View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Cadernos Espinosanos (E-Journal)

Sealability of MTA and calcium hydroxide-containing sealers

João Eduardo GOMES-FILHO[2], Jaqueline Viana MOREIRA[5], Simone WATANABE[4], Carolina Simonetti LODI[4], Luciano Tavares Angelo CINTRA[3], Eloi DEZAN JUNIOR[2], Pedro Felício Estrada BERNABÉ[1], Mauro Juvenal NERY[2], José Arlindo OTOBONI FILHO[2]

1- DDS, MSc, PhD, Full Professor, Department of Endodontics, Araçatuba School of Dentistry, UNESP - Univ. Estadual Paulista, Araçatuba, SP, Brazil.
2- DDS, MSc, PhD, Associate Professor, Department of Endodontics, Araçatuba School of Dentistry, UNESP - Univ. Estadual Paulista, Araçatuba, SP, Brazil.
3- DDS, MSc, PhD, Assistant Professor, Department of Endodontics, Araçatuba School of Dentistry, UNESP - Univ. Estadual Paulista, Araçatuba, SP, Brazil.
4- DDS, MSc, Graduate Program in Pediatrics, Araçatuba School of Dentistry, UNESP - Univ. Estadual Paulista, Araçatuba, SP, Brazil.
5- Undergraduate student, Araçatuba School of Dentistry, UNESP - Univ. Estadual Paulista, Araçatuba, SP, Brazil.

Corresponding address: Dr. João Eduardo Gomes-Filho - Faculdade de Odontologia de Araçatuba, Universidade Estadual Paulista - R. José Bonifácio, 1193 - Araçatuba - SP - Brasil - Phone (0055) 18 36363252 - Fax: (0055) 18 36363279 - e-mail: joao@foa.unesp.br

Received: October 2, 2010 - Modification: August 16, 2011 - Accepted: September 1, 2011

ABSTRACT

Objectives: The aim of this study was to evaluate the apical sealability of Fillapex®, Endo-CPM-Sealer® and Sealapex®. Material and Methods: Ninety-four freshly extracted single-rooted teeth were selected and decoronated. All teeth were radiographed to confirm the existence of a single and straight root canal, which was prepared using Protaper Universal and 2.5% sodium hypochlorite. The teeth were randomly divided in groups of 10 specimens each according to the sealer, and the canals were filled using the single cone technique and one of the sealers. Four additional teeth were used as controls. The teeth were submitted to dye leakage with Rhodamine B for 24 h but using vacuum on the initial 15 min. Thereafter, they were cut longitudinally and the leakage was measured in a linear fashion from apex to crown. Data were analyzed by ANOVA and Tukey's tests at 5% significance level. Results: Fillapex® and Sealapex® showed significantly less dye leakage than Endo-CPM-Sealer® ($p<0.05$). Conclusions: It was concluded that Fillapex® and Sealapex® were able to prevent apical dye leakage differently from Endo-CPM-Sealer®.

Key words: Root canal filling material. Leakage. Fillapex.

INTRODUCTION

One of the of root canal obturation goals is to obtain hermetic sealing of the root canal system favoring the process of apical and periapical repair after endodontic therapy[17]. Inadequate filling can result in fluid movements into the filling defects favoring a periapical chronic inflammatory reaction and compromising the treatment success[29].

Root canal ramifications, such as lateral, secondary and accessory canals can establish connection between the main root canal and periodontal ligament, as well as the apical foramen[3,9]. Several authors described that localized periodontal problems might be associated with necrotic and infected root canal ramifications highlighting the importance of the capacity of the endodontic sealer to flow into these irregularities[3,4]. Despite the significance of this physical property, the relationship between flow and its ability to penetrate narrow root canal ramifications has not been investigated[3,30].

Root canal sealers used clinically have several bases including zinc oxide-eugenol, epoxy resin, glass ionomer, and calcium hydroxide. Sealapex® (Sybron Endo Glendora, CA, USA) is an endodontic sealer that contains calcium oxide, which, in contact with water, forms calcium hydroxide and it was used in the present article as a reference.

A new formulation of MTA-labeled Endo-CPM-Sealer® (EGEO S.R.L., Buenos Aires, Buenos Aires, Argentina) was created to be used as root canal sealer. The composition of CPM Sealer is MTA with the addition of calcium carbonate to reduce the pH from 12.5 to 10.0 after set. This way, the surface necrosis in contact with the material is restricted, which allows the action of the alkaline phosphatase[14].

Besides CPM Sealer, Fillapex® (Angelus Indústria de Produtos Odontológicos S/A, Londrina, PR, Brazil) was recently introduced. Its chemical composition is based on the MTA with additional substances to obtain a consistency suitable to be used in root canal treatment. The composition of Fillapex® is trade secret, but it is known that synthetic Portland cement clinkers and disalicylate are the basic composition to form a ionic polymer. According to the manufacturer, it has: working time of 35 min, flow capacity of 27.66 mm, setting time of 130 min, optical density of 77% and solubility of 0.1%. Moreover, it is easily to be handled. It was not observed in the literature studies evaluating the sealability of Fillapex®.

The aim of this study was to evaluate the apical sealability of Fillapex®, Endo-CPM-Sealer® and Sealapex® endodontic sealers.

MATERIAL AND METHODS

Tooth selection and preparation

Ninety-four single-rooted teeth recently extracted for several reasons were selected and stored in neutral formaldehyde for at least 72 h from the tooth bank of the Araçatuba School of Dentistry, UNESP – Univ. Estadual Paulista, Brazil. The teeth were radiographed to confirm the existence of a single and straight canal and were decoronated at a mean distance of 11 mm from the apex.

Root canal instrumentation and obturation

Instrumentation was held by a single operator. A #10 K file (Dentsply Maillefer, Ballaigues, Switzerland) was introduced into the root canal until it was visible at the apical foramen. The working length was determined by subtracting 1 mm from this length. Root canal instrumentation was performed using the ProTaper Universal rotary instruments (S1, S2, F1, F2 and F3) (Dentsply Maillefer) activated by an electric motor with controlled speed of 300 rpm (Endo-Plus, Driller, Jaguaré, SP, Brazil). Originally a #10 or #15 K file was first introduced to the middle third of the canal. Instruments S1 and S2 were advanced until resistance was encountered, but not more than two thirds of the depth of the canal. It was carried out to introduce a #15 K file up to the working length followed by reintroduction of the instrument S1 to this length. The other instruments were then inserted into full-length work in sequence S2, F1, F2 and F3. The canals were irrigated with 3 mL of 2.5% sodium hypochlorite (Apothicário Compounding Pharmacy, Araçatuba, SP, Brazil) after each file. The fluid content was aspirated and the canals were dried with sterile absorbent paper points.

All root canals were filled by the single cone technique with the use of master gutta-percha F3 cone (Dentsply Maillefer). The teeth were divided into experimental groups of 30 specimens each according to the sealer as follows: Group 1: Fillapex®, Group 2: Endo-CPM-Sealer®, Group 3: Sealapex®. The remaining 4 teeth were used as control, two as positive control and two as negative control. Master gutta-percha point was calibrated with a calibration rule (Dentsply Maillefer) using the #30 hole. The materials were handled according to the manufacturer's instructions and inserted into the root canals with a lentulo (Dentsply Maillefer). The calibrated master gutta-percha point was involved by sealer and inserted into the root canal until reaching the working length. The excess of filling material was cut with the use of a heated condenser followed by vertical condensation. No sealer was used in the positive control group and the negative control teeth were filled in the same way as in Group 1.

Dye leakage assay

After instrumentation, the teeth were sealed with nail polish leaving only the apex free for penetration of 0.2% Rhodamine B during 7 days, using vacuum in the first 15 min. The teeth in the negative control group were sealed, including apex. For analysis of the sealing ability of the tested materials, leakage of the dye was linearly measured on the photographs that were taken under stereomicroscopy using the SigmaScan® Pro Image Analysis Software (Systat Software, San Jose, CA, USA). Leakage measurement considered the line with longer length of dye, on the material/dentin wall interface, from the most apical to the most cervical portion. If the leakage length were not similar on both sides of the root canal, only the longer length was considered. Leakage was independently measured by three calibrated examiners. The results (mean of leakage values obtained by each examiner) obtained in millimeters were tabulated and analyzed by ANOVA to investigate possible differences between materials, and Tukey's test to confirm the significance of difference between groups, using Pacotico statistical software. The significance level was set at 5%.

RESULTS

Kappa statistics showed that agreement between the three examiners was higher than 90%. The positive control showed total leakage in all specimens and the negative control did not show leakage (Figure 1). Analysis of the data for the 3 experimental groups revealed that Endo-CPM-Sealer® allowed more leakage than the other materials ($p=0.001258$). Fillapex® was similar ($p>0.05$) to Sealapex® and both materials showed significantly less ($p<0.05$) leakage when compared to Endo-CPM-Sealer® (Table 1).

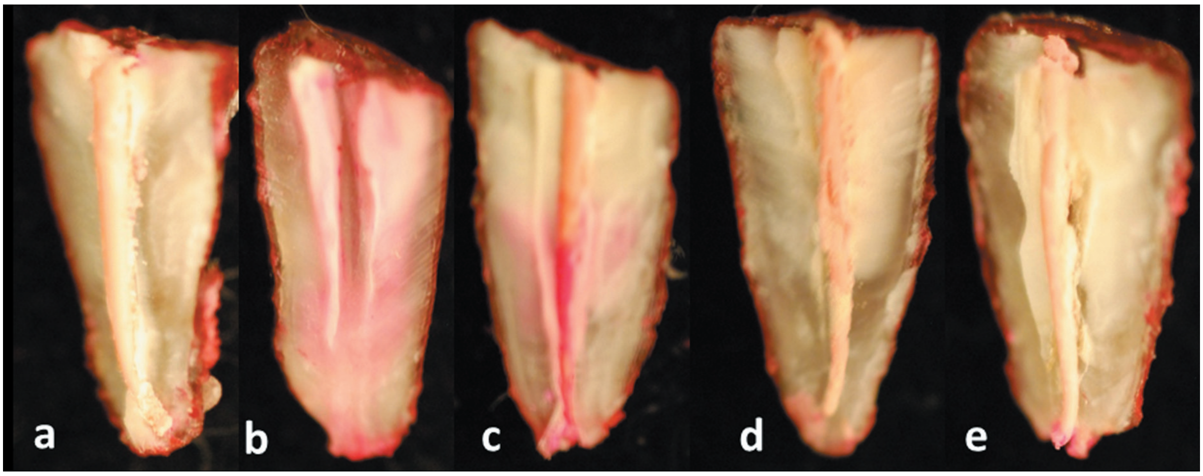

Figure 1- Leakage pattern according to the groups. a) Negative Control, observe absence of leakage (reddish staining); b) Positive Control, observe leakage along the walls from apical to the cervical root third; c) Endo CPM-Sealer®, observe leakage along the walls from the apical to the middle root third; d) MTA Fillapex®, observe absence of staining; e) Sealapex®, observe leakage only on the apical portion of the mater cone

Table 1- Comparison of mean dye leakage values (mm) and standard deviations (SD) of the endodontic sealers

Materials	n	Mean±SD (mm)
Fillapex®	30	0.80±0.61[a]
Endo-CPM-Sealer®	30	2.44±1.00[b]
Sealapex®	30	1.22±0.53[a]

*Same letters indicate no statistical difference among the groups (P>0.05).

DISCUSSION

The goal of this study was to evaluate the degree of apical leakage of Fillapex® compared with Sealapex® and Endo-CPM-Sealer® after filling of root canals prepared with the Protaper Universal system using the single-cone filling technique.

All procedures were performed by the same operator to avoid intra-operator discrepancies. Only teeth with single straight root canals were used because they can offer a more standardized method for evaluation of apical leakage. In addition, assessing the difficulties of managing curved canals was not within the study's scope.

The Protaper Universal system is the new version of the Protaper™ NiTi rotary system, which includes shaping, finishing and retreatment instruments[1,2]. Protaper Universal system was used in this study for reducing the time required for biomechanical preparation and improving the standardization of instrumentation[1,2]. Moreover, using the single cone technique for root canal filling allowed observing the sealability of the sealers in a more critical situation than that offered by the lateral condensation technique, as it is possible to speculate that the single master cone needs a greater interaction with the sealer to promote the sealing.

There is a lot of skepticism about the value of *in vitro* leakage studies with regard to clinical significance and limitations of the results[13,31]. Even so, they are widely used to evaluate and compare the sealing efficiency of materials, which must be assessed prior to their use in patients. Although in the present study the intensity of the coloration produced after the leakage was not evaluated, Rhodamine B was used because it does not suffer discoloration by calcium hydroxide-based materials, as occurs with methylene blue[12,30]. Vacuum was used according to studies that showed higher levels of leakage when it was employed compared with groups without its utilization, probably because the presence of air bubbles in the filling mass makes it difficult the penetration of dye, though they do not prevent the penetration of bacteria[11,13].

The results of this study showed lower leakage of dye in the groups filled with Sealapex® and Fillapex®, and higher leakage with Endo-CPM-Sealer®.

Sealapex® is a material specifically developed to be used as a sealer. It contains calcium hydroxide that will only be biologically active if calcium and hydroxyl ions are released over time[10,12,26]. An increase of pH has been shown to be bactericidal, interfering with the osteoclastic activity and promoting an alkalinization in the adjacent tissues. Calcium ions are also important in the activation of calcium-dependant adenosine triphosphatase, cell migration and differentiation, and reaction with carbonic gas to form calcium carbonate crystals (birefringent to polarized light), which serve as a nucleus for calcification and make possible the observation of mineralization with Von Kossa technique[12,24]. These biologic activities can explain the good clinical results observed with the use of some sealers containing calcium hydroxide, which stimulates apical foramen closure by mineralized tissue deposition, thus determining the biological sealing[12,18]. Besides the biological characteristics, the use of the calcium hydroxide-containing root canal sealer Sealapex has been questioned regarding its predisposition to solubility and subsequent effect on the root canal seal and periradicular healing. In this study, Sealapex® showed an adequate sealability, demonstrating that a calcium-hydroxide sealer can have not only adequate biological but also physical and chemical properties, such as sealability[8,20,21,32].

The results obtained with Fillapex® were similar to those obtained with Sealapex®. Fillapex® is based on MTA with additional substances to obtain a consistency suitable to be used in root canal treatment. MTA can form calcium ions and hydroxyl ions important for stimulation of hard tissue deposition[11]. The presence of MTA also suggests a possibility of setting expansion, which might have favored the sealability. Most dental materials have a tendency to shrink away from their interfacial margins, exposing a gap through which contaminating elements can penetrate. MTA setting results in the hydration of anhydrous mineral oxide compounds to produce calcium silicate hydrate and calcium hydroxide phases[6,7,22], which produces expansion against its confining margins, enhancing the seal and minimizing leakage[5,16,25].

According to its manufacturer, Endo-CPM-Sealer® has similar or better physical, chemical and biological characteristics compared with MTA, and have the same clinical indications. Endo-CPM-Sealer® has similar composition to that of MTA, but with the addition of calcium carbonate to reduce the pH after setting to 10, thus limiting the surface necrosis of the adjacent tissue and allowing the alkaline phosphatase action[14]. Endo-CPM-Sealer® has been shown to have adequate radiopacity, hydroxyl and calcium ion release, antimicrobial activity, biocompatibility (including stimulation of mineralization), and no cytotoxicity to fibroblast culture[14,16,23,27,28]. However, in the present study, this material allowed the highest leakage level, demonstrating that it was not able to prevent dye apical leakage, which can hazard the success of the endodontic treatment. Maybe the physical properties of the material can explain this finding.

CONCLUSIONS

Based on the results of the present study, it may be concluded that Sealapex® and Fillapex® were able to significantly prevent apical leakage differently from Endo-CPM-Sealer®, which showed the highest levels of leakage.

REFERENCES

1- Aguiar CM, Mendes DA, Câmara AC, Figueiredo JAP. Assessment of canal walls after biomechanical preparation of root canals instrumented with Protaper Universal™ rotary system. J Appl Oral Sci. 2009;17:590-5.

2- Ahlquist M, Henningsson O, Hultenby K, Ohlin J. The effectiveness of manual and rotary techniques in the cleaning of root canals: a scanning electron microscopy study. Int Endod J. 2001;34:533-7.

3- Almeida JFA, Gomes BP, Ferraz CCR, Souza-Filho FJ, Zaia AA. Filling of artificial lateral canals and microleakage and flow of five endodontic sealers. Int Endod J. 2007;40:692-9.

4- Barkhordar RN, Stewart GG. The potential of periodontal pocket formation associated with untreated accessory canals. Oral Surg Oral Med Oral Pathol. 1990;70:769-72.

5- Bentz DP, Jensen OM, Hansen KK, Olesen JF, Stang H, Haecker CJ. Influence of cement particle-size distribution on early age autogenous strains and stresses in cement-based materials. J Am Ceram Soc. 2001;84:129-35.

6- Camilleri J. Characterization of hydration products of mineral trioxide aggregate. Int Endod J. 2008;41:408-17.

7- Camilleri J. Hydration mechanisms of mineral trioxide aggregate. Int Endod J. 2007;40:462-70.

8- Cobankara FK, Orucoglu H, Sengun A, Belli S. The quantitative evaluation of apical sealing of four endodontic sealers. J Endod. 2006;32:66-8.

9- De Deus QD. Frequency, location, and direction of the lateral, secondary, and accessory canals. J Endod. 1975;1:361-6.

10- Estrela C, Sydney GB, Bammann LL, Felippe O Jr. Mechanism of action of calcium and hydroxyl ions of calcium hydroxide on tissue and bacteria. Braz Dent J. 1995;6:85-90.

11- Goldman M, Simmonds S, Rush R. The usefulness of dye-penetration studies reexamined. Oral Surg Oral Med Oral Pathol. 1989;67:327-32.

12- Gomes-Filho JE, Bernabé PFE, Nery MJ, Otoboni-Filho JA, Dezan-Júnior E, Costa MMTM, et al. Reaction of rat connective tissue to a new calcium hydroxide-based sealer. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;106:71-6.

13- Gomes-Filho JE, Hopp RN, Bernabé PFE, Nery MJ, Otoboni Filho JA, Dezan Júnior E. Evaluation of the apical infiltration after root canal disruption and obturation. J Appl Oral Sci. 2008;16:345-9.

14- Gomes-Filho JE, Watanabe S, Bernabé PFE, Costa MTM. A mineral trioxide aggregate sealer stimulated mineralization. J Endod. 2009;35:256-60.

15- Gomes-Filho JE, Watanabe S, Gomes AC, Faria MD, Lodi CS, Penha Oliveira SH. Evaluation of the effects of endodontic materials on fibroblast viability and cytokine production. J Endod. 2009;35:1577-9.

16- Hawley M, Webb TD, Goodell GG. Effect of varying water-to-powder ratios on the setting expansion of white and gray mineral trioxide aggregate. J Endod. 2010;36:1377-9.

17- Holland R, Murata SS, Barbosa HG, Garlipp O, Souza V, Dezan Júnior E. Apical seal of root canals with gutta-percha calcium hydroxide. Braz Dent J. 2004;15:26-9.

18- Holland R, Otoboni Filho JA, Souza V, Nery MJ, Bernabé PF, Dezan Junior E. Calcium hydroxide and a corticosteroid-antibiotic association as dressings in cases of biopulpectomy. A comparative study in dogs' teeth. Braz Dent J. 1998;9:67-76.

19- Hosoya N, Kurayama H, Iino F, Arai T. Effects of calcium hydroxide on physical and sealing properties of canal sealers. Int Endod J. 2004;37:178-84.

20- Ishimura H, Yoshioka T, Suda H. Sealing ability of new adhesive root canal filling materials measured by new dye penetration method. Dent Mater J. 2007;26:290-5.

21- Kielbassa AM, Uchtmann H, Wrbas KT, Bitter K. *In vitro* study assessing apical leakage of sealer-only backfills in root canals of primary teeth. J Dent. 2007;35:607-13.

22- Lee YL, Lee BS, Lin FH, Yun Lin A, Lan WH, Lin CP. Effects of physiological environments on the hydration behavior of mineral trioxide aggregate. Biomaterials. 2004;25:787-93.
23- Scarparo RK, Haddad D, Acasigua GA, Fossati AC, Fachin EV, Grecca FS. Mineral trioxide aggregate-based sealer: analysis of tissue reactions to a new endodontic material. J Endod. 2010;36:1174-8.
24- Seux D, Couble ML, Hartmann DJ, Gauthier JP, Magloire H. Odontoblast-like cytodifferentiation of human dental pulp cells *in vitro* in the presence of a calcium hydroxide-containing cement. Arch Oral Biol. 1991;36:117-28.
25- Storm B, Eichmiller FC, Tordik PA, Goodell GG. Setting expansion of gray and white mineral trioxide aggregate and Portland cement. J Endod. 2008;34:80-2.
26- Tagger M, Tagger E, Kfir A. Release of calcium and hydroxyl ions from set endodontic sealers containing calcium hydroxide. J Endod. 1988;14:588-91.
27- Tanomaru JM, Tanomaru-Filho M, Hotta J, Watanabe E, Ito IY. Antimicrobial activity of endodontic sealers based on calcium hydroxide and MTA. Acta Odontol Latinoam. 2008;21:147-51.
28- Tanomaru-Filho M, Chaves Faleiros FB, Saçaki JN, Duarte MAH, Guerreiro-Tanomaru JM. Evaluation of pH and calcium ion release of root-end filling materials containing calcium hydroxide or mineral trioxide aggregate. J Endod. 2009;35:1418-21.
29- Valera MC, Camargo CH, Carvalho AS, Gama ERP. *In vitro* evaluation of apical microleakage using different root-end filling materials. J Appl Oral Sci. 2006;14:49-52.
30- Venturi M, Prati C, Capelli G, Falconi M, Breschi L. A preliminary analysis of the morphology of lateral canals after root canal filling using a tooth-clearing technique. Int Endod J. 2003;36:54-63.
31- Wu MK, Van Der Sluis LW, Ardila CN, Wesselink PR. Fluid movement along the coronal two-thirds of root fillings placed by three different gutta-percha techniques. Int Endod J. 2003;36:533-40.
32- Yang SE, Baek SH, Lee W, Kum KY, Bae KS. *In vitro* evaluation of the sealing ability of newly developed calcium phosphate-based root canal sealer. J Endod. 2007;33:978-81.