



RESEARCH ARTICLE

EVALUATION AND COMPARISON OF DIMENSIONAL ACCURACY OF CONVENTIONAL ALGINATE AND ALGINATE ALTERNATIVE AT DIFFERENT TIME INTERVALS- AN IN VITRO STUDY

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ABSTRACT

Objective: The purpose of the study was to evaluate and compare the linear and cross arch dimensional accuracy of conventional alginate (Algitex) and alginate alternative (AlgiNot) at different time intervals.

Materials and Methods: Thirty two impressions of full arch master model were made with both the materials and they were divided into four groups: immediate pour, poured at 24 hours, 96 hours, and 120 hours. Anterior posterior (A-B & A-C) and cross arch (B-C) measurements were made on the casts with the help of coordinated measuring machine.

Results: Alginate Alternative (AlgiNot) produced the casts with minimum distortion at each time interval. Conventional alginate (Algitex) produced accurate casts when impressions were poured immediately. There was an increase in distortion at each time interval for conventional alginate. At the end of 120 hrs conventional alginate showed 3.67% increase in A-B (antero posterior) dimension, 3.53% increase in A-C (antero posterior) dimension and 2.18% in B-C (cross arch) dimension. At the end of 120 hrs alginate alternative showed 1.7% increase in A-B (antero posterior) dimension, 1.3% increase in A-C (antero posterior) dimension and 0.62% in B-C (cross arch) dimension.

Conclusion: Dimensional changes were evident with both the materials tested in the study at the end of 120 hours. Conventional alginate (Algitex) and Alginate Alternative (AlgiNot) both produced accurate casts at immediate pour. Conventional alginate (Algitex) showed marked dimensional changes at 24 hours, 96 hours, and 120 hours. Whereas, Alginate Alternative (AlgiNot) showed less significant changes at 24 hrs, 96 hrs and 120 hrs.

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INTRODUCTION

Dental impression materials are foundation for prosthodontic treatment to replicate teeth and associated oral structures. Important requirements of impression material are ease of manipulation, precise replication of oral tissues, dimensional stability and compatibility with cast materials (Fund *et al.*, 2002). Dimensional accuracy is one of the most important characteristics of an impression material. The most favored impression material is the one which reproduce accurate casts with exact dimensions of the original (Supowitz *et al.*, 1988). Irreversible hydrocolloid impression materials are being used in dentistry since 1940s for making primary impressions for fixed and removable prosthesis, orthodontic models, antagonistic arch models and study models (Fund *et al.*, 2002). Ease of use, low cost, coupled with good clinical and physical

properties make these materials a popular choice for constructing dental casts (Brian *et al.*, 1997). Greatest disadvantage of alginate impression materials is that, impressions should be poured immediately after removal from the mouth to obtain maximum accuracy. The introduction of alginate alternative impression materials has provided an additional choice of materials for the various clinical applications. These materials are advertised as alternative for conventional alginate materials (Nassar *et al.*, 2012). The term alginate alternative was first used in the investigations published in 1980 (Eames and Litvak, 1984; Suchak *et al.*, 1984). Currently available alginate alternative material is supplied as medium body addition type polyvinyl siloxane based materials (Nassar *et al.*, 2012). According to manufacturers of product AlgiNot (Kerr Corp., MI) the impressions may be poured at delayed time interval without any adverse effects on the final result. Purpose of this invitro study was to evaluate and compare the dimensional accuracy of conventional alginate (Algitex) and alginate alternative (AlgiNot) at different time intervals.

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MATERIALS AND METHODS

The alginate impressions were made on Frasco maxillary dentulous master model.

Preparation of the master model: On a maxillary Frasco dentulous model, three teeth were prepared (right central incisor, right 1st molar and left 1st molar) for full crown restoration. With the help of Nd:YAG industrial laser a '+' shaped reference mark was engraved on a piece of premolar orthodontic bands. These bands were cemented on to the center of the prepared occlusal surface on the molars and on to the prepared incisal edge of central incisor. These served as reference points for accurate measurements. Laser mark on right central incisor was considered as point 'A', on right 1st molar as point 'B' and on left 1st molar as point 'C'.

Tray and model aligning device: A device was fabricated to align the tray and the model and to standardize the positioning and thickness of the impression material.

Impression making: Dentulous stock metal perforated trays were used to make impressions. Conventional alginate (Algitex) was mixed with distilled water at room temperature according to manufacturer's recommended water/powder ratio. Alginate Alternative (AlgiNot) material was supplied in automixed cartridges. Mixing tips and elastomer mixing gun was used to mix and load the material.

The mix was loaded in the tray and positioned on the lower member of the aligning device. The upper member carrying the model was then placed over the tray. Once the material was set, the impression was removed with a single dislodging force (snap out method). Impressions with air entrapment or without details were discarded. A total of 64 impressions were made using both the impression materials with 32 impressions for each material. After removing the impressions from the jig, the impressions were rinsed and kept in zip sealed bags except those to be poured immediately. The impressions were poured at different time intervals which are: immediately, at 24 hours, 96 hours and 120 hours. The delay in pouring was intended to reflect a realistic clinical situation where dental practice is without an in-house lab. In such condition impressions are sent to an outside lab which requires storage of impressions for a longer duration. After the designated time interval, the impressions were poured with type III dental stone. Dental stone was allowed to set for one hour before separating the casts. Casts were numbered and allowed to dry for 24 hours.

Measurements

A coordinated measuring machine was used to measure A-B, A-C (antero posterior) and B-C (cross arch) dimensions.

Statistical analysis

Following statistical methods were applied in analyzing the results of the variables considered in the study.

Descriptive statistics

Independent sample 't' test

Paired t test

Statistical analysis were conducted with SPSS (version 16) .

RESULTS

The mean linear changes in both antero posterior and cross arch dimensions were calculated. To facilitate comparisons of relative amounts, the accuracy was expressed in percent of mean linear change rather than absolute values as shown in Table I, II, and III. There was an increase in antero posterior and cross dimensions as the time increased for both the materials. When A-B antero posterior dimension was compared at the end of 120 hours, conventional alginate showed 3.67% increase and alginate alternative showed 1.7% increase compared to the standard values obtained from the master model.

Table I. Comparison of A-B antero posterior distortion between Standard value and values obtained at immediate, 24 hrs, 96 hrs and 120 hrs for Conventional Alginate and Alginate Alternative (Alginot)

(A- mark on right central incisor, B- mark right 1st molar)

	Grp		Mean	N	Std. Deviation	Std. Error Mean	
Convnt	Pair 1	std	28.5400	8	.00000	.00000	
		imm	28.5800	8	.02070	.00732	
	Pair 2	std	28.5400	8	.00000	.00000	
		24hr	29.4338	8	.39634	.14013	
	Pair 3	std	28.5400	8	.00000	.00000	
		96hr	29.4675	8	.39478	.13958	
	Pair 4	std	28.5400	8	.00000	.00000	
		120hr	29.6288	8	.23012	.08136	
	Alginot	Pair 1	std	28.5400	8	.00000	.00000
			imm	28.5500	8	.01069	.00378
		Pair 2	std	28.5400	8	.00000	.00000
			24hr	28.5663	8	.01188	.00420
Pair 3		std	28.5400	8	.00000	.00000	
		96hr	28.6113	8	.01808	.00639	
Pair 4		std	28.5400	8	.00000	.00000	
		120hr	29.0550	8	.23139	.08181	

Table II: Comparison of A-C antero posterior distortion between Standard value and Values obtained at immediate, 24 hrs, 96 hrs and 120 hrs for Conventional Alginate and Alginate Alternative (Alginot)

(A-mark on right central incisor, C- mark on left 1st molar)

	Grp		Mean	N	Std. Deviation	Std. Error Mean	
Convnt	Pair 1	std	28.7200	8	.00000	.00000	
		immediate	28.7325	8	.00707	.00250	
	Pair 2	std	28.7200	8	.00000	.00000	
		24hr	29.0412	8	.03091	.01093	
	Pair 3	std	28.7200	8	.00000	.00000	
		96hr	29.2962	8	.06739	.02383	
	Pair 4	std	28.7200	8	.00000	.00000	
		120hr	29.7712	8	.11167	.03948	
	Alginot	Pair 1	std	28.7200	8	.00000	.00000
			immediate	28.7438	8	.01061	.00375
		Pair 2	std	28.7200	8	.00000	.00000
			24hr	28.8200	8	.02726	.00964
Pair 3		std	28.7200	8	.00000	.00000	
		96hr	28.9362	8	.03998	.01413	
Pair 4		std	28.7200	8	.00000	.00000	
		120hr	29.0762	8	.10281	.03635	

Table III. Comparison of B-C cross arch distortion between Standard value and Values obtained at immediate, 24 hrs, 96 hrs and 120 hrs for Conventional Alginate and Alginate Alternative (Alginot)

(B-mark on right 1st molar, C- mark on left 1st molar)

Grp	Mean	N	Std. Deviation	Std. Error Mean		
Convnt	Pair 1	std	46.9500	8	.00000	.00000
		imm	46.9700	8	.00926	.00327
	Pair 2	std	46.9500	8	.00000	.00000
		24hr	47.6113	8	.16479	.05826
	Pair 3	std	46.9500	8	.00000	.00000
		96hr	47.8950	8	.08367	.02958
	Pair 4	std	46.9500	8	.00000	.00000
		120hr	48.0013	8	.04643	.01641
Alginot	Pair 1	std	46.9500	8	.00000	.00000
		imm	46.9538	8	.00518	.00183
	Pair 2	std	46.9500	8	.00000	.00000
		24hr	47.0563	8	.04627	.01636
	Pair 3	std	46.9500	8	.00000	.00000
		96hr	47.1450	8	.04408	.01558
	Pair 4	std	46.9500	8	.00000	.00000
		120hr	47.2450	8	.04375	.01547

When A-C antero posterior dimension was compared at the end of 120 hours, conventional alginate showed 3.53% increase and alginate alternative showed 1.3% increase in the values. When B-C cross arch dimension was compared at the end of 120 hours, conventional alginate showed 2.19% increase and alginate alternative showed 0.62% increase in the values. A significant change was observed in both antero-posterior and cross arch measurements over immediate pour to 120 hours. (p value= .000) Changes in all the dimensions were more significant in conventional alginate than alginate alternative material. It is evident that initially both the material had almost same values as the standard values.

DISCUSSION

In this study conventional alginate and alginate alternative materials were evaluated and compared for their dimensional accuracy at different time intervals. The change in dimension indicates shrinkage of the impression material. It was found that increase in the pouring time led to increase in shrinkage of material. The accuracy of the casts was directly proportional to the water loss or gain during the different storage procedures. Loss of water during storage leads to shrinkage (synerisis). This shrinkage occurs towards the wall of the impression tray and that could cause the measured reference points to move further apart. If the water is gained, material will swell (imbibition), and the points of measurement would move close together. Therefore there should be a delicate balance between these two conditions (Han-Kuang *et al.*, 1993). Thus lack of equilibration between these two events lead to dimensional changes if impressions are not poured immediately after removing from patients' mouth (Drummond and Randolph, 1986). The amount of shrinkage caused by synerisis is always higher than evaporation. The evaporation of water from the gel can be prevented in a 100% moisture medium (Anderson, 1976). In the present study at the end of 120 hours conventional alginate (Algitex) showed increase of 3.67% in A-B (antero posterior) dimension, 3.53% in A-C (antero posterior) dimension and 2.19% in B-C (cross arch) dimension.

At the end of 120 hours alginate alternative material (AlgiNot) showed increase of 1.7% in A-B dimension, 1.3% in A-C dimension and 0.62% in B-C dimension. Impression materials have undergone shrinkage possibly due to synerisis and imbibition. Shrinkage of material occurs towards the tray because impression material is firmly adhered to the tray. Alginate alternative (AlgiNot) material provided minimal percentage change at the end of 120 hours, yielding better results than those obtained from conventional alginate (Algitex) material. These changes were consistent with the findings of other studies (Torassian *et al.*, 2010; Patel *et al.*, 2010). Advantage of having a low percentage dimensional change would enhance the suitability of these alginate alternative materials when used for purposes beyond making preliminary records. Limited dimensional change of this material would be beneficial in many clinical procedures; it would save the chair side time and also improve the fit of dental devices.

In a recent study triple cone-beam computed tomography procedure with a Triple Tray Alginot impression in place was used to augment a 3- dimensional virtual skull model with detailed dental occlusal data. This implementation reflects the thixotropic nature and dimensional stability of alginate alternative material (Swennen *et al.*, 2009). Currently available alginate alternative materials are medium body addition type polyvinyl siloxane based materials. They are auto mixed material, which produces a predictable consistency, which in turn leads to precise setting times. The uses of alginate alternative impression materials eliminate the problem associated with water based irreversible hydrocolloid impressions. The result of this investigation confirms that the material tested fall within the maximum dimensional change allowed by ANSI/ADA specification 19. Notably, the ANSI/ADA specification does not include values for percent linear dimensional change for irreversible hydrocolloid materials. By way of comparison, the ANSI/ADA standard for dimensional change of elastomer is 1.5% (Nassar *et al.*, 2012; Reddy *et al.*, 2010). The present study has its limitations because it was done under laboratory testing conditions. No method to simulate mouth temperature and no moisture equivalent to saliva was used. There was no way to simulate the biofilm that exists on the oral mucosa and comes in contact with the impression material.

The properties of impression material in the clinical situation still differ from the laboratory testing conditions. Further investigation should incorporate more closely simulated clinical conditions.

Conclusion

Casts produced from both the materials displayed that the dimensional accuracy is time and material dependent. Immediate pouring of the casts showed similar behavior for both the impressions materials. The Alginate Alternative (AlgiNot) material provided better dimensional accuracy compared to the conventional alginate (Algitex) at each time interval. Significant dimensional accuracy of the alginate alternative material may be advantageous in several aspects of clinical dentistry beyond the traditional use of preliminary casts.

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