

# In vitro study of the flow rate of five root canal sealers: Endofill, AH Plus, MTA Fillapex, Sealer 26 and Pulp Canal Sealer EWT

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## ABSTRACT

**Objective:** The aim of this study was to investigate in vitro the flow rate of the following commercially available root canal sealers: Endofill, AH Plus®, MTA Fillapex®, Sealer 26 and Pulp Canal Sealer EWT. **Material and Methods:** The sealers were manipulated according to manufacturer recommendations. The flow rate was determined in accordance with ADA (American Dental Association, 1993) specification # 57. In comparing the groups ANOVA (analysis of variance) was performed, and subsequently, Tukey

test at 95% confidence level. **Results:** According to the results, MTA Fillapex® root canal sealer showed the highest flow rate among the five sealers, and AH Plus® was the only sealer to exhibit a statistically significant flow rate after 24 and 48 hours. **Conclusions:** The authors therefore concluded that all tested sealers had a higher flow rate than the minimum recommended by ADA Specification # 57. MTA Fillapex® root canal sealer however was superior to the other sealers in terms of flowability.

**Keyword:** Endodontics. Root canal obturation. Flow.

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## Introduction

Endodontic treatment can only be considered successful when —radiographically and consistently— one can verify the integrity of the lamina dura along with the repair of a preexisting apical periodontitis. Furthermore, the tooth should be asymptomatic.<sup>1</sup> A successful root canal system (RCS) obturation is related to the inter-complementary action of this endodontic triad: coronal access, sterilization-modeling and root canal obturation. This stimulates the periapical tissue healing process while preventing reinfection by microorganisms.<sup>2</sup>

Ingle<sup>3</sup> ascribed the failure of endodontic treatment to incomplete filling of the RCS. Therefore, the use of a root canal sealer in combination with cones during the filling phase should three-dimensionally fill the RCS.<sup>4</sup> Among their functions during obturation, root canal sealers act by lubricating and assisting in seating the main cone, participating as a bonding agent between the cones and the root canal walls, as well as by filling the anatomical spaces that the primary filling material might have failed to reach. As a result root canal sealers significantly influence the end-result of endodontic treatment.<sup>5</sup> According to Grossman,<sup>6</sup> the ideal characteristics of a good root canal sealer are: to promote proper sealing, being homogeneous and radiopaque, having fine dust particles, not undergoing shrinkage after hardening, not staining the tooth structure, being bacteriostatic, exhibiting slow setting, being impervious to oral fluids, being well tolerated by periapical tissues, and being soluble to ordinary solvents.

According to their composition sealers can be classified as resin-based sealers (AH Plus), zinc oxide and eugenol-based sealers (Endofill and Pulp Canal Sealer), calcium hydroxide-based sealer (Sealer 26) and glass ionomer-based sealers. Among the new formulations recently launched in the market is a canal obturation product (MTA Fillapex<sup>®</sup>) based on MTA (Mineral Trioxide Aggregate).

Among the key factors during obturation is the flow rate of the root canal sealer. Ultimately, flowability pertains to the root canal sealer's ability to penetrate the lateral and accessory canals, and irregularities in the RCS so that the greater its flow rate, the higher its penetration potential.<sup>7</sup> This study aimed to compare the flowability of five different endodontic sealers.

## Methods

The root canal sealers selected for this study were: Endofill, AH Plus, MTA Fillapex, Sealer 26 and Pulp Canal Sealer EWT. The sealers were handled according to manufacturer recommendations.

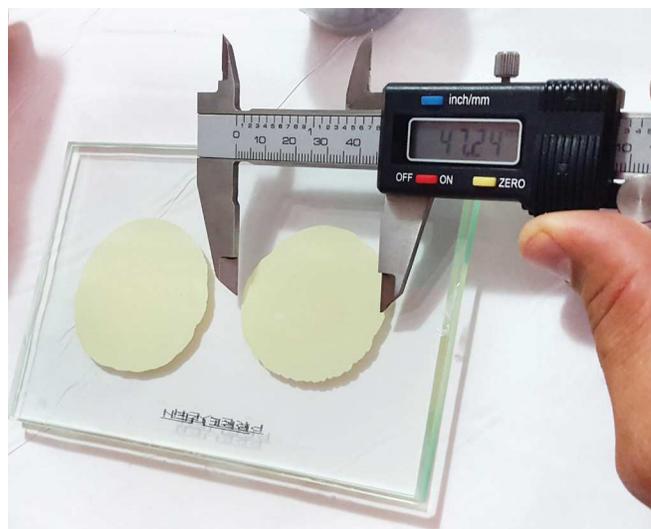
Flow rate was achieved in accordance with ADA Specification #57 (American Dental Association). The sealers were mixed to an ideal consistency, yielding a volume of 0.5 ml set to a 3 ml Luer syringe in an air conditioned environment at a temperature of 22°C.

The test was performed in duplicate for each sealer and an arithmetic mean reached, which represented the flow rate of the materials.

Thus, after manipulation, 0.5 ml of the sealer were placed on one side of the glass slab and another 0.5 ml of the same sealer on the other side of the slab, which was 10 cm wide and 15 cm long. Another glass slab was then placed on top of the manipulated sealer in equal proportions to the slab used to manipulate the sealer, in addition to a load of 120 grams. Ten minutes afterwards the weight was removed and the diameter of the discs formed by the sealers was measured using a digital caliper (Fig 1).

These measurements were taken at times 10, 20, 30 and 60 minutes, 24 hours and 48 hours.

For the statistical analysis the measures of central tendency, mean dispersion and standard deviation were



**Figure 1.** Disc diameter measurement performed with a digital caliper.

carried out for each group and each time. For comparison between groups and between times ANOVA (analysis of variance) was performed and subsequently Tukey test, all at 95% confidence level.

### Results

With a view to facilitating the analysis the sealers in this study were named Sealer A (Endofill), Sealer B (AH Plus), Sealer C (MTA Fillapex), Sealer D (Sealer 26), and Sealer E (Pulp Channel Sealer).

Table 1 depicts the means and standard deviations for each group and time comparing the differences among groups at each time.

MTA Fillapex root canal sealer exhibited the highest flow rate while Sealer 26 showed the worst flow rate (Fig 2).

This result was consistent at all times. No difference was found between Endofill and AH Plus, with the exception of times 24 and 48 hours, when AH Plus sealer showed a higher flow rate.

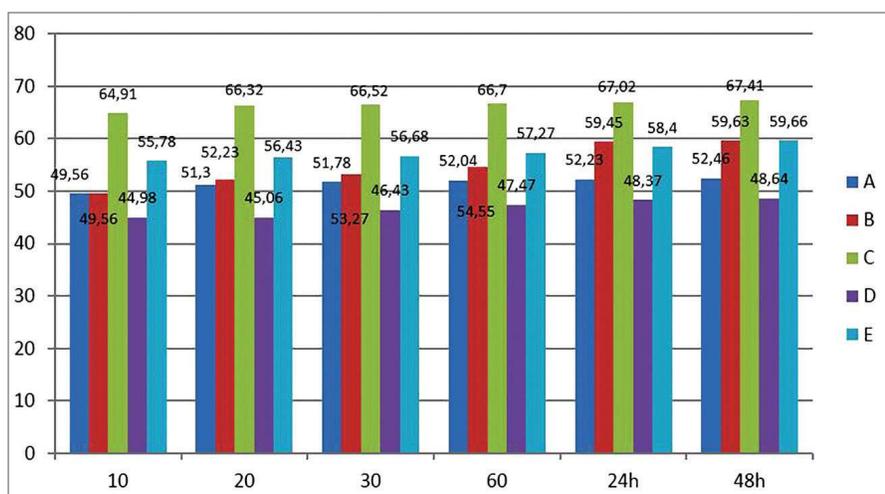
Both Sealer 26 and Pulp Canal Sealer showed an increase in the flow rate, although not statistically significant. Moreover, the latter (Pulp Canal Sealer) presented an average performance at all times.

Endofill and MTA Fillapex showed no increase in flowability over time.

**Table 1.** Mean and standard deviation per group and time.

Time	Root Canal Sealer										Statistics F	p
	A		B		C		D		E			
	X	SD	X	SD	X	SD	X	SD	X	SD		
10 min (a)	49.56	3.28	49.56	3.28	64.91	3.08	44.98	0.61	55.78	1.55	17.58	0.004
20 min (b)	51.30	7.54	52.23	3.30	66.32	3.23	45.06	0.69	56.43	2.14	7.45	0.025
30 min (c)	51.78	7.23	53.27	3.02	66.52	3.32	46.43	1.37	56.68	1.92	7.14	0.027
60 min (d)	52.04	7.01	54.55	3.12	66.70	3.16	47.47	1.54	57.27	1.48	7.01	0.028
1440 min (e)	52.23	7.10	59.45	1.77	67.02	3.38	48.37	1.20	58.40	1.58	7.46	0.025
2880 min (f)	52.46	7.25	59.63	1.87	67.41	3.24	48.64	1.06	59.66	2.04	7.37	0.025

A = Endofill, B = AH Plus, C = MTA Fillapex, D = Sealer 26 and E = Pulp Canal Sealer.



**Figure 2.** Flow rate: A = Endofill, B = AH Plus, C = MTA Fillapex, D = Sealer 26 and E = Pulp Canal Sealer.

## Discussion

The literature emphasizes that flowability is among the most important physical properties of root canal sealers, although researchers have not yet determined an optimal flow rate value. This lack of standardization of evaluation methods, despite the use of international specifications,<sup>8</sup> entails glaring contradictions between the values currently obtained by different researchers.

Grossman<sup>9</sup> found that the size of the sealer powder particles did not alter flowability.

Benatti et al<sup>10</sup> examined powder-liquid ratio and concluded that an increase in the amount of powder induced a decrease in flowability, which in turn impaired obturation.

Orstavik,<sup>11</sup> on the other hand, confirmed that any weight applied to the sealer can influence its flow rate. Thus, it would be fair to assert that the sealing technique, i.e., the pressure applied during filling, is closely related to the sealer's flowability.

This study evaluated the flow rate of five brands of root canal sealers widely used in endodontic therapy today. It revealed that MTA Fillapex<sup>®</sup> had the highest flow rate of all five sealers. However, this sealer showed no significant increase in its flow rate over time.

Moreover, AH Plus, which showed no more than an average flow rate at first compared to the others was the only sealer that achieved a statistically significant flow increase over 24 hours and 48 hours ( $p < 0.05$ ).

MTA Fillapex<sup>®</sup> root canal sealer was designed in an attempt to combine the physical and chemical properties of a sealer with the biological properties of MTA (mineral trioxide aggregate).

MTA is a sealer composed of tricalcium oxide and other mineral oxides such as tricalcium silicate and silicate oxide. Some properties, such as biocompatibility, low cytotoxicity and antimicrobial action give MTA some advantages in dental use. Thus, MTA Fillapex<sup>®</sup> was formulated having this sealer as a base. This is a calcium silicate based root canal sealer recently introduced in the market. Its composition comprises essentially MTA, salicylate resin, natural resin, bismuth oxide and silica. According to the manufacturer (Angelus, Londrina, PR, Brazil) this sealer boasts excellent properties that provide optimum sealing of the root canal system.<sup>12</sup>

However, few independent studies have evaluated the physicochemical properties and the potential of this sealer in actual practice. This study demonstrated that, in fact, MTA Fillapex<sup>®</sup> has a huge flow potential which is superior to the other four sealers in this study. In this respect, this study corroborates other research by Silva et al,<sup>12</sup> in 2013, which showed that the flow rate of MTA Fillapex<sup>®</sup> was significantly higher than that of AH Plus.

According to the aforementioned authors the composition of the different sealers and the size of their particles are determining factors in their flowability. Due to these properties MTA Fillapex<sup>®</sup> penetrates more easily into the ramifications and irregularities of the root canal system than AH Plus<sup>®</sup>, since the former exhibited in their study a higher flowability.

AH Plus is a fine example of a cutting edge resin-based root canal sealer developed with the purpose of advancing endodontic practice. It consists of two pastes comprising an epoxy resin polymer combining an enhanced, improved version of the classic AH 26<sup>®</sup> root canal sealer. According to the manufacturer AH Plus<sup>®</sup> provides biocompatibility, radiopacity, color stability, easy removal, proper fluidity with low shrinkage and solubility.<sup>2</sup>

In the present study, although MTA Fillapex<sup>®</sup> presented increased flow, AH Plus<sup>®</sup> was the only sealer that showed a significant flow rate after 24 and 48 hours.

This information corroborates the study by Bouillaguet et al<sup>13</sup> where AH Plus, after 24 hours, showed better flowability than GuttaFlow<sup>®</sup> and Epiphany<sup>®</sup>.

It is worth noting that, despite the importance of a sealer's flowability, if the flow is excessive there is a risk of the sealer overflowing into the periapex, which can damage the periapical tissues or cause painful symptoms.

The literature comprises a number of studies evaluating the biological properties and cytotoxicity of AH Plus. However, only few studies can be found comparing the flow rate of AH Plus with that of MTA Fillapex<sup>®</sup> root canal sealer given the fact that it has only recently been launched in the market.

It is therefore necessary that further research be conducted in order to investigate more thoroughly the physical properties of these materials.

## Conclusions

The authors concluded that all tested sealers conform to ADA Specification # 57. MTA Fillapex® root canal sealer however was superior to the other sealers in terms of flowability. The authors further concluded that AH Plus root canal sealer was the

sole sealer to present flowability after 24 hours and 48 hours. Given that MTA Fillapex® has only recently been launched in the market further studies are warranted to investigate the potential impact of the product's overfilling into the periapical tissues due to its high flowability.

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