Evaluation of apical leakage of white MTA associated with two different vehicles

Avaliação da infiltração apical do MTA branco associado a dois diferentes veículos

George Táccio de Miranda Candeiro[1], Antônia Izelda de Araújo Maia[2], Bruna Marjorie Dias Frota[3], Denusa Moreira Veríssimo[3], Giulio Gavini[4]

[1]Post-Graduation Program, University of São Paulo, São Paulo-SP, Brazil; [2]Municipal Secretary of Health, Independência-CE, Brazil; [3]School of Dentistry, Federal University of Ceará, Fortaleza-CE, Brazil; [4]School of Dentistry, University of São Paulo, São Paulo-SP, Brazil.

Abstract

Objective – Compare *ex vivo* apical leakage of white Mineral Trioxide Aggregate (MTA) associated with distilled water or AH Plus endodontic sealer when used as retrofilling materials. **Methods** – Forty-four extracted human molars were randomly distributed into four groups. Their distal/palatine roots were sectioned and chemical-mechanical preparation was performed by the step technique up to instrument #55. The roots were filled with gutta-percha cones and endodontic sealer (Tagger's hybrid technique). The roots had the apex removed with a 90º angulation, and after sealing, ultrasonic retro preparations were performed (depth 3mm), following the long axis of the root. The retrograde cavities were retrofilled with White MTA powder associated with distilled water (Group I) or AH Plus endodontic sealer (Group II). In Group III (positive control) no retrofilling was performed and the specimens from Group IV (negative control) were completely covered with sealant. The roots were immersed in Indian ink and kept in an oven (37ºC, 48 hours). Longitudinal wear of the root apical portion was performed in the vestibular-palatine direction, in order to analyze leakage. **Results** – Among the experimental groups, Group II showed less leakage than Group I ($p<0.05$). **Conclusion** – The association MTA/AH Plus sealer showed less marginal leakage when compared with MTA/distilled water.

Descriptors: Endodontics; Dental leakage; Dental materials

Resumo

Objetivo – Comparar *ex vivo* a infiltração apical do Mineral Trióxido Agregado (MTA) associado à água destilada ou ao cimento endodôntico AH Plus quando usados materiais retro-obturadores. **Métodos** – Quarenta e quatro molares foram randomicamente distribuídos em quatro grupos. Os dentes tiveram as raízes distais ou palatinas seccionadas e o preparo químico-mecânico realizado pela técnica escalonada até o instrumento #55. As raízes foram obturadas com cones de guta-percha e cimento endodôntico (Técnica híbrida de Tagger). As raízes tiveram os ápices removidos com uma angulação de 90º e, após a impermeabilização externa, foram feitos retro-preparos ultrassônicos (3 mm de profundidade), seguindo o longo-eixo radicular. As cavidades retrógradas foram preenchidas com o pó do MTA branco associado à água destilada (Grupo I) ou ao cimento endodôntico AH Plus (Grupo II). No Grupo III (controle positivo), não houve o preenchimento das cavidades e, os espécimes do Grupo IV (controle negativo) foram completamente cobertos com o material impermeabilizante. As raízes foram imersas em tinta Nanquim, permanecendo por 48 horas a 37ºC. Cortes longitudinais foram feitos na porção apical no sentido vestíbulo-palatino, a fim de analisar-se a infiltração. **Resultados** – Entre os grupos experimentais, o Grupo II apresentou menores infiltrações do que o Grupo I ($p<0,05$). **Conclusão** – A associação entre o MTA branco e o cimento AH Plus apresentou menores infiltrações quando comparada ao MTA branco e a água destilada

Descritores: Endodontia; Infiltração dentária; Materiais dentários

Introduction

Success of endodontic treatment depends on the correct chemical-mechanical preparation of the root canal, and filling with a material which, among other characteristics, presents good apical and coronal sealing to avoid bacterial and toxin leakage to the periapical tissues. In spite of the development of new debridement techniques, materials and instruments, periapical pathologies are frequently only resolved by surgical procedures.

Among the periapical surgery modalities, the goal of apicoectomy with retrograde filling is to prepare the apical region to receive a material capable of promoting the best sealing possible, making it difficult for micro-leakage and lesion recurrence to occur. To achieve this, it is necessary to prepare an adequate retrograde cavity with regular walls that accompany the main canal with sufficient depth, and the use of ultrasonic retrotips is suggested.

Several materials have been used as retrofillers, and the most common are amalgam, zinc/eugenol oxide-based cement (IRM, EBA, Super-EBA), ionomeric cements, resin composites, Sealapex associated with zinc oxide and mineral trioxide aggregate (MTA). Developed in 1993 by Torabinejad, MTA has some advantages in comparison with the others mentioned above, particularly due to its properties of biocompatibility[1], providing mineralized tissue formation[2], less apical leakage in periapical surgeries[3-5], less bacterial infiltration[6], better marginal adaptation to cavity walls[7-9], less need for condensation force and the possibility of using it in a humid field. However, some of the properties of MTA are not so efficient, such as antimicrobial activity and bonding to the dentin structure[3,10-11].

Although MTA is the most used retrofilling material at present, it is difficult to handle and insert in a cavity prepared for retrograde filling. One of the most relevant problems is that when the cement is prepared in accordance with the manufacturer's recommendations, with the addition of powder to water in the proportion of 3:1, it is extremely difficult to press it into the root, where the material tends to become displaced out of the site. Therefore, some endodontists have recommended, without preliminary studies, however, that the distilled water used in the MTA material should be replaced by AH Plus sealer, as this would improve the properties of manipulating and bonding of this material, in addition to which, the calcium hydroxide in this sealer would increase the properties of inducing the formation of mineralized tissue.

AH Plus sealer is used to fill root canals, and in its commercial presentation it has two component epoxy-amine resin-based pastes with the following characteristics: long term sealing, great dimen-

sional stability, bonding properties, high radiopacity, biocompatibility and antimicrobial activity[12-14].

The aim of this study was to compare the *in vitro* apical leakage of White MTA (Ângelus, Brazil), associated with distilled water or endodontic sealer AH Plus (Dentsply Maillefer, Ballaigues, Switzerland) when used as retrofilling materials.

Methods

Selection and distribution of specimens

This research was submitted to the Research Ethics Committee of the Ceará Dentistry Academy and approved under report number 03/09. Forty-four maxillary and mandibular molars, extracted for reasons other than the research were selected. They remained submersed in 0.01% thymol solution for 15 days, and were then used in the experimental stage. These teeth had their palatine or distal roots sectioned with a carborundum disk coupled to a handpiece, under constant irrigation with physiological solution. Next the roots were radiographed in the mesio-distal direction, to verify the presence of only one canal.

Forty-four roots were randomly distributed into 2 experimental groups (n=12 each) and 2 control groups (positive and negative (n=10 each) according to the retrofilling material used, Group I being: MTA powder (Ângelus, Londrina, Brazil) added to distilled water following the manufacturer's recommendation; Group II: MTA Ângelus powder added to endodontic sealer AH Plus to obtain a homogeneous mixture with similar consistency to the conventional mixture of MTA (Dentsply, Maillefer, Ballaigues, Switzerland); Group III: positive control, in which no retrofilling was performed, and Group IV: negative control, in which the teeth were completely covered with a sealing layer.

Preparation of specimens

All the roots were instrumented up to apical limit by the step technique with three withdrawals programmed at 1 mm each, using type K files, with type K #55 being the memory instrument (Dentsply, Maillefer, Ballaigues, Switzerland). Irrigation was performed with 2 ml of 2.5% sodium hypochlorite at every change of instrument. The root canals were dried with absorbent paper cones (Dentsply, Maillefer, Ballaigues, Switzerland) and filled to the limit of debridement with gutta-percha cones #55 (Dentsply, Maillefer, Ballaigues, Switzerland) and zinc-eugenol oxide-based filling sealer (Endofill, Dentsply, Maillefer, Ballaigues, Switzerland), using Tagger's hybrid technique.

Immediately after filling, the root apexes were removed with a Zecrya bur (Dentsply, Maillefer, Ballaigues, Switzerland) at high speed with abundant irrigation of physiological solution, 3 mm short of the apex and with angulation at 90º to the long axis of the root. Afterwards, Class II type retro-preparations were made with a retrotip 6.1107-5 (CVDentus, S. José dos Campos, Brazil) coupled to the ultrasound appliance (Jet Sonic Plus, Gnatus, Ribeirão Preto, Brazil). These retro-preparations were 3 mm deep and the diameter corresponded to the active tip of the ultrasonic instrument (Figure 1).

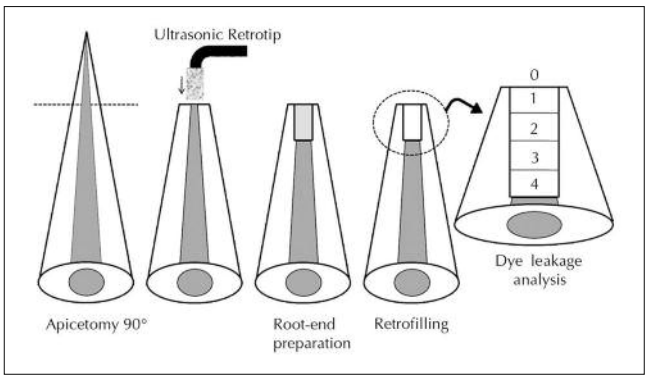


Figure 1. Methodology of the retro-preparations

After this, the retro-preparations were dried with absorbent paper cones (Dentsply, Maillefer, Ballaigues, Switzerland) and then retrofilled in accordance with the materials proposed for each group. In Group I a homogeneous mixture of white MTA powder (Ângelus, Londrina, Brazil) and distilled water was used, according to the manufacturer's recommendations. In Group II white MTA powder (Ângelus, Londrina, Brazil) was associated with the endodontic sealer AH Plus (Dentsply, Maillefer, Ballaigues, Switzerland) in order to obtain a homogeneous mixture with similar consistency to that of the conventional MTA mixture.

The next step was to seal the entire external surface of the root, by covering it with two layers of nail varnish. Care was taken not to allow the sealing material to cover the apical dentin surface exposed by apicectomy, with exception of the specimens in Group IV (negative control). The teeth were then immersed in Indian ink (Acrilex, São Bernardo do Campo, Brazil) and were kept in an oven at 37°C for 72 hours.

Analysis of specimens

After this period, the roots were washed under running water for 24 hours, and the root apical portion was worn longitudinally with carborundum disks, in the vestibular-palatine direction, until the root canal and the retrofilled cavity were exposed.

All the roots were scanned and analyzed by the software Image Tool, and the leakage measurements on the vestibular and palatine faces were noted in millimeters. The leakage measurements were transformed into scores (0 to 4), according to the percentage of dye leakage at the dentin/retrofilling material interface (Table 1).

Table 1 – Scores adopted according to marginal leakage

Score	Marginal leakage
0	0%
1	> 0% e ≤ 25%
2	> 25% e ≤ 50%
3	> 50% e ≤ 75%
4	> 75% e ≤ 100%

Statistical analysis

From the scores obtained, it was verified that there was no pattern of normality among the groups, using the software GraphPad. The Mann-Whitney test was used, with $p < 0.05$ being considered statistically significant.

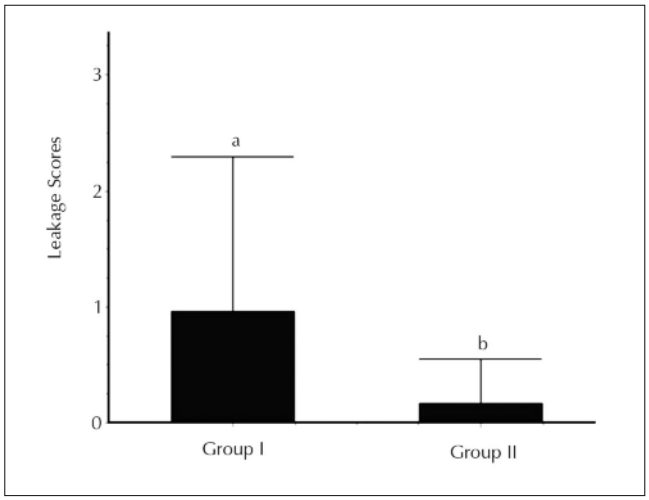
Results

With regard to the retrofilling material, there was leakage in two experimental groups, however, Group I (MTA/distilled water) showed a larger number of specimens with marginal leakage and deeper leakages than that in Group II (MTA/AH Plus). In Group I the presence of nine specimens with one of the faces showing marginal leakage was observed, but three specimens showed leakage on both faces. Whereas in Group II, it was verified that only four specimens showed leakage of dye at the tooth/retrofilling material interface, however, neither of the specimens showed leakage on the vestibular and palatine faces simultaneously.

It was also verified that the positive and negative control groups presented maximum and minimum leakage, respectively, in all the specimens.

It was verified that the proposed association between MTA and AH Plus endodontic sealer presented adequate sealing capacity, since there were a larger proportion of specimens with faces without apical leakage in Group II, when compared with specimens from Group I.

When submitted to Mann-Whitney analysis, only taking into account the experimental groups, the apical sealing of Group II was better than Group I, considered statistically significant ($p<0.05$) (Graph 1).



Graph 1. Comparison of marginal leakage between experimental groups, according to Mann-Whitney statistical analysis. Different letters (a or b) indicate a significant difference (p<0,05)

Discussion

The sealing capacity of filling materials is normally assessed by means of marginal leakage via apical or coronal tests. Several methods are used to assess this: use of bacteria, chemical and radioactive markers, electrochemical studies, scanning electronic microscopy, dye penetration and more recently, fluid filtration and glucose penetration[15].

The dye penetration method is still a widely used technique, particularly because it is low cost, easy to use, does not need sophisticated equipment, and mainly due to good visualization of the dye penetration at the dentin/material interface. Several dyes have been used, with emphasis on methylene blue, rhodamine B and Indian ink. The greatest disadvantage of this method is the need for diaphanization or performing transversal or longitudinal sectioning in order to visualize the possible leakages, making the specimens unfeasible for further analysis[15].

When the methylene blue dye comes into contact with MTA it undergoes discoloration, since it is unstable in the presence of the alkalinity of calcium. Therefore, when the calcium oxide contained in MTA comes into contact with water, it forms calcium hydroxide that discolors the methylene blue, which may lead to false results. The use of rhodamine B or Indian ink is indicated to evaluate leakages when the material examined is MTA[16]. In this study, the dye used was Indian ink, as used in others researches[17].

The results of this study show a greater effectiveness of the association of MTA/AH Plus endodontic sealer. This is probably due to the adequate sealing capacity of MTA added to the bonding properties to the dentin structure of AH Plus sealer. It was also observed that this association was more easily inserted and condensed inside the retrograde cavity, which allows less extravasation of the material into the surgical recess.

Mineral trioxide aggregate used according to the manufacturer's recommendations, adapts to the dentin walls and needs less condensation force; the presence of a dry field is not essential and contact of the material with humidity serves as stimulus for initiating the chemical reactions of hardening[18]. The sealing capacity of MTA may be related to its hydrophilic nature and the fact that this material undergoes a little expansion when it is in a humid environment[6,10]. It has high sealing capacity in comparison with other retrofilling materials, such as Super EBA and IRM[18] and high success rate in clinical studies[19].

Using the dye leakage methodology, MTA obtained better results than Sealapex sealer associated with zinc oxide[20] and when compared with IRM and Super EBA restorations[21]. On the other hand, when compared with substances with bonding capacity to dentin, such as resinous and ionomeric materials, MTA showed less sealing capacity[20,22], probably being the main reason for the results in this study.

The AH Plus sealer shows adequate biocompatibility in the periapical regions (14), bonding to dentin walls, diminishing apical leakage and it has antimicrobial activity, particularly against *Enterococcus faecalis* and *Candida albicans*[23].

Conclusion

One may conclude that the association MTA/AH Plus showed less marginal leakage, with statistical significance, when compared with MTA. MTA is an adequate retrofilling material, particularly because it has several physical-chemical-biological properties that are superior to those of the other materials used for this purpose. Several studies have been performed in order to confirm the results of this research, in addition to consolidating the clinical use of the proposed association between MTA and AH Plus endodontic sealer.

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Corresponding author:

Dr. George Táccio de Miranda Candeiro
Av. Desemb. Moreira, 2400 – apto. 603B – Dionísio Torres
Fortaleza-CE, CEP 60170-241
Brazil

E-mail: georgecandeiro@hotmail.com

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