Original Article

Comparison of custom trays and stock trays using polyvinylsiloxane to evaluate linear dimensional accuracy: An *in vitro* study

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BACKGROUND: While literature demonstrates that the optimum accuracy is obtained with the custom trays, the use of stock trays for elastomeric impressions appears to be popular in general practice. **OBJECTIVE:** This *in vitro* study was done to evaluate the linear dimensional accuracy of impression made in stock trays and custom trays, using polyvinyl siloxanes. **MATERIAL AND METHODS:** The different impressions technique of polyvinyl siloxanes utilized in this study are as follows: 1) Putty wash 2-step technique with polyethylene spacer using stock tray. 2) Single mix technique utilizing medium viscosity in a custom tray. 3) Multiple mix technique utilizing heavy viscosity and low viscosity combination in a custom tray. For each technique, 10 impressions of a maxillary dentulous metal master model were made. The accuracy was assessed by measuring the three dimensions on stone casts poured from impressions of the master model. **RESULTS:** One-way analysis of variance showed statistically insignificant difference among the three different impression techniques for the different dimensions. **CONCLUSION:** Making custom tray is time consuming and costly; therefore putty wash 2-step technique with controlled bulk in stock tray can be used as an alternative to provide accurate impressions, as obtained from custom trays.

Key words: Custom trays, dimensional accuracy, polyvinyl siloxane, stock trays

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INTRODUCTION

Polyvinyl siloxane impression materials are extremely popular because of their combination of excellent physical property, handling characteristics and dimensional stability.[1] Polyvinyl siloxane impression materials were introduced in 1970.[2] Such materials are reported to be the most stable in when they are even thickness of 2 to 4mm achieved with an acrylic custom made impression tray. Finally, making a custom tray is time consuming and expensive. An alternative approach is the use of stock trays. However, very little information concerning the reliability of this method[3] exists. The purpose of this study was to include these variables in an *in vitro* comparison of the linear dimensional accuracy of the impression made in stock trays and custom trays using polyvinyl siloxane.

MATERIALS AND METHODS

This *in vitro* study was conducted in our department to evaluate the linear dimensional accuracy of impressions made in stock trays and custom trays using polyvinyl siloxane.[4-6]

A metallic maxillary dentulous die was fabricated to represent the maxillary dentulous arch. Prominent reference points for cast measurements on either side of the arch and one on the median palatine region were provided, as shown in [Figure 1]

Impression trays

Stainless steel maxillary dentulous stock trays no. 4 (Jabbaar Co. India) were selected for the putty wash 2-step impression techniques, to provide sufficient space for both putty and wash impression material.[7]

Fabrication of custom trays

Perforated acrylic resin custom trays (Asian special, batch no.004 Asian acrylates, India) of thickness 3 mm with 2 mm space in between the occlusal surface of teeth and inner tray walls were fabricated.[3] To standardize the size and critical spatial dimensions of the trays, each size of tray was fabricated using the same spacer and mold made from the additional silicone putty consistency material[5] (Reprosil,

Dentsply USA.). Ten custom trays each for the single mix impression techniques utilizing medium viscosity and multiple mix impression techniques utilizing heavy viscosity and low viscosity combination were fabricated.

The custom trays were fabricated at least 24 hours before the impressions were made, to allow them to become relatively dimensionally stable.[4,8] Tray adhesives (Caulk, Dentsply, Germany) were applied to all the custom trays and stock trays, as they bond the impression material to the tray and hence control the direction of polymerization shrinkage of the material.[4,9] All the custom trays were kept for 48 hours after the application of tray adhesive, as a 48-hour adhesive drying time exhibits the highest mean adhesive tensile bond strength.[10]

Impression materials

Different viscosities of polyvinyl siloxane impression materials of the same brand. (Dentsply, U.S.A) were used. The impression material was not sponsored from the manufacturer.

A thermocouple device (digital temperature controller, Techno Lab, India.) was connected to the water bath, to set the temperature at 37 degree centigrade. The master model, with the positioning device, was placed in the warm water bath, to achieve a surface temperature that was close to the range of surface temperature of the oral tissues, at the time when the impressions were made.[11, 12]

Impression tray positioning device: The master model and trays were mounted in a positioning device made exclusively for this study, for the identical direction of insertion and removal of the trays that contain the impression materials.[3] Also, it provides a uniform distance of 2 mm between the occlusal surface of the teeth and the inner walls of the stock trays, with the help of vertical stop to maintain the material thickness in the stock trays. A standard weight of five pounds (2,267 kg) was applied to seat all the trays[11] [Figure 2].

Impression making

The impressions techniques of polyvinyl siloxanes, utilized in this study, were as follows. [4-6]

Group 1: Putty wash 2-step technique with polyethylene spacer using stock tray.
Group 2: Single mix technique utilizing medium viscosity in a custom tray.
Group 3: Multiple mix technique utilizing heavy viscosity and low viscosity combination in custom trays

For each impression technique, 10 impressions were made and a total of 30 impressions were obtained. For Group 1, a plastic spacer supplied by the manufacturer was placed over the master model, when the preliminary putty impressions was made and it was allowed to set for six minutes. Wash material was then added and the tray was reseated and allowed to set on the master model for six minutes [Figure 3]. Group 2, medium viscosity material was utilized both as tray and syringe material, i.e. single mix techniques. The impression material was mixed and loaded in a syringe and the remaining portion was placed in the custom tray. The tray was seated on the master model and allowed to set for eight minutes [Figure 4]. Group 3, the syringe material (low viscosity), was first dispensed on to the teeth and then the tray material (high viscosity) was loaded in the custom tray and seated on the master model and allowed to set for eight minutes [Figure 5].

All the materials were mixed in standardized proportions, as per the manufacturers' recommendations.[5] All the impressions were stored at room temperature (25°C ±1) for one hour, before being poured.[13]

One hour after the impressions were set, each of the 30 impressions were treated with a surface reducing agent.[14] (Debubblizer, Prima Dental Products, India). The impressions were poured with high strength dental stone (Type IV, Kalrock, Kalabhai Karson Pvt. Ltd India, Batch no. JC 01860 S). To standardize the effect of the setting expansion (0.10% max) of the stone, the powder was accurately weighed and the water was dispensed using graduated cylinder and a product of similar batch number was used to pour all the impressions.[5] The die stone was mixed in a water powder ratio of 23 ml : 100 gm in a mixing bowl, as per the manufacturer's instructions. The powder was added to the water and allowed to wet for 30 seconds. The mixture was hand spatulated with a round end, stiff blade spatula for 10 seconds, followed by mixing under vacuum mixer for 30 seconds. The mixture was poured into the impression on a vibrator and allowed to set. The measurements from the master and the stone model were made with the help of a traveling microscope[8,14,15] (Micron, Instrument Industries, India.), capable of measuring up to 0.001 mm. The vertical dimensions were measured with a non stretchable thread along the surface. The thread was then measured with the traveling microscope. Each dimension on the master model was measured 10 times. The mean for all the distance measurement was calculated and used as the control to compare the three impression techniques.

The statistical analysis included calculation of the mean and standard deviation of all the groups and the student 't' test. One-way analysis of variance (ANOVA) was used to compare the difference amongst the three impression techniques and the master model, for different dimensions.

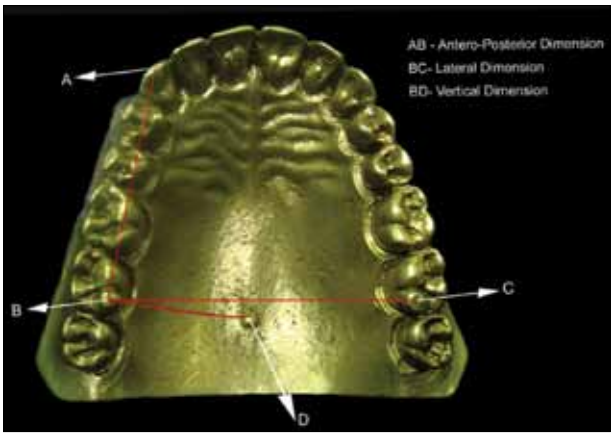


Figure 1: Master model with reference points

Figure 2: Impression tray positioning device

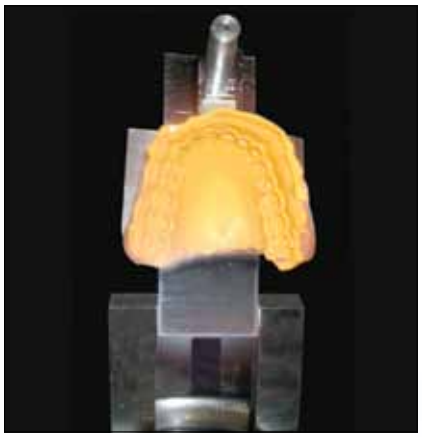


Figure 3: Group 1: Putty wash 2-step technique with polyethylene spacer using stock tray

Figure 4: Group 2: Single mix technique utilizing medium viscosity in a custom tray

Figure 5: Group 3: Multiple mix technique utilizing heavy viscosity and low viscosity combination in custom trays

RESULTS

Graph 1 shows absolute deviation of the means of the different dimensions for all the groups from mean of master model. The statistical analysis of all the impression techniques, for each dimension comparing with the mean of the master model dimension and evaluated with student 't' test, are tabulated in [Table 1]. Calculated and significant t value is designated as **#,** as it was greater than 't' tabulated value, i.e. 2.262 at 5% level of significance.

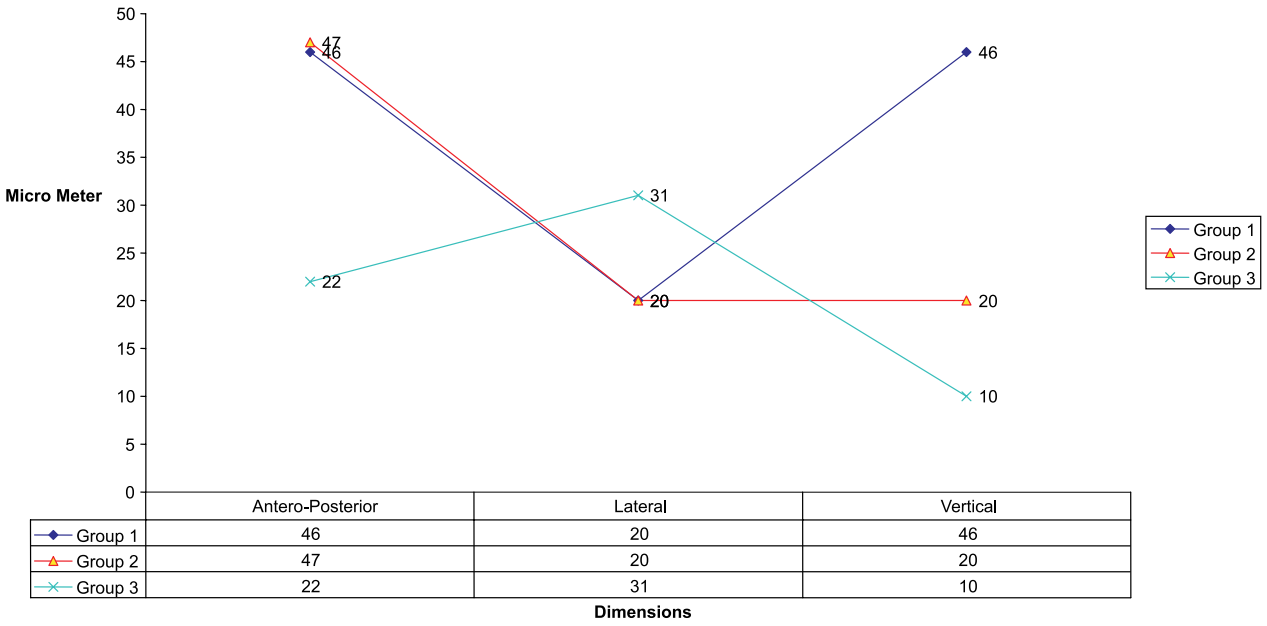
a) There was no significant difference between the master reading and Groups 1, 2 and 3 in antero-posterior dimensions. The result found Group 3 to be the most accurate in antero-posterior dimension.

b) There was no significant difference between the master reading and Groups 1, 2 and 3 observed in lateral dimensions. The result found Group1 to be the most accurate in lateral dimension.

Table 1: Comparison of antero-posterior, lateral and nertical dimensions (t-values) of different groups with mean of Master reading

	Antero posterior dimension	Lateral dimension	Vertical dimension
Master reading	35.91	45.90	34.11
Group 1	0.4634	1.7163	7.4627#
Group 2	2.0241	2.2140	2.2096
Group 3	2.0761	1.1696	0.9494

t- tabulated value is 2.262 at 5% level; #indicates calculated > tabulated



Graph 1: Average absolute deviation over 3 grounds at 3 given dimension (anterior-posterior, lateral and vertical dimension) for polyvinylsiloxane impression material

c) There was a significant difference between the master reading and Groups 2 and 3 in vertical dimensions.

The result found Group 3 to be the most accurate, followed by Group 2. Group 1 shows slight variations with that of the master model in vertical dimension. [Table 2] shows the analysis of variance (ANOVA) performed, combining the three groups and given as 'f' calculated values. There is no significant difference between the groups for antero posterior, lateral dimension and vertical dimensions.

DISCUSSION

Using custom trays for final impressions represents a dentist's best effort to obtain an exact duplication of the prepared teeth and adjacent tissues. They embody the twin pillars of rigidity and uniform impression thickness that several authors recommend.[16-19]

However, a majority of the dentists use stock trays for final impressions.[20] Research periodically shows that impression tray types do not affect the accuracy of final casts.[21,22] The text book fundamentals of fixed prosthodontics state that custom acrylic resin trays are an important part of rubber base impression techniques, although they later observe that when employing putty-wash technique a rigid, well fitting stock tray is acceptable. In spite of this, books reference custom trays.[23] Following a survey of almost 4000 American dentists, Shillinburg reported, that around 75% of the respondents used stock trays routinely, and about 90% of them used putty-wash silicone technique.[24]

While literature demonstrates that optimum accuracy is obtained with the custom trays, the use of stock trays for elastomeric impressions appears to be popular in general practice.[3,7,25-27] A contradiction appears when the theory supports the use of a custom tray but the dentist favors the use of stock trays. Making a custom tray requires planning a study model, laboratory time, curing interval and finishing time. In contrast, the stock tray can be selected, adapted and used in a single visit for both an anticipated and unanticipated situation.[28]

A new class of elastomeric impression material, highly filled silicones, has recently been introduced. They were developed to obviate the need for custom impression trays. The material is used with a manufacturer's stock tray to produce a custom tray intraorally. This is accomplished by placing a sheet of polyethylene in contact with the tissue side of the puttylike silicone, prior to insertion. Because of their high filler content, this putty like silicones should show less dimensional change than ordinary silicones with less filler. Once the preliminary set is made, which is done quite rapidly, the polyethylene spacer is removed and the use of low viscosity silicone is used to line or correct

Table 2: Analysis of variance combining the three groups to compare the means of all the groups

Dimensions	F - values	F-tabulated value
Antero posterior	0.0664	3.35 at 5% level
Lateral	0.0051	
Vertical	1.8315	

#indicates calculated > tabulated. There is no significant difference between the groups for antero posterior, lateral dimension and vertical dimensions.

the initial impression.[29]

Many studies[3,4,26,30,31] have reported that custom trays provide more accurate dental casts than stock trays, but if stock trays are properly oriented, giving uniform impression thickness, they can give better result than custom trays.[14]

The findings of this study indicated that the impression made in stock trays, i.e. putty-wash 2-step technique with polyethylene spacer, is as accurate as those for impression techniques in custom trays. This is in accordance with the study done by Thogthmmachat *et al*.[14] and Valderhaug and Floystrand.[3] Valderhaug and Floystrand reported that although ample amount of impression material (2 to 9 mm) was allowed, the linear dimensional stability of the impression made in stock trays was not inferior to the stability of the impression made in the custom made trays.

The clinical significance of the investigation is related to tooth to tooth relationship. If distortion occurs within the limit of periodontal ligament space, then the deviation should be acceptable.[14] The periodontal ligament space has been reported to range from 90 to 240 μm[32,33] A change of 90μm should be clinically acceptable.[14]

Among the deviations in this investigation, all the dimensions of different impression techniques are in the range of clinical acceptability i.e. 90μm.

The findings of this study dictate that Group 3 produced the most accurate result in antero-posterior and vertical dimension, followed by Group 1 for the most accurate result in antero-posterior and Group 2 for the most accurate result in vertical dimensions. Groups 1 and 2 were found to be the most accurate in lateral dimensions.

The accuracy of Group 3 may be attributed to

1) The controlled amount of bulk of impression material and adhesive systems[34]
2) Low polymerization contraction with the heavy body material, compared with the light body products, due to greater concentration of inert fillers.[35] Increased lateral dimension of Group 3 was found, when compared with the master model. A possible explanation for this is the contraction of the impression material towards the tray.[36] This is in accordance with the study by Eames and Siewke[37] and Lewinstein,[38] wherein they state that the impression materials' contraction towards the tray wall produce stone dies wider in the horizontal aspect (interabutment) and shorter in the vertical one.

In the light of the above discussion, it may be seen that if accurate impression material, good impression protocol and controlled conditions that approximate clinical situation such as oral temperatures are used, a rigid stock tray may be a valid alternative to custom tray.

Limitations of the study

One limitation of this study lies with the differences in making impressions *in vivo,* as compared to *in vitro*.

The measuring system used was linear and so did not account for rotational changes in the shape of the gypsum working cast.

Conclusion

Within the limitations of this study, the following conclusion was drawn: Putty wash 2-step technique with controlled bulk in stock tray can be used as an alternative to provide accurate impressions as obtained from single mix technique utilizing medium viscosity in custom tray and multiple mix technique utilizing heavy viscosity and low viscosity combination in a custom tray.

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