SEALING ABILITY OF MTA USED AS CERVICAL BARRIER IN INTRACORONAL BLEACHING

Manoel Brito-Júnior[1], André L. Faria-e-Silva[1], Bráulio Fonseca[2], Carla C. Camilo[1]

[1]Department of Dentistry, Dental School, State University of Montes Claros, Minas Gerais, Brazil.
[2]Brazilian Association of Dentistry, Montes Claros, Minas Gerais, Brazil.

ABSTRACT

The aim of this study was to compare the sealing ability of white mineral trioxide aggregate (MTA) with that of other materials used as a cervical barrier during intracoronal bleaching. Thirty eight extracted teeth were endodontically treated and 3 mm of filling was removed to receive the barrier material: G1– Coltosol; G2 – Vidrion R; G3 – White MTA; G4–No barrier (negative control) and G5– Roots totally protected with three layers of cyanoacrylate (positive control). The 30% hydrogen peroxide associated with the sodium perborate was left in the pulp chamber for 24 h. The specimens were immersed in a test tube containing a solution of potassium chromate (yellow), which turns blue in the presence of hydrogen peroxide. Two calibrated evaluators scored according to color in the presence of the detecting solution (0 – unaltered color, 1 – light blue and 2 – dark blue). Data were analyzed by the Kruskall-Wallis test (p<0.05). The results showed no statistically significant differences between the experimental group G3 and positive control (G5). No statistically significant difference was observed between G1 and G3. However, a statistical difference was verified between G2 and G3. MTA presented higher sealing ability than Vidrion R and did not differ from the positive control. However, there was no difference between MTA and Coltosol.

Key words: intracoronal bleaching, hydrogen peroxide, mineral trioxide aggregate.

CAPACIDADE DE SELAMENTO DO MTA USADO COMO BARREIRA CERVICAL EM CLAREAMENTO INTRACORONÁRIO

RESUMO

O objetivo deste estudo foi comparar a capacidade de selamento do agregado trióxido mineral (MTA) branco com outros materiais usados como barreiras cervicais durante clareamento intra-coronário. Trinta e oito dentes extraídos foram endodonticamente tratados e 3 mm de obturação foi removida para receber o material da barreira: G1– Coltosol; G2 – Vidrion R; G3 – MTA branco; G4–Nenhuma barreira (controle negativo) e G5– Raízes totalmente protegidas com três camadas de cianocrilato (controle positivo). Peróxido de hidrogênio a 30% (PH) associado com perborato de sódio foi deixado na câmara pulpar por 24 h. As amostras foram imersas em tubos de ensaio contendo uma solução de cromato de potássio (amarela) que se torna azul na presença de peróxido de hidrogênio. Dois avaliadores calibrados atribuíram escores de acordo com a cor obtida na solução detectora (0 – cor inalterada, 1 – azul claro e 2 – azul escuro). Os dados foram analisados pelo teste de Kruskall-Wallis (p<0,05). Os resultados não mostraram diferenças estatisticamente significantes entre o grupo experimental G3 e o controle positivo (G5). Nenhuma diferença estatisticamente significante foi observada entre G1 e G3. Entretanto, diferença estatística foi verificada entre G2 e G3. MTA apresentou maior habilidade de selamento que o Vidrion R e não diferiu do controle positivo. Entretanto, não houve diferença entre MTA e Cotosol.

Palavras chave: clareamento intra-coronário, peróxido de hidrogênio, agregado trióxido mineral.

INTRODUCTION

Endodontically treated teeth frequently present discoloration resulting from trauma, incomplete removal of pulp tissue or iatrogenic procedures. The main technique used to solve this esthetic problem is intracoronal bleaching. For this procedure, a pioneer study recommended the use of hydrogen peroxide associated with heat[1]. Later, a technique that uses sodium perborate and distilled water was described[2]. Sodium perborate can also be associated with 30% hydrogen peroxide in a technique referred to as walking bleaching[3]. The rationale behind the use of peroxide and perborate is that these composites generate oxygen after their dissociation. The oxygen diffuses through the dentin and oxidizes the pigments responsible for altering the color of teeth, resulting in their oxidative bleaching[4].

However, external cervical root resorption has commonly been associated with intracoronal bleaching[5]. The passage of bleaching agents into the periodontal space through defects at the cementoenamel junction (CEJ) is the main factor related to this resorption[6]. The exact mechanisms by which bleaching agents leak into the periodontal tissues and initiate the resorptive process are not fully understood. Several studies have shown that hydrogen peroxide induces pH changes and generates hydroxyl radicals that can degrade connective tissue components[7-10]. Based on this theory, a barrier placed between the endodontic filling material and the pulp chamber may avoid the passage of the bleaching agent through the CEJ, making it difficult for external cervical root resorption to develop[11].

Glass ionomer, zinc phosphate and zinc oxide based cements[12,13], as well as resin composite[14] have been used as barriers during the intracoronal bleaching procedure, presenting relatively satisfactory results. The pivotal feature of a protective base material for use as a barrier must be adequate sealing ability. The mineral trioxide aggregate (MTA) is a material recently made available to dentistry with excellent sealing properties. This material was first reported in 1993 for use in repairing lateral root perforations[15]. MTA, a powder consisting of fine hydrophilic particles that form a colloidal gel in the presence of water, solidifies into hard cement within approximately 4 hours. In addition to the satisfactory mechanical properties, the setting expansion improves its sealing capacity and helps to prevent leakage[15].

Thus, the aim of this study was to evaluate the sealing ability of cervical barriers made with MTA and to compare it with barriers made with other traditional materials. The null hypothesis was that there is no difference between the evaluated materials in terms of avoiding the passage of hydrogen peroxide from the pulp chamber to the external root surface.

MATERIALS AND METHODS

Sample selection and preparation

Thirty-eight extracted human maxillary incisors and canines, without endodontic treatment and with well-preserved coronal and radicular structures, were selected for this study. The selection criteria were: uniradicular teeth without pronounced flattening, straight roots, with a single root canal.

Coronal access was initially performed with a #1557 tapered carbide bur (S.S. White Dental products, Rio de Janeiro, RJ, Brazil) at high speed, followed by cavity wall finishing with an Endo-Z bur (Dentsply/Maillefer Instruments, Ballaigues, Switzerland). The root canals were prepared using a crown-down technique with a #50 K-file (Dentsply/Maillefer) as the master apical file. The root canals were irrigated with a 1% sodium hypochlorite solution (Biodinâmica Produtos Químicos Ltda, Ibiporã, PR, Brazil) between the application of each instrument, followed by smear layer removal using a 14.3% EDTA solution (pH 7.4; Odahcam-Herpo Produtos Dentários, Petrópolis, RJ, Brazil) for 3 minutes and further irrigation with 10 ml distilled water. The root canals were aspirated using metal suction tips and dried with paper points. Sequentially, the root canals were filled with gutta-percha cones and Sealer 26 cement (Dentsply, Petrópolis, RJ, Brazil) using the lateral condensation technique.

Artificial defects were then made along the CEJ. Holes were also made in the incisal portion of each tooth, to enable fixation in assay tubes. For both procedures, a #1 spherical drill at high speed was used. The root canal was sealed with zinc oxide and zinc sulphate hydrated temporary cement (Coltosol, Vigodent, Rio de Janeiro, RJ, Brazil). The specimens were stored at 37ºC and 100% humidity, for a period of one week.

Cervical barriers

The temporary cement, as well as the cervical portion of the filling were removed 3 mm below CEJ with a heated Paiva condenser. For this, the external cervical region was demarcated on the buccal, palatine, mesial and distal surfaces. The distance from the incisal reference point to the outline was measured using a Paiva condenser with a cursor and the measurements were recorded individually using a millimetric ruler. The teeth then received 3 mm of barrier material as follows (n = 8): G1– zinc oxide/ zinc sulphate hydrated temporary cement Coltosol (Vigodent); G2 – conventional glass ionomer cement Vidrion R (SSWhite, Rio de Janeiro, RJ, Brazil) and G3 – white MTA (Angelus, Londrina, PR, Brazil).

After one week, the external root surface was protected with three layers of cyanoacrylate (SuperBonder®, Loctite, Itapeva, SP, Brazil), with exception of the previously demarcated cervical region. The teeth in the negative control group (G4) received no barrier material; the teeth in the positive control group (G5) had their roots completely

protected with three layers of cyanoacrylate (SuperBonder®). A mixture of sodium perborate and hydrogen peroxide 30% was placed inside the pulp chamber for 24 h. The access opening was sealed with wax and made impermeable with cyanoacrylate as described above.

Sealing ability of cervical barriers

To verify the sealing ability of cervical barriers, a chemical method described in a previous study was used[16]. The incisal faces of teeth were fixed perpendicular to the axis with metal wire that was passed through the holes previously drilled in the specimens. They were then put into test tubes containing a potassium chromate solution (yellow), which turns blue in the presence of HP. Two calibrated evaluators scored according to color in the presence of the detecting solution (0 – unaltered color, 1 – light blue and 2 – dark blue), after 24 h. The solution was composed of 50ml of deionized distilled water; 10 drops of sulfuric acid 10N; 2 ml of a 10% potassium chromate solution and 2 ml of sulfuric ether[16].

Statistical analysis

The Kendall coefficient was used to verify inter-evaluator agreement. The scores were submitted to the Kruskall-Wallis non-parametric tests ($p<0.05$), using the statistical program SPSS 11.0.

RESULTS

The Kendall coefficient demonstrated a high level of inter-evaluator agreement (0.0936). Color changes in the presence of the detecting solution are described in Table 1. The negative control presented color change in the detecting solution with scores 2 for all specimens, while there was no color alteration for the positive control. In the experimental groups, none of the materials were able to seal the root canal entrance in any of the specimens. The MTA presented better sealing ability than Vidrion R ($p=0.009$). Coltosol presented intermediate values that did not differ from those of the other evaluated barriers. There was no statistical difference between MTA and the positive control ($p=0.361$).

Table 1: Results for color alteration of detecting solution.

Groups	*Medians*	*Means*	
Negative control	2.00	2.00	A
Vidrion R	1.00	1.19	B
Coltosol	0.75	0.69	BC
MTA	0.00	0.25	CD
Positive control	0.00	0.00	D

Different letters indicate statistical difference by Kruskall-Wallis test at the 95% confidence level

DISCUSSION

There has been an increasing demand for esthetic treatment over the last few years. The internal bleaching procedure has been widely used because it is efficient, relatively simply and low cost when compared with prosthetic treatments. However, this treatment does involve some disadvantages. The most serious and studied problem reported has been external resorption. Considering that the leakage of bleaching agents through dentin may be a possible etiological factor in the initiation of an inflammatory process in periodontal tissues followed by cervical root resorption[7-11], the placement of a cervical barrier before performing internal dental bleaching procedures is recommended[11-13,17]. The isolating barrier material is used to prevent the passage of peroxides from the pulp chamber into the periodontal ligament. This passage occurs through dentinal tubules where there are defects at the CEJ[12], allowing communication between the dentine and the periodontal space.

In the present study, the MTA presented less peroxide diffusion than the glass ionomer. Thus, the null hypothesis was rejected. The sealing ability of cervical bleach barriers has been tested by several methods. A previous investigation measured the leakage over a period of 5 days inside the dentinal tubules and along the root canal filling through glass-ionomer cement cervical bases using blue India Ink[13]. Other studies used a cervical glass ionomer barrier and quantitatively evaluated the cervical dentin permeability by copper ion penetration[18,19]. Experimental models that used methylene blue dye penetration [20] and microbial leakage [21] can also be found in the literature. In the present study a simple and useful method based on chemical color alteration was used to verify the extraradicular diffusion of hydrogen peroxide after placement of different base cements over the root-filling 3 mm below the CEJ. This chemical method was first described by Pecora et al.[22], who demonstrated the passage of hydrogen peroxide through cervical

dentin tubules, reaching the external radicular surface in teeth lacking cervical base material. In the present experiment, a scoring system was added to this method to allow for a quantitative analysis of bleaching agent leakage. For this purpose, the evaluators were previously calibrated and a high level of agreement among them was found. Thus, despite the subjective analysis, the scoring system used to quantify the color change in the presence of the detecting solution allowed for a reliable comparison of the effectiveness of different materials as cervical bleach barriers.

Despite the popularity of internal bleaching, there continues to be controversy regarding the choice of material to be used as a cervical barrier. Glass ionomer and zinc phosphate cements have frequently been used in several studies[12,13,17-21]. However, zinc phosphate has been shown to have poor sealing capacity [23]. In other studies, glass ionomer was also shown to be incapable of completely preventing peroxide diffusion through the CEJ, but it significantly reduced this diffusion[13,21]. Similar results were found in the present study. The inability of glass ionomer to prevent peroxide diffusion may be explained by its low bond strength to dentin and high solubility[24]. In addition to its low bond strength, it is difficult to manipulate glass ionomer, making it difficult to insert this cement. These difficulties may result in the incorporation of bubbles and other defects during insertion, creating space for the diffusion of peroxides.

Few studies have evaluated Coltosol and MTA as cervical barriers during internal bleaching[25,26], and compared them with glass ionomer. Vasconcellos et al.[25] verified that Coltosol presented significantly lower leakage values than glass ionomer cements. However, in the present study there was no difference between these two materials. Differently from those studies, in the present study, the occurrence of leakage was evaluated by color changes in the detecting solution in the presence of peroxide rather than with staining solutions. Thus, the differences in methodology may explain the different results. Barrieshi-Nusair and Hammad[26] demonstrated that MTA allowed less leakage than glass ionomer cement. In the present study MTA also presented a better performance, without differing statistically from the positive control.

Indeed, at present MTA is the most suitable sealing material used in endodontics. One possible reason for the sealing ability of MTA is its expansion upon setting[27]. However, it is important to emphasize that MTA did not differ from Coltosol, which also presents slight expansion upon setting[28]. MTA is presented in the form of a white or gray powder. Following preparation in distilled water, it acquires appropriate physical and chemical properties, including good sealing ability[14,15]. However, MTA has hardly been investigated as a cervical bleach barrier, possibly due to the commercial predominance of its gray formulation first available commercially, which could cause obvious esthetic problems. However, with the introduction of white MTA this problem has been minimized and its sealing ability has not been altered[15]. The results of the present study showed that a type of commercially available white MTA presented adequate sealing in the cervical area of teeth submitted to internal bleaching. In summary, within the limitations of this laboratory study it was possible to observe that white MTA could be a promising alternative as a cervical bleach barrier.

CORRESPONDENCE
André Luis Faria-e-Silva,
Universidade Estadual de Montes Claros,
Campus Universitário Professor Darcy Ribeiro -
Vila Mauricéia, Montes Claros, Caixa Postal 126.
CEP 39401-089 MG – Brasil
e-mail: (andrelfsilva@hotmail.com)

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