Effects of Implant Angulation, Material Selection, and Impression Technique on Impression Accuracy: A Preliminary Laboratory Study

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The aim of this preliminary laboratory study was to evaluate the effects of 5- and 25-degree implant angulations in simulated clinical casts on an impression's accuracy when using different impression materials and tray selections. A convenience sample of each implant angulation group was selected for both open and closed trays in combination with one polyether and two polyvinyl siloxane impression materials. The influence of material and technique appeared to be significant for both 5- and 25-degree angulations ($P < .05$), and increased angulation tended to decrease impression accuracy. The open-tray technique was more accurate with highly nonaxially oriented implants for the small sample size investigated. *Int J Prosthodont 2012;25:512–515.*

Implants with an axial orientation that is not in line with the needs of a prosthetic rehabilitation may occur for various reasons. As a result, the impression procedure may be adversely influenced.

Some studies have suggested the closed-tray impression technique to be the most accurate.[1] However, the majority have shown greater accuracy with an open-tray (pick-up, direct) impression technique.[2–4] Splinting of direct copings is advocated as a measure to reproduce the implant position more precisely. However, resin shrinkage and manipulation remains a concern.[5] Polyether and polyvinyl siloxane (PVS) are commonly used as impression materials. A few studies have indicated the importance of the impression material on accuracy, while others have failed to detect significant differences between PVS and polyether materials.[6] A recent systematic review concluded that further studies are needed to clarify factors associated with implant impression accuracy.[7]

The purpose of this preliminary laboratory study was to evaluate the accuracy of an impression procedure using three techniques and three types of impression materials on a cast with two different implant angulations: 5 and 25 degrees. The null hypothesis was that the impression technique, material, and implant angulation would have no effect on the accuracy of the master casts.

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Materials and Methods

Two reference casts (2 × 2 × 4 cm) were fabricated from duralumin. Two regular/wide EZ Plus (Megagen) implant analogs (13 mm long and 4.1 mm wide) were placed in each cast 2 cm from each other at 5- and 25-degree angulations.

Nine subgroups of impression procedures were investigated with each reference cast (Table 1). Closed- and open-tray impression techniques were employed using the respective manufacturer's recommended impression copings. The abutment technique involved use of multipost regular-size 5-mm-diameter EZ Plus abutments (Megagen) as open-tray impression copings (Fig 1). Screw access holes were blocked with wax and dental burs during the impression procedure to provide access for the screwdriver. Splinting with dental floss and Pattern Resin (GC) was used with the open-tray and abutment techniques (Fig 1). Acrylic resin was applied on both copings and dental floss, leaving a small gap. After 15 minutes, splinting was completed with a small amount of acrylic resin. Five impressions were made for each subgroup. Overall, 90 master casts (type IV stone; Shera Hard Rock, Shera) were fabricated.

Five photographs of each master cast with direct coping screws were taken using a digital camera (Canon EOS 400D, Canon) on a special stand. AutoCAD 2008 (AutoDesk) software was used to measure the change in analog angulation on the digital images, and this was done by one calibrated operator.[8]

Two-way analysis of variance, the Bonferroni post hoc multiple comparison, and a paired samples *t* test were used to determine statistically significant differences ($P < .05$).

Table 1 Impression Procedures Investigated with Both Implant Angulations (5 and 25 Degrees)

Subgroup	Impression technique	Impression material	Adhesive	Mixing technique	Manufacturer
CP OP AP	Closed tray Open tray Abutment	Polyether Impregum Soft Fast Set	Polyether adhesive	Pentamix 3	3M ESPE
CV OV AV	Closed tray Open tray Abutment	Take 1 (PVS) tray and regular body wash	PVS adhesive	Volume mixer	Kerr
CA OA AA	Closed tray Open tray Abutment	Alginot (PVS)	PVS adhesive	Volume mixer	Kerr

PVS = polyvinyl siloxane.

Fig 1 Multipost regular 5-mm-diameter abutments were connected using dental floss and splinted using Pattern Resin in two steps.

Table 2 Mean Angle Change in 5- and 25-Degree Abutments

	5 degrees		25 degrees		
Subgroup	Mean	SD	Mean	SD	*t* test*
CP	–1.00	0.52	–1.47	1.11	0.04
OP	0.47	0.51	0.07	1.21	0.01
AP	0.53	0.98	0.27	0.99	0.24
CV	0.07	1.57	1.07	1.15	0.13
OV	0.40	0.99	–1.07	1.16	0.32
AV	0.67	1.08	1.53	2.09	0.52
CA	–0.73	0.91	1.07	2.40	0.02
OA	–0.80	0.49	0.00	0.64	0.00
AA	0.33	0.83	0.87	0.38	0.04

SD = standard deviation.
*$P < .05$.

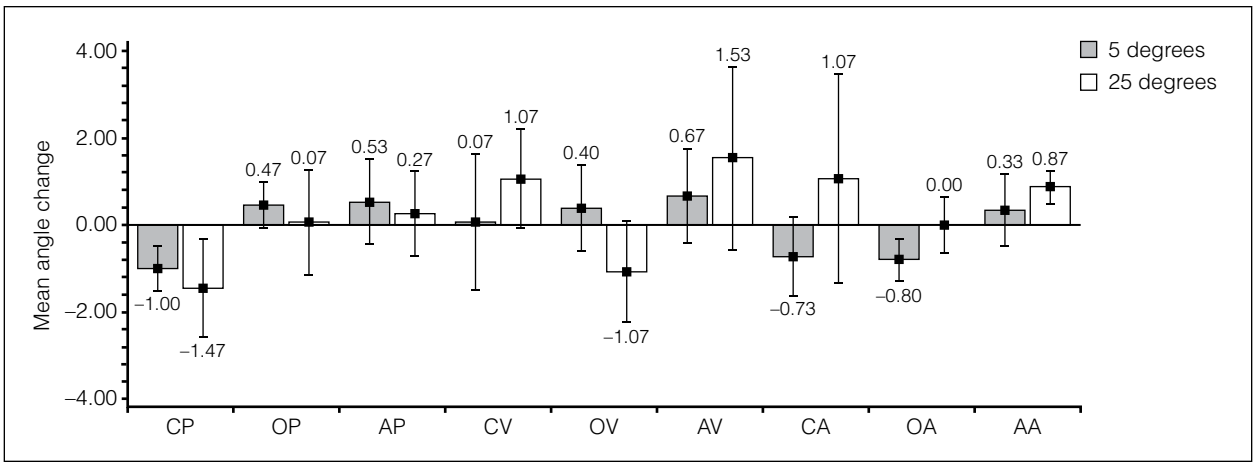
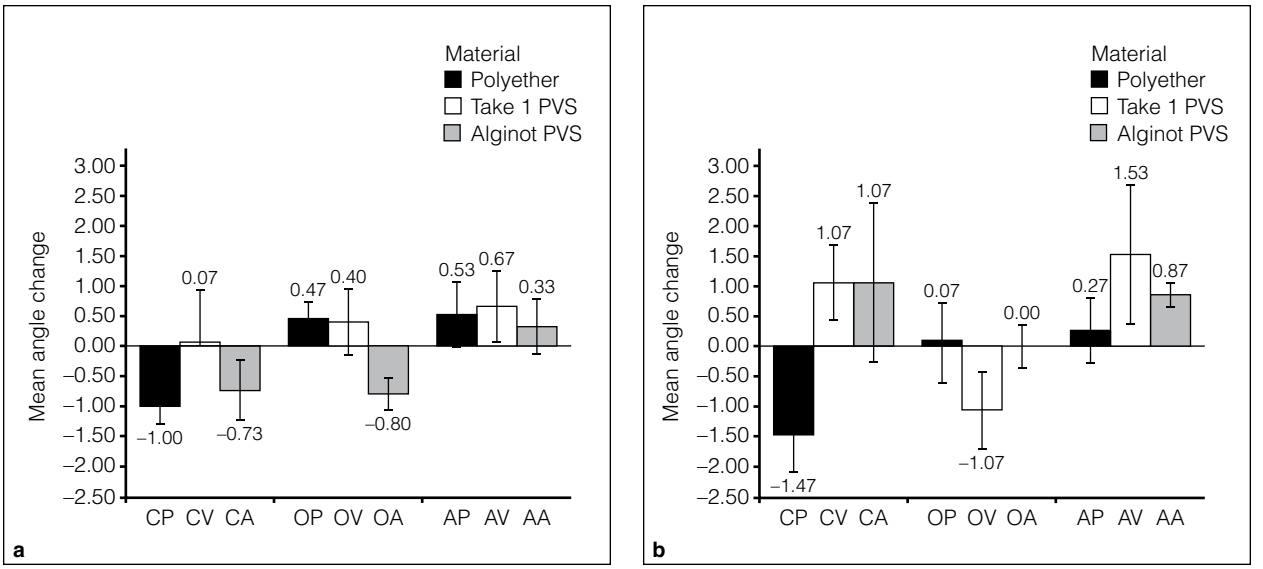


Fig 2 Bar plots comparing implant impression accuracy for 5- and 25-degree angulations (see Table 1 for subgroup acronyms; *t* test).

Results

Mean angle changes between subgroups with 5- and 25-degree angulations are presented in Table 2 and Fig 2. Considering implant analog angle changes in casts with implants at 5-degree angulations, the most accurate impression technique was CV, followed by AA, OV, OP, AP, AV, CA, OA, and CP (Fig 3a).



Figs 3a and 3b Accuracy of different impression techniques and materials with **(a)** 5- and **(b)** 25-degree implant angulations.

Positive mean values reflect an angle increase between both analogs on the master cast as compared with a reference cast and vice versa. For casts with implants at 25-degree angulations, the most accurate was the open-tray technique (OA and OP), followed by AP, AA, CV, OV, CA, CP, and AV (Fig 3b).

Discussion

A power analysis was not carried out to determine the optimal sample size for this study. Hence, the preliminary results must be interpreted with caution. Nonetheless, the results of the two-way analysis of variance suggest rejection of the null hypothesis. The impression technique and material were found to have significant influence on accuracy ($P < .05$).

In the 5-degree angulation group, angle change between the majority of subgroups did not differ significantly. Similarly, other studies failed to detect accuracy differences when nearly parallel implant models were used.[9] Impression technique was found to be a more significant factor (F = 14.7) than impression material (F = 7.8).

In the 25-degree angulation group, the open-tray technique was more accurate than the other techniques (excluding OV). This can be explained by the need to reposition copings with the closed-tray technique and because the abutments are shorter than direct impression copings. In agreement with other authors, no significant differences between impression materials were found,[10] and impression technique and impression material were found to have similar significance.

Increase in the angle between implant analogs (positive mean values) was more pronounced when splinting was utilized. This can be explained by shrinkage of the acrylic resin used for splinting.[7] A decrease in the angle between implant analogs was found more with the closed-tray technique and could be related to impression material distortion during removal and repositioning of the copings.

In this preliminary study, increased angulation tended to decrease impression accuracy. Available data suggest that the negative effect of angulation can be further reinforced by using a greater number of implants.[11]

Conclusions

The inherent limitations of this preliminary laboratory study permit the following conclusions:

- The influence of material and technique on impression accuracy was significant in both the 5- and 25-degree angulations.
- The open-tray technique with splinted impression copings can be recommended for highly unparallel implants.
- The abutment technique produced similar accuracy to the closed-tray technique in the 25-degree angulations, and the accuracy of the Alginot material (CA, OA, and AA subgroups) was comparable to the other impression materials tested.

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Literature Abstract

Mode of birth delivery affects oral microbiota in infants

The aim of this study was to compare oral microbiota by seeking differences in colonization patterns in infants delivered vaginally or by C-section. The human oral microbe identification microarray (HOMIM) was used to detect bacterial taxa. Two hundred seven mothers were included in this study. Mode of delivery (C-section or vaginal), intravenous treatment with antibiotics during delivery, and body weight and length were checked against medical records. The mothers completed a questionnaire on other possible confounders such as health issues (allergy, infections, stomach problems), the infant's use of antibiotics, feeding mode (breast- or bottle-fed), use of a pacifier, and the presence of teeth. Oral biofilm samples were collected by carefully swabbing the cheeks, tongue, and alveolar ridges. Samples were analyzed at the HOMIM microarray facility at The Forsyth Institute, Cambridge, Massachusetts, USA. Hybridization signals were read on a six-level scale (0 to 5), with a lower limit of detection of 10^4 cells. The results of the study showed that higher numbers of taxa were detected among infants delivered vaginally compared with those delivered by C-section, and treatment of the mothers with antibiotics during delivery was not influential on the oral microbiota in 3-month-old infants. The reasons for the differences are unknown, as is whether these differences have a long-term impact on the oral or general health of the child. Possible reasons for differences will likely include the relative influence of host receptor, mucosal, and saliva-immune phenotypes and interactions with environmental exposures.

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