

Comparison of Dimensional Accuracy of Cast Obtained from Polyvinyl Siloxane Impression with Different Putty- Wash Techniques and Spacer Thickness - In Vitro Study

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Abstract

Introduction: Dimensional accuracy of cast obtained after making impressions is crucial factor for the quality of fixed prosthodontic treatment. The impression technique with different thickness of putty wash material is critical factor affecting this accuracy. There is much discussion in the dental literature concerning the effect of this impression technique on the accuracy of cast restorations.

Materials and methods: This in- vitro study was carried out in 60 impression made from master model with Polyvinyl siloxane impressions material using single step putty- wash technique and two step putty-wash technique with varying spacer thickness (0.5mm, 1mm, 1.5 mm). It was further divided into four groups. Group I: Single step putty-wash impression technique, Group II: Two step putty- wash impression technique with 0.5mm spacer, Group III: Two step putty- wash impression technique with 1mm spacer, Group IV: Two step putty- wash impression technique with 1.5mm spacer. Each group consists of 15 impressions. Casts were poured using type IV dental stone after 1 hour. After 24 hour the die of each cast was scanned using CAD/CAM digital scanner and measured mesio-distally, facio-lingually, height (cervico- occlusally), interabutment or interdie distances. The data were recorded and statically analyzed.

Results: The highest mean values of mesio-distal, bucco-lingual, cervico-occlusal distances were shown by Group I, whereas the inter-die distance showed equal mean value in Group I, II and III. With the increase in the spacer thickness, the mean value also increases in mesio-distal distance. The mean measurement of bucco-lingual dimension was highest when spacer thickness was 0.5mm and it declined with the increase in spacer thickness. The spacer thickness had no effect on cervico-occlusal and inter-die dimensions.

Conclusions: Within the limitations of the study, accuracy of cast obtained from single step putty-wash technique was more accurate than two step putty-wash technique. In two step putty-wash technique, 1.5 mm thickness of spacer showed more accurate cast in comparison to 0.5mm and 1mm.

Key words: Dimensional accuracy, Die, Putty- wash technique, Spacer thickness

Introduction

Fabrication of a well fitted indirect restorations requires accurate casts of

intraoral hard and oral soft tissues.¹ Undistorted impressions of the prepared tooth is necessary which can be obtained only when there is thorough knowledge of impression materials, their properties, and manipulation techniques.²

Besides the selection of appropriate impression materials and trays, impression technique also plays a vital role for obtaining best dimensional accuracy. Among several techniques to improve

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the accuracy of the cast, putty-wash techniques are most commonly used. Single step putty-wash technique and two step putty-wash techniques with spacer are generally practiced with putty and light body elastomers.³

Although several studies regarding the efficacy of accuracy of cast obtained from different impression techniques has been conducted, there is lack of sufficient information of the impact of spacer thickness on accuracy of cast. Hence this study was conducted to evaluate and compare the accuracy of cast obtained from single and double step polyvinyl siloxane putty-wash impression technique with 0.5 mm, 1mm, and 1.5 mm spacer thickness.

Materials and methods

According to American National Standards Institute (ANSI)/American Dental Association (ADA) specification brass master model containing two complete crown abutments of stainless steel were fabricated. Dimension of occluso-gingival length of abutments of master model was 8 mm, width was 6.25 mm and the base was 2 mm in height with total taper of 6 degree. Cross grooves were provided on the occlusal surfaces of 1mm in depth to serve as reference points for making measurements. The distance between two dies was 21.5 mm. (Fig.1) Perforated brass trays were fabricated maintaining a space of 7 mm and holes of 2 mm in diameter for mechanical retention of the impression material. (Fig.2) Brass Spacers were also fabricated of 0.5mm, 1mm and 1.5 mm in thickness (Fig.3). Impressions were made accordingly:

Group I – Single step putty- wash impression technique:

Putty consistency polyvinyl siloxane impression material (Aquasil, Dentsply) was mixed as per manufacturer's instructions and loaded on the impression tray. Light body (Aquasil Ultra XLV,

Dentsply) was dispensed from auto mixing cartridge and injected over the abutment. Impression tray was pressed gently with finger to establish metal to metal contact.

Group II – Two step putty- wash impression technique with 0.5mm spacer:

Putty consistency polyvinyl siloxane impression material was mixed and loaded on the tray which was pressed over the abutment with 0.5mm spacer until metal to metal contact was established. After setting of the elastomeric impression material spacer was removed and light body elastomer was dispensed from auto mixing cartridge over the abutments and on the tray with putty. The tray was reseated and gentle pressure was applied with finger to establish metal to metal contact.

Group III – Two step putty- wash impression technique with 1mm spacer:

Impression procedure was similar to that done for Group II with the spacer of 1 mm thickness.

Group IV – Two step putty- wash impression technique with 1.5mm spacer:

Impression procedure was similar to that done for Group II with the spacer of 1.5 mm thickness.

All the impressions were poured after half an hour of impression making with type IV Dental stone mixed in the ratio of 22 ml of water: 100 gm of die stone which were allowed to set for 1hour before retrieval of the dies. After 24 hour each die was scanned in 3D Scanner. Measurements were made in facio-lingual, mesio-distal, cervico-occlusal and inter-die dimensions of abutment respectively for three times. Master Model was scanned in 3D Scanner and the measurements were recorded 10 times.

Mean of the repeated measurements were recorded and entered in Microsoft Excel to reduce the error. The data was cleaned and coded. It was then transferred to Statistical

Package of Social Sciences (SPSS) version 17.0 for further analysis. The data was displayed with the help of simple and component bar diagrams, line diagrams and frequency distribution tables. Comparisons of various dimensions of dies in the study groups were made with in the control (master die). Comparisons of diagnostic accuracy between the single tray and the double tray technique and between three different spacer thicknesses were also made. One Way - Analysis of Variance (ANOVA) with Benferroni post hoc tests were used to check for the level of significance which was set at 5%.

Results

The highest mean values of mesio-distal, bucco-lingual, cervico-occlusal was shown by Group I whereas the inter-die distance showed equal mean value in Group I, II and III. While in single and two step impression technique the highest mean difference of mesio-distal

dimension was seen in Group I and Group IV. (Table 1) The highest mean difference of bucco-lingual dimension was in Group I and Group II. (Table 2) In cervico-occlusal dimension the mean difference failed to reach statistical significance i.e. $p > 0.05$ indicating any technique can be used for recording this measurement. (Table 3) Similarly inter-die dimension also showed impression technique have no role in its measurement. (Table 4)

Comparing within two step impression technique with 0.5mm, 1mm, 1.5mm spacer showed that as the spacer thickness increases, the mean measurement also increases in mesio-distal measurement. (Table 5) The mean measurement of bucco-lingual dimension is highest when spacer thickness is 0.5mm and it starts to decline as spacer thickness increases. (Table 6) Measuring cervico-occlusal and inter-die dimension have no effect on spacer thickness. (Table 7 and 8)



Figure 1: Master Die

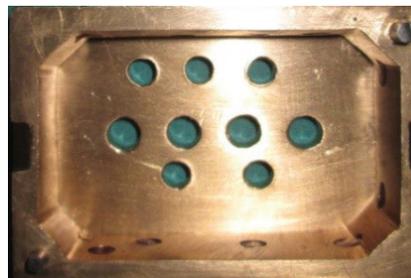


Figure 2: Customarily made tray



Figure 3: Spacers

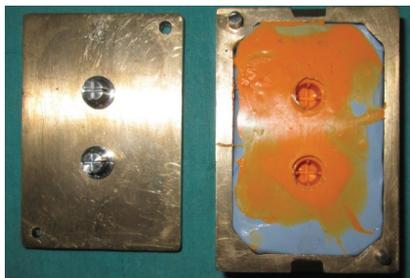


Figure 4: Putty-wash impression

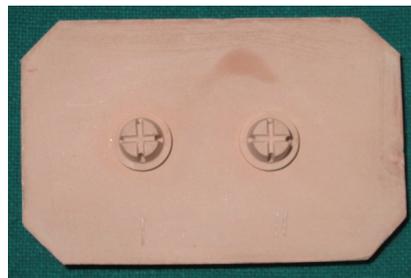


Figure 5: Die



Figure 6: 3D Image on monitor

Table 1: Variations in the measurement of mesio-distal dimensions (AB, CD) between the single and double tray technique.

Mesio-distal dimensions	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
AB dimension when using single tray technique (4.89 ± 0.05)	Group II (4.73 ± 0.10)	0.159	0.088	0.230	<0.001*
	Group III (4.76 ± 0.15)	0.137	0.066	0.208	<0.001*
	Group IV (4.81 ± 0.08)	0.086	0.015	0.157	0.017*
CD dimension when using single tray technique (4.88 ± 0.05)	Group II (4.74 ± 0.11)	0.143	0.075	0.212	<0.001*
	Group III (4.71 ± 0.11)	0.171	0.103	0.240	<0.001
	Group IV (4.75 ± 0.11)	0.127	0.058	0.195	<0.001

*Statistically significant.

Table 2: Variations in the measurement of bucco-lingual dimensions (EF, GH) between the single and double tray technique.

Bucco -lingual dimensions	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
EF dimension when using single tray technique (4.68 ± 0.06)	Group II (4.68 ± 0.06)	0.163	0.099	0.227	<0.001*
	Group III (4.52 ± 0.10)	0.143	0.079	0.207	<0.001*
	Group IV (4.54 ± 0.10)	0.098	0.034	0.162	0.003*
GH dimension when using single tray technique (4.74 ± 0.04)	Group II (4.56 ± 0.10)	0.180	0.113	0.247	<0.001*
	Group III (4.60 ± 0.09)	0.143	0.075	0.210	<0.001*
	Group IV (4.65 ± 0.12)	0.086	0.019	0.153	0.013*

*Statistically significant.

Table 3: Variations in the measurement of cervico -occlusal dimensions (EI, GJ) between the single and double tray technique.

Cervico - occlusal dimensions	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
EI dimension when using single tray technique (5.76 ± 0.07)	Group II (5.69 ± 0.81)	0.070	0.015	0.124	0.012*
	Group III (5.73 ± 0.08)	0.025	-0.029	0.079	0.361
	Group IV (5.70 ± 0.05)	0.050	-0.003	0.105	0.066

GJ dimension when using single tray technique (5.74 ± 0.06)	Group II (4.88 ± 0.05)	0.405	-0.097	0.907	0.112
	Group III (4.74 ± 0.11)	0.067	-0.435	0.570	0.789
	Group IV (4.71 ± 0.11)	0.074	-0.427	0.577	0.767

*Statistically significant.

Table 4: Variations in the measurement of inter die distance (KL) between the single and double tray technique.

Inter-die distance	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
KL dimension when using single tray technique (21.41 ± 0.02)	Group II (21.40 ± 0.08)	0.012	-0.039	0.065	0.626
	Group III (21.39 ± 0.07)	0.018	-0.034	0.070	0.498
	Group IV (21.41 ± 0.08)	0.004	-0.048	0.057	0.873

Table 5: Variations in the measurement of mesio-distal dimensions (AB, CD) when using 0.5mm, 1mm, 1.5mm spacers.

Mesio-distal dimensions	Comparison Group	Mean Diff	95% Confidence Interval		P value
			Lower	Upper	
AB dimension when using 0.5mm spacer (Group II) (4.73 ± 0.10)	Group III (1mm) (4.76 ± 0.15)	-0.021	-0.092	0.049	0.544
	Group IV (1.5mm) (4.81 ± 0.08)	-0.072	-0.143	-0.001	0.046*
Group III (1mm) (4.76 ± 0.15)	Group IV (1.5mm) (4.81 ± 0.08)	-0.050	-0.121	0.020	0.159
CD dimension when using 0.5mm spacer (Group II) (4.73 ± 0.10)	Group III (1mm) (4.76 ± 0.15)	0.028	-0.040	0.096	0.415
	Group IV (1.5mm) (4.81 ± 0.08)	-0.016	-0.085	0.051	0.631
Group III (1mm) (4.76 ± 0.15)	Group IV (1.5mm) (4.81 ± 0.08)	-0.044	-0.113	0.023	0.197

*statistically significant.

Table 6: Variations in the measurement of bucco-lingual dimensions (EF, GH) when using 0.5mm, 1mm, 1.5mm spacers.

Bucco -lingual dimensions	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
EF dimension when using 0.5mm spacer (Group II) (4.68 ± 0.06)	Group III (1mm) (4.52 ± 0.10)	-0.020	-0.084	0.043	0.5300
	Group IV (1.5mm) (4.54 ± 0.10)	-0.065	-0.129	-0.001	0.045*
Group III (1mm) (4.52 ± 0.10)	Group IV (1.5mm) (4.54 ± 0.10)	-0.045	-0.108	0.018	0.164

GH dimension when using 0.5mm spacer (Group II) (4.56 ± 0.10)	Group III (1mm) (4.60 ± 0.09)	-0.037	-0.104	0.029	0.271
	Group IV (1.5mm) (4.65 ± 0.12)	-0.094	-0.161	-0.027	0.007*
Group III (1mm) (4.60 ± 0.09)	Group IV (1.5mm) (4.65 ± 0.12)	-0.057	-0.124	0.010	0.095

*statistically significant

Table 7: Variations in the measurement of cervico -occlusal dimensions (EI, GJ) when using 0.5mm, 1mm, 1.5mm spacers.

Cervico - occlusal dimensions	Comparison Group	Mean Diff	95% confidence interval		P value
			Lower	Upper	
EI dimension when using 0.5 mm spacer (Group II) (5.69 ± 0.81)	Group III (5.73 ± 0.08)	-0.045	-0.099	0.009	0.101
	Group IV (5.70 ± 0.05)	-0.019	-0.073	0.034	0.478
Group III (5.73 ± 0.08)	Group IV (5.70 ± 0.05)	0.025	-0.028	0.080	0.346
GJ dimension when using 0.5mm spacer (Group II) (4.88 ± 0.05)	Group III (4.74 ± 0.11)	-0.337	-0.840	0.165	0.184
	Group IV (4.71 ± 0.11)	-0.330	-0.833	0.172	0.194
Group III (4.74 ± 0.11)	Group IV (4.71 ± 0.11)	0.007	-0.495	0.510	0.977

Table 8: Variations in the measurement of inter die distance (KL) when using 0.5mm, 1mm, and 1.5mm spacers.

Inter-die distance	Comparison Group	Mean Diff	95% Confidence Interval		P value
			Lower	Upper	
KL dimension when using 0.5mm spacer (Group II) (21.40 ± 0.08)	Group III (1mm) (21.39 ± 0.07)	0.005	-0.047	0.057	0.849
	Group IV (1.5 mm) (21.41 ± 0.08)	-0.008	-0.061	0.044	0.743
Group III (1mm) (21.39 ± 0.07)	Group IV (1.5mm) (21.41 ± 0.08)	-0.013	-0.066	0.039	0.604

*statistically significant.

Discussion

For obtaining good quality impression, selection of appropriate impression materials and impression techniques are important. The advancement in material science and development of different techniques have contributed to achieve this requirements.⁴ There are several studies in different dental literatures about the effect of material and impression technique on the accuracy of cast

and final restorations. Some authors showed that the cast accuracy is affected more by the used impression technique than by the chosen material.⁵⁻⁷ Other researchers reported that the impression technique does not affect the dimensional accuracy.⁷⁻⁹ Craig had stated that impression materials have improved upto such an extent that accuracy may be controlled more with technique than by material itself.^{9,10} Hung et al and Idris et al investigated the importance

of techniques and reported that impression accuracy is not technique dependent.(7, 8)

Whereas Nissan et al reported that two step technique is more accurate impression technique as there is uniform wash space for the light body material to polymerize. Furthermore, the wash thickness is an essential factor that influences the accuracy of elastomeric impression materials.^{11,12}

Among them elastomeric impression material is the most commonly used. According to American National Standards Institute (ANSI)/American Dental Association (ADA) specification #19, elastomeric impression materials must be able to reproduce fine detail of 25 µm or less for which polyvinyl siloxane impression materials are the best.¹³ Hence, dimensional accuracy of cast obtained from polyvinyl siloxane impression made by single step putty wash technique was more dimensionally accurate mesio-distally, bucco-lingually and in inter-die dimensions except in cervico-occlusal dimension.

This in-vitro study compared the dimensional accuracy of cast obtained from different impression techniques using spacers does not simulate the exact clinical scenario. Single step technique showed more accurate cast. The use of a standard model simulating tooth preparation rather than actual tooth preparation in patients contributes to the limitations of the present study. Therefore further investigations are necessary to evaluate the accuracy of cast obtained with different impression technique using spacer under closely simulated clinical conditions.

Conclusions

Cast obtained from polyvinyl siloxane impression made by single step putty- wash technique was more accurate dimensionally. Among two-step putty wash technique, 1.5mm spacer thickness was more accurate

dimensionally and 0.5 mm spacer thickness was least accurate.

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