Need for a reliable alternative to custom-made Implant Impression trays: An *in vitro* study comparing accuracy of custom trays versus specialized aluminum stock tray

Mukti Goel, Pankaj Dhawan, Piyush Tandan, Pankaj Madhukar

Department of Prosthodontics, Crowns and Bridge and Implants, Manav Rachna Dental College, Faridabad, Haryana, India

Abstract

Purpose: The aim of the present study was to evaluate and to compare the accuracy of implant casts obtained by open tray pick-up impression technique using 2 types of custom-made trays and a specialized aluminum stock impression tray.

Materials and Methods: A heat-cure acrylic resin master model was fabricated. Two implants were placed parallel to each other. Ten impressions were made from each group. Polyvinylsiloxane impression material with single step putty wash technique was used for making all the impressions. The resultant casts obtained were compared to the master models with respect to the distances measured between the reference points using a stereomicroscope. The data obtained was statistically analyzed using one-way ANOVA, Tukey's *post hoc* procedures, and *t*-test.

Results: Mean value obtained was 2.012967 cm ($\pm$0.007060) for corimplant stock tray, 2.012627 cm ($\pm$0.007945) for autopolymerizing acrylic resin tray, 2.010279 cm ($\pm$0.006832) for light-cure hybrid composite tray. *P* value was calculated to be >0.05; hence, there was nonsignificant deviation of observations from standard value in each group.

Conclusion: Statistically insignificant difference was found between the accuracy of casts obtained by the different impression trays. However, light-cure hybrid composite trays showed best results followed by autopolymerizing acrylic resin trays and Corimplant stock tray.

Keywords: Corimplant tray, custom-made trays, pick-up impression, specialized aluminum stock tray

INTRODUCTION

Replacing missing teeth have always presented a treatment challenge throughout the human history. The goal of modern dentistry is to restore the patient to normal oral health in a predictable scientific way. Increasing scientific evidence supports the use of osseointegrated implants for the oral rehabilitation of patients.[1-3] Successful implant surgical phase along with an accurate and passively fitting prosthesis is regarded as one of the essential requirements for long-term implant success.[4,5] Movement of the natural tooth ranges within 0.02 mm in its periodontal ligament, whereas the ankylosed fixture has a pseudomobility,

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ranging within 0.002 mm due to bone flexure.[6] Any tensile, compressive and bending forces introduced through misfitting super-structures may lead to unfavorable complications, which can be mechanical or biological in nature.[7] Connecting a multiunit implant prosthesis with completely passive fit in clinical situation is difficult to achieve because of many potential inaccuracies associated with current materials and techniques, which include dimensional changes in impression materials, investment materials, wax and acrylic patterns, expansion of gypsum die products and volumetric shrinkage of metal casting on solidification.[6,8,9] Therefore, clinicians should strive for improving the transfer accuracy of the impression. Accurate registration of the oral structures necessitates the use of an accurate impression material, a precise impression technique, and a rigid impression tray to support the material.[10-12] In the journey toward precision and accuracy, it is important for the clinician to make an informed decision of the previously mentioned variables. A newer range of implant impression trays are specially being marketed for the purpose of open tray impressions. To the author's knowledge, very few studies have been done on evaluating the accuracy of implant master models using these specialized trays. Therefore, there is an increased need for quantitative data analysis regarding the influence of these newer trays and tray materials on the accuracy of implant impressions and implant master models. Custom trays, however, are impractical in the routine clinical setting because of the additional time and cost associated with them; therefore, dentists typically use the more practical stock trays. To achieve a precise, passive fitting prosthesis different tray types, impression materials, and impression techniques have been suggested in the literature. The results in previous studies are quite contradictory and confusing.[13] Thus, the present *in vitro* study was an attempt to evaluate and to compare the accuracy of Implant Master Model obtained by open tray pick-up technique using three different impression trays, namely, Corimplant stock tray, autopolymerizing acrylic resin custom-made impression tray, and light-cured acrylic resin custom-made impression tray. The null hypothesis for the study was that different impression trays do not influence the accuracy of the implant master model.

MATERIALS AND METHODS

Study design
In the present study, a total of 30 impressions were made from a heat-cured acrylic partially edentulous Kennedy's Class III mandibular model with the implants placed at 2nd premolar and 2nd molar edentulous area. The impressions were grouped into different categories depending on the type of tray used to make the impression.

Group stock Corimplant tray
Impressions made using Corimplant stock impression trays which are specialized aluminum stock trays for implants with detachable plastic base. The plastic base is made of seven parts which are detachable *en masse* or individually to align with the position of implants. It is made of medical grade aluminum and can be reused as they are autoclavable at high temperatures.

Group custom-fabricated autopolymerzing acrylic resin tray
Impressions made using custom-fabricated impression trays of polymethyl methacrylate (PMMA) acrylic resin with standardized thickness and regulated inner space. These are designed to provide a uniform thickness of impression material to improve the accuracy of the resultant working cast.

Group custom-fabricated light-cured tray
Impressions made using custom-fabricated impression trays of light-cured hybrid composite with standardized thickness and regulated inner space. These resins are characterized by improved physical characteristics such as increased stiffness, good form and volume stability, and low sensitivity to moisture.

Preparation of the master model
A heat-cure acrylic resin model (master model) was fabricated of a partially edentulous Kennedy Class III (right 2nd premolar, 1st and 2nd molar missing), mandibular arch. Using a surveyor with milling unit, holes were made to accept 4.2 mm × 12 mm implants in the 2nd premolar and 2nd molar area on the right side of the cast. Two implants were placed inside the holes parallel to each other. V-shaped notches were made for accurate positioning of the trays and as a reference point for placing the same during impression making so that the position of the impression tray was constant for all the impressions. This framework was the standard for the assessment of all subsequent measurements made to determine the accuracy of casts obtained from different impression trays [Figure 1].

Fabrication of impression trays
Stock impression tray
For open-tray (pick-up) impression technique, Corimplant stock tray was taken and adjusted on the master model by altering the plastic bases in the tray such that the screws of the impression posts project out from these openings. For standardizing the positioning of the tray, autopolymerizing acrylic resin (Dental products of India (DPI) cold cure polymer) was used to make three extensions on the trays (1 anteriorly and 2 posteriorly) corresponding to the notches made in the master model for holding the trays at constant positions [Figure 2].

Autopolymerizing acrylic resin custom-made impression trays

A total of 10 custom trays made of autopolymerizing acrylic resin were fabricated. To standardize the fabrication of the trays, a mold was fabricated using a denture flask. To fabricate all the custom trays with identical spacer thickness, 4 mm of modeling wax was adapted over the master model to provide space for impression material, and impression was made using irreversible hydrocolloid to get a spaced cast. Three tissue stops, one in anterior region and two in posterior region were incorporated in the wax spacer to standardize the orientation of the custom trays on the model. A uniform thickness of wax in the form of tray was adapted over this spaced cast, and a silicone putty mold was prepared in the denture flask[14] [Figure 3] and then, wax was eliminated by boiling out for 7–10 min. Separating media was placed on both the halves of the flask. Autopolymerizing PMMA resin was mixed according to the manufacturer's directions and custom trays of identical thickness were fabricated with the help of this flask mold. The trays were removed after complete polymerization and allowed to bench cure for 24 h before the use. Retention holes were made in all the custom trays at uniformly spaced locations using a round bur [Figure 4].

Light-cured hybrid composite custom-made impression trays

A total of 10 trays were fabricated with light-cured acrylic resin (Plaque photo). The cast which was made with the 4 mm thickness spacer (for making autopolymerizing acrylic resin custom-made tray) was duplicated and used for making light-cured trays. The light cure tray material in the form of prefabricated upper base plate of uniform 2 mm thickness was adapted on the master cast and was cut to shape using a BP blade. The trays were cured in the light cure unit (Composite oven) as recommended by the manufacturer. The trays were trimmed and smoothened with sandpaper. The trays were stored for 24 h to allow for maximum polymerization shrinkage before making impressions. Holes were made with round bur to provide mechanical retention of the elastomeric impression material [Figure 5].

Impression procedure

Polyvinyl siloxane impression material was chosen for the study as it exhibits good resistance to deformation, good flexibility and is most commonly used in day-to-day clinical practice.[15] A total of 30 impressions were made using polyvinyl siloxane impression material (Aquasil, Dentsply) using a putty-wash single-step technique. Ten impressions were made for each group. Impression posts were screwed to the implants in position on the master model. Before making impressions, tray adhesive (Caulk®
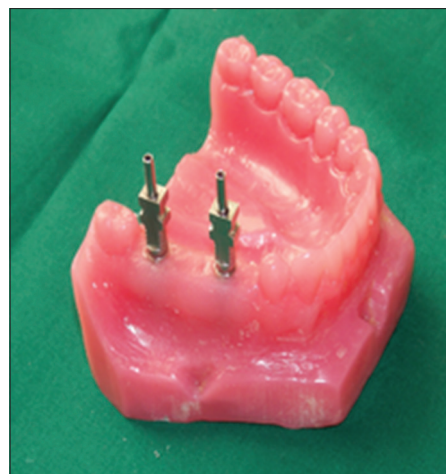

Figure 1: Acrylic resin master model with implants

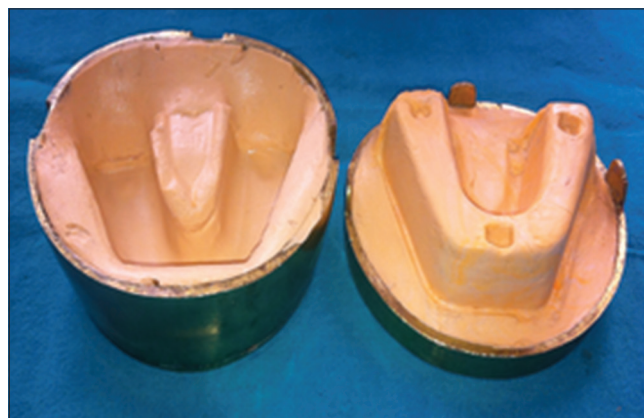**Figure 2:** Corimplant stock impression tray

Figure 3: Silicone putty mold for standardization of autopolymerizing acrylic resin custom-made impression trays

Tray Adhesive - Dentsply) was thinly and evenly applied over the inner surface of each tray. It was allowed to dry before impressions were made. In the putty-wash impression technique, both the phases of the impression material were placed in the tray at the same time and the light body

material was injected with an automatic cartridge dispensing gun around the impression posts. The trays were seated on the master model with gentle pressure until the tray projections got snugly fit into the V-shaped notches of the master model. A stop clock was used to note the time to load and level the tray, seating the tray on the displaceable bed, and allow for full setting, to standardize the impression protocol. The impression material was allowed to set for double the manufacturer's setting time to compensate for delayed polymerization at room temperature rather than at mouth temperature. The impression posts were unscrewed, and the trays were separated from the master model after the impression material polymerization.

Fabrication of casts

The laboratory pouring procedures were same for all the impressions made. Implant analogs were fitted to the impression posts, Type IV die stone (Kalrock, Super hard die stone, Class IV, Kalabhai Karson Ltd, Mumbai) was vacuum mixed according to the manufacturer's instructions. The impressions were poured using double-pour technique to minimize the volumetric expansion of the stone, resulting in more accurate die casts.[16,17]. An initial pour of stone up to the middle of analogs was carried out. The second pour of die stone was performed after half an hour.

Measurement protocol

Before making the measurements, all the casts were stored at room temperature for a minimum of 24 h. Images were digitally transferred to the software (Magnus-Pro) through a video camera (Olympus) coupled to a stereomicroscope [Figure 6]. Then, the measurements were computed by software. The linear distance of the implants (mesiobuccal point on 2nd premolar and distobuccal point on 2nd molar) measured on the master model was compared with the measurements done on the die stone casts. Three measurements were made, and an average of these measurements was considered as a final reading. The data obtained was statistically analyzed and computations were performed using SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc. (It was later acquired by IBM Corporation, New Orchard Road Armonk, New York, US). For each Group 10 sample, values were used and the data were subjected to descriptive analysis for the calculation of mean, standard deviation, and percentages. To find the significance of study parameters, One-way ANOVA test [Table 1] was used to compare the mean values between the three groups followed by *post hoc* test [Table 2] for group-wise comparison. One sample *t*-test [Table 3] is used to test the deviations of each group from standard value of 2.008205 cm. A $P \leq 0.05$
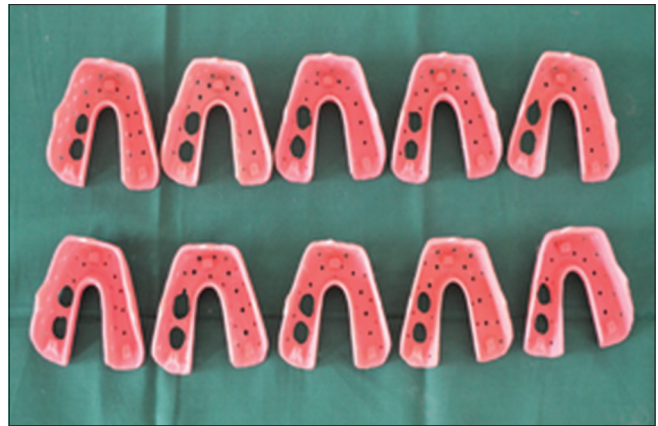

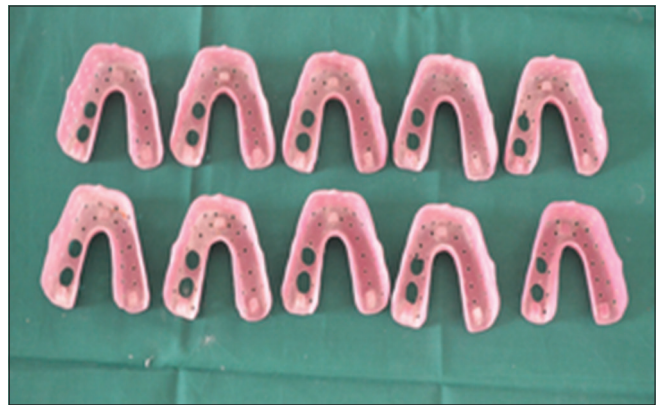**Figure 4:** Autopolymerizing acrylic resin custom-made impression trays

Figure 5: Light-cured hybrid composite custom-made impression trays

Figure 6: Stereomicroscope with camera

was considered to be statistically significant at 95% confidence interval.

RESULTS

It was observed that mean value for Corimplant stock impression tray was 2.012967 cm ($\pm$0.007060); for autopolymerizing acrylic resin custom-made impression

tray, it was 2.012627 cm (±0.007945) cm; and for light-cure hybrid composite impression tray 2.010279 cm (±0.006832) was recorded. *P* value was calculated to be > 0.05; hence, there was nonsignificant deviation of observations from standard value in each group. Based on the statistical results obtained, the mean linear dimensional changes of dies made from three different impression trays did not show any statistical significance. However, light-cure hybrid composite impression tray showed least deviation followed by autopolymerizing acrylic resin custom-made impression tray and Corimplant stock impression tray, respectively [Graph 1].

DISCUSSION

The results of the present study supported the null hypothesis as there was statistically insignificant difference between the impressions made from three different impression trays. It is important to remember that the major objective of fabricating prosthesis supported by osseointegrated implants is the production of superstructures that exhibit a passive fit, which in turn relies on the accuracy of the dental impression.[18] An accurate dental impression demands firm and rigid impression tray, a precise impression technique and a dimensionally stable impression material. In this study, a specialized aluminum stock tray with detachable plastic base

"Corimplant tray" was used. The Corimplant impression tray is a recently introduced option for making impressions of dental implants in a simpler and faster manner.

Madhan *et al*.[13] suggested from their study that the selection of impression technique and impression material can be based on clinical situation and the clinician's preference. The results of the present study are in accordance to a study conducted by Spector *et al*.[19] which has shown no significant difference between the accuracies of impressions with both the stock and custom trays. The results are also in conformity with the study conducted by Rueda *et al*.,[20] in which the linear dimensional stability of nonaqueous elastomeric impressions made from stock and custom trays was examined by measuring the casts derived from those impressions. Although the custom tray had the least amount of variation; however, the differences between the custom and stock trays were also not clinically significant. Carrotte *et al*.[21] suggested from their study that metal and rigid plastic stock trays

Table 1: Depicts one-way ANOVA test used for comparing the mean values of different groups

Measurement	ANOVA				
	Sum of squares	df	Mean square	*F*	Significant
Between groups	0	3	0	1.233	0.312
Within groups	0.001	36	0		
Total	0.002	39			
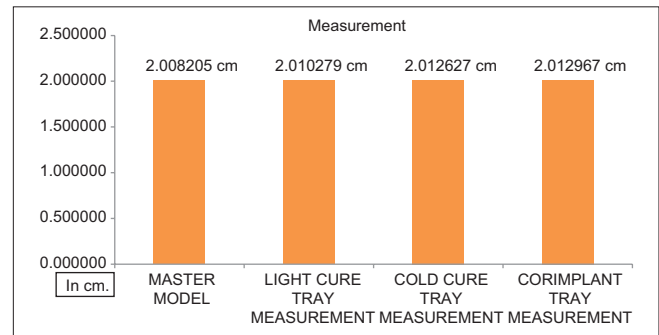
Graph 1: Comparison of linear dimensional changes between master model and three different groups of impression trays

Table 2: Represents the *post hoc* test for multiple intergroup comparisons

Measurement Tukey HSD		Multiple comparisons				
Group (I)	Group (J)	Mean difference (I−J)	SE	Significant	95% CI	
					Lower bound	Upper bound
Master model	Light-cure tray measurement	−0.002074	0.002833	0.884	−0.0097	0.005556
	Cold-cure tray measurement	−0.004422	0.002833	0.413	−0.01205	0.003208
	Corimplant tray measurement	−0.004762	0.002833	0.348	−0.01239	0.002868

SE: Standard error, CI: Confidence interval, HSD: Honest significant difference

Table 3: Represents the *t*-test for comparing the deviation of each group from the mean standard value

	One-sample test					
	Test value=2.008205					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Light-cure tray measurement (cm)	0.96	9	0.362	0.002074	−0.00281	0.006961
Cold-cure tray measurement (cm)	1.76	9	0.112	0.004422	−0.00126	0.010106
Corimplant tray measurement (cm)	2.133	9	0.062	0.004762	−0.00029	0.009813

CI: Confidence interval

provide greater accuracy than flexible plastic ones. Akça and, Cehreli[22] concluded from their study that stock trays when used with polyvinyl siloxane impression material for the open-tray (pick-up) impression technique results in more accurate impressions. Padmakar *et al.*[23] concluded from their study that putty wash two-step technique with controlled bulk in stock tray can be used as an alternative to provide accurate impressions, as obtained from the custom trays. In the present study, custom-made trays showed the least amount of variation, yet the difference between the custom made and stock tray was not statistically significant.

Limitations of the study

One limitation of this study lies with the differences in making impressions *in vivo*, as compared to *in vitro*. Second, sample size and number of implants used for the study were less. Moreover, both the implants were placed in a parallel position, a condition that is seldom achieved in the maxilla due to anatomical limitations. This scenario probably allowed the easy removal of the impressions, decreasing the distortion of the impressions, and resulting in low deviation values. To validate these results, future *in vivo* studies should be designed to measure the accuracy of impression trays in edentulous arches with multiple implants.

CONCLUSION

Within the limitations of this study, it can be concluded that neither stock tray nor custom-made trays contributed too much differences in the accuracy of the casts. Statistically insignificant difference was found between the accuracy of casts obtained by three different impression trays. However, light-cure hybrid composite implant impression trays showed best results followed by autopolymerizing acrylic resin implant impression trays and Corimplant stock impression tray. The specialized aluminum stock impression trays will be a time friendly and reliable alternative for custom-fabricated implant impression trays provided good protocol is used.

Conflicts of interest

There are no conflicts of interest.

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