

The effect of contact time between alginate impression material and type III dental stone on the surface properties of stone casts

Suha Fadhil Dulaimi ⁽¹⁾, Atyaf Maser Alnaser ⁽²⁾, Najwah Yousuf Hameed ⁽³⁾

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ABSTRACT

Background: Alginate impression material is the irreversible hydrocolloid material that is widely used in dentistry. The contact time between alginate and gypsum cast could have a detrimental effect on the properties of the gypsum cast. The objective of this study is to evaluate the impact of various contact time intervals of Alginate impressions & type III dental stone on surface properties of stone cast.

Materials and Methods: Time intervals tested were 1 hour, 6 hours and 9 hours. Surface properties of stone cast evaluated were surface detail reproduction, hardness and roughness. Surface detail reproduction was determined using cylindrical brass test block in accordance with ISO 1563. Surface roughness was measured by profilometer and hardness was measured by Durometer (Shore D).

Results: The detail reproduction showed significant difference ($P<0.05$), at 6 hr., and 9 hr. showed better results, while surface roughness significantly decreased ($p<0.01$) with prolonged contact time. However, surface hardness increased significantly ($p<0.01$) with increased contact time.

Conclusions: Surface detail reproduction increased with increasing the contact time and this was noticed at (6, 9 hours). However, 1 hour time interval showed decreased surface detailed reproduction. Roughness decreased when the contact time was increased between type III dental stone and alginate impression, whereas hardness was improved significantly with increasing contact time.

Keywords: Alginates, Surface properties, Dentistry, Hardness, Calcium sulfate. (Received: 2/6/2021, Accepted: 4/7/2021)

INTRODUCTION

In dentistry, methods of oral disease diagnosis and treatment are complemented by replicas of hard and soft tissue. Those replicas are known as study models, casts or dies. They are used for studying some cases in dentistry; and all of these replicas are used in the dental practice. ⁽¹⁾ Although there are several impression materials and procedures available for accurate impression making, irreversible hydrocolloids are among several impression materials that are commonly utilized in dental offices to produce stone casts ⁽²⁾.

An alginate impression is often made during the first visit as its outcomes are necessary to form a primary diagnosis about the patients' oral health condition ⁽⁴⁾. For several years, alginate impression has become an essential material for most dental, clinical and laboratory dental techniques.

The low cost and the ease of manipulation, integrated with good clinical and physical properties make alginate a popular choice among different dental practices ⁽³⁾.

Accurate diagnostic casts are essential to perform a multitude of functions throughout diagnosis, treatment planning and preparation for prosthodontics care ⁽⁴⁾.

Thus, it is of importance to understand the properties of those materials following some basic instructions so as to achieve predictable and flawless impressions and therefore avoiding repeated impression/restorations ⁽⁴⁾. Alginate is composed of a powder that contains potassium or calcium sulfate and fillers as primary constituents. The commercial Alginate contains some additive materials to calcium salts to improve its properties like Diatomaceous earth fillers to raise its rigidity and ease mixing, tetra sodium pyrophosphate (retarder), magnesium oxide (pH modifier) as well as the setting aids like sodium fluorosilicate ⁽⁵⁾. Delay pouring of alginate impression results in serious distortion due to shrinkage caused by syneresis and evaporation of water. A previous study recommended storing alginate impression up to 1 hr. in humid environment ⁽⁶⁾. Another factor that affects properties of final gypsum cast is the contact time between alginate and gypsum cast during its setting, the appropriate approach to prevent or decrease abrasion of gypsum cast during removal is by separating the cast from impression before hydrocolloid dehydration that occurs due to dried alginate ⁽⁷⁾. In some occasions in clinical and

(1) Assistant Professor, Department of Prosthodontics Technology, College of Health and Medical Technology, Middle Technical University (MTU) Baghdad – Iraq

(2) (3) Assistant Lecturer, Department of Prosthodontics Technology, College of Health and Medical Technology, Middle Technical University (MTU) Baghdad – Iraq

Corresponding author: suha.f.dulaimi@gmail.com

laboratory dental practice delay separation of gypsum cast from alginate impression after complete setting could happened.

Gypsum cast and die that are used in the production of dental restorations should give strength, resistance to scratch and accurate dimensional stability. The cast model's dimensional stability is influenced by the alginate water absorption and release as well as method of handling the impression by the clinician, in addition to contact time between alginate impressions and the gypsum's product ⁽⁵⁾. The gypsum setting time (the contact time between alginate impression and poured gypsum mix) should be observed to ensure the ideal properties of final cast model. Compatibility between alginate impression and gypsum product are also important for quality of cast model ⁽⁷⁾. A previous study investigated alginate impression storage time and recommended that impression must be poured immediately ⁽⁸⁾. Few information about the effect of contact time between alginate and gypsum, others recommended separating cast from alginate impression before dehydration of alginate started that have detrimental effect on cast quality ^(9,5).

The aim of the present study was to evaluate the effect of different contact time (1hr., 6hr. 9hr.) between alginate impression material and Type III dental stone on surface details reproduction, surface roughness and hardness of stone cast.

MATERIALS AND METHODS

Alginate impressions (Zhermack Badia Polesine, Italy) were evaluated with dental stone type III (Zhermack Badia Polesine, Italy) at different contact time intervals (1hr., 6hr. 9hr.)

Surface details reproduction:-

A brass cylindrical block (Figure1) was fabricated with three reference lines on surface 20 μ m, 50 μ m & 75 μ m in (width and depth). They were 2.5mm apart from each other according to ISO 1563 ⁽¹⁰⁾, the circular block had dimensions of 25mm in width and 15 mm in length.



Figure 1: The brass cylindrical block constructed according to ISO 1563

The 30 special trays were fabricated from chemical cure acrylic resin (Superacryl plus, Spofa dental, Markova, Czech Republic). Two wax sheets (2.8 mm) in width were orderly lined a round the cylinder, then acrylic dough was applied above wax sheets to create special tray to carry alginate impression.

The special trays were completed and perforated after setting of materials to prepare the samples. The manufacturer instructions were followed when alginate was mixed manually for 45 sec. and applied carefully in a special tray. Then, the top of the cylindrical brass was covered by a glass plate (weight 1 kg) ⁽¹¹⁾.

Setting of the impression material took 5 minutes before its removal from the cylindrical brass test. A cotton gauze moisten with ethanol was used to wipe the surface of the cylindrical test block, then washed with distilled water and kindly dried with compressed air before fabrication of each sample. Mixing of dental stones was done in accordance with guidelines of the manufacturer. After that, stone mix was poured in alginate impression for cast model production. The models were separated from impression after experimental time intervals (1 hour, 6 hours, 9 hours) Figure 2.

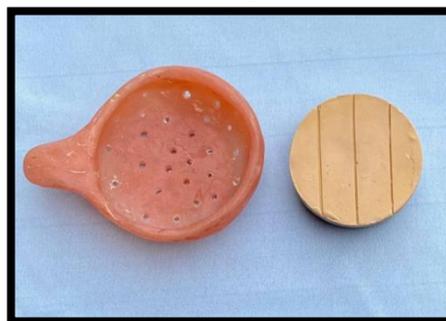


Figure 2: Custom made perforated tray and separated cast model

Group A, the control group, which contained (30 casts) were separated after an hour, Group B, the study group, which contained (30 casts): were separated after 6 hours, and Group C, which contained (30 casts) were removed following 9 hours.

Each group was then scanned at 1200 dpi resolution using a flatbed scanner (Genix, China), using a template as a guide on the surface of the scanner. The scanned images have been saved in jpg format. Evaluation of the surface detail reproduction was done by an operator who examined the images of specimens on computer monitor after x10 magnification and graded them according to scoring system from (1 to 4). The definition of the ratings was determined as follows: 1) Sharp detail continuous lines 2) Continuous lines, but with sharpness loss 3) Line details deterioration 4) Rough appearance, with loss of line continuity^(12, 13).

Surface roughness

Testing of the surface roughness was done by using a profilometer⁽¹⁰⁾ (Talysurf 4 profilometer, Taylor Hobson, USA).The surface of ten specimens for each time interval was measured in 3 different locations for each specimen then the average of mean roughness was calculated to each time interval.

Surface hardness

The surface hardness was assessed by making indentation using Shore D hardness digital tester (Digital hardness tester HT_6510C Shore C Shenzhen Handsome Technology G. Ltd. China) which is suitable for stone Type III material. Each specimen surface was exposed to three indentations in various positions, and the average hardness number of each specimen was calculated in separate manner, and the same process was performed for the other samples for each time interval.

Surface hardness and roughness results were analyzed with descriptive statistic, one way ANOVA and Games-Howell post hoc test. Results of surface detailed reproduction were converted into percentage and compared using Chi-Square test.

RESULTS

The descriptive statistics and Chi-Square test for surface detail reproduction of the 30 specimens was shown in table (1). The results showed that 1 hour time interval had 80% score 2 and 20% score 3. However, cast separated at 6 hours and 9 hours' time intervals showed 50% score 1 and 50% score 2 and eventually gave the best result. Chi-Square test

showed significant differences among the groups examined ($p < 0.05$).

Table 1: Distributions of surface details reproduction test among time groups with Chi-Square test

Surface details Reproduction (Scores)	N	Time groups			Chi-Square Test
		One hour	Six hours	Nine hours	
One	N		5	5	0.041 S
	%		50%	50%	
Two	N	8	5	5	0.041 S
	%	80%	50%	50%	
Three	N	2			0.041 S
	%	20%			
Total	N	10	10	10	0.041 S
	%	100%	100%	100%	

Table 2 showed the descriptive statistics and one way ANOVA tests of surface roughness. The results showed that the lowest mean for surface roughness was registered at 9 hours which was (2.544), while the highest mean value was related to the 6 hours (3.209). The one way ANOVA test between the studied groups found highly significant differences ($p < 0.01$). Games-Howell test Table 3 showed highly significant ($P < 0.01$) comparing one hour with six hours and nine hours, also highly significant ($P < 0.01$) comparing six hours with nine hours.

Table 2: Mean distributions of surface roughness test among time groups with ANOVA test

Time groups	N	Mean	Std. D	Std. E	Range		ANOVA test
					Min.	Max.	
One hour	10	3.209	0.001	0.0003	3.207	3.210	0.00 HS
Six hours	10	3.858	0.098	0.031	3.731	3.951	
Nine hours	10	2.544	0.096	0.030	2.430	2.651	

Table 3: Games-Howell test for surface roughness

Time groups		Games-Howell test (P-value)
One hour	Six hours	P=0.00 Highly sign. (P<0.01)
	Nine hours	P=0.00 Highly sign. (P<0.01)
Six hours	Nine hours	P=0.00 Highly sign. (P<0.01)

Table 4 showed the descriptive statistics and one way ANOVA test of surface hardness. The results showed that the highest mean value for hardness was registered at 9 hours which was (61.83), while the lowest mean value was related to the 6 hour

(49.27). One way ANOVA test between the studied groups demonstrated highly significance differences ($p < 0.01$).

Table 4: Mean distributions of surface hardness test among time groups with ANOVA test

Time groups	N	Mean	Std. D	Std. E	Range		ANOVA test
					Mini.	Max	
One hour	10	54.96	1.076	0.340	53.3	56.3	0.00 HS
Six hours	10	49.27	1.274	0.403	46.6	50.6	
Nine hours	10	61.83	3.009	0.952	57.3	65.3	

Table 5: Games- Howell test for surface hardness

Time groups	Games-Howell test (P-value)
One hour	Six hours P=0.00 Highly sign. (P<0.01)
	Nine hours P=0.00 Highly sign. (P<0.01)
Six hours	Nine hours P=0.00 Highly sign. (P<0.01)

Games-Howell test table (5) showed highly significant ($P < 0.01$) comparing one hour with six hours and nine hours, also highly significant ($P < 0.01$) comparing six hours with nine hours.

DISCUSSION

The immediate pouring of Alginate impressions could not always be achieved in everyday dental practices. Therefore, impressions are stored in sealed bags or wrapped in paper towels with suitable humidity. Without achieving such requirements, properties of the materials will be affected⁽¹⁴⁾.

However, if the separation of a cast from an impression is delayed, it will cause some model cast properties to be deteriorated⁽⁵⁾. This study was conducted to determine the probable changes in cast model properties following the varying contact time between dental stone type III and alginate impressions. The selected time intervals for the present study (1, 6, 9hr.) justified because previous study by Matqezan et al. 2012⁽⁷⁾ not recommended 12hr. time period of contact between alginate and gypsum cast because it influences the quality of gypsum cast.

The null hypothesis was rejected, the results of different periods for surface details reproduction, surface roughness and hardness showed differences among the three experimental time intervals. The surface details reproduction as in table (1) increased with the increase in contact time and this was

observed at 6 and 9 hours' time interval which gave 50% at score 1 and score 2. However, 1 hour time interval resulted in 80% score 2 and 20% score 3. Improvement in detail reproduction with prolonged contact time may be related to elevation in surface hardness and improved smoothness with prolonged contact time that is concluded in present study.

These results were in agreement with.....⁽¹⁵⁾ but disagreed with....⁽⁵⁾ who stated that surface details decreased with the increase in contact time and also disagreed with⁽¹¹⁾who revealed that paste type alginate impression materials and type III dental stone materials are compatible with each other and can reproduce surfaces details efficiently much better than powder type alginate with type III dental stone material.

However, surface roughness decreased when contact time increased to 9 hours and raised in 1 hour and 6 hours contact time as shown in table (2). The causative factor for this finding may be due to dehydration of stone due to prolonged contact time between the alginate impressions and the stone cast⁽⁷⁾.

A significant elevation in the surface hardness with increased contact time was recorded may be due to excess water evaporation from stone cast, in addition to smoothness of stone cast caused by decreased surface roughness with prolonged contact time found in present study. Results demonstrated that there was a decrease in the scratches depth when there was an increase in the contact time as in table (4). These results were similar to the findings of Ibrahim et al. 2015⁽⁵⁾.

CONCLUSION

Delay separation of stone cast from alginate impression affect surface properties variably:

- 1-Surface detailed reproduction significantly improved at 6hr. and 9hr. time interval.
- 2- Surface roughness reduced with increased contact time up to 9hr.
- 3-However surface hardness increased significantly up to 9hr.

Conflict of interest: None.

REFERENCES

1. Powers, J.M. and J.C. Wataha, Dental Materials-E-Book: Properties and Manipulation. 2014: Elsevier Health Sciences 10th Edition .
2. Nandini VV, Venkatesh KV, Nair KC. Alginate impressions: A practical perspective. J Conserv Dent.2008Jan;11(1):37-41.

3. Sayed ME, Gangad harappa P. Three-dimensional evaluation of extended pour alginate impression materials following variable storage time intervals and conditions. Indian J Dent Res. 2018 Jul-Aug;29(4):477-486.
4. Cervino, G., Fiorillo, L., Herford, A. S., et al. Alginate Materials and Dental Impression Technique: A Current State of the Art and Application to Dental Practice. Marine drugs 2018 Dec; 17(1):18.
5. Ibrahim, A.A., M.N. Alhajj, M.W. Gilada, Effect of contact time between alginate impression and type III dental stone on cast model properties. RSBO Revista Sul-Brasileira de Odontologia, 2015. 12(3):239-244.
6. Wadhwa SS, Mehta R, Duggal N, et al. The effect of pouring time on the dimensional accuracy of casts made from different irreversible hydrocolloid impression materials. Contemp Clin Dent. 2013 Jul;4(3):313-8.
7. Marquezan M, Jurach EM, Guimarães VD, et al. Does the contact time of alginate with plaster cast influence its properties? Braz Oral Res. 2012 May-Jun;26(3):197-201.
8. Penfold RRS, Brandt WC, Miranda ME, et al. Evaluation of dimensional stability and details reproduction of alginate molds storage in different times and temperature. Braz Dent Sci 2018 Jan/Mar;21(1):37-43.
9. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastometric impression materials. J Dent 2004; 32:603-609.
10. International Organization for Standardization. Dental alginate impression material. N° 1563:1990.
11. Murata H, Kawamura M, Hamada T, et al. Physical properties and compatibility with dental stones of current alginate impression materials. J Oral Rehabil. 2004 Nov;31(11):1115-22.
12. Dulaimi, S.F. and Z.N. Al-Wahab. The effect of disinfectants on the surface quality of irreversible hydrocolloid impression material and gypsum cast. Iraqi National Journal of Nursing Specility. 2012; 25(1): 95-100.
13. Taylor RL, Wright PS, Maryan C. Disinfection procedures: their effect on the dimensional accuracy and surface quality of irreversible hydrocolloid impression materials and gypsum casts. Dent Mater 2002; 18:103-110.
14. Nassar, U., Aziz, T., Flores-Mir, C. Dimensional stability of irreversible hydrocolloid impression materials as a function of pouring time: a systematic review. J Prosthet Dent , 2011; 106(2): 126-133.
15. Ibrahim AA, Alhajj MN, Khalifa N, et al. Does 6 hours of contact with alginate impression material affect dental cast properties? Compend Contin Educ Dent. 2017 Jun;38(6):e1-e4.

المستخلص

الخلفية: مادة الانطباع الجيني هي مادة غرواني مائي غير قابلة للعكس تستخدم على نطاق واسع في طب الأسنان. يمكن أن يكون لوقت التلامس بين الجينات والجبس تأثير ضار على خصائص قالب الجبس. الهدف من هذه الدراسة هو تقييم تأثير فترات التلامس المختلفة لانطباعات الألبينات وحجر الأسنان من النوع الثالث على الخصائص السطحية للحجر المصبوب. المواد والطرق: كانت الفترات الزمنية المختبرة ساعة واحدة و 6 ساعات و 9 ساعات. تم تقييم الخصائص السطحية للصب الحجري وهي إعادة إنتاج تفاصيل السطح والصلابة والخشونة. تم تحديد استنساخ تفاصيل السطح باستخدام كتلة اختبار أسطوانية من النحاس الأصفر وفقاً لمعيار ISO 1563. تم قياس خشونة السطح بمقياس بروفيلومتر وتم قياس الصلابة بواسطة مقياس التحمل (Shore D). النتائج: أظهر التكاثر التفصيلي فرقا معنوياً ($P > 0.05$) ، عند 6 ساعات و 9 ساعات. أظهر نتائج أفضل. بينما تقل خشونة السطح معنوياً ($p > 0.01$) مع زيادة زمن التلامس. ومع ذلك ، زادت صلابة السطح بشكل كبير ($p > 0.01$) مع زيادة وقت التلامس. الاستنتاجات: زيادة استنساخ تفاصيل السطح مع زيادة وقت التلامس وقد لوحظ ذلك في (6 ، 9 ساعات) مما يعطي 50٪ في الدرجة 1 والنتيجة 2. ومع ذلك ، أظهر الفاصل الزمني لمدة ساعة 80٪ درجة 2 و 20٪ درجة 3. خشونة انخفض عند زيادة وقت التلامس بين حجر الأسنان من النوع الثالث وانطباعات الألبينات بينما تحسنت الصلابة بشكل ملحوظ مع زيادة وقت التلامس.

