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## Original Research Article

# Comparison of MTA Fillapex radiopacity with five root canal sealers

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## Abstract

**Introduction:** The endodontic sealer is a filling material whose physicochemical properties are mandatory for the achievement of endodontic therapy final goal. An ideal endodontic sealer should have some properties, including radiopacity. **Objective:** This study compared MTA Fillapex™ radiopacity with the radiopacity of five others endodontic sealers: Endométhasone-N™, AH Plus™, Acroseal™, Epiphany SE™ and RoekoSeal™. **Material and methods:** Five cylindrical samples of each sealer were used, constructed with the aid of a matrix. On an occlusal film, a sample of each sealer was placed along with an aluminum stepwedge and five radiographic shots were taken. The radiographic images were digitized and each sample's gray scales were compared with each shade of the aluminum stepwedge, by using software. **Results:** The results, in decreasing order of radiopacity, were: AH Plus™ was statistically the most radiopaque sealer (9.4 mm Al), followed by Epiphany SE™ (7.8 mm Al), MTA Fillapex™ (6.5 mm Al), RoekoSeal™ (5.8 mm Al), Endométhasone-N™ (4.5 mm Al), and Acroseal™, the least statistically radiopaque (3.5 mm Al). **Conclusion:** It can be concluded that MTA Fillapex™ was the third most radiopaque sealer among all tested sealers. Also, MTA Fillapex™ has the radiopacity degree in agreement with ADA specification No. 57 (1983).

## Introduction

One of the key points for reaching endodontic treatment success is tridimensional obturation of root canal systems [14]. Following proper shaping and cleaning phases, obturation aims to seal root canal system in order to allow a favorable environment for tissue repair as well as to avoid root canal reinfection.

The success of root canal obturation is reached not only by the technique employed, but also by the type of the material chosen for treatment [25]. Although endodontic obturation is mainly constituted by gutta-percha, endodontic sealers are used aiming to decrease the gap existing among gutta-percha points themselves and gutta-percha points and root canal walls [13, 14]. Consequently, endodontic sealers must present some physicochemical properties to qualify them as a good material [10, 13, 16, 18].

According to Grossman (1958) [9], the endodontic sealers, regardless of type, should exhibit some requirements, as follows: biocompatibility, easy insertion into and removal from root canal, viscosity while handling, good adhesion to root canal's walls, satisfactory handling time, promotion of a tridimensional sealing, dimensional stability, good flowing, good radiopacity, lack of color change, insolubility to tissue fluids and saliva, solubility to common solvents when necessary, impermeability, and antimicrobial activity.

ADA specification No. 57 (1983) [1] recommends that endodontic filling material's physical properties be evaluated by flowing, radiopacity, thickness, setting time, dimensional stability, solubility and disintegration tests.

Radiopacity property is important because an endodontic sealer must be radiopaque enough to be differentiated from neighboring anatomical structures (bone and tooth structures) and other dental materials (resin, amalgam, and cements) [7, 11, 24, 28, 29, 30].

Mineral trioxide aggregate (MTA) is indicated for a series of applications in Endodontics: perforations sealing, pulp capping, pulpotomy, apicification, obturation, biological plug, and retro-filling material [12, 31]. MTA is basically composed of calcium, silica, and bismuth [29]. Bismuth oxide accounts for MTA radiopacity. The new MTA-based endodontic sealer (MTA Fillapex®) composition is similarly to MTA, except from the addition of natural resin and nanoparticulate silica.

In order to use MTA Fillapex® as a new option for endodontic sealer, its physical properties must be confirmed, in agreement with the characteristics cited by Grossman (1958) [9] for the ideal sealer.

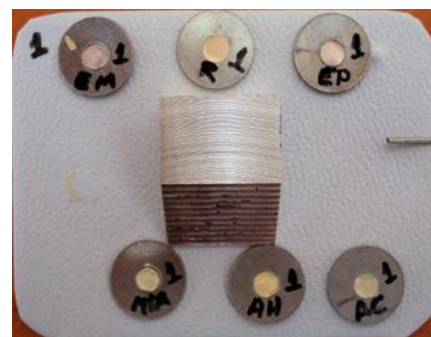
The aim of this study was to compare the radiopacity of MTA Fillapex® with AH Plus®, RoekoSeal®, Epiphany SE®, Endométhasone-N® and Acroseal® radiopacity.

## Material and methods

We used the following endodontic sealers Acroseal® (Septodont, France), AH Plus® (Dentsply, Konstanz, Germany), MTA Fillapex® (Angelus, Londrina, Brazil), Epiphany SE® (SybronEndo, USA), RSA RoekoSeal® (Roeko, Langenau, Germany), and Endométhasone-N® (Septodont, France).

The radiopacity test followed ANSI/ADA specification No. 57 (1983). Each endodontic sealer was manipulated according to the manufacturer's instructions. Following, with aid of a cylindrical matrix (5 mm diameter x 1 mm thickness), five samples of each endodontic sealer were constructed. Samples were kept in a heater, at 37°C, up to the last sample construction was completed.

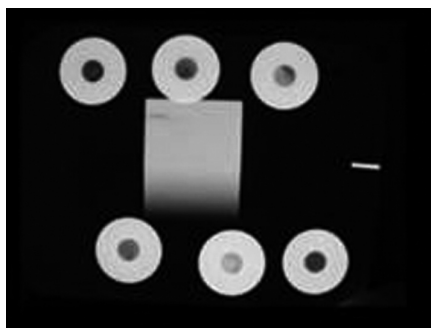
Next, each sealer sample was placed onto an occlusal film (Kodak Insight Speed E, Eastman Kodak Company, Rochester, USA) together with an aluminum 10-step wedge, each step measuring 1 mm height. Radiographs were obtained using the Gendex 765DC x-ray machine (Gendex Dental X-Ray Division, Dentsply International, Des Plaines, USA), at 65 kV, 7 mA, for 0.25 s of exposure time, and object-to-focus distance of 40 cm. Five radiographic shots were executed. One sample of each endodontic sealer and the aluminum stepwedge was placed onto the radiograph film (figure 1).



**Figure 1** – Occlusal film with the sealer samples and aluminum stepwedge in place for radiograph shot

Radiograph developing/processing was performed with an automatic device (Gendex GXP, Gendex Corporation, Des Plaines, USA). The radiographs were digitized in a digital camera (Canon 50D, Canon Inc, Tokyo, Japan). The photographs were obtained in macro mode (15

megapixel resolution) and a black paper covered all the light-box border surrounding the radiograph so that no light could alter the radiograph. The camera was kept at a standardized distance to allow that only the radiograph surrounded by the black border appeared on the photograph (figure 2).



**Figure 2** - Digitized image of the number 1 sample's radiograph

After images' digitization, areas with the same diameter of each sample and aluminum steps were compared and measured in a gray scale (0 to 255) by Adobe Photoshop version 7.0.1 software.

Data were analysed and the obtained numbers related to the gray-scale values were transformed into mm of aluminum (mm Al). Statistical analysis was performed by ANOVA by using each sealer mm Al mean.

## Results

One-way ANOVA and linear regression analysis confirmed the expectations regarding to the aluminum scale with different densities from 8 to 1 mm. We verified a radiopacity decreasing while the scale density decreased. The equation observed by the linear regression analysis evidenced that the radiopacity increase was significant with the density increase (table I).

**Table I** - Results obtained after the gray scale analysis, of each step of the aluminum scale, and each sealer (Photoshop gray scale ranges from 0 to 255 value, according to the increase of the gray shade. Photoshop gray-scale index of each tested sealer is already concerted into mm Al)

	Radiograph 1	Radiograph 2	Radiograph 3	Radiograph 4	Radiograph 5
<b>1 mm</b>	27	25	28	27	28
<b>2 mm</b>	43	37	44	42	44
<b>3 mm</b>	65	56	68	64	65
<b>4 mm</b>	87	59	92	88	90
<b>5 mm</b>	107	97	110	110	109
<b>6 mm</b>	126	115	129	126	127
<b>7 mm</b>	142	131	147	143	142
<b>8 mm</b>	154	143	159	156	156
<b>MTA Fillapex</b>	126/ 6.5 mm Al	113/ 5.8 mm Al	116/ 6.0 mm Al	143/ 7.4 mm Al	130/ 6.7mm Al
<b>AH Plus</b>	186/ 9.6 mm Al	176/ 9.1 mm Al	173/ 8.9 mm Al	178/ 9.2 mm Al	194/ 10 mm Al
<b>Epiphany</b>	142/ 7.3 mm Al	151/ 7.8 mm Al	166/ 8.6 mm Al	147/ 7.6 mm Al	150/ 7.7 mm Al
<b>Roeko</b>	96/ 4.9 mm Al	91/ 4.7 mm Al	131/ 6.8 mm Al	112/ 5.8 mm Al	134/ 6.9 mm Al
<b>Endométhasone</b>	58/ 3.0 mm Al	92/ 4.7 mm Al	103/ 5.3 mm Al	102/ 5.2 mm Al	86/ 4.4 mm Al
<b>Acroseal</b>	64/ 3.3 mm Al	62/ 3.2 mm Al	62/ 3.2 mm Al	52/ 2.7mm Al	96/ 4.9 mm Al

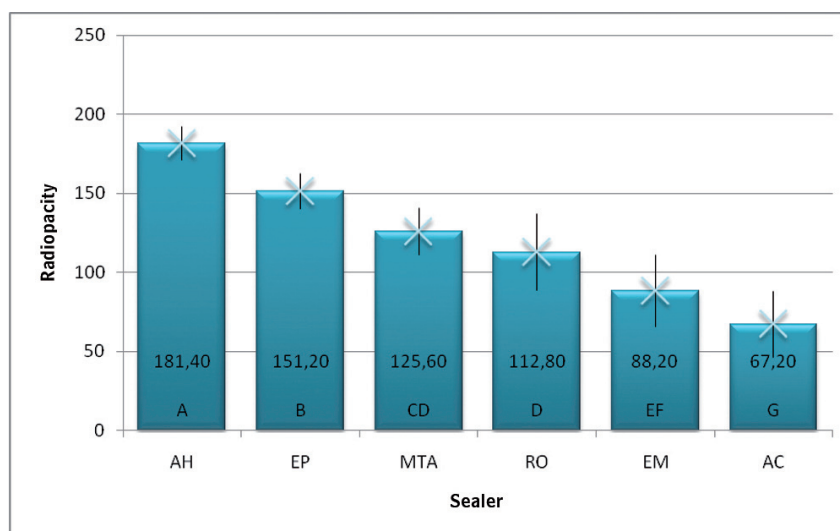
All tested sealers presented an mm-Al value above ADA requirements. ADA requirements demand that the radiopacity minimum must be above 3 mm of the aluminum stepwedge.

AH Plus® showed a mean of 9.4 mm Al significantly higher than all other sealers. Epiphany

SE® exhibited a mean of 7.8 mm Al significantly smaller than AH Plus® and significantly higher than all other sealers. MTA Fillapex® and RoekoSeal® presented means of 6.5 mm Al and 5.8 mm Al, respectively, without statistically significant difference between each other; however, these values

were smaller than AH Plus® and Epiphany SE®, but significantly higher than Endométhasone-N® (4.5 mm Al) and Acroseal® (3.5 mm Al). Endométhasone-N® showed a significantly higher mean than Acroseal®. This latter exhibited a significantly smaller mean than all the others.

In a decreasing order of radiopacity, AH Plus® (9.4 mm Al) was the most radiopaque sealer, followed by Epiphany SE® (7.8 mm Al), MTA Fillapex® (6.5 mm Al), RoekoSeal® (5.8 mm Al), Endométhasone-N® (4.5 mm Al), and Acroseal® (3.5 mm Al) (graph 1).



**Graph 1** - Result of the radiopacity of each tested sealer

AH = AH Plus; EP = Epiphany SE; MTA = MTA Fillapex; RO = RoekoSeal; EM = Endométhasone-N; AC = Acroseal

## Discussion

Radiopacity degree is mandatory for controlling root canal filling. A radiopaque filling material is important for its differentiation from tooth and periradicular anatomical structures, so that possible overfilling and lateral root canal filling can be controlled. Although there are specifications demanding only a minimum radiopacity limit, the extreme contrast of a material may lead to the false impression of a dense and homogenous filling [16].

Some clinical factors should be taken into account when deciding on the level of radiopacity. Bone, periodontal ligament, and dentin radiopacity presents different mm Al equivalencies. A sealer showing radiopacity above 3 mm Al is considered ideal for differentiation from, for example, lateral root canal obturation, over-filling, or anatomical structures [24].

In this study's radiopacity test, the endodontic sealers most employed in the Brazilian market were used: zinc oxide and eugenol-based sealer (Endométhasone-N®), silicon-based sealer

(RoekoSeal®), calcium-hydroxide-based sealer (Acroseal®), resin-based sealer (AH Plus®), methacrylate resin-based sealer (Epiphany SE®), MTA-based sealer (MTA Fillapex®). This latter was recently launched into the Brazilian market.

Several radiopacity studies have used the aluminum stepwedge comparison with different samples [7, 8, 29], in agreement with this study's methodology.

In our study, we used a conventional radiograph, because literature has demonstrated that there were no differences in results when either digital or conventional image is employed [2, 3, 5, 17]. Digital or conventional radiograph analysis methodology [21, 22] can be assessed by photodensitometry [20, 23] and radiograph digitization for posterior computer analysis. Tagger and Katz (2003) [27] applied this methodology to analyze endodontic sealer radiopacity by using standardized samples radiographed along with an aluminum stepwedge. In this method, the radiographs are digitized, and the samples compared with the aluminum stepwedge radiopacity through computer software. The evolution of the comparison with the digital



radiograph's image by applying an image analysis software makes simpler and easier the reproduction of the materials radiopacity [7, 26].

Baksi *et al.* (2008) [3] conducted a radiopacity study in which the sealer's radiopacity was compared as well as the methodology using digital and conventional radiograph. They found that Acroseal® was the least radiopaque sealer, in agreement with our results. Additionally, these authors concluded that there was no statistically significant difference between digital and conventional methods and both were valid for determining the smallest difference of a material's radiodensity distribution, showing either a higher or a smaller density.

According to graph 1, all sealers met ADA minimum requirements. The results demonstrated that AH Plus® and Epiphany SE® exhibited radiopacity greater than the other sealers. This result is similar to those found by other authors, in literature [4, 19, 26, 28, 30], where AH Plus® showed the highest radiopacity in comparison with silicon-based, calcium hydroxide-based and zinc oxide and eugenol-based sealers.

Concerning to calcium hydroxide-based sealers, our results are in agreement with literature. These sealers are generally the least radiopaque sealers, in comparative studies [3, 6, 15]. In our study, Acroseal® presented the smallest radiopacity.

MTA-based sealer (MTA Fillapex) exhibited a satisfactory radiopacity value (6.5 mm Al), similar to that found by Tanomaru *et al.* (2009) [29] with CPM Sealer® (6.3 mm Al), also a MTA-sealer.

## Conclusion

According to the methodology used and the analysis of the results, it can be concluded that:

- MTA Fillapex® sealer shows the third highest radiopacity in comparison with the other tested sealers;
- MTA Fillapex® sealer has a radiopacity degree in agreement with ADA specification No. 57.

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