Accuracy of 2 Impression Techniques for ITI Implants

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Purpose: *The aim of this study was to compare the accuracy of casts produced by 2 impression techniques and elastomeric impression materials commonly used for the fabrication of implant-supported fixed prostheses.* ***Materials and Methods:*** *A master model with 4 synOcta ITI implants placed unilaterally in place of the mandibular right central incisor, canine, first premolar, and first molar was constructed. Implant-level impressions were made by direct and indirect techniques. In the direct technique, synOcta impression caps with integral guide screws were used to transfer the implants using a custom-made acrylic resin tray and a polyether impression material (the PE direct technique). In the indirect technique, synOcta plastic positioning cylinders with impression caps were used to transfer the implants with either a custom-made acrylic resin tray and polyether impression material (the PE indirect technique) or with a stock tray with a vinylpolysiloxane impression material (the VPS indirect technique). After impression making, all casts (n = 21) were poured in type IV dental stone. Linear changes in −x or −y direction and numeric and descriptive angular changes between the implants were quantified using a coordinate measuring machine.* ***Results:*** *Seven of 12 distance measurements (6 for −x direction, 6 for −y direction) showed differences between groups ($P < .05$). Of these, 5 were associated with the PE direct versus PE indirect and PE indirect versus VPS indirect, and 3 were associated with PE direct versus VPS indirect. Two implants also showed angular changes but only for the PE indirect technique versus the VPS indirect technique ($P < .05$).* ***Conclusion:*** *The snap-on VPS indirect impression technique using a stock tray, which has the advantages of being clinically convenient and eliminating repositioning after removal of the impression, resulted in dimensional accuracy similar to that achieved with the PE direct technique.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:517–523

Key words: *dental implants, impression materials, impression techniques*

Accurate impression making has been emphasized as a significant element in the obtainment of a passive fit between implants and the superstructure.[1–4] To optimize accuracy, impression copings have been either splinted with acrylic resin or used nonsplinted with certain modifications.[5–8] Regardless of the procedures used, no method has resulted in the achievement of an "absolute" passive superstructure fit.[9–12] Accurate transfer of implant position from the mouth to working casts, therefore, remains a valid objective, of relevance to the obtainment of "optimum" fit between the implant and the superstructure.[9,10]

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There are 2 basic impression techniques used for transferring implant positions from the mouth to working casts; namely, direct and indirect impression techniques. In the direct technique, the impression transfer copings are picked up with the impression when it is removed from the mouth. However, the necessity of unscrewing guide screws retaining the transfer copings before removing the impression can be a disadvantage in clinical practice. In the indirect technique, the impression transfer copings are retained on the implants upon removal of the impression. The procedure is simple, but accurately repositioning the copings into their respective imprints is crucial. Although the indirect impression technique is clinically preferred, the impression copings are frequently not replaced correctly into the impression.[13,14]

Recently, the ITI Dental Implant System (Straumann, Waldenburg, Switzerland) introduced the snap-on impression technique. Positioning cylinders with impression caps placed in the solid-screw ITI implant's transmucosal neck are picked up in

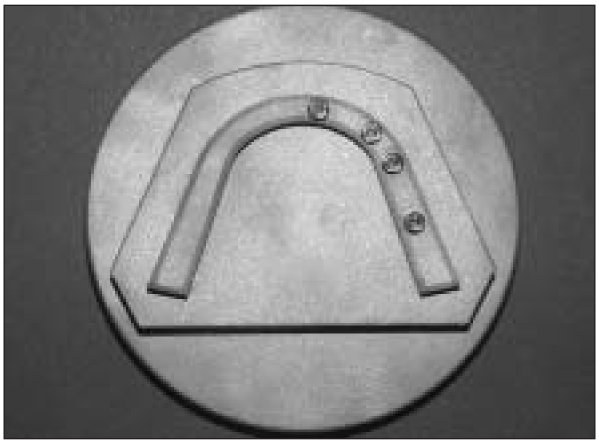


Fig 1 Top view of the master model hosting 4 synOcta ITI implants.

the impression without use of screws. This alternative method seems to combine the advantages of direct and indirect impression techniques. Indeed, this technique is simple and is easily handled in most cases. However, maintenance of the 3-dimensional positioning of cylinders with impression caps in the impression may be a problem during removal of the impression. Therefore, the purpose of this study was to evaluate the precision of the snap-on impression technique for ITI implants.

MATERIALS AND METHODS

A solid aluminum master model (AMM) of an edentulous mandibular arch was machined from a block of aluminum (EN-AW-AlMg1SiCu; Aluminium-Werke Wutöschingen, Wutöschingen, Germany). Four synOcta ITI solid-screw implants (Straumann) were placed unilaterally in the mandibular right central incisor (25[41]), canine (27[43]), first premolar (28[44]), and first molar (30[46]) regions. The locations of implants were determined according to the concept of the treatment of edentulous arches with implant-supported fixed prostheses.[15] Using a milling machine (Paraskop; Bego, Bremen, Germany) with 2.2- and 2.8-mm pilot and 3.5-mm twist drills followed by a 4.1-mm tapping drill, the implant sockets were prepared in the model perpendicular to the horizontal base plane. The 4.1×10-mm synOcta ITI solid-screw implants were then tightened into the sockets with the ratchet (Fig 1).

The distance between centers of the implant aperture in each direction (–x and –y) and the perpendicularity of each implant in comparison to the horizontal crestal plane in the master model were recorded using a coordinate measuring machine (CMM) (Mistral; DEA Brown & Sharpe, Grugliasco, Italy) that incorporated a 1-mm-wide straight probe placed into the measuring heading (Renishaw; DEA Brown & Sharpe) with PC-DMIS 2001 for Windows software (Wilcox Associates, Cadillac, MI). To classify linear changes, the horizontal and vertical distances between implant aperture centers in the horizontal crestal plane were measured separately for each pair of implants (Fig 2a). To evaluate the angular changes, long guide screws that were integrated into the synOcta impression caps were tightened into the implants to demonstrate the central axis of the implants. The perpendicularity of each implant's central axis to the horizontal crestal plane was recorded, and its alignment in –x and –y directions was defined descriptively, eg, 0.627 degrees; x+, y–. These baseline measurements were recorded each time on casts made using different methods and materials (Fig 2b).

The implants were transferred to a total of 21 working casts made by 14 indirect and 7 direct implant-level impressions. In the indirect technique, 7 impressions were made using a custom-made acrylic resin tray (Formatray; Kerr Europe, Basel, Switzerland) and polyether (PE) impression material (Impregum F; ESPE, Seefeld, Germany); the other 7 impressions were made in a stock tray with a vinylpolysiloxane (VPS) impression material (Panasil; Kettenbach Dental, Eschenburg, Germany) using the putty and light body simultaneously. The former will be referred to as the PE indirect technique; the latter will be referred to as the VPS indirect technique. The impression caps were snapped onto the necks of the implants and synOcta plastic positioning cylinders were placed in the impression caps (Fig 3a). While the mixed impression material was injected all around the impression caps, the remaining impression material was loaded into the tray. Then the loaded tray was pressed over the master model and left for 10 minutes for polymerization of the impression material under 2 kg static load.

Upon setting, the impressions, which retained the impression caps and positioning cylinders, were removed, and synOcta implant analogs were placed into the impressions. The impressions were immediately poured into type IV dental stone (Giludur; BK Giulini, Ludwigshafen, Germany), mixed according to the manufacturer's recommendations in a vacuum mixer (Motova SC; Bego). For the direct technique, synOcta impression caps were screwed into the implants, access holes were prepared on top of the custom-made acrylic resin tray, and the impressions were made with PE impression material (Fig 3b). This technique will be referred to as the PE direct technique. Upon the unscrewing of the impression caps, the impression was removed with captured transfer caps, the synOcta implant analogs were attached via

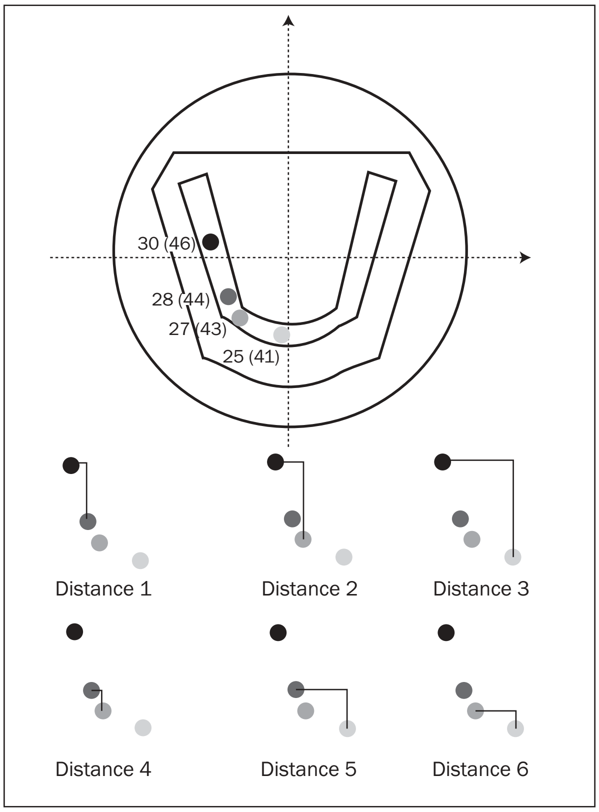
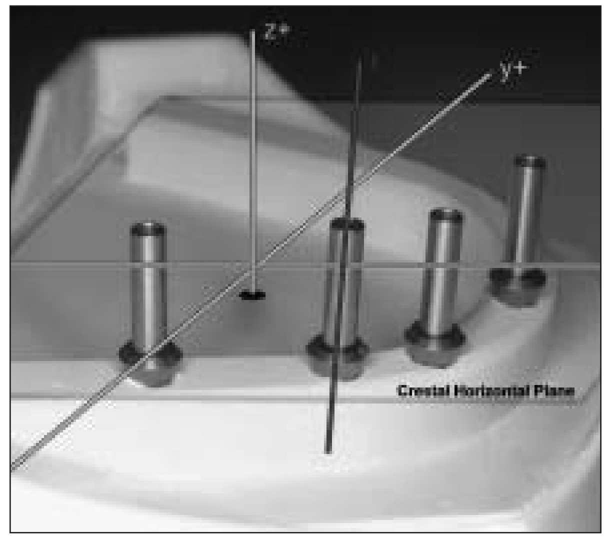
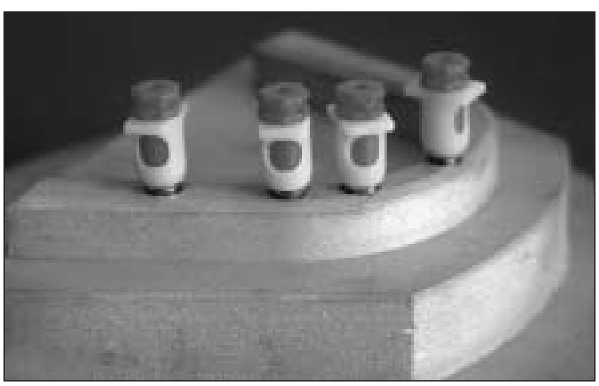


Fig 2a *(Left)* Measurements made of the distances between implants.

Fig 2b *(Below)* Illustration of the angle of an implant (I) in 3 axes (x, y, and z) according to the crestal horizontal plane in a produced cast. The angular changes of all implants in the master model and the produced casts were determined using long guide screws tightened into the implants to reveal the central axes of the implants.





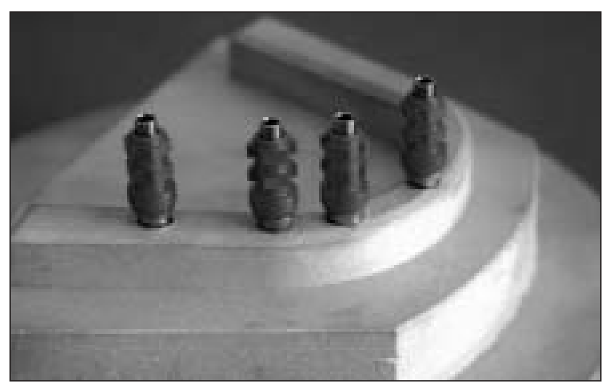
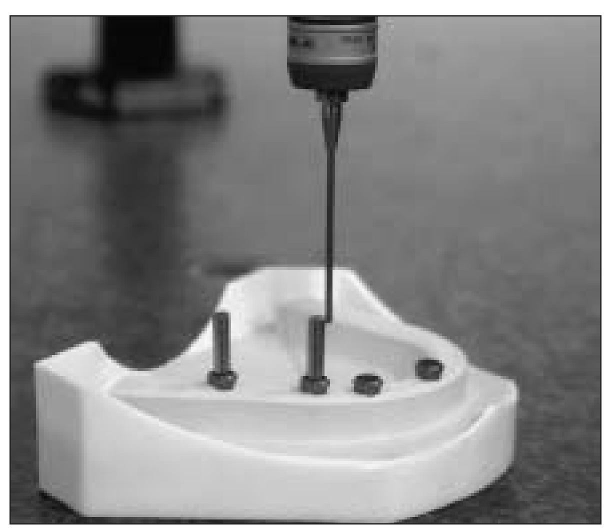


Fig 3a SynOcta plastic positioning cylinders with impression caps placed on the implants in the master model.

Fig 3b *(Top right)* SynOcta impression caps with integral guide screws attached to the implants in the master model.

Fig 4 *(Bottom right)* A 1-mm-wide straight probe in the measuring heading of the CMM. Long guide screws were tightened into the implants to demonstrate the central axes of the implants.



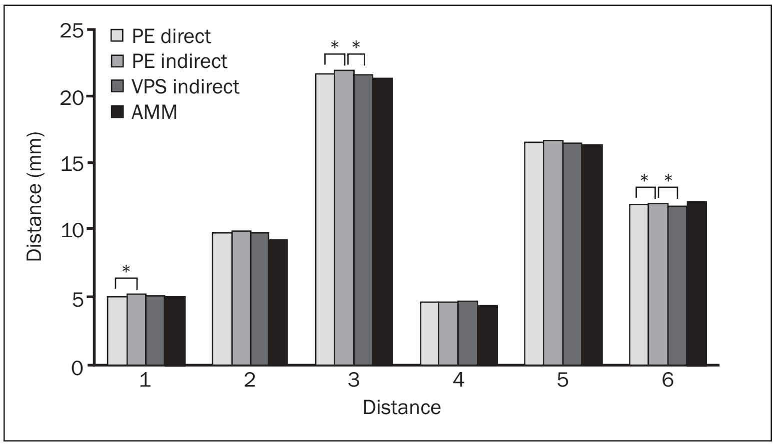


Fig 5a Mean distance measurements in –x direction in the horizontal plane. *Difference between groups is significant ($P < .05$).

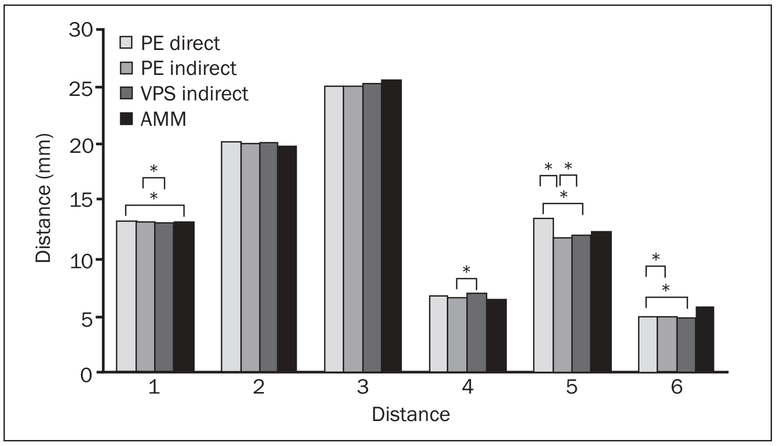


Fig 5b Mean distance measurements in –y direction in the horizontal plane. *Difference between groups is significant ($P < .05$).

integral guide screws, and casts were obtained following the previously described procedure. Finally, the linear and angular measurements performed on the AMM were repeated for all working casts (Fig 4).

Statistical Analysis

The linear measurements in the –x and –y directions and the angular measurements were evaluated separately. The differences between the linear measurements of 6 distances and angular measurements of 4 implant analogs between the impression methods were compared by Kruskal-Wallis tests, followed by Mann-Whitney tests, with significance levels set at $P < .05$.

RESULTS

The linear measurements of 6 distance classifications in the –x and –y directions are presented as means ± standard deviations in Table 1 and Figs 5a and 5b. For the –x direction, significant differences were found between impression methods for distances 1, 3, and 6. The differences between PE direct and PE indirect for distances 1, 3, and 6 and between PE indirect and VPS indirect for distances 3 and 6 were significant ($P < .05$) (Fig 5a). For the –y direction, differences were also found between impression methods for distances 1, 4, 5, and 6. The differences between PE direct and PE indirect for distances 5 and 6; between PE direct and VPS indirect for distances 1, 5, and 6; and between PE indirect and VPS indirect for distances 1, 4, and 5 were significant ($P < .05$) (Fig 5b).

The mean of angulation values to the horizontal crestal plane and the alignment directions are presented in Table 2 and Fig 6. Significant differences were found between PE indirect and VPS indirect impression methods for analogs of the implants in sites 25(41) and 27(43) in numeric angulation measurements ($P < .05$). The inclination of all analogs remained same in all impression methods for the X segment. The inclination of the analogs replaced for 28(44) and 30(46) changed to the opposite side in the Y segment for both PE direct and PE indirect impression methods, while analogs for 25(41) changed to other side in the Y segment for the VPS indirect method. The differences in distance measurements could not be correlated with measured distances (long versus short) or the location (straight versus curved) of the implant.

Table 1 Mean ± SD of Distance Measurements in mm in –x and –y Directions in the Horizontal Plane

	Distance					
	1	2	3	4	5	6
–x direction						
PE direct	5.078 ± 0.076	9.739 ± 0.097	21.615 ± 0.139	4.660 ± 0.083	16.537 ± 0.112	11.877 ± 0.081
PE indirect	5.269 ± 0.140	9.896 ± 0.289	21.876 ± 0.309	4.627 ± 0.162	16.607 ± 0.177	11.980 ± 0.044
VPS indirect	5.142 ± 0.106	9.828 ± 0.153	21.609 ± 0.141	4.687 ± 0.117	16.468 ± 0.103	11.781 ± 0.070
AMM	4.966	9.180	21.149	4.214	16.183	11.969
–y direction						
PE direct	13.457 ± 0.038	20.284 ± 0.167	25.185 ± 0.202	6.827 ± 0.148	13.654 ± 0.298	4.902 ± 0.149
PE indirect	13.423 ± 0.280	20.195 ± 0.250	25.189 ± 0.360	6.772 ± 0.438	11.766 ± 0.163	4.994 ± 0.163
VPS indirect	13.235 ± 0.032	20.172 ± 0.047	25.256 ± 0.036	6.937 ± 0.044	12.022 ± 0.045	5.085 ± 0.055
AMM	13.283	19.820	25.586	6.537	12.303	5.766

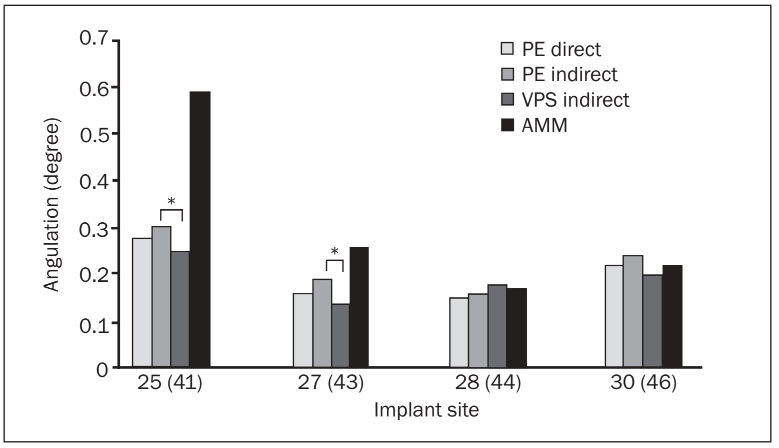


Fig 6 Mean of numeric angulations of the implants to the horizontal crestal plane. *Difference between groups is significant ($P < .05$).

Table 2 Mean Angulation Measurements in Degrees and Description of the Angulation of the Implants

	Tooth			
	25 (41)	27 (43)	28 (44)	30 (46)
Numeric angulation				
PE direct	0.281	0.161	0.151	0.223
PE indirect	0.298	0.190	0.163	0.242
VPS indirect	0.252	0.133	0.175	0.200
AMM	0.585	0.253	0.167	0.215
Descriptive angulation				
PE direct	x+y–	x+y+	x+y–	x+y–
PE indirect	x+y–	x+y+	x+y–	x+y–
VPS indirect	x+y+	x+y+	x+y+	x+y+
AMM	x+y–	x+y+	x+y+	x+y+

DISCUSSION

Mechanical adaptation and biologic seal of mating implant components are 2 major prerequisites for the fabrication of well-fitting implant-supported fixed prostheses. Therefore, priority should be given to impression making for accurate 3-dimensional transfer of implants. In this context, studies related to impression making have focused on impression techniques and/or materials. Impression techniques are based on either the direct or indirect transfer of components, but different impression materials and trays can be used depending on the preferred impression method. A number of alternatives are available for transferring implant positions to a working cast. Although the snap-on impression technique is indirect in nature, it has the advantage of being picked up in the impression material.

Carr[3] compared a direct impression technique to an indirect technique and demonstrated that the direct transfer method produced more accurate casts. Daoudi and colleagues[16] also investigated the accuracy of indirect impression techniques in repositioning either at the implant level or using the abutment-level pickup method and concluded that the indirect pickup technique at the abutment level could be more predictable. Spector and associates[13] reported that dimensional distortions of the resultant positions of transferred abutment analogs were different for these 2 impression techniques. Liou and coworkers[14] compared the accuracy of replacement for 3 different tapered transfer impression copings and concluded that none of the 3 copings could consistently and accurately be replaced into the original position. Vigolo and colleagues[15] investigated the accuracy of unmodified, sandblasted, and adhesive-coated screw-retained pickup transfer copings used for the direct impression technique and reported lower rotational movement for the modified ones. Depending on data analyses, Herbst and associates[17] found that dimensional differences between direct and indirect impression techniques can be clinically negligible. In the light of these studies, it is hard to determine which technique is clinically superior. However, similar outcomes have been reported repeatedly for PE and VPS materials.[1,12,14,18]

This study evaluated the dimensional and angular accuracy of ITI's snap-on impression method used with 2 different impression materials and revealed significant differences in 7 of 12 distance measurements for both –x and –y directions. Further evaluation within these 7 distance measurement groups showed that in 5 distance measurement groups, the differences between the PE indirect and PE direct and between the PE indirect and VPS indirect impression techniques were significant. In 3 distance measurement groups, there was a significant difference between the PE direct and VPS indirect impression methods. For angular differences, implants located at the 25(41) and 27(43) positions showed significant differences in numeric angular changes only between the PE indirect and VPS indirect methods (Fig 6). However, the clinical relevance of these statistically significant differences is questionable and the application of these findings to clinical situations could be a complex task. Despite the differences found, the outcomes using both techniques and impression materials appear to be comparable. This observation is in agreement with previous studies.[1,13,16] The similarity in outcome between the PE direct and VPS indirect impression techniques may imply that the snap-on pickup impression technique used with a stock tray and VPS impression material is an effective method. Because the bulk of the impression material surrounding the impression copings is relatively thicker in stock impression trays, the impression material can easily withstand pull-out forces. Thus, from a clinical point of view, impression making with a stock tray and VPS can be an efficient and cost-effective method and will likely result in well-fitting superstructures. Further studies are required to elucidate the effects of impression material thickness as well as the outcome of these impression techniques on superstructure fit.

CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. The outcomes achieved with the direct and indirect impression techniques were similar, as were the outcomes achieved using PE and VPS impression materials.
2. The positional and angular accuracy of ITI's snap-on impression technique using a stock tray with VPS impression material was acceptable, and this method was found to be convenient for multiple implant transfer in this model series.

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