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ORIGINAL RESEARCH

Impression Tray Positioning Device in Research Methodology

[1]Sunil Kumar Mishra, [2]Ramesh Chowdhary

[1]Senior Lecturer, Department of Maxillofacial Prosthodontics, Dental College, Azamgarh, Uttar Pradesh, India

[2]Clinical Professor, Department of Prosthodontics, S Nijalingappa Institute of Dental Sciences and Research, Gulbarga, Karnataka, India

Correspondence: Sunil Kumar Mishra, Senior Lecturer, Department of Maxillofacial Prosthodontics, Dental College, Azamgarh Uttar Pradesh, India, e-mail: sunilmsr200@yahoo.co.in

ABSTRACT

Purpose: In spite of best available impression materials and advanced techniques, we still come across imperfect fit of a dental prosthesis. Selection of impression material is based on the results from the research carried out, hence the accuracy of this research needs to be at the topmost priority, hence a proper research model and methodology has to be followed. The purpose of this paper was to highlight on technique and the device made to meet these requirements.

Method: An *in vitro* study was done to evaluate the linear dimensional accuracy of commercially available polyvinyl siloxanes of varying viscosities using different impression techniques. A standardized experimental procedure is required to provide identical direction of insertion and removal of the trays that contained the impression material. An impression tray positioning device has been designed and machined in an attempt to meet these requirements.

Conclusion: It was found that putty-wash 2-step techniques with controlled bulk in stock tray found to be as accurate as multiple-mix technique, utilizing heavy viscosity and low viscosity combination in a custom tray and single-mix technique, utilizing medium viscosity in a custom tray.

Keywords: Positioning device, Impression techniques, Dimensional accuracy.

INTRODUCTION

Production of exceptional crowns and fixed partial dentures requires the use of impression materials and proper technique that record prepared teeth and their relationship to the adjacent oral structures.[1] Various *in vitro* studies were done to find out the best impression material, more accurate techniques which can be followed in routine practice.[2-20] A standardize experimental procedure is required to provide identical direction of insertion and removal of the trays that contained the impression material, there should be reproducible seating of the impression trays relative to model, the thickness of the impression materials should be maintained while loading and seating of the tray on the model so that accurate technique can be followed in research of newer impression materials that lead to the discovery of certain more dimensionally stable impression materials.

Different methods to orient the tray on master model were used by various researchers.[1,2,9,11,15,16,21] Valderhaug and Floystrand[16] assessed and compared the dimensional stability of impression made in custom-made acrylic resin and stock trays. In this study, the model and trays were mounted in jigs which provide identical direction of insertion and removal of the trays that contained the impression material. The part of the jig containing the impression could be removed by turning the screws located on each side of the tray. In a study by Linke, et al,[15] to ensure a constant thickness of the light body polyvinyl siloxane, a jig was adapted over the master model to allow a 3 mm separation of putty around the abutments. The master model had three positioning rods with vertical stops to standardize tray positioning and the thickness of the impression materials. A rim lock impression tray was attached to a plexiglass plate. A water cooled rim lock tray was attached to a similar plexiglass plate. Three holes in the plexiglass plate were keyed to the positioning rods on the master model. Vertical stops allowed a 3 mm depth of impression material over the abutment and 15 mm over the palatal region. The impression was removed vertically along the positioning rods to eliminate lateral stress on the impression material. Fedrick and Caputo[1] had done a study comparing the accuracy of reversible hydrocolloid and elastomeric impression materials. In the study, the experimental setup used to make impressions included three metal rods attached to the periphery of the master model to provide vertical positioning stops. The rods were located between the central incisors and distal to the molars bilaterally. This procedure ensured reproducible seating of the impression trays relative to model. A standard weight of 5 pounds was used to seat all of the trays. Wadhwani et al[2] had done a study on accuracy of newly formulated fast setting elastomeric impression materials. To standardize the seating position and centering of the tray during impression making on the master model, positioning guides were constructed with light polymerized acrylic resin material. Idris, Houston and Claffey[11] in a study fabricated autopolymerizing acrylic resin index device and position it on the master model, so that the stock metal trays were positioned in the same orientation on the stainless steel model for each impression. Thongthammachat et al[9] in a study placed the trays in specially designed acrylic jig to standardize seating on the master cast.

Description of the Device

This article describes about a positioning device designed and machined to provide identical direction of insertion and removal of the trays mounted on it. There is reproducible seating of the impression trays relative to master model, provision to alter the thickness of the impression materials as required in the study and also same thickness of impression material can be maintained for all the trays if require. The device is user friendly for easy loading and seating of the tray on the model (Fig. 1).

Parts of the Positioning Device (Figs 2 and 3)

1. Movable upper member which consists of (a) Cylinder to apply the weight during seating of the tray. (b) Upper member holding rod. (c) Three screws to stabilize the tray. (d) Adjustable rings to vary the impression thickness in the tray as required. 2. Fixed lower membrane which consist of (a) Cast holding platform. (b) Screw to adjust the cast holding platform. (c) Four rectangular blocks to form the base of the positioning device. 3. Adjustable anterior vertical rod to hold the trays. 4. Two long vertical rectangular post to attach the upper member with the lower member.

Upper Member

The upper members of the device are attached and stabilize with the lower member with the help of two rectangular vertical rods posteriorly and a vertical rod anteriorly. On the top surface of the upper member, there are rings of various thickness secured with a screw. These rings can be placed to the anterior vertical rod to adjust the distance between the tissue surface of the tray and occlusal surface of the master model. A cylinder mounted on the top surface of the upper member to apply the weight during seating of the tray. Upper member along with its all components and cylinder apply a standard weight of 5 pounds during seating of the tray on the master model.[1] There is upper member holding rod which holds the upper member while loading the impression material to the tray. A rectangular plate extending downward from the upper member, to which three adjustable screws are attached, one anteriorly and two posteriorly on either side to provide a tripod effect for the seating and stabilization of the tray.

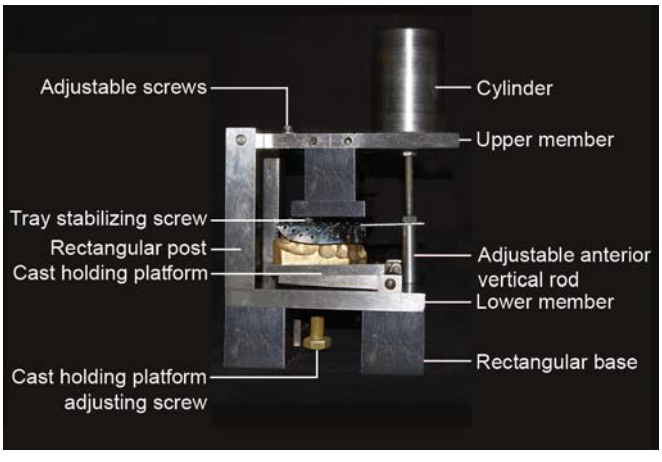


Fig. 1: Profile view of the impression tray positioning device

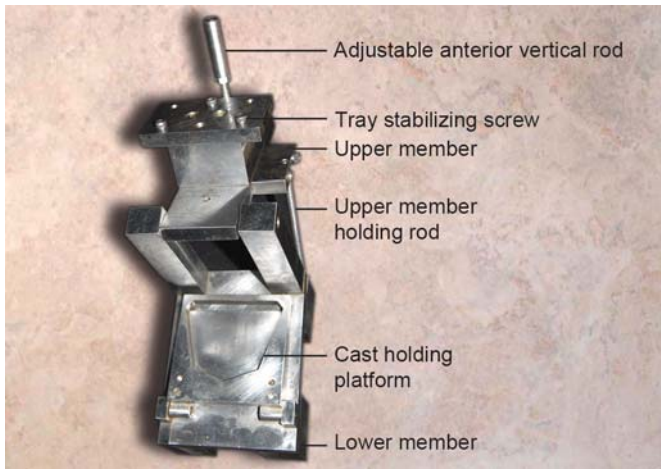


Fig. 2: Inner view of the upper and lower membrane of the impression tray positioning device

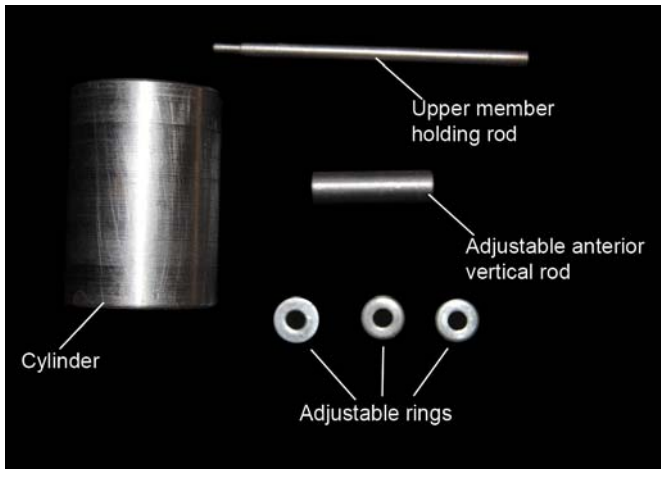


Fig. 3: Detachable parts of the impression tray positioning device

Lower Member

The lower member consists of a movable platform, which is attached to lower member anteriorly to hold the master model while making the impression. Below the lower member, there is a screw for adjustment of the movable platform.

Anterior Vertical Rod

The anterior vertical rod stabilizes the upper member anteriorly. There is a long cylindrical rod screwed to the vertical rod which can be unscrewed while mounting the tray. The cylindrical rod again screwed back once tray was mounted. After mounting the tray, the cylindrical rod along with anterior vertical rod should touch the lower member and thus it creates a uniform space of 2 mm between the tissue surface of the tray and occlusal surface of the master model.[22] Thus, the thickness of the impression material can be maintained and standardized in each tray. Also there is identical direction of insertion and removal of the trays on the master model. If the distance between the tissue surface of the tray and occlusal surface of the master model has to be increased, then in such cases adjustable rings secured on the top surface of upper member, available in sizes of 0.5 and 1mm can be taken and screwed

above the cylindrical rod attached to the anterior vertical rod. Thus, various impression thickness like 2, 2.5, 3, 3.5 and 4 mm can be obtained in the tray and useful in the study to evaluate about the impression materials and techniques.

Description of a Study Done using Impression Tray Positioning Device

A metallic maxillary dentulous master model is fabricated to represent maxillary dentulous arch. Prominent reference points for cast measurements were provided on either side of the arch and one on the median palatine region as shown in Figure 4. Different impression techniques of polyvinyl siloxanes utilizing various viscosities (Table 1) in this study are as follows:

1. Putty-wash, 2-step technique with polyethylene spacer using stock tray.[23]
2. Putty-wash, 1-step technique using stock tray[6] (Fig. 5).
3. Single-mix technique utilizing medium viscosity in a custom tray.[7]
4. Multiple-mix technique utilizing heavy viscosity and low viscosity combination in a custom tray.[8]

The master model and trays were mounted on a positioning device made exclusively for this study for the identical direction of insertion and removal of the trays that contain the impression materials.[16] Also, it provides a uniform distance of 2 mm between occlusal surface of the teeth and inner walls of the trays with the help of vertical stop to maintain the material thickness in the trays. A standard weight of 5 pounds (2,267 kg) was applied to seat all the trays.[1] For each technique, 10 impressions were made on a metallic maxillary dentulous master model. Accuracy was assessed by measuring reference points recovered on stone casts poured from impressions of the master model. The measurements from the master and the stone model were made with the help of traveling microscope[9,11] (Micron Instrument Industries, Hyderabad, India) capable of measuring up to 0.001 mm. The vertical dimensions were measured with a nonstretchable thread along the surface. The thread was then measured with a traveling microscope. Each dimension on the master model was measured 10 times. The mean for all distance measurements was calculated and used as the control to compare among four

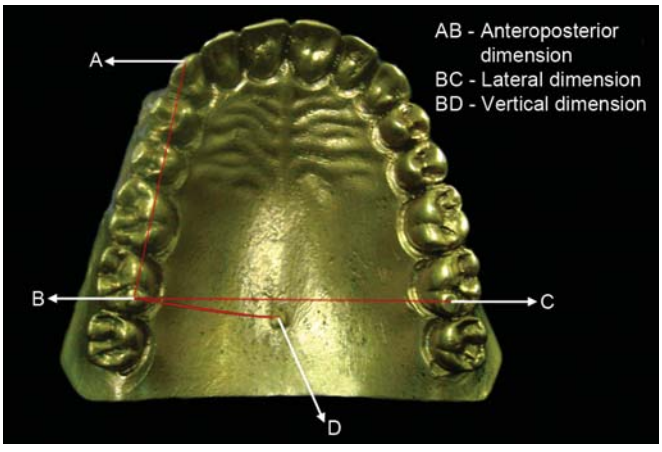


Fig. 4: Metallic maxillary dentulous model with reference points

Fig. 5: Putty wash 1-step impression technique using stock tray loaded on impression tray positioning device

impression techniques. Each stone cast measurement was repeated three times. The statistical analysis included calculation of the mean and standard deviation of all the groups and Student t-test. For each dimension, the difference between the mean values of stone casts (MSC) and the mean values of the master model (MMM), divided by the means of the master model and multiplied by 100, was expressed as the percentage deviations from the master model for each test group as follows:

$$\text{Percentage deviation} = [(\text{MSC} - \text{MMM})/\text{MMM}] \times 100$$

For each dimension, two separate one-way analyses of variance (ANOVA) were used to assess the differences in both the absolute dimensional measurements and in their corresponding percent deviations from the master model among all of the test groups.

RESULTS

Table 2 shows the mean values and standard deviations of anteroposterior, lateral and vertical dimensions of master model and different groups. Graph 1 shows the absolute deviation of the means of the different dimensions for each group from the mean of the master model. The statistical analysis of all the impression techniques, comparing each dimension with the mean of the master model dimension, evaluated with Student t-test are tabulated in Table 3. Calculated and significant t-values are designated with an asterisk (*).

1. There is no significant difference between the antero-posterior dimensions of the master reading and groups 1, 3 and 4. Group 4 heavy viscosity/light viscosity combination double-mix technique in a custom tray was the most accurate, followed by groups 1 and 3.
2. There is no significant difference between the lateral dimensions of the master reading and groups 1, 3 and 4. Group 3 and 1 were the most accurate, followed by group 4. Group 2 was the least accurate.

Table 1: Details of product tested and manufacturers

Product name	*Viscosity*	*Batch no.*	*Manufacturer*
Reprosil	Putty	070523	Dentsply, Caulk, Milford, USA
Reprosil	High viscosity	061106	Dentsply, Caulk, Milford, USA
Reprosil	Medium viscosity	070327	Dentsply, Caulk, Milford, USA
Reprosil	Low viscosity	070206	Dentsply, Caulk, Milford, USA

Table 2: Mean and standard deviations of anteroposterior, lateral and vertical dimensions of master model and different groups

	Anteroposterior dimension		*Lateral dimension*		*Vertical dimension*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Master reading	35.91	0.7705	45.90	0.7657	34.11	0.4564
Group 1	35.864	0.2978	45.92	0.0141	34.064	0.0201
Group 2	35.976	0.0372	45.98	0.0221	33.97	0.0221
Group 3	35.863	0.0249	45.88	0.0271	34.09	0.0249
Group 4	35.888	0.0289	45.931	0.0513	34.10	0.0316

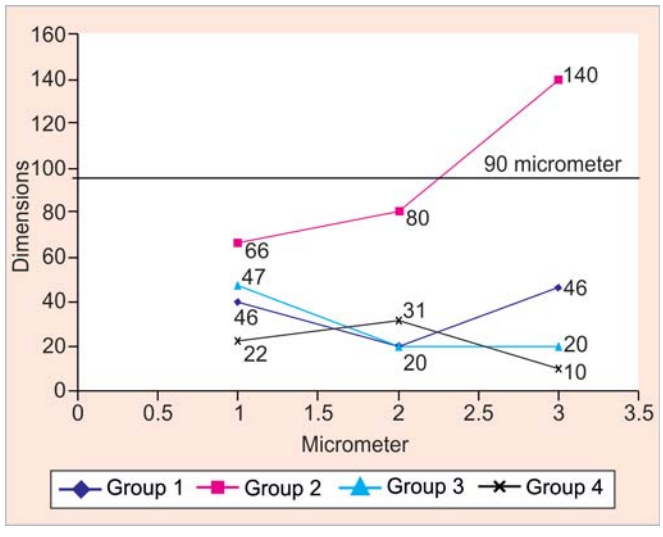
3. There is no significant difference between the vertical dimensions of the master reading and groups 3 and 4. Groups 4 and 3 were the most accurate. Group 1 shows slight variations with that of the master model, and group 2 was found to be the least accurate.

The one-way ANOVA (Table 4) revealed that all of the dimensions were significantly different among the impression techniques. Table 5 shows the percent deviations from the master model for each dimension, according to the impression technique. All the differences among the impression techniques were significant, as demonstrated by the one-way ANOVA Putty-wash 2-step technique with controlled bulk in stock tray

Table 3: Comparison of anteroposterior, lateral and vertical dimensions (t-values) of different groups with mean of master reading

	Anteroposterior dimension	*Lateral dimension*	*Vertical dimension*
Master reading	35.91	45.90	34.11
Group 1	0.4634	1.7163	7.4627*
Group 2	5.6452*	10.8597*	19.0045*
Group 3	2.0241	2.2140	2.2096
Group 4	2.0761	1.1696	0.9494

*Calculated > tabulated t-value is 2.262 at 5% level. For anteroposterior dimension, there is no significant difference between the master reading and groups 1, 3 and 4. For lateral dimension, there is no significant difference between the master reading and groups 1, 3 and 4. For vertical dimension, there is no significant difference between the master reading and groups 3 and 4. t-value calculated.



Graph 1: Average absolute deviation over four groups at three given dimensions (anteroposterior, lateral and vertical)

Table 4: One-way ANOVA for dimensions of stone casts according to impression technique (n = 10)

Dimension	*Source*	*df*	*Sum of squares*	*Mean square*	*f-value*	*p-value*
Anteroposterior	Between groups	3	0.0326	0.0109	0.4467	<0.01
	Within groups	36	0.8773	0.0244		
	Total	39	0.9099			
Lateral	Between groups	3	0.0508	0.0619	14.0833	<0.01
	Within groups	36	0.0421	0.0012		
	Total	39	0.0929			
Vertical	Between groups	3	0.2239	0.0746	4.8758	<0.01
	Within groups	36	0.5507	0.0153		
	Total	39	0.7746			

df: Degree of freedom. Differences are significant at $p < 0.05$.

Table 5: One-way ANOVA for percent deviations of dimensions of stone casts from those of master model, according to impression technique (n = 10)

Dimension	*Source*	*df*	*Sum of squares*	*Mean square*	*f-value*	*p-value*
Anteroposterior	Between groups	3	0.0326	0.2129	4.0864	<0.01
	Within groups	36	0.8773	0.0521		
	Total	39	2.5139			
Lateral	Between groups	3	0.1136	0.0379	11.4848	<0.01
	Within groups	36	0.1187	0.0033		
	Total	39	0.2323			
Vertical	Between groups	3	1.8919	0.6306	175.1667	<0.01
	Within groups	36	0.1307	0.0036		
	Total	39	2.0226			

df: Degree of freedom. Differences are significant at $p < 0.05$.

can be used as an alternative to provide impressions as accurate as those obtained from the single-mix technique using medium viscosity in a custom tray and multiple-mix technique utilizing heavy viscosity and low viscosity combination in a custom trays. If an accurate impression material, good impression protocol and controlled conditions that approximate the clinical situation are used, a rigid stock tray can be a valid alternative to a custom tray.

CONCLUSION

This positioning device has been designed and machined in an attempt to help the people involved in research field and provide them an alternative to orient the trays and standardize the study related to impression materials property and technique, so that they can come up with some new developments and advancement in material science.

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