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Original Article

Effect of Pouring Time and Storage Temperature on Dimensional Stability of Casts Made from Irreversible Hydrocolloid

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Abstract:

Objective: The aim of this study was to evaluate the dimensional stability of casts made from an alginate impression material poured immediately and stored after specific periods.
Materials and Methods: The common alginate used in Iran (Super; Iralgin, Golchai Co., Tehran, Iran) was tested. A master model was mounted on a special device and used to obtain the impressions. These impressions were stored at 23°C (SD=1) and 4°C (SD=1) in 100% relative humidity, then poured with gypsum immediately and again after 12, 25, 45 and 60 minutes. The casts were measured with a traveling microscope with the precision of 0.5 micrometer.
Results: The dimensional stability of the alginate and impressions were both significantly time and temperature dependent. The impressions were dimensionally stable significantly until 12 minutes of storage at room temperature and until 45 minutes of storage at 4°C (SD=1).
Conclusion: The dimensional stability of the alginate impressions was influenced by the storage time and environment temperature, but a humid environment and 4°C (SD=1) temperature may delay the pouring.

Key Words: Alginates ; Dental; Impression Materials ; Hydrocolloid

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INTRODUCTION

An impression material must have dimensional stability to cause the overall success of the cast made from it [1]. Irreversible hydrocolloid impression material has dimensional changes as a result of synergists or evaporation of water when exposed to air [1]. Therefore, whether or not irreversible hydrocolloid impression materials are accurate enough for restorative and prosthetic dental use is in question.

Several investigations have studied the dimensional stability of alginate-based impression [2], and different tests have been developed for analyzing this property [3-7]. Past studies have shown that these impressions between 0 and 12 minutes are necessary to maintain clinically acceptable accuracy [8]. Cohen et al [9] studied the dimensional stability of three different irreversible hydrocolloid impression materials under five different storage conditions. Storing of the impressions was carried out at different times as 10 min, 30 min, one hr and 24 hrs before pouring. They concluded that immediate pouring made the most accurate cast [9].

Jamani et al [1] investigated the best storage condition and time for pouring irreversible hydrocolloid impression material. The impressions were poured at 15 min, 30 min, one hr and three hrs after impression making. The results showed that if the irreversible hydrocolloid was poured within 15 min, it could be used as a final impression material [1].

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Fig 1. The base and the maxillary dentiform

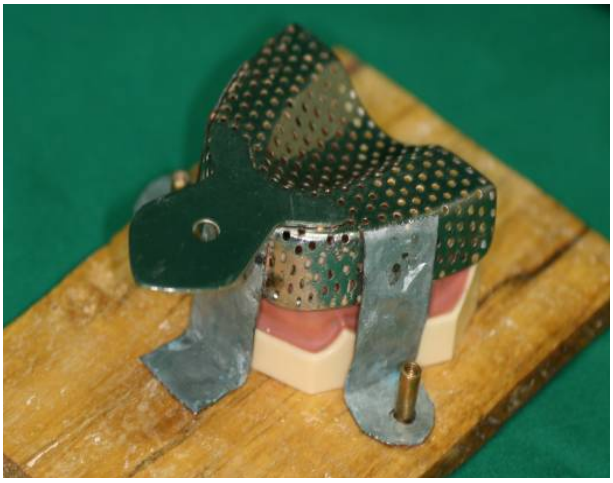

Fig 2. A metal perforated tray.

If it were safe to store the impressions for up to 30 minutes without clinically significant distortion, this would be an advantage to irreversible hydrocolloid users in the management of their practices.

The aim of this study was to verify the dimensional stability of one alginate-based impression material named Super (Iralgin, Golchai Co., Tehran, Iran) stored in a 100% relative humidity environment poured immediately and stored after specific periods.

MATERIALS AND METHODS

To reproduce the clinical conditions, a new testing device was developed consisting of three parts; namely, the base, the maxillary dentiform (master model) and a metal perforated tray (Figs 1 & 2).

The base is a quadrangular block on which three pins are entirely engaged into three holes on the maxillary dentiform. On the maxillary dentiform, three die cylinders (6 mm height and 6 mm diameter) were fixed.

The head of each cylinder was well-rounded and the die position was in the second left and right molars and 10 mm distance from the midline of centrals.

Three stainless steel studs, welded to the tray with two holes on the horizontal parts, and two guiding pins on the fixed base were engaged into the holes to maintain the tray in a fixed and stable position.

The alginate powder was stored at 23°C (SD=1) and 50% (SD=10) relative humidity in a temperature controlled-room for three days. All the procedures were carried out in the same condition. Two-hundred seventy impressions were taken under full standard condition and classified into nine groups, each including 30 impressions. The first group (control group) was poured immediately after taken. The remaining impressions were stored under 100% humid condition and two different temperatures; refrigerator temperature (4°C, SD=1; group A) and room temperature (23°C, SD=1; group B). The group selection was based on a pilot study method. Four different storage times (12, 25, 45 and 60 minutes) were tested.

Impression Procedure

Alginate impressions were made using the procedure described by Cohen et al [9] An immediate storing of the impression was carried out, according to Schleier and Gardner [4]. Immediate pouring of the casts was done after removal from the master model for the storage time indicated as “0 hours” (control group).

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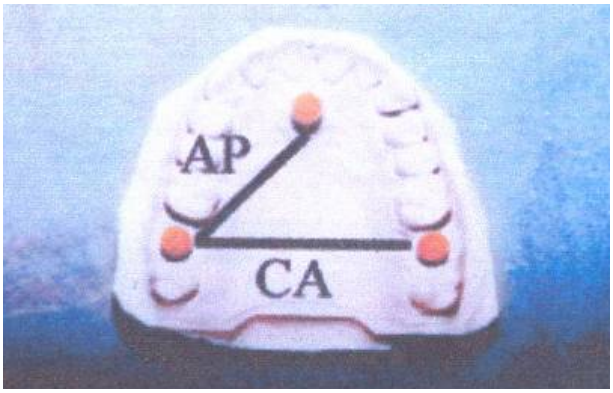

Fig 3. On each cast, three dies were present. Two measurements (µm) including the anterior-posterior (AP) dimension, and the cross arch (CA) dimension were recorded.

Cast Formation

When the predetermined storage time had elapsed, the impression was removed from the plastic bag and then 100 g of type III gypsum [TARA 250 ISO 6873] powder (mold stone) was mixed with 30 mL of distilled water. Mixing of stone was carried out manually for 5 seconds and was poured into the impression after mechanical mixing for 20 seconds. Using a vibrating machine (Vibrator R2 Degossa), pouring of impression with gypsum was done. The tray was then placed and maintained in position for the setting time indicated by the gypsum manufacturer. After the final setting of the gypsum, the casts were stored for 48 hours at 23°C (SD=1) and 50% relative humidity before measuring.

Measurements and Statistical Analysis

On each cast, three dies were present and two measurements (µm) were recorded for each model including anterior-posterior (AP) dimension and cross arch (CA) dimension as shown in Fig 3.

Table 1. The mean valves and standard deviation of measurements for stone casts made of irreversible hydrocolloid impressions stored in 4°C, 23°C and purred with gypsum stone at interval times.

Group /Dimension	Duration	Mean (µm)	Mean of Absolute value of errors (µm)	Standard Deviation
A(4°C, SD=1) / AP dimension	0	48.9613	0.0071	0.05643
	12	48.9750	0.0064	0.08718
	25	49.0088	0.0103	0.05842
	45	49.0100	0.0144	0.06481
	60	49.0665	0.0814	0.07572
A(4°C, SD=1) / CA dimension	0	35.9075	0.0125	0.03576
	12	35.9038	0.0057	0.04406
	25	35.8988	0.0015	0.05249
	45	35.8813	0.0094	0.05194
	60	35.8661	0.0427	0.06968
B(23°C, SD=1) / AP dimension	0	48.9613	0.0457	0.04039
	12	49.0050	0.0079	0.03024
	25	49.0500	0.0081	0.05657
	45	49.0900	0.001	0.04629
	60	49.1263	0.0417	0.06802
B(23°C, SD=1) / CA dimension	0	35.9075	0.0099	0.03576
	12	35.9034	0.0049	0.06803
	25	35.9029	0.051	0.07019
	45	35.9025	0.0058	0.01282
	60	35.9000	0.0027	0.03732

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Cast dimensions were measured by a dimensional measuring microscope (Mititoyo, Toko, Japan) with the precision of 0.5 micrometer and ×500 magnifications. The absolute differences between gold standard and the measurements were statistically analyzed with SPSS software (version 16.0, Chicago, IL, USA). The two way analysis of variance (ANOVA) was used. One way ANOVA and Dunnet test were used for comparison of dimensional stability at interval times in 4°C and 23°C. The level of significance was set at $P<0.05$.

RESULTS

Anterior-posterior dimensional stability of the stone casts made of irreversible hydrocolloid impressions was influenced by the storage time (P=0.000) and environment temperature (P=0.003). The interaction effect for anterior-posterior (P=0.438) and cross-arch (P=0.250) was not significant (Two way ANOVA test).

Cross-arch dimensional stability of the stone casts made of irreversible hydrocolloid impressions was not influenced by the storage time (P=0.738) and environment temperature (P=0.057).

The descriptive statics and the results of the statistical analysis by Dunnet tests are shown in Table I and II. In group 1 (temperature, 4°C, SD=1), AP dimensions after 12, 25 and 45 minutes showed no statistical difference from the control group (P>0.05), but after 60 minutes, there was significant change (P=0.015).

In group 2 (temperature, 23°C, SD=1), the AP dimension was significantly changed at 25, 45 and 60 minutes (P<0.05). Only after 12 minutes, it showed no statistical difference from the control group (P>0.05). In group 1 and 2, there were no changes in CA dimension at all times (P>0.05).

DISCUSSION

Previous studies that evaluated the accuracy and dimensional stability of irreversible hydrocolloid impression material demonstrated the necessity of immediate pouring of the material or as soon as possible after removal from the mouth [3,6,7,9,10]. However, if the impression could be stored for a reasonable time prior to pouring, this would be an advantage to irreversible hydrocolloid users in the management of their practices. There is no universal standard for clinically acceptable changes of hydrocolloid impression materials. Peters et al [11] reported that inaccuracy up to 78 µm and 50 µm, respectively are acceptable. They investigated the accuracy between the dies and the crown. In this study, the accuracy of casts made for building cobalt chromium removable partial dentures was evaluated. There were no available data on the suitable accuracy of casts used for building cobalt chromium removable dentures. By metal grinding, an incorrectness of up to 150 µm at the metal framework try-in stage could be easily adjusted, so this discrepancy might be considered acceptable [12].

The shrinkage of hydrocolloid materials may be stimulated by water evaporation [13] and the powder/water mixing ratio may influence the dimensional stability of the impression. In

Table 2. P-values of Dunnett test for dimensional changes of AP and CA distance (µm) compared with the control group.

Duration	Dimension			
	AP (4°C)	CA (4°C)	AP (23°C)	CA (23°C)
12	0.984	0.890	0.302	0.686
25	0.461	0.785	*0.007	0.800
45	0.438	0.356	*0.000	0.895
60	*0.015	0.439	*0.000	0.973

* The measurement is statistically significant compared with the control group (P<0.05)

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our study, we also used 35g of alginate powder for each impression.

By analyzing the measurements for alginate material (IRALGIN), it was shown that the dimensional stability of the tested alginate impression material changed quickly.

In group 1 and 2, the AP dimension increased, but in group 1 (temperature 4°C, SD=1) changes were not significant until 45 minutes (P>0.05), and in group 2 (temperature 23°C), the AP dimension was not significant only after 12 minutes (P=0.302).

This is probably related to the ability of the alginate material to retain water at 4°C (SD=1), which in turn makes them more dimensionally stable. These findings are in agreement with Roydhouse et al [14] and line 29 , Dahl et al [15].

Dissipation of the expansive forces due to confinement by the walls of the tray would cause the palatal part of the impression to lift away from the tray and the alveolar areas to be drawn in medially [14]. The cross-arch dimension becomes smaller over time, although in this study after 60 minutes no statistical difference was detected from the control group (P>0.05).

These findings are in agreement with Schleier and Gardner [4], Dahiet et al [15] and Eriksson et al [16].

Shrinkage of the alginate towards the center of the mass may explain why the distance between the dies decreased. Some limitations of this study may be identified.

First, in our study to prevent the distortion of the material during the removal of the impression, the least number of undercuts were used to prepare the acrylic master model. But removing the impression from the patient's mouth is usually less easy, so distortion may happen to the material. Using stock tray instead of custom tray is the second limitation of this study.

In comparison between these two trays, the results showed that stock tray may increase the risk of void formation on the surface of the impression [17].

Third, in this study, disinfection procedures were not used for the impressions. However, following a proper decontamination protocol did not have a clinically relevant influence on dimensional stability [18].

Finally, only one combination of irreversible hydrocolloids was tested. Additional research is needed to determine how newer materials would respond to similar treatments.

The clinical significance is when alginate material is used, an immediate pouring of the cast is still recommended. However, the results suggest that pouring can be delayed if the impression is correctly stored at 4°C (SD=1).

CONCLUSION

The following conclusions may be drawn:

1. Anterior-posterior dimensional stability of the stone casts made of irreversible hydrocolloid impressions were influenced by the storage time (P=0.000) and the environment temperature (P=0.003).
2. Alginate impressions should generally be poured immediately or until 12 minutes in 100% humidity at room temperature.
3. Alginate impression could be poured until 45 minutes if stored in 100% humidity at 4°C (SD=1).

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