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Human Resources in Odontology

Any discussion involving quality control in health, especially human resources, should be discussed with caution, since it relates to the formation of an individual with skills to care for a human being. Qualities and guidance of human services must be constantly reassessed. The differences are clearly observed in levels of complexity for individuals seeking a higher education – of those in charge and of necessary content to constitute a good dentist, a distinguished expert, a real master and a wonderful doctor. Examples should be provided to educate the whole person; examples of life, dignity, nature, and not just a human resource to work in the health field.

For some time the educational project had been flagged as a risk factor that could affect the quality of education. Definitely, a good educational project is important to the process. However, the pedagogical project alone, out of prepared people to run it, has the risk of being inefficient. As time passed, many projects were well structured, reformulated, used and canceled. Many changes in the way of life of globalized human were also tried and experienced. The feeling is that life is easier now, more accessible to different strata. However, a profound, effective and fast improvement is urgent in this professional who is being formed.

It is unacceptable to live and accept the lack of rigor in evaluations, at any academic level. It is common to hear that the assessments are complex, but it should be processed as quality control. It is common to witness that there shouldn't be failures, but there are disqualified individuals being approved to perform procedures that can affect the quality of life of others. It is understood that a group of teachers in some variations are common – such as ages, backgrounds, experiences, skills, personal balance and moral integrity. Some show skills for management, others for teaching, research, extension, etc. It is common on various specialties or parts that form a health profession an overzealous and trends in some areas. One caution that should be taken and the challenge is showing to the leaders, or those who are ahead of the educational process of the institution the need of knowing the set, before determining the way that operators should follow. There are constant mistakes in academic meetings.

It has been pointed out that the Brazilian dentistry is one of the best in the world, and that professionals have differentiated skills. No doubt, the professionals who has represented Brazil internationally, thanks to the efforts, training, dedication to teaching, research and own abilities, has earned their evidence. However, we know that is not the largest number of professionals who have been highlighted, and that, in order to have this statement as true, there must be changes in attitudes, in order to improve, update increasingly, leaving aside personal positions and mediocrities who can still be observed among some teachers. Thanks to the idealism of some colleagues, the value of undergraduate research has caught attention, since the beginning of the career, to the fact that the construction of knowledge is essential, and that science and technology are key targets for the success of human resources to be formed for society.

Therefore, the teaching factory – laboratory of knowledge – deserves to be treasured. The perception is that you need to honestly disclose that human resources are being prepared and that are eligible for the office of health and there is no doubt about this assertion. The change to improve the quality of human resources to be formed involving joint action and not isolated, with effective participation of administrators, teachers, students, support staff, backed by predisposition, exercise, and interest.

Carlos Estrela
Editor-in-Chief

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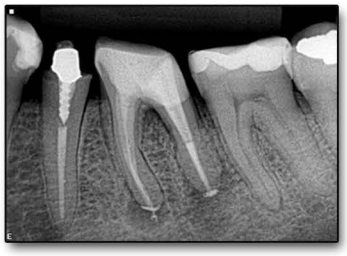
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The concept of Tooth Resorption and why it does not induce pain or necrotic pulp

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The concept of tooth resorption does not appear to be uniform in different scholarly studies, from a simple monograph to research texts published in the literature to dissertations. This article aims to contribute to the conceptual standardization of this important pathological process, which involves virtually all dental specialties, especially endodontics.

A concept can be defined as a mental representation of an object or phenomenon described by human reason based on the object's overall features. A concept can also be defined as the formulation of an idea in words. Concept can also be synonymous with conception, definition and characterization. In short, to conceptualize means to identify, describe and classify the different elements and aspects of reality.

In studies of tooth resorption, more often than not, the first sentence or paragraph is reserved for conceptualizing the very notion of tooth resorption. The concept is limited to a particular type or restricted to the context of a clinical case and does not take into account all issues involved in tooth resorption. Concepts should be of a general nature so as not to hinder understanding of the phenomenon as a whole. In some published studies[1-4] efforts were expended by the author(s), sometimes repeatedly and in different journals, to discuss the concept of tooth resorption candidly in an attempt to contribute to the formulation of future texts on the subject.

Tooth resorption: Two discrete mechanisms devoid of complexity, controversy or dispute

Two basic mechanisms have been well established in the occurrence of root resorption: Inflammatory and replacement.

Inflammatory Resorption mechanism

Cementoblasts "line" or "hide" the root surface while Sharpey's (collagen) fibers get attached in between them. The teeth are very close to the bone and separated by the periodontal ligament whose average thickness is 0.25 mm and ranges from 0.2 to 0.4 mm.

Bone is constantly remodeling through stimulation of local and systemic factors. This dynamism of the bone contributes to stabilizing the levels of minerals in the blood and imparts significant adaptive capacity to the functional demands on a daily basis. Bone remodeling depends on receptors located in the membrane of osteoblasts and macrophages, allowing local and systemic mediators to manage osteoclast activity. Osteoclasts have no receptors for mediators of bone remodeling and are functionally dependent on osteoblasts and osteoclasts.

On the other periodontal side, on the root surface, cementoblasts have no receptors for mediators of bone remodeling even though they are positioned very close to the bone. They do not respond to or "hear" the biochemical messages that induce resorption or

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neoformation of mineralized tissue on the root surface: They are "deaf" to the mediators of bone remodeling, even though they have receptors for other mediators essential to cell life such as growth hormone and insulin, for example.

Any causative factor acting on the site where the cementoblasts are, removing them from the surface, is bound to expose the mineralized root surface. As a result, bone cells, given their proximity, will promote root resorption (Fig 1), even if only temporarily. Tooth resorption has local causative factors that eliminate cementoblasts from the root surface and as yet no systemic causative factor has been shown to produce this sort of effect in teeth.

Replacement Resorption mechanism

Bone remodeling involves constant resorption of mineralized structures, but concurrently, continuous bone modeling takes place, even on the periodontal surface of the tooth socket. Naturally, each new layer of bone deposited on the periodontal surface of the tooth socket would increase proximity to the tooth and, with an average thickness of 0.25 mm alveolodental ankylosis would soon develop. Cementoblasts and osteoblasts would intermingle and create areas where cementum and bone would merge, alternating randomly distributed areas of resorption and bone formation. But this does not normally occur due to the presence of epithelial rests of Malassez, a network of with long and 4-8 cells wide, which produce what resembles a basketball hoop on the periodontal ligament around the tooth root.

The epithelial rests of Malassez constantly release epidermal growth factor (EGF) - like all other epithelia of the body - to self-stimulate and proliferate, maintaining their structure. But at the same time, this mediator in the ligament stimulates bone resorption in the periodontal surface of the alveolus. Thus the periodontal space is maintained and alveolodental ankylosis prevented.

Alveolodental ankylosis occurs almost exclusively when the epithelial rests of Malassez are eliminated - usually by dental trauma – be it a mild concussion or the most severe avulsion. With alveolodental ankylosis bone remodeling also involves the mineralized dental tissues, which will gradually and inevitably be resorbed and replaced by bone (Fig. 2), hence the term tooth resorption by replacement. In long delayed unerupted teeth, severe atrophy of the periodontal ligament due to disuse may facilitate the development of alveolodental ankylosis.

Based on the description of these two potential mechanisms, it does not seem reasonable to state that tooth resorption is a complex phenomenon with unknown mechanisms. It also does not seem reasonable to assert that its causes are debatable or controversial.

The etiopathogenesis of Tooth Resorption is not multifactorial

The expression *multifactorial etiology* suggests that for a certain disease or phenomenon to occur a wide range of causative factors must act in concert, although strictly speaking this connotation is not explicitly apparent in the meaning of the word *multifactorial* as it is found in dictionary entries.

Dental caries is a classic example of a disease with a multifactorial etiology. The emergence of dental caries requires the presence of dentobacterial plaque due to lack of oral hygiene, a diet based on carbohydrates, the presence of caries-prone tooth enamel and enough time for these factors to interact and generate the disease. In other words, occurrence of the disease depends on interaction between these causes.

Diabetes mellitus etiology is also multifactorial as it requires inheritance of the gene responsible for autoimmunity against insulin-producing cells in the pancreas and interaction with environmental factors such as obesity, poor nutrition, sedentary lifestyle, stress and many others for the disease to emerge.

Tooth resorption has several causes that act independently of one another. In some special cases a number of causes might combine to cause tooth resorption, but this is not usual. From a conceptual point of view one should avoid stating that tooth resorption is multifactorial, although it would be accurate to assert that it has multiple or many causes. The term *multifactorial* may convey a mistaken connotation of simultaneity of causes for tooth resorption to occur.

The causes of tooth resorption are well known

In inflammatory tooth resorption causative factors remove the cementoblasts from the surface in the same manner as:

1) Chronic periapical lesions: Toxic bacterial products such as lipopolysaccharides (LPS), as well as other noxious microbial agents resulting from metabolism are

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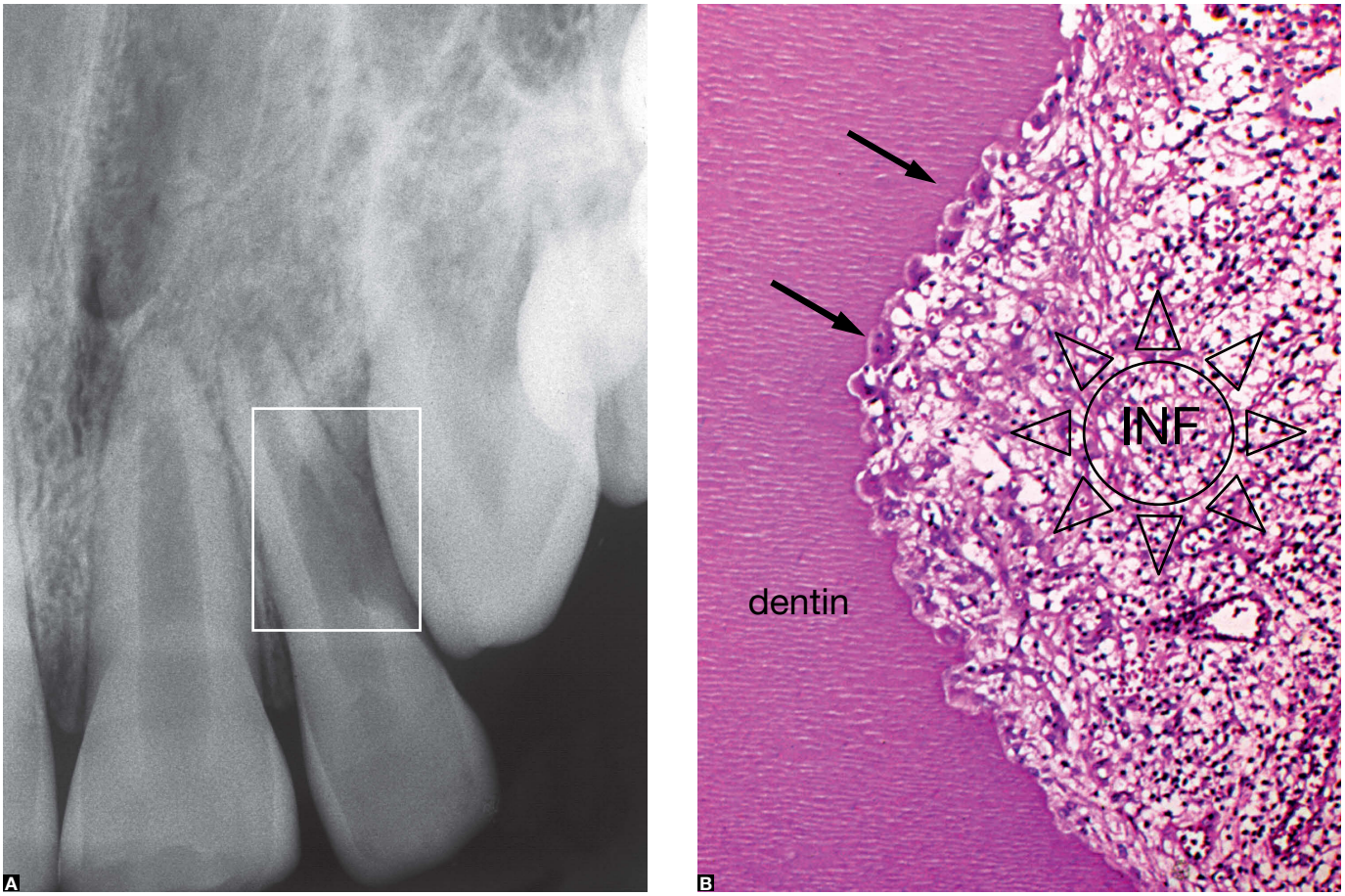


Figure 1. Inflammatory resorption by dental trauma and proximity to partially erupted maxillary canine. In B, it is emphasized that on the surface of teeth sharing the same condition, the osteoclasts (arrows) and other cells of the bone remodeling units are organized by mediators originating from the inflammatory process (INF) induced by the same causative factor responsible for the death of cementoblasts. The process is asymptomatic and of itself has no etiopathogenic relationship with the dental pulp, nor any symptoms.

either released into the periapical medium or reach the apical root surface via dentinal tubules. LPS are very toxic to human cells and, while some are killed by the cells, leukocytes release more inflammatory mediators when interacting with these molecules. In other words, LPS boost or amplify inflammatory phenomena, including any associated tooth or bone resorption.

2) Orthodontic forces can fully close the lumen of blood vessels and impair nutrition. On rare occasions the tooth-bone contact that results from excessive force can physically remove cementoblasts from the root surface by compression. The death of cementoblasts due to orthodontic movement is mainly caused by a lack of blood supply.

3) Unerupted teeth can compress the blood vessels of neighboring teeth when they are brought near to these teeth through the agency of eruptive forces, as is often the case with upper canines and third molars.

4) Accidental dental injuries can rupture blood vessels and put the tooth in contact with the alveolar bone surface (Fig 1). Dental trauma can be caused by surgical, operative and anesthetic factors.

5) Long periods of occlusal trauma can lead to death of cementoblasts and, in severe cases, induce inflammatory root resorption.

In replacement tooth resorption the causative factors eliminate the epithelial rests of Malassez in the periodontal ligament. The main and almost exclusive causative factor responsible for elimination of this ligament component is dental trauma (Fig 2), which can range

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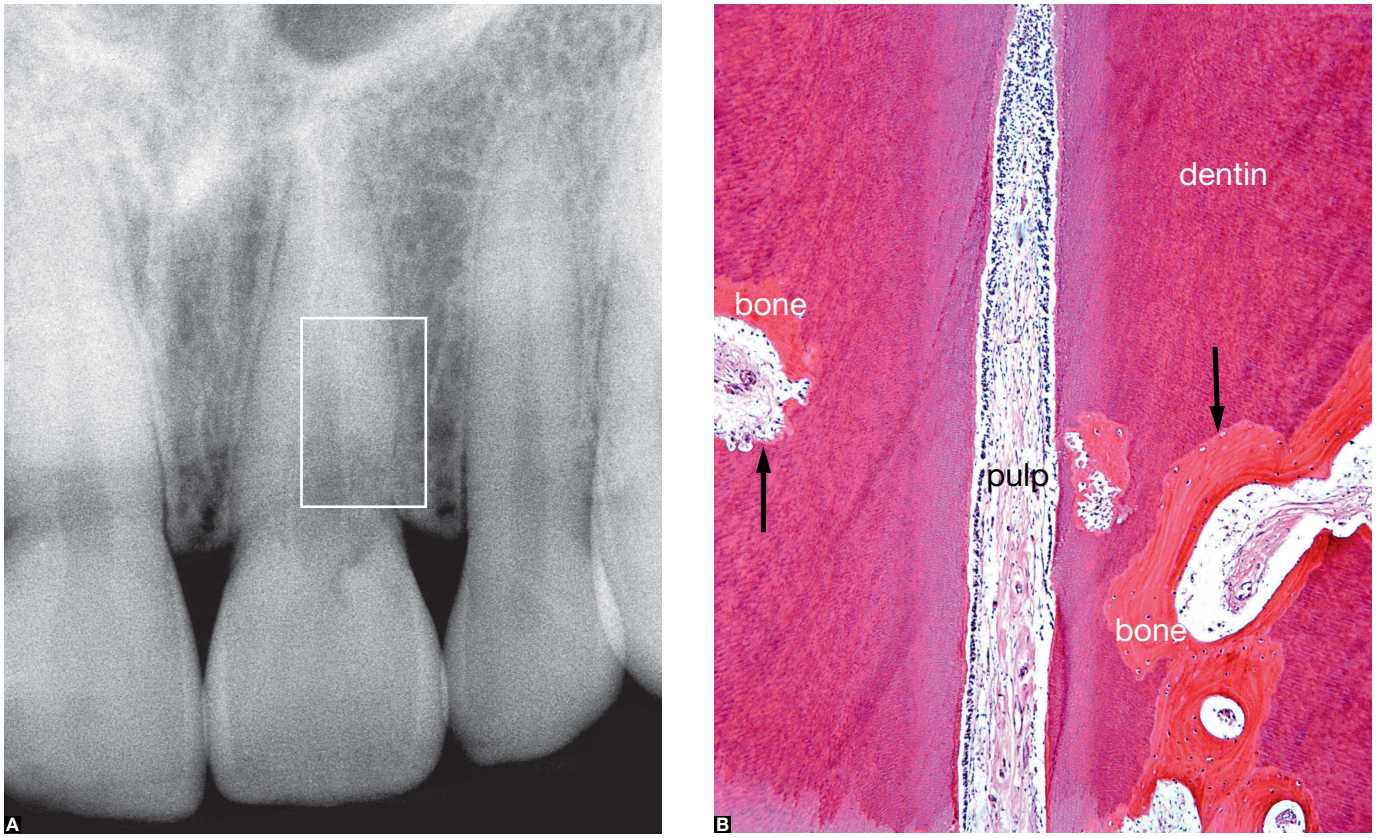


Figure 2. Replacement tooth resorption due to trauma. After ankylosis, dentin is gradually replaced by bone tissue, without any associated inflammatory process, as part of the remodeling process (arrows) that involved the tooth due to the death of the epithelial rests of Malassez. The process is asymptomatic and itself has no etiopathogenic relationship with the dental pulp, nor any symptoms.

from a concussion, in its milder form, to avulsion and reimplantation, in its most severe form. Dental trauma can be:

a) Accidental, when it occurs in leisure activities, car crashes, violence and other incidents.

b) Surgical, as in cases of untimely luxation of unerupted canines and during procedures aimed at removing unerupted third molars positioned over second molars.

c) By the action of laryngoscopes on the teeth during the process of intubation in general anesthetic procedures.

An additional, very specific causative factor refers to teeth that remain unerupted for long periods of time, whose excessive atrophy of the periodontal ligament may set the stage for the occurrence of alveolodental ankylosis and subsequent replacement resorption.

Even multiple tooth resorptions are not systemic or hereditary

In humans, cell and tissue events are triggered by information contained in genes, but this does not give a hereditary connotation to all these events. Root resorption, like all biological phenomena, involve genetically mediated cell and tissue events, but not necessarily implying inheritance or development of individual or familial predisposition.

In humans there are no diseases, conditions or susceptibilities transmitted from father to children whereby tooth resorption is potentially facilitated or prevalent. The causes of tooth resorption are local and necessarily affect the cementoblasts and epithelial rests of Malassez. In endocrine pathologies as well as in other systemic diseases, tooth resorptions are not part of the clinical or imaging manifestations.

Apex and root morphology – the crown-root ratio –

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as well as the shape of the alveolar bone crest have a bearing on the predictability of tooth resorption in orthodontic treatment. If necessary, one might go as far as asserting that patients with tapering tooth roots, pipette-shaped or torn apices and rectangular bony ridges are more predisposed or susceptible to root resorption during orthodontic treatment, but such proclivity is of a morphological – not genetic or hereditary – nature.

On the treatment and prognosis of tooth resorptions

Therapy of inflammatory tooth resorptions entails primarily the elimination of causative factors. When the inflammatory process and cellular stress cease in the resorption area, with the bone remodeling units and their osteoclasts undergoing demobilization and leaving the root surface, mediators disappear. The pH of the region returns to neutral state and new cementoblasts are formed, recolonizing root surfaces in a few days. New cementum is then formed through the reattachment of collagen fibers at the center of the new layer of cementoblasts. The root surface once again becomes biologically normal.

If the cause is contamination by bacteria via root canal, appropriate endodontic treatment should eliminate the cause while the inflammatory resorption repairs itself. If the causative factor is an orthodontic force, the process is stopped by deactivating the orthodontic appliance or through force dissipation. When one eliminates the possible causative factor and still the inflammatory tooth resorption does not cease, this would imply that the real cause has not been eliminated.

Replacement resorption always follows alveolodental ankylosis and once established there is no way the process can be stopped. When ankylosis is detected before it has evolved into replacement resorption, luxation followed by extrusion can in most cases restore the periodontal ligament on the bridges or bone-tooth connection foci. But if replacement resorption occurs when part of the tooth has been resorbed and replaced by bone, physical overlapping will prevent a cleavage to occur between them.

In summary: Inflammatory tooth resorption can be controlled, cured and has a positive prognosis, but replacement resorption has a poor prognosis, because sooner or later tooth loss is bound to occur.

Tooth resorptions do not induce pain or necrotic pulp

As close as they may be to pulp tissue, neither inflammatory root resorption nor replacement resorption causes any pain. The number of mediators present in order for resorption of mineralized tissues to occur is not sufficient to induce pain and discomfort in the patient. If there is pain sensitivity in teeth undergoing resorption, some other cause must be sought to explain it: Tooth resorption is an asymptomatic, "silent" biological process.

Tooth resorption may be further compounded or associated with microbial contamination, occlusal trauma, and pulp and periapical pathologies that can be symptomatic, but tooth resorption is not a causative factor in any of these conditions.

The same mediators, phenomena and bone resorption cells are present in tooth resorption but they do not cause pain. In the human skeleton, between 1 and 3 million bone remodeling units are acting on and resorbing the skeleton continuously with no symptoms.

Although very close to the pulp – or even in cases where tooth resorptions occur within the structure of the pulp itself as in internal resorption – tooth resorptions do not induce necrosis of dental pulp tissue. The process of tooth resorption does not release toxic products into the cells. Resorption of mineralized tissues is only aimed at deconstructing these tissues in order to recycle their mineral and non-mineral components, which will be reused as ions, amino acids and peptides.

Tooth resorptions are clinically asymptomatic and of themselves do not induce pulp, periapical and periodontal changes, as they are – more often than not – consequences and not causes of the latter.

Final considerations: The concept of tooth resorption

Resorptions in the body as a whole are phenomena that can be present in various clinical situations and refer to a mechanism whereby mineralized tissues are structurally removed. At the interface between osteoclasts and odontogenic mineralized tissue there occurs a release of acids and enzymes, and the resulting molecules are transported through the cytoplasm into vacuoles by a process known as transcytosis and secreted into the extracellular space in the form of amino acids,

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peptides and ions. In the extracellular matrix and in body fluids such as blood and lymph these components are reused by other organs, tissues and cells.

Tooth resorption is a process whereby mineralized odontogenic tissues are dismantled through the agency of bone cells located on their surfaces when the protective structures of the teeth in relation to bone remodeling are eliminated, especially cementoblasts and epithelial rests of Malassez. Resorptions consist of a pathological manifestation in permanent teeth and a physiological manifestation in primary teeth. In some clinical situations such as in orthodontic treatment tooth resorption is common and acceptable as long as anticipated and mitigated as part of the biological cost to have esthetically and functionally adequate teeth.

The mechanisms of tooth resorption are known and its causes well-defined. Tooth resorptions are clinically asymptomatic and of themselves do not induce pulp, periapical and periodontal changes, as they are – more often than not – consequences and not causes of these conditions. Tooth resorptions are local, acquired changes and do not reflect dental manifestations of systemic diseases.

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A comparison of clinical, histological and radiographic findings in periapical radiolucid lesions

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ABSTRACT

Objective: Pulpal inflammation and necrosis can eventually cause periradicular diseases or apical pathologies, which are clinical and radiographically suggestive of an inflammatory sequel. Thus, the objective os this study is to compare the degree of agreement between the diagnosis of teeth with periapical lesions and histopathological analysis. **Methodology**: Fifty nine patients with surgical indication (teeth with lesions) were selected. In the radiographic analysis the appearance was observed, the size of the lesion was measured and a diagnosis hypothesis was suggested. Histological sections were examined under the microscope and the specimens classified as granuloma, cyst or chronic abscess. **Results**: The results showed 40.7% of concordance between the clinical-radiographic and histological diagnosis. According to histological analysis, 35.6% of the cases were granuloma, the cystic lesions corresponded to 59.03% and 5.09% were chronic abscesses. **Conclusion**: Thus, through only clinical and radiographic examination is not possible to confirm the diagnosis of lesions, because even images considered as cysts can be resulted from abscesses or granuloma, whereas the opposite may also occur.

Keywords: Radiography. Diagnosis. Oral pathology.

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Introduction

Apical radiolucent lesions may include keratocyst, nasopalatin cyst, residual cyst, apical dysplasia, granulomatous inflammation and a variety of neoplasms.[1] Pulpal inflammation and necrosis, eventually cause changes in apical or periradicular space, which, in the absence of histological examinations, are clinical and radiographically suggestive of inflammatory sequel and may be present in the form of abscess (acute or chronic), granuloma or cyst.

The apical periodontitis is a chronic inflammation that leads to destruction of periradicular tissues and is caused by etiological agents of endodontic origin, most frequently microorganisms.[2] However, the bacterial profiles of the endodontic microbiota vary from individual to individual and this indicates that the apical periodontist has a heterogeneous etiology, where a single specie can not be considered the primary pathogen and multiple combinations are the causes of bacterial diseases.[3]

Chronic abscess is a circumscribed purulent collection without painful symptoms according to patients' reports and is detected by radiographic examination in the absence of a fistula.[4] Granuloma is found in the dental apex and it is rounded in shape, with regular margins well defined. Barbosa[1] studied the apical pathologies due to endodontic failures, through clinical, radiographic and histopathologic exams of 150 periapical lesions, and showed that the higher incidence was of granulomas (63.3%) while only 16.7% were of cysts.

The cystic formation is not well explained and the most accepted theory so far is the osmotic pressure, which can be divided into three stages. During the first phase the proliferation of epithelial cells rests (cells of Malassez) occur, in the second phase the cavity begins to be surrounded by epithelium and during the third phase there is cystic growth.[6]

There are two distinct categories of periapical cysts: (1) The cavity is completely enclosed by epithelium (true cyst) and (2) the cystic cavity is surrounded by epithelium, but opened to the light of the root canal (bay cyst). The reported prevalence of cysts among apical lesions varies from 6 to 55%, and histopathological studies with more strict criteria showed that the prevalence is below 20%.[7,8] In addition, the cystic lesions have been cited as a factor binding to the responses of endodontic treatment, as more than half of these lesions are true cysts and the rest are bay cysts.[9]

Traditionally, the diagnosis of periapical lesions is based on clinical and radiographic analysis. In the study conducted by Moraes et al,[6] 180 cases were analyzed and the concordance between the radiographic and the histopathological diagnosis occurred only in 66.6% of cases. For Mortensen et al,[7] lesions larger than 15 mm can be safely classified as cysts. However, according to Trope et al[16] and White et al,[18] preliminary diagnosis of the cyst may be present when the lesion diameter is greater than 20 mm, and other factor used as a differential diagnosis is the presence of a radiopaque lamina surrounding the cystic lesion.[14]

These reports have contributed to the idea that the considerable size of periapical lesions are usually well defined and should preferably be treated surgically. Hepworth and Friedmann[4] analyzed the use of endodontic retreatment and surgical treatment in cases of large cystic lesions, and the average success was 66% and 95%, respectively. Furthermore, Rahbaran et al[12] suggested that the size of the lesion has no significant influence on the treatment success.

The purpose of this study was to determine the concordance between the diagnoses of teeth with periapical lesions in different diameters, obtained by clinical and radiographic examinations, with the analysis of histopathological lesions.

Material and methods

Patients were selected at the Department of Surgery of the Faculty of Dentistry, at University of São Paulo (FOUSP). They were informed about the proposed study and, subsequently, their consent to participate was obtained. Indications for extraction were based on the surgical protocol of the surgery discipline. The study group included patients of both genders and different ages who had surgical indication (extraction) of teeth with periapical lesions, with a total of 59 samples for histological analysis.

Radiographic Study

After the clinical examination a thorough radiographic was performed. It was observed whether the lesion had a cystic appearance, if it was diffuse or circumscribed and if it presented an external resorption,

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thus allowing to obtain a diagnose. Each patient had the diagnosis written on an appropriate sheet. The lesion size was measured and the mean height by width was obtained in millimeters. The presence or absence of a radiopaque layer around the lesion was not taken into account during the measurement. The specimens were classified according to previously established criteria for identification, such as: A (<1 mm), B (= 1 mm or 2 mm) and C (>2 mm).

Histological Studies

The extraction was performed and the tooth (accompanied or not by periapical lesion) was immediately immersed in 10% formol solution, and then placed in fixation solution for 24 hours. The histopathological analysis were performed at the Laboratory of Oral Pathology (FOUSP). The teeth which had lesions were subjected to decalcification and then the steps for obtaining histological sections of tissue were carried out: Dehydration, diafanization, inclusion in paraffin, sections (4 µm - 5 µm of soft tissue and 7 µm of hard tissue), deparafinization and systematic staining with hematoxylin and eosin. Histological sections were examined by microscopy and the results were given in consensus by two pathologists.

The specimens were classified according to previously established criteria for identification, such as granuloma (G), cyst (C) or chronic abscess (AB).

Results

The comparison between clinical diagnoses and histopathologically confirmed cases are described in Table 1. From 28 cases histopathologically diagnosed as periapical granuloma, 75% had the same clinical diagnosis, while the accordance between periapical cyst diagnosis was 66% and 37.5% for chronic abscess. The overall agreement between the two diagnoses was 59.3%.

Table 2 shows the aspect of lesions in different sizes, determined by radiographic exams, and the classification of the lesions according to clinical and histopathological diagnoses. The results show that according to histopathological diagnoses, 35.6% of the lesions were periapical granulomas, from which 23.7% were in pure form and 11.9% were mixed (granuloma with epithelium cells). The cystic lesions corresponded to 59.3%, while 5.09% were chronic abscesses. According to the clinical diagnoses, on the other hand, 47.5% of the cases were granulomas, 39% were cysts and 13.5% were abscesses.

Discussion

The literature shows significant differences regarding to histopathological results of periapical lesions,

Table 1. Comparison of clinical diagnosis with specific histopathological diagnosis.

Clinical Diagnosis	Specific Histopatological Diagnosis (n=59)		
	Periapical granuloma (n=21)	Periapical cyst (n=35)	Chronic abscess (n=3)
Periapical granuloma	28	-	-
Periapical cyst	-	23	-
Chronic Abscess	-	-	8

Table 2. Relationship between lesion size, radiographic exam, clinical and histopathological diagnosis.

Lesion size	Radiographic exam		Clinical diagnosis			Histopathological diagnosis		
	cystic aspect	no cystic aspect	G	C	AB	G	C	AB
A (n=0)	-	-	-	-	-	-	-	-
B (n=19)	1	18	12	2	5	7	11	1
C (n=40)	21	19	16	21	3	14	24	2
% biopsy specimens (n=59)						35.59%	59.32%	5.09%

A (<1 mm); B (between 1 and 2 mm); C (>2 mm); G (granuloma); C (cyst); AB (abscess)

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the prevalence of granulomas ranging from 9% to 87%[17,18] and cysts of 6% to 55%.[7] In this study, from the 59 cases examined with HE, 20.3% were apical cysts, 11.9% were granulomas and 8.5% were chronic abscesses. These discrepancies with the results found by other authors may be due to different criteria used on the histological exams. For example, Ricucci et al[13] established the diagnosis based on the presence of a cyst cavity completely or partially surrounded by epithelium. According to his data, from 21 epithelial lesions, only 16 were classified as cystic.

Previous studies attempted to compare radiographic findings of periapical lesions with histological analysis and some authors stated that the preliminary clinical diagnosis of cyst can be done when the lesion is greater than 15 mm / 20 mm.[11,12,13] In contrast, our proposal was to investigate the number of agreement in diagnoses of teeth with periapical lesions of very small sizes (around 1 to 2 mm), which are certainly more difficult to be accurately diagnosed applying only clinical and radiographic exams.

No apical lesions with diameter less than 1 mm were found in the present study. Injuries with affined diameters larger than 2 mm were more easily diagnosed as a cyst compared to smaller lesions, with only 7.5% of error in diagnosis, but this relatively low average may have occurred because of the number of lesions with diameters larger than 2 mm (n = 40). Carrillo et al[2] found differences in radiographic size between granulomas and cysts and that the averages were higher in both epithelized granuloma and cysts. Therefore, the authors emphasize that it is not possible to base the differentiation only in radiographies.

The radiographic interpretation of periapical lesions is seen as an inaccurate, but Ricucci et al[13] stated that there is a tendency that the cysts are probably found in groups with a radiopaque layer around the lesion. For Carrillo et al,[2] from 70 cases reported, only 9 had the blade and just 2 were confirmed histologically as cysts. These results are consistent with ours; as from the 35 cystic lesions only 22 had radiopacity limiting the lesion.

These findings provide evidence to rebut the statements that it is possible to have an accurate diagnosis by radiographic size, or that the presence of a radiopaque lamina is the basis for a diagnosis of periapical pathology.

Conclusions

This study indicates that only through clinical and radiographic examination is not possible to confirm the diagnosis of lesions, because even images considered as cysts can be resulted from abscesses or granuloma, whereas the opposite may also occur.

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Comparison of the success rates of four anesthetic solutions for inferior alveolar nerve block in patients with irreversible pulpitis. A prospective, randomized, double-blind study

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ABSTRACT

Introduction: This study compared the efficacy of four anesthetic solutions for inferior alveolar nerve block (IANB) in patients with irreversible pulpitis. **Material and Methods:** This prospective, randomized, double-blind study included 60 adult volunteers. The patients were randomly divided into four groups of 15 and received conventional IANB as follows: Group ART - 2 cartridges of 4% articaine with 1:100,000 epinephrine; Group LID - 2 cartridges of 2% lidocaine with 1:100,000 epinephrine; Group PRI - 2 cartridges of 3% prilocaine with 0.03 IU felypressin; and Group MEP - 2 cartridges of 2% mepivacaine with 1:100,000 epinephrine. Access was begun 10 minutes after IANB, and patients were instructed to rate any pain felt during the endodontic procedure. The success of IANB was defined as access and instrumentation of root canals with no pain. If the patient felt any pain, the treatment was discontinued immediately and the anesthetic procedure was classified as unsuccessful. **Results:** The chi-square test was used to analyze results ($\alpha = 5\%$). There was no significant difference ($p > 0.05$) in the efficacy of IANB between the ART (53.33%), PRI (46.66%), and MEP (53.33%) groups. However, the success rate in the LID group was statistically lower (20%) than in the other groups ($p < 0.05$). **Conclusion:** None of the anesthetic solutions had an acceptable success rate for IANB in patients with irreversible pulpitis. The solution of 2% lidocaine with 1:100,000 epinephrine had the worst rate when compared to the other groups.

Keywords: Endodontics. Pulpitis. Anesthesia. Local.

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Introduction

In dentistry, clinical procedures are decisive in eliminating pain, and the effectiveness of local anesthesia is a critical factor in handling emergency situations in endodontics.[1] Pain control often begins with the application of a local anesthetic solution. According to Veering,[2] the dental anesthetics most often used, among those available in the market, are lidocaine, prilocaine, mepivacaine, bupivacaine, and articaine.

Inferior alveolar nerve block (IANB) is an injection technique routinely used for the local anesthesia of mandibular teeth during clinical procedures. However, this technique is not always successful for pulp anesthesia.[3] Clinical studies in endodontics[4-7] have reported failure rates ranging from 15 to 35% in the anesthesia of mandibular teeth. Success rates are poorer among patients with pulpitis.[8-14]

Several mechanisms have been described to explain the failure of local anesthesia, e.g. anatomic variations with crossover and accessory innervations,[4,15] and a decrease in local pH.[8,15] However, the most plausible explanation for the low success rates obtained in patients with pulpitis may be the activation of nociceptors by inflammation.[16,17] Inflammatory mediators reduce the threshold of nociceptor activation to such a low level that even minimal stimuli can activate them.[16,17,18]

Several studies have been conducted with the aim of comparing the efficacy of different anesthetic solutions during endodontic procedures for different reasons. However, to the knowledge of the authors, no study so far has compared the four anesthetic solutions used in this study for IANB in molars with irreversible pulpitis. Therefore, the objective of the present study was to compare the efficacy of the four anesthetic solutions most frequently used in dentistry for inferior alveolar nerve block, namely articaine, lidocaine, prilocaine, and mepivacaine, in patients with irreversible pulpitis.

Material and Methods

This prospective, randomized, double-blind study included 60 adult volunteers recruited at the Dental Emergency Department of the Catholic University of Campinas, São Paulo, Brazil.

The participants were experiencing pain in a mandibular molar and were in good health. They had no allergy to local anesthetic solutions or sulfites, no systemic diseases, were not pregnant or unable to respond to pain, and were not taking any medication that could interfere with pain perception, as determined by oral interview and written questionnaire. The study protocol was approved by the Research Ethics Committee of the Catholic University of Campinas, and written informed consent was obtained from each participant.

The following inclusion criteria were taken into consideration: Active pain in a mandibular molar; prolonged response to cold testing with Endo-Ice (Maquira, Maringá, Brazil); absence of any periapical radiolucency on radiographs, except for a widened periodontal ligament; and vital coronal pulp upon access.

Patients were randomly divided into four groups of 15, according to the type of solution used: Group ART - 2 cartridges of 4% articaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil); Group LID - 2 cartridges of 2% lidocaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil); Group PRI - 2 cartridges of 3% prilocaine with 0.03 IU felypressin (DFL, Rio de Janeiro, Brazil); and Group MEP - 2 cartridges of 2% mepivacaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, Brazil).

A topical anesthetic (EMLA cream, Astra Zeneca, São Paulo, Brazil), an eutectic mixture of 2.5% lidocaine 2.5% and prilocaine, was passively placed at the IANB injection site for 1 minute using a cotton tip applicator. All patients received standard IANB injections using two masked cartridges of one of the anesthetic solution tested. The solution was injected by the same clinician using self-aspirating syringes (Septodont, Saint-Maur-des-Fosses, France) and 27-gauge long needles (Septoject, Septodont). After reaching the target area, aspiration was performed, and 1.8 mL of solution (1 cartridge) was deposited at a rate of 1 mL/min. After 1 minute, another 1.8 mL was deposited, also at a rate of 1 mL/min. Five minutes after the second cartridge was used, patients were asked whether their lips were numb. If profound lip numbness was not recorded at this time, the block was classified as unsuccessful, and the patient was excluded from the study. Teeth considered as adequately anesthetized were isolated with a rubber dam, and access was performed.

Patients were instructed to report any pain felt during the procedure. In the presence of pain, the

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treatment was discontinued immediately, and the anesthetic procedure was classified as unsuccessful. IANB success was defined as access and complete instrumentation of root canals with no pain.

Results were analyzed using the chi-square test. Significance was set at $p = 0.05$ ($\alpha = 5\%$).

Results

Sixty adult patients (41 women and 19 men) aged 19 to 57 years old participated in this study. The rates of success and failure obtained in each group are shown in Figure 1.

No statistically significant differences were found between the ART, PRI, and MEP groups ($p > 0.05$). However, the success rate in the LID group was statistically lower ($p < 0.05$) than that found in the other three groups.

Discussion

Efficient anesthesia is extremely important to ensure patient comfort during endodontic procedures. Several studies have evaluated the efficacy of local anesthetic solutions for teeth with irreversible pulpitis.[1,8-14,19] Corbett et al[20] sent a questionnaire to 506 dentists in the United Kingdom and found that the anesthetic solution most often used was lidocaine with epinephrine, followed by prilocaine with felypressin. According to Malamed,[21] articaine has become the second drug of choice for local anesthesia in the United States since its introduction in 2000. Gaffen and Hass[22] conducted a study with 8,058 dentists in Ontario, Canada, and found that the anesthetic solutions most frequently used in dental clinics were lidocaine, articaine, mepivacaine, and prilocaine. However, our review of the literature did not yield any clinical studies that compared the four anesthetic solutions used in this study for IANB in molars with irreversible pulpitis.

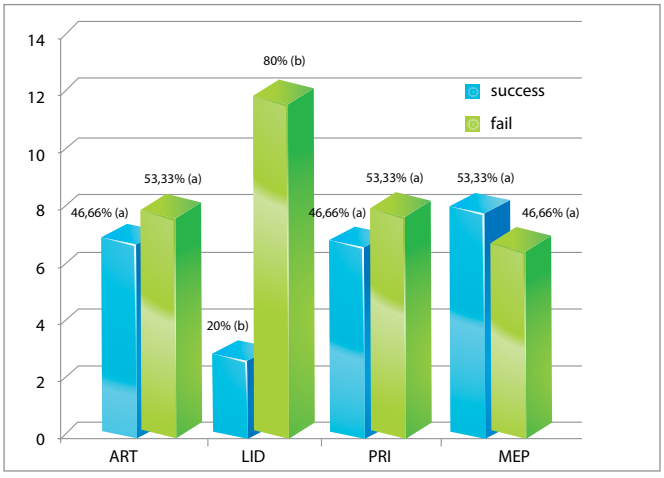


Figure 1. Success and failure rates obtained in the four study group. Different letters indicate the presence of significant differences ($p < 0.05$). ART = articaine + epinephrine; LID = lidocaine + epinephrine; PRI = prilocaine + felypressin; MEP = mepivacaine + epinephrine.

As part of our protocol, a topical cream (EMLA, Astra Zeneca, São Paulo, Brazil), an eutectic mixture of local anesthetics, was applied before the injection, which is in accordance with other clinical studies that have shown that EMLA is superior to benzocaine or lignocaine as a topical anesthetic.[23]

To achieve IANB, 3.6 mL (2 cartridges) of anesthetic solution were injected, as advocated by other authors.[24,25] The decision to use two injections was based on the low success rate reported in the literature for anesthetizing the pulp of mandibular teeth with irreversible pulpitis using only one cartridge.[12,14,26]

Endodontic procedures was initiated after 10 minutes of initial inferior alveolar nerve block, based on the findings of Lai et al,[27] who observed an onset time of 10 to 15 min after injection for mandibular anesthesia.

In this study, the presence or absence of pain was used to evaluate the efficacy of anesthetic solutions. Aggarwal et al[28] and Claffey et al[10] classified the success of IANB of mandibular teeth with irreversible pulpitis as the absence of pain or presence of only mild pain according to a visual analog scale (VAS). The success criterion employed in our study was the total absence of pain during access and instrumentation of the root canal system, because this is the purpose of local anesthesia in endodontic treatment.

In this study, IANB success rates for molars with irreversible pulpitis ranged from 20 to 53.33%, a finding that is in agreement with rates reported in the literature, which range from 19 to 56%.[10-14,29,30,31] Moreover, there were no statistically significant differences between the articaine (ART), prilocaine (PRI), and mepivacaine (MEP) groups. Although several other authors have also reported the absence of significant differences between lidocaine and other anesthetic solutions, using different techniques in clinical

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conditions,[8,19,25,32] in our study the lidocaine group had a statistically lower success rate (20%) when compared with the rates found for the other three groups. Our result is similar to the 19-26% success rates found by Bigby et al,[31] Nusstein et al,[13] Reisman et al,[12] and Claffey et al,[10] but lower than the 50-56% rates reported by Cohen et al[14] and Kennedy et al[11] - all these studies used lidocaine in teeth with irreversible pulpitis. The success criterion used in this study, namely total absence of pain during access and instrumentation, may explain our low success rate.

Finally, according to our results, IANB in mandibular molars with irreversible pulpitis was not clinically successful. Complementary techniques using supplemental buccal,[33] periodontal ligament[34] or intraosseous[35] injections should be assessed with the aim of increasing success rates and providing more comfort to patients and convenience to dentists.

Conclusion

The results of this study showed that the four anesthetic solutions under evaluation did not achieve an acceptable IANB success rate for mandibular molars with irreversible pulpitis. When compared to other solutions, 2% lidocaine with 1:100,000 epinephrine had the worst rate.

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Evaluation of calcium hydroxide dressing for short term prevention of coronal leakage

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ABSTRACT

Objective: The aim of this *in vivo* study was to evaluate the influence of coronal leakage on the apical dog's teeth healing, which were dressed with calcium hydroxide and kept or not in contact with oral environment. **Material and Methods:** After biomechanical preparation and filling with calcium hydroxide/saline paste, twenty six root canals were randomly divided into two experimental groups: Group 1 - coronally sealed with temporary restorative material; Group 2 - coronally unsealed. The animals were sacrified after 7 days and the specimens were prepared for histological analysis. **Results:** In both groups the results were similar. Inflammatory cells were not present in the apical tissue or in the cementum. Besides, it was observed necrosis in the coronary third surface of the pulp stump and microorganisms were noted just in contact with debris, which were present in the specimens pulp chamber without sealing but not in the root canal. **Conclusion:** It was concluded that the calcium hydroxide used as dressing prevented the contamination of the root canal and keeps its mechanism in the apical tissues even under defective sealing in a period of at least 7 days.

Keywords: Coronal leakage. Calcium hydroxide. Dressing. Healing process.

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Introduction

The use of intracanal medication has been advocated in the treatment of infected root canals. It may help to eliminate remaining viable bacteria unaffected by the chemomechanical preparation of the root canal[6,25] acting as a physicochemical barrier precluding the proliferation of residual microorganisms and also preventing the reinfection of the root canal by bacteria from the oral cavity.[1]

Instrumented root canals can be recontaminated between appointments in clinical situations by leakage through the temporary filling material, breakdown or loss of the temporary filling, or fracture of the temporary filling material and/or tooth structure. The root canal system then becomes exposed to oral microbiota, which jeopardizes the outcome of endodontic treatment. In these situations, intracanal medications that have antibacterial properties might be helpful in preventing bacterial invasion of the root canal system.[24]

Intracanal medications should have a broad antibacterial spectrum, no cytotoxicity, and should possess physiochemical properties that permit diffusion through the dentinal tubules and lateral ramifications of the root canal system.[3] However, whether interappointment temporary filling materials provide an adequate seal of the root canal system from contamination between sessions may still be questionable.[20]

Among the root canal dressings, calcium hydroxide ($Ca(OH)_2$) is considered to possess many properties of an ideal material[5] and has become popular because of its antimicrobial and biological properties.[9,10,15,17] The antimicrobial action of $Ca(OH)_2$ is related to its ionic dissociation in calcium and hydroxyl ions, and their toxic effects on bacteria which inhibits cytoplasmatic membrane enzymes with consequent changes in the organic components and nutrient transport.[10] Materials containing $Ca(OH)_2$ have been used to promote formation of hard tissue in apexification, perforations, fractures, resorptions.[5] $Ca(OH)_2$ is also related to the neutralization of lipopolysaccharides,[22] helping in the root canal cleansing.[14]

Some *in vitro* studies reported the time-dependent delay of coronal leakage with the use $Ca(OH)_2$ as dressing.[8,24] However, no *in vivo* study was found in the literature to demonstrate the ability of $Ca(OH)_2$ as dressing to prevent coronal bacterial leakage simulating a clinical situation where the inter-appointment restorative material had been displaced or fractured allowing a possible bacterial infiltration. So, the aim of the present study was to evaluate the effectiveness of $Ca(OH)_2$ dressing in the prevention of coronal leakage in unsealed dog's teeth.

Material and Methods

This study was conducted on 26 roots of premolar and incisor teeth from 1 adult mongrel dog aged 2-3 years old and weighing about 25 Kg. The use of animal for this research was in accordance to the guidelines approved by the Research Committee of São Paulo State University, Brazil, in compliance with the applicable ethical guidelines and regulations of the international guiding principles for biomedical research involving animals.

The animals were anaesthetized with 2 mL of a mixture of xylazine (Rompum; Bayer do Brasil S/A, São Paulo, Brazil) and ketamine hydrochloride (Ketalar; Park Davis-Aché Laboratórios Farmacêuticos S/A, São Paulo, Brazil), in a 1:1 ratio, administered intramuscularly and maintained with subsequent anesthetic injections. The animals were intubated with a cuffed endotracheal tube before beginning the experimental procedures.

After the placement of a rubber dam, the teeth were submitted to crown opening and pulp extirpation up to the apical barrier. The root canal was explored up to the apical level by using a 15 K-file (Dentsply Maillefer, Catanduva, Brazil), and removal of the root pulp was performed with a #20 Hedstrom file (Dentsply Maillefer, Catanduva, Brazil). Root canals remained exposed to the oral cavity for 7 days to achieve bacterial contamination. Due to the absence of a main apical foramen in dog's teeth but only an apical delta, an experimental model was employed. The root canals were biomechanical prepared up to a 40 K-file (Dentsply Maillefer, Catanduva, Brazil) at the level of the apical barreir, with abundant irrigation with 1.0% sodium hypochlorite (Biodinamica Química e Farmacêutica, Ibiporã, Brazil). The teeth were overinstrumented up to a #25 K-file (Dentsply Maillefer, Catanduva, Brazil) to obtain a cementum canal and a main foramen. After final irrigation with saline, the root canals were dried with sterile paper points and dressed with a calcium hydroxide P.A. in distilled water.[8,11]

After biomechanical preparation and filling with calcium hydroxide/saline paste, the teeth were randomly

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divided into two experimental groups: Group 1 - coronally sealed with temporary restorative material (Coltosol, Vogodent, Rio de Janerio, RJ, Brasil) (n=13); Group 2 - coronally unsealed (n=13).

Seven days after root canal treatment, the animals were sacrified by an intramuscular anesthetic overdose. The specimens were fixed in 10% neutral-buffered formalin solution and decalcified in formic acid-sodium citrate. Segments of the jaws, each containing one root, were prepared for histological examination. The specimens were embedded in paraffin, serially sectioned to an average thickness of 6 µm and stained with hematoxylin and eosin (H&E) and Brown and Brenn staining techniques. Severity and extent of inflammation, as well as predominant inflammatory cell type in the periapical tissues, were recorded. Data were submitted to statistical analysis by Kruskal Wallis and Dunn tests. Significance level was set at 5%.

Results

The Brown and Brenn staining evidenced large amount of bacteria only in the pulp chamber of Group 2 formed basically from the scarps of the regular diet, which were not found in Group 1 (Fig 1A). Both experimental groups presented similar results in relation to pulp stump and periapical tissues. It was observed vitality of the middle and apical third of the pulp stump, but the coronal portion which was in close contact with $Ca(OH)_2$ dressing, was necrotic with an usual observation of basophilic line separating the material from a mineralized tissue (Fig 1B and C). The vital portions of the pulp stumps were in continuation with a periodontal ligament with no inflammatory reaction and normal thickness with no statistically significant difference ($p>0.05$) (Fig 2 and Table 1). It was also possible to note that periodontal fibers were inserted into the cementum and adjacent bone tissue (Fig 1D).

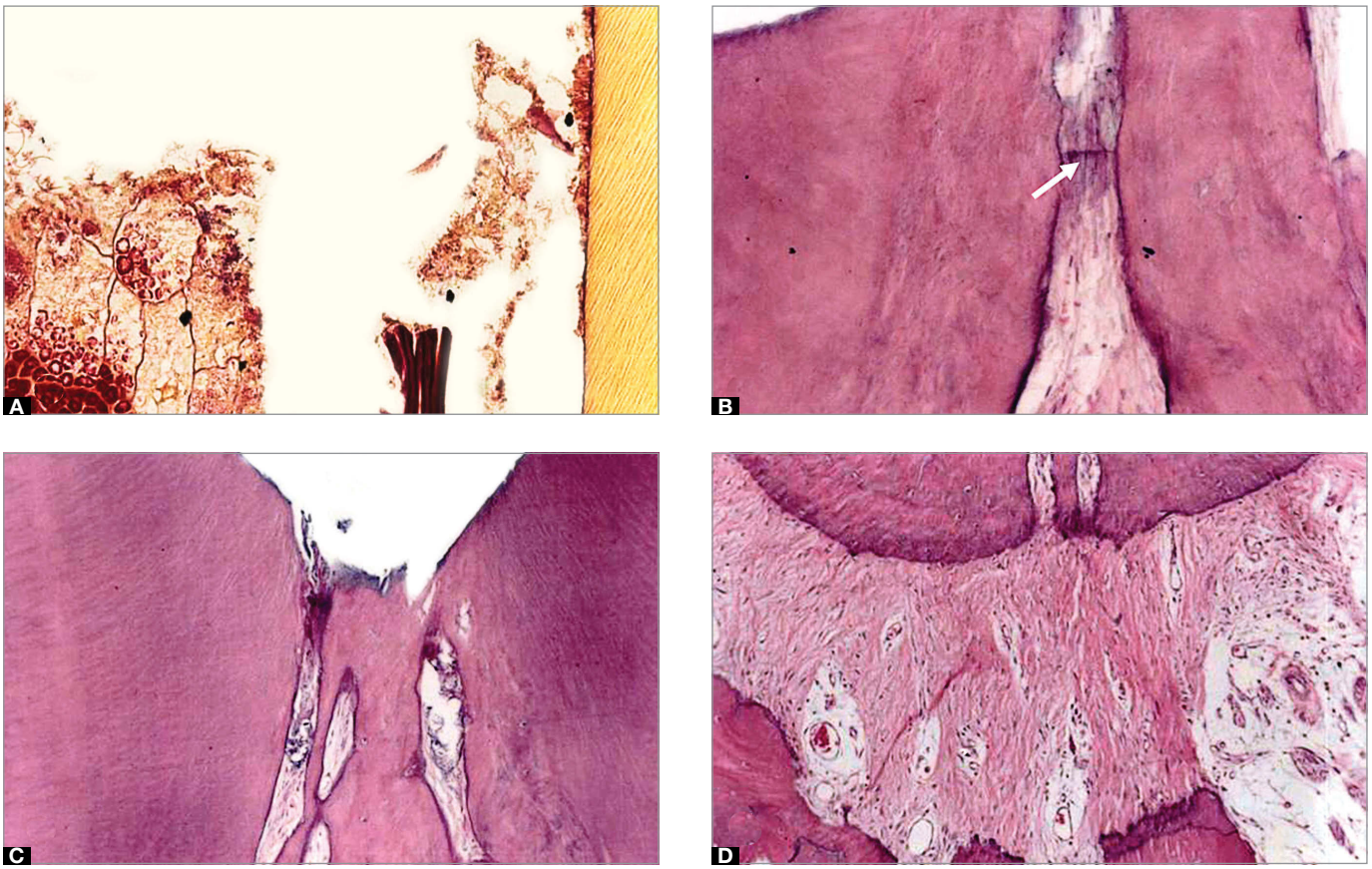


Figure 1. Group 2 **A**) Debris in the pulp chamber with Gram-positive microrganisms (Brown and Brenn, x200). **B**) Note basophilic line (arrow) delimiting the necrotic upper portion of the pulp stump (hematoxilin-eosin, x200). **C**) Cementum-Dentin limit (CDL). Note vital pulp stum (hematoxilin-eosin, x100). **D**. Panoramic view showing organized periodontal ligament without inflammatory cells and periodontal fibers inserting in the cementum and bone (hematoxilin-eosin, x100).

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Table 1. Frequence of histopatologic findings in each group.

Event	Group 1	Group 2
Cementum resorption		
Active	0	0
Inactive	0	0
Mineralized tissue		
Present	13	13
Absent	0	0
Periodontal ligament		
Thin	13	13
Thick	0	0
Periodontal ligament organized		
Present	13	13
Absent	0	0
Ankylosis		
Present	0	0
Absent	13	13
Dentinal resorption		
Active	0	0
Inactive	0	0
Bone resorption		
Active	0	0
Inactive	0	0
Inflammatory infiltrate		
Absent	13	13
Slight	0	0
Moderate	0	0
Severe	0	0
Bacteria		
Present	0	0
Absent	13	13

*Statistically significant.



Figure 2. Group 1. Organized periodontal ligament without inflammatory cells (hematoxilin-eosin, x100).

Discussion

Intracanal medications may prevent saliva bacteria penetration in the root canal in two ways: Chemically and/or physically.[24] The contamination of the root canal system occurs when the number of bacteria cells exceeds the antibacterial medication activity. Moreover, medications that fulfill the root canal act as a physical barrier against bacteria penetration. The canal contamination will only occur with the solubilization by saliva, the medication permeability to saliva, or percolation of saliva in the interface between the medication and the root canal walls. However, in any case, if the medication has antibacterial effects, neutralization may occur

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during the bacteria invasion.[26] Due to the alkaline pH, calcium hydroxide inhibits the bacterial enzyme activity and cellular membrane permeability[8] resulting in a direct and indirect antimicrobial effect over different microorganisms,[10,11] as well as hydrolysis of lipopolysaccharides.[22,23]

Calcium hydroxide paste acts as physicochemical barriers against infection with a marked pH-dependent antibacterial activity. The antimicrobial action of $Ca(OH)_2$ is related to its ionic dissociation in calcium and hydroxyl ions and their toxic effects on bacteria inhibiting cytoplasmatic membrane enzymes with consequent changes in the organic components and nutrient transport.[10] Saliva has buffer activity provided by proteins, phosphate and bicarbonate buffer system.[24] Thus, when exposed to saliva, it is likely that the calcium hydroxide chemical effect should be neutralized by its buffer ability. However, in the present study, bacteria was not seen in the root canal walls and the periodontal tissue surrounding the root was histologically normal, from which it can be inferred that calcium hydroxide/saline paste was able to prevent the contamination of the root canal system during a period of 7 days. These findings can be attributed to both, the chemical and physical characteristics of calcium hydroxide paste. The pH changes in the radicular dentin occur when calcium hydroxide is used and needs from 1 to 7 days to reach the external dentin.[21]

It was not possible to find in the literature *in vivo* results to be compared with the present ones. However, *in vitro* results have demonstrated that the root canals were completely contaminated after 19-day exposure to Staphylococcus epidermidis or after 42-day exposure to Proteus vulgaris.[26] Canals filled with calcium hydroxide/saline showed entire recontamination with an average of 14.7 and 16.5 days.[24] Recontamination was detected after an average time of 1.8 days in the unsealed canals medicated with calcium hydroxide paste.[8] These results evidenced differences in the time required for contamination or recontamination of the canals medicated with calcium hydroxide, mainly in detriment of the methodologies employed. The present study results showed that even in a critical situation, when the effectiveness of the restorative material is not present, the contamination did not occur for at least 7 days with the use of calcium hydroxide/saline paste as dressing.

Calcium hydroxide itself is a white odorless powder with a molecular weight of 74.08. It has a low solubility in water and a high pH (12.5–12.8).[9] When the powder is mixed with a suitable vehicle, a paste is formed. Three types of vehicle have been used: Aqueous, viscous or oily,[4] being the selection of the appropriate vehicle dependent on the clinical situation. If rapid ionic liberation at the beginning of treatment is required, an aqueous vehicle is indicated; whilst a viscous vehicle is appropriate when a more gradual and uniform release is necessary. Oily vehicle pastes have limited application. Another form to use calcium hydroxide is in points which are relatively recent and designed to release calcium hydroxide from a gutta-percha matrix. However, the rise in pH of root dentine at apical and cervical sites was significantly greater in teeth dressed with a aqueous calcium hydroxide paste material compared with teeth dressed with calcium hydroxide points.[4] In the present study, calcium hydroxide was used in a paste form from the mixing of calcium hydroxide powder with distilled water to allow a rapid ionic releasing, which can partly explain the results.

Another interesting point to be discussed is the biological property which is related to the periapical healing found in the present study. Calcium oxide may react with water or tissue fluids forming calcium hydroxide, which in contact with water dissociate in calcium ions and hydroxyl ions. The calcium ions react with the carbon dioxide in the tissues and form calcium carbonate granulations presented as calcite crystals birefringent to polarized light, which stimulates hard tissue deposition,[16] which aids its clinical use.[2,12,13,18,30] The diffusion of hydroxyl ions from the root canal raises the pH at the surface of root adjacent to the periodontal tissues, thereby possibly interfering with osteoclastic activity, and promotes an alkalinization in the adjacent tissues favoring the healing process.[29] Calcium ions are important due to their participation in the activation of calcium-dependant adenosine triphosphatase.[25] Calcium reacts with carbonic gas to form calcium carbonate crystals (birefringent to polarized light), which serve as a nucleus for calcification, and favors mineralization.[25] A rich extra-cellular network of fibronectin in close contact with these crystals strongly support the role

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of calcite crystals and fibronectin as an initiating step in the formation of a hard tissue.[25] Calcium is also needed for cell migration and differentiation.[24] This biological action can help to explain the vitality of the pulp stumps in continuation with a periodontal ligament with no inflammatory reaction and normal thickness, which is in accordance to other studies.[17,18,19]

Conclusion

Due to the present study results, it was possible to observe that calcium hydroxide/saline paste as dressing can promote an effective barrier against microbial invasion into the root canal system of dog's teeth in a period of at least 7 days, even if the coronal restoration fails to help the healing process of the periapical tissues.

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Influence of root canal irrigants on compressive strength and surface morphology of gray MTA Angelus®

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ABSTRACT

Objective: The present study aims to evaluate the influence of root-canal irrigants in the compressive strength and surface morphological characteristics of gray MTA Angelus using scanning electron microscopy (SEM). **Methods:** The MTA was mixed according to the manu instructions from manufacturer and packed incrementally into silicone cylindrical molds with an internal diameter of 2 mm and a height of 4 mm. After the initial setting, 30 samples were randomly divided into 3 groups (n=10). In Group C (control) the samples were immersed in a saline solution, in Group MC the samples were immersed in a 2.5% sodium hypochlorite solution and in Group MH the samples were immersed in a 2% chlorhexidine digluconate solution, all remaining for 1 hour. After rinsed, the compressive strength was measured in an Instron 4410 test machine with a crosshead speed of 0.5 mm / min. The surface morphological characteristics were determined by scanning electron microscopy (SEM). The statistical significance in compressive strength was evaluated by one-way analysis of variance (α=0,05). **Results:** The average compressive strength values (MPa) were 69.24±7.32 (Group C), 64.74±9.21 (Group MC) e 71.15±11.54 (Group MH), with no significant difference. The results of SEM had demonstrated that the microstructures from group C and MH were crystalline, composed of cubic crystals. A granular structure, in which crystals had not formed, was observed in the Group MC. **Conclusion:** The immersion in root-canal irrigants did not affect the compressive strength of MTA, with changes only in surface morphological characteristics. Further studies are needed to determine the clinical relevance of this crystal structure.

Keyhwords: Endodontics. Compressive strength. Microscopy.

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Introduction

MTA (*Mineral Trioxide Aggregate*) has been introduced in the dental market in 1993 by Torabinejad (Loma Linda University), with the indication for primary use in repairing lateral perforations in root canals and sealing apical areas. Currently, its indications are varied, persisting as drawbacks the long working time and difficult manipulation.[1]

This material consists of a powder of fine particles, which main components are tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. Its working time is 3 to 4 minutes and the setting time 3 to 4 hours.[2] The pH at mixing is 10.2, changing to approximately 12.5 after setting, thereby providing an antimicrobial action. There is also a possibility that MTA may promote tissue regeneration at its site of insertion.[3] Additionally, MTA presents two additional advantages in relation to other sealing materials: Its biocompatibility and the possibility of use in the presence of moisture.[4]

In endodontic therapy, we aggregate mechanical procedures and use of chemicals for removal of pathogens and chemicals that are harmful to the living tissues. Solutions based on sodium hypochlorite have been largely used with positive results, but there is also the alternative of using chlorhexidine solutions.[5]

However, information on the effect of such substances on MTA are still scarce. Still, when they are used in cases of root perforation, MTA is invariably exposed to these irrigants.

The objective of this study was to evaluate the influence of irrigating solutions on gray MTA Angelus® by assessing the resistance to compression and qualitative analysis of surface morphology on micrographs obtained by SEM (scanning electron microscopy).

Material and Methods

The matrices were obtained using devices consisting of an aluminum ring and a central base with a pin. Once these parts were positioned, addition silicone (Splash L - Discus Dental) was used to fill the rings and copied the cylindrical pins. After the setting of the silicone, the aluminum rings were removed (Figs 1A, B). Thirty samples were prepared inside the silicone matrices. The cylindrical cavities had a 2 mm diameter and a 4 mm height (Figs 1C and 1D). The material (Gray MTA Angelus - Lot 2302 - Angelus, Brazil) was handled under standard conditions (temperature 25 ± 2 °C and relative air humidity at 55%) using the proportion recommended by the manufacturer. The amount of powder was measured with a precision scale and the volume of the liquid dispensed with a micropipette.

The material was inserted into the matrix in reduced portions with a spatula and an amalgam condenser. The cavities were filled with an excess of the cement, with a constant vertical pressure of approximately 3 MPa applied for 1 minute in order to standardize the procedure.[6] The spilled material was carefully removed and the matrices were kept in containers at a temperature of 37 °C and 100% relative humidity for 72 hours. After storage, all samples were removed from the silicone matrix, checked for possible surface irregularities and, according to each experimental group (n = 10), immediately immersed for 1 hour in the following solutions:

» Group C: Control - saline solution.
» MC Group: 2% solution of chlorhexidine.
» MH Group: 2.5% solution of sodium hypochlorite.

Later, they were all rinsed in deionized and distilled water for 5 minutes and kept in a container with 100% relative humidity until the mechanical testing. The tests were performed in a test machine (Instron, model 4410, Norwood, MA, USA) at a crosshead speed of 0.5 mm / min. Compressive strength values were recorded in MPa.

In addition, two extra cylinders of equal size for each group were subjected to the experimental procedures previously described and stored in a container with 95% relative humidity. They were further evaluated in a scanning electron microscope model LEO EVO 40 (Carl Zeiss AG, USA), with low vacuum (0.05 to 2.0 Torr) in the region of the electrode, column and specimen chamber.[7,8] The images were recorded on file in TIFF (Tagged Image File Format) format in order to avoid errors caused by digital image compression, noise generation and distortion.

The original values obtained in the compressive strength test were subjected to analysis of variance, considering the model with one factor (dipping environment) and $\alpha = 0.05$, with the result described in the appendix. We used the software Microsoft Excel® with the add-in Analysis Tools (Microsoft Office® 2003).

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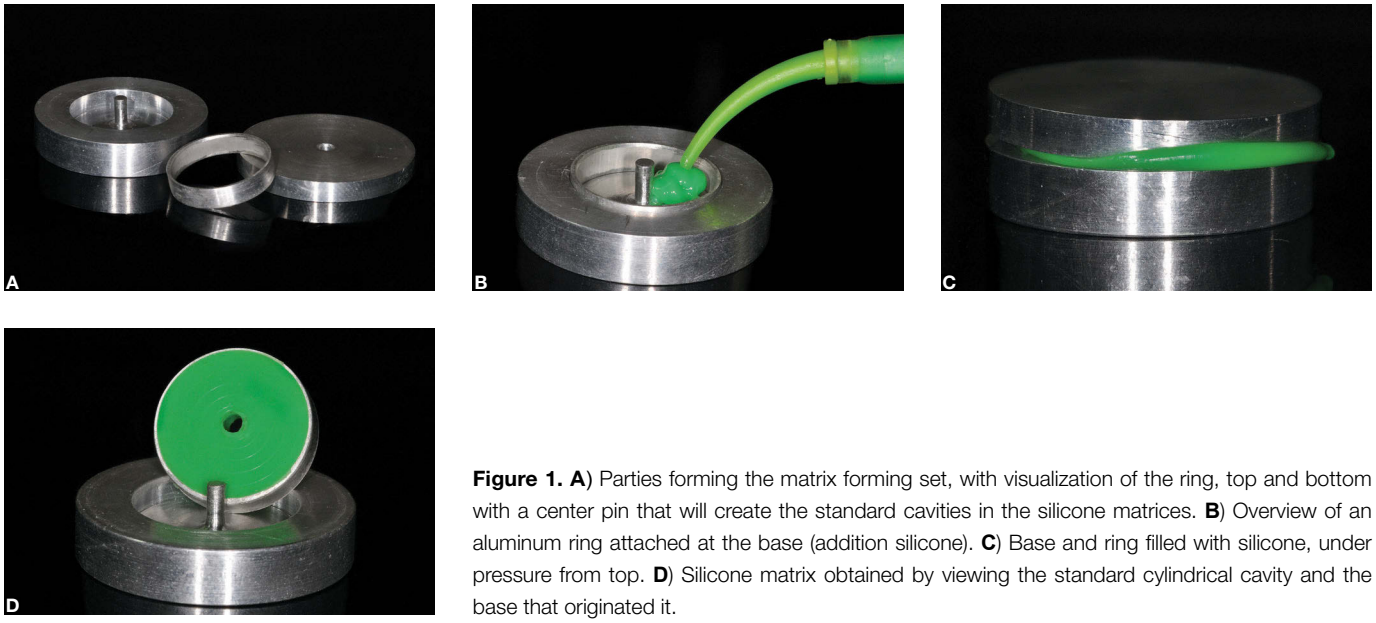


Figure 1. A) Parties forming the matrix forming set, with visualization of the ring, top and bottom with a center pin that will create the standard cavities in the silicone matrices. **B**) Overview of an aluminum ring attached at the base (addition silicone). **C**) Base and ring filled with silicone, under pressure from top. **D**) Silicone matrix obtained by viewing the standard cylindrical cavity and the base that originated it.

Results

After obtaining the values of compressive strength, no statistically significant difference between the groups was observed (Table 1):

Figures 2 - 7 show the photomicrographs used for qualitative analysis involving the samples surface. In Figure 2 it is noticeable the presence of cubic crystals with a greater variety of sizes and major proximity, increasing the compression on the surface, features which are more evident under higher magnification (Fig 3).

In the photomicrographs for the MC group, it is shown a major filling and partial recoating of the cubic crystals and gaps if compared to Group C (Fig 4). It can be seen with an even higher magnification (Fig 5) that gaps still remain on the surface, consistent with dissolution of less stable phases. These areas became less cohesive, what may be the cause for lower mechanical strength.[9]

The photomicrographs relative to Group MH showed less gaps along the analyzed surface (Fig 6) and a greater presence of smaller size cubic crystals among the larger crystals (Fig 7). This may increase the packing factor and the resulting structure. This fact allows a more sparse distribution of gray MTA Angelus particles in relation to the particles size. However, this feature may come to affect the homogeneity of the newly manipulated material.[6]

Discussion

The dental materials are constantly evolving and their clinical use should be preceded by a greater knowledge of their physical, chemical and biological

Table 1. Experimental groups, mean values of compressive strength and standard deviation as a function of immersion solutions.

Group	Mean Value	Standard Deviation
C	69.24[a]	7.32
MC	64.04[a]	9.21
MH	71.15[a]	11.54

Results are expressed in MPa. Mean values followed by same letter vertically do not show statistically significant difference (α = 0.05).

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properties.[10] Among these materials, MTA stands out due to its excellent repair properties, biocompatibility and tolerance to moisture.[1,2,4,11] Additionally, it shows a sealing ability within the standards, with the advantage of radiopacity provided by the presence of bismuth oxide.[12]

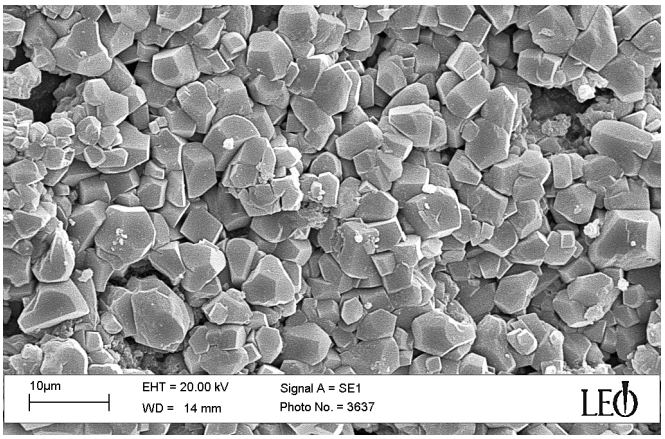


Figure 2. Photomicrograph displaying the surface for a representative sample of the group C (4000 x)

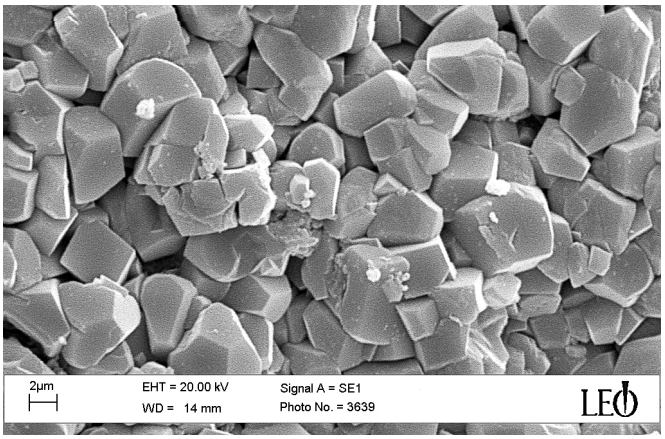


Figure 3. Photomicrograph displaying the surface for a representative sample of the group C (7000 x).

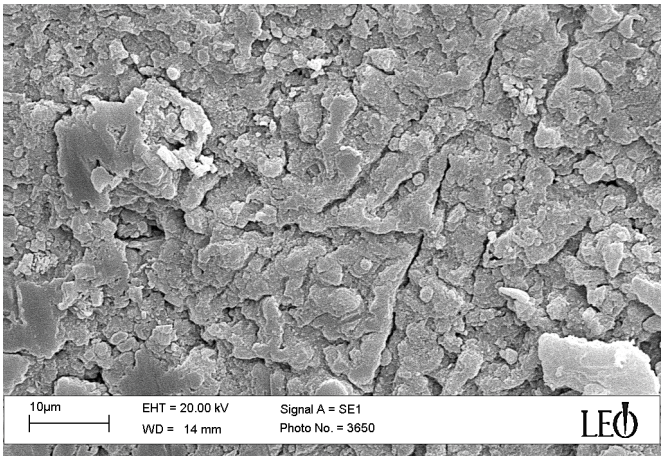


Figure 4. Photomicrograph displaying the surface for a representative sample of the group MC (4000 x).

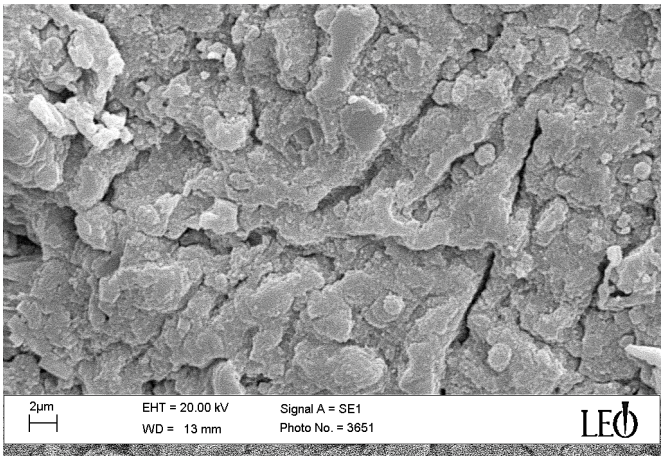


Figure 5. Photomicrograph displaying the surface for a representative sample of the group MC (7000 x).

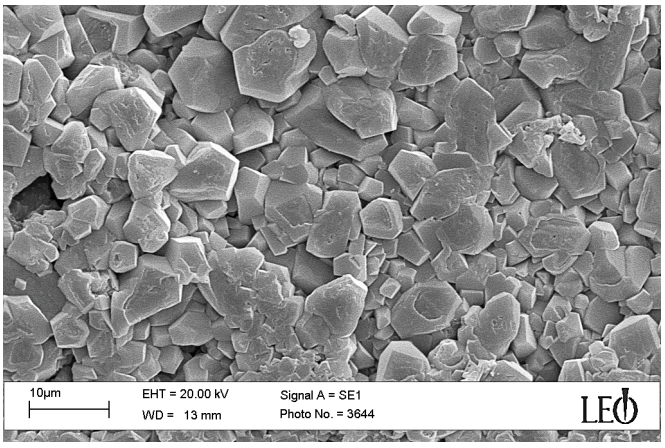


Figure 6. Photomicrograph displaying the surface for a representative sample of the group MH (4000 x).

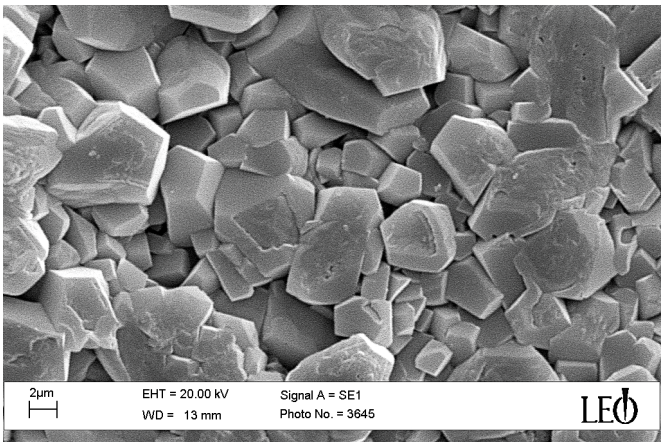


Figure 7. Photomicrograph displaying the surface for a representative sample of the group MH (7000 x).

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Characteristics related to mechanical strength may not be a factor of utmost importance when a material is inserted into cavities that do not directly support high stresses (e.g.: a retrofiller). However, one should consider that in situations such as furcation perforations in molars and direct pulp capping, this may be significant due to the occlusal loads.[13] In this study, the compressive strength was selected with the purpose of representing such clinical situation. It should be emphasized that applying a correct methodology in laboratory tests shows a direct relation to the standardization and validity of the results.[14] For instance, in compressive strength tests, the presence of internal and external failures can lead to the occurrence of complex loads. This may occur if the sample is too short or too long. To avoid bending, the sample should have a height twice its diameter.[15]

Because MTA has a long setting time, patients should be informed to avoid strong chewing on the MTA-treated tooth for at least 4 hours after placement. Research has confirmed that in cases of root perforations, the placement of the MTA should be performed via root canal with the aid of an amalgam holder and be gently compressed with moistened cotton pellets.[16,17]

In studies that address the relation between the insertion and mechanical strength of MTA,[18,19,20] there is frequent mention of the time of 72 hours that should be awaited in order to present satisfactory values of mechanical strength and resistance to displacement.

In this study, the mean compressive strengths (MPa) were 69.24, 64.04 and 71.15 respectively for the groups C, MC and MH. These values differ from those described in the literature, e.g., approximately 40 MPa after 21 days of insertion up to 67 MPa, which corresponds to those of IRM and Super EBA.[21] The manufacturer of the evaluated product (gray MTA - Angelus) describes the value of 42 MPa for the compressive strength after 28 days. Nevertheless, in literature there are mean values of 70 MPa for Gray MTA,[19] which are similar to those obtained here.

Given the variations found in the values of compressive strength, it should be considered that different protocols were used. It has been shown that the setting reaction of MTA is highly susceptible to the environment in which it occurs (presence of chemical substances and pH values).[22,23,24]

Looking for similarity between laboratory testing and clinical performance, solutions such as 2% chlorhexidine and 2.5% sodium hypochlorite were used in this study. This was performed to simulate the clinical situation in which the MTA would be exposed to these substances during endodontic treatment.[5,25] Such substances, either due to their composition or pH, change the structure and the surface morphology of the MTA,[8,17,24] which was actually demonstrated in this study.

Studies with similar methodology described the formation of cubic crystals in the MTA, when exposed to a neutral pH solution, a fact which corroborates the results of this study. However, there is a description of the presence of acicular crystals, which was not observed in the experimental conditions herein. Differences in the type of MTA and methodology may have been responsible for this variation.[17,26]

The analysis of the photomicrographs regarding the control group (Figs 2 and 3) showed characteristic images of cubic and compact crystals, with an approximate width of 5 mm and size and shape variations, which were consistent with the literature.[27,28] In Figure 3 the cubic crystals are presented juxtaposed, without the presence of an amorphous layer covering them.

In Figure 5 gaps still remain on the surface, consistent with dissolution of the less stable phases, related to lower mechanical strength.[9] However, the fact that they occur in small scattered regions causes them to not be representative in order to influence the compressive strength, a fact evidenced by the mechanical test performed.

The photomicrographs for the MH group exhibited less gaps along the analyzed surface (Fig 6) and a greater presence of cubic crystals with smaller size among the larger crystals (Fig 7), thus increasing the packing factor and the resulting structure. This fact provides a more sparse distribution of gray MTA Angelus particles in relation to the particles size. However, this feature may come to affect the homogeneity of the newly manipulated material.[6]

Despite the fact that the solutions did not influence the values of compressive strength, the clinical performance of a material is grounded in a satisfactory set of properties, acting in a synergistic way.

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Assessments involving surface relations under the tested conditions are necessary, in order to clarify whether such changes affect the interaction with other restorative materials and mechanical strength in the long-term.

Conclusions

Before the experimental conditions, we may conclude that:

» There was no statistically significant difference in compressive strength among the experimental groups.

» The SEM analysis showed variation on the surfaces, with a similar pattern between groups C and MH, and a granular structure occurring only in group MC.

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Accuracy of the Root ZX II using stainless-steel and nickel-titanium files

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ABSTRACT

Objective: The aim of this *in vitro* study was to evaluate the accuracy of the Root ZX II electronic apex locator (EAL) using hand stainless-steel file, nickel-titanium hand file and nickel-titanium rotary file. **Methods:** Twenty straight single-rooted maxillary central teeth were used. The actual working length (AWL) was measured by inserting a #15 K-file until the file tip was visible at 4x magnification. The file was removed from the canal and its length was measured using a digital caliper. For the electronic measurements, samples were fixed in glass recipients with plastic cover, containing 0.9% saline solution. The measurements were carried out using the Root ZX II and they were performed using a #15 K-file, NiTi hand file and a rotary Mtwo file. The files were attached to the EAL and during their insertion into the root canal the measurements were monitored until the display indicated "zero". The corresponding values of the difference between the AWL and the electronic measurement were recorded and submitted to ANOVA and Tukey test (α=0.05). **Results:** No statistically significant differences ($p<0.05$) was found among the tested files. **Conclusion:** It can be concluded that both stainless steel files and NiTi hand or rotary files are adequate to determine the working length using the Root ZX II.

Keywords: Tooth apex. Dental instruments. Endodontics.

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Introduction

Determining the working length (WL) correctly is an important step in the root canal treatment, ensuring that biomechanical preparation and filling materials be restricted to the canal space and avoiding, thus, harm to both periradicular tissues.[1] The WL is defined as the distance from a coronal reference point to the one in which the canal preparation and obturation should terminate.[2] Underestimation of the WL can lead to insufficient debridement of the root canal, whereas overestimation can result in damage to the periapical tissue, which will delay or prevent healing.[3,4]

Recently, electronic methods for determining the WL have become common in endodontic clinics. Several studies have demonstrated the high efficiency of electronic apex locators (EAL) as well as their ability to determine the WL even in adverse situations such as the presence of irrigation agents, blood and large foramen.[1,5,6] In addition, the radiographic method for determining the WL has limitations that include image distortion,[7] overlapping roots and anatomical structures, as well as exposure to higher radiation.[8]

Recent advances in endodontics include instruments made of nickel-titanium (NiTi). NiTi has some advantages such as improved apical third debridement for its greater flexibility[9], shorter operative time[10], as well as greater fracture resistance.[11] Thus, the objective of this study was to evaluate the accuracy of Root ZX II in permanent teeth using stainless steel files, NiTi hand files and NiTi rotary files.

Materials and Methods

Twenty straight single-rooted maxillary central teeth were used. Roots with resorption, fractures or open apices were excluded from the study. Canal patency was evaluated using a K #10 file (Dentsply-Malleifer, Ballaigues-Suíça). The cusps were flattened to establish an equal root length and a stable and reproducible reference point for all measurements. Pulp chambers and canal were cleaned by irrigating with 5 ml of 5.25% sodium hypochlorite.

The actual working length (AWL) was measured by inserting a K #15 file (Dentsply-Malleifer, Ballaigues-Suíça) until the file tip was just visible at using 4x magnification. After adjusting silicone stop to the coronal reference, the file was removed from the canal and its length was measured using a digital paquimeter with an accuracy of 0.01 mm.

For the EAL measurements, samples were fixed in glass with a plastic cover, containing 0.9% saline solution. Two holes were made in the plastic cover: In the first, the lip clip was placed in contact with the saline solution and in the second in which the root was adapted with the assistance of the utility wax, when it was needed, the root was in contact with the saline solution, instead. The measurements were carried out using the Root ZX II (J Morita, Kyoto, Japan).

It was performed using a K #15 file (Dentsply-Malleifer, Ballaigues-Suíça), NiTi hand file #15/0.02 (Dentsply-Malleifer, Ballaigues-Suíça) and a rotary Mtwo #15/0.05 file (VDW, Munich, Germany) in rotary motion using a VDW silver motor (VDW, Munich, Germany). The files were attached to the EAL and during their insertion into the root canal, the measurements were monitored on the EAL display until it indicated "zero". The measurement was considered valid if it remained stable for at least 5 seconds. After, the stops were set in the coronal surface, measurements were taken with a digital paquimeter and compared with the AWL obtained earlier. All measurements were made by the same operator. The corresponding values to the difference between the AWL and the electronic measurement (EWL) were recorded and submitted to Analysis of Variance (ANOVA) and subsequently to the Tukey test with a significance level of 5%. Statistical analysis was performed using SPSS software (LEAD Technologies, Chicago, USA).

Results

For each canal the difference between AWL and EWL were calculated. The means values of the difference between AWL and EWL and their standard deviations are shown in Table 1. The reliability rate (tolerance of 0.5 and 1 mm) of WL is presented in Table 2.

No statistically significant difference ($p<0.05$) were found among the tested files.

Discussion

Numerous *in vitro* and *in vivo* studies have reported the accuracy of EALs in determining the correct WL.[1,5,6,10,12] Although the absence of periodontal ligament is one of the inconveniences of the *in vitro*

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studies, it can be compensated using 0.9% saline solution. Saline solution is an excellent way to establish sufficient electrical circuit for the correct operation of LAEs as it has similar impedance properties as the periodontal ligament.[14] This model was used successfully in several studies[1,13,14] as well as in ours.

The possibility of doing rotary instrumentation with EAL coupled in the instrument opens a new perspective regarding the control of apical extension of instrumentation. It also makes the root canal treatment easier and faster, optimizing the endodontist work.

In the present study, there was no significant difference among the tested files groups, showing a high accuracy to determinate WL. These results are consistent with previous study that showed no difference between stainless steel files and NiTi hand files[15]. Contrary to these results, Siu et al,[16] achieved *in vivo* greater accuracy using hand files when compared with NiTi rotary files, probably due to a better movement control of the hand files. In the present study the measurement was also performed with rotational movements and no difference was found between hand and rotary files. Such results can be justified by the use of different methodologies to determine the WL and to assess the accuracy of the same.

Among the samples, only one in the hand steel file and in hand NiTi file group showed a difference of the AWL and the EWL greater than 1 mm. The majority of the measurements stayed between 0.01 and 1 mm from the apex. A 1 mm tolerance can be considered clinically acceptable.[1,3,10,13,14] Using this measurement criterion there was a high precision of all tested files showing 95% accuracy in NiTi hand files and stainless steel file and 100% in rotary NiTi files. Similar results were also found by other authors who obtained similar accuracy rate of LAEs location of fractures and perforations.[17,18]

Table 1. Mean difference between AWL and EWL (mm).

File	Size	Mean±SD (mm)
K files	15/0,02	0,483 ± 0,31[A]
NiTi hand file	15/0,02	0,436 ± 0,30[A]
NiTi rotary file	15/0,04	0,372 ± 0,25[A]

Same letters show no statistically significant difference

Table 2. Reability rate using different files.

Distance from AWL (mm)	K File n (%)	NiTi hand file n (%)	NiTi Rotary file n (%)
> 1	1 (5%)	1 (5%)	0 (0)
0,50 a 1	8 (40%)	6 (30%)	5 (25%)
0,01 a 0,50	11 (55%)	13 (65%)	15 (75%)
0	0 (0)	0 (0)	0 (0)

Conclusions

With the limitations of the present work, it can be concluded that both stainless steel files and NiTi hand or rotary files are suitable for determining the working length using the Root ZX II.

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Evaluation of light filter of portable dark chamber and its influence on radiographic image quality

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ABSTRACT

Introduction: The Ordinance 453 of the Brazilian Ministry of Health recommends processing intraoral radiographic films in opaque portable dark chamber without display and using the temperature x time method. However, the processing using the visual method in dark chambers with acrylic polymer display is still frequent. The aim of this study was to evaluate and compare the filtering capacity of four portable dark chamber (Unemol®, VH®, MPG® and a camera without identification) with the capacity of a conventional dark chamber (control) and check its influence on image quality in different radiographic films (Kodak®: DF-58 Ultra-Speed, E-Speed and IP-21 Insight; and Agfa® Dentus M2). **Methods:** The films were exposed with a step wedge of aluminum and a lead plate and processed in Kodak® solutions ready for use in each portable dark chamber and in the conventional dark chamber (control). The films remained three minutes in the developer and at every minute the films were approximated to the display, simulating the clinical condition, followed by intermediate bath and fixing for six minutes. Photodensitometric assessment was made and the data were analyzed by Mann-Whitney and Kruskal-Wallis tests. **Results:** The first test showed that in relation to the control group there was no statistically significant differences with the Unemol® chamber when using IP-21 Insight and E-Speed films and the VH® chamber when using IP-21 Insight film. The second test showed a significant statistical difference when comparing one film to each other. **Conclusion:** This research suggested that the acrylic display increases the base veiling density, jeopardizing the quality of the radiographic image.

Keywords: Dental radiography. Diagnostic imaging. Radiography.

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Introduction

Auxiliary diagnostic methods are extremely important for planning treatment and radiographic examination is one of the main methods. A radiographic image quality requires knowledge and control of all processing steps.[1] With limited space and relatively small amount of radiographic exposures in a dental office, beyond the need for execution of the transoperative radiographs in some specialties, it became feasible to use portable dark chamber by offering greater flexibility in processing radiographic without the need to shift the patient to a specialist clinic.[2]

In 1998, the Department of Health Surveillance of the Ministry of Health issued the 453 ordinance regulating the use of Dental Radiology. This ordinance allows the use of portable dark chamber for intraoral radiographs, provided they are made of opaque material and are fitted with clock and thermometer for the realization of radiographic processing by temperature-time method. However, the display in dark rooms with red acrylic, are still widely used in clinics, to perform the processing by visual inspection.

The operating conditions in a portable dark room should be such as to enable greater efficiency and image quality. Any failure during processing can compromise the image and hinder the diagnosis.[3] Currently, intra-oral films have become more sensitive, being essential the quality control of portable dark chamber and the knowledge of its handling by the professional.

The lack of studies on the effectiveness of red acrylic polymer filter adequately the components of the light spectrum in the dark chambers used in the dental office with films of different groups of sensitivity, led to this research, whose objective was to evaluate the relationship between the light filtering capability of four portable dark chambers brands and check their influence on the quality of radiographic imaging in intra-oral films of different sensitivities.

Materials and Methods:

This study evaluated four portable dark chamber types with viewers in red acrylic polymer with varying sizes: Portable Dark chamber UNEMOL®, MPG® (Manoel Pereira Goncalves Ind.), VH® and portable dark chamber without identifying the manufacturer and in use at the Dental Clinic of the Brazilian Association of Odontology of the Federal District (Fig 1). The periapical films used in this research were periapical Kodak group D (DF-58 Ultra-Speed), Group E (E-Speed), Group F (Insight) and Agfa® Dentus M2. The dark chambers were placed on a table, located under two fluorescent lamps, daylight 40 watts of Osram brand, located at a distance of 2.17 m.

A dental X-ray machine Dabi Atlante® Spectro 70X with 70 kVp and 8 mA, with total filtration equivalent to 2.5 mm aluminum was positioned with a finder cylinder perpendicular in a focus-film distance of 30 cm from the radiographic film. The film was placed on a sheet of styrofoam to avoid backscattered radiation. An aluminum step wedge with eight steps thickness covered part of the film and the remainder was covered by a lead plate which prevented completely the passage of the X-ray (Fig 2). For each film, several exposures were made in different times, and three evaluators determined the optimal exposure time for each group of film.

One hundred and twenty-five films were exposed to radiation in the conditions described above and divided into groups for processing. In each portable dark chamber were processed five films from each brand. In addition, five films from each group were exposed and processed in conventional dark chamber demonstrably protected from light entry, which is the control group.

The radiographic processing was conducted in solutions ready for use from Kodak® company, using the method temperature / time, with 3 minutes development time, and in every minute the film was approximated to the acrylic polymer and maintained for about 3 seconds, time required for viewing the image, simulating the dentist routine in the dental office. Then the films were subjected to intermediate water bath for 10 seconds and then, immersed in fixative for 4 minutes. Every 10 processed films, the solutions were changed to prevent damage, avoiding thus the interference of densities of X-ray in the following group (Fig 3).

The photodensitometric evaluation of radiographs was performed in the laboratory of Nuclear Energy, Federal University of Pernambuco (UFPE), using a digital densitometer 600B (Victoreen Inc., Ohio). The collected data were tabulated on a Microsoft® Excel 2003 and later were subjected to statistical tests of Mann-Whitney and Kruskal Wallis

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with SPSS 13.0 for Windows®. All tests were applied with 95% confidence intervals and numerical variables were represented by measures of central tendency and dispersion measures.

Results

To evaluate the dark chambers, it was used the Mann-Whitney test (compared with two groups) where each brand (Unemol®, VH®, MPG® and

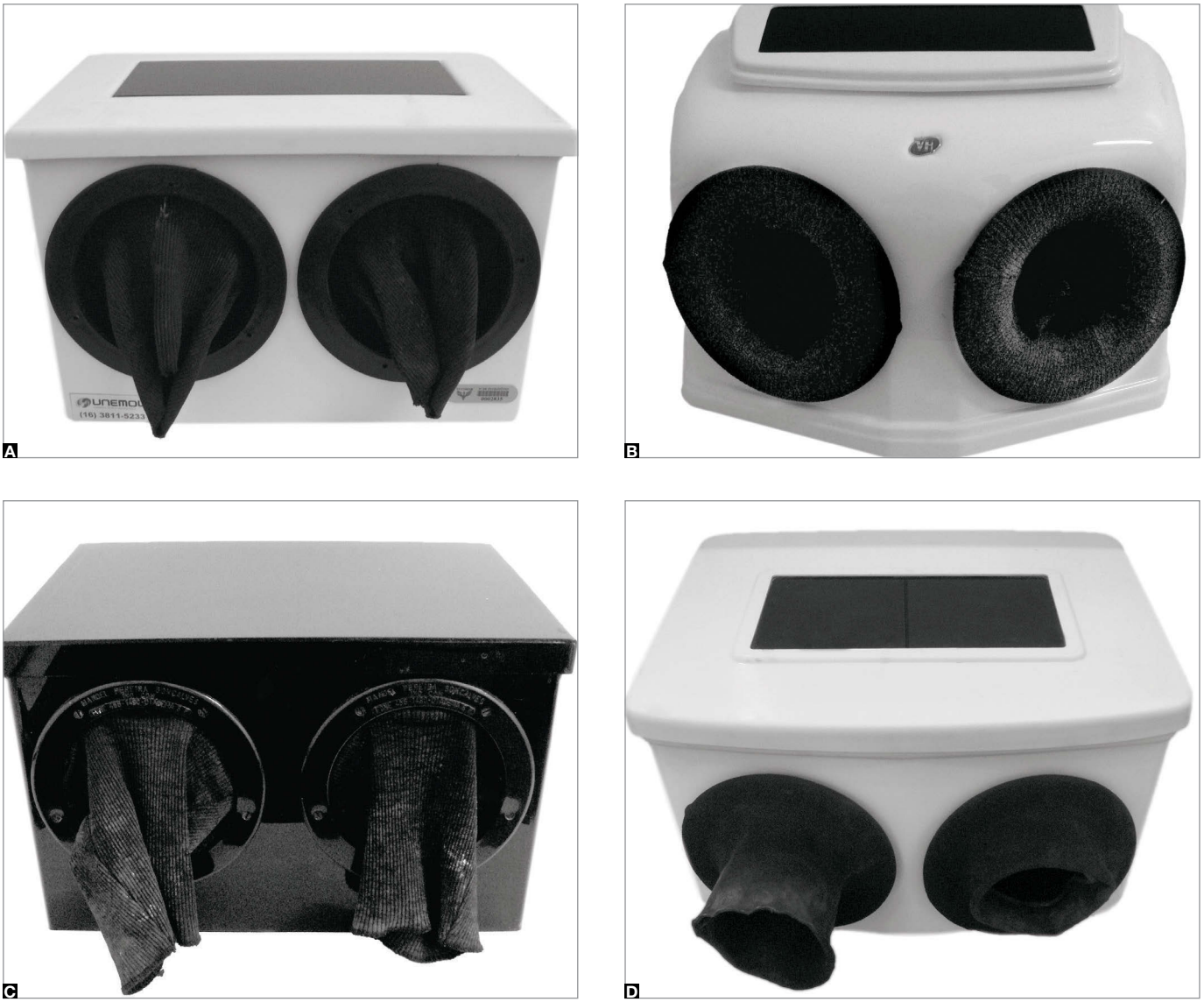
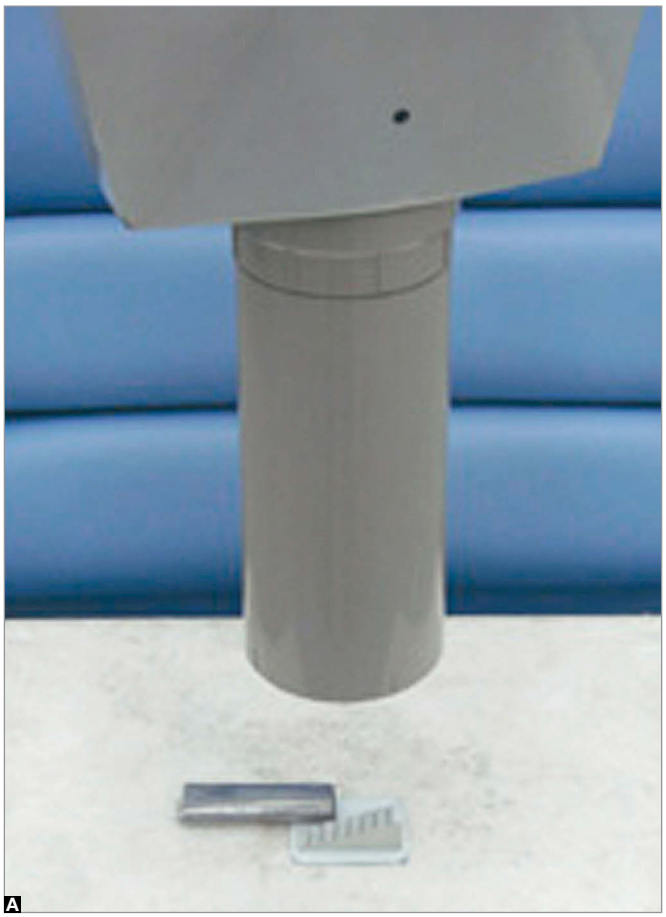
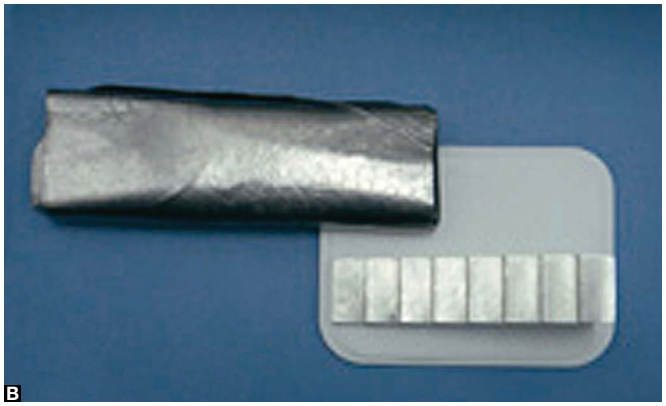


Figure 1. Portable dark chamber used in reseach **A**: UNEMOL® **B**: VH®, **C**: MPG® e **D**: Unbranded dark chamber.





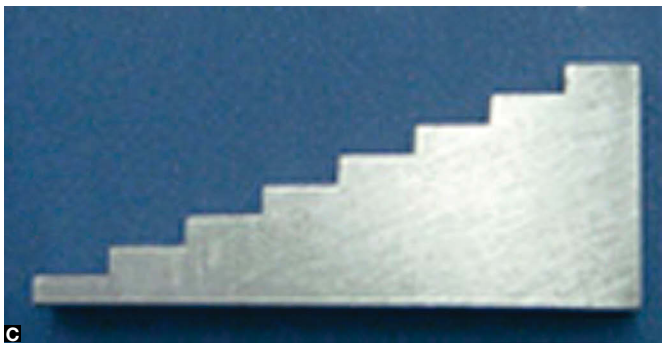


Figure 2. A) X-ray machine positioned, radiographic film, lead plate and step wedge on the Styrofoam; **B**) Detail of lead and step wedge on the radiographic film; **C**) Aluminum step wedge.

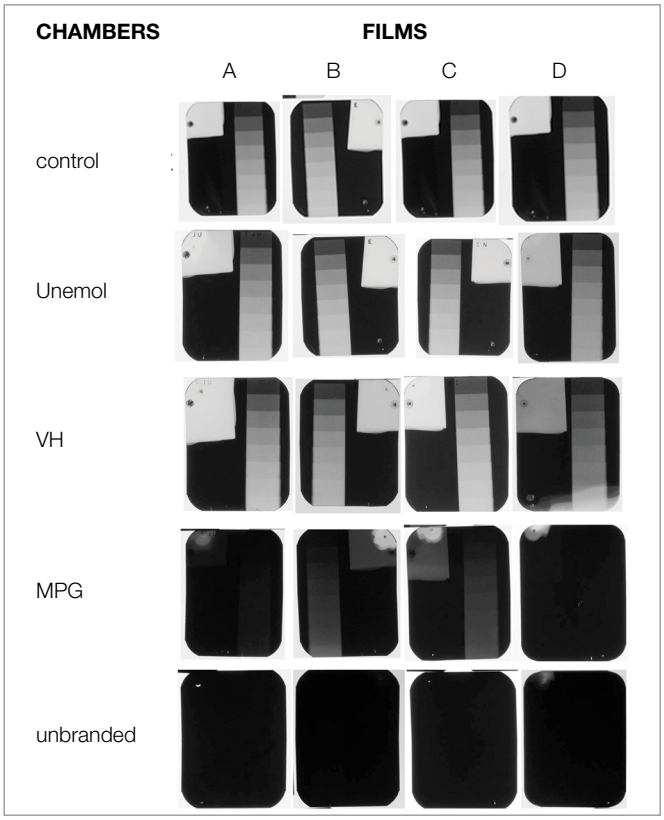


Figure 3. Films processed in the dark chambers: Control, Unemol®, VH®, MPG® and "Unbranded". **A**) DF58 Ultra-Speed, **B**) E Speed, **C**) Insight (KODAK), **D**) AGFA® Dentus M2.

unbranded portable dark chamber). Then thet were compared to the control group, taking into account each type of film used (Table 1). There was a statistically significant difference between the portable dark chamber Unemol® and the control one, when using the Kodak DF-58 and Agfa Dentus M2 films, which did not happen when using the Kodak E-speed and IP 21 Insight. For the brand VH®, there was a statistically significant difference in the control group when using all films except the IP 21 Insight film. For MPG® and unbranded portable dark chamber, there was a statistically significant difference in the control group when using all films.

To compare the films, it was used the Kruskal-Wallis test (compared with more than two groups),

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Table 1. Mann-Whitney test comparing each brand of dark chamber with the control group, taking into account the film used.

FILM	PORTABLE DARK CHAMBER BRANDS				
	Control	Unemol	VH	MPG	Unbranded portable dark chamber
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
DF-58 Ultra-Speed	0.19±0.006	0.21±0.011**	0.28±0.031**	2.42±0.102**	4.59±0.399**
E-Speed	0.16±0.007	0.16±0.004	0.26±0.185**	1.22±0.075**	3.27±0.290**
IP-21 Insight	0.22±0.011	0.22±0.012	0.22±0.014	1.34±0.089**	3.77±0.494**
Agfa Dentus M2	0.24±0.011	0.28±0.021**	0.54±0.077**	3.70±0.230**	4.79±0.344**

(*) Mann-Whitney Test.

(**) P value ≤ 0.05 compared to control group.

Table 2. Kruskal-Wallis test to compare the films to each other.

FILM	Mean	Standard deviation	p-value*
DF-58 Ultra-Speed	1.54	1.792	0.003
E-Speed	1.01	1.230	
IP-21 Insight	1.19	1.439	
Agfa Dentus M2	1.98	1.996	

(*) Kruskal-Wallis Test.

which showed a statistically significant difference between the films evaluated (Table 2).

Discussion

Radiographic examination should present a good image quality because it aims to diagnose bone and soft tissue lesions.[1] The professional must have scientific knowledge and respect all phases of obtaining radiographic image, from the technique execution to the end of the process. The image density, contrast, sharpness and blurring are influenced by processing and may result in different characteristics when the film is subjected to different processing conditions.[4,5]

Several studies have been conducted in order to verify the influence of types of processing solutions,[6] the types of radiographic processing,[5,7] temperature,[8] revelation,[9,10,11] exhaustion,[12,13] degradation[5] and the final wash[14] in image quality. However, studies of portable dark chamber and its influence on the radiographic image are rare.

The 453 Ordinance of the Ministry of Health began to regulate the exercise of Medical and Dental Radiology in Brazil. This standard requires that for the manual processing of intraoral radiographs is allowed to use portable dark chamber, provided that they are made of opaque material and is provided with thermometer and timer for the use of the method temperature / time.

Some researches indicate that portable dark chambers with transparent acrylic polymer cause opacification on radiographs and allow the processing realization by the inspecional method,[2] which was banned by 453 Ordinance, to lead to a lack of standardization and loss of image quality.[9] In this study we evaluated the ability of light filtering through acrylic polymer of four portable dark chamber brands and found its influence on radiographic image quality (base and blurring) of four intra-oral films of different sensitivities. Visually, the radiographs processed in VH® and Unemol® portable dark chambers did not have significant differences in relation to the control group (conventional dark chamber), but statistical analysis showed a significant difference between control groups and all the dark chambers, with the exception of Unemol® when using the Kodak E-Speed film and IP-21 Insight and VH® camera when using the IP-21 Insight film. These findings corroborate the results obtained by Watanabe et al[15] which indicated that the chambers of clear acrylic allow light passage causing blurring and then, increasing density and contrast of the radiographs.

Among the studied films, the Agfa Dentus M2 showed the highest density base-veiling in the control group and all portable dark chambers. For the control group and the portable camera with the best results (Unemol®), the decreasing sequence of base-blurring was: Agfa Dentus M2, Kodak IP-21 Insight, DF-58 Ultra-speed, E-speed. In other portable dark chambers the results were: Agfa Dentus M2, Kodak Ultra Speed DF-58, E-Speed and Insight, except the dark chamber without identifying where there was reversal of the last two films.

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It is suggested that further studies be developed on the issue. Other brands should be investigated because, despite advances in intra and extra-oral digital radiographic systems, conventional radiographic systems and portable dark chambers with acrylic display are widely used in dental offices in Brazil[16] and the lack of knowledge by the dentist about the need to follow some rules and procedures may affect the image quality and diagnosis.

Conclusion

The present study suggests that the acrylic display of portables dark chambers used in dental offices increases the base density and blurring, jeopardizing the quality of the radiographic image and the correct diagnosis.

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Use of synthetic hydroxiapatite and MTA in periapical surgery: A case report

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ABSTRACT

Objective: This article aimed to report a case of periradicular surgery in which biomaterials, such as MTA and synthetic hydroxiapatite were used. A periapical radiograph showed an extensive radiolucent area extending from the mesial aspect of the tooth 21 to distal aspect of tooth 22. Apicoectomy was performed and root-end cavities were prepared and restored with MTA as a retrofilling material. Synthetic hydroxiapatite was also used aiming to model the lost bone structure. The enucleated lesion was submitted for histopathological examination. A diagnostic of periapical granuloma was established based on the microscopic analysis. Two years after the periradicular surgery, there were no clinical or radiograph suggestive signs of treatment failbure. Instead, the patient's follow-up has shown that the case management has been successful as indicated by lesion regression and periodontal repair. Based on this case, we can conclude that the definitive diagnosis of the type of periapical lesion can only be made by a histological examination and apical surgery can be an excellent complementary procedure when endodontic treatment has not yielded healing outcome.

Keywords: Periapical diseases. Periapical periodontitis. Periapical tissue.

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Introduction

The progression of pulpal inflammation to the periapical region and microorganism colonization of the root canal system lead to innate and adaptive immune responses, and results to periapical alveolar bone destruction and periapical lesion formation.[1,2]

Classically, chemical and mechanical preparation of the root canal and local medication based on calcium hydroxide pastes, followed by the root canal system obturation results in elimination of the infection and healing of the periapical tissues. However, in some cases, the periapical lesion persists despite the conventional endodontic treatment. The lack of success is mostly attributed to the anatomical complexity of root canals, which makes impossible getting a satisfactory microbial stimulus elimination.[3] Other reasons for persistent periapical periodontitis are foreign body responses toward infected root dentin displaced by over instrumentation toward filling material or toward cholesterol crystals.

Periradicular surgery is indicated as a complementary procedure in cases in which endodontic treatment failed. Apicoectomy is the most common type of periradicular surgery, comprising the elimination of pathological tissues, resection of the apical third of the root and placement of a retrofilling material.[4]

This article reports a case of apicoectomy in which biomaterials such as MTA and synthetic hydroxiapatite (HAP-91)® were used. The periapical outcome after surgical enucleation of the lesion is also described.

Presentation of case

A 66-year-old male patient was referred to a particular clinic in Endodontics, Belo Horizonte, Brazil because of a chronic process involving the maxillary left central and lateral incisors.

The patient presented with parcial destruction of the buccal bone plate and edema at the apical third of the affected teeth (Fig 1A). In the review of the medical history, the patient did not mention any kind of health problems and denied a history of allergies or use of any medication. In the dental history review, he reported a car accident 5 years before which resulted in trauma to teeth 21 and 22. At this time, conventional endodontic treatment was performed and the patient had received a porcelain-fused-to-metal post in both teeth. Intraoral clinical examination did not reveal swelling of the labial mucosa adjacent to teeth 21-22. Periodontal pockets were absent. On vertical percussion, the teeth were painless. A diagnostic periapical radiograph showed an extensive radiolucent area extending from the mesial aspect of tooth 21 to distal aspect of tooth 22 (Fig 1B).

As root canal obturation with an acceptable quality was found from the periapical radiograph, the teeth were arranged by periapical surgery.

Under local anesthesia, a semilunar flap was lifted up and the roots of both teeth were exposed (Fig 2A ,B). The completion of the case was carried out in 3 phases. The first phase consisted of a carefully enucleation of the lesion. The enucleated material was submitted to

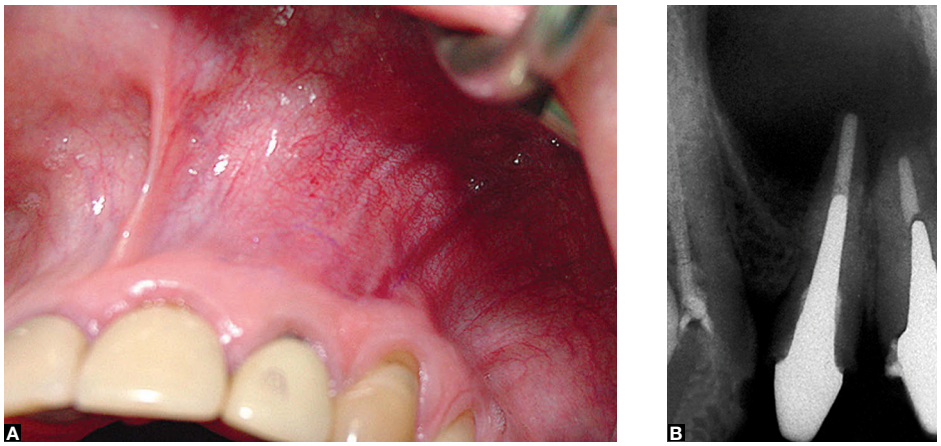


Figure 1. A) Edema at the buccal mucosa observed during clinical examination. **B**) Periapical radiograph showing a large radiolucent area surronding the tooth apex.

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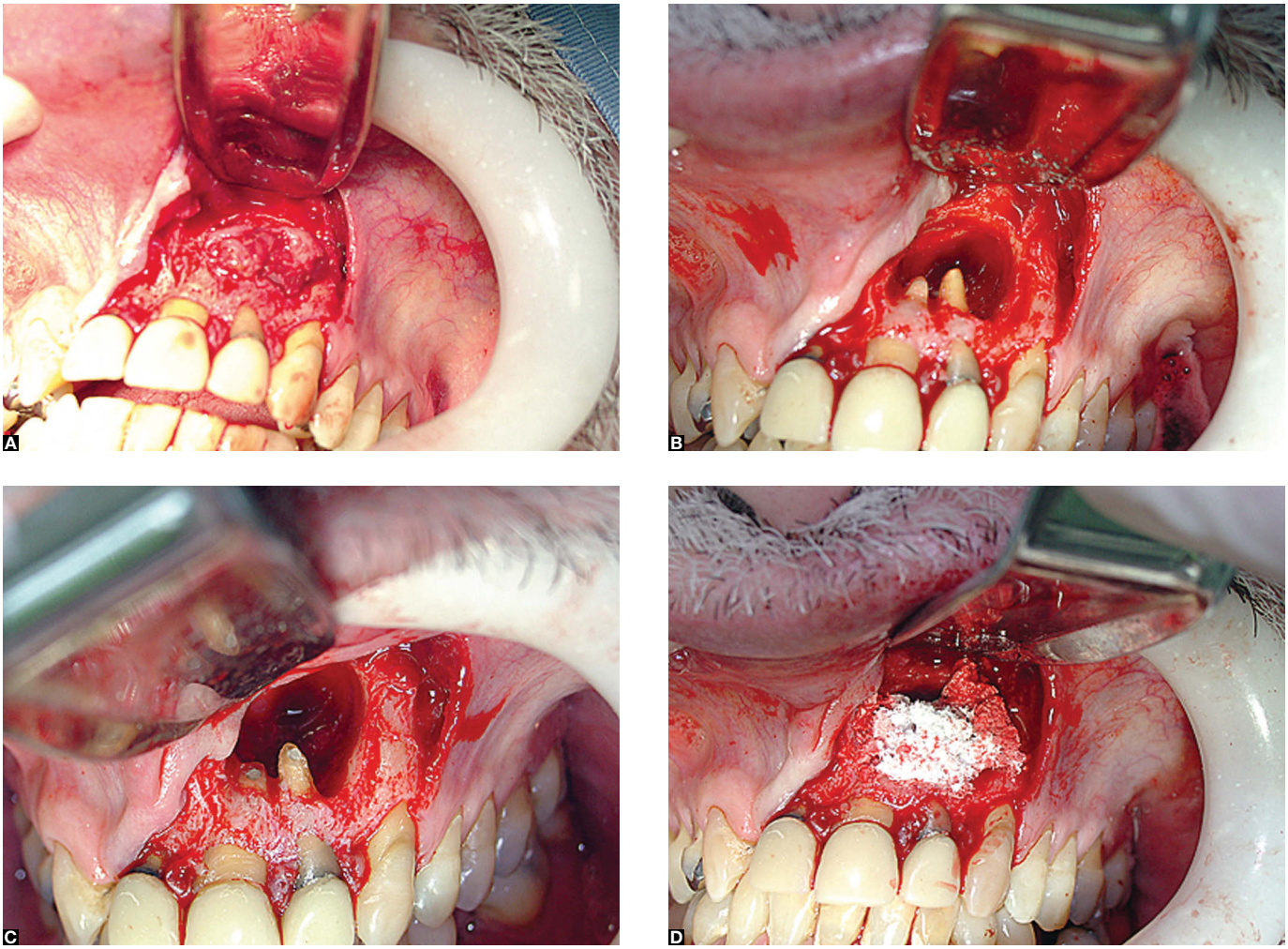


Figure 2. A) Exposed lesion **B**) Aspect after lesion enucleation **C**) Restoration of the root-end cavity with MTA after removal of the apical portion **D**) Use of synthetic hydroxiapatite to reconstruct the original bone architecture of the region.

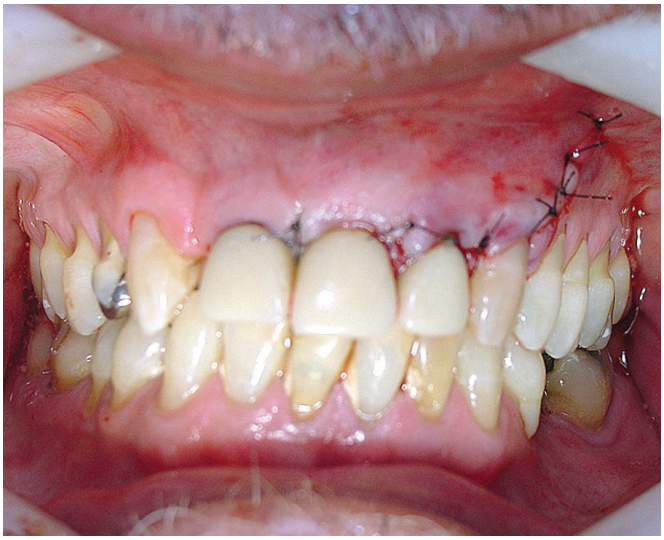


Figure 3. Aspect after surgery.

histopathological evaluation. Next, an apicoectomy was performed removing 2 mm of the apical roots. A specific diamond tip attached to the handpiece of an ultrasom device (Enac OE-3 Ultra-Endo Instrument System; Osada Electric Co., Tokyo, Japan) was used to prepare a root-end cavity. MTA was the material of choice because of its effective marginal sealing capacity (Fig 2C).

For internal filling and remodeling of the destroyed bone structure, synthetic hydroxiapatite (HAP-91) was used (Fig 2D).

After the mucoperiostal flap was repositioned, a conventional suture was placed. Sutures were removed 7 days postoperatively, and the patient was required to attend a follow up after 6 months (Fig 3).

The patient's follow-up showed that the case

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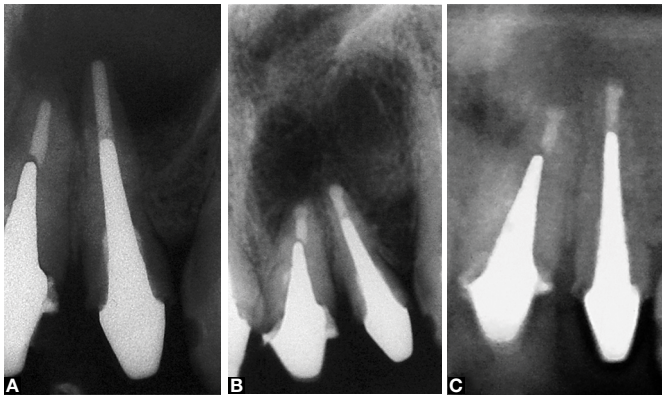


Figure 4. A) Preoperative radiograph **B**) Apicoectomy with MTA retrofilling on teeth 21 and 22 **C**) 1 year follow-up with periapical repair.

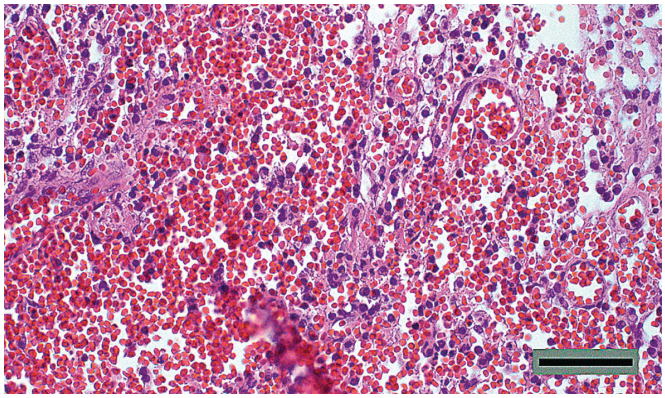


Figure 5. Histology of enucleated lesion.

management was successful and yielded lesion regression and periodontal repair (Fig 4).

Histopathological analysis

A conclusive diagnosis of periapical granuloma was established by histological examination: The fibrous conjunctive capsule enclosed granulomatous tissue contained chronic inflammatory cells, with varying dissemination (Fig 5). Blood vessels showing some vascularization were observed, but no epithelium.

Discussion

Lesions associated with apical periodontitis such as granulomas, abscesses, and cysts fail to heal after nonsurgical root canal therapy for the same reason, persistent intraradicular and/or extraradicular infection. However, the definitive diagnosis of the type of periapical lesion can only be made by a histological examination.

In the present case, the enucleated lesion was classified as periapical granuloma. The histological characteristics of the lesion were consistent with Nair et al,[5] that classified solid granulomas as symptomless pathologies with a granulomatous tissue infiltrated by lymphocytes, plasma cells and macrophages, and a well-developed fibrous capsule. This kind of lesion may be epithelialized. Their occurrence varies between 9,3%[6] and 87,1%.[7] In a recent study by Schulz et al,[8] using the same criteria defined by Nair et al,[5] the granuloma occurrence was 70%. Schulz et al[8] pointed out periapical granuloma as the most common pathology that could be expected in periapical lesions.

Periapical surgery was considered the choice due to prosthodontic risks associated with orthograde retreatment. It is generally believed that periapical surgery is the choice when nonsurgical endodontic retreatment is neither feasible nor indicated Schulz et al.[8] According to Nair et al,[9] in cases of apical granuloma or cysts, the surgical treatment is more likely to resolve these pathologies because they remain inaccessible to orthograde root canal debridement.

In this reported case, MTA was chosen as the retrofilling material. Several studies have shown that the cement is an osteoinductive and cementogenic agent that stimulates immune cells to release the lymphokines required for the repair and regeneration of cementum and stimulates bone coupling factors necessary for the bioremineralization and healing of osseous periapical defects.[10-15] Evidence also supports the ability of MTA to provide a reliable sealing capacity, being a bacteria-resistant barrier when used as a retrofilling material.[16,17]

Synthetic hydroxiapatite (HAP-91®) was used as bone filling material . It is relatively easy to handle during the surgery. The most notable characteristic of hydroxiapatite because of its high bone affinity and bone conductivity, is its ability to bind directly to the bone tissue. The binding form is called “bonding osteogenesis”[18]. The bonding mechanism has been well characterized in several studies.[19,20]

Conclusion

On the basis of the outcomes of this case, it might be concluded that:

» Endodontic surgery is often a promising

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alternative when conventional endodontic treatment has not yielded the desired healing outcome or even the retreatment has risks.

» The prognosis for endodontic surgery depends on the quality of the root canal filling. Because of its characteristics of promoting excellent marginal sealing and stimulating osteoblastic adherence to the retrofilling surface, MTA was chosen as the retrofilling material.

» The use of certain osteoinductive or osteoconductive materials such as synthetic hydroxiapatite can be very helpful to large bone destruction.

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Biocompatibility of the different portions of the content of AH Plus® sealer tubes through subcutaneous implantation

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ABSTRACT

Objective: Following the ISO/FDI and ANSI/ADA criteria, this study evaluated tissue response to the resinous sealer AH Plus®, analyzing its initial, middle and final tube segments as well as the total mixture of the two pastes that comprises it. This methodology was based on the clinical observation of the differences in consistency, homogeneity and fluidity of this sealer according to which part of the tube is used. **Methods:** Two subcutaneous implants were carried out in the dorsal region of 5 guinea pigs (Cavia porcellus) for each portion of the tested sealer and total mixture. The observation periods were 30 and 90 days. The animals were sacrificed and the implants were removed and histologically processed to obtain serial sections which were stained using hematoxylin and eosin. **Results:** The histological evaluation using an optical microscope at 20x, 100x, 200x, 400x and 1000x magnifications showed that the sealer induced moderate to severe inflammatory response at 30 days with expressive inflammatory infiltrate, which decreased to moderate to mild response at 90 days, with mild or moderate inflammatory infiltrate. There was no significant difference between the segments of the tube. **Conclusion:** This evaluation led to the conclusion that the studied sealer does not present conditions of biocompatibility within the parameters and the experimental conditions adopted and there is no biological difference between the initial, medium and final segments or complete mixture of the two pastes.

Keywords: Biocompatible materials. Subcutaneous tissue. Endodontics.

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Introduction

Endodontic therapy is characterized by an interconnected series of operative steps. Obturation requires special attention because substances and materials are introduced into the root canals and they may be in permanent contact with apical and periapical tissues.

An endodontic filling material must have physicochemical properties required for sealing and biological compatibility with the apical and periapical tissues. It must be inert or capable of inducing apical mineralization, known as biological sealing. When these conditions are met, the root canal treatment is considered to be successful.

Various materials have been proposed for endodontic obturation. The chosen material must not be cytotoxic, otherwise it might negatively interfere with the repair process of the tissue with which it is in contact.

Recent studies have shown that gutta-percha is the best root canal filling material, in spite of the slight irritation caused by the presence of zinc oxide in its composition.

The constant search for new root canal sealers has encouraged the study of the properties of existing materials as well as research to develop new materials with desirable physicochemical and biological properties.

The biological evaluation of root canal sealers using specific tests was carried out in line with standards set by the International Organization for Standardization (ISO), and document ANSI/ADA No. 41, of 1982.[1] The use of standardized methodologies facilitates the comparison of results from studies that use identical materials.

Among the obturation materials used for root canals, the cement-based plastic resins have become increasingly popular. AH Plus® sealer is an epoxy/amine based cement, in the form of two 4 ml tubes of paste, and equal amounts of paste A and paste B are used to prepare it. It has a working time of 4 hours at 23 °C, and setting time of 8 hours at 37 °C, according to the manufacturer. One drawback of the sealer is the difference in consistency, homogeneity and fluidity that is easily observed according to which section of the cement inside the tube is being used. The separation of the components that occurs in AH Plus® may cause chemical changes in different segments of the tube, leading to changes in the biological behavior of this material. This evaluation of the sealer's biocompatability was motivated by the fact that there were no studies in the literature that assess this property.

Material And Methods

Manipulation of AH Plus® sealer

An analytical scale (Gehaka, model AG 200) was used to weigh each segment of material. The scale has a minimum capacity of 0.002 g and maximum of 210 g. The content of two tubes of the cement was distributed onto glassime weighing paper; the weight of each tube was 8.64 g (Fig 1). This was considered the standard weight for the divisions of all tested cement tubes. Thus, each of the three



Figure 1. Net weight obtained for the contents of each tube of cement.

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segments of each tube was calculated to be 2.88 g. The 2.88 g portions were stored in aluminum tubes with an internal layer of varnish immediately after weighing and kept at room temperature (Fig 2). Five sets of AH Plus® sealer were used for the experiment: one set (lot 045000181) was used to check the weight, two sets (lot 04000181) were used for the division into segments and two sets (lot 0403001599) for the total mixture.

Surgical Procedures (Subcutaneous implantation)

Forty guinea pigs weighing approximately 800 g each were used to study the subcutaneous response to materials. Medication with atropine sulfate at a dose of 0.044 mg / kg (SC) was applied ten minutes before anesthesia to prevent cardiac arrhythmia in animals. The animals received an intraperitoneal injection of 0.6 ml of ketamine (100 mg / ml) mixed with acepromazine (0.5 mg / ml) as anesthetic. After anesthesia, trichotomy and skin disinfection with iodine alcohol solution at 5% were carried out to maintain the aseptic chain.

The vehicles that contained the material (specimens) were Teflon® tubes with an internal diameter of 1.3 mm and an external diameter of 1.6 mm. One of the ends of the tube was filled with a small amount of paraffin to prevent leakage and consequent contamination of the side walls, which were used as a control of the technique.

After trichotomy (Fig 3) and skin disinfection with 5% iodine alcohol solution, two small incisions were made (Figs 4 and 5) on the animals' backs for the introduction of needles. The methodology for the introduction of Teflon carriers, containing the material to be tested and using prepared needles, was proposed by Safavi et al.[9] After manipulation according to the manufacturers instructions, the cement was placed into the Teflon carriers with the aid of a stereoscopic magnification lens. The needles were introduced with their respective piston in position into the subcutaneous connective tissue of the animal parallel to the outer surface of the skin, up to about 2 cm deep (Fig 6). The original piston was removed, the Teflon tube was placed, with the end containing the material facing forward, and another plunger, without bevel, was introduced into the needle to gently insert the Teflon tube into the subcutaneous tissue. Each animal received two implants containing the same material (the initial, middle, final portion or the total mixture of the two pastes). A total of 10 implants for each portion, for each observation period were carried out.

Laboratorial processing

The experimental criteria were carried out

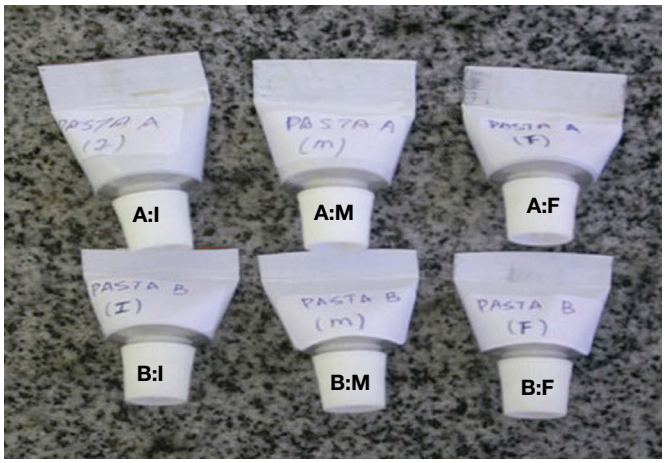


Figure 2. The portions of each paste properly stored: (A:I) initial portion of Paste A, (A:M) middle portion of Paste A, (A:F) final portion of Paste A, (B:I) initial portion of Paste B, (B:M) middle portion of Paste B, (B:F) final portion of Paste B.



Figure 3. Trichotomy of the animal's back.

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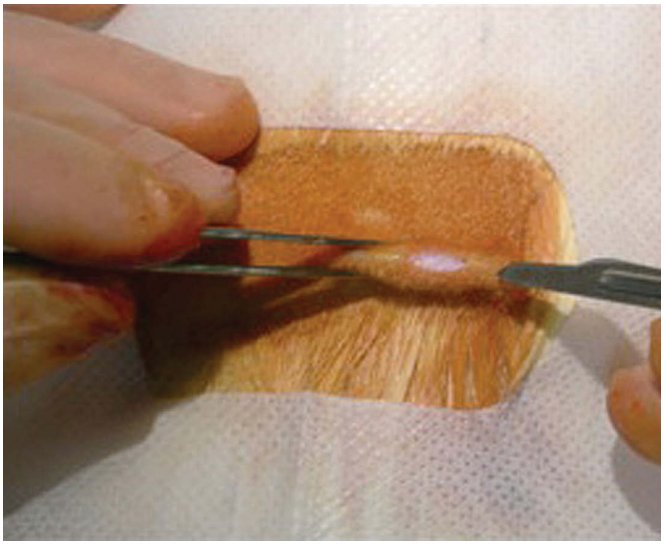


Figure 4. Making the incision in the animal's back.



Figure 5. After incisions.

according to the methodology defined by the Fédération Dentaire Internationale, Technical Report No. 9, page 173, item 4.11.

The observation times were 30 and 90 days, after which the animals were submitted to ortothanasia in a carbon dioxide chamber, the skin of the back was dissected and the tubes removed, with about 1 cm of surrounding tissue. The specimens were fixed for at least 48 hours in a 10% buffered formalin solution, pH 7.4.

After rinsing in running water for 12 hours, the specimens were dehydrated in increasing concentrations of ethanol solutions (70% to 100%), two baths of xylol and embedded in paraffin for histological processing.

Twenty-four slides were prepared, each with six sections, with approximately 144 semi-serial sections with the microtome set at 5 μm, in a plane parallel to the direction of the tube entry, in order to obtain the material / conjunctive tissue contact interface. The hematoxylin and eosin staining technique was used. After routine processing, slides were evaluated under an optical microscope.

Evaluation

The severity of the inflammatory response determined the acceptability (or not) of the materials. The classification of severity of response was obtained by recording the findings according to criteria established by the FDI.



Figure 6. Introduction of the needles and their pistons.

Results

Control

As described in the methodology, the areas defined as control (absence or minimal degree of inflammation) were the connective tissue interfaces with the side walls of the Teflon® tube, as shown in (Fig 7). The formation of a fibrous capsule without the presence of cells that indicate a significant inflammatory process can be observed, showing the slight reactivity to Teflon.

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Materials tested:

Table 1 shows the observation periods and distribution of the number of implants studied. Eighty implants were used in total, 10 for each observation time, totaling 20 implants for each portion of the tube and the total mixture of the material. It also illustrates the general aspects of the inflammatory responses of these portions and the intensity of the inflammation seen in each portion implanted, according to the criteria of FDI (1980)[3] and ADA/ANSI (1982)[1].

At 30 days, the portions of the assessed AH Plus® had similar inflammatory reactions, ranging from moderate to severe. This response is not acceptable from the standpoint of biocompatibility, according to the established criteria.

At 90 days of observation, there was a decrease in inflammatory response, which ranged from moderate to mild. The accumulation of inflammatory cells could be observed in many situations with a dispersion of the material in the connective tissue, promoting the perpetuation of an inflammatory response (chronic type). This demonstrates the low-intensity toxicity of the material tested.

The formation of thick fibrous capsule at 30 days, with a large focal accumulation of inflammatory cells, was a constant finding. At 90 days there was a significant decline and reduction of this infiltration.

Inflammatory responses did not differ significantly between the different segments of the AH Plus® sealer. On the sides of the tube, used as control, the formation of fibrous capsule occurred, always thinner than in the specimen opening region where the tested material was in contact with the tissue.

The tissue responses observed had the same magnitude and histological characteristics for all segments tested for each experimental period (Fig 8 and Fig 9).

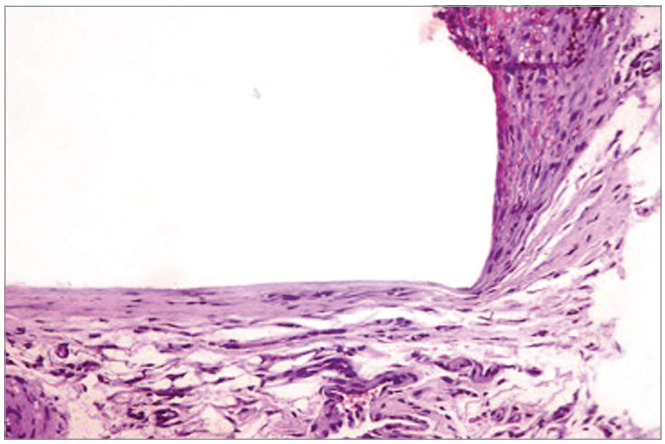


Figure 7. Histological figure that represents control areas.

Discussion

The biocompatibility of endodontic materials is characterized by several parameters such as genotoxicity, mutagenicity, carcinogenicity, cytotoxicity,

Table 1. List of subcutaneous implants and quality of inflammatory responses.

	AH Plus®							
	Initial Portion		Middle Portion		Final Portion		total	
Experimental Period (days)	30	90	30	90	30	90	30	90
Total of Implants	10	10	10	10	10	10	10	10
Slight inflammation	- (0%)	3 (30%)	- (0%)	6 (60%)	- (0%)	6 (60%)	- (0%)	4 (40%)
Moderate inflammation	6 (60%)	7 (70%)	3 (30%)	4 (40%)	5 (50%)	4 (40%)	6 (60%)	6 (60%)
Severe inflammation	4 (40%)	- (0%)	7 (70%)	- (0%)	5 (5%)	- (50%)	4 (40%)	- (0%)

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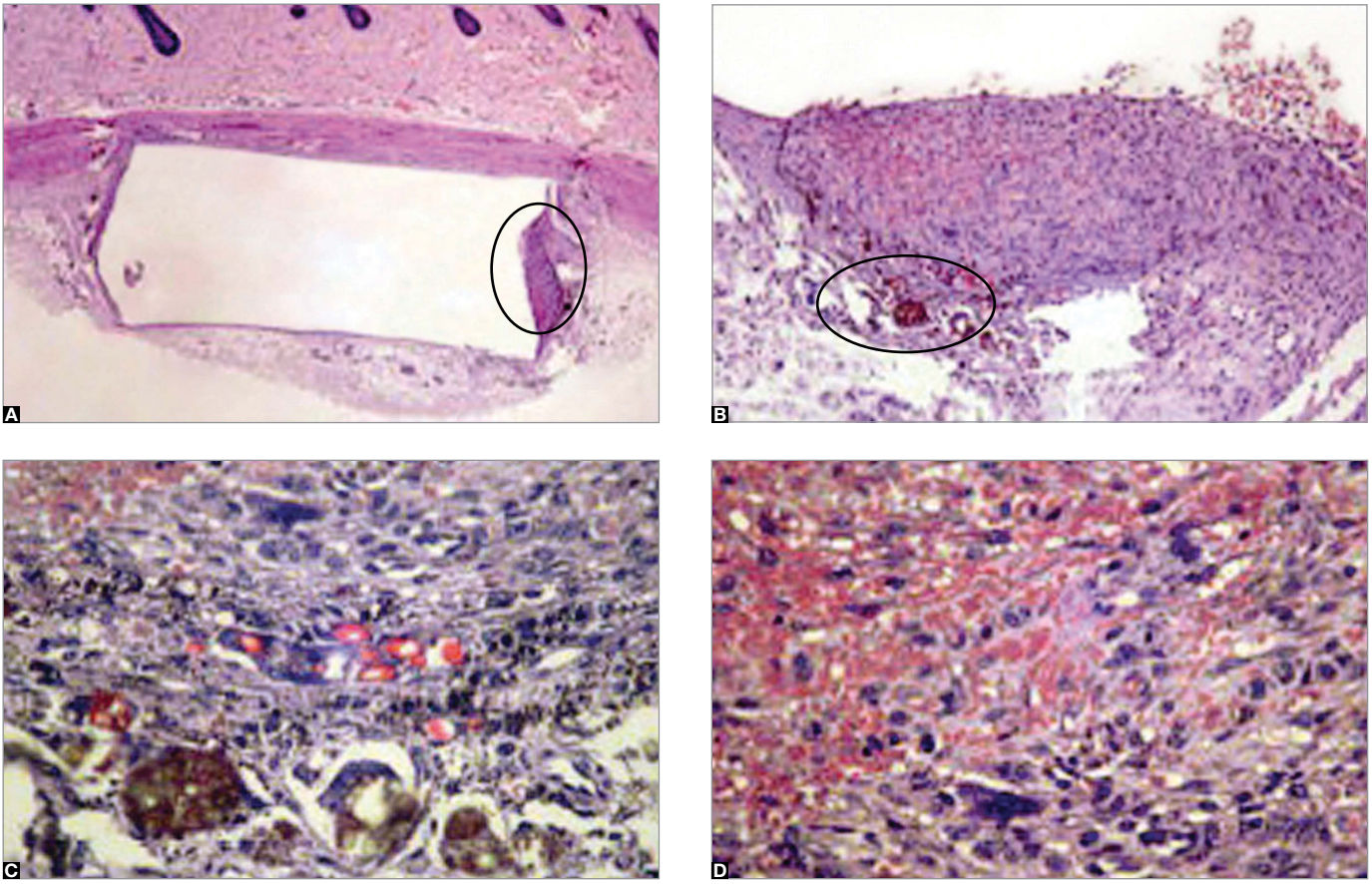


Figure 8. A) AH Plus® subcutaneous implant at 30 days. Overview of the region occupied by the Teflon tube/ **B**) Magnification of the demarcated area of **A**. Presence of extensive inflammatory infiltrate. **C** and **D**) Details of the demarcated area of **B** showing the focal accumulationof inflammatory cells with presence of giant cells and hyperemic areas.

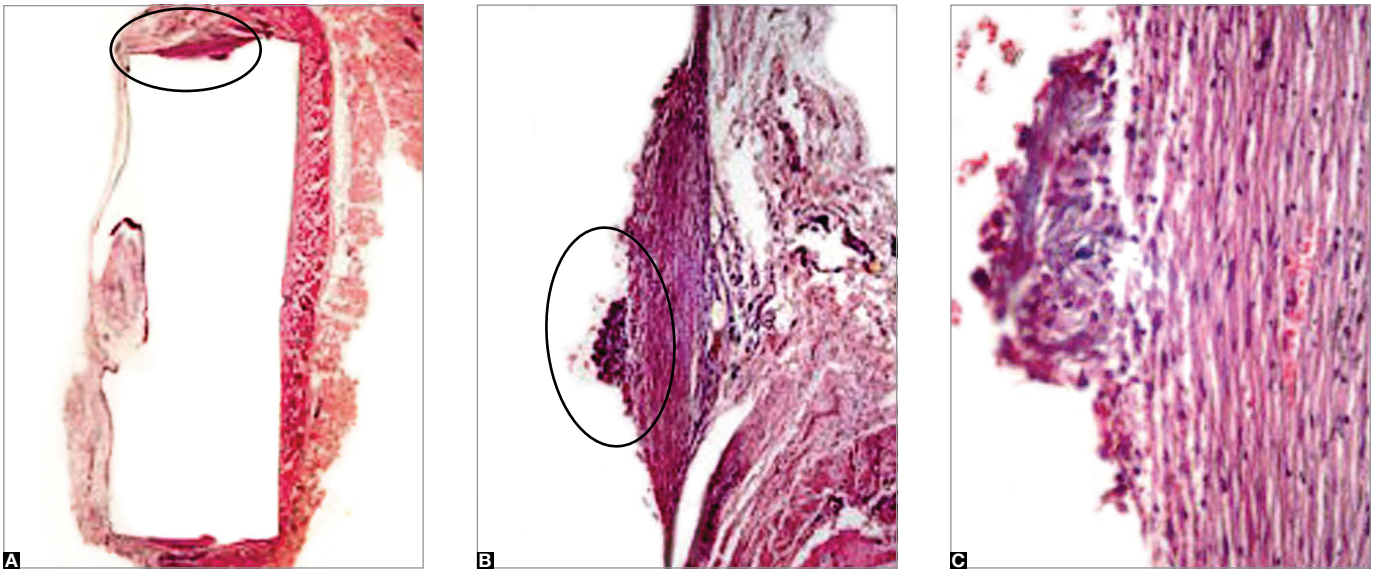


Figure 9. A) Overview of subcutaneous implantation. Note the formation of fibrous capsule at the interface with the cement **B**) Magnification of A showing the contact area of cement/tissue **C**) Detail of the fibrous capsule of **B**, Note the thick fibrous capsule and moderate inflammatory process.

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histocompatibility or microbial effects. It is biologically impossible to characterize a material as biocompatible or non-biocompatible after using just one methodological test. Its properties need to be investigated using several *in vitro* and *in vivo* tests.

Many tests have been suggested to evaluate the biocompatibility of endodontic sealers, in order to reproduce as closely as possible the clinical use of these materials. When considering the biological properties of materials used in root canal filling, several features must be observed, depending on the aim of the study.

The results of any investigation are influenced by the methods used. According to Paffenbarger[8] (American Dental Association), the "technique used for any material is as important as the material itself, because an inferior technique can ruin or damage a superior material." Thus, Spangberg,[10] Olsson et al,[6,7] Langeland et al[4] agreed that the studied materials should be handled and applied in laboratory tests exactly as recommended by manufacturers and as they are used in everyday practice. The sealers for root canal filling should be tested in their paste form because in a clinical situation the setting of the material is only complete after it has been introduced.[11]

For many decades, ISO/FDI, ADA, COMIET and other governmental or non-governmental organizations tried to regulate and standardize the various research methodologies recommended to evaluate the biocompatibility of materials used in clinical procedures. Thus, a sequence of tests was divided into initial tests, secondary tests and application tests, the latter described as pre-clinical tests.

The test of implantation of materials in subcutaneous tissue is the most widely used of the recommended secondary tests to assess biocompatibility of filling materials. The technique is standardized, and can be more accurately controlled because it has fewer variables. It enables one to determine the degree of irritability of various portions of the material studied.

New materials that have no acceptable scientific basis to justify their use are frequently introduced on the market. Therefore it is important to prove whether the main biological aspects of these materials meet those recommended by the organizations that seek the uniformity and standardization of tests, so that these materials can be widely accepted by the scientific community.

The secondary biocompatibility tests of dental materials are carried out using small animals. The advantage of implantation in subcutaneous tissue is that it shows the reaction of the connective tissue that occurs in the area of contact between material and tissue. An analysis of the methodology used in these studies shows that this procedure involves the careful evaluation of results, because inflammatory reactions are cumulative due to the initial surgery and may mask the true tissue response to the material. Seeking to circumvent this problem, Safavi et al.[9] developed a needle and plunger system, both having a beveled edge that completely blocks the needle. This methodology is now commonly used and was combined with the methodology recommended by the FDI for this study (Fig 6).

Several studies have shown that the evaluation of biocompatibility of subcutaneous implants of specimens of endodontic materials is a reproducible and acceptable methodology. However, the differences between animal species, implantation sites, methods, observation times and the criteria used to evaluate results makes it difficult to compare the results. The results produced by this methodology sometimes differ from those obtained by several authors who use different methodologies, and result in the definition of inflamatory response patterns according to particular observation criteria. In order to create reproducible results that can be compared with other researchers, this study used the methodology defined by the international scientific community (FDI[3], ADA/ANSI[1]).

AH Plus® sealer was launched in the 90s and has been widely studied. Some studies have evaluated the profile of the biological behavior of this material. The results of this study with subcutaneous implants (Table 1) show that, at 30 days, the inflammatory response for all portions of the material was moderate to severe (Fig 8), with obvious presence of chronic inflammatory cells and foreign body type giant cells in direct contact with the material. At 90 days, the response was mild to moderate, which shows that the trend is for a reduction of the inflammatory response, with significant regression of the inflammatory process and formation of thick fibrous capsule with the material dispersed at a distance, without

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the intense inflammatory phenomena observed in the first experimental period (Fig 9).

These results are consistent with those found by Chita,[2] who used the same methodology to compare AH Plus® cement with Endo Rez and Konne. The former had a lower inflammatory response at 90 days, although the chronic inflammatory profile continued. The formation of fibrous capsule between the implanted material and the tissue, without significant inflammatory infiltrate, has been considered as a criterion of acceptability of the material (FDI, 19803; Olsson et al.[6,7]), but the presence of chronic inflammation cells adjacent to the material at any observation period demonstrates the toxic nature of the cement. These results lead to the conclusion that the tested material is not biocompatible according to the defined parameters.

Montes[4] evaluated Epiphany® cement, a dual setting resin material with AH Plus® using intraosseous implants in guinea pigs, and found favorable tissue responses with Epiphany, unlike AH Plus,® which presented a severe reaction at 30 days and a mild to moderate reaction at 90 days.

In this study, the plane of the histological section passes through the opening of the Teflon® tube, including the entire interface between the connective tissue and the side walls of the tubes, which served as an excellent negative control. The areas that were examined in the histological sections were generally free of inflammation, indicating that the responses at the entrance of the tubes were related to the toxicity of the materials and demonstrated the compatibility of Teflon® (Fig 7). These areas are used as control, because of the excellent biocompatibility of Teflon when implanted in subcutaneous or intraosseous tissue.

Although the AH Plus® sealer is not biocompatible according to the FDI criteria, it has been accepted as a filling material because it has suitable physical characteristics such as good working time, good radiopacity and low solubility. It is because of these properties that the cement is one of the most frequently used by professionals. The biological aspect has proven capable of more research at all levels, so you can reach a conclusion. The simple fact that it has been shown to be more biocompatible than its predecessor, does not make it biocompatible by itself.

AH Plus Jet is a new form of AH Plus®. According to the manufacturer, it maintains the same chemical properties but with modified packaging. The material is mixed in a syringe with a cannula through which it is dispensed ready for use directly within the canal. There were no studies in the literature that use the new format of this material.

In this investigation, it was possible to define this cement as not acceptable according to the biocompatibility parameters initially established, despite showing a significant reduction in its potential for irritation at 90 days of observation. This is an incentive to continue using other tests over a longer observation period. There was also no significant difference in biological response when evaluating the various portions of the tubes or when a total homogenization was carried out.

Conclusion

The results show that the inflammatory response did not differ significantly between the the various segments of the tube or with the complete homogenization of AH Plus® cement.

The evaluation of the biocompatibility of AH Plus® cement does not enable it to be classified as biologically compatible within the established parameters and experimental conditions.

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Interdisciplinary treatment of an avulsed permanent tooth in patient with incomplete facial growth

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Felipe Cavalcanti **SAMPAIO**[2]
Orlando Aguirre **GUEDES**[3]

ABSTRACT

Introduction: The rehabilitation of patients with dental avulsion history could be complex and difficult to choose. The possibility of rehabilitation with dental implants may be considered when choosing the replantation, due to the possibility of bone tissue maintenance, especially in patients with incomplete facial growth. **Objective:** The purpose of this paper is to report a dental avulsion case treated by late tooth replantation, aiming at bone level maintenance for further rehabilitation with dental implant. **Case Report:** Male patient, 11 years old, suffered dental trauma during sports practice, resulting in tooth #21 avulsion. The tooth was found after 24 hours. The therapeutic choice was tooth replantation, although the conditions were adverse due to extraoral time (60 hours) and storage medium (dry). The tooth was cleaned, immersed in calcitonin for 15 minutes, and endodontically treated before replantation. Then, a semi-rigid splint was used for 10 days. One year after the replantation a replacement root resorption was radiographically diagnosed. After 7-year follow-up, the root was almost completely reabsorbed, with sufficient bone tissue for insertion of dental implant. The tooth remnant was removed and an immediate dental implant was performed. After 6 months, a ceramic-ceramic crown was confected. **Conclusion:** Thus, the importance of avulsed tooth replantation is clear in the maintenance of bone tissue level for dental implant placement and, consequently, reestablishment of function, as of esthetic and phonetic.

Keywords: Dental trauma. Tooth avulsion. Tooth replantation. Root resorption. Dental implant.

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Introduction

Traumatic dental injuries represents 5% of all head and neck traumatic injuries[1] and have become one of the most serious public health problem.[2] Among these injuries, dental avulsion is one of the few real emergency situations in dentistry and represents the most serious dental trauma,[3] which prevalence varies from 3,8% to 18,3%, and it is more usual in young adults and children.[2,4-12] The first choice treatment is the tooth replantation, the most conservative approach for this type of trauma, allowing esthetic and function preservation and avoiding the need of prosthetic rehabilitation.[3]

Among the factors which might affect the replantation prognosis are: Trauma extension, extraoral time, storage media, contamination and the avulsed tooth condition. These can result in periodontal inflammation, root resorption and anchylosis.[13-16]

The time elapsed until the replantation, essential factor for treatment success, depends on the knowledge level of the victim, family or school teachers. However, the population majority does not know the immediate conducts post-trauma.[17-20] The outcome is better when the replantation is performed less than 20 minutes after avulsion. As elapsed time increases, periodontal ligament cells mortify and success rate decreases substantially. Extraoral period higher than 60 minutes promotes, in most cases, extensive root resorption, which could lead to tooth loss.[3,16,21,22]

An alternative treatment for tooth loss due to root resorption is the dental implant. After implantology advent, bone maintenance began to receive significant attention.[21] However, in some situations the jaws do not have bone quantity, height or volume sufficient for settling an implant. Moreover, most of dental avulsion cases happens in young subjects, before the facial growth is complete.[21]

The present study aims to report a case of dental avulsion, treated by late replantation, aiming the bone level maintenance for posterior rehabilitation by dental implant.

Case Report

Male patient, 11 year-old attended dental care due to avulsion of the tooth 21. The trauma was caused by collision in an iron bar during sports practicing. The time elapsed between the trauma and the emergency appointment amounted approximately 60 hours, the tooth being kept in a napkin until the time of the treatment.

The dental replantation was the therapeutic chosen option, even with unfavorable conditions, like prolonged extraoral period and inadequate storage media. Another observed factor was the patient's craniofacial growth and development phase.

The treatment planning followed the guidelines proposed by the International Association of Dental Traumatology (IADT) for dental avulsion management.[3]

During the first appointment, the clinical exam showed the tooth socket healing process with a firm consistency clot. The tooth was submitted to a cleaning process with gauze and saline. Then, the tooth was kept in a calcitonin solution (Miacalcic®, Taboão da Serra, Brazil) for 15 minutes. This medication is used for treating osteoporosis, in order to reduce bone resorption, and in this case it was used to inhibit root resorption for as much time as possible.

Endodontic treatment was performed soon after the root cleaning. As a result of the prolonged extraoral time, pulp tissue necrosis was expected, preventing revascularization and regeneration. Moreover, the time addition necessary for the endodontic treatment would not interfere in the replantation outcome, as it was expected root resorption for the unfavorable conditions of the case.

The root canal was accessed using diamond burs 1012 and 1013 (KG Sorensen, Cotia, Brazil) and instrumented using a crown-down technique. The root canal cervical third was enlarged using a LA Axxess #2 drill (SybronEndo, Orange, CA, USA). The tooth was prepared up to a file size #55 (Dentsply Maillefer, Ballaigues, Switzerland), 1 mm short of the apical foramen. The root canal was irrigated with 3 mL of 1.0% sodium hypochlorite at each change of file. The root canal filling was performed using gutta-percha (Dentsply) associated to Sealapex (SybronEndo) as sealer, by the lateral condensation technique. The quality of canal filling was confirmed radiographically. The tooth was immediately restored with composite (3M ESPE, Irvine, CA, USA).

After the endodontic treatment, the clot was removed from the socket with saline, for posterior tooth repositioning. A flexible splint was performed on the replanted tooth with composite (3M ESPE) and nylon wire, which remained for 10 days. A tetanus vaccine intensification was recommended and a systemic antibiotics therapy was prescribed (amoxicillin 500 mg, 8-8 hours for 7 days), associated to an anti-inflammatory (nimesulide 100 mg, 12/12 hours for 3 days).

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Follow-up was realized by clinical and radiographic attendance at weekly intervals in the first month and every 3 months.

After 1 year follow-up, anchylosis and replacement root resorption was diagnosed. As this was expected, the resorption was followed-up while root tissue was gradually replaced for new bone tissue. Seven years after the replantation, the root resorption reached almost the entire root. The bone level at the #21 tooth site was near the adjacent tooth bone level. At this moment it was decided to perform the dental implant rehabilitation.

The tooth extraction was performed (Fig 3) and, at the same appointment, carried out the 3.75 mm diameter and 13 mm length (Osseotite®, BIOMET 3i, Palm Beach Gardens, FL, USA) implant placement (Fig 4 A, C). During surgical procedure primary stability was achieved, although the bone was Type III. A provisional

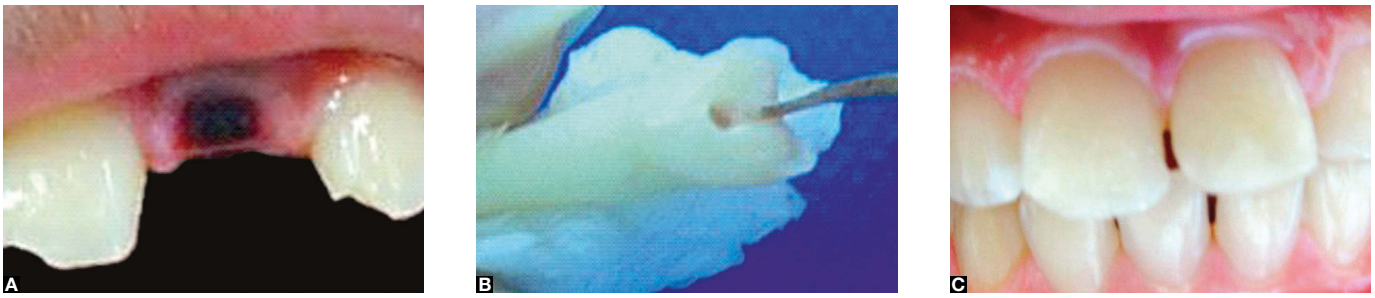


Figure 1. A) Tooth 21 avulsion. **B**) Endodontic treatment. **C**) Clinical aspect after tooth replantation.

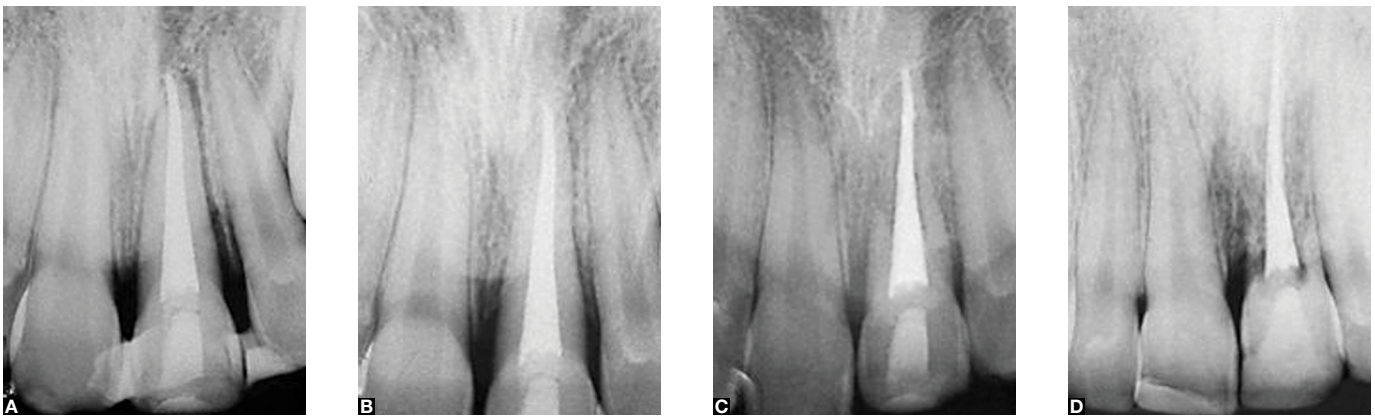


Figure 2. A) Radiographic aspect imediately after replantation. **B**) The beginning of replacement resorption after 1 year. **C**) Follow-up after 5 years. **D**) Follow-up after 7 years: complete root resorption.

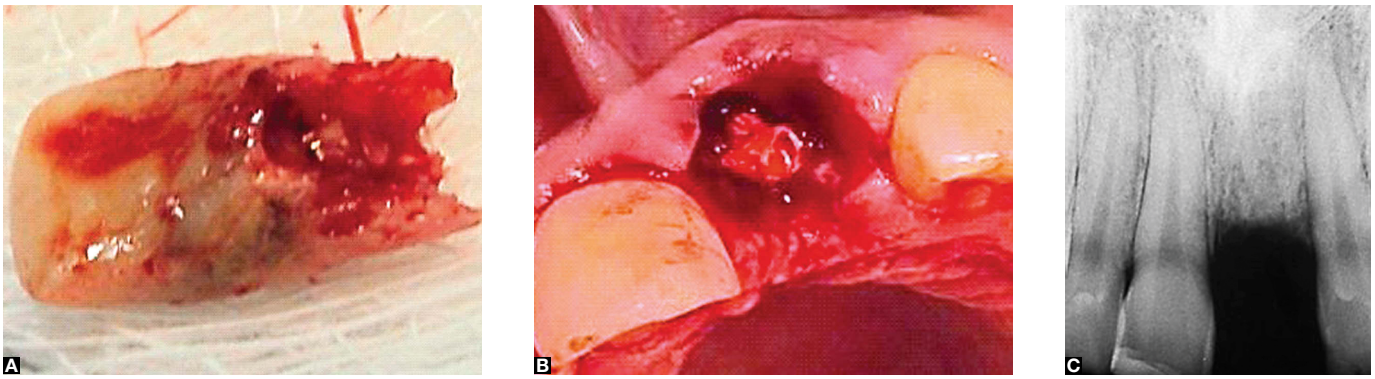


Figure 3. A) Tooth remnant. **B**) Clinical aspect after extraction. **C**) Radiographic aspect after extraction.

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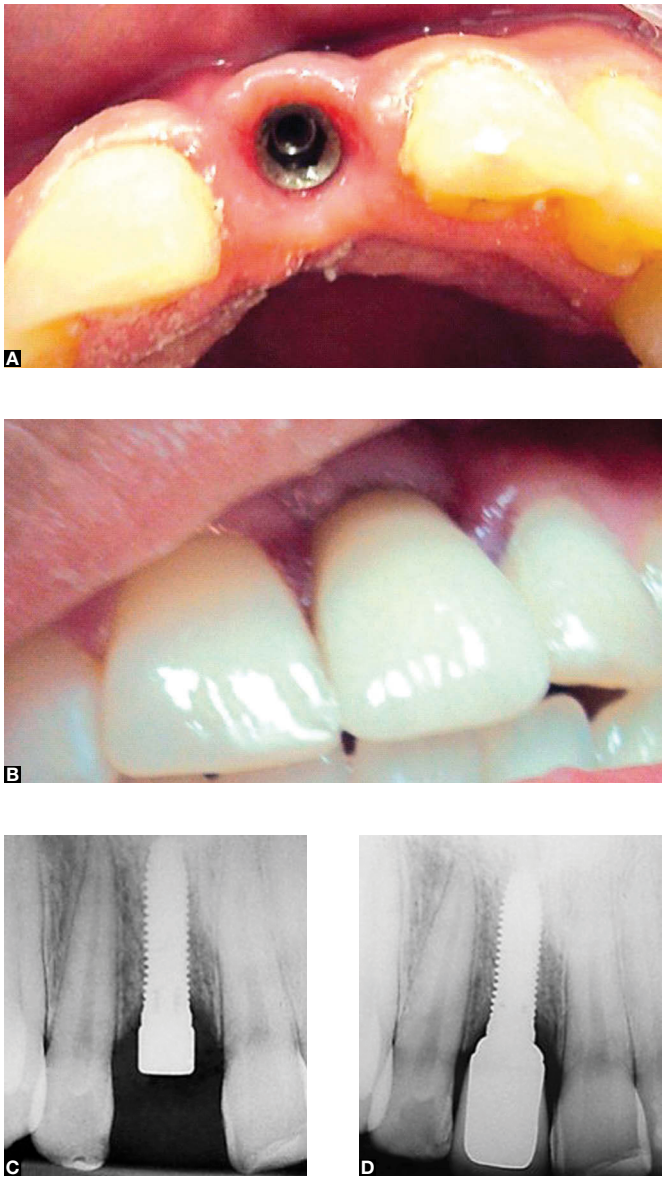


Figure 4. A) Clinical aspect after dental implant placement. **B**) Clinical aspect after crown installation. **C**) Radiographic aspect after dental implant placement. **D**) Radiographic aspect after crown intallation.

adhesive crown was made to maintain the esthetical aspects while the osseointegration was expected.

Six months after osseointegration confirmed radiographically, a ceramic-ceramic crown was manufactured. At the end, esthetic and functional satisfactory results were achieved, without any bone involvement or need of bone graft.

Discussion

The increase of violence, traffic accidents and sports practicing contributed to turn dental trauma in an emergent public health problem.[2,23,24] Dental avulsion represents from 4% to 18%, approximately, of the permanent dentition traumatic injuries,[2,4-12] being responsible for an expressive number of teeth losses due to complications, as, for example, root resorption.

The treatment for dental avulsion should be the replantation. Even if local or systemic conditions are not favorable, the replantation must be done, as the maintenance of the tooth in function for some years may be considered a success.[3,21,22]

After replantation, the tooth should be followed-up in short periods in order to diagnose possible complications.[3,21,22] The replacement resorption gradually replaces the dental root for bone tissue, and should be followed-up for a period of 5 years.[3,21] In the case reported, the tooth was followed-up weekly in the first month and every 3 months until the root resorption was almost complete.

Formation of bone imperfections is usual as a consequence of dental trauma. In dental avulsion, the non-replantation may cause alveolar bone loss, both in width and height.[21] Thus, dental implant rehabilitation could be compromised, for which bone grafts would be necessary.

The treatment proposed for the case reported aimed, while maintaining the tooth the longest possible in function, to avoid bone tissue loss, which would demand bone grafts for posterior dental implants placement.

The evolution of late replanted teeth for replacement root resorption is usual. This type of resorption is favorable, since there is formation of bone tissue, specially maintaining the bone height.[3,21,22,25] This condition is essential for dental implant rehabilitation without the need of bone grafts. Replacement root resorption should be followed-up until there is sufficient bone tissue for implant placement.[3,21,22]

Another possible complication after replantation is inflammatory root resorption, which have worse outcome related to replacement resorption. The chance of inflammatory resorption occurrence could be minimized by the previous necrotic tissue removal and endodontic treatment.[3,21,26] In the case reported, root canal filling was performed previously to the replantation. This procedure did not affect the outcome of the

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replantation, since the extraoral time was already pronounced, and in addition, it would minimize the chance of inflammatory resorption. This procedure is recommended by the guidelines proposed by the IADT.[3]

As most dental avulsion cases occur in young subjects, before facial growth is complete, the tooth maintenance is essential. In addition, even being the condition aimed, tooth replantation success does not require a healthy tooth in function for the entire life of the patient. The therapeutic modality which maintains the teeth for a few years and allows the complete facial growth and development should be considered a success.[21]

In the case reported, the periodontal ligament regeneration was not expected, as the extensive extraoral period and the absence of storage media caused necrosis of the periodontal ligament cells. The key for the replantation was the tooth disinfection.[3,21] Contamination in the root canal would hasten the resorption process, which could constitute a further complication factor, once the patient was still in facial growth and development phase.

The importance of the avulsed teeth maintenance for the most time possible in patients in facial growth phase is for the impossibility of dental implants placement. These act as anchylosed teeth, without eruptive potential, causing occlusal discrepancy. Several studies showed position changes of dental implants and interference in the jaws development next to implant sites when these were placed in incomplete facial growth subjects.[27-34]

The tooth replantation, in the case reported, allowed bone level maintenance both in height and width for the dental implant rehabilitation without bone grafts. This maintenance was essential for esthetics, as possible bone defects, especially in the anterior maxillary wall, would cause esthetic loss. Furthermore, it kept the tooth in function for 7 years, which should be considered a success for a late replantation.[21]

Conclusion

Dental avulsion cases, in incomplete facial growth patients, should be treated by the tooth replantation, even when conditions are not favorable. This treatment enables bone level maintenance without defects formation, allowing the stomatognathic system prosthetic rehabilitation. Thus, this treatment grants function, esthetic and phonetic re-establishment.

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Anatomic fiber posts, clinical technique and mechanical benefits – a case report

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ABSTRACT

Introduction: Glass fiber post usage has been extensively studied due to biomechanical benefits, in addition to adhesive capacity, which makes it able to be used in several clinical situations. Studies show that a perfect root canal adaptation is important for restorative properties improvement. **Objective:** The aim of this paper is to present a technical sequence of post relining for the restoration of a fractured upper central incisor with wide root canal. **Case report:** A 12-year old male patient came to dental school with a fractured upper central incisor, exposing pulpal tissue. After endodontic treatment procedures the selected post could not fit the root canal and a microhybrid composite resin was selected for post relining. After that the post was cemented with a autopolimerizing resin cement and the final restoration completed with the same resin. **Results:** The suggested technique resulted on a functional and esthetic rehabilitation with great possibilities of long lasting restoration.

Keywords: Tooth wear. Dentistry. Esthetics. Dental. Occlusal Adjustment.

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Introduction

Endodontically treated teeth can significantly reduce their fracture resistance if important parts of the dental structure are affected, especially the marginal ridges, enamel bridges, pulp chamber roof and the entire structure above it towards the occlusal and palatal or lingual surfaces.[1,2] The reconstruction of endodontically treated teeth, where part of the dental crown was lost due to caries, erosion, abrasion, anterior restorations, trauma and endodontic access, is one of the greatest challenges for Restorative Dentistry.[3]

In many clinical situations, the amount of remaining tooth structure do not allow a definitive restoration without post retention.[4] The use of anatomical or custom posts is one of the techniques proposed for large roots treatment. These are obtained through root canal relining with composite resin associated with prefabricated fiberglass or even can be obtained through the indirect technique, executing an impression and post manufacture at the prosthesis laboratory.[5,6] These techniques, in addition to expanding the indication of pre-fabricated posts, reduce the excessively large cement layer that would be used to replace the lost tooth structure in root canal.[5] The individualization of the post allows a good adaptation in the root canal, which enables the formation of a thin layer of resin cement, creating favorable conditions for post retention.[7] Because the resin cements have fewer filler particles (resulting in adequate fluidity), these materials tend to have lower values of cohesive strength[8] than microhybrid composites;[9] thus, the reduction in cement layer thickness contributes to increase the resistance of the whole tooth/post set.[10] Besides the mechanical factor, post and coronal restoration can be made of similar materials in subsequent processes in the same session, saving clinical time.[11]

The aim of this study is to present the technique sequence of fiberglass post relining for a large root canal of an fractured upper central incisor.

Case Report

A 12-year-old male patient came to dental care after an accident that resulted on fracture of the #11 tooth, affecting pulp chamber (Fig 1). After the indication and execution of the endodontic treatment, an analysis was done to evaluate the extension of the lost tooth structure. It was decided to be necessary to insert a post in order to ensure greater retention for the future dental restoration (Fig 2A).

A root canal relief was produced with Gattes Glidden bur #2, preserving 5 mm of apical obturation followed by the canal preparation with the bur provided



Figure 1. Initial smile of the patient with an oblique fracture at upper central left incisor, with pulp involvement.

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by the Exato post kit #3 (Angelus) (Fig 2B). The bur penetrated with free access in the cervical region of the root, effectively preparing the apical third. After testing the post into the conduct, it was decided to reline the fiberglass post with microhybrid composite resin (Natural Look, DFL, Brazil) because the diameter of the post did not fit the entire root canal (Fig 2C). The following steps describe the post surface treatment for the relining procedure.

The post was cleaned with 70% alcohol, conditioned with hydrogen peroxide 24% for 1 minute, washed with water and dried, and subsequently treated with coupling agent for 1 minute (Silano, Angelus) (Fig 2D). It was then applied the adhesive catalyst of Fusion Duralink adhesive kit (Angelus) (Fig 2E). A small portion of A2 dentin color composite resin (Natural Look) was placed on the post surface (Fig 2F) and after root canal isolation with a water soluble gel (K-Y®, Johnson & Johnson) (Fig 3A), the post with the resin was placed in the conduct and the resin adapted with a spatula (Fig 3B). After initial 10 seconds polymerization the anatomical post was removed from the canal (Fig 3C) and finally light cured for 40 seconds per side (Fig 3D). After that, the post was reinserted to verify the adaptation of the set (Fig 3E and 3F).

For cementation the post was conditioned with 37% phosphoric acid for 60 seconds and rinsed with water for the same time, for cleaning purposes. Post was dried and adhesive was applied (Fusion Duralink, Angelus) with lightpolymerization for 20 seconds. After that, the conduct was conditioned with 37% phosphoric acid for 15 seconds (Fig 4A), washed with water for 30 seconds (Fig 4B) and dried with cotton (Fig 4C). After that, a 3-step conventional chemically polymerized adhesive was applied (Fusion Duralink, Angelus) using a microbrush (Fig 4D and 4E). Adhesive excesses were removed with cotton (Fig 4F).

After treating the root canal and the post relining the cementation with a self-curing resin, cement was performed (Cement Post, Angelus). The cement was manipulated on a glass plate and inserted in the root canal with an endodontic file and also placed around the anatomical post (Fig 5A). The post was inserted into the conduct and the excess removed immediately, waiting 4 minutes to complete the polymerization process.

Completed the cementation, it was made a direct restoration with a microhybrid composite resin (Natural Look, DFL) (Fig 5B, 5C and 5D), through the application of a resin initial layer in incisal color (Fig 6A), followed by the A1 and A2 dentin colors (Fig 6B), ending with covering the buccal surface with A1 enamel and incisal colors (Fig 6C).

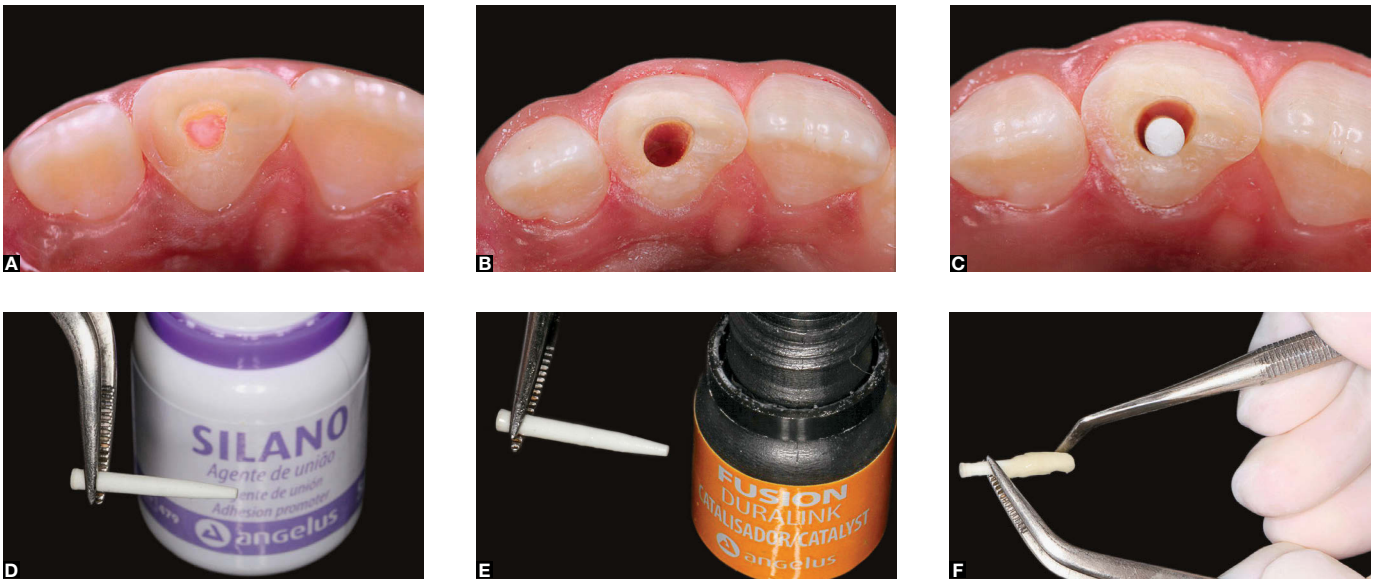


Figure 2. Technique for post relining - post treatment. **A**) Extensive fracture involving the entire palatal surface. **B**) Preparation of the root canal with burr #3. **C**) Exato post #3 testing, poor adaptation observed. **D**) Application of coupling agent. **E**) Application of adhesive catalyst Fusion Duralink. **F**) Application of Natural Look composite resin at the treated post.

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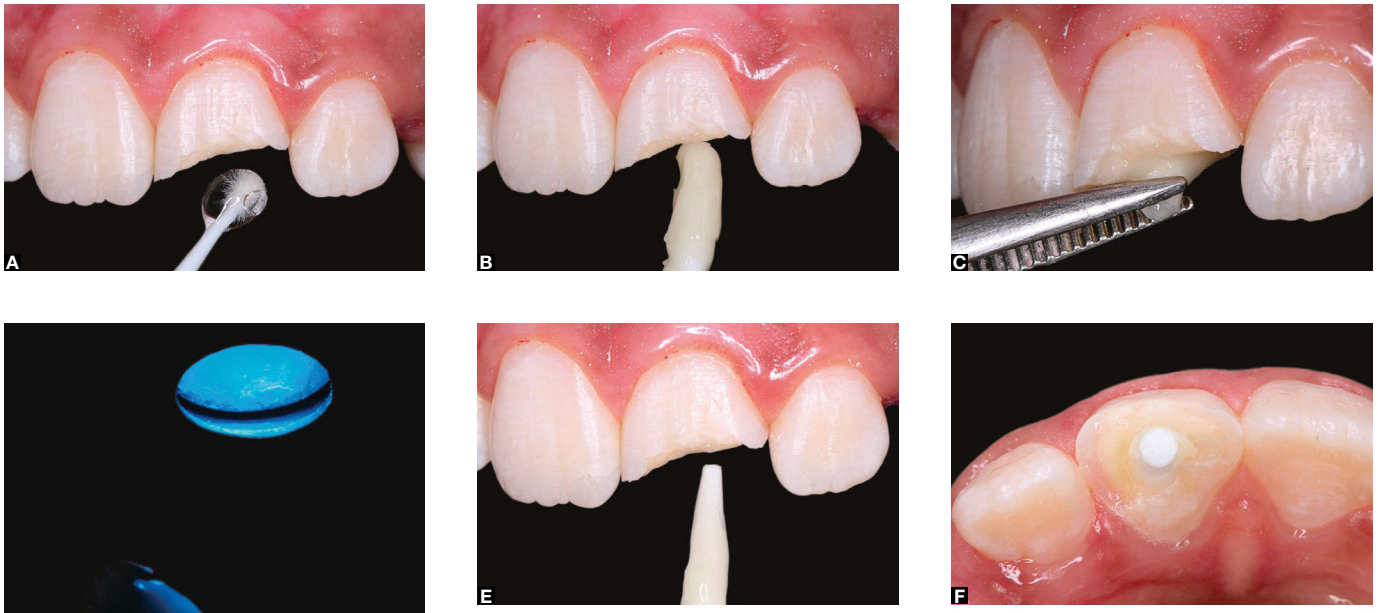


Figure 3. Technique for post relining - adaptation of the post into the conduct. **A**) Isolation of the conduct with water soluble gel. **B**) Positioning the post into root canal with composite resin. **C**) Post removal after initial polymerization for 10 seconds. **D**) Final polymerization for 40 seconds per side. **E** and **F**) Checking the adjustment of the anatomic post.

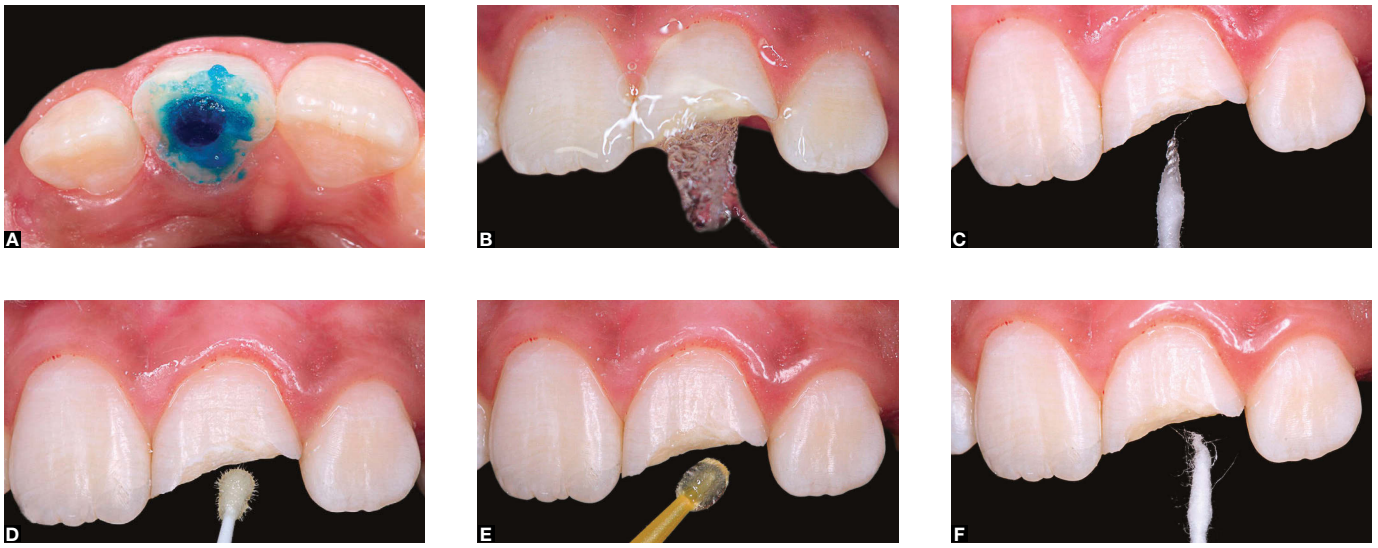


Figure 4. Conduct treatment for post cementation. **A**) Etching with phosphoric acid for 15 seconds. **B**) Drying for 30 seconds. **C**) Removal of moisture excesses. **D**) Application of primer. **E**) Application of the catalyst. **F**) Removal of adhesive catalyst excesses.

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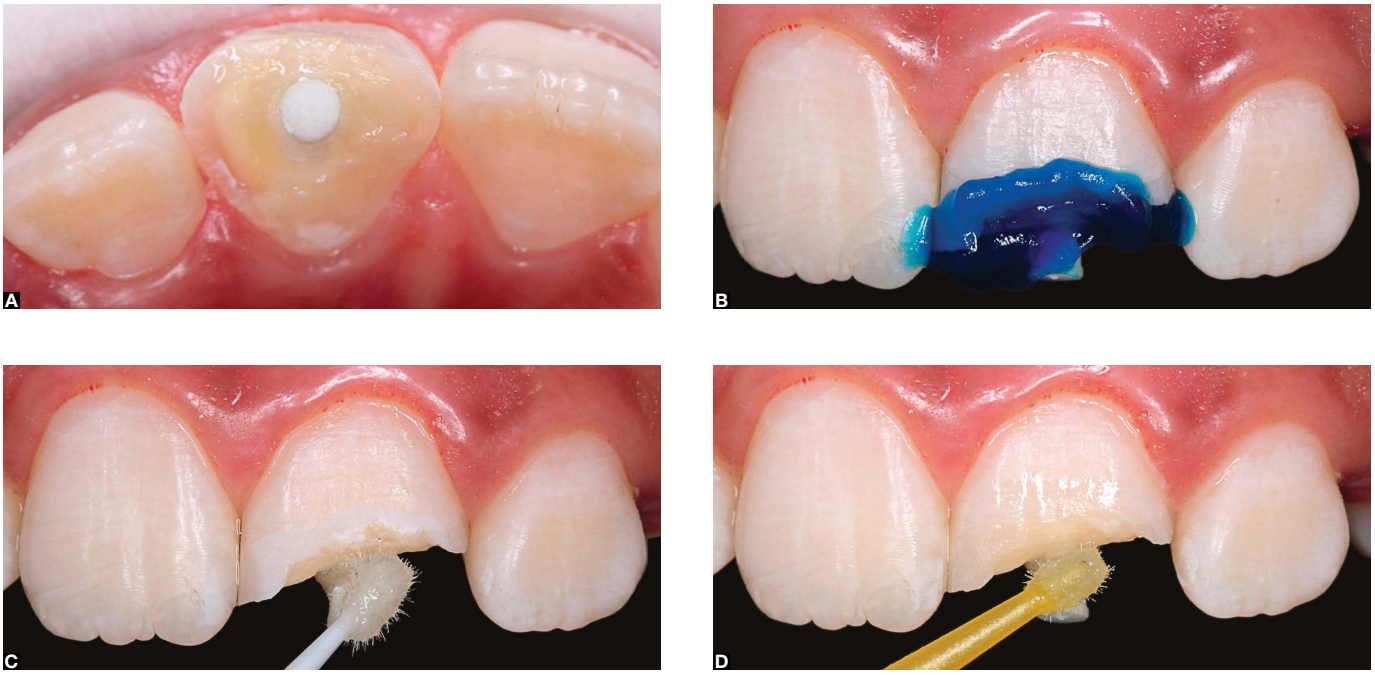


Figure 5. Adhesion to tooth structure. **A**) Cemented anatomic post. **B**) Etching with phosphoric acid for 15 seconds. **C**) Application of primer. **E**) Adhesive application and curing for 20 seconds.



Figure 6. Restoration with composite resin. **A**) Initial application of the incisal resin at palatal surface. **B**) Application of A1 and A2 dentin resin for the body construction. **C**) Finishing with enamel A1 and incisal resin.

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Figure 7. Final smile of the patient.

Results

The technique used was extremely effective, allowing the rehabilitation of the patient in a single session on a predictable manner and with satisfactory quality and esthetics (Fig 7). The fiber post relining technique generated a reduced cement layer with a tooth-resin-post set possibly more resistant.

Discussion

The use of composite resin for fiber post relining promotes close adaptation to the root canal walls, ensuring greater bond strength[7,12] and increasing the resistance of the set formed by the remaining tooth structure and the fiber post.[10] According to Clavijo et al[10] the use of anatomical direct and indirect manufactured posts warrant similar fracture resistance results to cast metallic posts. The present case used the direct technique for relining a glass fiber post, a faster procedure, with immediate high quality outcomes (Fig 7).

This technique provides the benefit of reducing resin cement thickness. Some studies have shown that dual-polimerizable cements do not polymerize effectively at great depths,[13] i.e., near the apex. Thus, the use of anatomic posts reduces the amount of cement that would display poor polymerization. In order to avoid this problem the use of self-curing resin cements can ensure better polymerization quality throughout the root canal, as used in this case.

Besides this fact, it is extremely important to have an effective adhesion between the employed materials, in order to ensure the formation of a single set that promotes better stresses distribution into the restored structure.[14] Therefore, the use of hydrogen peroxide post conditioning before silanization and adhesive application, has been shown to be the best surface treatment for adhesion to glass fiber posts.[15,16] According to Naves et al[17] the use of 24% hydrogen peroxide for 10 minutes on glass fiber or carbon posts promotes a greater availability of surface irregularities for bonding with resin cement due to the removal of the epoxy resin which lines the post fibers. In addition, Menezes de Souza et al[16] showed that the conditioning time (1, 5 or 10 minutes) with hydrogen peroxide does not affect the bond strength, and that the use of this substance at a concentration of 24% promotes similar results as the concentration of 50%. However, some authors showed no difference between various techniques for surface treatment of fiber posts.[18] Due to the benefits cited in several studies, the use of H_2O_2 conditioning appears to be important in order to avoid failure during fiber posts adhesive cementation.

Despite this concern be often overvalued, Ferrari

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et al[19] evaluating a total of 985 fiber posts for a period of 7-11 years have seen a failure rate of only 7-11% of cases, with only 21 posts detachment due to loss of adhesion (among other failures observed). Therefore, the promotion of a better adhesion for fiber posts seems important but few failures can be attributed to this factor. In order to ensure a good adhesive quality, the use of conventional 3-step adhesive systems (acid, primer and adhesive) avoids the occurrence of chemical incompatibility between auto or dual polymerized resin cements and single-bottle adhesives.[20] In this case we used an adhesive system (Duralink Fusion Catalyst, Angelus, Brazil) whith a self-curing "adhesive" ensuring efficient adhesion inside the entire root canal. For every cementation process it is mandatory that the clinician recognizes which material is in contact with the resinous cement, in order to provide better surface treatment. In an anatomic post, the composite resin used to reline the post will adhere with the resin cement in a direct technique, since they are both resinous materials polymerized almost at the same time during the clinical appointment. If an indirect technique is to be done, relined post surface needs to be faced as an indirect resin composite restoration, needing aluminum oxide sandblasting and silane application.[21]

The tooth final restoration can be made at the same operative time, right after post cementation, and after the polymerization of the resin cement (in this case, 4 minutes). The use of microhybrid resin composites produces good esthetic results combined with good final strength.[22] Case follow-up must be carried out regularly because the patient is a child, in spite of the fact that a high success rate have been cited by published studies.

Conclusion

The restoration of endodontically treated teeth with fiber posts can be improved with the use of anatomical posts created by post relining with microhybrid composites. The reported case resulted in biomechanical and esthetic success.

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A histological assessment of dentine, after the clinical removal of caries in extracted human teeth

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ABSTRACT

Introduction: Despite the evolution in the strategies used to prevent and treat dental caries, no consensus exists regarding the relationship among caries depth and bacterial contamination. **Objectives:** To analyze the depth of the carious lesion after clinical removal of carious dentin, and assess the presence, location and distribution of microorganisms in the dentinal tubules, in different degrees of the lesion depth. **Methods:** 20 carious human premolars were evaluated to determine the relationship among bacterial invasion and clinical carious degree using Brown and Brenn's bacterial stain. The data were subjected to Pearson's correlation coefficient. **Results:** The correlation between the number of microorganisms found within the different caries degrees was considered slightly positive (r = 0.038). No correlation between the distribution and the location of microorganisms in different caries degrees was verified. **Conclusion:** The presence of microorganisms in critical areas, such as the enamel-dentin junction and in the deeper cavity floor suggests the influence of anatomical characteristics on caries pathology.

Keywords: Dental caries. Dentin. Microorganisms. Radiographic exam.

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Introduction

When analyzing dental caries from a historical perspective, it can be seen the evolution in strategies used to prevent their development and the therapeutic strategies for treating them.[1,2] However, no consensus exists regarding the caries depth and the accuracy in diagnosis methods[3,4] or bacterial infection.[5] Consequently, there are different approaches to treating dental caries.

The characteristic of carious dentin is a point of great controversy among researchers which influences the therapeutic strategy to be adopted.[5,7,8] Appraisal of dentinal color and hardness — both of which are criteria for diagnostic procedures — is subjective, even when detector dye is used during caries removal.[7,9] Despite these parameters do not allow an accurate assessment of the degree of bacterial infection and pulp injury, they are commonly used to support any particular intervention.[9,10]

Although some studies point out that black or dark brown stained dentinal tissues generally indicate infected tissue, other studies report that natural stains do not always show significant amounts of bacteria.[7,9,10] Inspite of the difficulties in distinguishing the clinically affected dentin, the presence of microorganisms in dentinal tubules when caries are present is well established.[11,12]

Several investigations were conducted to evaluate the microbial status of deep dentinal caries and the possible effects of these microorganisms in intact or decalcified dentin, as well as in the dental pulp.[5,7,13] Though there is no consensus on the activity of remaining microorganisms inside the dentinal tubules, studies using bacteriological and histological methods have reported the persistence of bacteria in dentin even after the clinical removal of caries.[5,8,14]

The existing controversy regarding microorganism viability in relation to the demineralization of dentin, its location, and pulp response[5,11] leads to an increase in acceptance of the minimal-intervention dentistry observed in recent years.[7,9] A greater understanding of the impact of specific carious sites on tooth pathology (as well as the relationship between bacterial penetration inside dentinal tubules and the clinical diagnosis) may help in making treatment decisions.

Hence, it was considered worthwhile to examine the remaining dentin of freshly extracted human premolars after clinical removal of carious dentin for the presence, location, and distribution of microorganisms in the dentinal tubules in different degrees of lesion depth. It was hypothesized that the site and depth of the caries are strictly related to bacterial invasion inside dentinal tubules. The null hypothesis was that bacterial invasion of dentinal tubules is unrelated to clinical diagnosis of caries, using color and hardness criteria after excavation.

Materials and methods

In this study, 20 human upper premolars presenting proximal and/or occlusal caries recently extracted from 20 to 40 year-old patients for orthodontic or periodontal reasons were used (Table 1). The caries removal was done by a single calibrated operator. The bulk of carious dentin was removed using hand instruments followed by round low-speed burs (#2, #3, or #4). Throughout the entire clinical procedure, the cavity was irrigated with a saline physiologic solution. Carious tissue removal was considered complete when a probe running through the cavity floor demonstrated presence of hard dentin. The teeth were then split longitudinally in the mesiodistal direction using a sterile diamond disk under a jet spray of distilled water, taking care to reach both caries and pulp in the same cut. The hemi-split teeth were evaluated taking into account the enamel caries, and fixed in 10% buffered formalin solution for 24–48 hours.

The specimens were processed for routine histological examination, serial sections were cut with the microtome set at 5 μm thickness, and care was taken to obtain the whole carious lesion and the adjacent pulp tissue starting from the surface of each half of the tooth. Alternate slides were sequentially stained with Hematoxilyn-Eosin, for general examination, and modified Brown and Brenn technique for bacteria stain.[15]

Analysis of Bacterial Stain and Carious Degree

In this study 60 surfaces (proximal and/or occlusal) of 20 specimens were evaluated. The caries degree was established after carious tissue removal by a single calibrated operator, according to the scores previously defined by Biffi et al:[16] Absence of cavities (0), enamel caries (1), shallow cavity with up to 1/3 of dentin compromised (2), average decay up to 2/3 of dentin compromised (3), deep cavity with up to the

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entire dentin compromised but no evidence of pulp exposure (4), and pulp exposure (5).

The presence or absence of microorganisms in dentinal tubules, the depth of penetration (superficial or deep), and the location of bacterial niches were evaluated.

For statistical analysis, the Pearson coefficient of correlation was used ($-1 \leq r \geq +1$) for the qualitative variables, presence of microorganisms, location in the enamel-dentinal junction and pulp floor, and caries degree, to discover a possible positive, negative, or faintly positive correlation.

Results

Of the 60 surfaces (proximal and/or occlusal) of the 20 evaluated specimens, 37 were clinically diagnosed as decayed: 10 were of Degree 1, 10 of Degree 2, 8 of Degree 3, 5 of Degree 4, and 4 of Degree 5. Table 1 summarizes the number of cases evaluated, caries depth, microorganisms found in dentinal tubules, and observations concerning the depth and location of the microorganisms in the cavity. In the 10 Degree 1 caries, the presence of microorganisms was detected in just 1. In cases 5, 8, and 10, even with loss of dentinal content, contaminated dentin was not detected. In the remaining specimens, in at least 1 of the carious surfaces per tooth, the presence of microorganisms inside the dentinal tubules was observed (Fig 1).

The correlation between the number of microorganisms found within the different caries grades was

Table 1. Number of teeth (cases), caries depth*, microorganisms found in dentinal tubules and observations concerning the depth and location in the cavity. (M = Mesias surface. O = Occlusal surface. D = Distal surface)

Case	Carie Depth*			Detected Microorganisms			Observations
	M	O	D	M	O	D	
01	0	1	0		x		Shallow penetration in the dentin-enamel junction (Fig. 1A-F).
02	2	0	1	x			(M) Deep penetrating the floor of the cavity and dentin-enamel junction. (D) Not detected (Fig. 2).
03	2	0	1	x			(M) Penetration on the floor surface and enamel-dentin junction. (D) Not detected.
04	1	0	4			x	(M) Not detected. (D) Penetration in the floor surface.
05	2	0	0				Microorganisms undetected.
06	4	0	3	x		x	(M and D) Penetration on the floor surface and enamel-dentin junction.
07	3	0	3	x			(M) Penetration on the floor surface and enamel-dentin junction. (D) Not detected.
08	3	0	0				Microorganisms undetected.
09	3	0	2	x			(M) Penetration on the floor surface. (D) Not detected.
10	2	0	0				Microorganisms undetected.
11	3	0	1	x			(M) Deep penetrating the floor and dentin-enamel junction. (D) Not detected.
12	2	3	1	x	x		(M) Deep penetrating the floor and dentin-enamel junction. (O) Penetration surface under restoration. (D) Not detected (Fig. 1G-K).
13	3	0	2	x			(M) Penetration on the floor surface and enamel-dentin junction. (D) Not detected.
14	1	0	1				Microorganisms undetected.
15	1	0	1	x			(M) Penetration at dentin-enamel junction. (D) Not detected.
16	5	0	2			x	(M) Not detected. (D) Penetration in the floor surface and enamel-dentin junction (Fig. 3A-F).
17	4	0	4	x		x	(M and D) Penetration in the limit of dentin-enamel junction.
18	5	0	4	x		x	(M) surface penetration on the floor and walls of the pulp chamber. (D) Penetration in the floor surface.
19	2		5	x		x	(M and D) Penetration on the floor surface and enamel-dentin junction (Fig. 3G-N).
20	2	0	5			x	(M) not detected. (D) Deep penetrating the floor and dentin-enamel junction.

* 0 = No caries, 1 = caries in enamel, 2 = shalow caries involving 1/3 the thickness of dentin, 3 = average decay involving 2/3 the thickness of dentin, 4 = deep cavity involving 3/3 the thickness of dentin without pulp exposure, and 5 = pulp exposure.

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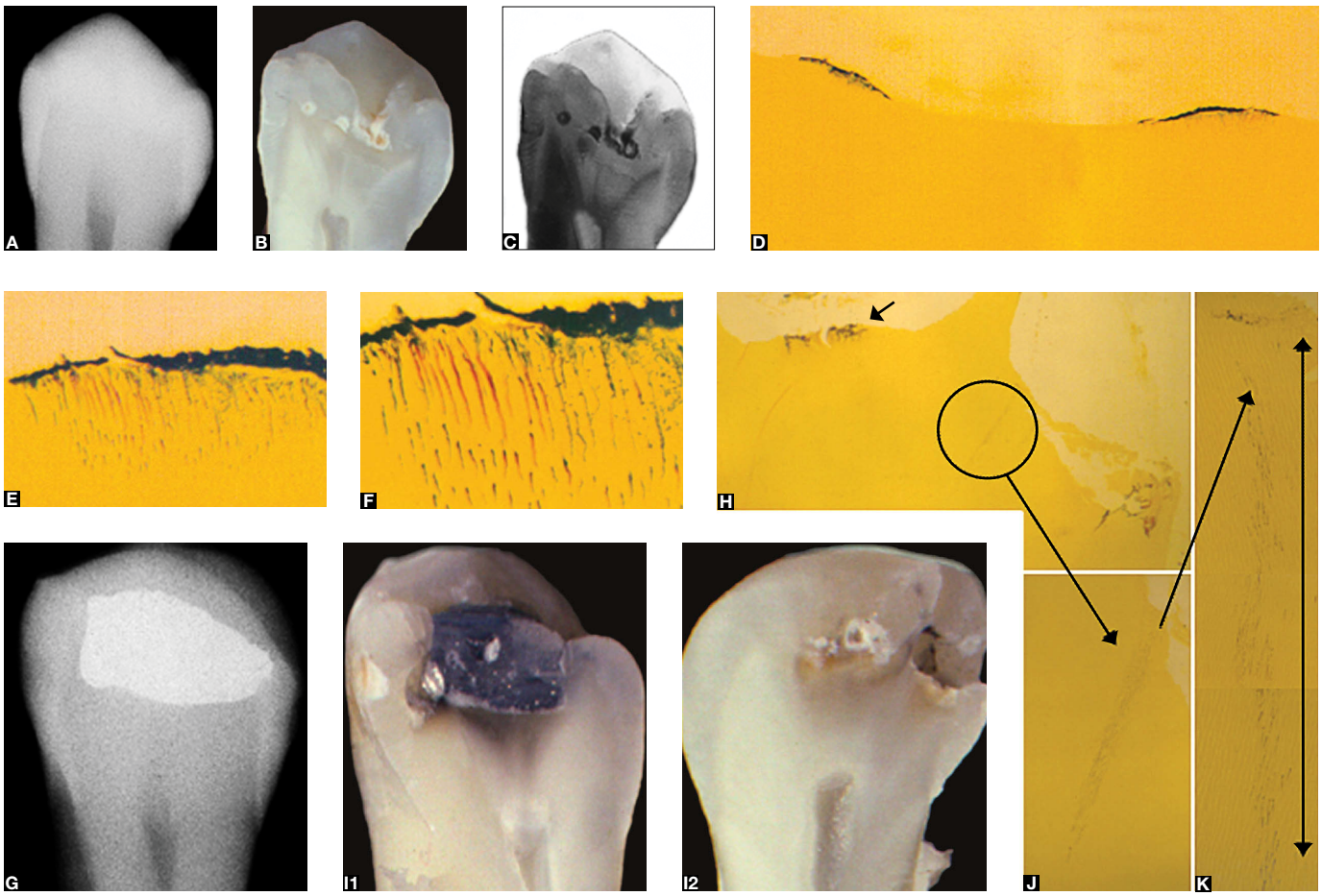


Figure 1. Illustrative images of cases evaluated in current research. Case 1 (**A-F**). A – Radiograph, diagnosis hypothesis – absence of occlusal caries. **B** – Longitudinal cut of teeth at center of pulp. Enamel caries evidence. **C**) Negative image of hemi-section, enamel caries confirmation. **D**) Microorganisms in dentin, subjacent to enamel caries (Brown e Brenn; original mag. 100X). **E**) Microorganisms in dentinal tubules after enamel caries removal (Brown e Brenn; original mag. 1000X). **F**) Microorganisms distribution, superficially (Brown e Brenn; original mag. 1000X). Case 12 (**G-K**). **G** - Radiograph, diagnosis hypothesis – proximal caries and occlusal amalgam. **H**) Microorganisms in mesial and occlusal surfaces subjacent to the amalgam restoration (Brown e Brenn; original mag. 100X). **I**) Longitudinal cut of teeth at center of pulp. Buccal hemi-section I1) and lingual hemi-section (I2). **J**) Deep penetration (conical shape) of microorganisms in dentinal tubules after caries removal (Brown e Brenn; original mag. 400X). **K)** Higher magnification of H (circle) (Brown e Brenn; original mag. 400X).

considered faintly positive (r=0.038). This statistical finding confirms that the location and distribution of microorganisms in the dentinal tubules were varied and independent of the caries depth.

When the correlation between microorganisms found in different caries degrees and their distribution (superficial or deep) and location (enamel-dentin junction and pulp floor) was established, the null correlation was verified, demonstrating that the location and distribution of microorganisms in areas considered critical in this study did not correlate to caries depth. Figures 2 and 3 illustrate the lack of correlation between the location of the microorganisms and classification of carious lesions.

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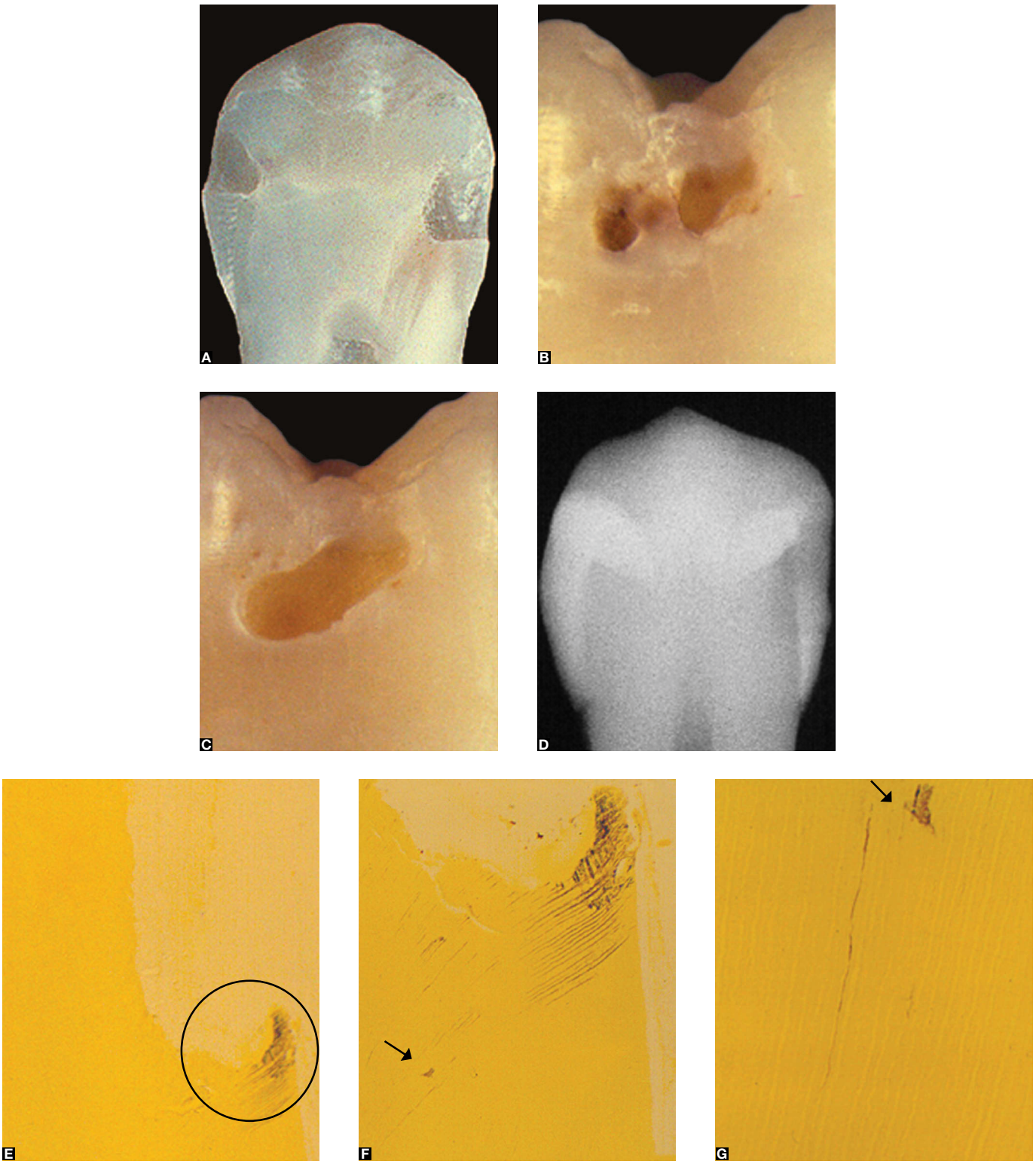


Figure 2. Illustrative images of cases evaluated in current research. Case 2 (**A-G**). **A**) Longitudinal cut of teeth at center of pulp. Hemi-section showing caries evidence at the bottom of cavity. **B**) Photograph of proximal caries. **C**) Photograph after caries removal. **D**) Radiograph, diagnosis hypothesis – deep proximal caries. **E**) Microorganisms in dentin (circle) (Brown e Brenn; original mag. 100X). **F**) After caries removal, deep penetration of microorganisms in dentinal tubules (Brown e Brenn; original mag. 100X). **G**) Higher magnification of F. Deep penetration in dentinal tubules (arrow) (Brown e Brenn; original mag. 400X).

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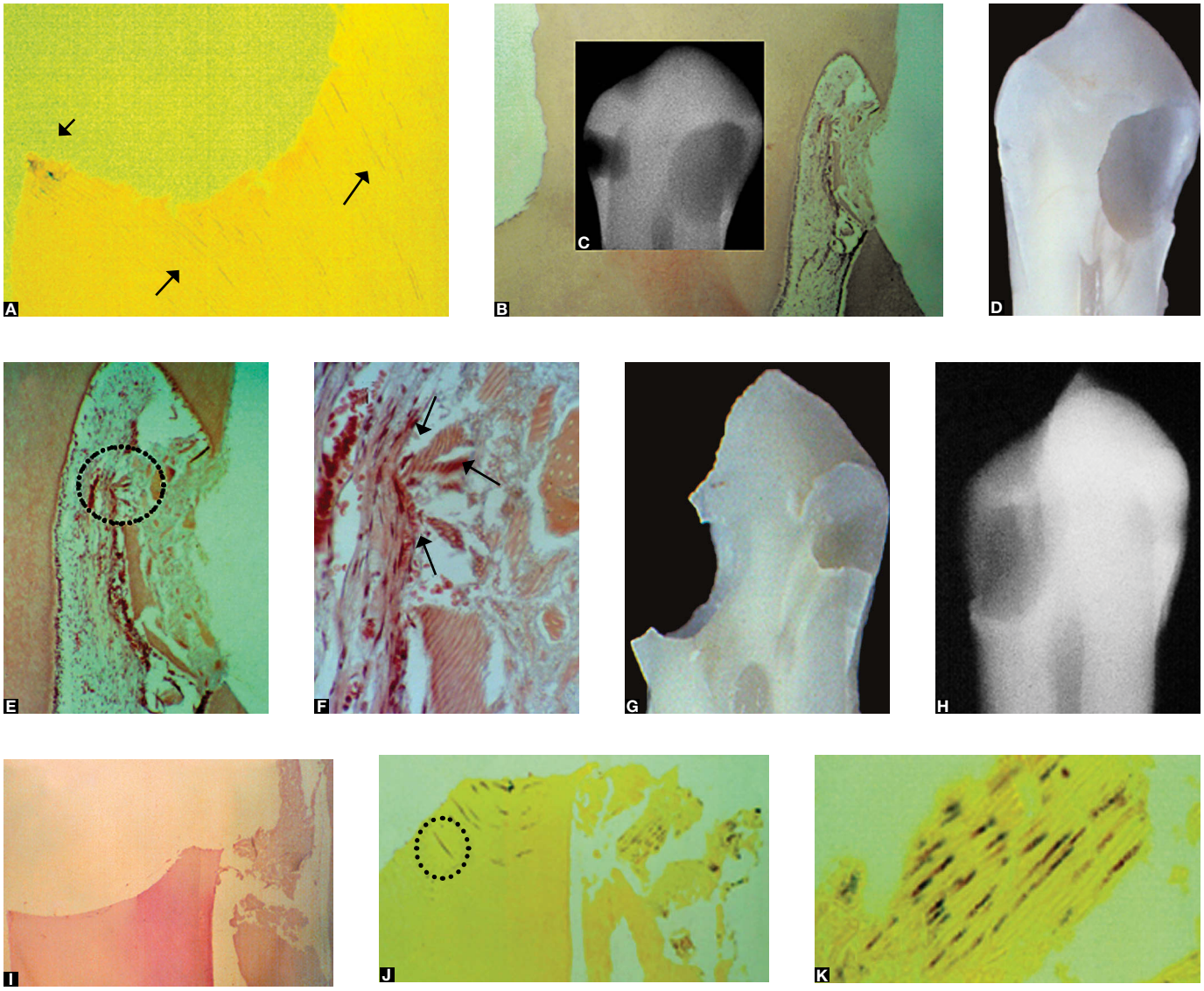


Figure 3. Illustrative images of cases evaluated in current research. Case 16 (**A–F**). **A**) Microorganisms at the enamel-junction, lower border of cavity; homogeneous distribution of microorganisms (arrow) (Brown e Brenn; original mag. 100X). **B**) Distal, Mesial caries with pulp exposure (HE; original mag. 100X). **C**) Radiograph, diagnosis hypothesis – proximal (M and D) caries. **D**) Longitudinal cut of teeth at center of pulp. Hemi-section showing cavity after caries removal. **E**) Higher magnification of B; pathologic pulp exposure (H.E. original mag. 400X). **F**) Dentinal chips in pulp chamber after caries removal (H.E. original mag. 400X). Case 19 (**G-N**). **G**) Hemi-section, presence of distal caries with pulp exposure. **H**) Radiograph, diagnosis hypothesis – proximal (M and D) deep caries. **I**) Pulp exposure (HE, orig. mag. 100X). **J**) Presence of contaminated dentine spicules (arrow) (Brown and Brenn. original mag. 10X). **K**) Higher magnification of K, (Brown and Breen. original mag. 400X). **L**) Generalized contamination of the dentinal tubules; (Brown and Breen. original magnifying 100X). **M**) Presence of microorganisms of the enamel-dentin junction; (orig. mag. 400X). **N**) Presence of microorganisms in the morphologically unchanged tubules, (Brown and Breen. original magnifying 1000X).

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Discussion

In the present study the null hypothesis was accepted: That the presence, location, and distribution of microorganisms in dentinal tubules is unrelated to clinical diagnosis of caries after removal. This finding may have clinical implications and may help clinicians understand the differences on caries pathology and its relation to the site.

The destination of the remaining microorganisms in dentinal tubules is thought to be suspicious[12] and there are directed researches to speculate whether the persistence of microorganisms after caries removal could contribute to lesion progression and affect the prognosis of treatment.[8,14] Although parameters related to caries inactivation with the initial excavation procedure has not been the focus of this study, we recognize the importance of such analysis to assess the effectiveness of indirect pulp treatment.[5] For this purpose, several bacteriological studies have been conducted to evaluate what kind of bacteria predominates in lesions of different depths and if these remain viable after conservative restorative procedures.[5,8,11,14,15]

Taking into account the fact that dentinal tubules run from the enamel-dentin junction to the pulp and have variable specific characteristics, depending on the analyzed area,[17,18,19] we chose to assess the pulp floor and the enamel-dentinal junction, which are considered critical areas.[20] According to Garberoglio and Brännström,[17] microorganisms located in the deeper layers of the pulp floor are not affected by isolation from the oral environment. They will stay alive and may have the potential to continue the carious process regardless of the type of restoration base or sealant used. The enamel-dentin junction is easily permeated by metabolic residue diffusion, enzymes, bacterial toxins, and poisonous components of restoring materials[20,21] which can continue the carious process.

In present study, microorganisms were detected in the enamel-dentinal junction, showing both superficial and deep penetration. They were also detected under unsupported enamel, which functions as a bacterial niche, compromising the restoration by interfering with the marginal seal. Figure 3 (case 16) shows microorganisms in the enamel-dentinal junction. This study also demonstrated the presence of microorganisms under amalgam restoration in the occlusal surface (Fig 1, case 12). However, it is not possible to determine if they came through the tooth-restoration interface or if they were already superficially established in the dentinal tubules when the loss of enamel occurred. Furthermore, it takes special importance the persistence of microorganisms into dentinal tubules, even after the removal of carious tissue and tooth restoration.

The bacterial stain also demonstrated that bacteria persisted in dentinal tubules, and there was not always a correlation between the location of the microorganisms and carious lesions clinically classified as shallow, verification extended to the other caries grades. Figure 2 (case 2) confirms this finding. Another important finding was that caries removal based on clinical criteria (such as hardness and color of the dentin) does not guarantee total elimination of microorganisms and a healthy pulp, because dentin remains contaminated, as it has been verified by several publications.[14,22,23] In addition, the clinical evaluation of dentin can vary according to the tactile and visual criteria inherent to each investigator, usually guided by his or her own sensorial responses and clinical experience, which motivates speculation regarding the persistence and location of microorganisms in dentinal tubules. The findings in this research confirm these statements. Figure 1 (case 1) demonstrates that, although caries had been clinically diagnosed as enamel caries only, it was histologically observed that microorganisms were already invading the tubules on the dentin surface.

Pulp exposure may result from clinical deep carious excavation, and preservation of the pulp tissue becomes challenging because the actual pathologic condition cannot be clinically established. Furthermore, contaminated dentin debris may fall into the pulp chamber, compromising the tissue, as demonstrated in Figure 3 (case 19). The presence of microorganisms deeply embedded in dentinal tubules of morphologically unaffected dentin is also demonstrated in this figure. Clinical examination by the professional will give the impression of healthy dentin because of its hardness. Figure 3 (case 16) shows pulp exposure on the distal surface and no contaminated dentin chips in the pulp space in a tooth where the caries was clinically classified as grade 2, while the mesial surface shows microorganisms in the entire cavity floor. This is a condition that is impossible to diagnose clinically.

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On the other hand, the absence of bacteria in 16 analyzed surfaces (43.25%, Table 1), which were clinically classified as having caries and having evidence of loss of dentinal content under microscopic examination, does not assure the sterility of dentin or the complete clinical removal of caries. It can be speculated that the process of demineralization may interfere with the visualization and characterization of the microorganism. There are reports[24] showing a severe reduction in number and in the staining capacity of Gram-positive bacteria when formic acid is used for decalcification. However, other methods commonly used in research, such as Polymerase Chain Reaction (PCR) or culture of the samples, also have limitations and would not be able to determine the presence or absence of microorganisms in the pulp wall – which is one of the objectives of the present study.

It was observed in this study that bacteria were located in the dentinal tubules morphologically unaffected, and penetrated following their curvature, becoming a cone in occlusal caries extending in an S form in sections of interproximal caries. In areas of superficial penetration, the microorganisms followed the dentinal tubules toward the pulp cavity and dispersed alongside in the intertubular dentin. In deeper penetration areas, some microorganisms dispersed only near the dentinal tubules, which is a histological finding in agreement with the study by Ozaki et al.[25]

The present study substantiates this problematic theme by demonstrating the presence of microorganism in areas considered critical, such as the enamel-dentinal junction and the deep cavity floor; and the microorganisms persisted regardless of the caries grade. Though these data are supported by current literature, studies of this nature contribute to a better understanding of the process and to improving the care to be taken during any clinical management. We suggest further studies combining different methodologies for a better understanding both of the contaminated dentin and of the pulp response.

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Antibiotic prescription behavior of specialists in endodontics

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ABSTRACT

Introduction: The present study proposed to determine the antibiotic prescription behavior of endodontic specialists regarding antibiotic administration timing, indication and first choice options. **Methodology:** A four-question questionnaire was delivered to 105 endodontists in São Paulo state, Brazil. The results were statistically analyzed. **Results:** Within the interviewed specialists, 48.5% were male and 51.5% female. Amoxicillin was the first choice antibiotic for 84.7% of professionals. For a scenario of penicillin allergic patients, 47.6% would prescribe clindamycin and 42.8% azithromycin. The great majority (79%) indicates antibiotics administration for a period of 5 to 7 days. Close to one third of interviewed individuals inadequately indicated antibiotic therapy. **Conclusion:** The majority of professionals were able to correctly select the antibiotic for non-allergic and penicillin allergic patients, as well as regarding the administration timing. On the other hand, there are still professionals inappropriately applying antibiotic therapies, favoring bacterial resistance.

Keywords: Antibiotic therapy. Endodontics. Bacterial resistance.

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Introduction

The discovery of the first antibiotic in 1928 by Alexander Fleming, a Scottish bacteriologist, besides revolutionizing medical conduct front infectious scenarios, served as base for studies directed to antibacterial agents.

With antibiotic production in large industrial scale starting from the 40's, several medication options were marketed. This fact might have helped health professionals regarding antibiotic therapy, but in relation to dentists, it led to difficulties during antibiotic selection and prescription.[1]

The lack of knowledge and information in relation to medication therapies by dentists is a result initially of a dental training deficiency. When performing surgical interventions, in which most of times there is a need for analgesic and/or anti-inflammatory or even antibiotic prescriptions, dentists face a very doubtful situation concerning the medication choices.[2]

The results of these difficulties contributed for an unchanged prescription behavior in Dentistry for more than 25 years.[1]

Antibiotic therapy limits infectious process development, creating favorable conditions of organisms to eliminate bacterial or fungic contingent by means of their immunologic defense mechanisms.[3.4] Although medication therapeutics is cooperative to clinical intervention and thus not always employed, its consistent and judicious employment is essential for a conscious and ethical practice in Dentistry.[2]

When prescribing a medication, the dentist has the legal responsibility to know the pharmacological aspects of employed drugs and to critically evaluate the therapeutic results.[5] Moreover, dentists should have absolute control of each case, evaluating patients' overall health and balancing the real necessity for an antibiotic therapy. Antibiotic administration in endodontics is indicated only in situations of periradicular acute abscesses, presence of symptomatology and/or persistent exudate, and for bacterial endocarditis prevention.[3]

The administration of antibiotics for infections of low relevance or for simple inflammatory processes might strongly contribute for the worldwide bacterial resistance problem.[6] Moreover, nondiscriminatory prescription has been contributing to greater incidence of collateral reactions and side effects.[7,8]

The aim of the present study was to evaluate the antibiotic prescription behavior of specialists in endodontics, regarding different endodontic pathologies and specific patient's characteristics.

Materials and Methods

One hundred and five endodontists from São Paulo State were interviewed through a questionnaire composed by 4 multiple-choice questions (Fig 1).

At the end of data collection, the results were ordered in tables and quantified in percentage to identify the most prescribed antibiotic for patients with no history of allergy and for penicillin allergic patients, and the antibiotic therapy administration timing and indication.

Results

From the total of 105 interviewed professionals, 48.5% were male subjects and 51.5% female. More than half of the individuals (60%) aged between 25

Name: _____ **Gender:** _____

Specialty: _____

Time as specialist: _____ **State:** _____

USE OF ANTIBIOTICS IN ENDODONTICS

1. Which antibiotic of choice for patients with no allergy history?

a) Amoxicillin.
b) Amoxicillin + clavulanic acid.
c) Clindamycin.
d) Azitromycin.
e) Metronidazole.
f) Other_____

2. For how many days do you prescribe antibiotics?_____

3. Which antibiotic do you prescribe for penicillin allergic patients?

a) Clindamycin.
b) Azitromycin.
c) Metronidazole.
d) Cephalosporin.
e) Lincomycin.

4. In which of the following scenarios do you prescribe antibiotic therapy?
Mark all items that apply.

a) Irreversible pulpitis, moderate / severe pain.
b) Necrotic pulp without swelling, no pain / light pain.
c) Necrotic pulp without swelling, moderate / severe pain.
d) Necrotic pulp with swelling, no pain / light pain.
e) Necrotic pulp with swelling, moderate / severe pain.
f) Necrotic pulp with fistula, no pain / light pain.

Figure 1. Questionnaire applied to endodontists.

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and 30 years, 28.5% aged between 35 and 45 years, and 11.5% with age greater than 45 years.

Regarding time in the specialty, the interviewed individuals were distributed into three groups: Less than 5 years (55.24%), from 5 to 20 years (40%) and over 20 years (4.76%) (Fig 2). The mean time in the specialty was 7 years, being 36 years the highest observed time for a professional in the endodontic specialty.

The administration timing of antibiotics varied from 2 to 10 days. However, the great majority of specialists (79%) prescribe antibiotic therapy for 5 to 7 days (Table 1).

Amoxicillin was the choice antibiotic within 84.7% of interviewed specialists for the treatment of patients with no history of allergic reaction. The association of amoxicillin and clavulanic acid, a penicillinase enzyme inhibitor, was reported by 9.5% of professionals. The indication of azithromycin, cephalosporin, metronidazole and others were reported in 5.8% (Table 2).

For penicillin allergic patients, the first antibiotic choice was clindamycin (47.6%), followed by azithromycin (42.8%), cephalosporin (7.8%), metronidazole (0.9%) and erythromycin (0.9%). None of the interviewed individuals opted for lincomycin (Table 3).

Table 4 brings the percentage of professionals according to their antibiotic therapy indication for different pathologies related to periapical and pulp tissues. The prescription of antibiotics for irreversible pulpitis with moderate to severe symptomatology was indicated by 5.7% of the interviewed endodontists. For the pulp necrosis with no swelling and light to no pain, or moderate to severe pain, antibiotic was indicated by 2.8% and 29.5% of endodontists, respectively. Fifty point four percent and 93.3% of the interviewed professionals indicated antibiotic therapy for pulp necrosis with swelling and light to no pain, or moderate to severe pain, respectively. Eight percent of the interviewed individuals did not indicate antibiotic therapy for any of the described scenarios. Antibiotic therapy was indicated by 31.4% of the professionals for pulp necrosis with the presence of fistula and light to no symptomatology (Table 4).

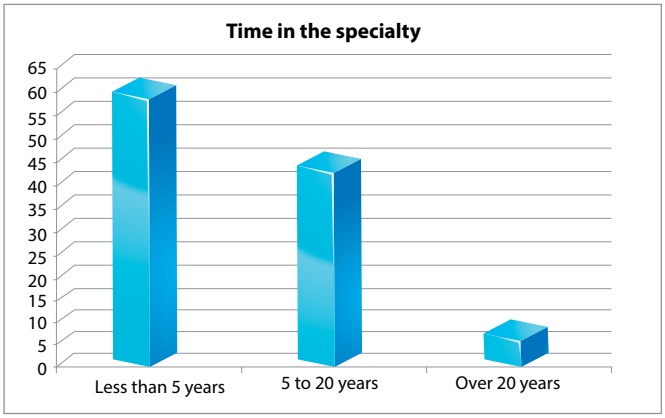


Figure 2. Distribution of interviewed individuals according to their time in the specialty.

Table 1. Prescription timing of antibiotic administration.

Timing (days)	%
2-4	11.4
5-7	79
8-10	9.6

Table 2. Antibiotic of choice for patients with no allergy history.

Antibiotic	%
Amoxicillin	84.7
Amoxicillin + clavulanic acid	9.5
Others	5.8

Table 3. Antibiotic of choice for penicillin allergic patients.

Antibiotic	%
Clindamycin	47.6
Azithromycin	42.8
Cephalosporin	7.8
Metronidazole	0.9
Eritromycin	0.9

Table 4. Scenarios when antibiotic were prescribed.

Scenarios	Antibiotic prescription (%)
Irreversible pulpitis, moderate / severe pain	5.7
Pulp necrosis with no swelling, light / no pain	2.8
Pulp necrosis with no swelling, moderate / servere pain	29.5
Pulp necrosis with swelling, light / no pain	50.4
Pulp necrosis with swelling, moderate / severe pain	93.3
Pulp necrosis with fistula, light / no pain	31.4
None of the mentioned scenarios	8.0

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The amount of professionals that prescribed antibiotics for the irreversible pulpitis scenario (5.7%) belongs to the less than 5 years in the specialty group. The interrelation between the interviewed individuals indicating antibiotic therapy for chronic processes (34.2%) (pulp necrosis without swelling and light to no pain, or pulp necrosis with fistula and light to no pain), and the time in the specialty revealed that 66.8% belong to the less than 5 year in the specialty group. The remaining professionals are distributed within the two other groups, between 5 to 20 years group (30.5%) and the over 20 years group (2.7%).

Discussion

The antibiotic therapy is a strong ally for dentists facing treatment of oral infectious processes. Antimicrobials aid the defense of organisms promoting a decrease or stabilization on invasive bacteria or fungi quantities. However, it is important to highlight that every treatment is directly related to an adequate diagnosis and planning of actions, being the medication therapy only an adjunct and never a substitute for the localized action of health care providers.[9]

The time for antibiotic therapy administration is determinant for the therapeutic success. The most important dentist decision is not related to which type of antimicrobial will be used, but to which specific scenarios they should be prescribed.[10] The indication for antimicrobials should be clearly evaluated, like the presence of persistent infections or in systemically compromised patients, the presence of fever on the last 24 hours, trismus, swelling, malaise in healthy patients, limphadenopathy and/or immunocompromised patients such recently transplanted, HIV positive and under chemotherapy patients.[1]

Studies have been conducted in the United States[1] and Spain[6,11] to evaluate the knowledge and behavior of dental professionals about antibiotics prescription. The present study interviewed 105 endodontists at São Paulo State based on questionnaires proposed in previous researches.

The results revealed the mean prescription timing of the present study was between 5 to 7 days. According to Pallash,[13] endodontic infections present fast onset and short duration, lasting from 2 and 7 days at most. Antibiotic therapy should be sustained only during the infection signs and symptoms persistence[12] and should be stopped as long as the clinical evidences are solved. Antibiotic prescription timing of 5 to 7 days is the most appropriate for the majority of infections,[11] once it is initiated right after signs and symptoms onset. The maintenance of prolonged antibiotic therapy leads to selection of drug resistant microorganisms and increases bacterial tolerance of oral flora to colonization by unusual microorganisms.[13]

Within the interviewed individuals, the first choice medication for penicillin non-allergic patients was amoxicillin alone (84.7%) or associated to clavulanic acid (9.5%). This medication is highly efficient against anaerobic microorganisms,[14] and due to its broad action spectrum it is indicated for dentoalveolar abscesses, where the presence of different microorganism species is observed.[15] The association of amoxicillin and clavulanic acid (9.5%) is a very viable alternative for infections with presence of beta-lactamase producing bacteria.[14]

Penicillin VK is the first option antibiotic for oral infections in North-America, being amoxicillin the second option.[1] In a study conducted in Norway,[16] penicillin VK was often prescribed by dentists, followed by metronidazole, erythromycin, amoxicillin and others. However, penicillin VK presents some disadvantages in relation to amoxicillin as this last is well tolerated and better absorbed by the gastrointestinal tract.[6]

The interviewed professionals opted for clindamycin (47.6%) as the antibiotic of choice for penicillin allergic patients. This is a lincomycin derived antibiotic with broad spectrum of action; it is well absorbed by oral route; it is bacteriostatic or bactericide; and it is characteristic for penetrating into macrophages and leucocytes, which favors high concentrations of this drug in dental abscesses.[1,17,18] Previous studies revealed clindamycin as dentists preferred drug for patients presenting hypersensibility to penicillin.[1,6,11] Azithromycin was the second option (42.8%) within the interviewed individuals. This is a macrolide-derivated drug, from erythromycin, which presents similar action spectrum as penicillin. Besides its greater action spectrum over larger number of microorganism species, azithromycin presents greater capacity of tissue penetration than erythromycin.[19]

Question 4 from the questionnaire (Fig 1) listed different diagnosed scenarios related to pulp and periapical pathologies in which endodontists should

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choose those requiring antibiotic therapy. After clinical diagnosis, the medication therapy to be adopted should take into consideration especially the general health status of patients. Although the presented scenarios in question 4 did not bring clinical particularities or medical history, the distinction between acute/chronic and between inflammatory/infectious inflammatory situations was very clear.

For the scenario of irreversible pulpitis, 5.7% of endodontists prescribed antibiotics. For pulp pathologies in general (acute or chronic) there are still not infection evidences and pulp tissue is vital; thus antibiotic prescription is unnecessary. Although this is an apparently simple and obvious scenario, many dentists indicated antibiotic therapy for these particular situations.[1,6,20,21]

Antibiotic therapy was indicated for the necrotic pulp with no swelling and light to no pain and pulp necrosis with fistula and light to no pain by 2.8 and 31.4% of endodontists, respectively. Antibiotic therapy is contraindicated for infections at chronic phases. According to Al-Haroni e Skaug,[17] the majority of infections, either acute or chronic, can be successfully treated by eliminating the infection source, by disinfecting root canals, draining abscesses or extracting teeth, with no need for antibiotic, with exception of evident systemic compromise.

In relation to inadequate antibiotic prescriptions, the results detected in the present study showed a relationship between time in the specialty of professionals and adequate use of antibiotic therapy. Professionals indicating antibiotic for irreversible pulpitis were from the less than 5 years in specialty group. The majority of professionals (66.8%) prescribing medication for chronic scenarios of pulp necrosis were also from this group. The professional experience might be an important factor for these situations.

It was noted the great majority of interviewed specialists correctly adopts antibiotic therapy front endodontic infections, although still one third of them inadvertently prescribes antibiotics. The bacterial resistance is highlighted as a consequence of this practice, besides the possible occurrence of adverse side effect reactions for patients.[22]

Indiscriminate use of antimicrobials is recently a worldwide concern. In Brazil, the government adopted new guidelines for antimicrobial prescriptions starting in 2010, in order to face this problem and to police antibiotic market with no prescription. The necessity of single-copy prescriptions, being a copy for the patient and the original retained at the pharmacy, is within this new guideline. It is however pertinent for health care providers to seek for constant recycling of their knowledge and to carefully reflect front possible antibiotic therapy indications.

Conclusion

The majority of interviewed specialists correctly prescribe antibiotics. However, there are still professionals that inadvertently apply antibiotic therapy. This fact favors bacterial resistance and also exposes patients unnecessarily to adverse side effects of medications.

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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.

3. Dental Press Endodontics - Statement and Notice

DENTAL PRESS ENDODONTICS endorses the policies for clinical trial registration enforced by the World Health Organization - WHO (http://www.who.int/ictrp/en/) and the International Committee of Medical Journal Editors - ICMJE (# http://www.wame.org/wamestmt.htm#trialreg and http://www.icmje.org/clin_trialup.htm), recognizing the importance of these initiatives for the registration and international dissemination of information on international clinical trials on an open access basis. Thus, following the guidelines laid down by BIREME / PAHO / WHO for indexing journals in LILACS and SciELO, DENTAL PRESS ENDODONTICS will only accept for publication articles on clinical research that have received an identification number from one of the Clinical Trial Registers, validated according to the criteria established by WHO and ICMJE, whose addresses are available at the ICMJE website http://www.icmje.org/faq.pdf. The identification number must be informed at the end of the abstract.

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

Yours sincerely,

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