analyzing basis of a delineator (Bio-Art, São Carlos, SP, Brazil),determining that superior and inferior parts of the delineator were in the exact position for the specimens tests. The superior edge of the posts was fixed in the superior rod of the delineator (Bio-Art) using wax #9 (Lysanda, São Paulo, SP, Brazil), such that the long axis was perpendicular to the basis. Then, they were positioned in the center of the PVC tube, cut with 22 mm height.

After this procedure, the inclusion of the root and the post in acrylic resin (Vipi Flash, São Paulo, SP, Brazil), inside the PVC tube, 2 mm below the cementum-enamel junction.

The specimens, properly individualized according to the group, were submitted to the push-out test in the Universal Testing Machine Kratos 5002 (Kratos, Cotia, SP, Brazil). The specimens were positioned vertically, to minimize lateral forces and keep the tension in the tooth long axis. An increasing tensile strength was applied to the post, with ascent speed of 0,5 mm/min, until the post was dislocated from the root canal.

The strengths values needed to dislocate the posts were recorded in Kgf/cm^2. The values were submitted to statistical tests ANOVA and Tukey, with significance level of 5%, by the software Assistat 7.6 (UFCG, Campina Grande, PB, Brazil).

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Results

The results found by the push-out test showed that the control group (G1) presented higher bond strength (M=598,05) and the specimens which received obturation by Endofill (G4) had the lower resistance (M=213,70). The Tukey test showed statistical significant difference between control and AH Plus groups (G1 and G2, respectively) and the Endofill group (G4). The results are described in Table 1.

Discussion

The retention of intracanal post is a frequent cause of failure in the rehabilitation treatment. Ferrari et al[16] evaluated retrospectively 985 treatments with intracanal posts, verifying failure in 79 cases. Twenty one of these cases were caused by the loss of post adhesion to root dentin. The main factors that influence retention are length and diameter of the post, root canal shaping and the type of cement used to fix the post.[5,17-21] Thus, a sealer that provide adhesion to dentin and post material may favor the retention and directly influence the rehabilitation success.[7,8]

Table 1. Mean and standard deviation values of bond strength of root canal posts, in Kgf/cm^2, and the results of the Tukey test.

Groups	Mean (SD)	Tukey Test
G1 (Control)	598.05 ± 153.38	A
G2 (AH Plus)	475.42 ± 156.20	A
G3 (Sealapex)	358.03 ± 149.17	AB
G4 (Endofill)	213.70 ± 152.53	B

However, one of the main problems from cementation resinous systems is the polymerization. This may not occur in the complete extension of the root canal, especially the apical region. This problem could be enhanced by the use of cast posts, which do not allow the penetration of light to the apical portions of the root. Therefore, the use of post that allow the penetration of light could be a determinant factor to the durability of the prosthetic treatment.[22] Although, one criterion for the use of fiber posts is that these are applied to teeth that have at least 50% of coronal reminiscent, a rare fact in endodontically treated teeth.[21]

Santana et al[23] showed that the use of cast posts failure is more associated the dental fracture, while fiber posts are more prone the post fracture failure. However, Veloso et al[21] showed that most cast posts are cemented without the properly requirements, which could cause a higher number of fractures, once most studies do not report the real condition of the cast posts, only report the fractures.

Moreover, the insufficient polymerization of the apical region could cause, beyond the physical problems related to retention, biological problems. The infiltration of monomers to the periapical region could cause inflammatory reaction and necrosis of the periodontal tissues, resulting in endodontic treatment failure.[24,25] Thus, the maintenance of a root canal filling reminiscent of at least 3 mm is essential to prevent infiltration not only of microorganisms, but also of cytotoxic substances from the restorative materials.[26,27,28]

In addition to the penetration of light, another factor could be decisive for the polymerization of resinous cements is the use of substances in the root canal filling that interfere this process. A highly studied root canal filling material related to the polymerization is the root canal sealer, especially containing eugenol.[10,12,13,29-33] This is a substance known for the interference in the polymerization process of resinous material, due to its phenolic components that interact with free radicals.[10]

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This study verified that the use Endofill, a zinc oxide and eugenol based root canal sealer, resulted in lower levels of bond strengths in comparison to the other cements. These results were similar to those found by several studies that associated the use eugenol containing root canal sealer to lower bond strength of the posts.[12,13,30,31,32] However, there are some divergences between authors concerning to the influence of the root canal sealer type on the bond strength of intracanal posts, which there was no statistical significant difference in some studies when zinc oxide and eugenol based root canal sealers were compared other sealers.[10,29]

Hagge et al[34] also evaluated the influence of the eugenol containing root canal sealer in the retention of posts at different times (immediate, 1 week, 4 weeks). The authors observed that the presence of eugenol for 4 weeks showed the lower results. This fact could be due to the penetration of eugenol in the dentinal tubules, impairing its removal. This fact agrees with the results from this study, which found influence of eugenol in the adhesion of posts to root canal walls, placing the eugenol containing root canal sealers as decisive factor for the rehabilitation failure. However, Dias et al[10] did not verified the influence of time (immediate, 72 hours, 4 months) in the retention of posts in teeth filled with eugenol containing root canal sealer.

Conclusion

The eugenol influenced the bond strength of intracanal cast posts using resinous cement decreasing tensile resistance.

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Efficiency of different concentrations of sodium hypochlorite during endodontic treatment. Literature review

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ABSTRACT

The aim of this study is to evaluate, through a literature review, the effectiveness of various concentrations of sodium hypochlorite during endodontic treatment. It was possible to verify that the 0.5% sodium hypochlorite concentration needs more time to dissolve organic tissue while causing less irritation to periapical tissues. The 1% concentration showed lower loss of chlorine due to the presence of stabilizer, making the solution more reliable for long periods after open. The 2.5% concentration showed better bactericidal action and a good tissue dissolution time; the 5.25% concentration showed higher solvent potential and bactericidal effect, with lower surface tension and consequently better root canal decontamination. However, the highest concentration was also more toxic to periapical tissues, promoting greater irritation. Based on the literature review it can be said that the 2.5% sodium hypochlorite concentration, due to its less cytotoxic properties, is the most suitable for endodontic treatment of root canals.

Keywords: Sodium hypochlorite. Antimicrobial activity. Organic solvent. Irrigation solutions.

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Introduction

The use of chemical substances in order to reduce or eliminate bacteria has always been present in Endodontics. The chemical means (auxiliary chemicals substances) along with the mechanical (action of instruments) and physical means (irrigation and aspiration) form a single and simultaneous process, which is the chemomechanical preparation of root canal.[15]

It is highly desirable that chemical substances selected as endodontic irrigants have antimicrobial and organic tissues dissolution properties besides helping in the debridement of the root canal system and not being toxic to the tissues.[4] Thus sodium hypochlorite (NaOCl) has been chosen as an endodontic irrigating solution for use by the majority of professionals. This is due to the mechanism of action of this solution, which is capable to promote cellular biosynthetic changes, cellular metabolism alterations, destruction of phospholipids as well as for its excellent properties: It has the ability of dissolving organic tissues, antimicrobial action, alkaline pH, promote whitening, is deodorizing and has low superficial tension.[8]

Walker[35] was the first researcher to think of NaOCl as irrigant and according to Spångberg, Engstrom and Langeland,[30] the use of NaOCl at high concentrations has been recommended to degrade protein products present in the root canal. However these high concentrations can cause damage to the periapical tissue.

According to Estrela et al,[10] several irrigating solutions have been proposed to help in the root canal preparation. Nevertheless, according to these authors, an effective solution is crucial to the sanitization process, because it favors the cleaning, preparation and neutralization of septic necrotic content of root canals allowing for its subsequent filling. In reviewing the microbial efficacy of NaOCl it seems to be similar to calcium hydroxide, because of the high pH of NaOCl, which interferes in the integrity of the bacteria cytoplasmic membrane, the cellular metabolism and the degradation of phospholipids present in the root canal. The dissolution of organic tissue can be seen in the saponification reaction that occurs due to the action of NaOCl on lipids and fatty acids.

The NaOCl became the most popular agent for endodontic irrigation, although its ideal concentration is not an universal consensus.[4]

Therefore, this literature review was conduct in order to verify which NaOCl concentration is the most efficient in controlling microorganisms during endodontic treatment.

Literature review

The root canal cleaning not only depends on the mechanical action of instruments, but also on the action of irrigating solutions that lubricates this canal during the cutting action of endodontic instruments, help in removing smear layer and have germicidal potential and solvent action on exudate and pre-dentin.[30] The components of these formulations may cause more or less disinfection of the root canal system, so there is the need to compare the different NaOCl concentrations assessed in studies reported on the literature, distinguishing the results obtained by means of different methodologies and concentrations.

Thus, in this literature review, seven points were highlighted and this division aimed at facilitating the understanding about this subject. The following databases were used for the electronic searches: MedLine, PubMed, BBO, Lilacs, SciELO, Piracicaba Dental School (FOP-UNICAMP) library archives and Ingá Dental School (UNINGÁ) library archives.

1. Ability to dissolve organic tissue

The ability of NaOCl to dissolve organic tissues is directly proportional to its concentration.[2,5,19,31] According to Baumgartner and Cuenin,[1] efficacy of the solvent and disinfectant action of NaOCl solutions at low concentrations can be increased by using higher volume of solution and frequent exchanges.

Fachin, Hahn and Palmini[11] conducted a study on the use of NaOCl solutions in endodontics, analyzing aspects such as: optimal concentration, solvent action, tissue reaction, bactericidal effect and capability of removing organic debris. They observed that at higher concentrations the dissolution of organic tissue is increased.

Spanó et al[31] studied *in vitro* the solvent effect, the level of residual chlorine, pH and surface tension before and after dissolution of tissues, of four concentrations of NaOCl (0.5%, 1.0%, 2.5%, and 5,0%) on bovine pulp tissue. The higher concentrations of NaOCl were more rapid on dissolution of the pulp tissue, and showed lower decrease in chlorine concentration.

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Okino et al[21] evaluated the solvent activity of various irrigants on bovine pulp tissue. The tested solutions were 0.5%, 1.0% and 2.5% NaOCl; 2% chlorhexidine gluconate solution and 2% chlorhexidine gel. Chlorhexidine preparations were not able to dissolve the pulp tissue. All NaOCl solutions were effective in dissolving pulp tissue and the dissolution rate varied with the solution concentration.

Following the studies of Cunningham and Balakejian,[5] Sirtes et al[29] evaluated some effects of pre-heating NaOCl solutions. The ability of 1% NaOCl in dissolving human pulp tissue was assessed, *in vitro*, at 45°C and 60°C, and these values compared to 5.25% NaOCl at 20°C. At the concentration of 1% and at 45°C, this substance dissolved pulp tissue with the same efficiency than the 5.25% at 20°C. At 60°C the 1% NaOCl was more effective than the 5.25% at 20°C. Results showed that the solvent capacity is directly proportional to temperature, in other words, the higher the temperature of NaOCl solution the greater is its solvent ability.

2. Effective antimicrobial action

Siqueira et al[28] studied the antibacterial effect of endodontic irrigants in anaerobic Gram negative bacteria and facultative bacteria. The solutions used were: 0.5%, 2.5%, and 4.0% NaOCl; 0.2% and 2.0% chlorhexidine; 10.0% citric acid and 17.0% EDTA. All solutions inhibited the tested bacteria. The 4.0% NaOCl proved to be the most effective antibacterial agent. Both 0.2% and 2,0% chlorhexidine solutions inhibited all bacteria, but were less effective than 2.5% and 4.0% NaOCl.

D'Arcangelo, Varvara and De Fazio[6] analyzed the antimicrobial action of 0.5%, 1%, 3% and 5% NaOCl; 0.2%, 0.3%, 0.4%, 0.5% and 1% liquid chlorhexidine; and 0.2%, 0.3%, 0.4%, 0.5% and 1% Cetrimide on facultative anaerobic microorganisms, microaerophilic and strict anaerobes. Results demonstrated that all substances showed bactericidal effect on all studied microorganisms at all concentrations and after a short contact period.

Vianna[34] evaluated the antimicrobial activity of gel and liquid chlorhexidine in 0.2%, 1%, and 2% concentrations against various strains and compared it with the action of NaOCl in 0.5%, 1%, 2.5%, 4% and 5.25% concentrations. The results led the authors to conclude that the antimicrobial action is related to the concentration, presentation and type of microorganism.

Dametto et al[7] evaluated *in vitro* the antimicrobial activity of 2% chlorhexidine gel against the *Enterococcus faecalis* compared with 2% chlorhexidine liquid and 5.25% NaOCl. The authors observed that the 2% chlorhexidine gel, chlorhexidine liquid and 5.25% NaOCl showed significant antimicrobial reduction immediately after preparation. However, NaOCl was not able to maintain this reduction after 7 days. The results show again[22] the residual effect provided by the chlorhexidine.

Raphael et al[26] performed an *in vitro* study of the antibacterial efficiency of 5.25% NaOCl, used at different temperatures. Extracted human teeth were used, which were sterilized, instrumented and inoculated with *Enterococcus faecalis*, *Pseudomonas aeruginosa* or *Staphylococcus aureus*. The root canals were irrigated with NaOCl at temperatures from 21°C to 31°C and the 0.9% saline solution was used as control. The results showed that there is no direct relation between the NaOCl temperature and its antimicrobial action, since the increase in temperature did not provide difference in the number of negative cultures.

3. Alkaline pH

Pécora[24] proposes a NaOCl solution with 0.5% to 0.6% of active chlorine per 100 ml, with boric acid to reduce the pH, decreasing pH solution near to neutral. The addition of boric acid decrease the pH and provides less free NaOCl, reducing the irritant effect of NaOCl. The author stresses the fact that the proposed solution is unstable, should not be stored for too long, must be packed in amber glass and kept in a cool place with no incident light. The NaOCl with higher pH is more stable and presents slower chlorine release. When the pH is reduced, the solution becomes very unstable and the chlorine release is faster, resulting in a lower life cycle. It is known that concentrated NaOCl solutions are more unstable and if exposed to light, heat and environment, they may present decreased concentration of available chlorine, losing the capacity to dissolve organic tissue.[3,9]

The alkaline content of NaOCl is proportional to its concentration, in other words, the higher the concentration, the higher the pH, since it has greater amount of NaOH molecules. According to Thé, Maltha and Plasschaert,[32] the high pH of these solutions is not a disadvantage, since their action is limited to the surface of the tissue; it may even represent a positive action because, by being alkaline, this pH neutralizes the medium acidity, making it inappropriate for bacterial growth.

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4. Deodorant action

The NaOCl solution also acts as a deodorant substance by acting on decomposing matter. According to Gomes, Drucker and Liley,[13] infections caused by anaerobic bacteria often produce strong odor due to the production of short-chain fatty acids, sulfur compounds, ammonia and polaminas. Chlorine through its lethal activity on microorganisms and oxidative action on dead tissues and bacterial products, eliminates the fetid odor produced by necrosis.[18]

According to Estrela et al,[8] NaOCl neutralizes the amino acids forming water and salt. With the output of hydroxyl ions, a reduction in the pH occurs. The hypochlorous acid, a substance present in the NaOCl solution, when in contact with organic tissue, acts as a solvent releasing chlorine — which, combined with the amino group of proteins, forms chloramines. Hypochlorous acid (HOCl) and hypochlorite ions (OCl-) lead to degradation of amino acids and hydrolysis, so the dissolution of organic necrotic tissue can be verified in the saponification reaction when NaOCl degrades fatty acids and lipids, resulting in soap and glycerol and promoting a deodorant effect.

5. Low surface tension

Another factor to be mentioned on the NaOCl solutions is its surface tension, which is similar to the water and somehow prevents a intimate contact of this liquid with the dentin. The reduction in the surface tension of these substances was investigated by Pécora, Guimarães and Savioli.[23]

Lopes, Siqueira Jr. and Elias[14] defined the surface tension as a intrinsic characteristic of each liquid, varying with temperature and the type of surface contacted. It was suggested that in the less concentrated NaOCl solutions, there is a greater interaction of hypochlorous acid (HOCl) with organic matter (reaction 4) and in more concentrated solutions there is a greater interaction of sodium hydroxide (NaOH) with organic matter (reaction 2), leading to greater surface tension reduction in NaOCl solutions with higher concentration.

According to Spanó et al[31], the higher the initial concentration of NaOCl solution, the greater is the reduction in surface tension on the final solution. This can be explained by the fact that the solutions with higher active chlorine concentration and therefore higher sodium hydroxide concentration, provides greater formation of fatty acids salts (soaps). The soaps formed reduced the surface tension of the resulting solutions.

6. Cytotoxicity (toxic to periapical tissues)

Nóleto et al[20] evaluated *in vivo* the irritating potential of different NaOCl concentrations used in root canals irrigation. Were tested the 1.0%, 2.5% and 4.8% concentrations. The authors concluded that the evaluated NaOCl solutions promoted irritation with variable intensity depending directly on the concentration used.

Mehdipour et al[16] and Silva et al[27] reported that the severity of NaOCl cytotoxicity depends on the solution concentration, pH and duration of tissue exposure to the agent. They also say that the highest concentration shows more irritating effects on periodontal ligament.

Farren, Sadoff and Penna[12] advocated, in a case report, that NaOCl can be an extremely cytotoxic material. The leakage of this material during endodontic treatment may cause sequelae such as pain, swelling, bruising and numbness, compatible with a chemical burn.

7. Effectiveness time

Milano et al[17] observed *in vitro* that the pulp dissolution time with different NaOCl concentrations (0.5%, 1%, 2.5% and 5.25%) ranged from 20 minutes to 2 hours.

Radcliffe et al[25] compared the effectiveness time of 0.5%, 1%, 2.5% and 5.25% NaOCl on *Actinomyces naeslundii*, *Candida albicans* and *Enterococcus faecalis*. All concentrations proved effective against *Candida albicans* and *Actinomyces naeslundii* in less than 10 s. But against *Enterococcus faecalis* — which is a species more resistant to NaOCl — there was a variation in cells inactivation time: the 0.5% concentration took 30 minutes; at 1%, took 10 minutes; at 2.5%, 5 minutes; and at 5.25%, 2 minutes to reduce the number of viable cells to zero.

Valença et al[33] evaluated in rats the dissolution time of 60 pieces of conjunctive tissue (dorsum) and skeletal muscle (tongue) by using 1% and 2.5% NaOCl of different brands and observed that the time required for complete dissolution of the fragments ranged between 74 and 335 minutes.

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Discussion

Due to its positive and negative aspects described in this paper, the NaOCl solution, in different concentrations, has been used and researched until nowadays.

As presented by Cunningham, Balakejian;[5] Spanó et al;[31] Beltz, Torabinejad, Pouresmail;[2] Naenni, Thoma and Zehnder,[19] the NaOCl ability to dissolve organic tissue is directly related to its concentration. This statement confirms Baumgartner and Cuenin[1] study, which observed that the higher the concentration, the more rapid the tissue dissolution.

Fachin, Hahn and Palmini[11] affirmed that the 0.5% NaOCl concentration is more biocompatible but less stable, allowing us to understand that if open and exposed to intense bright or not stored under refrigeration (6 °C), it becomes inappropriate for use. Radcliffe et al,[25] who also reviewed 0.5% NaOCl, showed that the time required to extinguish all *Enterococcus faecalis* at this concentration is 30 minutes.

According to Borin, Melo and Oliveira,[3] the 1% NaOCl concentration is the most used and studied and it has great action on organic tissues by dissolving 0.43 mg per minute. Examining 1% NaOCl, Radcliffe et al[25] reported that the time needed to inhibit all *Enterococcus faecalis* strains is 10 minutes. Fachin, Hahn and Palmini[11] reported that the 1% NaOCl has stabilizers (sodium chloride) which makes its use more viable at long term because this stabilizers gives greater shelf life, provided it is refrigerated and stored in amber bottle.

The 2.5% NaOCl proved to be a better solution than the others,[17] because it has greater effectiveness than 0.5% and 1% concentrations and has lower cytotoxicity than the 5.25% concentration. The 2.5% NaOCl is capable to inhibit 100% of the *Enterococcus faecalis* in 5 minutes, eliminating the pain of a patient with endodontic urgency, with faster inhibition of bacteria and the shorter time for root canal sanitization.[25]

Regarding the organic tissue dissolution and bacterial inhibition, a 5.25% NaOCl solution is more effective in a shorter time, because its high concentration of hypochlorous acid in contact with organic tissues leads to amino acids degradation and hydrolysis, promoting the death of the root canal bacteria within 2 minutes.[8] Nevertheless — in cases of extravasation — the 5.25% NaOCl can, due to its high cytotoxicity,[11,12] cause sequelae such as pain, swelling, bruising and numbness, which makes its handling a little bit tricky.

Conclusions

1) Based on this literature review it is clear that all NaOCl concentrations mentioned in this paper have limitations, as well as clinical indications. Therefore research on new substances in order to find an ideal irrigant for endodontic treatment should be performed.

2) According to this study, it was observed that 5.25% NaOCl has better effectiveness in dissolving organic tissue, greater antibacterial action, more alkaline pH, and shorter effectiveness time. In contrast is more irritating to the periapical tissues, making its use undesirable.

3) Both 2.5% NaOCl and 5.25% NaOCl have similar properties, but the first on is less cytotoxic, being more indicated for root canals endodontic treatment.

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Dental fracture stabilization for insertion of fiber-reinforced post and tooth-fragment reattachment: 6-month follow-up

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ABSTRACT

Dental fractures in endodontically treated teeth with a great loss of dental structure may be restored using bonding techniques associated with glass fiber post retention of the fragment. The present study reports a weakened and fractured crown restored by dental reattachment after crown stabilization with polyvinilsiloxane matrix, and a glass fiber post cementation for dental fragment retention. The employed techniques enabled the correct dental positioning during reattachment, with a possible increase of resistance. After 6 months follow-up the periodontal tissues showed itself in health condition and functional evaluations maintained the success of the proposed treatment.

Keywords Fracture. Reattachment. Adhesion. Glass fiber post.

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Introduction

Endodontically treated teeth are more susceptible to fracture than vital teeth,[1] becoming a challenge for Restorative Dentistry.[2] This susceptibility has been attributed to substantial structure loss and changes in the architecture of the crown-root complex,[3,4,5] due to caries, fracture, preparation and instrumentation during endodontic treatment,[2,6,7] with loss of reinforcing structures as marginal ridges, enamel bridges, pulp chamber roof and all structure above it.[8,9]

Restoring endodontically treated teeth with complicated crown or crown root fractures requires profound knowledge in endodontics, periodontics and operative dentistry.[10] If the fracture extends further subgingivally, it might be necessary to expose the fracture line[5] per gingivoplasty and osteotomy procedures, or per orthodontic extrusion of the apical fragment, converting the subgigival fracture to a supragingival one and enabling restoration.[11,12]

There are many alternatives to restore fractured crowns, being the original fragment reattachment the most indicated because cavity preparation is not required and also esthetic and functional outcomes are facilitated.[13,14] The esthetic is obtained once the anatomic form, color, bright, and original surface texture are maintained. Furthermore, incisal edge of the dental fractured will suffer similar wear to adjacent teeth over time;[15] this technique is faster than direct or indirect restoration techniques and provides results quite predictable in the long term.[14]

In endodontically treated teeth with great structure loss, the pulp chamber space might be used as an internal reinforcement with adhesive materials[16], avoiding any other wear in order to achieve greater resistance to fracture. The use of a glass fiber post promotes the fragment retention[10,17,18,19] and might enable tooth reinforcement.[9,20]

The objective of this study is to present a case report of restoration of an weak endodontic treated tooth fractured due to occlusal overload. The clinical sequence includes tooth fragment stabilization and reattachment and insertion of glass fiber post, periodontal assessment and occlusal adjustment with 6 months follow up.

Case report

The patient, 21 years old, search dental care after right lateral incisor fracture during normal masticatory function. The patient reported that the tooth had been submitted to endodontic treatment for more than 5 years ago, before orthodontic treatment. Clinically, it was observed that the fragment was represented by entire dental crown, which remained in place because of subgingival periodontal ligament attachment. Figure 1 shows the purplish appearance of supporting periodontal tissues as a result of an inflammatory episode after fracture; however, the fragment was intact and looking good at vestibular side. Patient teeth showed demineralized white spots from remineralized enamel caries after orthodontic treatment. Radiographic analysis (Fig 2) revealed fracture near the bone, requiring correction of biological distances.

In order to allow periodontal surgery procedures to expose the fracture line, tooth #12 should be fixed at its original position, adopting the following technique. After perfect adaptation of the fragment, a polyvinilsiloxane matrix (Futura AD, Nova DFL, RJ, Brazil) was manufactured (Fig 3) to hold the tooth in position during procedures for adhesive anchorage.

Teeth #11, #12 and #13 were etched with 37% phosphoric acid (Alpha Etch, Nova DFL) for 15s and a dentine bonding agent (Adper Single Bond 2, 3M-ESPE, USA) was applied in two layers with gentle air in their palatal surfaces. Before photopolymerization, the matrix was positioned and then light exposition performed for 20s in each tooth. A composite resin layer (Natural Look, color A1E, Nova DFL) with an average thickness of 2 mm was used and light cured for 40 seconds per tooth (Fig 4).

Figure 5 shows the tooth #12 fixed to #11 and #13, and removal of the composite resin from pulp chamber. It is possible to verify the fracture line with perfect adaptation to the remaining root after the fixation procedures, and also the reduced presence of dentine inside the fragment, characterizing its increased friability. The root canal was prepared leaving 5 mm in length of root filling at apical region, and prepared with drill #3 of Exact Translucent fiberglass post system (Angelus, Londrina, PR, Brazil) in order to have a close fit between the walls of the root canal and the fiber post.

After preparation, the post was cleaned with alcohol and etched with 37% phosphoric acid for 1 minute, then silanized in hot air for 2 minutes and received a thin adhesive layer (Adhesive, Fusion Duralink, Angelus). The inner of the root canal was protected with a cotton ball and the coronal cavity

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Figure 1. Initial image of darkened tooth #12 and inflammation of supporting tissues due to subgingival fracture.

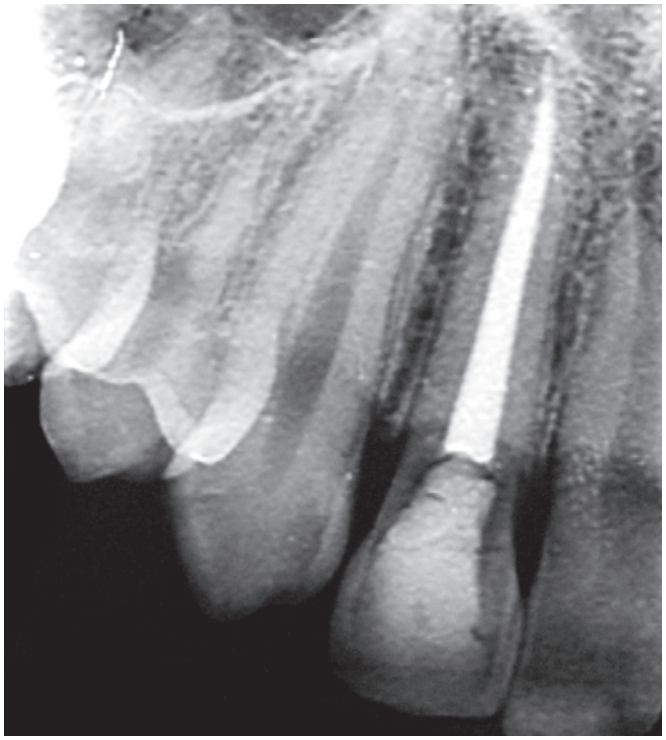


Figure 2. Periapical radiograph showing fracture line and endodontic treatment well executed.

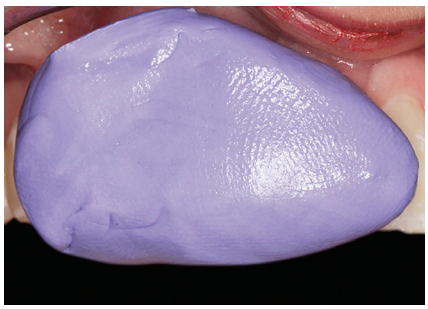






Figure 3. Direct impression of properly re-positioned teeth for producing the polyvinilsiloxane matrix. The matrix was cut with a scalpel blade maintaining the incisal portion to be used for fragment fixation.

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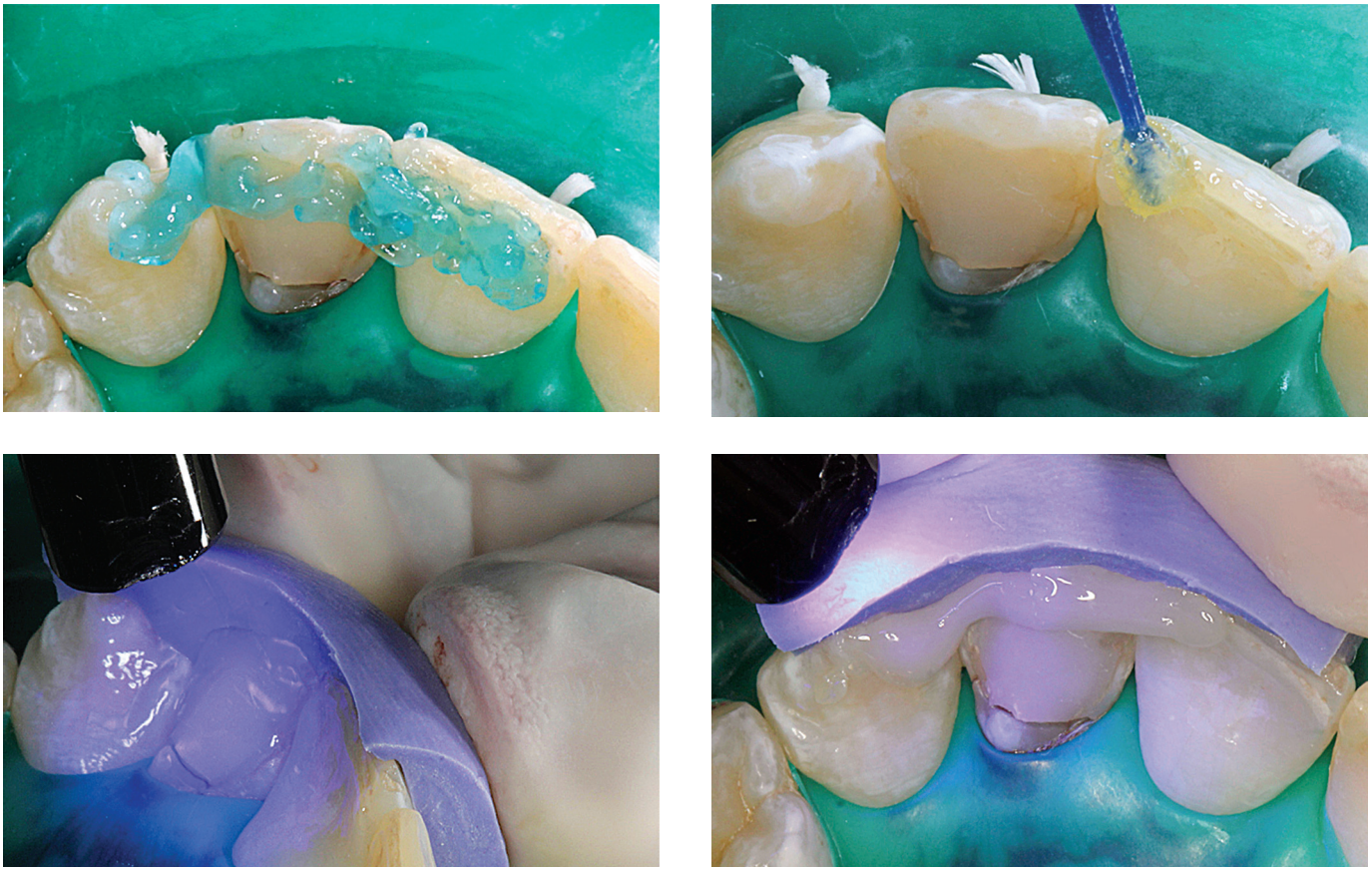


Figure 4. Adhesive technique for fixation of the fragment on adjacent teeth. For the fixation, the silicon matrix must be kept in place during the photopolymerization of the bonding agent and composite resin.

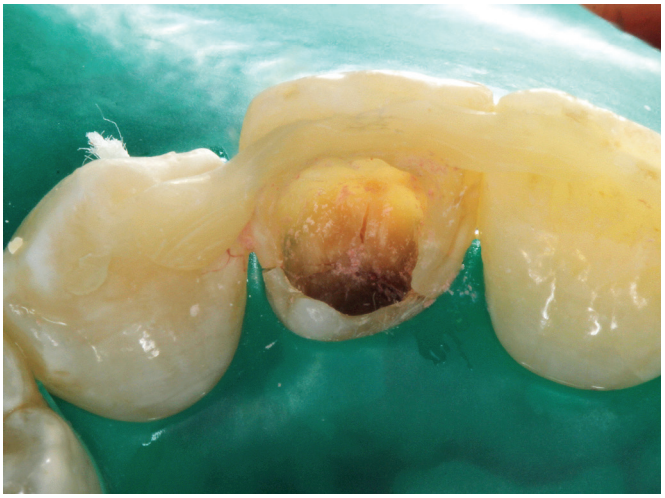


Figure 5. Tooth #12 fractured. Note the fracture line traversing the entire crown and the tooth fixed to the adjacent teeth allowing the restorative procedure.

etched for 15s with 37% phosphoric acid, application of two layers of primer and one layer of adhesive (Fusion Duralink, Angelus). The cotton ball was removed and the interior of the root canal filled with a self-etch adhesive resin cement (U-100, 3M-ESPE, USA); then, the fiber post was inserted. After 5 minutes, the cement was photopolymerized for 40 seconds on each side, and the pulp chamber incrementally restored with a nanoparticulate composite resin Z350XT (3M-ESPE), color A2B (Fig 6).

In Figure 6 it is possible to see the immediate restoration with a lighter appearance of gingival tissue and restored tooth. The patient was referred for periodontal evaluation, and during surgery it was noticed the perfect adaptation of the reattached fragment. Figure 7 shows excursive mandibular movements of protrusion (upper images) and right laterality (lower images), showing the correct occlusal adjustment, relieving any contact on the restored tooth and maintaining balanced contacts. Figure 8 shows 6 months follow-up, with gingival health and maintenance of the initial result.

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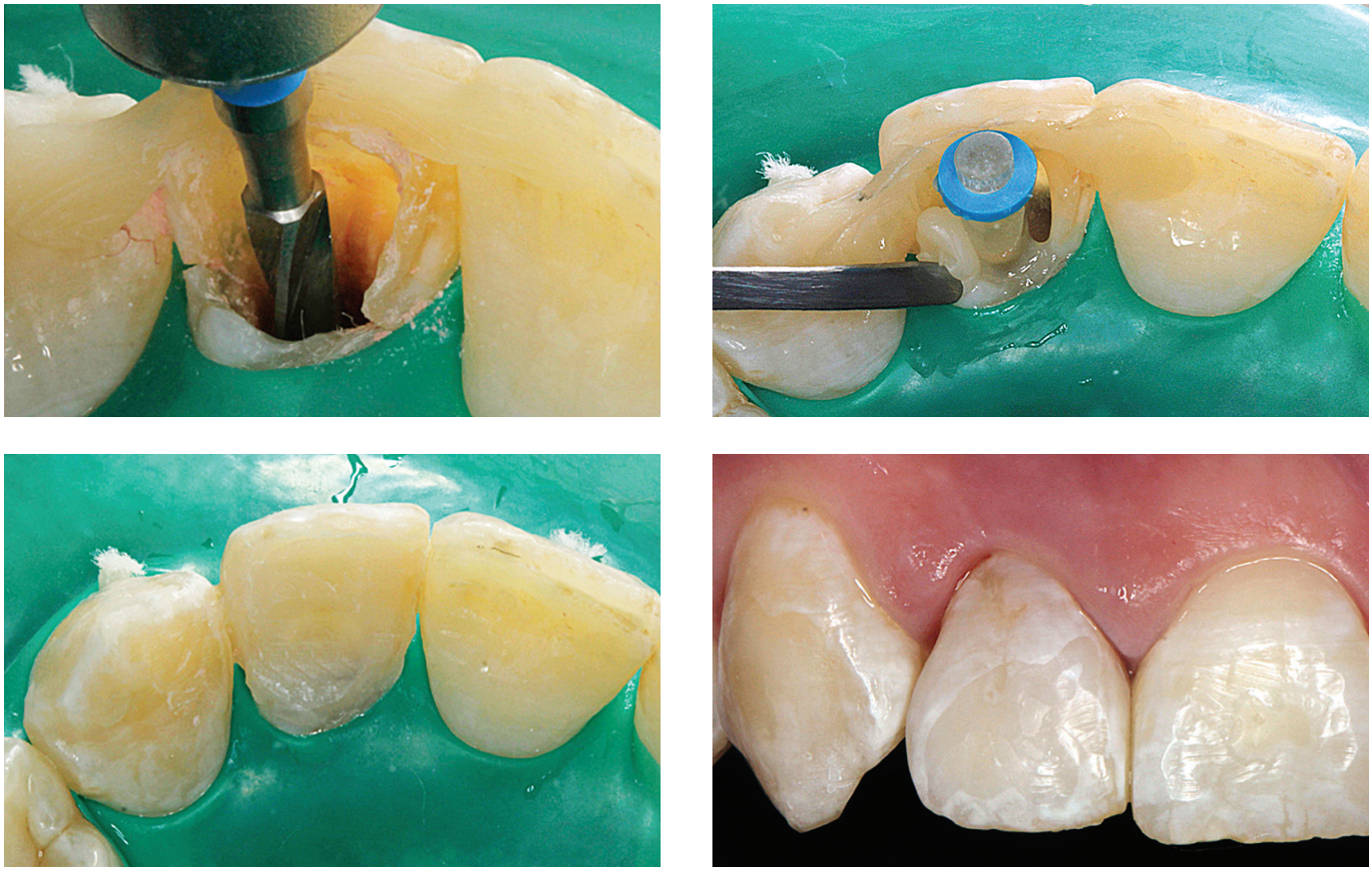


Figure 6. Root canal preparation and luting of fiberglass post with subsequent composite resin restoration. It can be verified the immediate result of fragment reattachment and fiber post insertion.

Discussion

The employed technique promotes immediate resolution for cases in which fragments possess optimal adaptation to the remaining tooth structure. However, it is difficult to determine its survival rate, even though the scientific literature reports many cases of successful reattachments[10,19,21] and restorations with glass fiber posts.[20,22] The survival rate of reattachments depends on fragment's fractured size,[23] and some studies report up to six years of successful follow-up.[10,19] Fokkinga et al[22] reported in a clinical trial, after 17-years follow up, that the survival rate of endodontically treated teeth with glass fiber posts ranged from 71% to 80% when the remaining tooth presents residual coronary walls.

Loguercio et al[24] investigated, in a *in vitro* laboratory study, the performance of some techniques for tooth fragment reattachments in endodontically treated teeth and reported that the placement of a post prior to reattachments of the fragment does not promote tooth reinforcement. However, in this laboratory study the fragment had a small size and the endodontic treatment did not produced a great loss of sound structure.

In the present case an extensive fracture occurred during normal masticatory function as a result of the fragility of the tooth structure. Therefore, in these situations, the association of a glass fiber post and composite resin in endodontically treated teeth promotes greater fragment retention,[25,26] and may produce greater reinforcement[9,20] since the entire fragment was composed of enamel, which is a friable tissue and more prone to fractures than dentin.[27]

Previous studies have shown that endodontically treated teeth can have the pulp chamber filled with composite resin in order to be reinforced.[14,28] Composite resins show elastic modulus similar to dentin; when properly bonded to the tooth structure there is the creation of a single unit (tooth plus restoration),[29] minimizing stress concentration at the interfaces between

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Figure 7. Excursive mandibular movements with anterior guides protecting tooth #12. Upper pictures shows protrusion with absence of contacts in #12, which is also observed in the lower pictures with right laterality.



Figure 8. Image of 6 months follow-up showing the quality of supporting tissues and tooth color.

tooth/resin or resin/post.[29] In the study by Loguercio et al,[24] the fracture resistance of endodontically treated teeth with a bonded fragment was similar to intact teeth filled with composite resin and fiber glass post.

When prefabricated fiberglass post is to be used, the space between the post and root canal walls results in a very thick cement luting line,[30] generating a weak area that can potentially compromise the long-term prognosis.[30] Thus, the use of fitted fiberposts, juxtaposed to the root canal, has been considered important to increase the resistance of restored set,[35] as done in this case.

The present report showed that a crown fragment could be restored with a fiberglass post in order to increase retention and possibly resistance to fracture, considering fragment margins were perfectly adapted and could be accessed. The technique of positioning the fragment with polyvinilsiloxane matrix enabled a greater precision to bonding procedures and resulted in functional and esthetic quality, besides the advantage of ease implementation and low cost.

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Conclusion

Extensive crown fractures can occur in endodontically treated teeth with great loss of sound structure. The fragment reattachment requires maintenance of structural integrity of the tooth, in addition to a secure retention. In the present case, the stabilization of the fragment with a polyvinilsiloxane matrix and use of a fiberglass post showed to be a simple and effective procedure.

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Removal of a silver cone by using clinical microscope and ultrasound: Case report

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ABSTRACT

Introduction: The retreatment of teeth with endodontic failure associated with the use of silver cone as filling material is still today a reality in the endodontic practice. The present work reports a case of endodontic failure resulting from the use of silver cone and subsequent endodontic retreatment. **Case report:** The procedure consisted of removing the existing metal-ceramic crown and endodontic retreatment with removal of the silver cone, which was apically sectioned by using ultrasound and clinical microscope. Next, the root canal system was filled and glass-fiber posts and metal-ceramic crown were placed. **Conclusion:** The use of microscope in association with ultrasound was crucial for performing the retreatment, thus allowing the silver cone to be safely removed without unnecessary wear of the dentinal structure.

Keywords: Retreatment. Ultrasound. Microscopy.

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Introduction

The retreatment of teeth with endodontic failure associated with the use of silver cones as filling material is still commonly found in the endodontic practice.

Silver cones were introduced as filling material by Trebitsh,[1] in 1929,being largely used in the past.[2] However, studies began to show that this material offered a poor apical sealing, leading to their exposure to tissue fluids and inducing both corrosion and formation of cytotoxic by-products.[3] This was mainly observed in those cases of overextension or where the sealer did not fill the entire area surrounding the cones.[4-7]

The phase of removal of the filling material is one of the most critical in the endodontic retreatment, mainly in those cases in which the silver cones are sectioned at the level of the middle and apical thirds, where no direct access is allowed. In this sense, the use of clinical microscope in association with ultrasound is extremely useful for the removal of silver cones,[8] since the former allows the filling material do be directly viewed and the latter enables to reach the root canal in depth, thus providing shearing of the sealer and opening spaces for the endodontic file.[9] Moreover, whenever needed, the cone itself can be carefully eroded without causing damage to the adjacent dental tissues.[6,10,11]

This study has reported a case of endodontic failure resulting from the use of silver cone as filling material and the subsequent endodontic retreatment of the tooth, which was conducted by using clinical microscope and ultrasound.

Case report

A 54-year-old female patient attended the endodontic clinic at the Federal University of Rio de Janeiro complaining of discomfort in her tooth #15, which had already been endodontically treated.

During the intraoral exam, it was observed diffuse oedema in areas of teeth #14 to #16 without presence of fluctuation point. Patient had pain at palpation and percussion. Pulp sensitivity test was not performed because the tooth had been previously endodontically treated. Radiographic analysis showed endodontic treatment with silver cone, sectioned at the apical third in association with thickening of the periapical ligament (Fig 1).

A treatment planning consisting of removal of the pre-existing crown, endodontic retreatment, cementation of the glass-fiber post and placement of a new metal-ceramic crown was proposed and accepted by the patient.

During the appointment, the metal-ceramic crown was removed by using a #3216 diamond bur (KG Sorensen) and transmetal cylindrical bur (Dentsply Maillefer). Next, an ENAC ultrasound (Osada Electric Co. Ltd. Nakatsu, Japan) in association with ultra-sonic inserts and clinical microscope (DF Vasconcelos) were used to remove the sealer completely until reaching the apical area, where the silver cone could be visualized. Once the silver cone was found, a #10 K-file (Dentsply Maillefer) was used to find the passage between silver cone and root canal wall, but this was not possible. As a result, the sealer line was carefully eroded to allow a passage. After this small erosion of the sealer, the #10 K-file (Dentsply Maillefer) could reach beyond the silver cone (Fig 2).

The tooth was instrumented until #25 K-file (Dentsply Maillefer). A #25 Hedströem file was used to try to pull the cone off, but unsuccessfully.

The tooth was temporarily sealed with coltosol (Vigodent) and camphorated paramonochlorophenol (Biodinâmica) was used as intracanal medication. A new appointment was scheduled to try removing the silver cone.

In the second appointment, the dressing was removed by using a #1012 spherical rotary bur (KG Sorensen) at high speed and then an exploration of the canal was performed with a #25 K-file (Dentsply Maillefer). Next, the apical region was widened until #35 K-file (Dentsply Maillefer) in order to pull the cone off by using a #35 Hedströem file (Dentsply Maillefer), but again unsuccessfully. By using a clinical microscope, it was possible to observe that the silver cone could not be removed because it was still stuck in the sealer. Again, ultrasound was used to aid removing the sealer still present in the root canal by vibrating both the file indirectly along the cone and directly the cone. In this way, it was possible to break the sealer at the interface level and remove the silver cone with the #35 Hedströem file (Dentsply Maillefer).

Instrumentation was then performed again according to the pre-enlargement technique, which consisted in preparing the middle-coronal third with

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Gates-Glidden drills in ascending order of size (#1, #2, #3, #4, #5) and subsequent preparation of the apical third.[12] Instrumentation was performed at zero limit, that is, within the apex in order to provide cleaning of the foramen. A 5.25% sodium hypochlorite solution was used for irrigation throughout the chemical-mechanical preparation, whereas the smear layer was removed with 17% EDTA. The root canal was dried with paper cones (Endopoints) and then obturation was performed by using extra-long medium gutta-percha – specialist series (Endopoints) and Pulp Canal sealer (Kerr-Syborn). Obturation was performed according to the condensation technique and the pack-down phase was performed with a thermo-compactor (Easy). Next, the root canal was refilled with thermoplastic gutta-percha (re-pack phase) by using a plugger (Obtura Spartan, Fenton) and the tooth was sealed in order to avoid contamination of the root canal system.

In the following appointment, the glass-fiber post (Reforpost, Angelus) was cemented to work as an intra-radicular support. Moreover, a filling nucleus was prepared, a metal-ceramic crown was made, and temporary crown was placed.

The case was finished in the following week with cementation of the metal-ceramic crown (Fig 3).

Discussion

The conventional retreatment is always the first treatment option in the cases of endodontic failure.[1,13] In the present case, the use of microscope in association with ultrasound was crucial for performing the retreatment. The silver cone was well-adjusted and trapped at an apical position, and according to the literature, well-adapted silver cones sectioned at the apical third level are difficult or even impossible to be removed.[14] The use of clinical microscope was crucial not only for aiding to visualize the cone, but also for removing it as

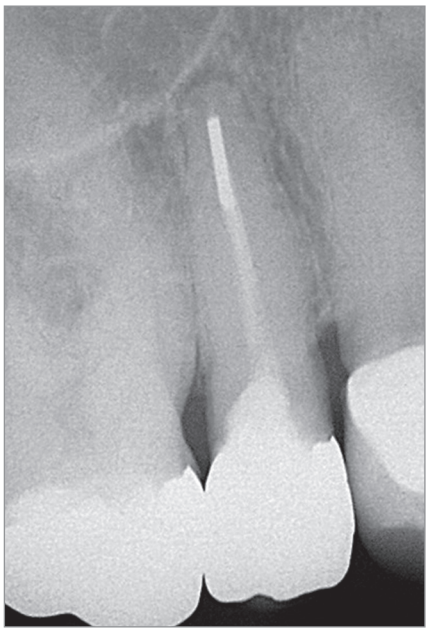


Figure 1. Initial radiograph.

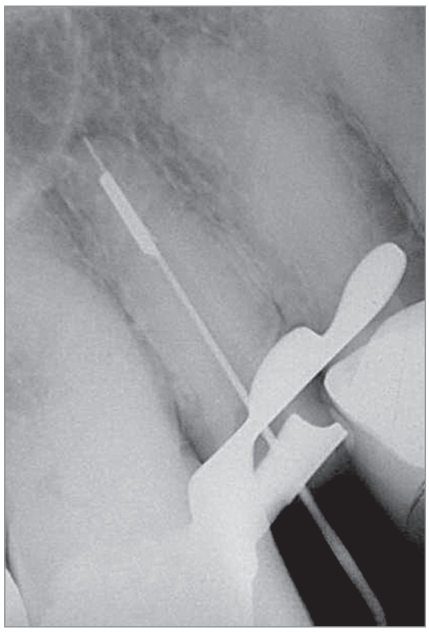


Figure 2. Radiograph showing the file reaching beyond the silver cone.

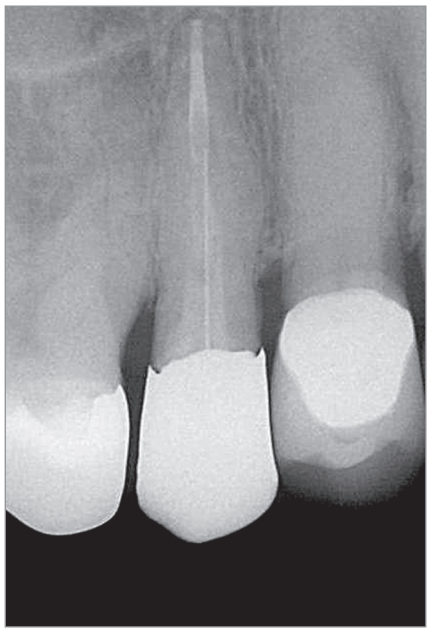


Figure 3. Final radiograph. Case was concluded after endodontic retreatment and cementation of glass-fiber post and metal-ceramic crown.

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well as for assessing whether there was the presence of a second canal, since the literature shows that about 40-50% of the second pre-molars have two canals.[15,16] This was not the case in our work either.

According to previous studies, the use of clinical microscope in association with ultrasound has increased the likelihood of success in the endodontic retreatment, since this technique enables better visualization of the root canal in terms of magnification and illumination. In addition, the ultrasonic inserts are increasingly specific used to facilitate the removal of cones from inside the canal without eroding the dental structure unnecessarily.[17,18,19] In the present case, the ultrasonic inserts were very useful because the tooth was fully filled with sealer, that is, from the cone to the coronal region and with no presence of gutta-percha. Removing this sealer with low-rotation burs would result in more wear of the dental structure and risk of deviations and/or perforation.

In the case reported here, following removal of the silver cone, the root canal was prepared before its obturation as no clinical sign contra-indicating the obturation was observed, such as the presence of exudates.[1,2,13]

With the passage along the silver cone and its removal, it was possible to perform instrumentation throughout the entire root canal and have a hermetic and three-dimensional root canal system, which will favour the prognosis of this new treatment.[1]

A glass-fiber post was chosen because it requires less time for preparation, besides being less expensive compared to cast metal posts, since the procedure is performed in only one session and requires no laboratory phase.

Moreover, these posts behave biomechanically better than the cast metal ones as they have an elasticity module similar to that of the dentin, thus being less rigid than the metal posts.[20,21] The metal-ceramic crown was chosen due to its low cost and because the area was not esthetically demanding.

Conclusion

The use of clinical microscope in association with ultrasound has been crucial for performing the treatment, since this technique allowed the silver cone to be removed on a safe basis, that is, without eroding the dentinal structure unnecessarily.

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The use of white MTA in the treatment of internal root resorption: Case report

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ABSTRACT

Introduction: Internal root resorption is a rare occurrence, asymptomatic, with slow progression, detected through routine radiographic examination, in which appears as a radiolucent and uniform lesion. The etiology and pathogenesis are not well understood, and it can occur as a result of trauma, orthodontic force, excess of heat, and other iatrogenic causes. After diagnosis of internal resorption, endodontic treatment is the choice. **Objective:** This article aims to report the clinical case of a female patient, 19 years of age, underwent orthodontic treatment. After three years of treatment in the clinical and radiographic examination was verified the presence of internal root resorption in the tooth #22, which was asymptomatic. **Methods:** Pulpectomy and changes of calcium hydroxide curative was performed. After six months of the beginning of treatment, with the tooth asymptomatic, radiographically stable and no bleeding, was performed the fill of the pulp cavity with white MTA. In esthetic recovery of the element, was chosen subepithelial connective tissue graft through the technique of plastic and microsurgery, subsequently a direct facet of composite resin was made. **Conclusion:** Therefore, it can be concluded that the clinical and radiographic control of patients undergoing orthodontic treatment is important in the diagnosis of internal resorption. The White MTA presented itself as an excellent alternative for treatment of internal resorption, assisted with esthetic treatments.

Keywords: Root resorption. Root canal obturation. Esthetics.

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Introduction

Root resorption is characterized by the loss of hard dental tissues by the action of clastic cells (osteoclasts, odontoclasts and dentinoclasts).[2,16]

Internal root resorption is a relatively rare occurrence,[4,9,12,14,16,20] generally asymptomatic,[1,3,4,5,8,11-14,16,17,18] and is detected in routine radiographic exams,[1-5,8,11,12,14,17-20] in which it appears as a radiolucent[1,3,4,12,14,16,18] and uniform[1,4,14] lesion.

When this pathology has been diagnosed — if the tooth is considered restorable and has a reasonable prognosis —, endodontic treatment is the treatment of choice,[16] and must begin as quickly as possible to limit the progression of internal resorption.[8]

Selection of the suitable restorative material for cases of root perforation continues to be a challenge, especially if there is extensive tooth loss.[11] Various biomaterials have been used to seal root perforations, among them MTA has gained popularity due to its biocompatibility,[1,4,7,11,15,18] potential to induce osteogenesis and cementogenesis,[19] sealing capacity superior to that of other materials,[1,4,11,14,15,18] mechanical strength,[19] capacity to promote healing of the peri-radicular tissues,[19] bactericidal activity,[14,18] capacity for adhesion in the presence of blood,[14,18] radiopacity,[4,14] resistance to humidity,[4] in addition to being well tolerated by the tissues.[9]

Due to its excellent physical and biologic properties, MTA has been used in various clinical situations, such as: pulpotomy,[1,7,11,15,18] pulp capping,[1,7,11,15] cases of root perforation,[1,4,11,14,15,18] apexification,[7,14,18] root canal filling,[14,15] and in root resorptions.[4,11]

White MTA has a reduced setting time, increases the fracture resistance of a weakened tooth, in addition to being of a color similar to that of the tooth.[19]

The aim of this article is to report a clinical case of internal root resorption with root perforation, using white MTA as reparative material.

Case report

The patient, a 19-year-old woman, was indicated for endodontic treatment after radiographic analysis of tooth #22, as it presented no clinical signs or symptoms. In anamnesis, the patient reported that she had undergone orthodontic treatment for three years.

In the clinical exam, tooth #22 did not respond to the test for pulp sensitivity to cold, and in the radiographic exam (Fig 1) the presence of an oval-shaped bone rarefaction was verified in the middle third of the root, which characterized internal root resorption.

The patient was informed of the diagnoses, treatment and prognosis, which could even compromise maintenance of the tooth, seeing that communication of the internal resorption with the alveolar bone had been visible in the initial radiograph.

After coronal opening and access to the root canal, pulpectomy was performed with Hedströem files, with the aid of ultrasound, odontometry, irrigation with sodium hypochlorite and final irrigation with physiological solution and dressing with $Ca(OH)_2$ paste and distilled water. There was abundant bleeding, characteristic of teeth with internal root resorption. The presence of dystrophic calcification did not allow access to the apical third of the root (Fig 2).

In the second week, the second session was performed, with instrumentation of the canal up to #80 file, irrigation with sodium hypochlorite and final irrigation with physiological solution activated by ultrasound and dressing with $Ca(OH)_2$ paste, propylene glycol and iodoform. The canal was filled, using a 1.2 ml special syringe and 0.17 Capillary Tip (Ultradent®) (Fig 3). As the patient presented sensitivity, 500 mg of naproxen every 12 hours for 3 days was prescribed.

After this a new appointment was made to change the $Ca(OH)_2$ dressing for 15 days, then another three changes every 30 days and a final change at 60 days, all performed with canal instrumentation, irrigation with sodium hypochlorite and final irrigation of physiological solution activated by ultrasound and dressing with $Ca(OH)_2$ paste (Fig 4).

After the period of 6 months from the beginning of treatment, and finding that the tooth was asymptomatic, without bleeding and the internal resorption radiographically stable, including the formation of mineralized tissue in the area of communication of the internal cavity with the periodontium, the internal pulp cavity was filled with white MTA (Ângelus - Londrina - PR, Brazil) with the aid of calibrated shims of the Schilder type (Fig 5).

Clinical/radiographic control was continued for one year after beginning with the clinical treatment (Fig 6). The tooth was shown to be stable, without signs and symptoms and with absence of apical rarefaction, however, with perceptible change in color, especially

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Figure 1. Initial radiograph of tooth #22, evidencing internal resorption.

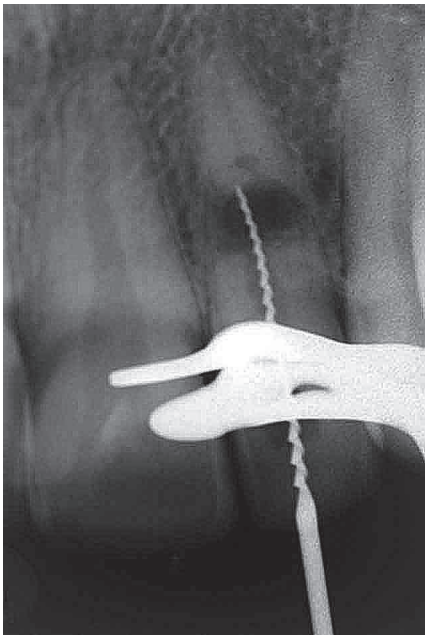


Figure 2. Odontometry and emptying of root canal with the aid of a Hedströem file and ultrasound.

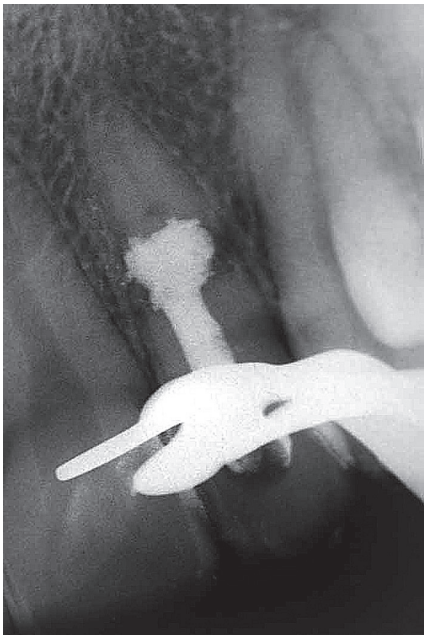


Figure 3. Radiograph showing root canal filling with $Ca(OH)_2$ paste and iodoform.

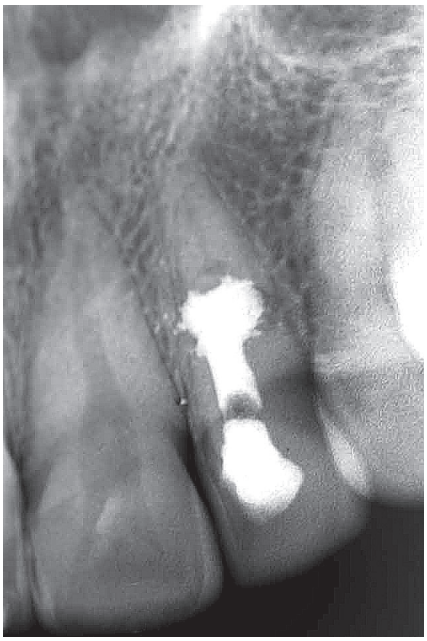


Figure 4. Radiograph showing root canal filling with $Ca(OH)_2$ paste and iodoform, 15 days after the first session.

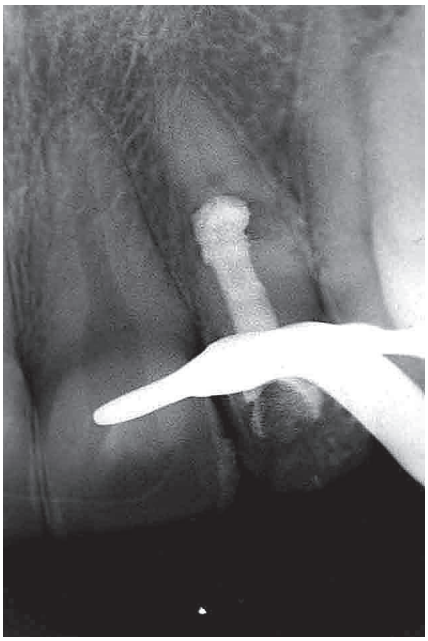


Figure 5. Radiograph showing root canal filling with white MTA. It can be observed the formation of mineralized tissue.

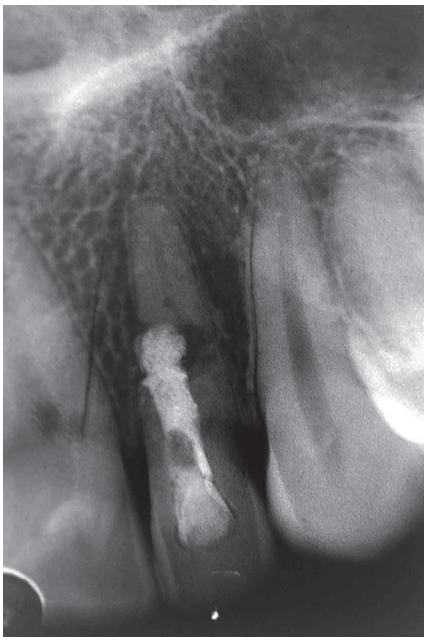


Figure 6. Follow-up radiograph after one year of treatment.

in the cervical third (Fig 7). As a minimally invasive alternative for the esthetic recovery of this tooth, initially the option was to place a subepithelial conjunctive tissue graft, by means of the micro plastic surgery technique, in order to increase the thickness of the inserted gingiva, helping to mask the root discoloration at the gingival margin (Fig 8) and afterwards, the fabrication of a direct facet made of resin composite (Fig 9).

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Figure 7. Lateral view, evidencing the darkening of tooth #22, mainly on cervical.



Figure 8. Clinical aspect of right facet in composite resin, performed after the graft for increasing gingival thickness of tooth #22.



Figure 9. Final aspect of smile, preserving the element #22 and reestablishing anterior esthetics.

Discussion

Although its etiology and pathogenesis have still not been completely elucidated,[16] some factors have been proposed for the development of internal root resorption, such as trauma,[8,9,12,13,14,16,19] excessive heat generated during denting cutting,[9,14,16,19] resection of the roots,[16] and other iatrogenic causes. When there is no specific cause, it is denominated idiopathic internal root resorption.[18] These factors stimulate the pulp tissue, leading to the development of inflammation, and after this, some cells within the pulp differentiate into osteoclasts and macrophages, resulting in dentinal resorption.[13]

The cement acts to protect the external root surface. The pre-dentin and odontoblast layers act to prevent the resorption of dentin. However, the pulp inflammation may lead to loss of the pre-dentin and odontoblast layers, thus permitting resorption by the clastic cells.[2] The internal aspect of the root canal is resorbed by the action of multinucleated giant cells which are adjacent to the granulation tissue of the inflamed pulp.[1,12]

Orthodontic movement has been associated with some alterations in the dentin-pulp complex, such as interruption of the odontoblast layer, alteration in the microcirculation of the pulp and hypoxia. Depending on the duration, type and magnitude of force, these alterations may affect the pulp tissue in a reversible or irreversible manner. Orthodontic forces are capable of triggering a cell response similar to that observed during caries progression, cavity preparation and occlusal trauma.[6] This may have occurred in the case presented, involving tooth #22, which led to the appearance of internal root resorption, however, as it did not present signs and symptoms, late diagnosis was made. Irrespective of the trigger factor (trauma, orthodontic treatment or some other factor), there is a general consensus that in order for progression to occur, internal root resorption depends on two situations: the pulp tissue in the area of resorption must be vital, and the coronal pulp must be completely or partially necrotic so that resorption occurs, because it allows the bacterial infection and microbial antigens to enter into the root canal. Microbial stimulation is

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necessary for the continuation of inflammatory internal root resorption.[9] Nevertheless, a negative pulp sensitivity test cannot be obtained as a result of the presence of necrotic pulp tissue in the coronal portion of the root canal,[12] as occurred in the clinical case described, in which tooth #22 did not respond to the sensitivity to cold test.

After the diagnosis of internal root resorption, the treatment must be started rapidly, with the objective of removing any vital remnant of apical tissue and necrotic coronal portion of the pulp, which may be sustaining and stimulating the resorption cells by means of their blood supply.[16] Therefore, coronal opening of tooth #22 was immediately instituted in order to empty the pulp cavity, using Hedströem files and ultrasound. According to Jacobovitz,[11] when blocking the activities of the cells responsible for the resorption process, one avoids greater loss of hard tissue, in addition to preventing this loss from attaining the external surface of the root, resulting in root perforation,[14] and destruction of the adjacent periodontal tissues.[3,14] However, in the case of tooth #22, when the diagnosis was made, communication between the pulp cavity and the alveolar bone had already occurred.

In the treatment of teeth with internal root resorption, there is a great deal of bleeding due to the presence of a part of the pulp that is alive, which may make it difficult to visualize access to the canal. By means of irrigation with sodium hypochlorite, one obtains a reduction in bleeding, thus facilitation visualization of, and access to the canal.[9] Calcium hydroxide may also be used to control the bleeding; in addition to this, it acts on necrotizing the residual pulp and causes the necrotic tissue to become more soluble in the sodium hypochlorite.[9] Calcium hydroxide has properties such as antibacterial action to destroy microorganisms, dissolution of tissues, stimulating the formation of hard tissues and inhibiting clastic cells.[17]

The irregularities present in the root canal system, especially in internal root resorption defects, make it difficult to clean and fill the root canal. The persistence of organic rests and bacteria in these irregularities may interfere in the success of endodontic treatment in the long term.[18] The removal of vital tissues from the resorption gaps is aided by irrigation with sodium hypochlorite and the use of calcium hydroxide paste, filling the entire canal and resorption gap, leading to necrosis of any remaining tissue present in this region, and causing these tissue remainders to be removed by means of the irrigation with sodium hypochlorite.[20] In the clinical case of tooth #22, irrigation with ultrasound and calcium hydroxide dressings were used to promote adequate cleaning and induce repair by hard tissue deposition.

MTA may create an environment favorable to periodontal cure, allowing the growth of cement on its surface.[1] The clinical use of MTA in humans has demonstrated its applicability in a humid environment, preventing bacterial infiltration and alkalinization of the medium. On account of the presence of calcium oxide in its formulation, it has biologic properties similar to those of calcium hydroxide, making it useful for healing the tissue.[11] This is why MTA was elected the filling material in the clinical case of tooth #22.

One of the disadvantages of MTA is related to its color.[1] The original formulation, gray MTA, may cause a gray line that may be visible through the tooth structure.[10] White MTA was introduced in 2002 for use in esthetic areas.[10] With the introduction of white MTA on the marked, the problem of discoloration was revolved.[1] Because we used white MTA in the clinical case of tooth #22, in spite of a year having passed, there was a discrete discoloration of the tooth, and it was necessary to perform a graft to increase the thickness of the gingiva, and afterwards place an esthetic facet.

Conclusions

Performing clinical and radiographic control of teeth in patients submitted to orthodontic treatment is important in the diagnosis of internal root resorption.

With the use of adequate techniques for emptying the pulp cavity, irrigation activated with ultrasound and medications that help with hemostasis, high success rates may be obtained in the treatment of teeth with internal resorption.

The use of white MTA was shown to be an excellent alternative filling in internal resorptions with great destruction and communication, as occurred in this case, and with a favorable prognosis for the maintenance of the tooth.

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Treatment of a lately replanted avulsed permanent tooth: Case report

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Thaís Mageste **DUQUE**[4]

ABSTRACT

Avulsion after dental trauma is one of the most serious emergencies in the dental offices. Treatment success for this kind of injury lies on explaining to patients and dentists about the prompt management of the avulsed tooth. In the present study it's emphasized the relationship between the whishes of the patient and his parents and the maintenance of the avulsed tooth in the oral cavity, exerting its esthetic and masticatory functions. Besides the time, other factors such as handling the tooth to be reimplanted, replantation technique, storage medium, endodontic treatment of the reimplanted tooth, intracanal medication and postoperative control contribute to a better prognosis. Dental avulsion usually affects children during their periods of bone growth, thus replantation aims to eliminate esthetic, psychological and social consequences for the patient, and can avoid prosthesis, satisfying patient's whishes.

Keywords: Dental avulsion. Dental replantation. Facial traumas.

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Introduction

Dental trauma is one of the main causes of loss of permanent anterior teeth.[34] Avulsion, as a possible result of traumatic injuries, is one of the most serious emergencies in dental offices,[26] causing the complete separation of the tooth and its alveolus (bone cavity where it is inserted), and disruption of the periodontal ligament fibers, remaining part of it adhered to the cementum of the tooth and the other part to the bone.[23]

The traumatic removal of a tooth from its respective alveolus produces disruption of periodontal ligaments and blood supply to the pulp tissue. As a result, the dental pulp gets necrosis and the periodontum is severely damaged. The type of cure is directly related to the extent of extra-oral time and the conditions under which the tooth was kept before replanted.[6] The replantation has been proposed as an attempt to reintegrate the avulsed tooth to its normal anatomical position. It represents one of the most conservative behavior in dentistry because it allows the preservation of function and esthetics, postponing the need for fixed or removable prosthesis and reducing the psychological impact resulting from immediate tooth loss.[2,20,23,27,32]

The highest incidence of avulsion affects the upper incisors in children from 7 to 12 years of age due to the childhood and adolescence activities. The overjet with incisors protrusion and insufficient lips sealing are predisposing factors to dental traumas.[20,23,26,27,28,32]

The tooth loss can determine a psychosocial impact especially among teenagers. The body appearance, especially the face, plays an important role in humans relations,[38] and the eyes and the mouth are the components most commonly associated with physical attraction, acting as key-factors in social interactions and in determining the personal success.[9]

Although it is impossible to guarantee the long term maintenance of a traumatized tooth, the patient's age, injury severity, timely treatment and follow-up of the teeth can maximize the success chances.[3] The delay in reimplanting the tooth is often related to the lack of knowledge of the patients, their parents or who treated them.[32]

Mackie and Wortington[21] mentioned that replantation should always be considered as an alternative for the treatment. Andreassen[5] concluded that there are many factors that influence the treatment, as factors outside the office and the way the dentist works. Also concluded that the most important factor is the extra-alveolar time, and the smaller the time the tooth remains outside its alveolus, the greater the odds of a successful replantation.

The factors that can change the prognosis of replantation are: The extent of the trauma, length of extra-alveolar time, storage medium, contamination, how the tooth is handled and status of the avulsed tooth. These factors can cause problems such as periodontal inflammation, root resorption, and ankylosis, which interfere with the success of reimplants.[20,23]

The best storage medium for avulsed teeth would be the alveolus itself.[24] When there is no possibility of maintaining the tooth in the patient's mouth, the ideal solutions are: Milk, saliva, saline solution, blood and tissue culture media.[11,14,20,32,37]

It is important to carefully handle the tooth, not touching and/or scraping the periodontal ligament. The accidental removal of part of this ligament determine the ankylosis of the reimplanted tooth.[28]

Therefore, the endodontic treatment of an avulsed tooth is necessary since pulp necrosis occurs as a consequence. Some dressing therapies are proposed as a way to preserve the tooth, however the medications exchange time vary with the degree of impairment and sequelaes.[8,16,18] A new therapy with chlorhexidine gel, calcium hydroxide and zinc oxide for treating avulsed and reimplanted teeth has been proposed by Soares and Souza-Filho.[37]

For this reason, aiming at enlightening the treatment and replantation of avulsed teeth, this case report will describe the clinical and radiographic condition of an anterior avulsed and reimplanted tooth, treated with dressing of calcium hydroxide with different vehicles, and the seven years follow-up.

Case report

An 11-year-old female patient presented to the endodontics office 40 days after the avulsion and replantation of tooth #21.

Before the anamnesis, her mother (legal responsible) demanded the non-extraction of the traumatized tooth. Therefore the whole endodontic therapy

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was elucidated and discussed in order to prevent or postpone the extraction of that tooth. Thus the mother reported that the patient was playing in the playground and fell to the ground causing the avulsion of tooth #21. After the accident she took about 15 minutes to find the avulsed tooth. After this period she was suggested to wash the tooth with water for about 5 minutes. The mother asked the patient to keep it under her tongue and went to a dental office where the dentist cleaned the tooth in a saline solution without scraping the root external surface. About one hour after the avulsion, the dentist performed the replantation with a semi-rigid orthodontic wire (splinting), performed the coronary access, pulpectomy, application of calcium hydroxide-based dressing with saline solution and temporary restoration with Coltosol.

The dentist prescribed prophylactically tetanus vaccine — since the patient's mother had doubts whether her daughter had received this medication — as well as prescribed amoxicillin-based systemic and antibiotic medication.

The splinting was maintained for approximately 30 days and only after its removal the patient went to the endodontist. Also during the anamnesis it was found that the patient had no systemic health problem, and the radiographic examination showed that the #21 tooth presented a large area with external root resorption and also an open apex, although in this evaluation it was observed the absence of root fracture or bone fracture (Fig 1A).

About 40 days later, the coronal opening was improved and biomechanical preparation of the root canal was performed with endodontic hand files and 1% sodium hypochlorite. The odontometry was performed during the canal preparation to confirm the working length (Fig 1B).

The canal was dried with sterile paper points, and flooded with 17% EDTA for 3 minutes with manual agitation. After removal of EDTA, a new drying was performed and calcium hydroxide aqueous solution (saline) was inserted into the root canal, which was replaced after 15 days.

In the second session it was inserted a calcium hydroxide paste with propylene glycol and iodoform (Fig 1C). The dressing was changed when it was radiographically verified that it had been partly resorbed. These exchanges are justified because it was a tooth with external resorption and incompletely formed apex.

After one year and nine months, the endodontist was informed by the responsible for the patient that she would take part on a exchange program abroad for 3 years. Thus the endodontist decided to make a temporary root canal filling with calcium hydroxide, 2% chlorhexidine gel and zinc oxide in a 02:01:02 proportion,[37] in Coltosol consistency, which was incrementally inserted and adapted by means of vertical condensers throughout the whole root canal until apical portion. Later, the teeth were sealed with Coltosol, restored with composite resin and then radiographed (Fig 1D).

After three years and one month the patient returned to the office to continue the treatment. It was made a periapical intraoral radiograph (Fig 2A) and also requested a cone beam tomograph to accurately assess the root involvement (Fig 2B). When evaluating the results it was observed mild resorption of the temporary filling of root canal, and stabilized root resorption, offering conditions for the permanent root canal obturation.

A few days later the endodontist removed the temporary filling of the root canal, performed new biomechanical preparation, as described before, and performed root canal filling with gutta-percha and sealer based on calcium hydroxide (Figs 2C, 2D).

After seven years, the patient presented to perform follow-up. Periapical intraoral radiographs, cone beam computed tomograph and intraoral photographs were requested. Through these exams it was observed the root resorption stabilization (Fig 3A); mild coronary darkening possibly due to the use of iodoform; cervical gingival recession and periodontal health (Fig 3B); lack of mobility and presence of periapical repair with continuous lamina dura throughout root length (Fig. 3C).

Discussion

Dental replantation is one of the most conservative procedures in dentistry,[2] although the improper handling of the teeth can lead to its loss.[36] According to Poi et al[32] and Marzola,[23] this occurs because almost 82% of the population don't know what to do after dental traumas. In the present case report, after the avulsion, the mother washed the tooth with water and asked the

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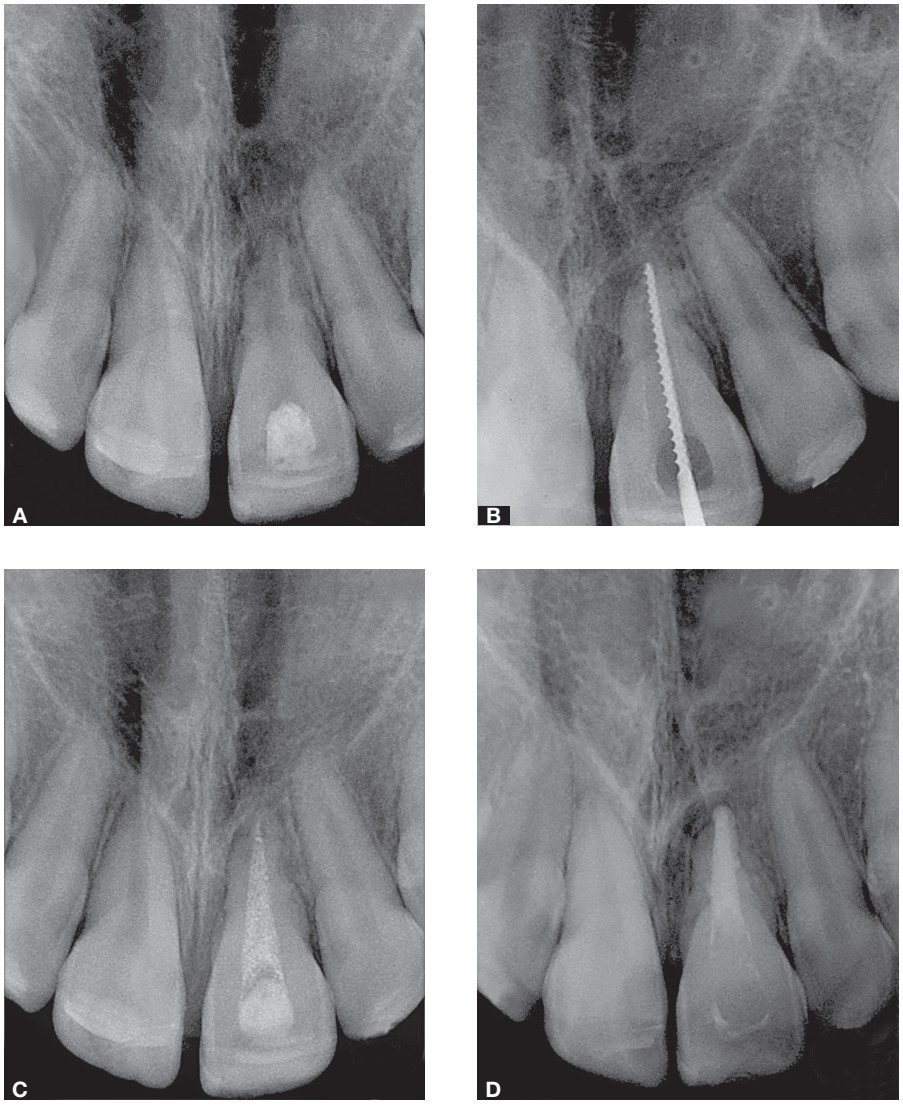


Figure 1. A) Initial radiograph showing area with external root resorption and open apex. **B**) Odontometry to confirm the working length. **C**) Dressing with calcium hydroxide, propylene glycol and iodoform. **D**) Temporary root canal filling with calcium hydroxide, 2% chlorhexidine gel and zinc oxide in 02:01:02 proportion.

patient to put it under the tongue. According to Marzola et al,[22] the best storage medium to avulsed tooth is its alveolus. Morgado et al[28] reported that water as that storage medium is as harmful as the dry medium, because it is important the correct osmolarity and pH of the storage medium and the hypotonic conditions result in lysis of cells. However Blomlof,[11] O'Donnell and Wei[30] report that despite saliva has some disadvantages such as low osmolarity and bacterial content, it minimizes the storage period in dry medium and maintains the tooth moisturized, offering the highest success odds.

Also according to Marzola[23] and Peterson et al[31] the milk can also act very effectively, promoting amazing results and helping to remove debris from the root and dissolve bacteria. In addition, due to its availability, remains the best option to be recommended and disseminated to the general population.[10] Thus, with the huge amount of information available in the media and internet, dentists should utilize these resources to make the patients aware that if the avulsed tooth cannot be immediately reimplanted, it should be kept in a proper storage medium.

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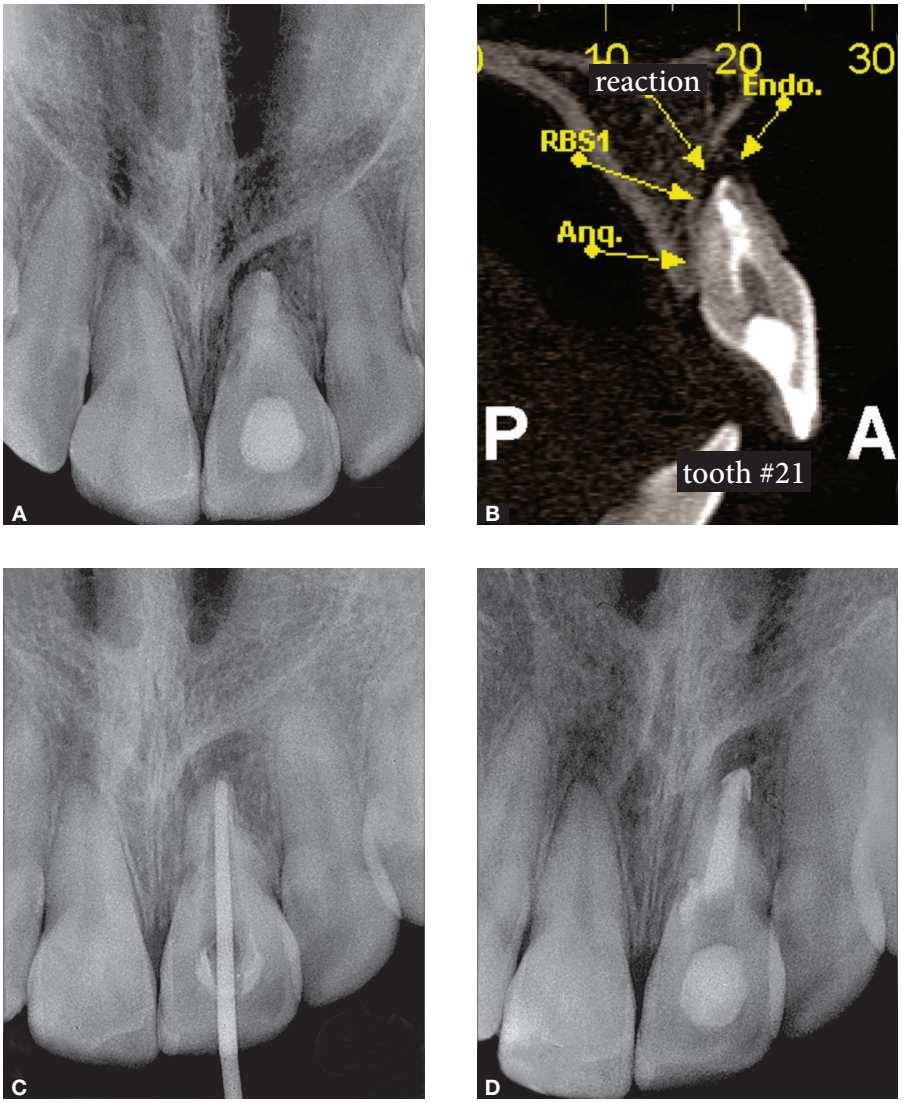


Figure 2. A) Radiograph after 3 years and 1 month with temporary filling. **B**) Tomographic image showing the root involvement. **C**) Removal of root canal temporary filling. **D**) Definitive root canal obturation with gutta-percha and calcium hydroxide-based sealer.

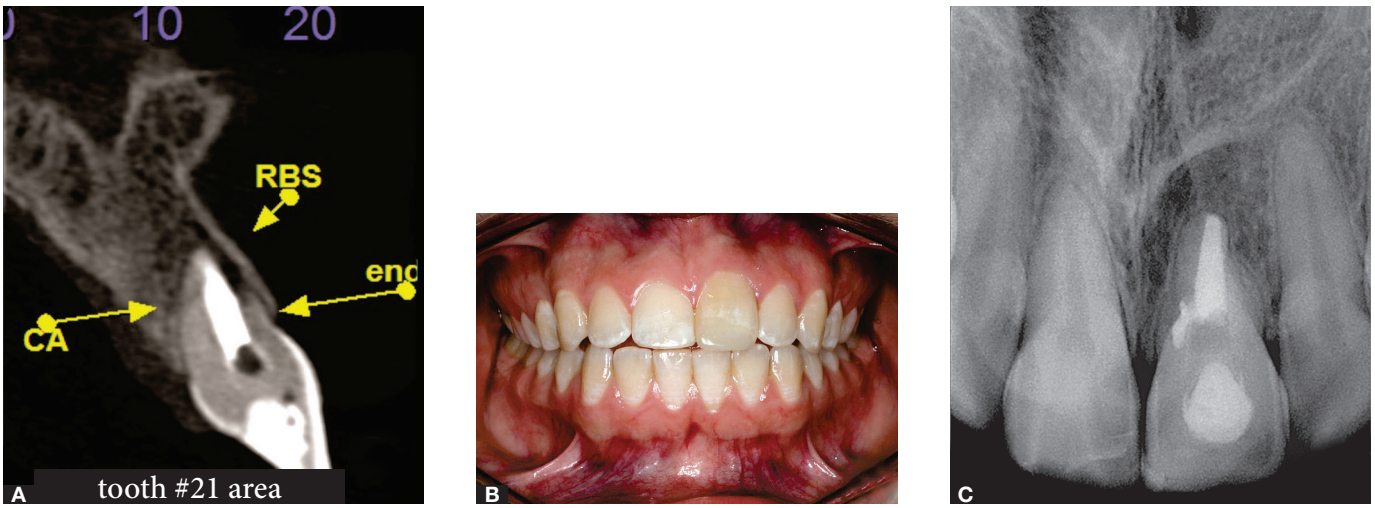


Figure 3. A) Follow-up tomography, after 7 years of treatment beginning. **B**) Photograph showing mild crown darkening, cervical gingival recession and health periodontium. **C**) Follow-up radiograph, after 7 years of treatment beginning, evidencing the presence of periapical repair, with continuous lamina dura.

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The recommended ones according to Hwang et al[19] are: Hank's saline solution, eggwhite, milk powder, Gatorade®, propolis and green tea.

At the office, the dentist chose to clean the tooth with saline solution and do not scrap the root surface before dental replantation. This is corroborated by Ruellas et al,[34] Morgado et al[28] and Marzola,[23] who attest that the presence of periodontal ligament remnants in the root surface is essential to the success of reimplanted teeth, and the preservation of its vitality is the primary factor. Saad Neto et al[35] believe that even parched, the cemental periodontal ligament should be preserved. If well-treated it promotes the functional recovery of the structures on the periodontal ligament space. Morgado et al[28] and Marzola[23] attest that in order to inhibit or retard the external root resorption, the treatment of this root surface can be done with the use of fluoride associated with immersion in antibiotic. According to Moreira[27] and Marzola,[23] replantation must be done immediately by slow insertion, to allow the leakage of fluids from the alveolus, along with continuous pressure for five to ten minutes. If replantation is abrupt the pressure of fluid may cause extrusion of the tooth, and care must be taken not to let it in premature occlusal contact.

After the replantation, the dentist performed a semi-rigid splinting with orthodontic wire, which was maintained for a period of 30 days in order to stabilize the tooth in the alveolus. The semi-rigid immobilization allowed arrangement of functional periodontal ligament fibers, avoiding ankylosis.[24] However the period in which the splinting was used in this case contradicts the period recommended by other authors[6,7,33] who claim that the ideal time is 7 to 10 days, since the more rigid and lasting is the stabilization, greater root resorption is expected.

The current trend is to make a soft splinting and establish an occlusal function that will act as a physiological stimulus in the metabolism of periodontal tissues.[23,31] The physiological movements of the teeth are indicated because they promote fibrous union instead of osseous union of root to alveolar bone.[31]

EDTA was used before the medication for all sessions and before the final root canal filling in order to increase the permeability of dentin and facilitate the diffusion of calcium hydroxide ions on dentin. This is justified because in the literature there is a great number of studies using EDTA in different concentrations and associations, in order to improve the cleaning of root canal walls, by removing the smear layer.[15,25]

In order to help in the decontamination of root canal, to promote the apical closure and/or deposition of mineralized tissue and to stabilize resorption, the endodontist firstly used in this case report a dressing based in calcium hydroxide paste with aqueous vehicle (saline solution), promptly promoting the diffusion of calcium hydroxide; and at a second moment, a viscous vehicle (propyleneglycol) in order to promote a slower diffusion of calcium hydroxide. This association with various vehicles can also inhibit bacterial growth and control infections by residual lipopolysaccharides. Aiming to decrease the number of necessary exchanges of this medication, other authors[16,17,29] agree with this protocol employed. However Felippe et al[13] disagree because they claim that this medication could remain for longer periods as three, six or twelve months. The use of temporary filling based in calcium hydroxide, 2% chlorhexidine gel and zinc oxide is corroborated by Soares and Souza-Filho[37] that state that when this medication was maintained for an average of 9.1 months caused a decrease in the percentage of all clinical signs and symptoms initially observed, with the exception of ankylosis, which remained unchanged, showed a significant reduction in the percentage of thickening of the periodontal ligament. And regarding root resorption, it can be noted that there was no reduction in the percentage of inflammatory resorption. The presence of these resorption associated with dental trauma was also reported by Andreasen.[4]

In the present study we believe that the period of extra-alveolar time, the roots washing with water and saline solution, semi-rigid splitting, intracanal dressing and temporary filling with the paste contributed to preserve the tooth in the oral cavity exercising its esthetic and masticatory function, avoiding prosthetic or even radical procedures, such as extraction. Thus, we can say that spite of the tooth being a little more dark and with gingival retraction, it was the right decision not to extract the teeth in the initial treatment. We also believe that the satisfaction of the patient and their parents was achieved because, as in the study of Moreira,[27] giving the patient information about the treatment and prognosis, and explaining the possible consequences of replantation after

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avulsion (ankylosis, external resorption and infection) is extremely important to obtain patient collaboration with the selected therapy.

Conclusion

Based on the clinical results of this case report, we stated that the replantation of avulsed permanent teeth is a valid clinical management, because it can preserve the tooth in the oral cavity, and we believe that intracanal dressing based in calcium hydroxide, still reveals as the better substance to be used in an attempt to obtain good clinical condition to establish the tooth in the oral cavity. The dentists should, whenever it's possible, try to respect the wishes and desires of the patients, because in this way the patient will get better cooperation across the treatment.

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Healing of an extensive periapical lesion by means of conventional endodontic treatment

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ABSTRACT

Objective: The radicular cysts, also called peripheral cysts, are inflammatory cysts of the jaws, formed in the dental apices, with necrotic and infected pulps. The aim of this study was to report a clinical case of an extensive periapical lesion of endodontic origin, suggestive of peripheral cyst between teeth #33 and #34, near the region of the mental foramen. **Methods:** The necropulpectomy endodontic treatment was performed no tooth #34, the dressing with calcium hydroxide paste was renewed on a monthly basis for 10 months, followed by endodontic obturation. **Results:** After one year of conventional endodontic treatment the patient is without signs of recurrence. **Conclusions:** The treatment endodontic provided a favorable clinical and radiographic response, without pain symptoms with the signs of regression of lesions, no need for additional surgery in the periapical region.

Keywords: Calcium hydroxide. Radicular cyst. Root canal treatment.

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Introduction

The radicular cyst currently represents the most common odontogenic cysts, this lesion predominates in adults between the third and sixth decade of life.[1-5] Also called peripheral cysts, are inflammatory cysts of the jaws, formed in the dental apices, with necrotic and infected pulps, thus they are considered as direct consequences of apical granulomas.[3,6] Its etiology generally come from the root canal infections caused by caries. It is known that the immune-inflammatory process is the basis of formation of dental granulomas and radicular cysts.[7]

The radicular cyst represents a pathological cavity, internally coated by epithelium and externally by a fibrous that contains, inside a semi-fluid or fluid material.[8,9] The formation of the radicular cyst has three distinct phases: initial phase, the phase of cyst formation and growth stage. In the first phase the epithelial rest of Malassez are continuously proliferate when stimulated by chemical mediators released during the inflammatory process, forming a epithelial net inside the apical granuloma. In the last phase, the existing micro cavity characterizes a cystic lesion that may be microscopically diagnosed. The cystic growth occurs slowly and continuously.[5]

Radiographically, the radicular cyst presents a picture which is radiolucent homogeneous density unilocular, circumscribed, round, oval, associated with an intact root apex, a devitalized tooth with rupture of the hard lamina at the apex,[10] very familiar to granuloma, as a circumscribed peripheral bone rarefaction may present a radiopaque line delimiting the lesion.[11]

According to World Health Organization the radicular cyst is classified as an inflammatory odontogenic cyst and represents a major cause of bone destruction of the jaws. Therefore and the frequent incidence of these lesions in the clinics that provide dental care, researches are developed in this area.[12,13] The recommended treatment for periapical lesions, with or without the involvement of periapex, has been the root canal treatment. A discussion regarding the efficacy of one and two-visit treatment of infected root canals has been going on among scientists for a long time.[14] Currently strong scientific evidence indicates regression of cystic lesions after conventional endodontic therapy with periodic changes of the medication based on calcium hydroxide with or without paramonochlorophenol camphor or 2% chlorhexidine gel, with a very high success rate.[15-20]

The endodontic surgery should only be given when the conventional endodontic treatment fails to restore the integrity of the peripheral tissue.[11,21]

Case report

The patient, age 49, female, Caucasian, ought dental endodontic referred by a dentist oral maxillofacial, who found the presence of a radicular cyst between teeth #33 and #34, near the region of the mental foramen. The patient complained of pain and mobility in the region of tooth #34. Anamnesis was conducted, clinical examination, radiographic examination and testing of pulp vitality in teeth #33 and #34. Pulp necrosis and mobility was observed only on tooth 34. In peripheral radiograph (Fig 1), the panoramic (Fig 2) and tomography (Fig 3), observed the presence of radiolucent, unilocular, located in the anterior mandible between the elements #33 and #34. By the clinical and radiographic characteristic, the hypothetical diagnosis was inflammatory peripheral cyst associated with the first pre-molar, tooth #34. The necropulpectomy endodontic treatment was performed using the crown-apex technique. The channel was modeled irrigated with solution sodium hypochlorite 1%, the instrument memory was #45 K-file. After biomechanical preparation complete was used as canal dressing calcium hydroxide paste, made with calcium hydroxide pro-analysis and propylene glycol. The dressing with calcium hydroxide paste was renewed on a monthly basis for 10 months. The coronal sealing was carried out with light-curing glass ionomer cement type IV (Vitremer, 3M ESPE, U.S.A). After 10 months through periapical radiographs was observed significant regression of lesions with significant new bone formation and no symptoms in the patient and performed the root canal filling using thermoplastic technique using gutta-percha cones and Endofill cement with the help of a thermo compactor 60 (Mc Spadden), after a week was made final restoration of the tooth 34 with composite resin (Filtek- 3M ESPE- U.S.A).

Results

After one year of conventional endodontic treatment the patients without signs of recurrence, the endodontic treatment provided a favorable clinical and

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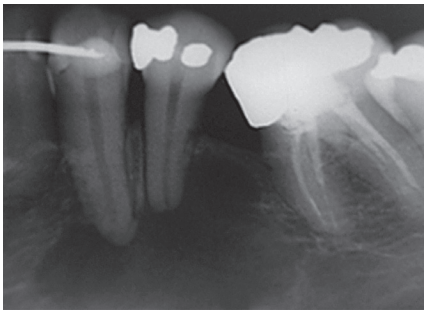


Figure 1. Periapical radiograph showing extensive periapical lesion of endodontic origin, suggestive of periapical cyst between teeth #33 and #34.

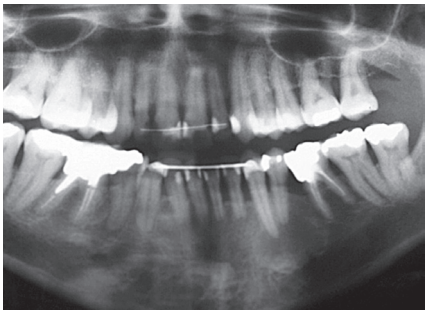


Figure 2. Panoramic radiograph showing extensive periapical lesion of endodontic origin, suggestive of periapical cyst between teeth #33 and #4.

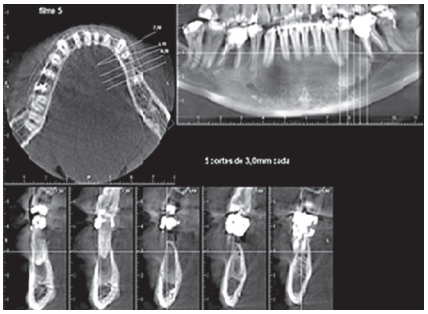


Figure 3. Cone beam volumetric tomography with shooting in small volumes the jaw teeth #33 to #36.

periapical (Fig 4) and panoramic radiographic (Fig 5), without pain symptoms with the signs of regression of lesions, no need for additional surgery in the periapical region. The case remains being accompanied.

Discussion

In this case was observed a significant regression of a cystic lesion associated with tooth #34 after conventional endodontic treatment associated with the medication a paste of calcium hydroxide monthly renewed for 10 months.

The results of this study is in agreement with other studies[22-28] which observed regression of non-surgical radicular cysts after conventional endodontic treatment, allowing tissue reactions and immunological and inflammatory nature, consistent with the repair. Was inferred that the endodontic treatment non-surgical can be successfully implemented in a high percentage of cases of radicular cysts and that its success doesn't depend on the nature of the lesion, but appears to be influenced by individual variations of host 't immune response.[22] Proper preparation of biomechanics followed by calcium hydroxide medication periodically renewed represents a nonsurgical approach to resolve extensive inflammatory peripheral lesions.[28] The regression of the cystic lesion with conservative treatment (based on successive changes of dressings $Ca(OH)_2$ basic, could occur due to collagen deposition generated by the healing process. Such a deposit would compress the capillaries involved in nutrition of the epithelial cystic line, which is degenerate being phagocytized by macrophages.[29]



Figure 4. Periapical radiograph after 1 year of endodontic obturation of the tooth #34. Note advanced repair in the periapical region between teeth #33 and #34.

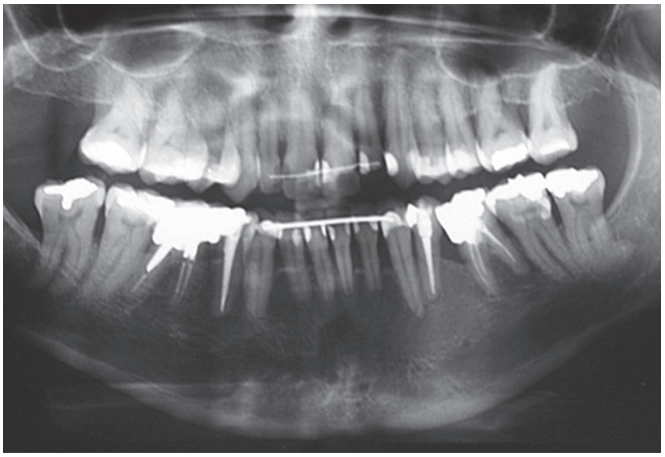


Figure 5. Panoramic radiograph after 1 year root canal filling of the tooth #34. Note advanced repair in the periapical region between teeth #33 and #34.

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It has been shown that treatment with calcium hydroxide as an intracanal dressing in the presence of large and chronic peripheral lesions can create and environment more conducive to healing and start bone repair. Calcium hydroxide is an effective intracanal antibacterial agent because of its high pH 12.5, with bactericidal and bacteriostatic.[20]

In the literature, some authors believe that direct contact with calcium hydroxide to the peripheral tissue benefits the osteoinduction, others have suggested that calcium hydroxide in the apical region has anti-inflammatory activity of neutralizing acidic products, stimulates alkaline phosphatase and also has antibacterial action.[30] The bacterial activity of various pastes of calcium hydroxide was confirmed with different vehicle.[28]

The success rate of endodontic treatment has increased significantly, explained fact by the development of techniques and instruments used for modeling and root canal filling and also related to pathology installed.[31-34]

In this clinical case, as in other studies, because it is an extensive peripheral lesion, in a region close to the mental foramen with clinical and radiographic characteristics, suggestive of periapical cyst, Panoramic, periapical and tomography radiographs were performed. Although the panoramic radiographs and periapical acceptable reproduce details in the mesiodistal, the observation in the bucco-lingual is inadequate, being important a tomography that provides three-dimensional visualization of pathologic lesions and their relationship to important anatomic structures.[35]

Conclusions

After one year of conventional endodontic treatment the patient is without signs of recurrence, the endodontic treatment provided a favorable clinical and radiographic response, without pain symptoms, with evidence of regression of the lesion, with significant bone formation without the necessity for additional surgical in the periapical region. The case is being accompanied.

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Articles with more than six authors

De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M, et al. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res. 2005 Feb;84(2):118-32.

Book chapter

Nair PNR. Biology and pathology of apical periodontitis. In: Estrela C. Endodontic science. São Paulo: Artes Médicas; 2009. v.1. p.285-348.

Book chapter with editor

Breedlove GK, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services; 2001.

Dissertation, thesis and final term paper

Debelian GJ. Bacteremia and fungemia in patients undergoing endodontic therapy. [Thesis]. Oslo - Norway: University of Oslo, 1997.

Digital format

Oliveira DD, Oliveira BF, Soares RV. Alveolar corticotomies in orthodontics: Indications and effects on tooth movement. Dental Press J Orthod. 2010 Jul-Aug;15(4):144-57. [Access 2008 Jun 12]. Available from: www.scielo.br/pdf/dpjo/v15n4/en_19.pdf

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1. Registration of clinical trials

Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and with other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

In acknowledging the importance of these initiatives and so that Latin American and Caribbean journals may comply with international recommendations and standards, BIREME recommends that the editors of scientific health journals indexed in the Scientific Electronic Library Online (SciELO) and LILACS (Latin American and Caribbean Center on Health Sciences) make public these requirements and their context. Similarly to MEDLINE, specific fields have been included in LILACS and SciELO for clinical trial registration numbers of articles published in health journals.

At the same time, the International Committee of Medical Journal Editors (ICMJE) has suggested that editors of scientific journals require authors to produce a registration number at the time of paper submission. Registration of clinical trials can be performed in one of the Clinical Trial Registers validated by WHO and ICMJE, whose addresses are available at the ICMJE website. To be validated, the Clinical Trial Registers must follow a set of criteria established by WHO.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (http://www.who.int/ictrp/network/en/index.html), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all the existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of the information available on this portal is guaranteed by the producers of the Clinical Trial Registers that form part of the network recently established by WHO, i.e., WHO Network of Collaborating Clinical Trial Registers. This network will enable interaction between the producers of the Clinical Trial Registers to define best practices and quality control. Primary registration of clinical trials can be performed at the following websites: www.actr.org.au (Australian Clinical Trials Registry), www.clinicaltrials.gov and http://isrctn.org (International Standard Randomized Controlled Trial Number Register (ISRCTN). The creation of national registers is underway and, as far as possible, the registered clinical trials will be forwarded to those recommended by WHO.

WHO proposes that as a minimum requirement the following information be registered for each trial. A unique identification number, date of trial registration, secondary identities, sources of funding and material support, the main sponsor, other sponsors, contact for public queries, contact for scientific queries, public title of the study, scientific title, countries of recruitment, health problems studied, interventions, inclusion and exclusion criteria, study type, date of the first volunteer recruitment, sample size goal, recruitment status and primary and secondary result measurements.

Currently, the Network of Collaborating Registers is organized in three categories:

- Primary Registers: Comply with the minimum requirements and contribute to the portal;
- Partner Registers: Comply with the minimum requirements but forward their data to the Portal only through a partnership with one of the Primary Registers;
- Potential Registers: Currently under validation by the Portal's Secretariat; do not as yet contribute to the Portal.

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Consequently, authors are hereby recommended to register their clinical trials prior to trial implementation.

Yours sincerely,

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