

Original Article

Effect of Storage Time and Temperature on Dimensional Stability of Impressions Made with Zinc Oxide Impression Paste

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Abstract

Objectives: This study aimed to assess the effect of storage time and temperature on dimensional stability of impressions made with Cavex Outline zinc oxide impression paste.

Materials and Methods: A round stainless steel mold with five grooves (three horizontal and two vertical) was used in this in-vitro experimental study. Cavex Outline impression paste was prepared according to the manufacturer's instructions and applied to the mold. The mold was placed on a block and stored at 35°C and 100% humidity for setting. The impressions were poured with stone immediately and also after 30, 120, 240 and 420 minutes and 24 hours. The distance between the vertical lines on the casts was measured and compared with that in the immediately poured cast.

Results: Storage in a refrigerator and at room temperature for zero to seven hours had no significant effect on dimensional stability of the impressions; however, 24 hours of storage in a refrigerator or at room temperature decreased the dimensional stability of Cavex Outline (P=0.001). Also, a significant association was found between dimensional changes following 24 hours of storage in a refrigerator (4°C) and at room temperature (23°C; P<0.01).

Conclusions: The optimal pouring time of Cavex Outline impressions with stone is between zero to seven hours, and 24 hours of storage significantly decreases the dimensional stability.

Keywords: Dental Impression Materials; Zinc Oxide; Cavex

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INTRODUCTION

Complete or partial edentulism is a common occurrence [1]. To fabricate accurate dental prostheses for rehabilitation of an edentulous area, precise impression of the hard (dental) and soft tissue taken with impression material with high dimensional stability is necessarily required [2,3]. Use of impression materials with inadequate dimensional stability and accuracy increases the costs of treatment due to the need for repeating the impression and re-fabrication of the prosthesis or the need for modifications. Moreover, long-term use of an improper prosthesis by the patients may have adverse consequences and can cause oral ulcers and subsequent infections. Thus, impression making plays an important role in fabrication of an accurate prosthesis and

minimizes the costs and complications of prosthetic treatment [4,5]. Different impression materials are available in the market with different compositions and characteristics, which make them suitable for use in different clinical situations. Sodium alginate, polyether and silicon materials such as polyvinyl siloxane are among the most commonly used impression materials. Metal oxide pasts have extensive applications in dentistry [6]. Zinc oxide impression pastes have long been used for final impression making of the edentulous jaws and rebasing of complete dentures. They are available in two forms of powder-liquid and paste. The polymerization shrinkage of these materials is insignificant following setting and has reported to be less than 0.1%. This results in their optimal dimensional

stability [7]. Due to having low consistency before setting, these materials can yield a precise impression with well-defined surface details. They are used for final impression making of edentulous ridges with small or no undercuts, or as a light body with other impression materials, bite registration pastes and temporary liners for dentures and surgical dressings. Moreover, these materials are non-toxic and can precisely record the details. They can be used for taking mucostatic or mucodisplacive impressions and they remain stable within their shelf life [7,8].

The choice of impression material depends on the clinical indication and the clinician's judgment. Since in some cases dentists do not have quick access to a laboratory to pour the impressions, impression materials preserving their dimensional stability for long periods of time must be necessarily used.

This study aimed to assess the effect of storage time and temperature on dimensional stability of impressions made with Cavex impression material.

MATERIALS AND METHODS

A round stainless steel mold was fabricated with five grooves (three horizontal and two vertical) according to ISO 3107:2011 [9]. In addition to these grooves, the mold had two lateral grooves to be filled with the impression material. The mold had been specifically designed for the purpose of determining the dimensional stability of the impression material and reconstruction of details (Fig. 1).

Cavex Outline Light Body Impression Paste



Fig. 1: The mold with three horizontal and two vertical grooves

(Cavex Holland BV, RW Haarlem, Netherlands) was prepared as instructed by the manufacturer (mixing time of 45 seconds, working time of 2.15 to 3.30 minutes) and applied to the mold. The mold was placed on a block and stored in an incubator under 1kg load, simulating oral conditions in terms of temperature and humidity (35°C and 100% humidity) until completion of setting time. The casts were poured immediately (time zero) and after 30, 120, 240 and 420 minutes and 24 hours with type IV dental stone (Heraeus Kulzer Inc., South Bend, IN, USA)(Fig. 2).

All timings were kept using a chronometer (Junso, Tokyo, Japan). The impressions were stored at room temperature (23°C) in group one and in a refrigerator at 4°C in group two. After completion of the setting time according to the manufacturer's instructions (final setting time of four minutes), the cast was removed from the mold. To determine the linear dimensional stability in each group, a digital caliper (Mitutoyo, Tokyo, Japan) with 0.001mm accuracy was used. Next, the distance between the vertical lines on the casts was compared with that in the immediately poured cast. According to Walker et al, [10] the change in the distance between the two vertical lines should not be more than 0.5%; otherwise, the impression cannot be identified as dimensionally accurate.

The results were subjected to statistical analysis in SPSS Version 22 (SPSS Inc., IL, USA) to compare dimensional stability of the impressions based on the pouring time and storage temperature and calculate the absolute measurement error.

RESULTS

The results showed that storage of impressions in a refrigerator and at room temperature for zero to seven hours had no effect on dimensional stability of the casts ($P>0.05$). However, 24 hours of storage in a refrigerator or at room temperature increased dimensional changes and decreased dimensional stability compared to the impres-



Fig. 2: Pouring the mold with stone

sions stored for zero to seven hours in the same conditions ($P=0.001$). Also, a significant association was found between dimensional changes following the storage of materials in the refrigerator (4°C) and at room temperature (23°C) for 24 hours ($P<0.01$; Tables 1 and 2).

Figure 3 compares the mean and 95% confidence interval of the measured dimensions on the casts based on the pouring time (the interval between the impression making and pouring). As seen in Figure 3, the mean distance between the vertical lines on the casts (that can be used as an index to determine the acceptable threshold of dimensional changes) was 24.78 mm after zero to seven hours of storage. After 24 hours of storage in a refrigerator (4°C) and at room temperature (23°C), the difference (Δ) was found to be 0.13mm, and exceeded the acceptable threshold of dimensional changes for metal oxide impression materials, which is 0.1mm.

DISCUSSION

Studies have shown that impression materials undergo dimensional changes due to the effect of environmental factors such as humidity and heat, composition of the impression material and storage time. The magnitude of these changes is variable for different materials [10-15]. Cavex

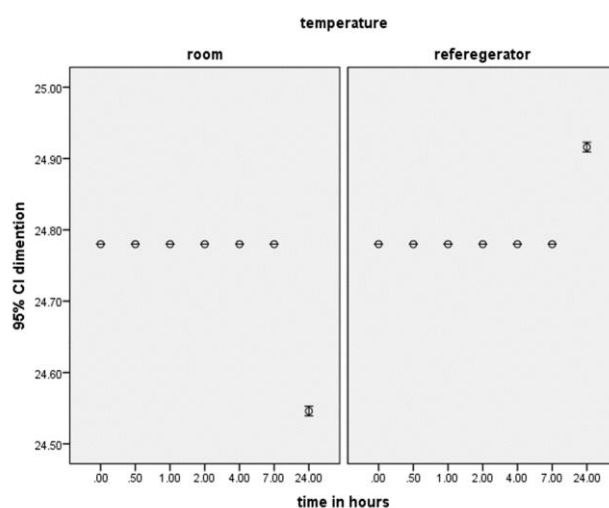


Fig. 3: Mean and 95% confidence interval of the measured dimensions on the casts based on the pouring time

Outline is a commonly used rigid impression material and belongs to the group of metal oxide impression materials. It has several applications for taking final impressions of edentulous ridges. This study aimed to assess the precision of stone casts made using Cavex Outline impressions after different storage times in order to find the most suitable pouring time and storage temperature. The results showed that storage of Cavex Outline impressions in a refrigerator or at room temperature from zero to seven hours had no effect on their dimensional stability ($P>0.05$). However, 24 hours of storage in a refrigerator or at room temperature increased the dimensional changes (decreased dimensional stability) compared to the impressions stored for zero-seven hours in the same conditions ($P=0.001$). Also, a significant association was found between dimensional changes due to 24 hours of storage of materials in a refrigerator (4°C) and at room temperature (23°C ; $P<0.01$).

Ghasemi et al, [11] in their study evaluated the effect of storage time on dimensional changes of alginate, an irreversible hydrocolloid impression material. In their in-vitro, experimental study, 30 alginate impressions were made and poured after 15, 60 and 240 minutes with dental stone within 10 seconds and after 45 minutes. They concluded

Table 1: The distance (in millimeters) between the vertical lines on the casts of impressions kept at 23°C

	Delay Time						
	0 min.	30 min.	60 min.	120 min.	240 min.	460 min.	24 h
1	24.78	24.78	24.78	24.78	24.78	24.78	24.54
2	24.78	24.78	24.78	24.78	24.78	24.78	24.54
3	24.78	24.78	24.78	24.78	24.78	24.78	24.55
4	24.78	24.78	24.78	24.78	24.78	24.78	24.55
5	24.78	24.78	24.78	24.78	24.78	24.78	24.55

that increasing the pouring time from 15 to 60 minutes resulted in dimensional changes in the height of the small die but did not affect other dimensions. Their study was different from ours in that they used a metal pattern with two abutments for a three-unit bridge and a small and a large die; whereas, in the current study, a round stainless steel mold was used to assess the dimensional stability of Cavex Outline impression paste. Nonetheless, our results confirmed those of Ghasemi et al, [11] and showed that increasing the storage time decreased the dimensional stability of Cavex Outline impression material. Cohen et al, [12] and Hollenback and Smith [13] evaluated the dimensional stability of hydrocolloid impressions and showed that hydrocolloid impressions must be poured immediately or maximally within 12 minutes. Some researchers have reported that it is safe to keep the impressions in a humid environment for one to 18 hours [14-16]. Recent studies on impression materials show that the manufacturers are attempting to increase the storage time of impression materials [12,13]. Johnson and Craig [14], Eriksson et al, [15] and Schleier et al, [16] reported that the storage time of hydrocolloid impression materials has increased and hydrocolloid materials can be stored in a humid environment for one, two or even four hours without undergoing significant dimensional changes. Comparison of extended-pour and conventional alginates revealed that the casts poured after five days

Table 2: The distance between the vertical lines (in millimeters) on the casts kept at 4°C

	Delay Time						
	0 min.	30 min.	60 min.	120 min.	240 min.	460 min.	24 h
1	24.78	24.78	24.78	24.78	24.78	24.78	24.91
2	24.78	24.78	24.78	24.78	24.78	24.78	24.91
3	24.78	24.78	24.78	24.78	24.78	24.78	24.92
4	24.78	24.78	24.78	24.78	24.78	24.78	24.92
5	24.78	24.78	24.78	24.78	24.78	24.78	24.92

were not significantly different from the standard models. Our findings were in line with the results of the above-mentioned studies and showed that storage for up to seven hours had no effect on dimensional stability, but 24 hours of storage resulted in unacceptable dimensional changes. Review of the literature yielded no similar study on dimensional stability of Cavex Outline metal oxide impression pastes. Thus, we compared our results with two other studies on different types of irreversible hydrocolloids from Cavex. Erbe et al, [17] in 2012 made impressions with seven different materials namely Blueprint, Cavex CA37, Cavex Color Change, Jeltrate, Orthoprint, Cavex Orthotrace, and Tetrachrom according to ISO/CD 21563. They compared the three-dimensional stability of irreversible hydrocolloid (IH) impression materials stored for up to seven days in low-moisture (in a humidifier) and high-moisture (wrapped in a wet paper towel) conditions. The results revealed that if stored in a humidifier, pouring of the IH impressions must be done within four hours. If stored in wet conditions, non-color-change IH impressions must be poured within two hours. In general, IHs with variable colors showed higher dimensional changes. For optimal dimensional stability, IH impressions must be poured as soon as possible. In another study in 2008, Sedda et al. [18] evaluated the precision of casts made from alginate impression material poured immediately or after storage for specific time periods. They

used five types of alginate namely CA 37 (Cavex), Jeltrate (Dentsply Caulk), Jeltrate Plus (Dentsply Latin America), Hydrogum 5 (Zhermack) and Alginoplast (Heraeus Kulzer). The master model was mounted on a special jig and the impressions were made. The impressions were stored at 23°C with 100% humidity and were then poured with dental stone immediately and after 24, 72 and 120 hours. Casts were evaluated and the results showed that the dimensional stability of the impression materials was influenced by the type of impression material and storage time. Our findings were in accord with those of the above-mentioned studies and showed that increasing the pouring time for up to seven hours had no significant effect on Cavex Outline but further increase in storage time from seven to 24 hours decreased the dimensional stability, and the obtained casts were no longer reliable.

CONCLUSION

Assessment of the precision of stone casts obtained using Cavex Outline impressions stored for different time periods showed that the safe storage time for this impression material was zero (immediately poured) to seven hours and further storage for longer periods of time resulted in loss of dimensional stability. These findings suggest that impressions stored for more than seven hours should not be poured because of their decreased dimensional stability.

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