Physicochemical properties of AH Plus and Sealer Plus cements: hardening and flow time

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ABSTRACT

Introduction: Endodontic treatment seeks to sanitize the root canal system to allow adequate three-dimensional filling, for which plastic materials such as guttapercha are required, associated with endodontic cements with adequate physico-chemical characteristics. **Methods:** Comparison of the physico-chemical properties hardening and flow time of the AH Plus and Sealer Plus endodontic sealers according to the American Dental Association / American Dental Association Specification 57 for sealing materials. **Results:** The hardening time of the AH Plus was 1178 minutes and the Sealer Plus was 422 minutes. The AH Plus flow was 3259 millimeters and the Sealer Plus was 3150 millimeters. **Conclusions:** The AH Plus hardening time was higher when compared to the Sealer Plus cement and there was no statistical difference in the flow between the cements studied.

Keywords: Endodontics. Dental Cements. Root Canal Obturation

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Introduction

Technology has been improving Endodontic procedures providing comfort, practicality and a more affordable cost to patients who resort to it. Thus, like a good part of the Dentistry specialties, Endodontics has been evolving rapidly, demanding, from the professional, a constant review of knowledge and mastery of execution techniques.

The filling materials must fill the entire pulp root cavity, previously occupied by the pulp tissue and provide the biological sealing of the apical foramen, concluding the endodontic treatment.[1] During the evolution of Endodontics, numerous materials were used, however, an intense search still persists today for a material that includes several physical-chemical characteristics that guarantee a good seal, which motivates the study of the properties of the existing materials and the research for the development of new materials.

Cements are divided according to their chemical composition: zinc oxide and eugenol cements, calcium hydroxide cements, glass ionomer cements, based on epoxy resin, based on methacrylate and based on polymeric resin. With the wide variety of commercially available cements, there is a need for the characteristics of each to be researched and put into analysis.[2]

Among the resin cements, AH Plus (Dentsply Sirona, Konstanz, Germany), based on epoxy resin, has been considered the gold standard, since it has good flow capacity and apical sealing,[3] low solubility and adequate radiopacity and adhesion to root dentin, showing adequate adaptation to the root canal wall and penetration into the dentinal tubules.[4] It is presented in the form of paste / paste, in the proportion of 1: 1, according to the manufacturer.

Sealer Plus (MK Life, Porto Alegre, Brazil) was the first endodontic cement based on epoxy resin launched in the Brazilian market, being developed and researched by the Endodontics Team of the College of Dentistry of Bauru (FOB-USP) and presents the following characteristics, as stated in the package insert: formulation based on epoxy resin; excellent fluidity; low prey contraction; low solubility; easy and quick handling; high radiopacity; low cytotoxic risk; and biocompatibility, which avoids sensitivity and inflammation of periapical tissues.

In this context, it is important to highlight the role that filling materials have been playing in filling the root canal system, given that this is the stage that complements the clinical procedures for emptying, enlarging and disinfecting the canal, and should seal them as tightly as possible.[5] Therefore, it is necessary to know the physical-chemical and biological properties of the material that is used in the clinic, in order to carry out a safe clinical procedure with good results.

Among the biological and physico-chemical requirements of an endodontic cement we can mention: tissue tolerance, being reabsorbed in the periapex when leaking, stimulating or allowing the deposition of fibrous repair tissue, being antimicrobial, not triggering an immune response to apical and periapical tissues, easy to be removed when necessary, have a good handling time, do not suffer contractions, have good flow, be radiopaque and allow the most hermetic sealing of the root canal.[6]

In the meantime, this paper intends to present one of the newest sealer cements on the market, the Sealer Plus (Mk Life), comparing its physical chemical properties of flow and hardening time of this material in relation to the AH Plus endodontic cement (Dentsply Sirona).

Materials and methods

The physical-chemical properties of the materials used are crucial to assess the final quality of the root canal filling. The present study aimed to evaluate some of the physicochemical properties of Sealer Plus endodontic cements (MK Life, Porto Alegre, Brazil) and AH Plus endodontic cement (Dentsply Sirona, Konstanz, Germany). The evaluated properties were: hardening and flow time.

The analysis of physical and chemical properties followed Specification number 57 of the American National Standard Institute / American Dental Association (ANSI / ADA)[7] for filling materials, with changes in the sizes of the samples.[8]

The tests were carried out under environmental conditions of 23 ° ± 2 ° C of temperature and 50 ± 5% of relative air humidity, maintained 48 h before the beginning of the procedures.

For each test, samples were prepared with pure cements, with AH Plus and Sealer Plus cement being used in a 1: 1 ratio. All cements were mixed until homogeneous consistency was obtained.

The tests were performed as described below and repeated 5 times for each cement studied and the arithmetic averageof the repetitions was obtained.

To carry out the hardening time test, 5 cylindrical stainless steel molds were made, with internal diameters of 10 mm and uniform thicknesses of 2 mm, for each material. The mold was fixed, on its external face with the aid of utility wax, on a glass plate 1 mm thick by 25 mm wide and 75 mm long.

Then, the cement to be tested was manipulated and placed inside the metal mold, until it was completely filled. 120 ± 10 s after the beginning of the mixture, the glass plate / mold / cement set was placed in a plastic container with airtight seal. and maintained at a constant temperature of 37 ± 2° C and 95 ± 5% relative air humidity, inside a greenhouse (Olidef, Ind. and Com. Hospital Equipment, Ribeirão-Preto, SP, Brazil), until the end of test.

150 ± 10 s after the start of the mixing, a Gillmore needle of 100 ± 0.5 g and active tip of 2 ± 0.1 mm was lowered vertically on the horizontal surface of the material. The placement of the needle on the material was repeated at regular intervals of 60 min until it no longer caused indentations in the tested cement, establishing the hardening time.

Carrying out the flow test, a 3mL glass Luer syringe was adapted and filled with 0.5 mL of the mixture of each cement. The cements were placed in the center of a smooth glass plate, with dimensions of 10 x 10 cm. 180 ± 5 s after the beginning of the mixing, a second plate of the same dimensions was placed on the cements and, finally, on this last one, an additional weight, making a total of 120 grams. The additional weight was removed, 10 minutes after the start of the mixing and measured with the aid of a digital caliper (Digimess, Shiko, China), the smaller and larger diameters of the discs formed by the cements.

During the test, it was necessary, for its validation, that the discs obtained were uniformly circular and that they presented, in their diameters, larger and smaller, a variation not greater than 1mm. Samples that did not meet these requirements were discarded and the test repeated, following the same experimental parameters, until 5 discs of each cement needed to perform the study were obtained.

To determine the flow, 5 repetitions were performed for each cement tested and the arithmetic average was calculated.

Results

The statistical test used was the t-test after accepting that the two variables, hardening and flow time, follow the normal distribution - Kolmogorov-Sminov test. The level of significance used in both differences was 5% ($P < 0.05$). The first test performed was the flow test. The results obtained show that the average flow between the AH Plus and Sealer Plus cements does not differ statistically ($P = 0.477$). The data can be seen in table 1.

Table 1. Maximum, minimum, average, median flow and standard deviation by type of cement.

		Flow (mm)				
		Maximum	**minimum**	**average**	**median**	**standarddeviation**
Cement	AH PLUS	3603	2843	3259	3243	287
	SEALER PLUS	3327	2944	3150	3103	156

Table 2. Maximum, minimum, average, median hardening time and standard deviation by type of cement.

		Endurecimento (min)				
		Maximum	**minimum**	**average**	**median**	**standarddeviation**
Cement	AH PLUS	1290	975	1178	1205	119
	SEALER PLUS	537	321	422	411	91

Discussion

The American Dental Association (ADA)[7] carried out, under the heading of Specification 57, a series of standards and tests for the evaluation of the physical-chemical properties of endodontic filling materials, with the purpose of promoting uniformity of results, which led researchers to perform these tests with greater criteria and scientific rigor.

The physical-chemical properties of the materials used exert an influence on the final quality of the root canal filling, as an adequate hardening time provides a good handling time and the flow of the cement allows for three-dimensional sealing of the root canal system. As the AH Plus cement is a reference for the studies of several other endodontic cements, the present research aimed to evaluate these physical-chemical properties and compare them in relation to Sealer Plus cement, new on the market and still without in-depth studies.

Almost all studies of physico-chemical properties involving AH Plus cement do it by comparing it with other materials, attributing to them almost always satisfactory results over the others, although there is some variation in the results.[9,10]

Thus, there is a variation in the literature for the values found for the setting time of AH Plus cement when studied under temperature conditions at 37°C: 955 minutes,[11] 500 minutes,[12] 1440 minutes.[13] In the AH Plus cement package insert the statement "... under certain storage conditions, AH Plus (paste B) may have a slightly homogeneous appearance. However, it has been shown that this fact does not negatively affect the performance of the product after mixing"[14] The manufacturer stipulates in the package insert a minimum time of 8 hours at 37°C. The paragraph of standard 57 of ANSI / ADA,[7] which refers to setting time, says that the results must be within a variation of up to 10% of that established by the manufacturer. However, the setting time found in this research was well above the minimum value presented by the manufacturer.

Sealer Plus hardening time was shorter, a factor that can compromise handling time, but it can be favorable because the delay in hardening time can result in tissue irritation.[15] This discrepancy in values in setting time is justified due to the difference in chemical composition of the tested cements.

Regarding the flow time, the studies also present very variable values: 43mm[10] and 38, 57mm.[12] The results found in this paper are well above the minimum recommended by ANSI / ADA,[7] which is 20 mm. An adequate flow contributes to penetration in the dentinal tubules, isthmus and accessory channels, the filling of these irregularities in the root canal system and the union of the sealing material with the canal walls prevent bacterial microleakage and apical reinfection. It is necessary to emphasize that excessive flow can cause leaks in the periapical tissues, which, depending on how cytotoxic the material is, can impair the healing process.[16] In this paper, the flow of Sealer PLus is in agreement with other studies.[17]

Conclusion

It was concluded that there was no significant difference in relation to the flow index of the two cements tested. However, with regard to the hardening time, Sealer Plus cement presented a shorter setting time when compared to AH Plus cement, showing a statistically significant difference between both.

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