Accuracy of Three Implant Impression Techniques with Different Impression Materials and Stones

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The purpose of this study was to compare the accuracy of casts made using three different impression techniques to obtain an accurate definitive cast for fabrication of multiple-implant prostheses. Twelve experimental groups were formed combining the following conditions: three impression techniques, two impression materials, and two cast materials. The main effects of the three factors were analyzed by three-way analysis of variance using the full factorial general linear model between factors. The results showed that there were no significant differences in mean values for the transferred dimensions between the control and experimental groups. None of the measurements in the horizontal plane of the definitive casts demonstrated significant differences among the impression techniques with different impression and cast materials ($P > .01$). *Int J Prosthodont 2012;25:44–47.*

Since dental implants are routinely used, the number of implant-supported restorations is increasing. To have a successful long-term result with implant prostheses, a passive and precise fit of the implant superstructure to an implant abutment is recommended. The fabrication of accurate impressions and definitive casts is critical to achieve a passively fitting implant-retained prosthesis. The accuracy of the definitive cast is dependent on the impression technique, impression material, splinting material (if used), and cast material.[1,2]

The purpose of this in vitro study was to compare the accuracy of three different impression techniques (closed-tray impression with transfer impression copings [CTI], open-tray impression with splinted impression copings [OTI-S], and open-tray impression with unsplinted impression copings [OTI-U]) to obtain an accurate cast for fabrication of multiple-implant prostheses using one of two different impression materials and one of two different cast materials. The research hypothesis was that the different implant impression techniques, impression materials, and cast materials would influence the dimensional accuracy of the definitive casts.

Materials and Methods

A machined aluminum arch was fabricated to serve as a master cast, simulating an edentulous dental arch. Five parallel holes were drilled perpendicular to the aluminum arch, and five internal-octagon Morse tapered implants (Sybron ProTL, Sybron Implant Solutions) were positioned parallel to each other. To fabricate the master cast, a polycarbonate stock impression tray was used with prefabricated 2-mm-thick acrylic resin copings placed on each abutment to create a uniform and optimal space for the impression material. The dimensions of these copings were standardized using a digital caliper. Twelve experimental groups were created combining three impression techniques (OTI-S, OTI-U, CTI), two impression materials (Impregum Penta Soft, 3M EPSE and Imprint II Garant, 3M ESPE), and two cast materials (Microstone, Whipmix and Resin Rock, Whipmix) (Table 1). For each group, five impressions were taken and poured, one for each impression with the designated stone for evaluation.

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For OTI-S impressions, the acrylic resin pattern for the bar splint was made on the impression copings 1 day prior to the impression procedure and sectioned into four separate pieces. The sectioned pieces were reconnected by adding acrylic resin incrementally prior to the impression procedure to minimize polymerization shrinkage. For OTI-U impressions, each impression tray, which had five windows to allow access for the coping screws, was placed on the cast, and the material was allowed to polymerize as indicated previously. For CTI impressions, direct solid abutments, plastic impression copings, and positioning cylinders were used.

The solid abutments were screwed onto the implant analogs of each definitive cast before measurement. The center-to-center distances between the solid abutments of the five implants in each definitive cast and a solid aluminum master cast were measured in the horizontal plane using a computer-aided microscope (Nikon SMZ-U, Nikon Instruments) (Fig 1). One examiner performed all measurements (10 times per cast). The differences in distances for the impression techniques, impression materials, and cast materials compared to criteria values measured on the solid aluminum master cast were analyzed using the single-sample t test. The main effects of the three factors were analyzed using three-way analysis of variance (ANOVA) in the full factorial general linear model between factors.

Table 1 Characteristics of Test Groups

Group	Impression technique	Impression material	Cast material
1	OTI-S	Impregum Penta (polyether)	Microstone
2	OTI-U	Impregum Penta (polyether)	Microstone
3	CTI	Impregum Penta (polyether)	Microstone
4	OTI-S	Impregum Penta (polyether)	Resin Rock
5	OTI-U	Impregum Penta (polyether)	Resin Rock
6	CTI	Impregum Penta (polyether)	Resin Rock
7	OTI-S	Imprint II Garant (polyvinyl siloxane)	Microstone
8	OTI-U	Imprint II Garant (polyvinyl siloxane)	Microstone
9	CTI	Imprint II Garant (polyvinyl siloxane)	Microstone
10	OTI-S	Imprint II Garant (polyvinyl siloxane)	Resin Rock
11	OTI-U	Imprint II Garant (polyvinyl siloxane)	Resin Rock
12	CTI	Imprint II Garant (polyvinyl siloxane)	Resin Rock

OTI-S = open-tray impression with splinted impression copings; OTI-U = open-tray impression with unsplinted impression copings; CTI = closed-tray impression with transfer impression copings.

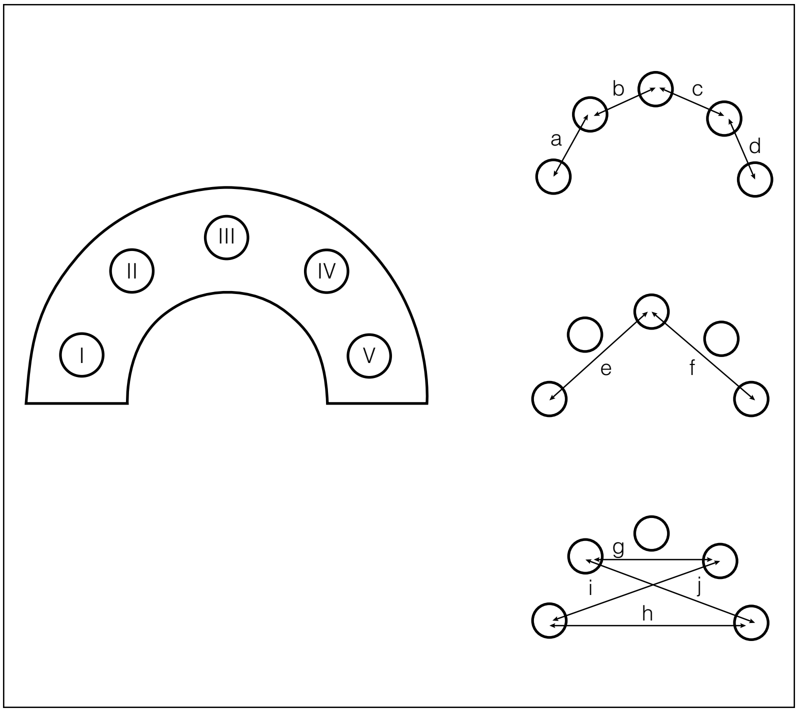

Fig 1 Ten center-to-center distances were measured between five implants. Distance between implants within the tray: *(a)* distance between implant I and implant II; *(b)* distance between implant II and implant III; *(c)* distance between implant III and implant IV; *(d)* distance between implant IV and implant V; *(e)* distance between implant I and implant III; and *(f)* distance between implant III and implant V. Distance between implants across the tray: *(g)* distance between implant II and implant IV; *(h)* distance between implant I and implant V; *(i)* distance between implant I and implant IV; and *(j)* distance between implant II and implant V.

Table 2 Distance Differences Between Impression Techniques and Criteria Values (mm)

		OTI-S			OTI-U			CTI			
Distance	CV	Mean	SD	*P**	Mean	SD	*P**	Mean	SD	*P**	*P†*
a	10.31	10.31	0.03	.904	10.30	0.04	.167	10.29	0.03	.110	.208
b	19.99	19.98	0.03	.649	19.99	0.04	.610	19.99	0.04	.859	.807
c	19.65	19.66	0.04	.111	19.66	0.03	.118	19.65	0.05	.762	.213
d	10.43	10.45	0.03	.132	10.45	0.06	.254	10.44	0.07	.759	.411
e	28.23	28.23	0.04	.909	28.25	0.04	.239	28.25	0.04	.183	.560
f	27.95	27.97	0.03	.119	27.97	0.07	.321	27.97	0.04	.129	.986
g	34.56	34.58	0.05	.117	34.58	0.05	.116	34.58	0.04	.114	.961
h	40.04	40.05	0.05	.206	40.04	0.05	.404	40.04	0.04	.373	.947
i	38.68	38.69	0.05	.202	38.69	0.04	.321	38.69	0.04	.262	.933
j	38.55	38.56	0.05	.553	38.55	0.03	.895	35.54	0.05	.347	.531

CV = criteria value; SD = standard deviation.
*Single-sample *t* test.
†Three-way ANOVA in full factorial model.

Table 3 Distance Differences Between Impression Materials and Criteria Values and Between Cast Materials and Criteria Values

		Impregum Penta (polyether)			Imprint II Garant (polyvinyl siloxane)				Microstone			Resin Rock			
Distance	CV	Mean	SD	*P**	Mean	SD	*P**	*P†*	Mean	SD	*P**	Mean	SD	*P**	*P†*
a	10.31	10.30	0.04	.285	10.30	0.03	.130	.526	10.30	0.04	.285	10.30	0.03	.030	.526
b	19.99	19.99	0.04	.341	19.98	0.04	.553	.314	19.99	0.04	.341	19.98	0.04	.553	.314
c	19.65	19.66	0.04	.217	19.67	0.04	.329	.559	19.66	0.04	.217	19.67	0.04	.029	.559
d	10.43	10.46	0.06	.252	10.45	0.04	.184	.550	10.46	0.06	.052	10.45	0.04	.084	.550
e	28.23	28.25	0.04	.225	28.24	0.04	.365	.476	28.25	0.04	.025	28.24	0.04	.365	.476
f	27.95	27.97	0.06	.193	27.97	0.04	.220	.856	27.97	0.06	.193	27.97	0.04	.020	.856
g	34.56	34.58	0.05	.131	34.58	0.04	.101	.872	34.58	0.05	.131	34.58	0.04	.101	.872
h	40.04	40.05	0.04	.162	40.04	0.05	.493	.500	40.05	0.04	.062	40.04	0.05	.493	.500
i	38.68	38.69	0.04	.137	38.69	0.04	.183	.778	38.69	0.04	.137	38.69	0.04	.183	.778
j	38.55	38.55	0.04	.583	38.55	0.05	.913	.707	38.55	0.04	.583	38.55	0.05	.913	.707

CV = criteria value; SD = standard deviation.
*Single-sample *t* test.
†Three-way ANOVA in full factorial model.

Results

Table 2 presents the summary of mean values, standard deviations, and results of the Student *t* test between impression techniques (n = 20) and criteria values of the 10 measured distances. No significant differences were found between mean horizontal distances of each measurement for the impression techniques. The results of the three-way ANOVA in full factorial model are shown in Table 3. There were no significant differences for horizontal distances (a to j) in all impression and cast materials. Therefore, none of the combinations of impression techniques, impression materials, and cast materials for definitive casts had a significant effect on the deviations of each horizontal measurement.

Discussion

The research hypothesis of the present study was not accepted because the accuracy of the CTI technique was comparable to that of the OTI technique, regardless of the type of impression and cast materials used.

The results of the horizontal plane measurements demonstrated that all impression techniques reproduced original dimensions in the reference cast with no significant differences. This may be because the upright and parallel configuration of the implants on the master cast could cause minimal stress between the impression materials and copings when the impression tray was removed from the cast.

Since the CTI technique is easier in clinical application, it has increased in popularity. However, the design of transfer copings may have an important role in the fabrication of an accurate definitive cast.[3] In the present study, plastic impression copings and positioning cylinders were used for the CTI technique. Plastic impression copings remaining in the impression may improve accuracy by preventing both impression copings and the coping-analog assembly from rotating within the impression.

From a clinical perspective, the results of this study support the use of polyether and polyvinyl siloxane for completely edentulous multi-implant restorations.[4] The use of polyvinyl siloxane or polyether for direct multi-implant impressions for edentulous arches produces similarly accurate solid implant casts.[5] These results are consistent with findings reported for an indirect implant impression technique. There was no influence of the type of stone on accuracy of the definitive casts in the present study. Certainly, the present study was limited to the change in the horizontal dimension; thus, the change in the vertical dimension was not considered. However, the results showed that there was no significant displacement of the impression copings in the impression.

This experimental design had three independent variables: impression techniques (three levels), impression materials (two levels), and cast materials (two levels). Each level was composed of 20 specimens for impression technique and 30 specimens both for impression and cast materials. This considerable sample size showed the statistical significance between each independent variable, including interaction by general linear model. Although each group had only five specimens created for each combination of impression technique, impression material, and cast material, the authors tried to clarify the differences between factors influencing the reproducibility of the distances between the five implants by stratification. Further studies are needed to evaluate the accuracy between CTI techniques with different impression copings and that of angulated implants with the same protocol used in this study.

Conclusion

Within the limitations of this study, the accuracy of the CTI technique with plastic impression copings and a positioning cylinder was not different from that of the OTI technique with unsplinted and splinted impression copings, regardless of the impression and cast materials used to fabricate the impressions evaluated. Both CTI and OTI techniques are recommended for the fabrication of implant prostheses.

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