EVALUATION OF SEALING ABILITY OF THREE MATERIALS USED AS BARRIERS OVER THE REMAINING FILLING MATERIAL AFTER POST SPACE PREPARATION

Lorena V. Souza[1], André L. Faria-e-Silva[1], Giulliana P. Soares[2], Flávio H. Aguiar[2], Maria A Ribeiro[1]

[1] *Department of Dentistry, Federal University of Sergipe, Aracaju, SE, Brazil.*

[2] *Department of Restorative Dentistry, Piracicaba Dental School, State University of Campinas, Piracicaba, SP, Brazil.*

ABSTRACT

The filling material remaining after post space preparation may not be enough to prevent the contamination of periapical tissues when the root canal is exposed to saliva. Thus, the purpose of this study was to evaluate leakage through three different materials used as barriers over the remaining filling. Thirty-two human premolars were selected for this study. Following the endodontic treatment, post spaces were prepared, leaving 4 mm of filling material. A barrier 1 mm high was placed over the filling material using Cotosol, VitoFil or MTA (n=8). Absence of barrier was used as control. The specimens were immersed in 2% methylene blue dye for 12 hours, after which they were sectioned immediately below the barriers and the apical portions were ground into powder in a mill for hard tissues. The powder was immersed in absolute alcohol to dilute the dye and then the dye concentration was analyzed using an absorbance spectrophotometer. Dye concentration was classified according to scores from 0 to 4, and the scores were submitted to Kruskal-Wallis and Tukey's post-hoc tests (α = 0.05). Only Cotosol and MTA reduced the leakage when compared to control. Vitrofil showed leakage values similar to both MTA and control, but higher than Cotosol. In conclusion, the material used as a barrier can have an effect on leakage through the remaining filling material.

Keywords: *Dental Leakage; Post and Core Technique; Mineral Trioxide Aggregate*

AVALIAÇÃO DA CAPACIDADE DE SELAMENTO DE TRÊS MATERIAIS USADOS COMO BARREIRA SOBRE O MATERIAL OBTURADOR REMANESCENTE APÓS PREPARO DO CANAL PARA RECEBER PINO

RESUMO

O material obturador remanescente após o preparo do canal para receber pino pode não ser suficiente para evitar a contaminação dos tecidos periapicais quando o canal radicular é exposto à saliva. Assim, o objetivo deste estudo foi avaliar quantitativamente a infiltração através de três diferentes materiais usados como barreira intra-orifício sobre a obturação remanescente. Trinta e dois pré-molares foram selecionados para este estudo. Seguindo o tratamento endodôntico, o espaço do pino foi preparado deixando 4-mm de material obturador. Uma barreira com 1 mm de altura foi colocada sobre o material obturador usando Coltosol, VitroFil ou MTA (n=8). Nenhuma barreira foi usada como controle. A seguir, as amostras foram imersas em 2% de azul de metileno por 12 horas. Após este tempo, os dentes foram seccionados imediatamente abaixo da barreira e a porção apical foi triturada em pó através de um moinho de tecido duro. O pó foi imerso em álcool absoluto para diluir o corante e então a concentração de corante foi analisada em um espectrômetro de absorbância. Dados de concentração de corante foram classificados em escores de 0 a 4, sendo que os escores foram submetidos ao testes de Kruskal-Walluy e de Tukey (α = 0,05). Apenas Cotosol e MTA reduziram a infiltração quando comparados ao controle. Vitrofil mostrou valores de infiltração similares tanto ao MTA quanto ao controle, mas maior que o Cotosol. Em conclusão, o material usado coo barreira pode influenciar na infiltração através do material obturador.

Palavras-chaves: *Infiltração dental; Técnica de pino e preenchimento; Agregado Trióxido Mineral.*

INTRODUCTION

The prevention of the dissemination of microorganisms throughout the root canal system and periapical tissues is essential for successful endodontic therapy [1,2]. Thus, the use of a rubber dam is essential during endodontic treatment in order to prevent the contamination of the root canal by microorganisms from the saliva. However, this contamination may occur after endodontic treatment during the restorative procedures, compromising the success of endodontic therapy. Usually, intra-radicular posts are used to restore endodontically treated teeth when their remaining coronal tissue can no longer provide adequate support and retention for the

restoration[3]. However, the preparation of the post space and the cementation of the retainer are often performed without the use of a rubber dam. In these situations, the root canal is exposed to microorganisms from the oral environment, increasing the risk of contamination of the root canal system and periapical tissues[4]. Furthermore, inadequate temporary restoration between the post pace preparation and its cementation may also enable contamination of the root canal system[5].

Considering that the remaining filling material after post space preparation may not be enough to provide a proper seal[6-10], several materials and techniques have been suggested for use as an additional barrier[11-14]. It has been demonstrated that the use of barriers decreases leakage through the remaining filling material[15-19]. Placing a barrier over the remaining filling material after post space preparation may prevent contamination during the procedure of intra-radicular post placement. Glass ionomer cement[17,18], zinc oxide/zinc sulfate hydrated cement[16] and mineral trioxide aggregate (MTA) [16] have been indicated for use as barriers. Thus, the aim of this study was to evaluate microleakage through a barrier made from one of three materials by using the passive dye penetration method. The hypotheses of this study were that (1) all materials used as barriers are able to reduce microleakage; and (2) there is no difference between the materials.

MATERIALS AND METHODS

Thirty-two human premolars with single root canal and stored in saline solution were used in this study. The crowns and coronal portion of root were removed to obtain a root remainder 15 mm long. A #10 K-file (Dentsply-Maillefer, Ballaigues, Switzerland) was inserted into the root canal until it could be seen at the apical foramen, to establish the patency length. The working length was determined to be 1 mm shorter than this measurement. The root canal was instrumented with ProTaper® rotary instruments (Dentsply-Maillefer) according to the manufacturer's instructions. S1 and SX files were used to prepare 2/3 of the more cervical region of root canal. Then S1, S2, F1, F2, and F3 files were employed up to the working length. Between each rotary file, the root canal was irrigated using a 27-gauge needle with 5% NaOCl. The prepared root canals were filled with gutta-percha cones and Sealer-26 resin sealer (Dentsply, Petrópolis, RJ, Brazil) using the lateral condensation technique. The filled roots were stored for at least 72 hours at 37°C to allow the resin sealer to set.

The post space was prepared by introducing Peeso reamers (#4) to a depth of 11 mm, leaving 4 mm of the filling material. A barrier 1 mm high was placed over the filling material using one of following materials (n = 8): Zinc oxide/zinc sulfate hydrated temporary cement - Coltosol (Vigodent, Rio de Janeiro, Brazil); Gray MTA (Angelus, Paraná, Brazil); and regular glass ionomer - VitroFil (DFL, Rio de Janeiro, Brazil). Eight other specimens were left without a barrier and used as control. All materials were used according to manufacturers' recommendations. VitroFil was inserted directly over the remaining gutta-percha using a Centrix syringe, while Coltosol and MTA were inserted with an endodontic plugger.

After 24 hours, the external root surface was protected with three layers of nail varnish. The specimens were then immersed in 2% methylene blue solution with pH 7.0 for 12 hours, after which they were rinsed in tap water and dried. The nail varnish was removed using a scalpel blade and varnish remover. The specimens were sectioned immediately below the barriers and the apical portion was weighed. Then the apical portion was ground into powder in a mill for hard tissues (Marconi Equip. Ltda., Piracicaba, Brazil). Each powdered specimen was weighed again and any samples having a difference greater than 10% between the initial and final weight were discarded.

Each powdered sample was individually immersed in a glass tube containing 4 ml of absolute alcohol (Merck, Darmstadt, Germany) for 12 hours in order to dilute the methylene blue. After this procedure, the solutions were centrifuged (Tomy, IC 15NA, Tomy Ind., Tokyo, Japan) at 3,000 rpm for 3 minutes. The supernatant was analyzed using an absorbance spectrophotometer (Beckman DU 65 – Instruments, Inc., Fullerton, CA, USA) adjusted at a wavelength of 668 nm. In order to determine the absorbance, the spectrophotometer was adjusted to an appropriate wavelength for methylene blue, corresponding to the maximum absorbency for the dye. To calibrate the spectrophotometer, the absorbance of standard solutions (0.1; 0.2; 0.3; 0.5; 1; 2; 4; 6 mg/ml) was determined at wavelengths ranging from 400 to 700 nm, and the maximum value was obtained at 668 nm. To estimate the dye concentra-

tion in the experimental samples, a linear regression was obtained. The regression equation is expressed as: y = 0.2716 x – 0.0075, where *y* is the absorbance and *x* the dye concentration. The microleakage of each specimen was expressed as µg of dye/ml.

The leakage of each sample was scored according to dye concentration: 0: ≤ 0.005 mg/ml; 1: > 0.005 and ≤ 0.01 mg/ml; 2: > 0.1 and ≤ 0.2 mg/ml; 3: > 0.2 and ≤ 0.4 mg/ml; and 4: > 0,4 mg/ml. Data were submitted to Kruskal-Wallis test followed by post-hoc test ($\alpha = 0.05$).

RESULTS

The Kruskal-Wallis test showed a significant effect of the treatment ($p < 0.001$). The results of Tukey's test are shown in Table 1. Cotosol had the lowest scores for microleakage, which differed statistically from glass ionomer and control. MTA had similar values for microleakage as Cotosol and glass ionomer, but lower than control. No difference was observed between the control and glass ionomer.

DISCUSSION

Contamination of periapical tissues by colonization of bacterial species may result in failure of the endodontic treatment[2,5-8]. The filling material in the apical region acts as the last barrier against possible leakage along the root canal, while the sealing ability of gutta-percha is proportional to its extension[7,8]. However, it has been recommended to insert longer portions of intra-radicular post into root canal in order to improve their retention and to reduce the risk of fracture[19,20]. A longer intra-radicular post reduces the length of filling material in the root canal and may compromise the sealing ability of the remaining filling material. Thus, the use of a barrier over the filling material can be important to prevent the contamination of periapical tissues.

Table 1: Medians (1st / 3rd quartiles) for microleakage scores.

Material used as barrier	Scores
Cotosol	0 (0/0) A
MTA	1 (0/2) AB
Glass ionomer	1.5 (1/2) BC
No barrier	3 (3/4) C

Different letter indicate significant differences (α =0.05).

This study showed that the use of a 1-mm barrier over the remaining filling material can reduce leakage across the apical seal. However, this leakage reduction depends on the material, while the glass ionomer showed similar values of leakage to control. Thus, the study hypotheses were rejected. The post space was prepared leaving 4mm of the gutta-percha. It has been suggested that 4 to 5 mm of remaining filling material are acceptable to promote apical seal[8]. However, using 1 mm of Cotosol or MTA over the gutta-percha created an additional barrier against dye penetration, reducing the leakage when compared to the control. These outcomes are in agreement with previous studies[15-18].

The sealing ability of Cotosol and MTA is related to their expansion upon setting[21-,23]. MTA is presented in the form of a white or gray powder that is mixed with a vehicle such distilled water. Cotosol is available as a paste that does not require any mixing procedure. The main disadvantages of these materials is that their setting time is longer than that of glass ionomer[24,25]. However, both materials showed proper performance when exposed to dye after 12 hours. Considering that this delay time is clinically acceptable, these materials are available for use as barriers. In contrast, no difference was observed between the glass ionomer cement and the control. Despite the chemical bond to the dental substrate[26], the insertion of glass ionomer into a root canal is difficult. The possible presence of blisters in the material reduces its sealing ability and favors leakage through material[27].

Several *in vitro* methodologies, such as the use of dye, pressure-driven system, fluid filtration model and microbial marker, have been used to evaluate the sealing ability of materials used in endodontics. This study used a passive penetration of dye model, which has been demonstrated to be adequate for evaluating leakage[28]. Leakage evaluation usually involves the immersion of specimens in a dye solution followed by their section into two or more slices, followed by visual determination of the extension of leakage. The main problem in this method is that the evaluation is performed only on the surface of the slice, whereas possible presence of dye inside the slice is not visualized. The methodology used in this study allows the presence of dye within the sample to be evaluated[29]. However, despite these advantages, it has been demonstrated that methodologies using dye to measure leakage may not relate closely to clinical reality[30].

The outcomes of this study show that placing Cotosol or MTA as an additional barrier over the remaining filling material evaluated reduced leakage, and may thus be recommended in order to reduce the contamination of the apical seal during the procedure of intra-radicular post placement. However, it is important to emphasize that all materials presented some leakage and it is difficult to determine the clinical relevance of these leakage measurements, so intra-radicular post placement should be performed using a rubber dam whenever possible.

CORRESPONDENCE
André Luis Faria-e-Silva
Departamento de Odontologia
Centro de Ciências Biológicas e da Saúde
Universidade Federal de Sergipe
Rua Cláudio Batista, s/n – Sanatório. CEP 49060-100
Aracaju-SE, Brazil
andrelfsilva@hotmail.com

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