

THE EFFECT OF DIFFERENT DOUBLE- STEP IMPRESSION TECHNIQUES ON ACCURACY OF STONE DIES

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ABSTRACT

Purpose: To investigate accuracy of dies obtained from different double-step putty-wash impression techniques.

Materials and method: A master model was constructed having Co-Cr abutments (Remanium Star, Dentaaurum, Germany) in a custom made acrylic dentoform (Vertex- Dental B.V., The Netherlands) representing condition of missing maxillary left first molar. Impressions (Express, 3M ESPE, USA) were taken to the model with putty-wash technique following 5 different protocols: Group 1: Aluminum foil (Sanita, Beirut, Lebanon) was used as a spacer between the dentoform and the putty impression; Group 2: Escape grooves were carved in the putty impression before taking the wash impression using Putty cut (Zhermack, Badia Polesine, Italy); Group 3: No modification was done to the putty impression before taking the wash impression. Group 4: The tray was moved in ant-posterior rocking motion during setting of the putty impression. Group 5: The putty impression was taken with the temporary crowns (Prevision CB, Heraeus Kulzer GmbH, Germany) on the abutments simulating the condition of unprepared abutments. All impressions were poured using type IV stone material (Elite rock, Zhermack, Badia Polesine, Italy). Dies were then examined under a stereomicroscope (Leica M205 A, Leica microsystems, Switzerland) for accuracy using linear measurements between standardized points at the abutments compared to that on the master model. Data were collected and statistically analyzed.

Results: Regarding inter-abutment distance, there was a statistically significant difference ($p > 0.05$) between all groups. There was statistically no significant difference ($p > 0.05$) between group 1 and group 4. There was statistically no significant difference ($p > 0.05$) between group 2, 3 and group 5. Moreover, molar and premolar heights showed statistically significant ($p < 0.05$) difference with all groups.

Conclusions: The impression technique affects the accuracy of the stone die. Antero- posterior rocking movement technique showed the best accurate results, followed by foil technique. Further clinical studies are imperative for confirmation of the laboratorial findings.

KEYWORDS: Double step, Consistency, Impression technique and Accuracy.

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INTRODUCTION

Successful dental prosthesis is dependent on the perfection of many steps in the dental office. Impression taking is considered the most critical step among all. ⁽¹⁻¹⁰⁾ All of the oral tissue details must be precisely duplicated and delivered for the dental lab. The final impression comprises all of the clinician skill and expertise poured in a tray. The lab technician pours the impression and master cast is created, on which fabrication of the restoration will take place.

There are several techniques for making fixed prosthodontic secondary impressions ⁽¹¹⁻¹⁶⁾: (1) the single step and single consistency (Monophase) technique, (2) the single step and double consistency technique, (3) the double step and double consistency technique, (4) the three way impression technique (in which an impression for upper and lower arches is taken along with bite registration in single step). Many studies have been concerned about impression accuracy. ⁽¹⁷⁻²²⁾ Most of them were in vitro studies but some in vivo studies investigated the quality and accuracy of final impressions. ⁽²³⁻²⁴⁾

There is a lot of debate about the best impression technique used to produce optimum results. Double mix technique in which two materials of different viscosity are used together ^(5, 7-9, 25, 26), have been preferred by many authors. Single-step or 2-step procedures may be performed with putty and light body or heavy body and light body ^(5, 7-9, 25). Single-step technique, in which both materials polymerize simultaneously, reduces chairside time and saves impression material. Although time is a limiting factor since the prosthodontist has to accommodate both low and high consistency materials simultaneously before setting occurs, this technique yields accurate impressions ⁽²⁶⁾. It was used and preferred by few authors, as they claim it decreases procedure time, but it does not allow for the error compensation ⁽²⁷⁾. In the 2-step technique, a high-viscosity material is used as a preliminary (tray) impression, while the

final impression is performed with a lower-viscosity material. Even though the 2-step technique has been widely adopted and can offer good accuracy ^(3,7,8), some problems may be experimented with this technique, such as dimensional alterations ^(5, 26, 28), extra chairside time, and extra material needed ⁽⁵⁾. Idris et al. ⁽²⁵⁾, Nissan et al. ^(7, 8), and Caputi and Varvara ⁽³⁾ demonstrated that the 2-step putty-wash technique performed with vinyl polysiloxane produced very accurate stone dies when a 2mm relief was done in the preliminary impression. Hung et al. ⁽⁵⁾ observed that the use of a plastic spacer on the master model during the preliminary impression resulted in 2-step impressions as accurate as the single-step technique. The 2-step hydraulic and hydrophobic technique. However, advises no relief of the preliminary impression. According to this technique, the high-hardness property of the high-consistency vinyl polysiloxane is supposed to generate a hydraulic pressure that propels the low-consistency impression material into the sulcus and all the internal aspects of the preparation, eliminating the need for packing retraction cord or using die spacers. These conflicting data urged the authors to lay down this study, to investigate the accuracy of dies obtained from different 2-step techniques performed with PVS impression material. The null hypotheses to be tested were that there would be no significant differences in the accuracy of dies obtained from different materials or impression techniques.

MATERIALS AND METHOD

A master model was constructed having Co-Cr abutments (Remanium Star, Dentaform, Germany) in a custom made sectional acrylic dentoform (Vertex- Dental B.V., The Netherlands) representing a condition of missing maxillary left first molar. The abutments were prepared to a 0.5 mm chamfer finish line using 0.5 mm round end taper diamond bur with guiding pin # 8881 P (Komet, Brasseler, Germany) on a parallelometer (Amann Girrbach, Germany).

A 1mm depth and width groove was drilled in the middle of the buccal surface of abutments. (**Fig 1**)

Impressions (Express, 3M ESPE, USA) were taken to the model using putty-wash technique,



Fig. (1) Master Model

following 5 different protocols (Table 1): Group 1: Aluminum foil (Sanita, Beirut, Lebanon) was used as a spacer between the dentoform and the putty impression; (**Fig 2**) Group 2: Escape grooves were carved in the putty impression before taking the light wash impression using Putty cut (Zhermack, Badia Polesine, Italy) (**Fig 3**) ; Group 3: No modification was done to the putty impression before taking the

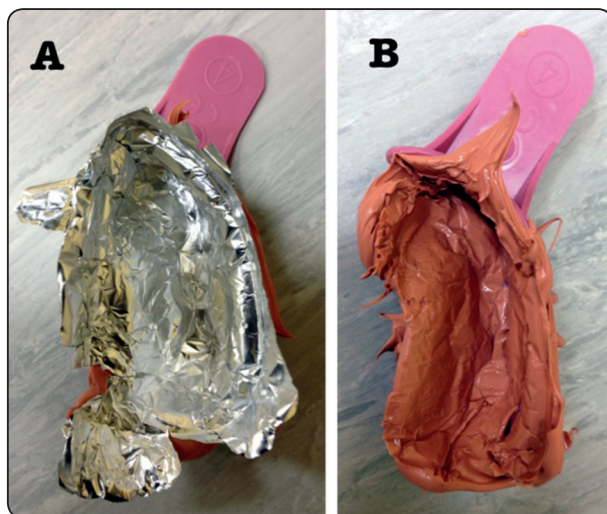


Fig. (2) Group 1; A: Aluminum foil on putty material B: Tray material after foil removal



Fig. (3) Group 2; with escape grooves carved in the putty before the wash impression

light wash impression. Group 4: The tray was moved in ant-posterior rocking motion during setting of the putty impression. Group 5: The putty impression was taken with temporary crowns (Prevision CB, Heraeus Kulzer GmbH, Germany) on the abutments simulating unprepared abutments condition. (**Fig 4**)

According to each groups, putty impression was mixed using automatic mixing machine (Pentamix, 3M ESPE, USA) and was injected into a sectional tray then was inverted on the model under pressure. The impressions were separated from the preparation with single axial movement after 10 minutes. The wash material (light body) was injected around the dies. All impressions were evaluated for errors and defects. All defected impressions were discarded. Then impressions were stored at room temperature for 2 hours to allow elastic recovery of the elastomeric materials. Impressions were poured using type IV stone material (Elite rock, Zhermack, Badia Polesine, Italy) in a 0.19 water to powder ratio under mechanical vibration (A12, Zhermack, Badia Polesine, Italy). After 2 hours, the stone die was separated from the impression and its base placed in a quadrant rubber base that was filled with



Fig. (4) Group 5; Temporary crowns, simulating unprepared abutments condition

different color stone material (Elite base, Zhermack, Badia Polesine, Italy) to fabricate die base. (Fig 5)

The casts were evaluated for accuracy using linear measurements between standardized points



Fig. (5) Stone dies

at the abutments and comparing them compared to that on the a stereomicroscope (Leica M205 A, Leica microsystems, Switzerland) Inter-abutment distance, molar and premolar heights were calculated and compared to the control group. A descriptive analysis was used to examine the means and standard deviation (SD) for all groups. The data recorded was coded, entered using the statistical package SPSS version 15 and summarized as: mean, standard deviation, minimal and maximum values for quantitative variables. Statistical differences between groups were tested using Nonparametric Mann Whitney test quantitative variable. P-values less than or equal to 0.05 were considered statistically significant.

TABLE (I) Sample grouping

Group	Rehabilitation technique	No of samples
1	Aluminum foil	7
2	Escape grooves	7
3	No modification	7
4	Ant-posterior rocking motion	7
5	Before preparation (Temporary crowns)	7
Total		35

RESULTS

a) Inter-abutment distance

Master model was (9.057 ± 0.000) mm. (Fig 6) The mean and standard deviation values of stone models obtained from group 1 were (9.226 ± 0.05 mm), (9.346 ± 0.02 mm) from group 2, (9.396 ± 0.03 mm) from group 3, (9.221 ± 0.05 mm) from group 4 while the values were (9.406 ± 0.06 mm) from group 5. (Fig 7) (chart I)

Dimensional changes in stone models obtained were as follow; from group 1; 0.169 (1.856%), group

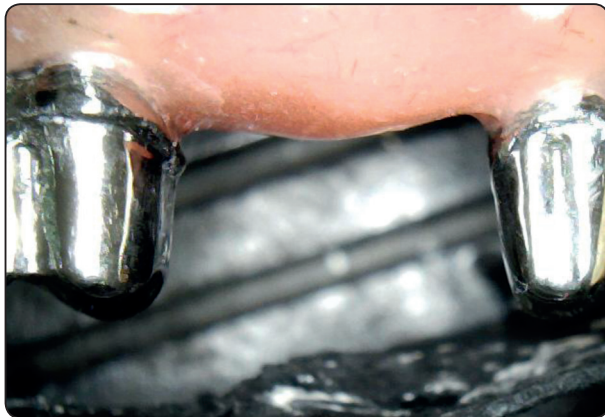


Fig. (6) Master Model Measurements

2; 0.289 (3.186%), group 3; 0.339 (3.742%), group 4; 0.164 (1.809%) and group 5; 0.349 (3.854%) (Table 2).

Master model measurement showed statistically significant ($p < 0.05$) difference with all groups. There was statistically non-significant ($p > 0.05$) difference between group 1 and group 4. There was statistically non-significant ($p > 0.05$) difference between group 2, 3 and group 5.

b) Molar height

Master model was (4.371 ± 0.000) mm. The mean and standard deviation values of stone models obtained from group 1 were (4.537 ± 0.144 mm), (4.594 ± 0.051 mm) from group 2, (4.699 ± 0.026



Fig. (7) Stone Die Measurements

mm) from group 3, (4.422 ± 0.064 mm) from group 4 while the values were (4.693 ± 0.015 mm) from group 5 (chart II).

Dimensional changes in stone models obtained were as follow; from group 1; 0.166 (3.797%), group 2; 0.223 (5.099%), group 3; 0.328 (7.493%), group 4; 0.05 (1.145%) and group 5; 0.322 (7.353%) (Table 3).

Master model measurement showed statistically significant ($p < 0.05$) difference with all groups except for groups 1 and 4 where the differences were statistically non-significant ($p > 0.05$). There was statistically non-significant ($p > 0.05$) difference between group 2, 3 and group 5.

TABLE (2) Comparison between dimensional accuracy of all groups and master model for inter-abutment distance

Variable	Group	Mean $\pm$ SD	D. change	Change %	P value
Inter-abutment distance	Group 1	9.226 ± 0.05	0.169	1.856	<0.0001*
	Group 2	9.346 ± 0.02	0.289	3.186	
	Group 3	9.396 ± 0.03	0.339	3.742	
	Group 4	9.221 ± 0.05	0.164	1.809	
	Group 5	9.406 ± 0.06	0.349	3.854	

c) Premolar height

Master model was 4.314 ± 0.000 mm. The mean and standard deviation values of stone models obtained from group 1 were (3.926 ± 0.061 mm), (3.863 ± 0.066 mm) from group 2, (3.864 ± 0.064 mm) from group 3, (3.673 ± 0.027 mm) from group 4 while the values were (3.800 ± 0.046 mm) from group 5 (chart III).

Dimensional changes in stone models obtained

were as follow; from group 1; $-0.38849(9.005\%)$, group 2; $-0.45135(10.462\%)$, group 3; $-0.44989(10.428\%)$, group 4; $-0.64104(14.859\%)$ and group 5; $-0.51429(11.9206\%)$ (Table 4).

Master model measurement showed statistically significant ($p < 0.05$) difference with all groups. There were statistically non-significant ($p > 0.05$) differences between group 1, 2, 3 and group 5. Also there were statistically non-significant ($p > 0.05$) differences between group 2, 3, 4 and group 5.

TABLE (3) Comparison between dimensional accuracy of all groups and master model for Molar height

Variable	Group	Mean $\pm$ SD	D. change	Change %	P value
Molar height	Group 1	4.537 ± 0.144	0.166	3.797	0.0047*
	Group 2	4.594 ± 0.051	0.223	5.099	
	Group 3	4.699 ± 0.026	0.328	7.493	
	Group 4	4.422 ± 0.064	0.050	1.145	
	Group 5	4.693 ± 0.015	0.322	7.353	

TABLE (4) Comparison between dimensional accuracy of all groups and master model for premolar height

Variable	Group	Mean $\pm$ SD	D. Change	Change %	P value
Premolar height	Group 1	3.926 ± 0.061	-0.38849	9.005	<0.0001*
	Group 2	3.863 ± 0.066	-0.45135	10.462	
	Group 3	3.864 ± 0.064	-0.44989	10.428	
	Group 4	3.673 ± 0.027	-0.64104	14.859	
	Group 5	3.800 ± 0.046	-0.51429	11.9206	

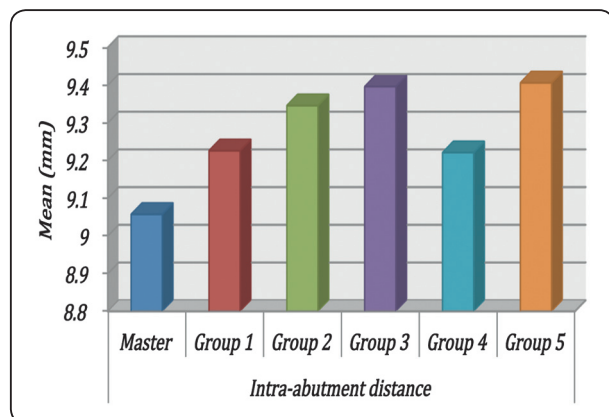


CHART (I) inter-abutment distance mean values of master model and stone models for all groups

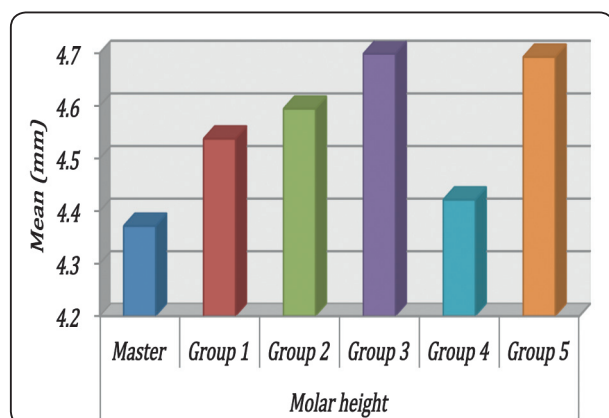


CHART (II) Molar height mean values of master model and stone models for all groups

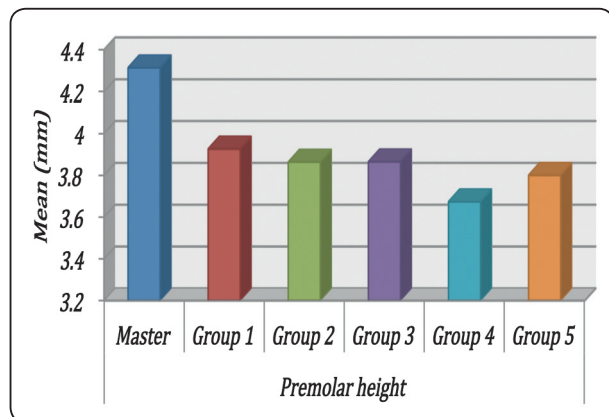


CHART (III) premolar height mean values of master model and stone models for all groups

DISCUSSION

In two-step putty wash impression technique, first impression is provided by putty and then final impression is taken by wash material. As sometimes after final impression, minor defects are seen, which can be corrected by overall rewash (reline). In order to accomplish that, in the tray material, undercuts and interproximal walls are eliminated so that impression could fit easily in its place. ⁽²⁹⁾

Bombery & Hatch⁽³⁰⁾ agreed that overall rewash impression should be taken to correct minor defects in the impression. As Gullett & Podshadley⁽³¹⁾ mentioned correcting the impression defects saves 46% of dentists and patient's time, also 62% of the impression material.

There are several factors that may affect the dimensional accuracy of elastomeric impression material, including the viscosity of the used material ⁽³²⁻³⁶⁾, thickness ^(34,35), the impression technique ^(32,35,37,38), the adhesion method of impression materials to the tray, time elapsed to cast pouring ⁽³⁵⁾, the material's hydrophilicity, release of byproducts, polymerization shrinkage, thermal shrinkage and incomplete elastic recovery ^(34-36,39).

During reseating of the tray, the wash induces tension on the high-viscosity material, thus inducing deformation on the already set impression. After setting and on removal, the high-consistency material is likely to exhibit elastic recovery, returning to its original position ^(2, 5, 6, 46), thus resulting in smaller dies. This was observed in a study conducted by Petersen and Asmussen ⁽⁹⁾.

Results of this study showed that there were significant difference between the impression techniques used. Results are in accordance with many authors ^(33,36,38,40,41) who concluded that the cast accuracy is affected more by the used impression technique than by the chosen material. On the other hand, other researchers reported that the impression technique does not affect the dimensional accuracy. ^(37,42-45)

Viewing the results, group 4 scored the highest result. This may be due to the creation of optimum space- for wash material- in all teeth, not for abutments only. Which may result in, easier repositioning, even wash material thickness and proper escape channels for excess wash material.

Group 1 came next in accuracy, may be due to that, the foil placed on the unset tray material, created space for the wash material. This space may be excessive at palatal and sulci areas, which may create slight dimensional inaccuracy due to increased thickness of -lower filler – wash material. This finding is in agreement with Franco EB, et al, ⁽⁴⁷⁾ who stated that relief of the preliminary impression, use of die spacers, and the use of a plastic sheet over the preliminary impression may be good alternatives to produce adequate space for the wash material to flow in the 2-step technique.

Escape grooves in group 2 seems to fail to provide optimum exit for excess wash material leading to entrapment and inaccuracy. On top of uneven thickness of wash material in abutment areas.

The least accurate were for group 3 and 5, where the wash material seem to be trapped inside set tray material leading to increased inaccuracy. As most significant strain maybe when relining done without relief. Because, if no relief is performed on the preliminary impression, there is no space to allow the wash material to flow, which complicates the reset of the primary impression. ⁽⁴⁷⁾

This study showed that, the selection of the appropriate impression technique is important in obtaining optimal results. It must be emphasized, however, that the data hereby expressed present the limitations of an in vitro study, and further clinical studies are imperative for confirmation of the laboratorial findings.

CONCLUSIONS

Within the limitation of this study, it could be concluded that, the impression technique affects accuracy of the stone die. Antero- posterior rocking movement technique showed the best accurate results, followed by foil technique.

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