Cross arch and antero–posterior dimensional changes of impressions and stone casts at different storage times

Sawsan H Al–Jubori
BDS, MSc (Assist Lect)

Department of Prosthetic Dentistry
College of Dentistry, University of Mosul

ABSTRACT

The aim of study is to evaluate the linear dimensional changes (cross arch, antero–posterior dimensions) of impressions and die stone casts of two brands of addition silicone impression materials (Express and President) for special master model using two–steps (putty–wash) technique, at different storage times before pouring of impression, by using of three dimensional measuring machine and to compare between the accuracy of the two brands of impression materials.

The results indicated that a significant difference between the interabutment distances of impression and die stone casts. The Express impression materials produce the most accurate results.

There is slightly increase in interabutment distances of stone casts. At one hour storage time there are the smallest dimensional changes of impressions and stone casts in relation to construction of complete–arch fixed partial denture.

Key Words: Addition silicone, impression material, 3D measurements.

الخلاصة

إن الهدف من هذه الدراسة هو تقييم التغييرات الحاصلة في الأبعاد الخطية بين الأسنان الساندة (الأبعاد العرضية والأمامي خلفية) للطبعات وقوالب الجبس الصلب لأثنين من مادة طبعة السيليكون إضافي التفاعل (Express and President) للموديل الرئيسي باستخدام تقنية الخطوتين وعند فترات زمن خزن مختلفة وقد تم إجراء القياسات باستخدام ماكنة قياس الأبعاد الثلاثة. وتم مقارنة الدقة الحاصلة من كل من مادتي الطبعة.

وقد توصلت الدراسة إلى أن هناك فروق معنوية بين الأبعاد الخطية بين الأسنان الساندة للطبعات والقوالب الجبسية. وأن أفضل النتائج نتجت من مادة الطبعة (Express) وأن هناك زيادة طفيفة في الأبعاد الخطية بين الأسنان الساندة للقوالب الجبسية وأن زمن الخزن (ساعة واحدة) أعطى أفضل الطبعات والقوالب الجبسية التي تعطي أفضل النتائج في حال استخدامها في صنع وتصميم التعويض الجزئي الثابت للفك بكامله.

INTRODUCTION

The accurate replication of teeth and their arch position requires impression materials that exhibit limited distortion.[1] The range of contemporary elastomers includes some which have remained almost unaltered during 30 years of use and others which are still being assessed both clinically and in the laboratory.[2] The putty–wash (p/w) technique with silicone impression materials was popular.[3, 4]

The modern elastic materials are highly accurate, with these materials excellent complete–arch fixed partial dentures can be made from a single cast poured from one master impression.[5–8]

The relationship between the edentulous ridge and the teeth that support the

restorations has been more influential in the fitness of fixed and removable prosthodontic restorations.[9, 10]

Stone casts are used with an indirect technique for various purposes such as working casts, opposing casts, casts for diagnosis and so on. In the recent years three–dimensional measurement has been done to analyze precisely the distortion of impressions and stone casts.[11–13] The p/w impression technique was originally recommended to overcome the problems associated with polymerization shrinkage of elastomeric impression materials. The advantage of this technique is that the impression of teeth and edentulous areas can be captured with the wash materials.[14–16]

Recently, the interest in vinyl polysiloxane impression materials has increased, because of their properties and the new automixing devices.[17, 18]

The purpose of this study was to compare and evaluate:

1) The ability of each brand of impression material to produce and record the most accurate dimensions.
2) Different storage times before pouring of impression and their effect on acc-uracy of impressions and stone casts.
3) Linear dimensional changes of inter-abutments distances at cross arch and antero–posterior dimensions of imp-ressions and stone casts.

MATERIALS AND METHODS

By using of special master model (FRASACO, West Germany) and test apparatus,[19] 80 impressions were taken using two brands of vinyl polysiloxane impression materials (Express, automix. 3M Dental Products, Div St Paul MN, USA) and (President, hand mix. Coltene, Altstatten, Switzerland).

Each impression material manipulated according to manufacturer's instructions using p/w (two steps) impression technique. The standard spacer (3M Dental Products, MN, USA) was used on the master model to provide desirable space for light body impression material. The test apparatus with impression was placed in an incubator during the setting time of impression at 37 $\pm$ 1 ºC under constant pressure at each corner of upper part of test apparatus.

After setting, impressions that not be poured immediately were stored in an incubator at 23 $\pm$ 1 ºC according to ADA Specification No. 19[20] for each of bench set time evaluated.

Impressions were poured with Silky Rock die stone material (Whip Mix, Louisville, USA). The water / powder ratio was 100 mg of powder was added to 23 ml of distilled water.

The stone casts were allowed to set for 1 hour, and drying for 24 hours before measuring procedure.

The measurements of different linear dimensions between the abutments of impressions and stone casts were evaluated in different periods of storage times (immediately, 1 hour, 24 hours, 1 week) by using of 3D measuring machine (IOTA, 1203, Italy) with special computerized program for this study in three axes (X, Y, Z) to evaluate the linear interabutments distances in cross arch and antero–posterior directions.

RESULTS AND DISCUSSION

Means and standard deviation of linear measurements (cross arch and antero–posterior dimensions) of impressions, stone casts and master model are presented in Tables (1) and (2).

The analysis of variance procedure indicated there is a significant difference at 1% level between the results of linear dimensional measurements as shown in Table (3).

Table (1): Linear dimensional measurements (in millimeters) of impressions of two brands of addition silicone impression materials

Storage Times	(M–M)	(P–P)	R(P–M)	L(P–M)
	Mean ± SD			
	Express Impression			
Immediately	39.377 ± 0.02	29.862 ± 0.011	16.941 ± 0.007	17.989 ± 0.031
1 Hour	39.396 ± 0.021	30.022 ± 0.003	17.012 ± 0.021	18.061 ± 0.047
24 Hours	39.425 ± 0.07	29.927 ± 0.017	17.006 ± 0.038	18.078 ± 0.05
1 Week	39.478 ± 0.001	29.984 ± 0.024	17.025 ± 0.021	18.223 ± 0.022
	President Impression			
Immediately	39.297 ± 0.031	29.990 ± 0.01	16.960 ± 0.007	18.094 ± 0.033
1 Hour	39.400 ± 0.024	30.042 ± 0.032	16.981 ± 0.041	18.035 ± 0.011
24 Hours	39.212 ± 0.05	29.898 ± 0.03	16.958 ± 0.023	18.186 ± 0.02
1 Week	39.371 ± 0.001	29.854 ± 0.022	17.076 ± 0.051	17.860 ± 0.045

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension; R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.

Table (2): Linear dimensional measurements (in millimeters) of stone casts and master model

Storage Times	(M–M)	(P–P)	R(P–M)	L(P–M)
	Mean ± SD			
	Stone Cast From Express Impression			
Immediately	39.518 ± 0.021	30.020 ± 0.033	17.162 ± 0.032	18.399 ± 0.009
1 Hour	39.507 ± 0.009	30.050 ± 0.01	17.043 ± 0.018	18.323 ± 0.041
24 Hours	39.497 ± 0.015	30.023 ± 0.027	17.023 ± 0.033	18.328 ± 0.09
1 Week	39.481 ± 0.011	30.102 ± 0.031	17.120 ± 0.012	18.433 ± 0.024
Master Model	39.500 ± 0.0031	30.012 ± 0.0001	17.026 ± 0.001	18.349 ± 0.007
	Stone Cast From President Impression			
Immediately	39.529 ± 0.014	30.047 ± 0.003	17.164 ± 0.041	18.152 ± 0.022
1 Hour	39.430 ± 0.022	29.913 ± 0.025	17.044 ± 0.002	18.301± 0.001
24 Hours	39.420 ± 0.028	30.014 ± 0.017	17.140 ± 0.033	18.372 ± 0.003
1 Week	39.391 ± 0.011	30.046 ± 0.022	17.088 ± 0.07	18.388 ± 0.027

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension; R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.

Table (3): Mean square analysis of linear measurements

SOV	df	MS			
		(M–M)	(P–P)	R(P–M)	L(P–M)
Between Materials	2	0.3241**	0.0557**	0.0129**	0.089101**
Between Storage Times	3	0.0287**	0.0428**	0.0233**	0.0261**
Interaction	6	0.0272**	0.0395**	0.0109**	0.1294**

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension; R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.

SOV: Sum of variance; MS: Mean square; df: Degree of freedom.
** Indicated there is a significant difference at 1% level.

In comparison between the accuracy of linear measurements between the abutments of impressions and stone casts of two brands of impression materials, the results revealed that the Express automix impression material produced the smallest dimensional changes of measurements in relation to the master model and most accurate dimensions for complete–arch fixed partial denture.[3, 17, 18, 29] This can be explained by the automatic mixing system provides advantages to the properties of addition silicone impression materials which improve the accuracy (Figures 1 and 2).

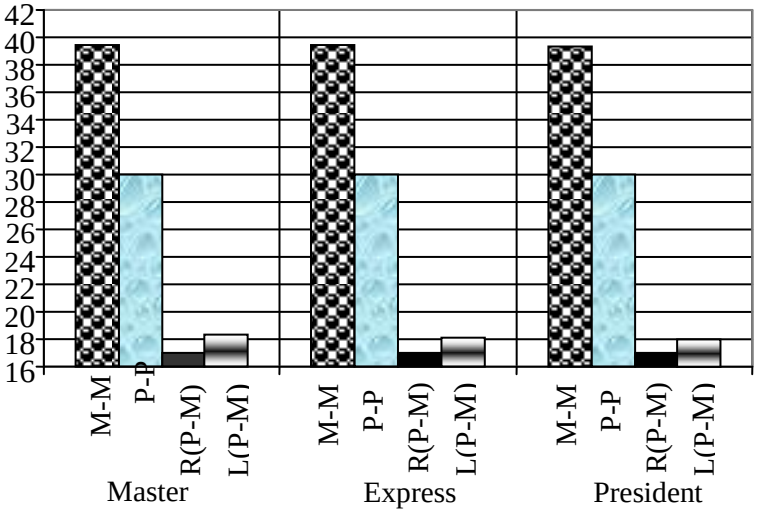

Figure (1): Cross arch and antero – posterior measurements (in millimeters) of impressions in relation to master model

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension; R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.

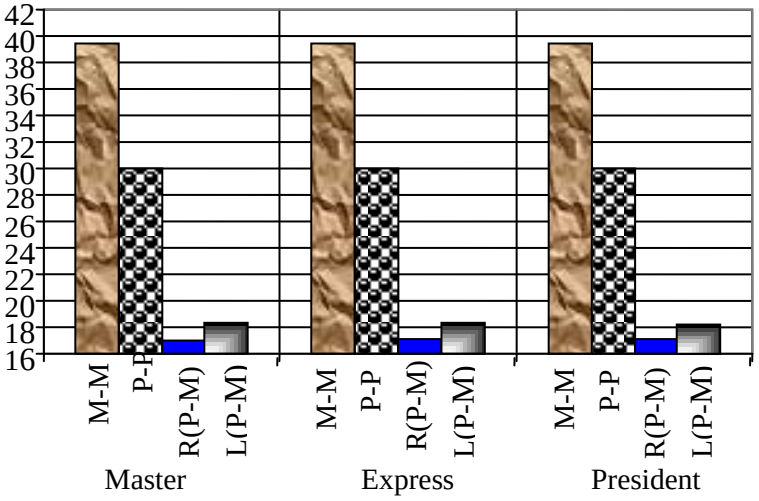

Figure (2): Cross arch and antero – posterior measurements (in millimeters) of stone casts in relation to master model

(M–M): Molar to molar dimension; (P–P): Premolar to premolar

dimension; R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.

In order to detect the effect of storage time intervals on cross arch linear dimensional measurements of impressions and stone casts of two brands of imp-ression materials, Duncan's New Multiple Range Test showed that the storage time of impression before pouring for one hour produce more accurate dimensions in relation to master model (Table 4 and Figure 3), and in antero–posterior dimensions of right and left sides[1, 11, 15, 19, 31] (Table 5 and Figure 4). These results explained due to the physical properties of elastic impression material which should be allowed to regain its original shape after the stress that occurred in impression materials when withdrawn from the master model (elastic recovery) before pouring of the die stone.[8, 9, 21, 22]

Table (4): Duncan's New Multiple Range Test for cross arch linear measurements (in millimeters) at storage time intervals

Storage Times	Impressions		Stone Casts	
	(M–M)	(P–P)	(M–M)	(P–P)
Immediately	39.391 ^{C}	29.955 ^{B}	39.516 ^{A}	30.026 ^{B}
1 Hour	39.432 ^{B}	30.025 ^{A}	39.479 ^{B}	29.991 ^{D}
24 Hours	39.379 ^{D}	29.946 ^{D}	39.472 ^{B}	30.016 ^{BC}
1 Week	39.443 ^{A}	29.950 ^{C}	39.457 ^{BC}	30.053 ^{A}

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension. Measurements with the same letter indicated no significant differences among them.

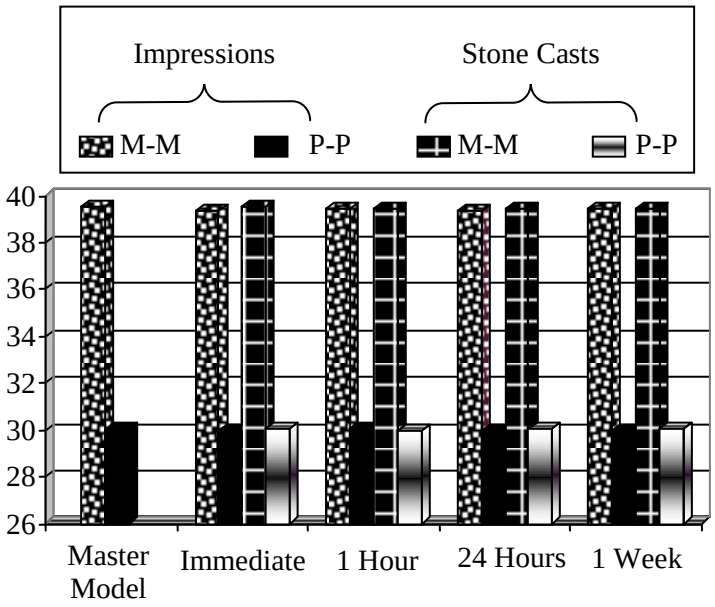

Figure (3): Cross arch linear dimensional measurements (in millimeters) of impressions and stone casts

(M–M): Molar to molar dimension; (P–P): Premolar to premolar dimension.

Table (5): Duncan's New Multiple Range Test for antero–posterior linear measurements (in millimeters) at storage time intervals

Storage Times	Impressions		Stone Casts	
	R(P–M)	L(P–M)	R(P–M)	L(P–M)
Immediately	16.975 ^{D}	18.144 ^{C}	17.117 ^{A}	18.300 ^{B}
1 Hour	17.006 ^{B}	18.148 ^{B}	17.037 ^{C}	18.358 ^{A}
24 Hours	16.997 ^{C}	18.204 ^{A}	17.063 ^{B}	18.383 ^{BC}
1 Week	17.042 ^{A}	18.144 ^{C}	17.078 ^{B}	18.357 ^{A}

R(P–M): Right (premolar to molar) antero–posterior dimension; L(P–M): Left (premolar to molar) antero–posterior dimension.
Measurements with the same letter indicated no significant differences among them.

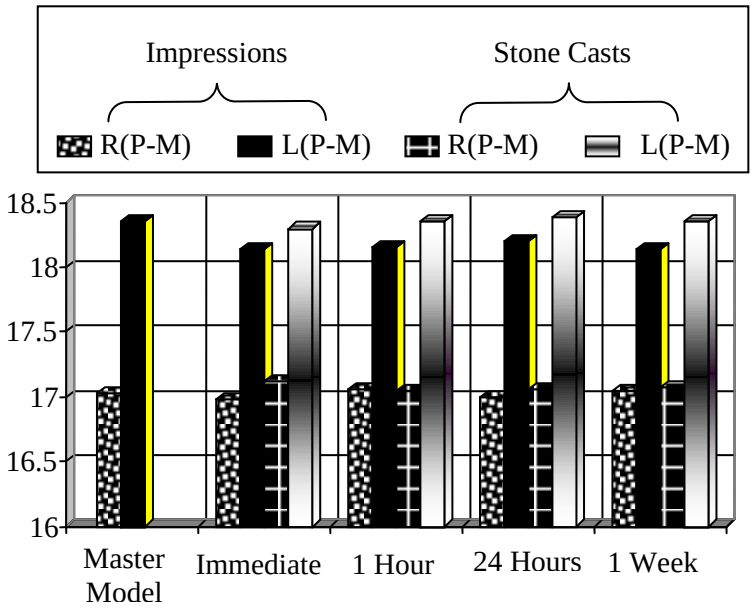

Figure (4): Antero–posterior linear dimensional measurements (in millimeters) of impressions and stone casts

R(P–M): Right (premolar to molar) antero–posterior dimension;
L(P–M): Left (premolar to molar) antero–posterior dimension.

Generally, the results indicated that the interabutments distances of impressions seen to be slightly decreased (cross arch and antero–posterior dimensions) in relation to that of master model;[1, 9, 27, 28, 31] e.g., in molar–molar (M–M) dimension decrease 68 μm in relation to master model after one hour storage time. This change in dimension due to shrinkage result in movement of the free surface of set material. This is the impression surface and due to the residual polymerization reaction.[5, 7, 9, 16, 27]

The cross arch and antero–posterior distances of stone casts are slightly increased for all measurements in comparison

with master model,[14, 18, 23–26] except the distance (M–M) which decreased by, e.g., 21 μm at one hour storage time. This increase in the interabutments distances of stone casts seen may be explained by linear setting expansion of the die material throughout the entire bulk of the stone block[13, 23, 26] (Table 4 and Figure 3) for cross arch measurements, and (Table 5 and Figure 4) for antero–posterior measurements.

CONCLUSIONS

1) The automix (Express) impression materials produce the most accurate impressions and stone.
2) One hour storage of impressions pro-duce smallest dimensional changes (linear interabutment distances).
3) There is a decrease in linear measure-ments of interabutments distances (cross arch, antero–posterior dimen-sions) of impressions, while in stone casts all measurements of linear interabutments distances are slightly increased in cross arch and antero–posterior dimensions except the (M–M) cross arch measurements.

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Received: 19/2/2003 ***Accepted for Publication: 14/8/2003***