

# Comparison of Radiopacity of Six Endodontic Sealers

## Original Article

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## Abstract

**Introduction:** Optimal radiopacity is one of the properties required for a root canal sealer that helps the distinction between the sealer and surrounding anatomic structures and evaluation of the quality of root filling. So, the purpose of this study was to evaluate the radiopacity of six root canal sealers at different focal distances.

**Materials and Methods:** In this in vitro study, six endodontic sealers (ADSEAL, AH26, AH plus, Dorifill, MTA fillapex, and ZOE), were prepared and placed in a mold with 1mm thickness and 10mm diameter. The specimens were positioned alongside an aluminum step wedge on a digital detector (occlusal size 76×57 mm). Radiographic imaging was performed at 15 and 30cm focal distances and radiopacity of each specimen was measured. One-way ANOVA and paired t-test were used and  $p < 0.05$  was considered significant.

**Results:** All sealers were found to be more radiopaque than 3 mm aluminum. At 15cm focal distance, the radiopacity values were 31.7, 60.68, 121.48, 52.4, 48.6, and 48.08 aluminum for ADSEAL, AH26, AH plus, Dorifill, MTA fillapex and ZOE, respectively. At 30cm focal distance, the figures were 80.32, 153.6, 253.6, 139.92, 144.08, and 129.92 for ADSEAL, AH26, AH plus, Dorifill, MTA fillapex and ZOE, respectively.

**Conclusion:** All of the sealers investigated in this study met the standards for minimal radiopacity. AH plus had the highest radiopacity at both focal distances. Radiopacity decreased by increasing the focal distance and the decline was statistically significant for AH plus.

**Key words:** •Endodontic •Digital •Radiography

## Introduction

One of the most important steps in root canal therapy is filling the canal after it is cleaned and shaped.<sup>(1)</sup> Although guttapercha is not an ideal root canal filler due to lack of appropriate flow and adhesiveness to canal walls, it is still the first option for root canal filling.<sup>(2)</sup> A satisfactory seal cannot be obtained without the use of a sealer, because guttapercha does not spontaneously bond to dentinal walls. An ideal endodontic sealer should flow along the entire canal wall surface and fill all the voids and discrepancies between guttapercha and canal walls to minimize the failure of an endodontic treatment.<sup>(3,4)</sup> It should have optimal radiopacity to be distinguished from proximal anatomic structures such as tooth and bone.<sup>(5,6)</sup> Higginbotham was the first to publish a study comparing the radiopacity of different endodontic sealers and guttapercha used for root canal filling.<sup>(7)</sup> Standard of ISO 68701/2001 specified the equivalent of 3mm thickness of aluminum as the minimum radiopacity of guttapercha and endodontic sealers. According to ANSI/ADA specification No. 57, radiopacity of an endodontic sealer should be at least the equivalent of 2mm aluminum more than dentin and bone.<sup>(8)</sup> As radiography is used to assess the quality of root canal filling, less than standard radiopacity of a sealer can be misdiagnosed as a void. Thus, the aim of this study was to evaluate the radiopacity of six endodontic sealers and the relationship of the radiopacity of sealers and the distance between X-ray source and image receptor.

## Materials and Methods

Six kinds of sealers used in this experimental study were selected from currently available sealers in Iran as follows: AH26 (Dentsply, USA), AHplus (Dentsply, jmbUSA), ADSeal (META BIOMED, South Korea), Dorifill (Dorident, Austria), ZOE (Golchay, Iran) and MTA fillapex (Angelus, Brazil).

Five specimens of each sealer were prepared on a glass slab using a mixing spatula according to the manufacturer's instructions and placed in brass ring molds (6mm diameter and 1mm height). Sealers were placed in the molds using a syringe and vibrated for one minute to avoid emergence of bubbles (Figure 1). A glass plate was used to ensure the top surface was smooth and all excess materials were removed. Specimens were stored in a moist chamber at 37°C for 7 days. A radiograph was taken of each specimen and it was excluded if a void was seen. An aluminum step wedge (Radraresh, Iran) was made of 93.04% pure aluminum from 1mm to 12mm, in uniform steps of 1mm each (Figure 2).

Radiographs were obtained using an occlusal size (76x57 mm) PSP sensor with spatial resolution of 6 lines per millimeter and a dental X-ray machine (Minray, Soredex, Finland) operating at 70 kVp and 7 mA and focal distance of 15 and 30 centimeters. Three specimens were randomly selected and placed on the sensor along with the aluminium step wedge for each exposure. Radiopacity was measured using Density Measurement option in Diagora™ for Windows 2.5 software. Results were analyzed by calculating the means of five measurements per sample (one point in the central area and four points in the different quadrants) and registered as grey level (0-255) (Figure 3). To minimize the errors in positioning the sample related to step wedge and its accidental position in the occlusal sensor, five samples were prepared out of each sealer and the final digit was the mean value of five measurements.

Radiopacity was expressed in millimeters of aluminum equivalent. Statistical analysis was performed by one-way ANOVA and Paired t-test. If significant, Scheffe was used for post hoc test. SPSS 18 software was used and p-value less than 0.05 was considered significant.



Figure 1: Step wedge and specimens in brass ring mold placed on the digital sensor



Figure 2: Aluminum step wedge

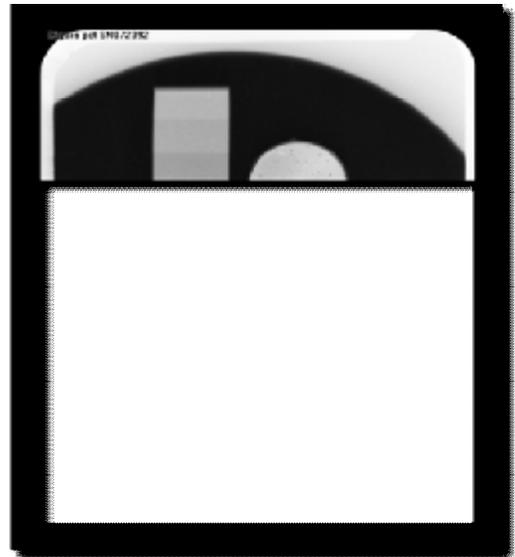


Figure 3: Digital radiographic image of specimens beside the step wedge

## Results

Table 1 shows the mean values and standard deviations of radiopacity of the materials investigated in 15 and 30 centimeters distances.

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At both distances, AHplus was the most opaque sealer and the least opacity was related to ADSEAL. ( $p < 0.001$ )

Radiopacity of all sealers decreased by increasing distance and the reduction was significant for AHplus. ( $p < 0.001$ )

Table 1: comparison of radiopacity (mm aluminum) of different sealers investigated at 15 and 30 centimeters distances

Group	15			30		
	min	max	mean±SD	min	max	mean±SD
ADseal	2.49	7.77	4.92±1.82a	3.50	5.40	4.61±0.46a
AH26	6.09	12.99	9.73±1.97b	7.09	10.10	8.94±0.58b
AHplus	14.73	21.58	18.7±1.89*c	12.29	14.52	13.66±0.54*c
Dorifill	4.73	11.90	8.53±2.15b	6.90	8.97	8.04±0.58b
MTA fillapex	7.78	11.18	9.21±1.04b	7.36	9.26	8.28±0.45b
ZOE	4.4	10.27	7.83±1.91b	6.50	8.33	7.41±0.48

\*significantly different in each column ( $p < 0.05$ ) - Same letters in each column refer to non –statistical significance at  $\alpha = 0.05$

## Discussion

The current study showed that all of the sealers investigated, met the standards of ISO 6870/2001 for minimum radiopacity. ADSEAL and AHplus had the most and the least radiopacity respectively. This is in agreement with the results of previous studies;<sup>(9-13)</sup> although Tagger et al. showed that AH26 was more opaque than AHplus.<sup>(14)</sup> The difference may be due to different aluminum alloys used for step wedge (more than 98% versus 93%) and differences in receptor (conventional film versus digital receptor) and focal distances.

Radiopacity is a critical characteristic of sealers. In resin sealers, radiopacity can simply change by adding mineral opacifiers, such as what happened when 1.5 $\mu$ m particles of zirconium oxide and 8 $\mu$ m particles of calcium tungstate were added to AHplus sealer. These particles consist 76% of the sealer's weight and highly radiopaque even in very thin layers.<sup>(15)</sup> This fact, caused the higher radiopacity of AHplus compared to other sealers used in this study. Bismuth oxide and silver and titanium dioxide are used as fillers in AH26. The opacifier agents in ZOE are zinc oxide and barium sulfate; while bismuth trioxide and barium sulfate are used to increase the opacity of MTA fillapex.<sup>(16)</sup> Zirconium oxide is also used as filler in ADSEAL.<sup>(9)</sup> In our study, ADSEAL had the least radiopacity that was in agreement with the study of Tasdemir et al. Probably, this is related to less radiopaque fillers used in this sealer.<sup>(13)</sup>

According to ANSI/ADA 2000, the focal distance in experimental studies is considered 30 centimeters. To generalize to clinical practice, we evaluated the effect of focal distance on the radiopacity of sealers. Re-

sults showed that the radiopacity of all sealers decreased by increase in focal distance. This was in agreement with the study of Gu et al.<sup>(17)</sup>

In our study, the range of radiopacity of all sealers was 4.61 to 8.94 except for AHplus that was 13.66. Maybe an extraordinary increase in filler amounts can cause some problems in diagnosis because of increased radiopacity. Regarding the results of this study, it seems that in addition to minimum radiopacity, the acceptable diagnostic range should be considered when assuming a standard for a sealer and the manufacturers should take it into consideration while adding radiopaque fillers to a sealer.

Further studies with sufficient sample size considering all of the relevant factors such as type of collimator and processing condition are recommended.

## Conclusion

All of the sealers, AHplus, AH26, MTA fillapex, Dorifill, ZOE and ADSEAL met the standards for minimum radiopacity. AHplus showed the widest range of radiopacity among the sealers. Radiopacity of the sealers decreased by increase in focal distance and the decline was statistically significant for AHplus.

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