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Dental Materials

Original Article

EFFECT OF STORAGE TIMES ON DIFFERENT ALGINATE DENTAL IMPRESSION MATERIALS

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ABSTRACT

Dental alginate impression materials are used world-wide because they are cost effective and easy to use. The purpose of this in vitro study was to see the effect of storage times on three different types of alginate impression material. Two commercial (Blueprint Cremix and Tropicalgin) and one experimental dental alginate (according to British Dental Association) were compared in the current study. A total of 36 samples with 12 samples per material, per condition, per thickness (1 mm and 3 mm, to mimic the clinical situation) group were prepared Each group was left in air at room temperature 230C ±10C. Each sample was weighed at predetermined time intervals and its percentage weight change was calculated. SPSS version 20.0 was used for data analysis and mean, and standard deviation were reported for quantitative variables such as the mean loss of weight. From the results it was evident that all the three materials lost weight throughout 10 min, 30 min and 1-hour period. The least weight loss at each timeline was reported in experimental alginate. Alginates stored under air, as expected, were dimensionally unstable with weight losses up to 16.71% (1 mm) and up to 8.64% (3mm), at 1 hour. It was concluded from the present study that commercial as well as experimental alginate showed dimensional changes under various storage times as the conditions were standard.

Keywords: *Dental Alginate, Impression material, Storage, Dimensional changes*

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INTRODUCTION

Alginates are hydrophilic in nature and alterations in osmotic potential after immersing them in liquids cause them to absorb water, leading to swelling up. This osmotic potential can be reversed when the water-soluble salts, which are present in the matrix of alginates, are eluted, leading to diffusing out of water, subsequently causing the material to shrink. The resulting process occurs simultaneously; therefore, alginates can be regarded as especially susceptible to unpredictable distortion after immersion into liquids. This can lead to compromised accuracy of impression, having adverse effect on clinical outcomes.[1]

The typical formulation of alginate includes sodium or potassium compound for ensuring good reproducibility of impression at interface with storage material. The use of magnesium oxide (MgO) is previously observed to act as cross-linker agent in dental alginates. Substantial evidence persists on MgO playing an important role in chemical reaction resulting in pH rise during the settling process.[2]

Alginate, a biomaterial that makes it use for various biomedical purposes, occurs naturally as a polysaccharide which is extracted from brown algae also called as seaweeds like Laminaria hyperborean and lessonia.[3] Their presence in seas is profound all over the globe. The biochemical structure of alginate is a 1, 4-linked B-D-mannuronic (M) and a-L-guluronic (G) acid residue. The insoluble form of alginate is align or alginic

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acid. A mixture of sodium, potassium or ammonium hydracids with alginate produces or converts it into a form of soluble salt.[4]

An important feature of alginate is their use as impression material for prostheses and as dental impression material. Dental impressions show vital role for making teeth models, revealing oral tissue features.[5] For producing an impression, a mixed impression material is ideally used appropriately by putting into tray and sealed by inserting into patient's mouth. With the usage of dental plaster or dental stone material for pouring purpose and converting into cast or model. A positive impression is produced after the setting and now it is actually called a model or a cast.[6]

For commercial dental impressions, alginate is used in the form of mixture with sodium or potassium, being dispensed as a powder form.[7] Typically, alginate powder contains about 70% diatomaceous earth (filler), 12% sodium / potassium alginate, 12 % CaSO4 (cross-linking agent), 4 % sodium silicofluoride (pH controller), 2 % Na3PO4 (retarding agent) and 3% magnesium oxide (pH controller).[8] Alginate is commonly used in dentistry, to make partial as well as complete dentures, orthodontics and casts for dental study. Alginates are most used impression material worldwide. Alginates due to their properties tend to distort with storage time after ten minutes, as a result it cannot be used for procedures such as crowning and for bridge preparation after around one to three hours. Reason for this is alginate's dimensional instability, which tends to shrink because of thermal difference.[9]

The objective of this study was to evaluate the effect of storage time on three different alginate impression materials.

The effects of thickness, 1mm and 3mm on the dimensional stability of three dental alginates was also investigated to mimic the clinical situation, where impressions vary in thickness.

MATERIAL AND METHODS

This research studied the three different varieties of dental alginate materials used in the study, i.e. two commercial and one experimental formulated material. The used commercial materials in this study were Tropicalgin (Zhermach, Italy) and Blueprint Cremix (Dentsply, UK).

The experimental dental alginate (in house formulation) is a sodium alginate impression material. The ingredients are: 14% sodium alginate, 9% calcium sulphate hemihydrate (CaSO4), 3% potassium fluorotitinate (K2TiF6), 0.42% tetrasodium pyrophosphate (Na4P2O7), 10% Magnesium oxide (MgO) and 63.58% diatomaceous earth (filler) (Table 1).

An experimental dental alginate formulation is being investigated together with two commercially available materials, one of which is used in the Barts and London Dental clinics. The experimental alginate was developed in the Dental Physical Sciences department Queen Mary University of London.

Experimental dental alginate material used was sodium alginate impression material.

For preparation of the impression, a custom tray with handle attached to a cup was used, having 50 mm length and 15 mm width (tray) and 23 mm diameter and 20 mm height (cup) having small holes which was used for making precise impressions.

Disinfecting agent was Perform-ID (45g pentapotassiumbis peroxymonosulphate) bis (sulphate). Solution was made by dissolving 2 level measuring scoops of Perform-ID through scattering it into 2 liters of lukewarm water. The disinfection was done as immersion disinfection.

The materials were thoroughly mixed manually in rubber bowl using metal spatula. Tap water was used for mixing at around 190C ±1. Powder and water ratio were one scoop for powder (9g) and measured water, 17 ml and 24 ml, respectively. Ratios and mixing time were carried out according to the manufacturer's instructions. For experimental dental alginate impression material, the setting time was 2 min 20 seconds, for Tropicalgin 2 min 35 seconds and for Blueprint Cremix alginate 2 min 10 seconds.

All the three materials, after thorough mixing for about 1 min ± 5sec were poured in a 1 mm thick metal rectangular mould (10mm x 40 mm) apparatus shown in Figure 1. For ensuring all samples to be of same size and shape. On top, a glass slide was placed using pressure from finger for obtaining flat surface. The use of 1 mm and 3 mm thickness material was to check for any swelling or shrinking in each subset.

In each group, similar material and methods were used except the thickness of metal mould was kept at 3 mm. A total of 36 samples were prepared, i.e. 12 samples for each material, each divided into groups of 1 mm and 3 mm thickness. After setting of the samples, they were removed immediately from mould and weighed, then stored under the following condition: after setting of samples and weighing them immediately, they were left in air at room temperature (230C ±1) after which they were weighed after 10, 30 minutes and then 1 hour (10). Any distorted impression in the mould was excluded from the study.

SPSS version 20.0 was used for data analysis. The changes in weigh measurement were reported as frequency and percentages as they were quantitative variables. P-value <0.05 was considered as statistically significant.

RESULTS

The condition and thickness score of the various materials used in study are shown in Table 2 where sampling of the 3 dental materials used in the study namely the commercially prepared materials Tropicalgin, Blueprint cremix and one experimental formulated material, i.e., alginate. Each material was divided into 2 groups having 1 mm and 3 mm thickness of metal mould.

The comparison of change in thickness among all the three different materials Tropicalgin, Blueprint cremix and experimentally formulated alginate stored using two thicknesses of 1 mm and 3 mm and stored in air under room temperature is shown in Table 3 and Figure 2. From the results it is evident that all the three materials lost weight throughout 10 min, 30 min and 1-hour period. The least weight loss at each timeline in each group was reported in the experimentally formulated alginate. Significant change in thickness was although observed in all the three groups, however the least change was seen in group 3 and highest in group 1.

DISCUSSION

The extended storage of irreversible hydrocolloid material (alginate) is one of the important factors which may affect its physical, mechanical and chemical properties, where it is observed that alginate contains around 85% water.[11] There are three processes that can affect the accuracy of casts produced from alginates. In particular, the syneresis phenomenon is exudation of a liquid film on the gel surface. After making an impression, the clinician may not always hand the material over to the dental nurse for disinfection/bagging resultantly causing the alginate materials to lose less amount of water by evaporation and shrinkage as a result of clinical consequence.[12] The ratio of calcium to sodium plays an important role in loss of water from alginate materials. When the ratio of calcium to sodium is high, the alginate loses water more rapidly than alginates with a lower ratio of calcium to sodium, even though the dimensional stability was greater with higher ratio of filler to alginic polymer and, lower-molecular weight polymer chains in alginates, could improve the dimensional stability of the material.[13]

A study measured the loss of water, from alginates in air, by weight change and found that water loss is a diffusion process. As a result of a major decrease in

TABLE 1: THE MANUFACTURERS AND THE COMPOSITIONS OF EXPERIMENTAL FORMULATION OF ALGINATE MATERIAL.

Component	Manufacturer	Composition
Mangule®DJX	FMC Biopolymer Ladyburn Works, Girvan, Ayreshire, KA26 9JN, Scotland, UK	Sodium alginate
Potassium fluorotitanate	Rose Chemical Ltd., 73 Englefield Road, London, N1 4HD, UK	
Diatomaceous earth (non-washed)	Sigma-Aldrich Company Ltd., Fancy Road, Poole, Dorset, BH12 4HQ, UK	Cristobalite (72%) and quartz
Crystacast plaster	CFS Partnership, Unit A United Downs Industrial Park, St Day, Redruth, Cornwall, TR16 5HY, UK	Calcium sulphate hemihydrates
Tetrasodium pyrophosphate	Sigma-Aldrich Company Ltd., Fancy Road, Poole, Dorset, BH12 4HQ, UK	
Magnesium oxide	Aldrich Chemical Company Ltd., The Old Brickyard, New Road, Gillingham, Dorset, SP8 4XT, UK	

TABLE 2: BASELINE INFORMATION OF MATERIAL, THICKNESS, AND CONDITION

Material	Thickness	Condition (Air)	Total samples
Tropicalgin (Group 1)	1 mm	6	12
	3 mm	6	
Blueprint Cremix (Group 2)	1 mm	6	12
	3 mm	6	
Experimentally formulated (Alginate) (Group 3)	1 mm	6	12
	3 mm	6	

TABLE 3: FREQUENCY OF SHRINKING (LOSS OF WEIGHT) IN THE 3 MATERIALS KEPT AT DIFFERENT STORAGE TIMES.

	10 min		30 min		1 hour		p-value
	1 mm	3 mm	1 mm	3 mm	1 mm	3 mm	
Tropicalgin (Group I)	6.33 % (2.02)	2.76 % (1.62)	10.31% (1.61)	5.55 % (1.31)	18.26% (1.99)	8.34 % (1.32)	<0.01
Blueprint Cremix (Group II)	4.63% (1.92)	1.76 % (0.84)	8.16 % (1.85)	4.50 % (0.92)	16.71% (1.58)	8.34 % (0.99)	<0.01
Experimentally formulated (Alginate) (Group III)	3.37 % (0.54)	1.88 % (0.54)	6.86 % (2.33)	4.82 % (0.62)	14.47 (2.14)	8.64 % (0.71)	<0.01

*One-way ANOVA was applied to test for significance in-between the groups

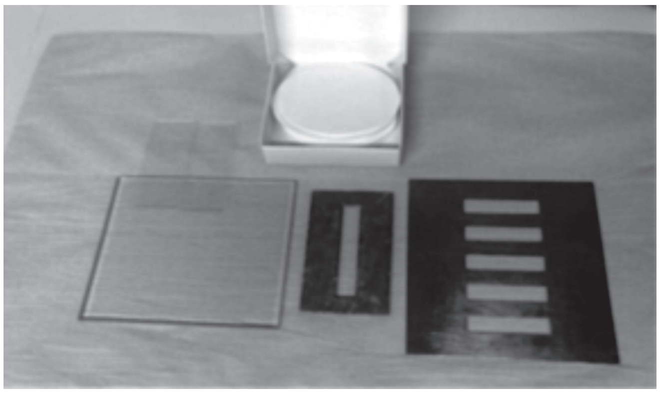
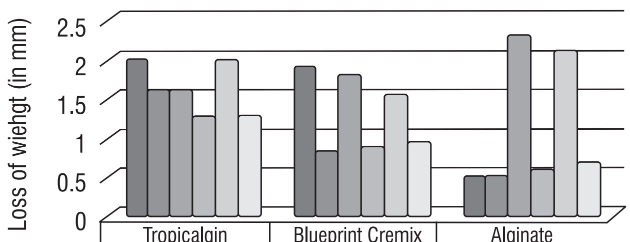


Fig 1: Metal mould (1mm, 3mm thick) and glass slide



	Tropicalgin	Blueprint Cremix	Alginate
10 min (1mm)	2.02	1.92	0.54
10 min (3mm)	1.62	0.84	0.54
30 min (1mm)	1.61	1.85	2.33
30 min (3mm)	1.31	0.92	0.62
60 min (1mm)	1.99	1.58	2.14
60 min (3mm)	1.33	0.99	0.71

Fi 2: Graphical representation of shrinkage (loss of weight) in the 3 materials kept at 1 mm and 3 mm storage (p<0.001)

entropy consequent on the cross-linking reaction, leads to less loss of water from alginate in air on setting. The theoretical prediction of 1/3 linear shrinkage of the corresponding weight loss in the early stages is followed by linear shrinkage in air only were reported compared to alginate impression materials with other elastomeric impression materials.[14] The results of the study showed that alginate impression materials had accuracy similar to those of the elastomeric impression materials, but the alginate impression materials became unstable after hours compared to the elastomeric impression materials.[14]

Under the condition of keeping the materials in air at room temperature, it was found that the 1mm thick samples lost twice the amount of weight compared with the 3mm thick samples for the three different materials, Blueprint Cremix, Tropicalgin, Experimental formulation (14.47-16.71%) and ~14.47- 18.36% for 1mm thick samples and ~8% for 3mm thick samples. It is suggested that the thickness plays an important role to keep water inside alginate materials for long time. However, this is difficult in the clinical situation because variable thicknesses are always present.[15]

It has also been seen that in air there is very little difference in percentage weight change (~8%) between the 3mm thick samples of all three materials.[16] With the 1mm thick samples slightly different weight changes were recorded between the three materials, with priority of Experimental Formulation, around 14% weight loss was obtained compared to Blueprint Cremix and Tropicalgin with 16%, 18%, respectively. It has been suggested that the composition, mixing and water/powder ratios of each material may play a significant role to show this difference between the alginate materials.[17]

CONCLUSION

According to the results of this study, it was concluded that the commercial as well as experimental alginate showed dimensional changes at different storage times of 10 min,30 min and 1 hour.

However, the least weight loss was observed in the experimental alginate material having minimum weight loss even after 1 week.

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1	**Muhammad Anwaar Alam:**	Conception of study, analysis of data.
2	**Mustafa Qadeer:**	Manuscript write up.
3	**Fareed Ahmad:**	Plagiarism check, proof reading.
4	**Faiqua Yasser:**	Expert opinion and experience in finalizing the manuscript.
5	**Ali Anwaar:**	Contribution to the writing conception & design.
6	**Fars Mughrbi:**	Data analysis.

News

Pakistan Oral & Dental Journal has been publishing articles of Dr Jachmen Sultana, Maxillofacial Surgeon working at Banglabandu Medical University (BSMMU) Shahbag, Dhaka, Bangladesh. She has been awarded PhD degree from this University. We extend our congratulations & best wishes to her.

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