RADIOPACITY AND FLOW OF DIFFERENT ENDODONTIC SEALERS

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ABSTRACT

The present study evaluated the radiopacity and flow of different endodontic sealers: AH Plus, Endo CPM, MTA Fillapex, Sealapex, Epiphany, and Epiphany SE. For the radiopacity test, six specimens measuring 10mm in diameter and 1mm in thickness were fabricated from each material. They were radiographed on an occlusal film alongside an aluminum step wedge. Radiographs were digitized to determine the radiopacity equivalence in millimeters of aluminum. To evaluate the flow, a 120 g load was placed on top of a glass slab containing 0.05 ± 0.005ml of sealer. The diameters of each material were measured (mm) with a caliper and samples were photographed. Digitized images were analyzed using the UTHSCSA Image Tool for Windows software, to determine the sealer area (mm2). Data were submitted to ANOVA and Tukey's test at 5% significance. AH Plus and Epiphany SE presented the greatest radiopacity (12.5 mm Al and 12.0 mm Al, respectively) (p> 0.05), followed by Epiphany (9.6 mm Al) and Fillapex (8.9 mm Al). Endo CPM (5.46 mm Al) and Sealapex (5.51 mm Al) presented lower radiopacity. MTA Fillapex presented significantly higher values of flow than other sealers (33.11 mm and 844.9 mm2). AH Plus, Epiphany, and Epiphany SE had similar values. Endo CPM (21.05 mm and 342.8 mm2) and Sealapex (19.98 mm and 352.5 mm2) presented the lowest flow values (p> 0.05). All sealers presented radiopacity and flow values according to ISO and ANSI/ADA recommendations.

Key Words: *Endodontic sealer, radiopacity, flow, Mineral Trioxide Aggregate.*

RADIOPACIDADE E ESCOAMENTO DOS CIMENTOS ENDODÔNTICOS AH PLUS, ENDO CPM SEALER, MTA FILLAPEX, SEALAPEX, EPIPHANY E EPIPHANY SE

RESUMO

O objetivo deste estudo foi avaliar a radiopacidade e o escoamento dos cimentos endodônticos: AH Plus, Endo CPM Sealer, Fillapex, Sealapex, Epiphany e Epiphany SE. Para o teste de radiopacidade foram confeccionados corpos de prova com 10mm de largura e 1mm de espessura, radiografados juntamente com uma escala de alumínio sobre filme oclusal. As imagens foram digitalizadas e foi determinada a equivalência em milímetros de alumínio. Para avaliação do escoamento, foram colocados 0,05 ± 0,005 ml do cimento em placa de vidro, e sobre este uma massa de 120g. Foi realizada mensuração do maior e menor diâmetro de cada espécime e as amostras foram fotografadas e digitalizadas para mensuração da área do cimento em mm2 pelo programa UTHSCSA Image Tool for Windows Versão 3.00. Os dados foram analisados por ANOVA e teste Tukey, com 5% de significância. AH Plus e Epiphany SE apresentaram maior radiopacidade (12,5 mm Al e 12,0 mm Al, respectivamente) (p> 0,05), seguidos pelo Epiphany (9,6 mm Al) e Fillapex (8,9 mm Al). Endo CPM (5,46 mm Al) e Sealapex (5,51 mm Al) apresentaram menor radiopacidade. O MTA Fillapex apresentou valor de escoamento superior aos demais materiais (33,11 mm e 844,9 mm2). Os cimentos AH Plus, Epiphany e Epiphany SE apresentaram valores similares e intermediários (p> 0,05), seguidos pelos cimentos Endo CPM Sealer (342,8 mm2 e 21,05 mm) e Sealapex (352,5 mm2 e 19,98 mm) que apresentaram menor escoamento (p> 0,05). Todos os cimentos avaliados estão em acordo com as recomendações da norma ISO e ANSI/ADA.

Palavras-chave: *Cimento endodôntico, radiopacidade, escoamento, Mineral Trióxido Agregado.*

INTRODUCTION

The goals of endodontic therapy are to prevent, diagnose, and treat pathologic changes of the pulp and periapical region[1]. Root canal filling, one of the phases of endodontic treatment, aims to completely fill the root canal system[2,3] using filling materials with adequate biological and physicochemical properties. Endodontic filling materials should be radiopaque enough to allow their distinction from adjacent anatomical structures[4-6] such as bone and teeth.[7] Eliasson & Haasken (1979)[8] established a method for radiopacity evaluation of materials by measuring the optical radiographic density in equivalence to the same thickness of aluminum.

Another important property of endodontic materials used in root canal fillings is their flow[2,9,10]. Endodontic sealers should be capable of penetrating accessory canals and irregularities of the root canal system[10]. However, excessive flow may increase the risk of material extrusion beyond the apex, which can promote damage to the periodontal tissues[11].

With the goal of enhancing the adhesion between the filling materials and the root canal walls, endodontic sealers based on methacrylate resin[12] have been developed. Epiphany SE (self-etch), a new version of the resin-based Epiphany sealer, does not require use of primer[13].

MTA has been widely used in different clinical applications due to its outstanding biocompatibility[14]. However, MTA presents physical characteristics that make its insertion into the root canal very challenging[15]. New MTA-based materials have been developed for use as endodontic sealers. Among these MTA-based materials is Endo CPM, which contains tricalcium silicate, tricalcium oxide, tricalcium aluminate, and other mineral oxides[16]. This cement presents good biological[17], physical[18] properties and antimicrobial activity[19]. Another MTA-based endodontic sealer recently introduced into the market is MTA Fillapex (Angelus, Londrina, PR, Brazil).

Considering some important physical-chemical properties of a new endodontic sealer, the aim of this study was to evaluate the radiopacity and flow of different endodontic sealers.

MATERIAL AND METHODS

The evaluated endodontic sealers are listed in Table 1. The materials were manipulated according to their manufacturers' instructions.

Radiopacity test

This test was carried out as previously described by Tanomaru-Filho et al. (2007)[20]. After manipulation, sealers were placed into rings measuring 10 mm (internal diameter) and 1 mm (height). Six specimens were made from each material. Samples were

Table 1: Materials evaluated in this study.

Sealers	Composition	Manufacturer
AH Plus	**Paste A:** bisphenol-A epoxy resin, bisphenol-F epoxy resin, calcium tungstate, zirconium oxide, silica, iron oxide pigments **Paste B:** dibenzyldiamine, aminoadamantane, tricyclodecane diamine, calcium tungstate, zirconium oxide, silica, silicone oil	Dentsply DeTrey, Konstanz, Germany
Endo CPM	**MTA:** silicon dioxide, calcium carbonate, bismuth trioxide, barium sulfate, propylene glycol alginate, sodium citrate, calcium chloride	EGEO S.R.L. Bajo Licencia MTM Argentina S.A., Buenos Aires, Argentina
Fillapex	salicylate resin, diluting resin, natural resin, bismuth trioxide, nanoparticulated silica, MTA, pigments	Angelus, Londrina, Brazil
Sealapex	20% calcium oxide, 2.5% zinc oxide, 29% bismuth trioxide, 3% silicon particles, 20% titanium dioxide, 1% zinc stearate, 3% tricalcium phosphate, isobutyl salicylate + methyl salicylate + 39%, pigment	SybronEndo - Sybron Dental Specialties, Glendona, CA, USA
Epiphany	UDMA, PEGDMA, EBPADMA, BISGMA and methacrylate resins; barium borosilicate glasses treated with silane; barium sulfate; silica; calcium hydroxide; bismuth oxychloride with amines; peroxides; photopolymerization initiator; stabilizers, and pigments	Pentron Clinical Technologies, LLC., Wallingford, CT, USA
Epiphany SE	EBPADMA, HEMA, BISGMA and acidic methacrylate resins, silane treated bariumborosilicate glasses, silica, hydroxyapatite, Ca-Al-F silicate, bismuth oxychloride with amines, peroxide, photo initiator, stabilizers, and pigment	Pentron Clinical Technologies, LLC., Wallingford, CT, USA

kept at 37°C and 100% humidity for 48 hours. After that, they were radiographed on an occlusal film (Insight – Kodak Comp, Rochester, NY) alongside an aluminum step wedge with graduated thickness varying from 2 to 16 mm. Radiographs were taken using a GE 1000 X-ray unit (General Electric, Milwaukee, WI) operating at 50 kV, 10 mA, and 18 pulses per second, with a focus-film distance of 33 cm. Exposed films were developed in an automated processor and evaluated using the UTHSCSA ImageTool for Windows software, Version 3.00. On the radiographs, the different thicknesses of the step wedge were compared with the optical density of each material. The radiopacity was expressed as the thickness of aluminum (in millimeters) that presented the same radiopacity of each sealer, according to Vivan et al. (2009)[21].

FLOW TEST

These tests were conducted according to the methodology proposed by the ISO 6876/2001[22], also described by Asgay et al. (2008)[23]. By means of a graduated syringe, 0.05 ± 0.005 ml of sealer was dispensed on the center of a glass slab. After 3 minutes, another glass slab was placed on top of that which contained the material (20 g), and a l00 gram load was positioned over the assembly, totaling a 120 g load. After an additional 7 minutes, the diameter of each sealer was measured. Two different assays were carried out to assess the flow of the materials. In the first method, the smallest and the greatest diameters obtained for each material were measured (mm) using a digital caliper. Only the measurements from specimens displaying less than 1 mm of discrepancy between these diameters were considered (n=10). In the second method, the samples were photographed alongside a ruler, in a standardized manner. The area (mm^2) of each sample was calculated from the digitized images, using the UTHSCSA Image Tool for Windows software, Version 3.00, as described by Tanomaru-Filho et al. (2007)[20] in a previous study on the properties of gutta-percha.

Data obtained from both tests were subjected to ANOVA and Tukey's test at 5% significance.

RESULTS

Statistical analysis demonstrated significant differences in radiopacity between the sealers evaluated. The means, standard deviations, and results from Tukey's test (α=0.05) are presented in Fig.1.

Fig. 2 shows the mean diameters and mean areas for each sealer. MTA Fillapex presented the highest flow among all the materials evaluated (33.11 mm and 844.9 mm2).

DISCUSSION

The radiopacity of an endodontic sealer is an important property that allows assessment of the quality of a root canal filling and detection of the occurrence of apical extrusion[24,25]. Despite the fact that the norms only suggest the minimum radiopacity values for these materials, it should be pointed out that excessive contrast may lead to the false impression of a dense and homogeneous fill[26].

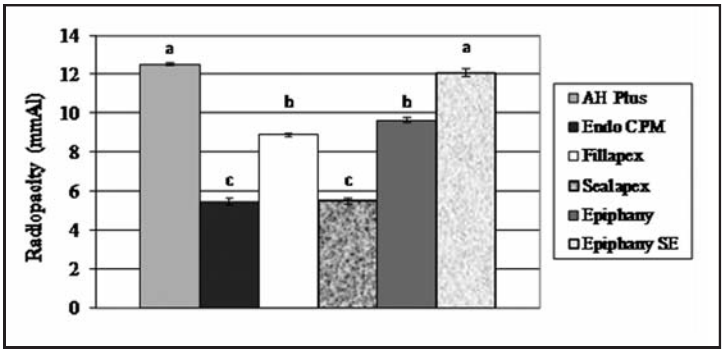
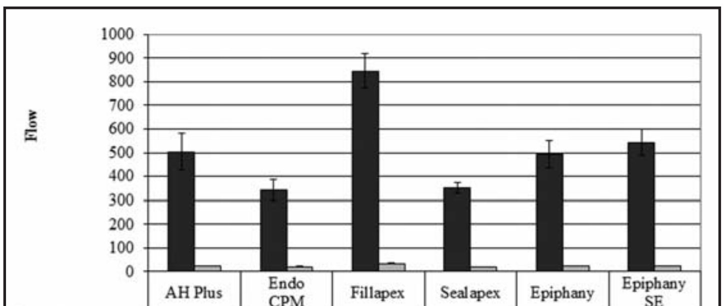


Fig. 1: Means and standard deviations for the radiopacity values of the materials tested. Materials with the same letters did not show statistical differences (p> 0.05).



	AH Plus	Endo CPM	Fillapex	Sealapex	Epiphany	Epiphany SE
Area (mm2)	504,1 B	342,8 C	844,9 A	352,5 C	495 B	544,1 B
Diameter (mm)	23,56 B	21,05 C	33,11 A	19,98 C	23,66 B	24,66 B

Fig. 2: Mean areas (mm^2) and mean diameters (mm) after the flow assays. Means followed by the same letters do not present statistically significant difference (p> 0.05).

According to the ANSI/ADA specification Nº 57[27], endodontic filling materials should present a difference in radiopacity of at least 2 mm Al from dentin or bone. Minimum radiopacity of 3 mm Al is proposed by the ISO 6876:2001[22] for endodontic sealers[7,9]. Several studies have evaluated the radiopacity of endodontic sealers using an aluminum step wedge as the standard reference[20,21,28].

Our results showed that AH Plus and Epiphany SE presented the greatest radiopacity among all cements evaluated. Tanomaru et al. (2001)[28] and Tanomaru-Filho et al. (2004)[29] e (2007)[20], also observed greater radiopacity for AH Plus compared to silicone-based materials, calcium hydroxide, zinc oxide and eugenol, and resin cements[29]. All endodontic sealers evaluated presented radiopacity above the minimum values recommended by both norms[30].

The radiopacity of a particular material is related to specific components in its formulation (Table 1). The high radiopacity observed for AH Plus can be attributed to the presence of iron oxide, zirconium oxide, and calcium tungstate in its composition. Sealapex includes zinc oxide and bismuth trioxide in its formulation. The sealers Epiphany and Epiphany SE contain barium and bismuth sulfates. Endo CPM contains bismuth trioxide and barium sulfate, and the radiopacity of Fillapex is attributed to bismuth trioxide.

Another important property of endodontic sealers is their flow rate[31,32]. According to ADA No. 57[27] and ISO[22] specifications, sealers should present diameter of at least 20 mm in the flow assay. In the present study, AH Plus, Endo CPM, Fillapex, Epiphany, and Epiphany SE presented flow above the minimum values recommended by these international standards, corroborating with previous studies[33-35]. The mean flow diameter observed for Sealapex (19.98 mm) was close to the minimum values proposed, and similar to that observed for Endo CPM ($p>0.05$).

Significantly higher flow rates were observed for Fillapex ($p<0.05$), followed by AH Plus, Epiphany, and Epiphany SE. The flow observed for AH Plus was similar to values previously reported by other authors[25,32-34]. Epoxy resin is the component responsible for providing flow to these endodontic sealers[11]. The ideal sealer should not present excessive flow, because this increases the risk of extrusion into the periapical tissues[11]. Therefore, Fillapex may present greater risk of extrusion.

Considering the experimental conditions of the present work, it was possible to observe that although the endodontic sealers evaluated differed in terms of their radiopacity and flow values, all were in conformity with the ISO 6876/2001 and ANSI/ADA specifications.

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