Evaluation of Physicochemical Properties of a New Root Canal Sealer

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Abstract

Introduction: The aim of this study was to evaluate some of the physicochemical properties of a new root canal sealer. **Methods:** The sealers tested were Sealer Plus compared with AH Plus. For the radiopacity, flow, solubility, and fabrication of test specimens relative to setting times, the American National Standards Institute/American Dental Association No. 57 (2000) and International Organization for Standardization 6876 (2012) specifications were followed. To measure the initial and final setting times, the ASTM C266/2008 standard was used. pH was evaluated in the time intervals of 3, 24, 72, and 168 hours. Statistical tests were applied to the results obtained at a level of significance of 5%. **Results:** The results demonstrated that the Sealer Plus sealer showed a lower radiopacity value than AH Plus sealer ($P < .05$); however, this was higher than the minimum value recommended by the specifications (ie, 3 mm Al). Relative to flow, the value for Sealer Plus was 19.19 mm and for AH Plus, 19.81 mm ($P > .05$). Sealer Plus presented initial and final setting times of 138 minutes and 210 minutes, respectively, whereas the values for AH Plus were 437 minutes and 849 minutes, respectively ($P < .05$). Relative to solubility, Sealer Plus presented 0.21% and AH Plus, 0.27% ($P > .05$). None of the sealers showed a significant increase in pH ($P > .05$). **Conclusions:** Sealer Plus sealer presented physicochemical properties in accordance with American National Standards Institute/American Dental Association (2000) No. 57 and International Organization for Standardization 6876 (2012) specifications. *(J Endod 2017;■:1–5)*

Key Words

Endodontic sealers, materials testing, physical and chemical properties, resin epoxy, root canal obturation

Significance

The endodontic sealer performs an important function of filling areas that are difficult to access, such as ramifications, apical deltas, accessory canals, and spaces into which gutta-percha is incapable of being adapted.

Successful endodontic treatment depends on root canal cleaning, shaping, and filling (1). The filling stage comprises a set of operative procedures performed in an orderly sequence with a view to achieving tridimensional sealing. Therefore, its purpose is to prevent colonization and reinfection of the root canal by pathogenic microorganisms and their communication with the periapical tissues (2).

A deficient filling may lead to endodontic treatment failure (3, 4). According to Cohen and Burns (5), Leonardo and Leal (6), and De Deus (7), an adequate filling must be performed with antiseptic or inert materials, capable of ensuring good sealing. This would prevent percolation and leakage of exudate into the canal, and consequently, the possibility of reinfection, creating an environment favorable to the repair process. The endodontic sealer performs an important function of filling areas that are difficult to access, such as ramifications, apical deltas, accessory canals, and spaces into which gutta-percha is incapable of being adapted (2, 8).

At present, the filling sealer considered the gold standard is AH Plus (Dentsply, DeTrey GmbH, Konstanz, Germany), frequently used as a comparison material in endodontic research (9). This epoxy resin–based sealer has excellent physicochemical (10–12), biological (13–15), and antimicrobial (16–18) properties.

Recently, new root canal filling materials were proposed and introduced to the market, such as epoxy resin–based Sealer Plus sealer (MKLife, Porto Alegre, Rio Grande do Sul, Brazil). However, up to now, there are no studies in the specific literature about the physicochemical properties of the cited sealer.

The materials used for root canal filling must have adequate physicochemical and biological properties, such as antimicrobial activity and tissue tolerance (19), providing a suitable sealing and low cytotoxicity, favoring or not interfering with the periapical healing (20). To determine the physicochemical properties, there are requisites and standardized evaluation tests, defined by the International Organization for Standardization (ISO) 6876 (21) and American Dental Association (ADA) No. 57 (22). These properties are closely related and justify the biological properties of root canal sealers.

In this context, the aim of this study was to evaluate some of the physicochemical properties of this new filling sealer in comparison with AH Plus sealer. The null hypothesis was as follows: there would be no difference between these 2 sealers in relation to their physicochemical properties.

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Material and Methods

The sealers tested (Table 1) were manipulated in accordance with the manufacturers' instructions. For the radiopacity, solubility, and flow tests, as well as the initial and final setting times, the American National Standards Institute (ANSI)/ADA (22) No. 57 and ISO 6876 (21), specifications that specify the requisites and test methods for root canal filling materials, were followed. The ASTM C266/08 standard was used to determine the final setting time. The analyses were performed by a single, duly calibrated operator.

Radiopacity Analysis

The sealers were carefully poured into metal rings measuring 10 mm in diameter and 1-mm thick that were placed on flat, smooth glass plates. The set was stored in an oven at 37°C. After the sealers had set, the plates were removed and the thicknesses of the test specimens were checked with a pachymeter (Mitutoyo Corp, Tokyo, Japan). Those approved were placed on Kodak insight occlusal film (Kodak Comp, Rochester, NY), together with an aluminum penetrometer (graded from 2 to 16 mm Al). The films were sensitized with an X-ray appliance (Gnatus XR 6010; Gnatus, Ribeirão Preto, SP, Brazil), with 60 kV, 10 mA, with exposure times of 0.3 seconds and focus/film distance of 30 cm.

Radiopacity was analyzed by digital image, by means of the ImageJ 1.48v program (National Institutes of Health, Bethesda, MD). The radiopacity value was determined according to the radiographic density, converted into millimeters of aluminum (mm Al), according to the formula proposed by Duarte et al (23):

$$A \times 2/B + \text{mm/AL immediately below RDm}$$

Being:

A = radiographic density of the material (RDm) – radiographic density of the pa aluminum step immediately below RDm;

B = radiographic density of the aluminum step immediately above RDm –radiographic density of the pa aluminum step immediately below RDm;

2 = 2-mm increment between one aluminum step and the other.

TABLE 1. Root Canal Sealers, Composition, and Manufacturers

Cement	Composition	Manufacturer
AH Plus	Paste A: Bisphenol epoxy resin–A, Bisphenol epoxy resin–F, calcium tungstate, zirconium oxide, silica, iron oxide pigments. Paste B: Dibenzyldiamine, aminodiamantana, tricyclodecane–diamine, calcium tungstate, zirconium oxide, silica, silicone oil.	Dentsply, DeTrey GmbH, Konstanz, Germany
Sealer Plus	Basic Paste 6.5 g, yellow color: 40% Bisphenol A-co-epichlorohydrin 30; Bisphenol F epoxy resin (formaldehyde, oligomeric product with 40% 1-chloro-2,3-epoxypropanol and phenol) 30; 17% zirconium oxide 13; 4% silicone and siloxanes 2; 0.5% iron oxide (pigment) 0.1; 15% calcium hydroxide 10. Catalyzer Paste 9.5 g, white color: 32% Hexamethylenotetramine 28; 20% zirconium oxide18; 4% silicone and siloxanes 2; 15% calcium hydroxide 10; 40% calcium tungstate 30.	MK Life, Porto Alegre, RS, Brazil

Flow Analysis

The recommendations of the ISO 6876/2012 and ANSI/ADA 2000 standards were followed. After manipulation, a volume of 0.05 mL of each sealer was deposited on a glass plate (P1) with the aid of a 1-mL insulin syringe. Within 180 ± 5 seconds after mixing the sealers, a second glass plate (P2), weighing approximately 20 g, was carefully placed on the material. After this, a 100-g weight was placed on this set (P1 + sealer + P2), totaling a mass of 120 g on the endodontic sealer between the 2 plates. After 10 minutes, the weight was removed and the largest and smallest diameters of the discs formed by the compressed sealers were measured with the aid of a digital pachymeter (Mitutoyo MTI Corp., Huntersville, NC). The maximum and minimum diameters were obtained and evaluated 3 times for each specimen, with 5 specimens being used for each experimental sealer.

Setting Time Analysis

Specifications number 57 of the ADA and 6876 of ISO were used for fabrication of the test specimens, and the ASTM C266/08 standard, for determining the setting times. After being duly proportioned and manipulated, the sealers were placed in metal rings measuring 10 mm in internal diameter and 2-mm thick ($n = 5$). The test was performed under controlled temperature and humidity conditions: 37°C ± 1°C and 95% ± 5%, respectively. After 180 seconds had elapsed from the beginning of spatulation, the specimens were marked with vertical pressure, initially using a 113.5-g Gilmore needle to determine the initial setting time, and subsequently, a 453.5-g needle for the final setting time. The initial and final setting time values were computed in minutes for the purpose of statistical analysis.

Solubility Analysis

Three test specimens were fabricated in accordance with the ISO 6876 (21) specification. Teflon rings 20 mm in diameter and 1.5 mm high were used. These were filled with the sealers in a room at a temperature of approximately 25°C. To fill the rings, they were placed on glass plates protected with cellophane paper. After filling, a nylon thread was inserted into the sealer mass. The duly filled rings were protected with cellophane paper, and another glass plate was seated on them to regulate the test specimen surfaces. The set was taken to an oven, where it remained at 37°C and relative humidity of 95% for 3 times the length of the material setting time. After this period had elapsed, the test specimens were removed from the rings, and weighed on an analytical balance with a precision of up to thousandths of a gram. Subsequently they were immersed in receptacles containing 50 mL distilled water, sealed, and maintained for 7 days. The nylon thread that had been inserted into the test specimens allowed them to be suspended in the distilled water without touching the walls of the flasks. After the experimental period, the test specimens were removed, dried with absorbent paper, and taken to a dehumidifier for 24 hours, and were then weighed again. The solubility value was determined by the loss of mass of the test specimen that occurred during the immersion period; that is, by the difference in mass of the test specimen before and after immersion in distilled water.