Sealer influence on radiopacity of single cone root canal fillings

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ABSTRACT

Objective: The aim of this study was to evaluate the influence on radiopacity of AH Plus and Endofill sealers used in single cone obturation of simulated canals. **Methods:** Twenty resin blocks with simulated curved root canals were prepared until F3 ProTaper rotary instrument. After the final irrigation, the canals were dried with paper points and a F3 gutta-percha point was inserted into the canal, and then a digital radiography was taken for each sample. Two experimental groups (n = 10) were randomly distributed according to the sealer. Endofill and AH Plus were the sealers associated to the gutta-percha for canal fillings. After the setting of sealers, new digital images were performed in the same manner as preoperative radiographics. Radiographic images of pre and post sealer association with gutta-percha were overlaid and analyzed to register the pixels number of the images. Statistical analysis was performed using the Student's t-test and Wilcoxon Signed-Rank test; the significance was set at 5%. **Results:** Both groups showed similar radiopacity of gutta-percha ($p > 0.05$). However the addition of sealer significantly increased ($p < 0.05$) the radiopacity of radiographic images. The radiopacity was increased in 68.10% with AH Plus sealer and 46.02% with Endofill sealer, with statistically significant difference between the sealers. **Conclusions:** The sealer addition significantly increased the radiopacity in obturations with single cone technique. The AH Plus was more radiopaque than Endofill sealer.

Keywords: Endodontics. Root canal obturation. Root canal filling materials. Gutta-percha. Physical properties.

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Introduction

A three-dimensional root canal filling should prevent bacterial leakage from the oral cavity to periapical tissues, so this procedure step is closely related to the quality and success of endodontic treatment.[1] Besides preventing ingrowth of bacteria, the sealing ability of the root filling must promote the entombment of remaining microorganisms and prevent stagnant fluid used as nutrients for bacteria.[2] The root canal systems have a great anatomic variability and should be filled with an inert, dimensionally stable and biocompatible material.

The gutta-percha has been the main solid filling material used as a central core and presents better performance when associated with a flowable endodontic sealer, which is responsible to fill voids and provide adhesiveness to the root canal walls.[2] Several properties should be consider to indicate a root filling materials, among them the degree of radiopacity is fundamental to allow the professionals to make a clear distinction between the materials and surrounding anatomic structures and to control root fillings quality.[3,4]

The introduction of NiTi rotary files established a new scenario to the root canal instrumentation due to more efficient procedures, with regard to safety and faster working time.[5] Despite of different systems, the preparation of the root canals tends to show diameter and taper directly corresponding to the used instrument; so the use of a gutta-percha point that matches the geometry of nickel-titanium instruments[6,7] in a single cone technique could provide a faster procedure[8] and satisfactory sealing of obturation.[9,10]

The digital radiography is a widely used device in endodontic practice and also used in laboratory researches to evaluate the radiopacity of root canal sealers using different softwares for the quantitative analysis of radiographs.[11-13] The type and the thickness of root canal sealers can influence the radiopacity of the root fillings,[12] so it is important to evaluate different sealers in association to single cone technique, especially due to the unclear influence of the sealer radiopacity when performing larger root canal preparation.

The aim of this study was to evaluate the radiopacity influence of AH Plus and Endofill sealers used in single cone obturation of simulated canals.

Materials and Methods

Sample preparation and radiographic imaging

Twenty resin blocks with simulated curved root canals with 17 mm length and 60° angle of curvature (IM do Brasil Ltda, São Paulo, Brazil) were used in the study. A #10 K-file (Dentsply Maillefer) was inserted in the root canals until it reached the apical foramen, so the working length was established 1 mm shorter than the apical foramen. The root canals were prepared with ProTaper rotary files system (Dentsply Maillefer, Ballaigues, Switzerland) until a F3 instrument, using a X-Smart electric motor (Dentsply Maillefer) at 250 rpm. Canal irrigation was performed with 3 mL of 1% sodium hypochlorite after the use of each instrument.

After the final irrigation the canals were dried with paper points and a F3 gutta-percha cone (ProTaper, Dentsply) was inserted into each canal. Then the samples were placed in the central region of a digital radiography sensor of (RVG 5000, Eastman Kodak Company, Rochester, USA) and the images were taken with a dental X-ray device (70 Spectro X-Dabi Atlante, Ribeirão Preto, Brazil) using 70 kVp, 8 mA, 0.08 seconds exposure time and target distance of 8 cm.

The samples were randomly distributed into two experimental groups (n = 10), AH Plus (Dentsply) and Endofill (Dentsply) were the sealers associated to the F3 gutta-percha (Dentsply) for root canal fillings. The gutta-percha points were coated with sealers that were mixed according to manufacturer's instructions and then inserted into the canals until the established working length. Excess material was seared off and condensed with a plugger 1 mm below the canal orifice.

All specimens were stored at 37°C with 100% humidity for 48 hours, then new radiographs were performed in the same manner as preoperative radiographic images.

Radiography analysis

Radiography images of pre and post sealer association with gutta-percha points of each sample were overlaid and cut at the same cervical level, to present the identical length; then each image was analyzed with Adobe Photoshop CS5 software using the "histogram" tool, in order to register the pixels number of the images. The same range of gray tones was used for both images.

Statistical analysis

The preliminary analysis of pixels data with Kolmogorov-Smirnov test showed normal distributions. Statistical analysis was performed using the Student's t-test; Wilcoxon Signed-Rank test was used for intragroup analysis. The significance was set at 5% and the Prism 5.0 software (GraphPad Software Inc, La Jolla, CA, USA) was used as the analytical tool.

Results

In both groups the radiopacity of gutta-percha was similar ($p > 0.05$). However the addition of sealer significantly increased ($p < 0.05$) the radiopacity of radiographic images for both groups. The radiopacity was increased in 68.10% with AH Plus sealer and 46.02% with Endofill sealer, with statistically significant difference between the sealers. The results are show in Table 1, and representative samples are presented in Figure 1.

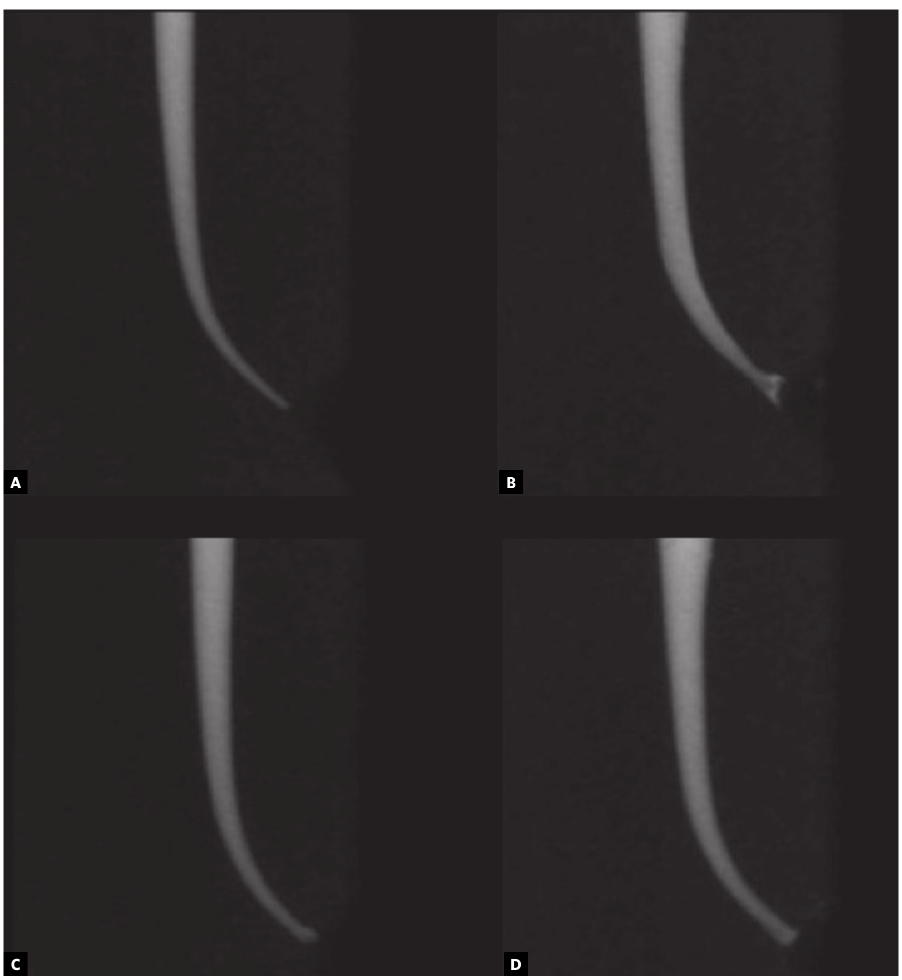

Figure 1. Radiographic images of F3 gutta-percha points (**A** and **C**) and the same points associated with AH Plus (**B**) and Endofill (**D**) sealers.

Table 1. Mean and standard deviation of number of pixels in radiographic images.

	Group	n	Mean	SD	%
G1	GP	10	3183.80[a]	322.62	68.10[a]
	GP + AH Plus	10	5331.60[b]	567.94	
G2	GP	10	3204.90[a]	438.47	46.02[b]
	GP + Endofill	10	4659.20[c]	574.72	

*GP means gutta-percha. Different superscript lower case letters in each column indicate statistically significant differences ($p < 0.05$). The last column indicates the percentage of radiopacity increase with sealer addition.

Discussion

The radiopacity is a fundamental property of obturation materials because it allows to clinically control the placement and quality of root canal fillings. However this property must be balanced because a filling material shall be visible the minimum necessary for disclosure and differentiation with other structures. On the other hand, the presence of a strong radiographic contrast can lead to erroneous assessment of the obturation quality when evaluating the radiographic image.[2] According to Brito-Júnior et al,[14] the material used for root filling and the voxel resolution can influence the presence of streaking artifacts observed in cone bean computed tomography images.

Beyer-Olsen and Orstavik[4] proposed the use of an aluminum step wedge with 2mm-increments to show the radiopacity of root canal sealers as a standard comparison mode. Usually the radiopacity test for root canal filling materials recommend that samples should be made by using a metallic ring measuring 10mm in inside diameter and 1mm thickness. After complete setting time of sealers, the samples are radiographed together with an standard aluminum step-wedge, used as reference. So the radiopacity value is determined according to the radiographic density and converted into millimeters of Al.[4,11,15-19]

The ISO 6876/2001 standards recommends that root canal filling materials should be radiopaque at least as a 3 mm-thick equivalent in the aluminum wedge. According to the ANSI/ADA #57 specification, the obturation materials should present a radiopacity higher to 2 mm of aluminum in comparison to bone or dentin. The conventional gutta-percha points are about 6 mm Al-equivalents[2,18] and the most common endodontic sealers range 3-15 mm Al-equivalents.[3,13,15-17,20]

Zinc oxide-eugenol-based root canal sealers presents low radiopacity, among different commercial brands; the Endofill showed a radiopacity ranging from 4 to 6 mm Al.[16,21] Barium sulfate is the responsible for this property. But the powder/liquid ratio could interfere in the radiopacity property. In a previous study, Camps et al[20] showed that a higher powder/liquid ratio promoted a significantly higher radiopacity.

Other endodontic sealers are produced as two pastes, a base and a catalyst. The AH Plus sealer is a two-tube system, one tube contains epoxy resins (Bisphenol A/F) and the other contains polyamines (Dibenzyldiamine, aminoadamantane and tricyclodecane-diamine). This sealer contains zirconium oxide, which contributes for its greater radiopacity; however, some studies showed variable results ranging from 6.3 to 14.85 mm Al.[3,13,15-17,22] But it is important to consider the portion of pastes in the tubes, as from the beginning, middle or end in which they were supplied, Baldi el at[22] showed that segregation occurs between the organic and inorganic components of AH Plus sealer, thereby changing its radiopacity.

But the minimum necessary values of radiopacity can be considered low and the clinical application of traditional methodology may be questionable. In clinical situation the soft tissue, bone, dentin, sealer, and gutta-percha cones constitute the overall density value of the root canal filling.[12] Thus some authors have proposed the evaluation of radiopacity in simulated root canal fillings considering the interaction of different materials, gutta-percha and sealer.[12] In the present study were used simulated root canals in transparent acrylic teeth to evaluate the radiopacity of gutta-percha and its association with cement; it was found that the sealers increased the radiopacity of fillings, in agreement with the results of Baksi et al.[12] study.

Digital radiography is an important tool to endodontic practice and increasingly more common. According to a previous study[23] the image quality of a digital system was considered as good as conventional film images and superior to cone beam computed tomography images, for the evaluation of both homogeneity and length of root fillings in single-rooted teeth. Other studies also showed no differences between digital images and conventional radiographs for simulated voids detection in root fillings.[24] On the other hand, some authors showed that material's radiopacity measured on the digital sensor was greater as compared with film.[18] Akcay et al.[11] found that the choice of the imaging system may effect radiopacity measurements, and suggested that the radiopacity recorded on traditional or digitalized films may not be equal to the radiopacity recorded using a digital sensor.

The present study evaluated the mean grey values of the materials using the histogram analysis function of Photoshop software as a previous study,[11] and results showed that the AH Plus was more radiopaque than Endofill sealer, as found by other authors,[3,21] but on closer simulation of the clinical condition due to the employed methodology. It is an important data because the type of root canal sealer can affect the clinical evaluation of the root canal filling, as detecting filling voids during radiographic analysis.[25,26]

Conclusions

The sealer addition significantly increased the radiopacity in obturation with single cone technique. The AH Plus was more radiopaque than Endofill sealer.

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