

SEALING ABILITY OF RETROGRADE OBTURATION MATERIALS CONTAINING CALCIUM HYDROXIDE OR MTA

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ABSTRACT

Newly available materials for retrograde obturation should have their sealing properties evaluated. The goal of this study was to evaluate the sealing ability of Endo CPM sealer, an MTA-based endodontic cement. Single-rooted extracted human teeth were endodontically treated. After apical sectioning, retrograde cavities were prepared. Teeth were divided into five experimental groups ($n=12$), in which the following materials were used: Sealer 26 (S26), white Mineral Trioxide Aggregate (MTA), Endo CPM Sealer (CPM1), Endo CPM Sealer in thicker consistency (CPM 2), and zinc oxide and eugenol cement (ZOE), and two control groups

($n=3$). After retrograde obturation, the teeth were immersed in 0.2% rhodamine B dye for 48 hours in a vacuum chamber. Marginal leakage data were subjected to ANOVA and Tukey tests at 5% significance level. S26 presented greater sealing ability ($p<0.05$) than ZOE, MTA, CPM1, and CPM2, all of which had similar results ($p>0.05$). We concluded that Sealer 26 has the greatest sealing ability. Endo CPM Sealer, with sealing ability similar to MTA, could be used as a retrograde obturation material.

Key words: Dental leakage, obturation, retrograde, canal sealants, root.

CAPACIDAD DE SELLADO DE LOS MATERIALES DE OBTURACIÓN RETRÓGRADA QUE CONTIENEN HIDRÓXIDO DE CALCIO O MTA

RESUMO

Materiais recentemente disponíveis para obturação retrógrada devem ter suas propriedades seladoras avaliadas. O objetivo deste estudo foi avaliar a capacidade seladora do Endo CPM sealer, um cimento endodôntico à base de MTA. Dentes unirradiculares humanos extraídos foram tratados endodônticamente. Após secção apical, foram preparadas cavidades retrógradas. Os dentes foram divididos em cinco grupos experimentais ($n=12$), nos quais foram utilizados os seguintes materiais: Sealer 26 (S26), Mineral Trioxide Aggregate branco (MTA), Endo CPM Sealer (CPM1), Endo CPM Sealer na consistência mais espessa (CPM 2), cimento de óxido de zinco e eugenol (ZOE) e dois grupos con-

trole ($n=3$). Após obturação retrógrada, os dentes foram imersos em rodamina B a 0,2% por 48 horas em uma câmara a vácuo. Os dados da infiltração marginal foram submetidos aos testes ANOVA e Tukey com nível de significância de 5%. O S26 apresentou maior capacidade seladora ($p<0,05$) que ZOE, MTA, CPM1 e CPM2, os quais tiveram resultados semelhantes ($p>0,05$). Conclui-se que o Sealer 26 apresenta maior capacidade seladora. Endo CPM Sealer promove selamento similar ao MTA, podendo ser utilizado como material retrobturador.

Palavras-chave: Infiltração dentária, obturação retrógrada, cimento obturador de canal radicular.

INTRODUCTION

Endodontic surgery is an option in clinical cases not solved by conventional endodontic therapy¹. Retrograde obturation consists of preparing an apical cavity after apicoectomy and filling it with a retrograde material¹.

Amalgam was widely used as a retrograde obturation material but its use has been replaced by zinc oxide and eugenol-based materials such as IRM and Super EBA, which provide a better seal and have more adequate biological behavior^{2,3}. Sealer 26 (Dentsply, Rio de Janeiro, RJ, Brazil) is an epoxy resin-based cement containing calcium hydroxide. Its calcium ion release rate is lower than that of cal-

cium hydroxide-based materials⁴. When used as a retrograde obturation material, more powder is incorporated into the product⁵, resulting in more hydroxyl and calcium ion release⁶. Sealer 26 has demonstrated good sealing ability⁷ and satisfactory biocompatibility⁵.

Mineral trioxide aggregate (MTA) contains tricalcium silicate, tricalcium aluminate, and other mineral oxides. It shows adequate sealing ability when used as a retrograde filling material^{8,9}, as well as in root or furcal perforations^{10,11}. Its antimicrobial activity¹² and biocompatibility¹³ has also been demonstrated. Despite these advantages, MTA presents some technical difficulties, particularly

regarding its manipulation and insertion into the retrograde cavities.

The similarity between MTA and Portland cement suggest that some of the additives used to alter the physical, chemical, and mechanical characteristics of Portland cement could be added to the composition of MTA cement. The addition of calcium chloride to Portland cement, besides promoting reduction of the setting time, also facilitates its manipulation^{14,15} and improves the material's sealing ability¹⁶.

Endo CPM Sealer (EGEO S.R.L. under license of MTM Argentina S.A., Buenos Aires, Argentina) is an endodontic sealer developed from MTA, whose formulation includes calcium oxide. This material has satisfactory plasticity, adherence, and flowability, in addition to good biological behavior¹⁷. Similarly to Sealer 26, Endo CPM Sealer can be used as an endodontic sealer or, when manipulated in a higher powder/liquid ratio, it can serve as a retrograde obturation material. Tanomaru-Filho et al.⁶ observed that Endo CPM Sealer at normal or thicker consistency release hydroxyl and calcium ions, suggesting this material as an alternative for retrograde obturation.

Tanomaru et al.¹⁸ showed that Sealapex, Sealer 26, Endo CPM Sealer and white MTA presented antimicrobial activity against *Micrococcus luteus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and *Enterococcus faecalis*. Other properties of Endo CPM have to be evaluated in order to support its indication as a retrograde obturation material. Brito-Júnior et al.¹⁹ observed that White MTA had better sealing ability as a cervical barrier during intracoronal bleaching than Vidrion R. Brito-Júnior et al.²⁰ demonstrated that the use of propyleneglycol as a vehicle for gray MTA-Angelus increased its sealing ability in furcal perforations.

Therefore, the goal of this study was to evaluate and compare the sealing ability of Sealer 26 manipulated as a retrograde obturation material, and of MTA and Endo CPM Sealer, both conventionally manipulated and in a higher powder/liquid ratio.

MATERIALS AND METHODS

Sixty-six recently extracted human mandibular single-rooted bicuspid with straight roots were selected for this study. All teeth had a single root canal, with no curvatures, and apical diameter corresponding to a K # 15 or K # 20 file.

Teeth were cross-sectioned at the cement-enamel junction. Mechanical preparation up to the working length

(1 mm short of the apex) was performed with K-files up to size 60. The root canals were irrigated with 3 mL of 1% sodium hypochlorite after each instrument change, and with 17% EDTA solution (Biodinâmica, Ibiporã, PR, Brazil) at the end of preparation. Root canals were filled with #60 gutta-percha cone and a zinc-oxide and eugenol sealer (Dentsply Ind. Com. Ltda., Petropolis, RJ, Brazil). Forty-eight hours after the canals were obturated, apicoectomy was performed using a #699 carbide crosscut tapered fissure bur. The cut was performed perpendicularly to the long axis of the root, 3 mm from the apex, with water refrigeration. Retrograde cavities, 3 mm deep, were prepared using an ultrasonic unit (Enac, Osada, Japan) and retrograde preparation ultrasonic tips (6.1107-6 – CVDentus, São José dos Campos, Brazil). An operating microscope (M 900 D.F. Vasconcelos, Belo Horizonte, Brazil) was used to aid the preparation of the retrograde cavities.

The external surfaces of the roots were impermeabilized with two layers of adhesive (Araldite-Ciba-Geigy S.A., Taboão da Serra, SP, Brazil), avoiding application of the adhesive on the apical sectioned surfaces. The roots were then randomly divided into five experimental groups with 12 specimens each, and two control groups with three roots in each. The ones in the positive control group (n=3) did not receive retrograde obturation material. The ones in the negative control group (n=3) were completely impermeabilized after retrograde obturation using one of the materials being evaluated.

Sealer 26 (S26) was manipulated in a 5:1 powder/resin ration, according to Tanomaru-Filho et al.⁵ For MTA a powder/liquid ratio of 0.33 g/1 g²¹ was used, while Endo CPM Sealer was manipulated according to a previous study, in a powder/liquid ratio of 0.20 g/0.05 mL (4:1 in mass), considered adequate for its use as a root canal sealer (CPM1). This same cement was also evaluated in thicker consistency (0.30 g powder to 0.05 mL liquid - 6:1 in mass) (CPM2) for its use as a retrograde obturation material, as previously determined in another study. The zinc oxide-eugenol cement (ZOE) was manipulated in a powder/liquid ratio of 1 g/0.2 g²². The materials were placed in the retrograde cavities with curettes and condensers for retrograde filling.

After retrograde obturations were completed, the teeth were maintained in moisture condition during 10 minutes, and then immersed in 0.2% rhodamine B in a vacuum chamber. Vacuum was provided by a

suction pump (Tecnal TE-058, Piracicaba, SP, Brazil). The specimens from all groups were kept in the dye for 48 hours. Afterward, they were washed in water for 30 minutes. After that, the roots were longitudinally sectioned, exposing the cavity and the retrograde obturation material. The images were digitized and analyzed using the Image Pro Plus software (v.6.1; MediaCybernetics, MD, USA). Measurements were performed by calibrated "blind" examiners (unaware of the identity of the groups) after removal of the retrograde obturation materials, using curettes. The measurement of the leakage was made from the apical surface of the retrograde cavity to the maximum penetration of dye.

Data obtained were subjected to statistical analysis (ANOVA) and individual comparisons between groups were performed by the Tukey test, at $p < 0.05$ significance.

RESULTS

Fig. 1 shows the means of the approximate marginal leakage values for each group. ANOVA demonstrated significant difference between the experimental groups ($p < 0.05$). Tukey test revealed statistically significant difference between Sealer 26 and MTA ($p < 0.001$); Sealer 26 and CPM Sealer 1 ($p < 0.001$); Sealer 26 and CPM Sealer 2 ($p < 0.001$); and Sealer 26 and ZOE ($p < 0.001$). No statistically significant difference was found between the other experimental groups ($p > 0.05$). In the control groups, complete dye leakage was observed in the positive control and absence of leakage was found in the negative control group.

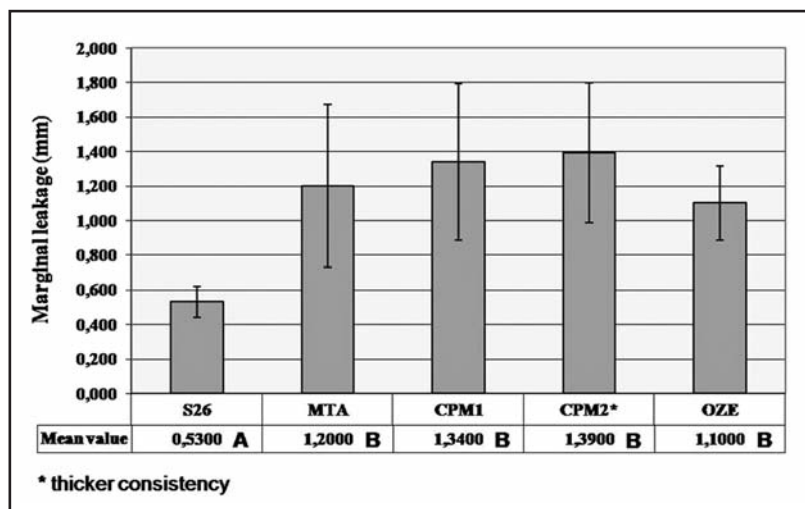


Fig. 1: Marginal leakage means and standard deviation of the tested materials. Means followed by the same letter did not differ significantly ($p > 0.05$).

DISCUSSION

Various methods have been used for *in vitro* evaluation of the sealing ability of endodontic materials. Assessment of dye leakage is one of these methods^{2,8,15,23-25}. Methylene blue is widely used in this technique^{8,23}. However, when methylene blue comes into contact with alkaline materials, it becomes colorless, losing its marking ability²⁶⁻²⁸. Therefore, in this scenario, rhodamine B is a viable alternative to methylene blue, since it is not affected by alkaline material^{15,23,27,28}. Although other techniques can be used for assessment of the sealing ability of materials, such as the fluid transport method²⁹, dye leakage is accepted as a valid method for the initial evaluation of experimental retrograde obturation materials³⁰, such as Endo CPM in both consistencies.

The results from the present work indicated that Sealer 26 has statistically significant better sealing ability compared to MTA-Angelus ($p < 0.001$), Endo-CPM-Sealer ($p < 0.001$), and ZOE ($p < 0.01$). Sealer 26 is an epoxy resin-based material containing calcium hydroxide, and according to Siqueira Jr et al⁷, has greater ability to prevent bacterial penetration than IRM and glass ionomer (Fuji IX). When Sealer 26 is manipulated in thicker consistency, as in the present study, it is easy to manipulate and to insert into the retrograde cavity. It also shows satisfactory biocompatibility, comparable to MTA, in dogs' teeth⁵.

Calcium chloride has been used in association with MTA as a cure-accelerating additive and also to improve its consistency^{14,15}. Bortoluzzi et al.¹⁵ evaluated the influence of the addition of calcium chloride on the sealing ability of two types of white MTA. The authors compared the resulting formulations with white Portland cement by the dye leakage evaluation method using 0.2% rhodamine B. Their results demonstrated that ProRoot MTA, MTA Angelus, and Portland cements with the addition of calcium chloride scored better in terms of sealing ability than the same cements in their original formulations. Brito-Júnior et al.²⁰ demonstrated that the use of propyleneglycol as a vehicle

for gray MTA-Angelus increased its sealing ability in furcal perforations.

Endo CPM Sealer, besides containing calcium chloride, also includes calcium carbonate, barium sulfate, and propylene glycol as a vehicle, among other components⁶. Gomes-Filho et al¹⁶ studied the inflammatory response to Endo CPM Sealer and to MTA-Angelus in subcutaneous tissue in rats at different experimental timepoints. The authors concluded that Endo CPM Sealer induced biological response similar to MTA. It was already demonstrated that Endo CPM, in both consistencies tested in the present study, released calcium ions and had alkaline pH, similarly to MTA⁶. Our results showed no statistically significant difference between Endo CPM Sealer in normal and in thicker consistency in terms of its sealing ability ($p>0.05$). The marginal leakage values for MTA in this study were different from those presented by other authors, who described the leakage for this cement to be minimal or even absent^{8,30}. However, in previous studies the authors had utilized 1% methylene blue, which might have provided lower than actual

leakage values. Rahimi et al⁹ also found significantly lower leakage values for MTA, although in this case after retrograde obturation the teeth were kept in an environment with 100% humidity for 48 hours, which allowed the cement to cure, reducing its solubility. Moreover, the teeth were subsequently maintained in phosphate buffer saline for an additional 48 hours, which may have led to the formation of a hydroxyapatite layer around the MTA, further improving its sealing ability.

The present study demonstrated that the sealing ability of Sealer 26 was greater than that of ZOE, MTA Angelus and of Endo CPM Sealer in two different consistencies. Furthermore, our results show that Endo CPM Sealer performed similarly to MTA, and may therefore be considered an alternative as a retrograde obturation material. The thicker consistency resulting from using a higher powder/liquid ratio facilitates its insertion into the retrograde cavity. The physical, chemical, and biological properties of this cement should be further evaluated in order to substantiate its indication as a retrograde obturation material.

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