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Original Article

A Comparative Evaluation of "Cerafill" and "iRoot" Bioceramic Sealers: Mechanical and Chemical Insights

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ABSTRACT

Little was known about the physical characteristics of the new bioceramic "Cerafill" root canal sealer when it first hit the market. This study sought to evaluate its properties in comparison to the previous iteration, "iRoot." Fresh pastes of each sealer underwent a setting time test. The set discs were submerged in deionized water to measure the solubility percentage, pH variations, and calcium ions (Ca++) released after 1, 7, 14, and 28 days. In addition, each sealer's film thickness and flowability were evaluated. When $P < 0.05$, the ANOVA statistical test was applied. In comparison to iRoot, Cerafill showed a significantly lower solubility percentage and a faster start and final setting time ($P < 0.001$). With no discernible difference, Cerafill and iRoot both showed high alkaline media ranges (9.17–11.52) and released Ca++ ($P < 0.01$). iRoot showed the highest flow and the lowest film thickness (22.2 ± 0.12 mm and 50 ± 0.2 µm, respectively) in comparison to Cerafill (19.5 ± 0.5 mm and 70 ± 20 µm, respectively). Setting periods, solubility, pH variations, Ca++ release, flowability, and film thickness are all improved in the new Cerafill, which satisfies the specifications for the perfect root canal sealer.

Keywords: Root canal sealers, Bioceamic root canal sealers, Physical properties, iRoot, Cerafill

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Introduction

The sealer fills in the gaps and imperfections in the obturating material, which is necessary for endodontic therapy to be effective. A variety of sealers were applied to the obturation to avoid microleakage and provide a fluid-tight seal [1-3]. These sealers include the bioceramic-based sealer, which has been on the market since 2009 [4]. When exposed to tissue fluid found within the dentinal tubules, its primary constituents, calcium silicate, and calcium phosphate, enhance bioactivity and generate the chemical apatite, resulting in tight sealing [5]. Several kinds of bioceramic root canal sealers, such as iRoot (BC, Innovative BioCeramix Inc., Vancouver, Canada), are available in injectable premixed paste form. The physical and chemical characteristics were assessed in a previous work [6, 7]. Its solubility result exceeded the permissible limit of 3 percent [6, 8, 9].

Cerafill (Prevest DenPro, Jammu, India) is a recently developed bioceramic root canal sealant. According to the manufacturer's instructions, it is a premixed calcium silicate sealer that contains zirconium oxide (as a radio-opacifier), calcium phosphate, bioactive glass particles, and aluminum-free [10]. It was said to have outstanding physical qualities. There are presently not enough papers showing their physiochemical behavior.

The physical and chemical characteristics of Cerafill and iRoot bioceramic, such as setting times, solubility percentage, pH variations, released calcium ions, flow, and film thickness, were to be compared in this study. The null hypothesis stated that the three examined sealers employed in this investigation were identical.

Materials and Methods

The procedures of this study were started after agreement from the ethics committee of King Abdulaziz University. Two calcium silicate Bioceramic-based root canal sealers; Cerafill and iRoot were evaluated. AHplus; (Epoxy resin, Dentsply, De Trey, Germany) was used as a gold standard control sealer.

Setting time

For each sealer, ten samples (n = 10) were prepared according to the manufacturer's instructions based on ISO 6876/2012 [11]. In a 10 mm internal diameter and 2 mm height mold, the injectable paste of bioceramic sealers and a fresh mixture of AH-Plus were placed. Every 15 minutes, beginning after 30 minutes, a Vicat needle (Jin-Ching-Her, Taiwan), having 50 mm length, 10 mm diameter, and 100 g weight, was periodically inserted, on the sample surface When the needle was difficult to penetrate within the sealer, it indicates the time of initial setting. However, when no visible depression was detected on the surface of the sealer, it indicates the time of complete sets [12].

Solubility %

The initial weight (W_0) of each disc (n = 10) was performed by an electric balance (Scientech, USA); after it had fully hardened. It was then put in a tube containing deionized water (10 mL). All samples were incubated at 37 °C/100% humidity. All discs were taken out after each experimental period (1, 7, 14, and 28 days), allowed to dry overnight, and then weighed again (Wt_1, Wt_7, Wt_{14}, and Wt_{28}). The following Equation [13] was used to calculate the solubility percentage (%).

$$\text{The solubility (\%)} = \frac{W0 - Wt}{W0} \times 100 \qquad (1)$$

pH changes

The pH of the solution at 1, 7, 14, and 28 days was assessed using the pH meter (Bibby Scientific, UK). The pH meter was previously calibrated using reference solutions of 4.0 and 7.0 pH [6].

Calcium release

The solution of each solubility period (1-28 days) was evaluated using the EDTA titration technique to determine the releasing calcium ions (Ca^{++}) [14, 15].

Sealer flow and film thickness

The flowability test was carried out based on ISO 6876/2012 for root canal sealers, [11, 15]. Five samples of each sealer were prepared. On a glass slab (n = 5) measuring 35 by 35 by 6 mm^3, one drop of 0.05 volume was placed. After three minutes, a second glass slab of 20 mg and an additional 100 g weight was added to the top of the spreading sealer. At 37 °C and 100% humidity incubator, the sealer within the glass slabs and 100 g weight were placed for 10 minutes. Using a digital caliper (Cole-Parmer, Montreal, Canada), the dimensions of the circular sample were measured after the upper glass slab and top weight were removed [16, 17]. The test was repeated if the resulting circle had an uneven diameter or if it was larger than 1 mm [13].

Following the flowability test, the thickness of both glass slabs containing the sealer (Ts) was measured by a digital caliper. An empty double slab thickness (T0) was also determined. The equation (Ts-T0) was used to calculate the film thickness of each sealer [11, 13].

Statistical analysis

All the recorded data; including setting time, solubility (%), pH variations, Calcium ions released, sealer flow, and film thickness were statistically analyzed at a significance level of 5% using SPSS software (Version 16.0; Chicago, IL) to compare the investigating sealers. According to Shapiro-Wilk (> 0.05), One-way ANOVA and Tukey tests were used.

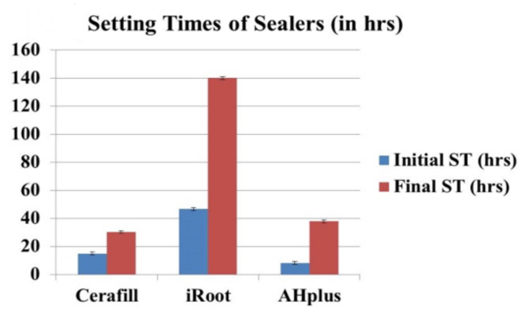
Results and Discussion

Setting time

Figure 1a illustrates the mean ± standard deviation (SD) of the setting times (initial and final) recorded by the three root canal sealers. AHplus exhibited the significant fastest setting times initial as well as final times, however, the significant delayed setting times (initial and final times) were detected by iRoot ($P < 0.001$).

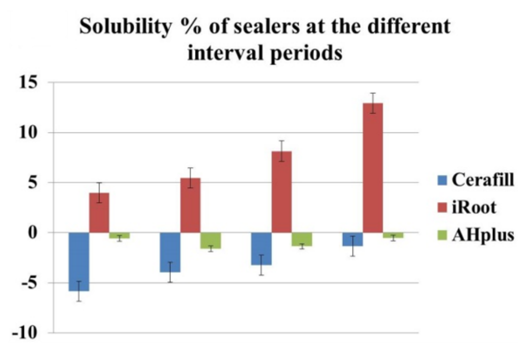
Solubility %

The mean ± standard deviation (SD) of the beginning and ultimate setting times that the three root canal sealers observed is shown in **Figure 1a**. Although AHplus had the fastest start and end setup times, iRoot was able to identify the substantially delayed start and end-setting times (P < 0.001).



14.89 ± 0.53	46.65 ± 1.85	8.3 ± 0.64	Initial ST
30.22 ± 0.19	140.1 ± 5.02	37.86 ± 1.52	Final ST

a)



Day 1	Day7	Day14	Day28	
−5.85 ± 0.55	−3.96 ± 0.65	−3.22 ± 0.89	−1.35 ± 1.87	Cerafill
3.97 ± 0.54	5.44 ± 0.5	8.14 ± 0.68	12.94± 0.61	iRoot
−0.57 ± 0.23	−1.6 ± 0.46	−1.37 ± 0.83	−0.52 ± 2.32	AHplus

b)

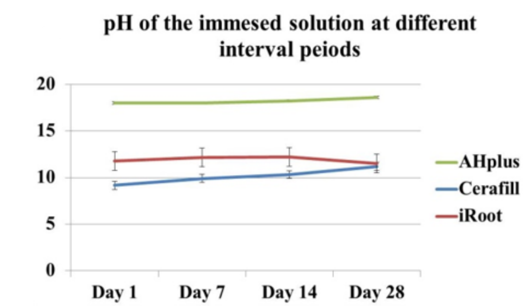
Figure 1. The mean ± SD of setting times, a) and solubility (%), b) of the investigated sealers among the experimental periods.

pH Change

The mean ± SD values of the sealers' pH change over the experimental periods are shown in **Figure 2a**. The storage deionized water of AHplus demonstrated weak alkaline (8.85 ± 0.08) on day 1 and subsequently declined to be nearly neutral (7.39 ± 0.14) on day 28. Nevertheless, both Cerafill and iRoot sealers indicated high alkaline solutions (ranging between 9.17-11.52) throughout all experimental times, with Cerafill obtaining the highest significant values (P < 0.001), and the two sealers' differences at day 28 (P = 0.137, not significant).

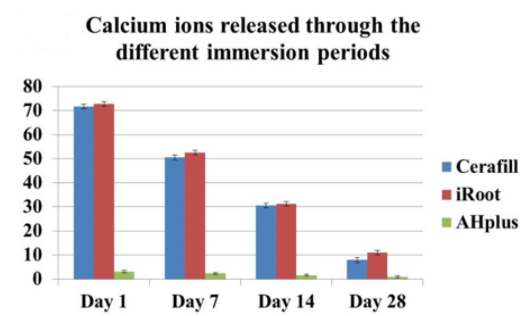
Calcium ions released

The mean ± SD values of the calcium ions emitted from all root canal sealers under investigation throughout all experimental periods are shown in **Figure 2b**. There was no statistically significant difference between iRoot and Cerafill (P > 0.05), although the iRoot sealer showed considerably higher mean values of the leaked material (P < 0.001) throughout all study periods. Nevertheless, AHplus found a noticeably low mean value (P < 0.001) for the entire trial.



8.85 ± 0.08	8.11 ± 0.25	7.91 ± 0.52	7.39 ± 0.14	AHplus
9.17 ± 0.47	9.92 ± 0.3	10.33 ± 0.25	11.22 ± 0.46	Cerafill
11.79 ± 0.48	12.18 ± 0.09	12.21 ± 0.26	11.52 ± 0.32	iRoot

a)



71.68 ± 1.21	50.52 ± 6.0	30.64 ± 3.2	7.9 ± 4.65	Cerafill
72.71 ± 4.51	52.6 ± 2.53	31.19 ± 3.48	11.0 ± 1.39	iRoot
3.11 ± 0.65	2.35 ± 0.32	1.59 ± 0.29	0.97 ± 0.45	AHplus

b)

Figure 2. The mean ± standard deviation (SD) of pH changes, a) and calcium ion release, b) of the three sealers during the experimental period.

Sealer flow and film thickness

Cerafill found the significant lowest mean value (19.5 ± 0.5 mm), at P < 0.001, while iRoot recorded the substantial greatest mean flowability (22.2 ± 0.12 mm), followed by AHplus (21.4 ± 0.41 mm). In terms of film thickness, Cerafill had a substantially higher mean value (70 ± 20 µm, at P < 0.001), although the mean values for iRoot and AHplus were almost identical (50 ± 0.2 and 51 ± 0.1 µm, respectively). The difference between iRoot and AHplus was negligible ($P > 0.05$).

The ADA specification #57 and Grossman's recommended requirements for optimum root canal sealers [18, 19] state that the sealers' physical and chemical characteristics have an impact on the quality as well as the efficiency of obturation [20]. Setting periods, solubility, pH, Ca++ released, flow, and film thickness of the new "Cerafil" bioceramic sealer are compared to those of the older "iRoot" bioceramic sealer in the present research. The outcomes of setting times, solubility percentage, flow, and film thickness disproved the null hypothesis, although pH and discharged Ca++ supported it, based on the current research on bioceramic sealers.

To potentially avoid periapical irritation, the setting time should be a realistic beginning period that allows for the appropriate working time and is finally established in a short period [18, 21]. Both the start and ultimate setup timeframes were substantially faster with Cerafill (14.89 ± 0.53 and 30.22 ± 0.19 hours, respectively) than with iRoot (46.65 ± 1.85 and 140.1 ± 5.02 hours, respectively). All bioceramic sealers failed or took too long to finish the set in earlier tests [22, 23]. To facilitate the creation of the calcium silicate hydrate phase, which is in charge of full sealer hardening, the hydration reaction of the bioceramic sealers requires a wet environment. In line with this, other investigations found that iRoot required a longer setup time [24, 25]. According to Loushine *et al*. [26], "even in various humidity environments, the endosequence root canal sealer requires at least 7 days for a complete set [26]." The absence of the sulfate phase in iRoot may be the cause of the variations in outcomes between the two bioceramic sealers. However, because it is regarded as a reactive phase and regulates the calcium silicate material hydrates [27], Cerafill's calcium phosphate levels, "as described in the manufacture brochure" [10], are what cause quick setting. The command From 8.3 ± 0.64 to 37.86 ± 1.52 hours till the final set, AHplus had a quick setting time. Contrary to this, AHplus took 10–12 hours to set a time in a prior investigation [28], which was ascribed to its epoxy amine polymerization process [29].

The longevity of the endodontic prognosis may be impacted by the sealer's solubility. It can cause the sealer to deteriorate, endangering the apical seal and increasing the rate of bacterial leakage [30, 31]. The weight loss during the solubility test was not above 3%, following ISO 6876 [11]. The solubility percentage of iRoot in the current investigation was much higher than the permitted limit, ranging from 3.97 to 12.94 over the 28-day testing periods. It could be because of its delayed setting time, which permits its particles to deteriorate. But AHplus and Cerafill have gained ground, with Cerafill achieving noticeably higher values. One earlier research supported AHplus, citing its capacity for water sorption and significant expansion during resin polymerization [30]. There haven't been any publications about Cerafill's physical characteristics up to this point. Its calcium sulfate phase may be responsible for the water diffusion inside its polymerized particles, which accounts for its weight rise [32].

To counteract the inflammatory state, encourage periapical tissue repair, and improve dentin mineralization, the alkaline medium and Ca++ release are crucial [33, 34]. There was no discernible distinction between the Cerafill and iRoot sealers ($P > 0.05$), and both showed strong alkaline solutions and considerable Ca++ release during all study periods **(Figure 2)**. Every prior study found that the environment surrounding bioceramic sealers was very alkaline [6, 9, 23, 25]. Changes in pH and the release of Ca++ were related. Ca++ discharges more when the pH is more alkaline. It is ascribed to the calcium hydroxide by-product generated during the calcium silicate setting process [24]. Upon reacting with water, this calcium hydroxide separates into Ca++ and hydroxyl ions (OH^-). Ca++ increases dentin mineralization and bioactivity when exposed to tissue fluid [5], whereas hydroxyl ions (OH^-) encourage the alkaline medium [35] which is advantageous for antibacterial activity [36, 37]. AHplus, the control, showed a weak alkaline pH at first, but it eventually dropped to neutral. After resin polymerization, the modest quantity of calcium hydroxide that was present in its composition diminished. A large number of investigations accepted this conclusion [22, 35].

For root canal obturation to improve dentin adaptation and sealing ability and, consequently, reduce microleakage, flow, and film thickness qualities are crucial [36]. If the sealer is extruded into periapical tissue, nevertheless, the high flow can cause tissue irritation [38]. All three of the examined sealers met ISO 6876 criteria for flow quality and film thickness [11], with iRoot achieving the highest flow value (22.2 ± 0.12 mm) and Cerafill achieving the highest film thickness (70 ± 20 µm). It might be explained by Cerafill's quick setting and iRoot's delayed setting periods. A high flow of bioceramic sealers (varying between 23 and 26 mm) was also found in earlier research [25]. This is in contrast to calcium silicate MTA-Fillapex, which had a larger flow (37.97 ± 0.55 mm) than AHplus (29.04 ± 0.39 mm).

Conclusion

Root canal sealers are excellent, and the new bioceramic “Cerafill sealer” satisfies those needs. It has a longer setting time than the previous “iRoot” sealer and does away with solubility characteristics. It fosters a pH medium and releases Ca++, which may support periapical tissue healing potentiality, biocompatibility, bioactivity, and antibacterial activity. Additionally, its flow and film thickness are appropriate. Additional research is necessary to evaluate its adaptability and sealability.

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Conflict of Interest: None

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Ethics Statement: The procedures of the current study were approved by the Ethical Committee of KAUFD.

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