JCDP

10.5005/jp-journals-10024-1921

ORIGINAL RESEARCH

Effect of Intermixing Brands on the Dimensional Accuracy of Master Cast using Putty-wash Impression Technique

[1]Mohammed E Sayed, [2]Bandar MA Al-Makramani, [3]Fuad A Al-Sanabani, [4]Mohamed S Mohamed

ABSTRACT

Aim: The aim of this study was to evaluate the effect of intermixing brands of addition silicone impression materials on the dimensional accuracy of stone models using two-step putty-wash technique.

Materials and methods: Two common brands of addition silicone impression material (Express and Aquasil) were used in this study. A total of 40 impressions of a stainless steel model simulating a three-unit bridge were made, 10 impressions for each group. Accuracy was assessed by measuring two dimensions (inter-abutment and intra-abutment) on stone models obtained from impressions of the stainless steel model. Each sample was measured thrice and the mean value was calculated. The data were analyzed using analysis of variance (ANOVA) and Scheffe's *post hoc* test.

Results: The results indicated that each of the inter-abutment and intra-abutment dimensions of the stone models was significantly higher than those for the stainless steel model ($p < 0.001$). However, there was no statistically significant difference in each of the inter-abutment and intra-abutment dimensions of the stone models among the four tested groups ($p < 0.05$).

Conclusion: The results obtained were statistically analyzed and the values of the inter-abutment and intra-abutment dimensions were all within the clinically acceptable range.

Clinical significance: Intermixing brands of additional silicone impression materials evaluated in this study did not affect the dimensional accuracy of obtained stone casts. This will help to minimize the wastage of materials due to lack of either light or putty consistency of the same brand of additional silicone impression material.

Keywords: Dimensional accuracy, Impression materials, Putty-wash.

[1]Department of Restorative Dentistry, Rutgers School of Dental Medicine, Rutgers University, Newark, New Jersey, USA

[1-4]Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University, Jazan, Kingdom of Saudi Arabia

Corresponding Author: Bandar MA Al-Makramani Department of Prosthetic Dental Sciences, College of Dentistry Jazan University, Jazan, Kingdom of Saudi Arabia, Phone: +00966568557923, e-mail: makramani@yahoo.com

How to cite this article: Sayed ME, Al-Makramani BMA, Al-Sanabani FA, Mohamed MS. Effect of Intermixing Brands on the Dimensional Accuracy of Master Cast using Putty-wash Impression Technique. J Contemp Dent Pract 2016;17(9):734-739.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Taking and pouring an impression are essential steps in the fabrication and fitting of dental prosthesis. The detailed replication and dimensional accuracy of elastic impression materials play a major role in the success of indirect dental prosthesis. Therefore, accurate reproduction of hard and soft tissues around prepared and adjacent teeth requires impression materials that exhibit good dimensional stability.[1,2]

There are several elastic impression materials available for dental use. Synthetic elastomeric polymers, including polysulfide, condensation silicone, addition silicone (polyvinyl siloxanes) and polyether, are among the materials most commonly used to make impressions of various areas of the dental arch.[3]

It is known that addition-type silicones have the best surface reproduction and elastic recovery of all available impression materials. They have achieved a high level of dentist and patient acceptance, as they are clean, odorless, and tasteless. In addition, polyvinyl siloxanes possess outstanding dimensional stability because they are not vulnerable to changes in humidity, and they do not release any by-products.[3-7]

The quality of impression is affected by some factors, such as design of tooth preparation, management of soft tissue, selection of tray, impression material, the bulk of the material, and impression technique.[8-12]

Several techniques have been used for taking impressions. Currently, putty-wash technique is the most commonly used technique in making impressions with polyvinyl siloxanes. It consists of polymerizing a low-viscosity, light-body, or wash elastomer against a high-viscosity putty elastomer. The putty, used in a perforated metal stock tray, simulates a custom-made tray.[5,9,10]

Two different putty-wash techniques exist, namely a one-step technique that records putty and wash simultaneously and a two-step technique during which an initial putty impression is later relined with a wash material. The one-step putty-wash technique requires less chair-side time. The two-step putty-wash technique has been reported to be more accurate than the one-step putty-wash technique because there is uniform wash space for the light-body material to polymerize and the details are recorded by the light-body material only.[10,11,13-15]

Several brands of additional silicone impression materials are available in the market to be used in oral rehabilitation. The effect of intermixing brands of these impression materials on the dimensional accuracy of stone models using putty-wash technique was not investigated.

Therefore, this study was conducted to evaluate the effect of intermixing brands on the dimensional accuracy of stone models using putty-wash addition silicone impression materials in a two-step fashion. The null hypothesis was that no differences would exist in the dimensional accuracy of stone models fabricated using two-step putty-wash technique with intermixing brands of addition silicone impression materials.

MATERIALS AND METHODS

Two common brands of addition silicone impression material (putty and light-body consistencies) were used in this study (Table 1).

Table 1: Trademark and manufacturer of the impression materials studied

Material	*Trademark*	*Manufacturer*
Additional silicone putty	Express TM XT Putty soft	3M ESPE, Seefeld; Germany
Additional silicone light body	Express TM XT light body	3M ESPE, Seefeld; Germany
Additional silicone putty	Aquasil Soft Putty	Dentsply Caulk, Milford, DE, USA
Additional silicone light body	Aquasil Ultra LV	Dentsply Caulk, Milford, DE, USA

A machined standard stainless steel model, containing two complete-crown tapered abutment preparations, was fabricated. The die preparation simulates a three-unit fixed partial denture situation replacing a single tooth. The abutments were prepared with a uniform 6° total taper and firmly attached to a horizontal metal platform for immobilization during impression making (Fig. 1).

Reference cross-grooves were placed on the occlusal surfaces of the two abutments for assessing changes in the horizontal (inter-abutments) and vertical (intra-abutments) dimensions (Fig. 1). A standard 2-mm-thick metal coping was fabricated for each abutment using nonprecious alloy (Wiron 99, Bego, Bremen, Germany) with the purpose of producing uniform space for wash material in the putty impressions (Fig. 1).

A 1-mm-deep orientation groove was placed on the horizontal metal platform for proper orientation of the tray during impression making (Fig. 1). These grooves standardized the placement of the tray and repeatedly seated it with uniform pressure each time an impression was made. The stainless steel model was duplicated using duplicating silicone (Dupliflex-22, Protechno, Vilamalla, Girona, Spain), and stone models were poured and used for the fabrication of the special trays. A total of 40 perforated acrylic custom trays (Meditray, Promedica Dental Material GmbH, Neumunster, Germany) were fabricated to accurately relocate on the master model for each impression. The impression trays were fabricated with a space of 7 mm between the inner surface of the tray and the abutment preparation for the impression material (Fig. 2).

The impressions were categorized into four groups as follows:

Group I: Dentsply putty and Dentsply wash impression materials were used

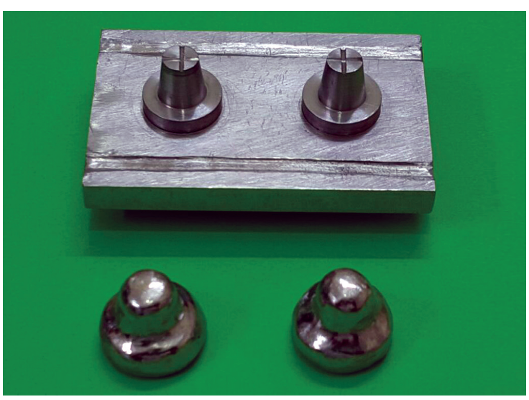


Fig. 1: The stainless steel model and the 2 mm thick metal copings

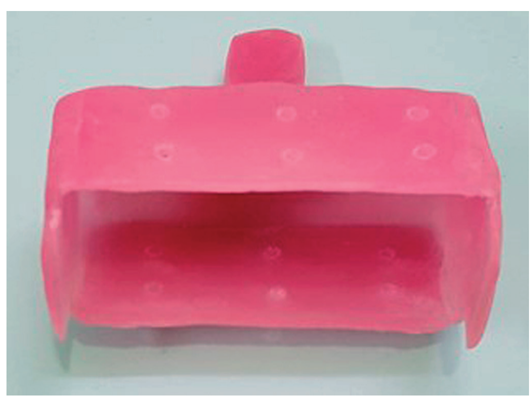


Fig. 2: Acrylic custom tray

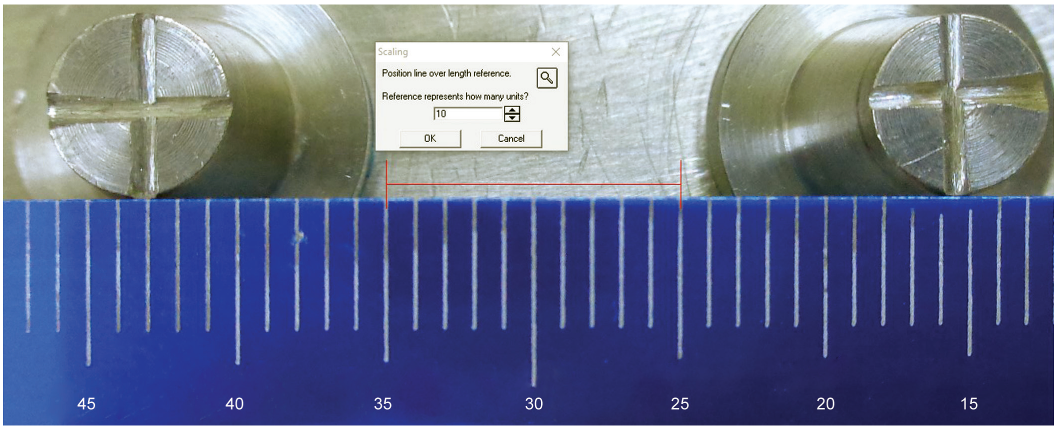


Fig. 3: A computer screen showing calibration of the specimen

Group II: 3M putty and Dentsply wash impression materials were used

Group III: 3M putty and 3M wash impression materials were used

Group IV: Dentsply putty and 3M wash impression materials were used.

For each group, 10 impressions were made using the putty-wash two-step impression technique. In the first step, the 2-mm-thick metal copings were seated on each abutment to create a uniform wash space, and the putty impression was taken and allowed to set for double the recommended setting time in the mouth. In the second step, the copings were removed, the wash material added, and the preliminary impression was reseated on the master model and allowed to set for double the recommended setting time in the mouth.

The impressions were then boxed using modeling wax (Cavex Set Up regular, Cavex Holand BV, RW Haarlem, the Netherlands). To control the effect of the setting expansion of the die stone, the powder was accurately weighed on an electronic weighing machine and water was dispensed using a clear graduated plastic cup. In addition, a type IV die stone (Royal Rock Pink, Talladium Inc, Muirfield Ln. Valencia, CA) of similar batch number was used to pour all impressions. The die stone was mixed using an automatic vacuum mixer (Mix-R, Dentalfarm, Torino, Italy) with a ratio of 100 gm die stone: 23 mL water following the manufacturer's recommendations.

Measurement

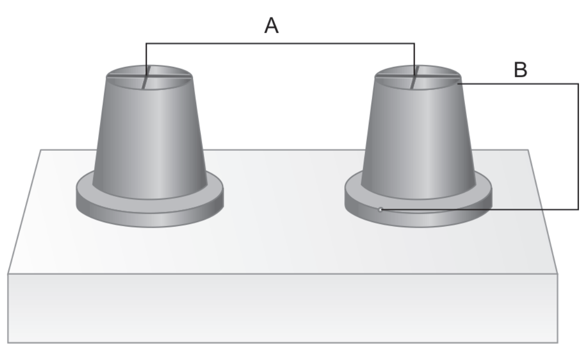
Standardized photographs were taken for the master model and stone casts with a digital camera (Sony Cyber-shot, DSC-W730, Sony Corp, Tokyo, Japan) using a millimeter ruler were used as a reference for the measurements. All images were transferred to a computer, and the horizontal dimension (inter-abutments) and the vertical dimension (intra-abutments) were measured by one investigator using image processing software (Image Pro 6, Media Cybernetics, Inc., 8484 Georgia Avenue Silver Spring, Maryland, USA). Calibration was achieved based on the millimeter ruler (Fig. 3), and the location of the distances measured (inter-abutments and intra-abutments) are illustrated in Figure 4.

The horizontal (inter-abutments) and the vertical (intra-abutments) dimensions on the stainless steel model were measured 10 times. The mean and standard deviation for the two measurements were calculated and used as the control to compare among the four groups.

To ensure reproducibility, each stone die measurement was repeated three times, and the corresponding mean values were considered as the statistical units. The accuracy of casts was expressed as the percentage of deviation from the stainless steel model values.

For each dimension, the difference between the mean value of the stone models (MSM) and the mean value of the stainless steel model (MSSM) divided by the MSSM and multiplied by 100 was expressed as the percentage of deviation from the stainless steel model for each test group of each dimension.

$$\text{Percentage of deviation} = [(\text{MSM} - \text{MSSM})/\text{MSSM}] \times 100$$



A. Horizontal (Interabutments) distance
B. Vertical (Intra-abutments) distance

Fig. 4: Two-dimensions measured on stainless steel model and stone models

Statistical Analysis

The means, standard deviations, and mean percent deviations from the stainless steel model for vertical and horizontal dimensions were calculated for each impression group.

One-way analysis of variance (ANOVA) was used to assess the significance of the differences in both dimensional measurements and in the percent deviations of stone models from the stainless steel model among all test groups. Furthermore, multiple comparisons were performed between the test groups using Scheffe's *post hoc* test to determine the pair of means that differ significantly.

The Statistical Package for the Social Sciences (SPSS) software package, version 21 (SPSS Inc., Chicago, Illinois, USA) was used to perform the statistical analysis. Statistical significance was set at $\alpha = 0.05$.

RESULTS

The mean and standard deviation of horizontal and vertical measurements (mm) on the stainless steel model and stone models for the four tested groups are shown in Table 2. The horizontal and vertical dimensions of the stone models were greater than those for the stainless steel model. The one-way ANOVA revealed that the horizontal and vertical dimensions on the stainless steel model and stone models were significantly different ($p < 0.001$). Based on Scheffe's *post hoc* test, each of the horizontal and vertical dimensions of the stone models was significantly higher than those for the stainless steel model ($p < 0.001$). However, there was no statistically significant difference in each of the horizontal and vertical dimensions of the stone models among the four tested groups ($p > 0.05$).

Table 3 shows the percentage deviations (%) and absolute changes (μm) of dimensions of stone models from those of the stainless steel model for the four tested groups. The one-way ANOVA showed that all the differences in horizontal and vertical dimensions among the four tested groups were not significant. In general, the Dent putty/Dent wash and Dent putty/3M wash groups yielded the lowest and highest percent of deviations respectively, for each of the horizontal and vertical dimensions. In terms of accuracy, the 3M putty/3M wash and 3M putty/Dent wash groups performed better than the Dent putty/3M wash but worse than the Dent putty/Dent wash group.

Table 2: The mean (SD) measurements (mm) on the stainless steel model and stone models for the four tested groups

Dimension (mm)	*SSM*	*Dent putty/Dent wash*	*3M putty/ Dent wash*	*3M putty/3M wash*	*Dent putty/3M wash*
Horizontal	27.488 (0.001)	27.502 (0.008)	27.507 (0.006)	27.506 (0.007)	27.510 (0.007)
Vertical	8.351 (0.001)	8.360 (0.007)	8.366 (0.007)	8.364 (0.008)	8.369 (0.005)

SD: Standard deviation

Table 3: The percentage of deviation (%) and absolute change (μm) from stainless steel model of each of the four tested groups

	Dent putty/ Dent wash		*3M putty/ Dent wash*		*3M putty/ 3M wash*		*Dent putty/ 3M wash*	
Dimension	*%*	*μm*	*%*	*μm*	*%*	*μm*	*%*	*μm*
Horizontal	0.050	14	0.067	19	0.064	18	0.079	22
Vertical	0.105	9	0.170	15	0.146	13	0.204	18

DISCUSSION

Addition-type silicone impression materials gained high acceptance among dentists because of their outstanding dimensional stability, physical properties, and handling characteristics.[3-7,10] To the best of the author's knowledge, i.e., the first study that investigated the effect of intermixing brands of additional silicone on the dimensional accuracy of stone models fabricated using two-step putty-wash technique. In this study, the dimensional accuracy of stone models fabricated using two-step putty-wash technique with intermixing brands of addition silicone impression materials was evaluated. The results of the present study support acceptance of the null hypothesis.

The putty-wash technique was originally recommended with condensation silicone impression materials to overcome problems associated with polymerization shrinkage. This technique has also been suggested with addition silicone impression materials.[10,13,14] The most commonly used impression techniques are putty-wash one-step and two-step techniques.

Hung et al[13] and Idris et al[14] studied the importance of impression techniques and stated that impression accuracy is not technique dependent. On the other hand, other studies suggested that the impression technique is a significant factor in determining the accuracy of the impression. The two-step putty-wash technique has been reported to be more accurate than the one-step putty-wash technique.[4,10,15,16] The two-step putty-wash technique produces some more precise castings.[10]

Additionally, the wash thickness is an important factor that impacts the accuracy of elastomeric impression materials. The wash thickness of 1–2 mm was reported to be the most accurate for fabricating stone dies when using polyvinyl siloxane impression materials with the two-step putty-wash impression technique.[10,11] The current study used standardized metal copings of 2 mm thickness to create a uniform wash space, which is essential for accuracy.

In this study, there was a significant difference of horizontal and vertical stone cast measurements *vs* stainless steel model. On the contrary, other studies found no significant statistical difference between stone cast measurements and master cast.[17-19] However, this study found no significant difference between the horizontal and vertical stone cast measurements among the four tested groups.

In this study, when the stone models and stainless steel model were compared, the horizontal and vertical dimensions of the stone models increased. This is in agreement with those of the former studies.[15,17] On the contrary, some studies reported smaller vertical dimensions and greater horizontal dimensions.[10,14,20] This was clarified by the contraction of the impression material in the direction of the tray walls.[15]

The percent of deviation from the stainless steel model for vertical dimension was of larger magnitude than those for horizontal dimension in this study, which was in agreement with similar studies.[14,15] This may be clarified by the fact that the greater contraction of the impression material in the direction of the tray walls might have principally affected the areas with the smaller quantities of the impression material for each wall surface, e.g., in the regions surrounding the abutments. Besides, the greater percent of deviations for the vertical dimensions were expected because they were calculated on the basis of much smaller measurements.[14,15,17]

Although the horizontal and vertical dimensions of the stone models were significantly higher than the stainless steel model in this study, Tjan et al[21] stated that differences from the master model of approximately 50.0 μm were clinically acceptable, because they were unlikely to impede the full seating of a casting. Regarding horizontal dimension in this study, the stone models fabricated by Dent putty/3M wash group were the largest, with a mean difference of 22 μm from the stainless steel model. The lowest value of the mean difference from the metallic model was 14 μm for Dent putty/Dent wash group. Regarding vertical dimension, the lowest value of the mean difference from stainless steel model was 9 μm for Dent putty/Dent wash group, and the highest value was 18 μm for Dent putty/3M wash group.

In this study, the mean horizontal and vertical differences of the stone models from the stainless steel model did not exceed 22 μm and were within the acceptable limit for clinically acceptable cast dimensional change.[14,21] Even though the dimensional changes across the groups were within clinically acceptability range, using viscosities of the same brand would help to reduce the overall error considering all the potential errors that may happen throughout the steps of fixed partial denture construction.

This study was limited to only two brands of polyvinyl siloxane impression materials. Further research with several brands of polyvinyl siloxane impression materials is needed.

CONCLUSION

Within the limitations of this *in vitro* study, it can be concluded that intermixing brands of additional silicone impression materials does not affect the dimensional accuracy of the resultant stone models.

CLINICAL SIGNIFICANCE

Intermixing brands of additional silicone impression materials evaluated in this study did not affect the dimensional accuracy of obtained stone casts. This will help to minimize the wastage of materials due to lack of either light or putty consistency of the same brand of additional silicone impression material.

ACKNOWLEDGMENT

The impression materials used in this study were provided by the College of Dentistry, Jazan University, Jazan, Kingdom of Saudi Arabia.

REFERENCES

1. Faria AC, Rodrigues RC, Macedo AP, Mattos Mda G, Ribeiro RF. Accuracy of stone casts obtained by different impression materials. Braz Oral Res 2008 Oct-Dec;22(4):293-298.
2. Rathee S, Eswaran B, Eswaran M, Prabhu, R, Geetha, K, Krishna, G. A comparison of dimensional accuracy of addition silicone of different consistencies with two different spacer designs – *in vitro* study. J Clin Diagn Res 2014 Jul;8(7):ZC38-ZC41.
3. Sakaguchi RL, Powers JM. Replicating materials – impression and casting. In: Sakaguchi RL, Powers JM, editors. Craig's restorative dental materials. 13th ed. Philadelphia (PA): Elsevier/Mosby; 2012. p. 277-325.
4. Mandikos MN. Polyvinyl siloxane impression materials: an update on clinical use. Aust Dent J 1998 Dec;43(6):428-434.
5. Dugal R, Railkar B, Musani S. Comparative evaluation of dimensional accuracy of different polyvinyl siloxane putty-wash impression techniques-*in vitro* study. J Int Oral Health 2013 Oct;5(5):85-94.
6. Samet N, Shohat M, Livny A, Weiss EI. A clinical evaluation of fixed partial denture impressions. J Prosthet Dent 2005 Aug;94(2):112-117.
7. Haim M, Luthardt RG, Rudolph H, Koch R, Walter MH, Quaas S. Randomized controlled clinical study on the accuracy of two-stage putty-and-wash impression materials. Int J Prosthodont 2009 May-Jun;22(3):296-302.
8. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastometric impression materials. J Dent 2004 Nov;32(8):603-609.
9. Chee WW, Donovan TE. Polyvinyl siloxane impression materials: a review of properties and techniques. J Prosthet Dent 1992 Nov;68(5):728-732.
10. Nissan J, Laufer BZ, Brosh T, Assif D. Accuracy of three polyvinyl siloxane putty-wash impression techniques. J Prosthet Dent 2000 Feb;83(2):161-165.

11. Nissan J, Gross M, Shifman A, Assif D. Effect of wash bulk on the accuracy of polyvinyl siloxane putty-wash impressions. J Oral Rehabil 2002 Apr;29(4):357-361.
12. Nam J, Raigrodski AJ, Townsend J, Lepe X, Mancl LA. Assessment of preference of mixing techniques and duration of mixing and tray loading for two viscosities of vinyl polysiloxane material. J Prosthet Dent 2007 Jan;97(1): 12-17.
13. Hung SH, Purk JH, Tira DE, Eick JD. Accuracy of one-step versus two-step putty wash addition silicone impression technique. J Prosthet Dent 1992 May;67(5):583-589.
14. Idris B, Houston F, Claffey N. Comparison of the dimensional accuracy of one- and two-step techniques with the use of putty/wash addition silicone impression materials. J Prosthet Dent 1995 Nov;74(5):535-541.
15. Caputi S, Varvara G. Dimensional accuracy of resultant casts made by a monophase, one-step and two-step, and a novel two-step Putty/light-body impression technique: an *in vitro* study. J Prosthet Dent 2008 Apr;99(4):274-281.
16. Craig RG. Review of dental impression materials. Adv Dent Res 1988 Aug;2(1):51-64.
17. Al-Zarea BK, Sughaireen MG. Comparative analysis of dimensional precision of different silicone impression materials. J Contemp Dent Pract 2011 May 1;12(3):208-215.
18. Panichuttra R, Jones RM, Goodacre C, Munoz CA, Moore KB. Hydrophilic polyvinyl siloxane impression materials dimensional accuracy, wettability and effect on gypsum hardness. Int J Prosthodont 1991 May-Jun;4(3):240-248.
19. Thongthammachat S, Moore BK, Barco MT, Hovijitra S, Brown DT, Andres CJ. Dimensional accuracy of dental casts: Influence of tray material, impression material and time. J Prosthodont 2002 Jun;11(2):98-108.
20. Craig RG. Evaluation of an automatic mixing system for an addition silicone impression material. J Am Dent Assoc 1985 Feb;110(2):213-215.
21. Tjan AH, Nemetz H, Ngnyen LT, Contino R. Effect of tray space on the accuracy of monophasic polyvinylsiloxane impressions. J Prosthet Dent 1992 Jul;68(1):19-28.