Evaluation of Dimensional Accuracy of Alginate Impressions Material with Immediate and Delayed Pouring

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Abstract: The aim of the present study was to compare the dimensional accuracy and stability of Alginate materials with immediate and delayed pouring. Two types of alginates were tested: Neocolloid (Zhermack) and Jeltrate (Dentsply). A master model was mounted on a special device and used to obtain the impressions. These impressions were poured with Glastone (Dentsply) type III dental stone, and again after 4 and 8 hours. The casts were measured and the data were analyzed by one way analysis of variance (ANOVA) and Post Hoc test at $p<0.05$. The means of pouring time for all distances were slightly greater than those of the master model for both immediate and delayed pouring, deviations were positive; i.e. the distances both inter-abutment (D13, D23, D16, D26) and intra-abutment (D3 & D6) were increased compared to the master model. Both alginate impression materials are dimensionally sufficient stable for construction of diagnostic casts and acrylic appliances.

[Alruthea MS. **Evaluation of Dimensional Accuracy of Alginate Impressions Material with Immediate and Delayed Pouring.** *Life Sci J* 2014;11(10):1075-1079]. (ISSN:1097-8135). http://www.lifesciencesite.com. 162

Keywords: Dimensional accuracy; dimensional stability; alginate; impression

1. Introduction

Alginate was presented as a material in 1936 (Starcke, 1975), and used as impression material in 1947 (Hansson and Eklund, 1984). Since that time it becomes the most commonly used materials because it is easy to use, well accepted by the patient, and has low price (Nandini et al., 2008) for production of diagnostic casts, occlusal splints, acrylic appliances and removable partial denture frameworks (Reisbick et al., 1997).

The dimensional stability of alginate impression materials has been studied since the 1970s. (Sawyer et al., 1976). In specific, the phenomena of syneresis (losing water) and imbibition (water absorption), Miller (1975), Dahl et al., (1985), Durr and Novak, (1987). Consequently, the dental professionals believed that the alginate impression must be poured immediately or within 12 minutes after the impression is removed from the patient's mouth (Sedda et al., 2008). Researchers have recommended this technique due to lack of sufficient storage method for any hydrocolloid impression material (Rudd et al., 1969). Addition to that, Rudd and colleagues (1969) and Phoenix and colleagues (2003) reported that clinicians should never immerse alginate impressions in a liquid or wrap them in a damp paper towel.

Currently, many types of Alginates are marketed with claims of dimensional stability and accuracy of as long as seven days (Torassian et al., 2010). The aim of this study was used in vitro investigation, to compared the dimensional accuracy and stability of Alginate materials with immediate and delayed pouring. The null hypotheses were that, there would be no significant difference in dimensional accuracy and stability between the immediate or delayed pouring.

2. Material and Methods

To simulate the clinical situations, a testing device was manufactured from a stainless steel, modified from that described by Stauffer et al. (1976). This device consists of three parts: the base, the master model, and the carrier (Fig. 1).

The base is a quadrilateral plate with four parallel guideposts to which the master model is attached and four movable metal stops (Stauffer et al., 1976). The master model mimic the upper dental arch with 4 abutments of known dimensions resembling the sites of canines (13 & 23) and first molars (16 & 26) (Nassar et al., 2012).

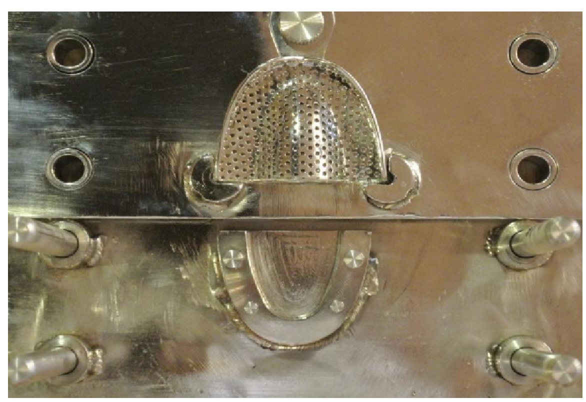

Figure 1. The base, the master model, and the carrier

These specific sites permit the investigators to precisely measure the intra-abutment, as well as the inter-abutment measurement (Nassar et al., 2012).

The location of the distances measured on each of the master and stone models is illustrated in (Fig. 2). The master model measurements were used as controls (Table 2).

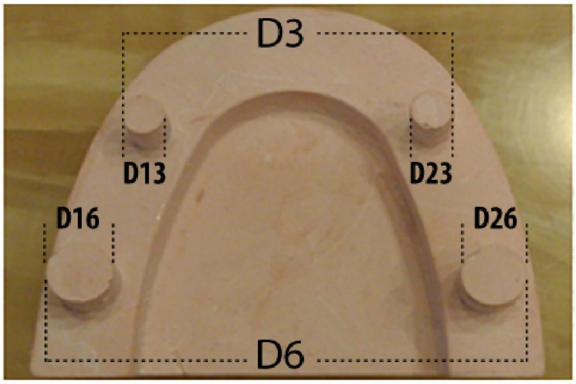

Figure 2. Measurements analyzed in the master model, and in the obtained casts

The carrier is a quadrilateral plate on which the stock metal tray attached and keep a 3 mm distance away from all the parts of the master model (Stauffer et al., 1976). For consistency, and to ensure rigidity of the tray, one size of perforated stainless steel impression tray (upper size A3, Zenit, Madrid, Spain) was used to make impressions of the master model throughout the study (Tjan et al., 1981).

An aerosol universal adhesive was sprayed on the tray and left to dry for 5 minutes (Leung et al., 1999). Tow alginate impressions materials were used (Table 1).

Impressions of the master model were made according to each manufacturer's instructions but were left on the master model for an extra one minute before separation. The impressions were fabricated by one operator in a manner that closely approximated steps used in the clinical setting (Nassar et al., 2012).

Table 1. Materials used in the study

Material	Type	Manufacturer	Lot no.
Neocolloid	Irreversible hydrocolloid	Zhermack	142260
Jeltrate	Irreversible hydrocolloid	Dentsply	121016
Glastone	Type III dental stone	Dentsply	091227
Tray Adhesive	Adhesive	Pulpdent Corp Of America	090219
Clorox	Sodium hypochlorite	Clorox Company	-

All of the impressions were placed under cold running water for 30 seconds after removal from the model, and then the excess water was removed with air spray in a way that the surface would not be desiccated, Then the impressions were disinfected for 5 minutes by 0.5% Sodium Hypochlorite and again placed under running water for 30 seconds (Amin et al ., 2009).

The impressions that were not poured immediately sealed in a plastic bag in which a paper sheet wetted with distilled water had been inserted 10 minutes before, according to Schleier et al. (2001) for 4 & 8 hours. This time frame is the same as that used in previous studies of irreversible hydrocolloid materials, Hiraguchi et al., (2005), and Hiraguchi et al., (2007).

All impressions were casted via the single-pour technique in a type III gypsum product by vacuum mixing according to manufacturer instruction then poured into the impressions in a standardized manner. The poured casts were left to set for 1 hour. After being removed from the impressions, casts were allowed to dry for 24 hours before measurements were obtained. All measured was made by a single investigator using a Mitutoyo IP 54 digital micrometer (Mitutoyo, Kawasaki, Japan; resolution 0.001 mm) (Nassar et al., 2012).

A total of 120 impressions of the master model were made, 60 impressions for each of the 2 materials, with pouring immediately or after 4 & 8 hours of storage. This sample size that used in this study was based on the results of a previous study (Walker et al., 2010).

The results were statistically analyzed with SPSS ver. 21 (SPSS, Inc., Chicago, IL, USA). One sample t-test was used to compare between each reading and the master (control) model, followed by multiple measure one way analysis of variance (ANOVA) to compare intra-group for immediate, 4 hours and 8 hours measurements, and a Post Hoc and confidence interval adjustment was applied using Benferroni's correction groups. The level of significance was adjusted at $p<0.05$.

3. Results

In order to make the interpretation of the achieved results easier, a summary is provided in Table 2. Overall and regardless of pouring time the means for all distances were slightly greater than those of the master model for both immediate and delayed pouring. Deviations were positive; i.e. the distances (D) both inter-abutment (D13, D23, D16, D26) and intra-abutment (D3 & D6) were increased compared to the master model.

Regarding inter-abutment measures it shows a statistically significant increase in measurement either in comparison to master model or intra-group. The percentage of change was ranged from 0.02% to 0.6 %. Similarly intra-abutment measures showed a statistically significant increase both intra-group and inter-groups with range of change 0.06% to 0.16.

Table 2: Means (millimeters) for the measurements on the master model and the means and standard deviations for the stone models made from the impression materials regardless of immediate and delayed pouring.

			Model	Neocolloid (N1= 21)			Jeltrate (N2=21)		
				Imm (mean±SD)	4H (mean±SD)	8H (mean±SD)	Imm (mean±SD)	4H (mean±SD)	8H (mean±SD)
intra-abutment	D13	Measure	5.915	5.932 ± 0.015	5.933± 0.009	5.943± 0.007	5.935± 0.004	5.948± 0.003	6.017± 0.006
		With control(1) t (p)		5.207 (p<0.001)*	9.193 (p<0.001)*	17.357 (p<0.001)*	21.366 (p<0.001)*	43.296 (p<0.001)*	84.224 (p<0.001)*
		Intra-group (2) F(p)		12.825 (p=0.001)*			2117.076 (p<0.001)*		
	D 23	Measure	5.911	5.929± 0.016	5.948± 0.0162	5.950± 0.021	5.934± 0.004	5.965± 0.006	5.982± 0.013
		With control(1) t (p)		4.895 (p<0.001)*	10.641 (p<0.001)*	8.488 (p<0.001)*	27.034 (p<0.001)*	43.882 (p<0.001)*	26.451 (p<0.001)*
		Intra-group (2) F(p)		17.617 (p<0.001)*			251.887 (p<0.001)*		
	D 16	Measure	8.805	8.823± 0.016	8.828± 0.013	8.839± 0.010	8.815± 0.004	8.842± 0.007	8.844± 0.016
		With control(1) t (p)		5.302 (p<0.001)*	7.692 (p<0.001)*	15.158 (p<0.001)*	11.421 (p<0.001)*	22.760 (p<0.001)*	10.684 (p<0.001)*
		Intra-group (2) F(p)		31.366(p<001)*			54.763 (p<0.001)*		
	D 26	Measure	8.803	8.816± 0.013	8.819± 0.008	8.837± 0.004	8.816± 0.004	8.824± 0.008	8.833± 0.0105
		With control(1) t (p)		4.695 (p<0.001)*	8.830 (p<0.001)*	39.074 (p<0.001)*	15.809 (p<0.001)*	12.497 (p<0.001)*	13.126 (p<0.001)*
		Intra-group (2) F(p)		28.738 (p<0.001)*			34.007 (p<0.001)*		
inter-abutment	D3	Measure	44.205	44.268± 0.046	44.265± 0.048	44.276± 0.046	44.234± 0.0165	44.247± 0.023	44.281± 0.021
		With control(1) t (p)		6.273 (p<0.001)*	5.720 (p<0.001)*	6.952 (p<0.001)*	8.014 (p<0.001)*	8.634 (p<0.001)*	16.412 (p<0.001)*
		Intra-group (2) F(p)		1.487 (p=0.240)			41.773 (p<0.001)*		
	D6	Measure	63.081	63.135± 0.005	63.137± 0.016	63.150± 0.020	63.153± 0.007	63.170± 0.028	63.175± 0.028
		With control(1) t (p)		51.917 (p<0.001)*	16.000 (p<0.001)*	16.001 (p<0.001)*	48.076 (p<0.001)*	14.507 (p<0.001)*	15.560 (p<0.001)*
		Intra-group (2) F(p)		7.313 (p=0.003)*			11.648 (p=001)*		

(1) t test for comparison with master model
(2) Repeated Measure ANOVA for intra-group comparison
*: significant at p<o.o5

4. Discussions

Two of the most important features determine the choice of the impression material are the accuracy and dimensional stability. The processes that influence alginate dimensional stability are expansion due to water absorption or shrinkage due to evaporation of water (Miller, 1975), .

This study investigated the dimensional accuracy and stability of Alginate materials with immediate and delayed pouring. The results of this study showed slightly increased in all distances than those of the master model for both immediate and delayed pouring. Thus, the null hypothesis, " there would be no significant difference in dimensional accuracy and stability between the immediate or delayed pouring" is rejected.

For casts to be clinically acceptable, American Dental Association (ADA) specification no. 18 (dental alginate impression material) does not mention the acceptable dimensional change range for alginate impression materials. On the other hand, ADA specification no. 19 enumerates the acceptable dimensional change for elastomeric impression materials to be 0.40 percent for polysulfide's and 0.60 percent for silicones. Applying the principle of specification no. 19 on the results of the current study, regardless of the material or the pouring time that found to be within acceptable limit.

The results of this study showed that, the dimensional changes of casts made from both immediate and delayed pouring were increased in all measurements regardless of alginate impression materials. On average, Jeltrate impression materials was slightly more accurate than Neocolloid (Table 2).

There was no effect of either of pouring time on intra-abutment (D3 & D6) distances. Both immediate and delayed pouring time, were associated with a slight increase in dimension compared to the master model. The intra-abutment (D3 & D6) data for individual materials, regardless of immediate and/or delayed pouring time, increased slightly. Although the deviations from the master model were similar to those found for the inter-abutment (D13, D23, D16, D26) differences, the small scale of measurements show finding statistically significant differences for the effects of immediate/delayed pouring time or material type on the results. The results of this study agree with those of Schleier et al., (2001). They reported that the dimensional stability is not affected by pouring time.

There was a statistically significant difference of both immediate and delayed pouring time and material on inter-abutment measurement D3. However, since the mean deviations were small, ranging from 0.059 µm to 0.071 µm, it is doubtful if these differences are clinically not significant. The post hoc test revealed that the differences between immediate and delayed pouring time conditions affected only Neocolloid impression materials significantly (Table 2).

In agreement with the present study, Sedda et al., (2008), Nassar et al. (2012) and, Imbery et al., (2010), reported that inter-abutment (D13, D23, D16, D26) distances were greater for all dies using different alginate dental impression materials. However, from the clinical perspective the differences between the master model and the dental stone models in the present study were not of sufficient magnitude to cause concern; mean deviations ranging from 0.010 µm to 0.102 µm.

The increases in distances observed may be explained by the factors include syneresis, and imbibition, ratios of calcium to sodium and filler to polymer, molecular weight of alginic polymers and other proprietary constituents, Saitoet al., (1998) and Imbery et al., (2010), linear setting expansion of the die material throughout the entire bulk of the stone block.

Conclusion:

Either immediate or delayed pouring time of two alginate impression materials showed dimensional changes, however the magnitude of this change is questionable in terms of clinical significance. Within the limitations of this study, both the alginate impression materials are dimensionally sufficient stable for construction of diagnostic casts and acrylic appliances.

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9/25/2014