The Effects Of Environment and Time Intervals On The Dimensional Stability Of Three Indigenously Produced Irreversible Hydrocolloids.

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Abstracts: Aim: Several new irreversible hydrocolloid formulations have recently become available with claims of an improved dimensional stability by the manufacturers. The aim of this study was to evaluate the accuracy of casts made from alginate impression materials poured immediately and after specific storage periods. Methods and Materials: Three alginates were tested Zelgan (Dental Products of India), DMC Algitex (Dental manufacturing & marketing Company) and A1 Alginate (occlusion products of India). A special stainless steel die representing a crown preparation was used to obtain impressions. These impressions were poured at different time intervals i.e immediately after a lapse of 5 minutes, 15 minutes, 30 minutes & 1 hour. Impressions were stored in a three different environments i.e. Air, water & 100% humidity. The casts were made & data were analyzed. Results: The dimensional stability of the alginate impressions was both material & time dependent. Conclusion: The dimensional stability of the alginate impressions is influenced by the selected materials and the storage time. An atmosphere of 100% humidity appears to be best storage medium. Clinical Significance: Alginate impressions should generally be poured immediately . Longer the period of storage more significant dimensional changes were observed. [Patwa A et al NJIRM 2012; 3(4) : 131-134]

Keywords: Die, Dimensional stability, Impression, Irreversible hydrocolloid

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Introduction: Dimensional stability of impression materials has been widely discussed in the dental literature[1]. The dimensional stability depends directly on the elastic recovery of the material, shrinkage of the impression material, evaporation of volatile components from the impression material, or expansion of the gypsum[2]

Alginate based impression materials have been used in dentistry since 1947.Originally used as precision impression materials in Fixed Prosthodontics now they are more commonly used for the initial impression to obtain a preliminary model used for diagnostic purposes, treatment planning and for the fabrication of a provisional prosthesis or custom tray[3]. The dimensional stability of alginate based impression materials has been studied since 1970. Unavoidable delay encountered in clinical practice create this for a suitable means of temporary storage[4]. In this study attempt has been made to see the nature and extent of the dimensional changes produced as a result of storage in various environments which are normally present in clinics and laboratories as far as humidity is concerned. Effects of different time intervals between the recording of impression and pouring of the cast in dimensional stability was also observed.

Materials And Method: The materials used in this study were a Zelgan (Dental products of India) as Brand A, DMC algitex (dental manufacturing and marketing company) as Brand B and A1 Alginate (Occlusion products of India) as Brand C. In order to obtain the impressions a stainless steel die stimulating a full crown preparation (Fig.1) was used having 2.4 cm height (H), 2.22 cm base (D_1) and 2.038 cm at the top (D_2) with three degree tapering occlusally. The die was covered by a means of perforated metal cap which fitted the die so that a uniform space for the material was established. Metal Cap was designed in such a manner that it would represent an impression tray. Standard and regular perforations were made. Each perforation having 2 mm in diameter and were spaced at 2mm from each other uniformly. The impression materials were mixed according to the manufacturer's instructions. Three level scoops powder and one and a half measure of distilled water were taken. The room temperature at which study was carried out varied from 30 to 35°C. The cap portion of the die was filled with mixed material taking care that no air bubble was trapped in mixed material while loading the cap & impression was taken. The impression was withdrawn with a sudden jerk in a direction parallel to the long axis of the die, then impression was poured according to time limits with standard dental stone. The various environments under which the five successive impressions of each brand of material were exposed to, under different period of time limit were recorded. Such impressions were repeated five times for each component of time & environment. Thus total of 65 impressions were taken for each brand. So the sample size for the study was 195 specimens of impression and stone cast. The impressions were poured at different time intervals i.e. zero(0) immediately after recording, after a lapse of 5 minutes,15 minutes, 30 minutes & 1 hour[5,6].

For storage in air all the impressions were stored in open air (Fig. 2) on the laboratory table. For water all the impressions were submerged in water at room temperature (Fig. 3) & for 100% humidity (Fig. 4) a decicator was used. Lower part of the decicator was filled with water. The various measurements of the master die and the stone cast measured with the help of sensitive vernier caliper. For measuring a height a special deviator was used. Two Diameters, one of the base of the die (D_1) and another at the top of the die(D_2) were measured with the help of sensitive vernier and recorded. Three reference points were marked on the circumference of the top surface of the stone cast as A_1, A_2 & A_3 equidistant from each other. Height (H) was measured at three levels from the points(1) at A_1, (2) at A_2 and (3) at A_3 with the help of divider.

Measurements of standard die:
Height(H) = 2.4 cm
Diameter(D_1) = 2.2 cm ; r_1=1.11 cm
Diameter D_2 =2.038 cm; r_2=1.019 cm

$$\text{Volume} = \frac{\pi h\,(r_1^2 + r_2^2 + r_1 r_2)}{3}$$

$22/3 \times 2.4(1.11)^2 + (1.019)^2 + (1.11)(1.019) = 8.552$ cubic centimeter

For each of the stone cast all the above mentioned measurements were made as done for the die and recorded. Three readings were taken at three different reference points for the height (H) at A_1,A_2,A_3 diameter (D_1) and Diameter (D_2) for each of the stone die and mean was calculated. The volume of each stone die was calculated by applying formula stated above. Difference in volume between each of the stone die and master die was calculated and results were subjected to statistical analysis.

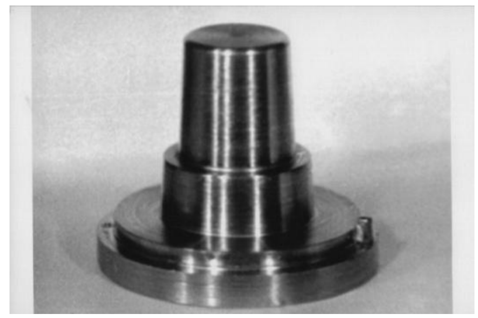

Fig. 1 Stainless steel die

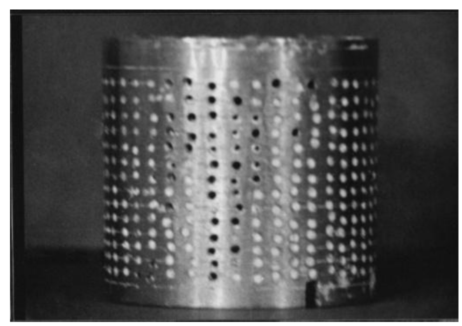

Fig. 2 Impression kept in open air

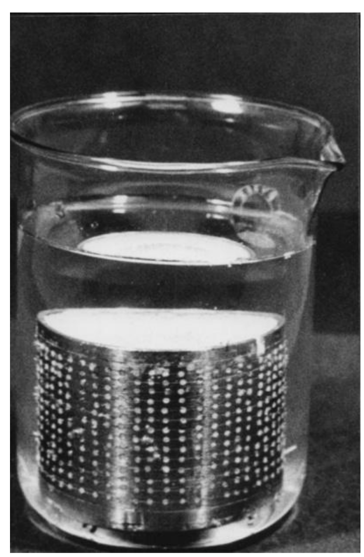

Fig. 3 Impression immersed in water

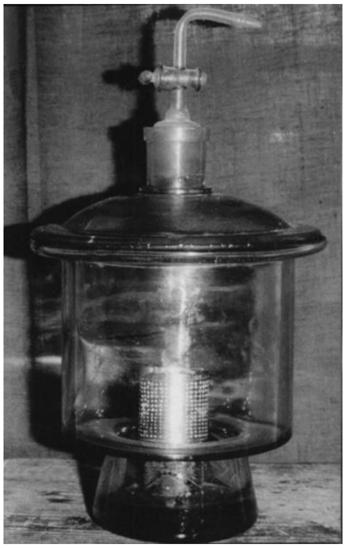

Fig. 4 Impression in humidor

Results: The results of the statistical analysis are shown in tables I, II, III, IV .

Table I: Mean height 'H' in cm. Standard height of die = 2.4 cm

	0 min	5 min	15 min	30 min	60 min
A					
0	2.400	-	-	-	-
Air		2.388	2.395	2.398	2.392
Water		2.390	2.391	2.990	2.382
100% humidity		2.400	2.400	2.382	2.380
B					
0	2.400	-	-	-	-
Air		2.400	2.398	2.396	2.400
Water		2.394	2.380	2.382	2.372
100% humidity		2.400	2.399	2.400	2.398
C					
0	2.374	-	-	-	-
Air		2.352	2.352	2.350	2.350
Water		2.354	2.354	2.362	2.352
100% humidity		2.392	2.394	2.390	2.392

Table I shows the mean heights of the cats obtained from different brands of impression materials after being exposed to various environments of humidity and various time intervals after the impressions were recorded and casts were poured. The change in height of the cast was observed when the impression was stored in water for 60 minutes & brand A (2.383) & brand B (2.372). In contrast to above two brands Brand 'C' material showed maximum deviation in height (2.35) in all the conditions except in 100% humidity.

Table II shows mean value diameter of the casts at the base (D_1). The mean diameter of standard metal die D_1 was 2.22 cm. In brand 'A' the minimum diameter D_1 was observed when impressions were stored for 30 minutes in water and maximum was observed after 60 minutes of storage in air. The brand B shows maximum diameter of 2.24 cm was obtained after 60 minutes of storage of impression in air. Brand 'C' shows maximum deviation in all the conditions.

Table II: Mean diameter 'D_1' in cm. Standard diameter 'D_1' = 2.22 cm

	0 min	5 min	15 min	30 min	60 min
A					
0	2.215	-	-	-	-
Air		2.216	2.229	2.239	2.244
Water		2.217	2.208	2.203	2.211
100% humidity		2.216	2.210	2.215	2.230
B					
0	2.220	-	-	-	-
Air		2.227	2.228	2.229	2.240
Water		2.218	2.215	2.212	2.213
100% humidity		2.216	2.215	2.214	2.211
C					
0	2.234	-	-	-	-
Air		2.280	2.254	2.280	2.292
Water		2.210	2.238	2.222	2.225
100% humidity		2.232	2.237	2.234	2.234

Table III shows mean value of the diameter of the casts at the top D_2 with brand 'A' & 'B' minimum charges were observed maximum diameter of 2.046 cm was obtained when impressions were stored for 60 minutes in the air. In 'C' material the value of D_2 decreased when the impressions were stored for 60 minutes in water.

Table III: Mean diameter 'D_2' in cm. Standard diameter 'D_2' = 2.038 cm

	0 min	5 min	15 min	30 min	60 min
A					
0	2.039	-	-	-	-
Air		2.027	2.042	2.040	2.046
Water		2.035	2.029	2.028	2.035
100% humidity		2.038	2.038	2.037	2.039
B					
0	2.037	-	-	-	-
Air		2.042	2.045	2.046	2.049
Water		2.034	2.037	2.039	2.039
100% humidity		2.038	2.038	2.040	2.040
C					
0	2.036	-	-	-	-
Air		2.090	2.098	2.072	2.070
Water		2.042	2.032	2.030	2.030
100% humidity		2.042	2.041	2.049	2.049

Table IV shows change in the volume of the casts. If volume of the stone cast is greater than the volume of the standard metal die it is indicated by "(+)" which may be due to shrinkage of impression material resulting into increase in mould space. If the volume of the stone cast is lesser than the volume of the standard metal die it is indicated by "(-)" which may be due to expansion of impression material resulting into decrease in mold. After calculating the volume of the stone casts, the difference in volume was calculated in percentage. According to statistical analysis if change in volume is more than -1, it is significant materials 'A' & 'B' show the dimensional changes in volumes which are within the limits of insignificant range of ± 1% while the material 'C' shows significant dimensional changes.

Discussion: The three alginates tested in this study yielded different results showing the dimensional stability of the impression is directly related to the type of material used. The results obtained are similar to that obtained by Maurizio Sedda et al in their study. The authors have tested five different alginates and found that the dimensional stability of of alginates is basically material and time dependent. As observed through the results from the present study, impressions should neither be stored in air since the contraction can occur nor should be stored in water since either a swelling can result [7,8].

Table IV: Mean volume 'V' in cubic cm. mean volume of standard die = 8.552 cubic cm

	0 min	5 min	15 min	30 min	60 min
A					
0	8.539	-	-	-	-
Air		-8.455	+8.587	+8.636	+8.653
Water		-8.495	-8.441	-8.447	-8.445
100% humidity		-8.536	-8.516	-8.531	-8.526
B					
0	8.549	-	-	-	-
Air		+8.602	+8.607	+8.608	8.680
Water		-8.507	-8.460	-8.462	-8.431
100% humidity		-8.539	-8.534	-8.535	-8.517
C					
0	8.508	-	-	-	-
Air		+8.828	+8.753	+8.749	+8.790
Water		-8.364	-8.437	-8.393	-8.371
100% humidity		+8.588	+8.613	+8.619	+8.627

All the three brands of impression materials exhibited a small initial expansion when casts were poured immediately after recording impression. This statement is supported by skinner el-al[5], Skinner, Cooper and Beck, Gotaro Sato by their studies. The cause of this initial expansion may probably be attributed to a continued imbibition of water by the soluble alginate [2,9]. As seen from the results and graphs all the three impression materials remain dimensionally stable when stored in 100% humidity. If the impression must be sent to a commercial dental laboratory it can be suspended in some type of humidor and kept stable for a number of hours. The best method to take full advantage of the accuracy of these materials is to pour the cast immediately after the impression is removed from the mouth to avoid dimensional changes.

Some limitation of this study can be identified. Syneresis and imbibition greatly depend on thickness of impression material used. In order to compare the results statistically it would be advisable to have a standard die with common specifications for all such studies.

Conclusion: Within the limits of this study the following conclusions can be drawn:

- The dimensional stability of the alginate impression was influenced by either the type of alginate or the storage time prior to pouring.
- There was significant difference amongst these three brands in respect to their dimensional stability when behaviour of these materials were compared amongst themselves.
- In the light of all the data obtained it was concluded that the best method for insuring the accuracy of the model is to pour the model immediately after the impression has been obtained..
- An atmosphere of 100% humidity appears to be the best storage medium.
- Dimensional changes were directly proportional to the time intervals. Longer the period of storage more significant dimensional changes were observed.

Clinical significance: When alginate materials are used an immediate pouring of the casts is still recommended. However the results suggest pouring may be delayed provided a stable impression is correctly stored.

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