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RESEARCH ARTICLE
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Effects of heating on the physical properties of bio ceramic root canal sealer (in vitro comparative)

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ABSTRACT

The goal of this study was to determine how heating affected one type of bio ceramic root canal sealer's physical characteristics when that heat applied to the tooth surface by hot obturation techniques which lastly preferred from endodontist because of their ability to fill the canal irregularities and compare it with physical properties of bio ceramic sealer that used with cold obturation techniques without heat . .Materials and Methods: Changes in setting time, flow, and film thickness were assessed in line with ISO6876:2012 requirements after being heated at 100°C for 1 minute by comparative study in which each test setting time, flow and film thickness was repeated eight times in room temperature and eight times in 100c for 1minute that represent the environment of hot obturation techniques . All root canal sealants heated to 100°C demonstrated notable reductions in setting time and flow, as well as a notable increase in film thickness. Root canal sealants made of calcium silicate that have been heated set faster, flowed less, and formed thicker films. The severity of these modifications, however, differed between the products. The current research suggests that warm vertical condensation technique could suffer from heat-induced alterations in the physical characteristics(setting time,flow,film thickness) of calcium silicate-based root canal sealers.

Keywords: *calcium silicate-based sealers, heat-induced changes, heating, physical properties, warm vertical condensation*

INTRODUCTION

After removing the cause of the infection, the root canal is filled with a biocompatible material to tightly seal the canal, encasing any infections still present and preventing their spread from the oral environment to the periapical tissues [1]. Over time, different obturation techniques have been used to complete the root canal system, but none of them were flawless(37). Schilder contends that the ideal root canal obturating substance must adapt to the imperfections and canal walls (37). Root canal sealers are required in order to tightly seal the gap between the root canal wall and solid root canal filling materials like gutta-percha [2]. Root canal sealants are necessary to prevent the root canals from drying out, according to Caicedo and von Fraunhofer (37).

The materials employed in the sealing technique must be physically robust since long-term tight sealing of the root canal depends on the qualities of the sealer [3]. Compared to the lateral condensation and single-cone approaches, the warm vertical compaction produces a root canal filling that is homogenous, dense, and adaptable to the imperfections of the root canals [4–7]. However, it has been shown that heat can change the composition of the set products as well as the physical characteristics of several root canal sealers [8–14]. Root canal sealants of all forms, including those based on silicone, glass ionomers, resin, zinc oxide eugenol, and calcium hydroxide, have been widely utilized up to this point. However, in recent years, clinical practice has become quite interested in root canal sealers that are primarily made of calcium silicate. The majority of experts agree that calcium silicate-based root canal sealers are advantageous because of their biocompatibility, low toxicity, high alkalinity, and resistance to shrinkage [15–18]. Furthermore, a homogenous root canal sealer can be injected straight from the syringe into the root canal because premixed calcium silicate-based root canal sealers do not require mixing. Premixed sealants are typically utilized in single-cone techniques, but more recently The effects of heat on the physical characteristics of calcium silicate-based root canal sealers are less well understood. Therefore, this study investigated the effects of heat on the physical characteristics of a particular class of calcium silicate-based root canal sealers, which served as the study's test materials. The null hypothesis stated that heating does not alter the physical characteristics of root canal sealants made of calcium silicate.

MATERIALS AND METHODS

root canal sealants made of calcium silicate are invistigated. Table 1 displays the sealers' compositions. At various temperatures, setting time, flow, and film thickness were evaluated in accordance with ISO 6876:2012 [19]. There were eight runs of each experiment.

Setting the time

BC In line with ISO 6876:2012 [19], sealers were distributed into gypsum molds because they need moisture to set. After the mold had been fully filled, samples were stored and categorized according to whether they had been heated to 100 degrees for one minute in an oven before being transported to 37 degrees and 95% humidity. Before usage, the molds created for the experiments carried out at 100°C were heated in the oven. According to the method outlined in ISO 6876:2012, setting time was measured by slowly lowering a Gilmore-type metric indenter onto the samples' surfaces at 1-min intervals and timing the moment at which the indenter failed to leave a discernible indentation.

Flow

A syringe was used to place the sealer (0.05 ± 0.005 mL) on the center of a glass plate (dimensions: 40 mm × 40 mm, thickness: 5 mm), and 180 ± 5 s later, the sealer was overlaid with a similar glass plate. The total weight was adjusted to 120 ± 2 g by adding weight (100 g). Ten minutes after placement of the sealer had begun, the added weight was removed, Each sealer was measured at room temperature (23± 2°C) or, after being inserted into an oven, at a temperature of 100°C for 1 min. In the experiment, a glass plate that had been warmed in an oven to 100°C was employed. The test was repeated when the maximum and minimum diameter differences were more than 1 mm. data collected using a digital calliper.

film thickness

The sealer was applied to the center of the first glass plate, which had a thickness of 5 mm, and was then covered with a second glass sheet with a contact area of roughly 200 25 mm2. Each sealer was either left at ambient temperature (23 2°C) or heated to 100°C for 1 minute. A 150 N load was then applied vertically to the glass plate with a loading device after 180 s of placement. Before usage, the glass plate used for the tests was heated to 100°C. A microcaliper was used to measure the combined thickness of the two glass plates and sealer after the sealer had completely filled the space between them and 10 minutes had passed since placement began.

Statistical analysis

The collected data were analyzed using SPSS (SPSS Inc., Chicago, IL, USA) version 26. The collected data of physical properties were tested for normality using Shapiro-Wilk, and the data shows normal distribution. Independent sample t+test was used to compare between groups at a significance level of $p<0.05$.

DISCUSSION

Endodontists frequently employ the warm vertical technique and other forms of thermoplasticized obturation due to their effectiveness in filling canal irregularities (37).This study demonstrated that when the sealers were heated, significant changes in setting time, flow, and film thickness were observed in all the sealers tested. Therefore, the null hypothesis was rejeced.When using the warm vertical condensation technique, it is advised to heat the plugger to about 200°C [21]. But according to earlier tests, the temperature that actually occurred when the System B plugger was utilized at a temperature setting of 200°C was only about 100°C, not 200°C [8,9]. Additionally, it was noted that the average temperature in different kinds of heat pluggers was roughly 140°C [20]. The clinical setting was replicated in the current tests by using 100°C heating for one minute [10] as well as 100°C preheating of glass plates and molds for direct heating. In this investigation, using heat drastically shortened the setting time for all sealers. The setting time for calcium silicate-based root canal sealers heated in a prior investigation was reported to be shorter than in the current study, which was consistent with earlier findings for iROOT SP (an alternative to BC Sealer) [10]. High temperatures accelerate hydration reactions in Portland cement [22], and calcium silicate-based root canal sealers are predicted to have a similar setting acceleration. A setting time of at least 30 minutes is advised by ISO 6876: 2012 standards [19] to enable ample time for a root canal filling treatment.

In addition to calcium silicate, BC Sealer also includes calcium dihydrogen phosphate and calcium hydroxide. Thus, following the reaction between calcium dihydrogen phosphate and calcium hydroxide during setting, hydroxyapatite and water are created, and the water produced, along with the ambient moisture, speeds up the hydration reaction of calcium silicate [13]. In contrast to the current findings, a recent study found that heating at 100°C for 1 minute had no impact on the setting times for BC Sealer and BC Sealer HiFlow [18]. This discrepancy can be explained by the fact that heating had a definite effect in this investigation because the mold was preheated to 100°C before the experiments were conducted.

Particle size, shear rate, temperature, time, the inner diameter of the root canal, and insertion speed are thought to affect the flow of root canal sealants [1]. To seal abnormalitiesThe current flow values at room temperature met the ISO 6876:2012 requirement of >17 mm and were equivalent to those of earlier reports [25,26]. On the other hand, because the setting process is accelerated at high temperatures, heating significantly reduced flow in all sealers [10,22]. The flow of sealer heated in the current investigation did not fulfill the prerequisite specified in ISO 6876:2012. in the root canal and the apical area, an appropriate flow during the procedure's allotted period is crucial [1]. . Calcium silicate cements, on the other hand, often expand by 0.2% to 6% [28]. Additionally, different sealer types were said to have different sealing capacities in accordance to their thickness [29]. Additionally, it has been noted that calcium silicate-based root canal sealers produce more calcium ions and are more soluble than AH Plus [30]. Apatites are produced as a result of the reaction between released calcium ions and nearby phosphate ions, and they accumulate as a precipitate on the sealer's top layer [31,32]. The high biocompatibility of calcium silicate-based root canal sealers is thought to be a result of this [16,18].

However, the long-term maintenance of root canal sealing ability may not be advantageous if a thick coating of sealer dissolves. Under the current experimental setup, heating calcium silicate-based root canal sealers at 100°C for 1 minute sped up setting time, reduced flow, and thickened the film; however, the degree to which these changes occurred varied amongst the products. When calcium silicate-based root canal sealers are utilized for heated vertical condensation method, these changes in physical qualities could have a negative impact on the quality of root canal filling.

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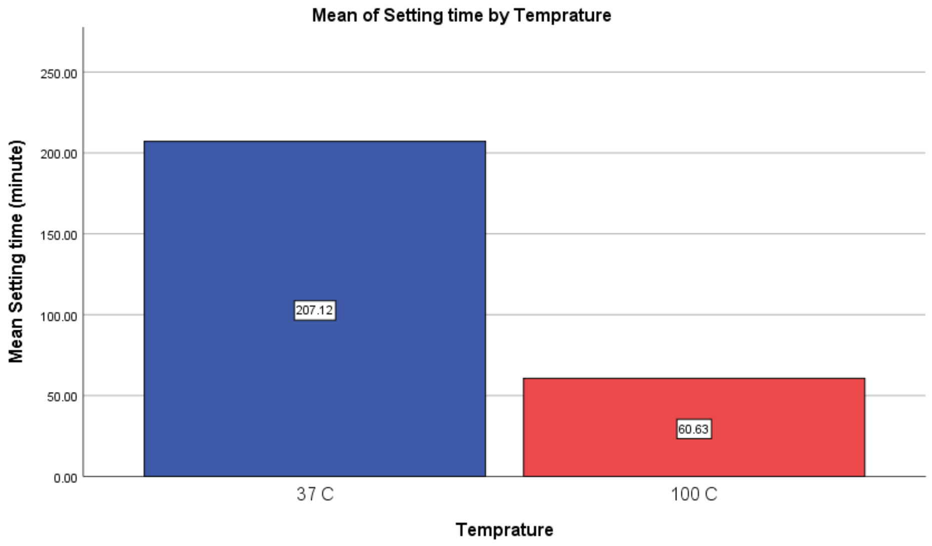
Normality of data

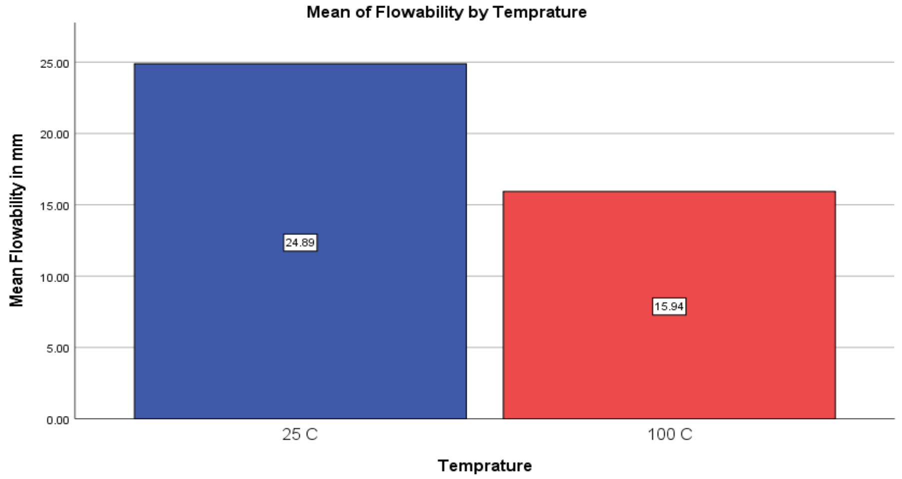
The data were normally distributed according to Shapiro-Wilk test

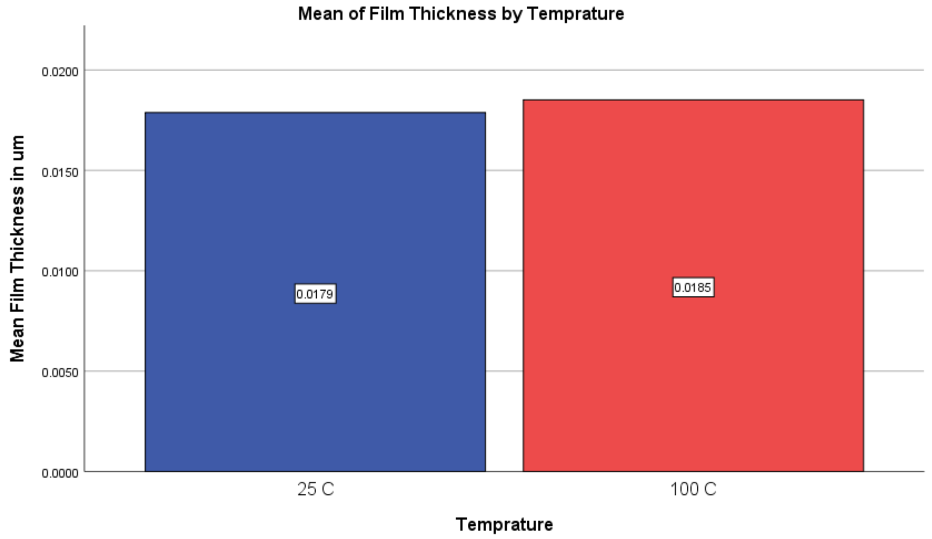
Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
37c setting time	.252	8	.144	.903	8	.309
100c setting time	.136	8	.200*	.969	8	.890
rt flowbility	.125	8	.200*	.958	8	.792
100c flowbility	.139	8	.200*	.975	8	.937
rt film thickness	.260	8	.120	.860	8	.120
100c film thickness	.243	8	.181	.820	8	.046
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

Descriptive statistics

Group Statistics					
Physical Properties	Temperature	N	Mean	Std. Deviation	Std. Error Mean
Setting time (minute)	37 C0	8	207.13	10.47	3.70
	100 C0	8	60.63	4.66	1.65
Flowability (mm)	25 C0	8	24.89	0.53	0.19
	100 C0	8	15.94	0.46	0.16
Film Thickness (µm)	25 C0	8	0.0179	0.0010	0.0004
	100 C0	8	0.0185	0.0007	0.0003

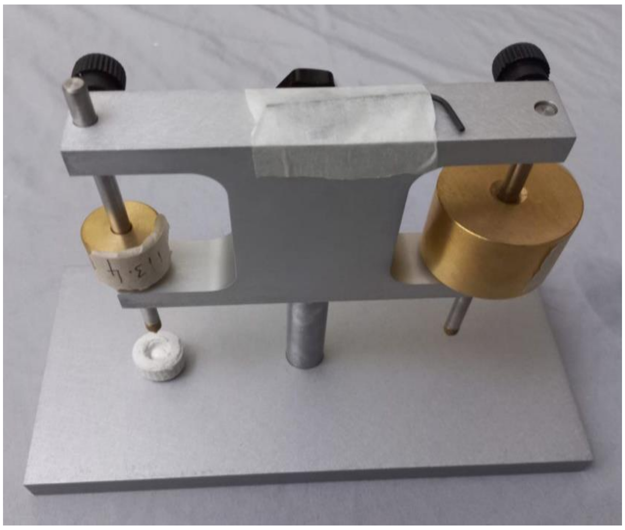

Mean of Setting time by Temprature
250.00
200.00
150.00
100.00
50.00
0.00
Mean Setting time (minute)
207.12
60.63
37 C
100 C
Temprature

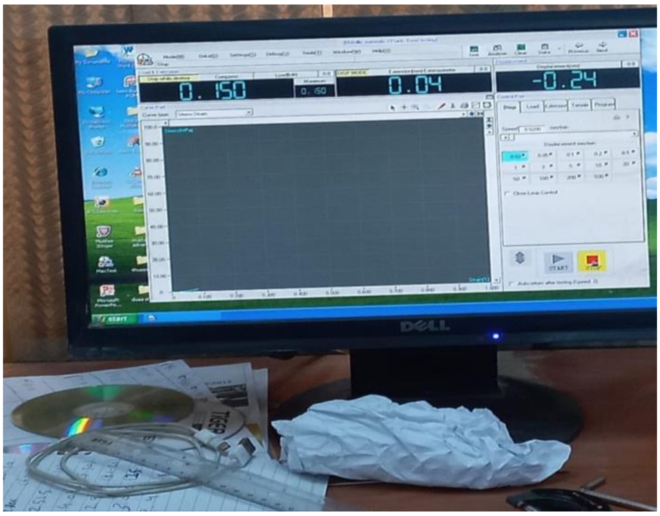

Mean of Flowability by Temprature
25.00
20.00
15.00
10.00
5.00
0.00
Mean Flowability in mm
24.89
15.94
25 C
100 C
Temprature


Mean of Film Thickness by Temprature
0.0200
0.0150
0.0100
0.0050
0.0000
Mean Film Thickness in um
0.0179
0.0185
25 C
100 C
Temprature

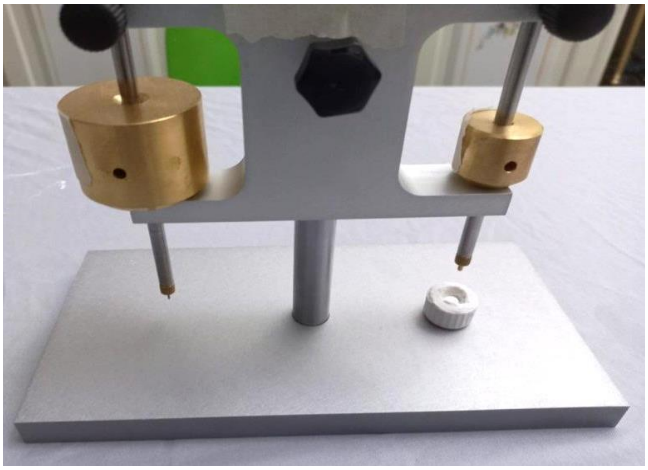
Inferential statistics

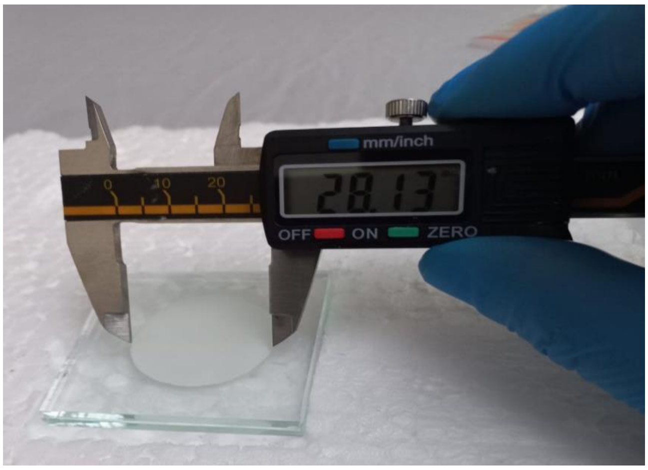
Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	P- value	Mean Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Setting time	Equal variances not assumed	11.485	0.004	36.169	9.668	0.000	146.50000	137.43282	155.56718
Flowability	Equal variances assumed	0.268	0.613	36.072	14	0.000	8.95000	8.41784	9.48216

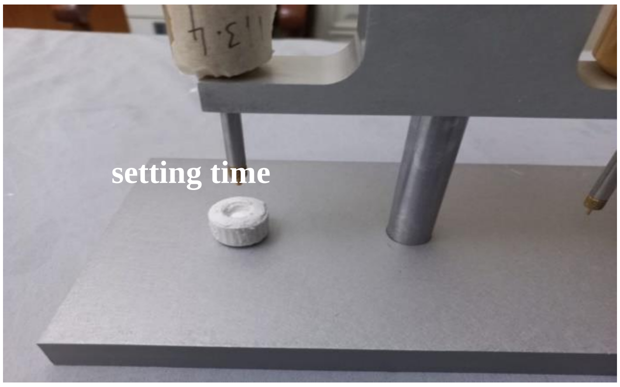


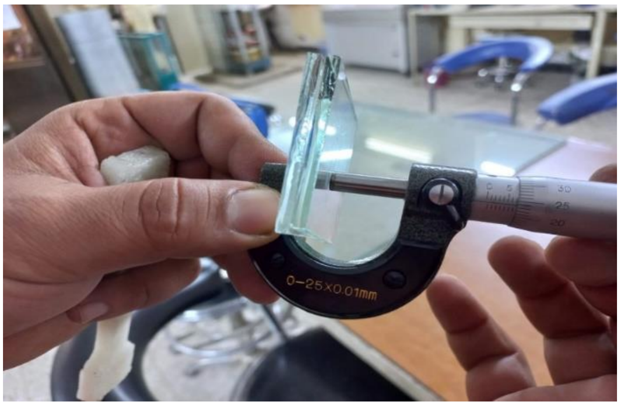



0-25X0.01mm




mm/inch
28.13
OFF ON ZERO


setting time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