EFFECT OF CALCIUM HYDROXIDE-BASED DRESSING ON APICAL SEALING IN IMMATURE TEETH FILLED WITH MTA

Efeito da medicação à base de hidróxido de cálcio no selamento apical de dentes imaturos obturados com MTA

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Abstract

OBJECTIVES: To evaluate the effects of a calcium hydroxide-based intracanal dressing on the initial apical adaptation and leakage of fillings performed with mineral trioxide aggregate (MTA) in teeth with open apices. STUDY DESIGN: A total of 24 canals were manually prepared and randomly divided into two groups (n = 12). In the experimental group, root canals were dressed with calcium hydroxide-based paste for 21 days; in the control group, no medication was applied prior to the filling of root canals with mineral trioxide aggregate. Apical sealing was evaluated on the basis of rhodamine B penetration and the detection of microscopic apical defects at the filling interface (SEM). The data obtained were compared by means of t and Fisher’s Exact tests (α = 0.05). RESULTS: The difference in mean dye leakage between the experimental (5.03±1.97 mm) and control (4.14±1.13 mm) groups was not statistically significant (p < 0.05). The number of microscopic fissures at the experimental group interface (2/12) was significantly lower than that observed for the control group (9/12) (p < 0.05). CONCLUSIONS: The use of a calcium hydroxide-based intracanal dressing did not interfere with the initial apical sealing of immature teeth filled with MTA.

Keywords: Calcium hydroxide. Mineral trioxide aggregate. MTA: Root canal apexification.
INTRODUCTION

Successful treatment of immature pulpless teeth requires special manoeuvres for adequate debridement and sealing of the typically thin and divergent root canal walls. Historically, long-term calcium hydroxide dressings have been applied to provide additional disinfection and induce the formation of a mineralised barrier in the apex of immature teeth, so that condensation of gutta-percha in the canal can be properly achieved (1).

In contrast to traditional gutta-percha, mineral trioxide aggregate (MTA) is a powder that hardens and releases calcium ions in the presence of moisture. It is thus able to seal the root canal (2-4) and concomitantly induce apical hard tissue deposition (5, 6). For these reasons, MTA is currently the material of choice for one-visit apexification because it minimises the deleterious risks involved in Ca(OH)$_2$ multiple appointment therapy (e.g., coronal leakage and tooth fracture) (7-10).

To improve the bacteriostatic and biological performance of MTA in the root canal, a calcium hydroxide dressing is usually advocated prior to the filling (5, 6). When this procedure is performed before root canal filling with gutta-percha and sealer, however, it has been shown contradictorily to both improve (11-12) and impair (13) the quality of sealing. Considering the scarcity of evidence clarifying this issue and the increasing use of mineral trioxide aggregates for the obturation of immature teeth, this laboratory study sought to determine whether prior calcium hydroxide-based dressing affects apical adaptation and sealing due to obturation of an open apex tooth via MTA.

MATERIALS AND METHODS

Specimen preparation

This research was approved by the local ethics committee, which is in accordance with the Declaration of Helsinki (DoH). A total of 24 mandible immature third molar teeth were selected according to the following inclusion criteria: the mesial root was straight or slightly curved and 8±3 mm long, the tooth exhibited only one canal, and the apex was open. After surgical extraction, the teeth were kept into 0.5% thymol solution until use.

The mesial root of each tooth was cut from the remaining structure, and the canal was initially instrumented with Gates Glidden burs no. 4,3,2 and 1 (Denstply Maillefer™, Tulsa, OK, USA) in a crown-down manner until the no. 1 size bur could pass through the apical foramen. Root canal length was assessed by placing a size 50 K file (Dentsply-Maillefer, Ballaigues, Switzerland) inside each canal, until the tip perforated through the apical foramen. The instrument was withdrawn 1mm to record the working length, and canals were then sequentially enlarged with K-type files (Denstply Maillefer,
Ballaigues, Switzerland) to size 100. Irrigation with 5 ml of 1% sodium hypochlorite (Biodinâmica™, Ib�orã, PR, Brazil) was used throughout instrumentation, and this was followed by 3 minutes of irrigation with 17% EDTA (Biodinâmica, Ib�orã, PR, Brazil) and a final flush with 3 ml of distilled water, before drying with sterile no. 80 paper points (Tanari®, Manacapuru, AM, Brazil).

The roots were then double-coated with a layer of epoxy-based adhesive (Araldite™, Brascola, Joinville, SC, Brazil) and a layer of a nail varnish (except for the apical 1 mm). After drying, specimens were placed into saline-soaked sponges (Scothbrite™, 3M do Brasil, Sumaré, SP, Brazil) to simulate a moisturised periapical environment.

The experimental group was formed with 12 randomly chosen roots that were filled with a paste composed of Ca(OH)2 (Inodon™, Porto Alegre, RS, Brazil) with 25% iodoform by weight (Inodon, Porto Alegre, RS). The powder was mixed with propylene glycol (Synth™, Diadema, SP, Brazil) in a powder-to-liquid ratio of 3:1. The paste was inserted using a lentulo spiral carrier (Dentsply Maillefer, Ballaigues, Switzerland) in a slow-speed handpiece, and completeness of filling was checked with the aid of radiographs. The roots were then sealed with Cimpat (Septodont™, Saint-Maur-des-Fossés, Cedex, France) and stored at 37°C and 100% humidity for 21 days. In the control group, the root canals were instrumented but not dressed.

Following the removal of experimental group dressings by irrigation with 1% NaOCl and reaming with a size 100 k-type file, root canals from both the control and experimental groups were then filled with mineral trioxide aggregate (MTA, Ângelus™, Londrina, PR, Brazil). For this procedure, a small amount of MTA was picked up with a number 50 spatula (SSWhite Duflex™, Rio de Janeiro, RJ, Brazil) and delivered into the canal with a lentulo spiral (initially set at 2.0 mm from the established working length). The back of a n. 80 paper point was then used to condense the material in the apical third of each canal. Thereafter, the MTA inserted into the middle and coronal parts of the canal were gently packed with a Paiva n. 3 plugger until the filling, confirmed with radiographic analysis, was complete.

Immediately, the apical 4 mm of each root were placed inside a flask containing 1 ml of 0.2% rhodamine buffered solution (Merck™, Darmstadt, Germany), and the set was incubated at 37°C during the 4 hours necessary for MTA hardening. Later, specimens were washed with running water for 60 minutes to remove excess ink before being left to dehydrate at room temperature (25±3°C) for 72 hours.

The dry specimens were coated with 300 µm of gold and observed under a scanning electron microscope (Jeol/JSM-T220A™, Tokyo, Japan). The apex of each root was examined at 150 X original magnification, and the obtained images from the MTA/dentin interface were randomly assessed by an examiner for the presence of any defect (e.g., cracks or fissures).

Afterwards, the roots were sectioned longitudinally, and the two resulting halves were serially digitalised near a slide caliper (727 Starrett™, Mount Airy, NC, USA) using a professional photo-camera (D70, Nikon™, Tokyo, Japan) with a 105 mm micro-lens (Nikkor, Nikon™, Tokyo, Japan). Obtained images were imported into open source software (Image Tool v. 3.0™ for Windows, UTHSCSA, San Antonio, TX, USA). The leakage extent was evaluated from the apical root end of each hemisection to the most coronal extent of dye penetration by one blinded examiner. A digital caliper set at 1 mm was used as a standard reference for measurements.

Data obtained from dye penetration were statistically compared by means of the t-test, whereas categorical differences in the number of fillings with apical microscopic defects for each group were determined using Fisher’s Exact test. Both tests were adjusted to the 95% significance level and were performed with SPSS software (SPSS v.11 ∙ 0 for Windows™, Chicago, IL, USA).

RESULTS

The experimental group demonstrated apical dye penetration of 5.03±1.97 mm, which was not significantly different from the 4.14±1.13 mm detected for the control group (p < 0.05).

The number of fillings with defects in the apical interface was significantly lower in the experimental (2/12) than control (9/12) group (p < 0.05). Representative micrographs are presented in Figures 1, 2.
methods was applied: scanning electron microscopy and examination of dye leakage.

The apical leakage detected for MTA fillings dressed with calcium hydroxide paste was not significantly lower than that in fillings not dressed, a result already reported in other investigations (14, 16) but in contrast to results observed for gutta-percha fillings (11, 12). This inconsistency may be explained simply by the decolourisation that methylene blue dye, adopted in those studies, suffers in the presence of hydroxide (17, 18). Thus, it may have produced apparently lower levels of dye leakage.

Furthermore, in those studies that adopted Indian ink as a tracer, calcium hydroxide-medicated roots filled with gutta-percha showed significantly more leakage than non-medicated roots (13). Calcium hydroxide does not interfere with rhodamine labelling. Since iodoform and propylene glycol were also present in the dressing compound, however, their potential to neutralise the potency of the rhodamine tracer should not be ignored.

To justify the expressive leakage in the experimental group, we suggest that complete removal of the calcium hydroxide intracanal dressing was not possible using only a file and alternating irrigation (19), as performed in this experiment. It is possible that paste remnants may have acted as mechanical obstacles to MTA and generated spaces at the filling interface, at which tissue fluids could leak via dissolution (13, 16).

Another possible explanation for the statistical equivalence in leakage levels between groups resides in the methodological procedures employed. The adhesion between mineral trioxide aggregate and dentin after physical contact occurs in a slow and progressive way (20, 21). In contrast to similar studies in which MTA samples were left to set for as much as 168 h before dye immersion (2, 4, 14, 16), this research sought to reproduce the actual clinical situation in which wound exudates might be present on periodontal tissues. In this research, therefore, roots were filled and immediately placed into the dye tracer solution so that the initial adhesion between MTA and the root canal walls could take place under a completely wet environment. These conditions may have permitted deep penetration of rhodamine, especially in the control group.

Independently of prior dressing with calcium hydroxide-based pastes, we reinforce the

**DISCUSSION**

In contrast to studies using mature teeth to simulate open apices (2, 4, 14-16), this investigation evaluated the sealing ability of MTA for extracted immature teeth. In these teeth, natural features add realistic value to this research. Since there is no current standard protocol for evaluating the sealing ability of teeth with divergent apices, a combination of
recommendations of other authors suggesting that one-session MTA apexification with at least 5 millimetres of apical filling thickness should provide an adequate seal against leakage (4, 22, 23).

Given the lower number of apical microscopic deficiencies detected in the experimental group, a subsequent reduction in dye leakage was expected to occur; however, this was not noticed. To explain this finding, we suggest that deficiencies were in fact not detected by SEM because they were filled with paste remnants unable to prevent dye penetration. In addition, the cracks and fissures present in both groups were more likely related to the manual placement of MTA (15, 23) than the presence of calcium hydroxide paste residue at the moment of filling. Although sample dehydration was conducted without heating, prior to gold coverage for scanning microscopic analysis, the interference of inherent artefacts (surface cracks or enlargement of interface fissures) should be taken into account upon quality assessment. Thus, when investigating the adaptation of MTA fillings, methods that do not require dehydration for sample analysis are preferred.

The leakage and adaptation defects detected during setting in this experiment do not necessarily conflict with the remarkable sealing behaviour of MTA (2, 14-16, 20, 23). In a recent study, it was observed that the seal of an MTA orthograde apical plug improved after specimens were immersed in phosphate buffered saline for 4 weeks (20). When immersed in saline, mineral trioxide aggregate spontaneously precipitates carbonate apatite (21). Thus, it is hypothesised that greater amounts of this precipitate could form an interfacial layer at the cement-dentin interface that might be able to minimise leakage (21). If this theory is confirmed, this property could compensate for the undesirable deficiencies generated during insertion, compaction and hardening of this material inside root canals.

To date, the effects of calcium hydroxide dressings on the biological performance of MTA have not been scientifically proved. When intracanal medication is performed, more efficient ways to remove the paste or insert and condense MTA into root canals (the incorporation of ultrasonic streaming) offer valid methods for improving the sealing ability of MTA fillings applied for one-appointment apexification (21-24).

**CONCLUSIONS**

The use of calcium hydroxide-based paste as an intracanal dressing did not interfere with the initial apical sealing of immature teeth filled with mineral trioxide aggregate.

**REFERENCES**


