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RESEARCH AND EDUCATION

Conventional open-tray impression versus intraoral digital scan for implant-level complete-arch impression

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ABSTRACT

Statement of problem. The best-fit method is frequently used to evaluate the accuracy of different implant impression techniques. However, the method includes inherent superimposition errors, which may accumulate and become more exaggerated in complete-arch impressions.

Purpose. The purpose of this in vitro study was to evaluate and compare the trueness and precision of conventional open-tray impressions and intraoral digital scans at the implant level in an edentulous maxillary model with 6 implant replicas without superimposition.

Material and methods. A master model was fabricated using epoxy resin by duplicating a maxillary edentulous cast that had 6 implant replicas in the right first molar, right first premolar, right lateral incisor, left lateral incisor, left first premolar, and left first molar positions. The conventional open-tray, splinted-coping impression technique was used to fabricate 10 definitive casts (group CI). Intraoral digital scans were performed, after which scan bodies were connected to each implant replica to fabricate 10 digital models (group IOS). For the master model and group CI, a computerized coordinate-measuring machine was used to determine the 3D spatial orientation of the implant replicas. For group IOS, the scan bodies were converted to implant replicas using a digital library, and an inspection software program was used to measure the implant replicas. To compare the accuracies of different impression techniques, a 3D part coordinate system was set to compute the centroid and projection angles of each implant replica. The changes in the centroid coordinates (linear displacement: Δx, Δy, Δz, and ΔD; $\Delta D=\sqrt{\Delta x^2+\Delta y^2+\Delta z^2}$) and projection angles onto XY and ZX planes (angular displacement: ΔθXY and ΔθZX) were statistically compared (α=.05).

Results. Group CI gave more accurate trueness values than group IOS for overall Δx (P<.001), Δy (P =.029), Δz (P<.001), and ΔD (P<.001). Furthermore, group CI had more accurate precision values for Δx, Δy, and Δz. Group IOS exhibited a statistically greater angular displacement in the ZX plane (P=.002), but the difference was only 0.24 degrees. No differences were found between the 2 groups for the angular displacement in the XY plane (P=.529).

Conclusions. Conventional open-tray impressions produced significantly smaller linear displacements than the digital scan obtained using an intraoral scanner at the implant level in a complete-arch model. (J Prosthet Dent 2019;122:543-9)

For the long-term success of an implant prosthesis, an accurate definitive cast must be fabricated which exactly replicates the intraoral location of the implants.[1] Different impression techniques have been used to fabricate accurate definitive casts.[2] A systematic review of the accuracy of implant impressions concluded that greater accuracy is achieved by splinting impression copings for internal-connection implants and that direct impressions produce more accurate definitive casts than indirect impressions when the number of implants is 4 or more.[3] A recent critical review reported that the results obtained by splinting copings are consistently accurate for external-connection implants but are inconsistent for internal-connection implants.[2] Unlike tooth impressions, implant impressions encounter inherent possible displacements of components, whereas impression copings are connected to implants or replicas.[4,5] Because of the inherent displacements caused by the connection of components, greater errors could be accumulated in impressions of multiple implants than in impressions of single implant.

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Clinical implications

The conversion of scan bodies to implant replicas using a digital library could cause linear and angular displacements of the implant replicas; therefore, the conventional open-tray impression technique is recommended for implant-level, 1-piece complete-arch prostheses.

The introduction of intraoral scanners has impacted clinical dentistry, and the accuracy of intraoral scanners has been evaluated.[6-8] Furthermore, the development of scan bodies has made it easier for clinicians to record implant locations, and patients feel more comfortable when the scanners are used than when conventional impressions are made.[9,10] From the perspective of accuracy, the use of an intraoral scanner can reduce the number of connecting procedures; therefore, its use might minimize the amount of unavoidable component displacement. The accuracy of complete-arch implant impressions obtained using intraoral scanners has been evaluated. Vandeweghe et al[11] compared the accuracy of the digital scan of an edentulous mandible with 6 implants obtained using 4 different intraoral scanners and reported that the mean trueness ranged between 28 and 112 μm and that 3 of the 4 intraoral scanners were considered suitable for recording implant locations for a complete-arch prosthesis. Papaspyridakos et al[12] evaluated the accuracy of an intraoral scanner using 5 implants in an edentulous mandible model and concluded that the accuracy of the intraoral scanner was comparable with that of the conventional direct implant impression technique. In previous studies, the master model with scan bodies was digitalized using a high-resolution industrial scanner, and then, digital images obtained using intraoral scanners were superimposed on the digital image of the master model using the best-fit method.[13,14] The best-fit method inherently includes superimposition errors; therefore, Güth et al[15] recommended that the best-fit method be used for the evaluation of only partial-arch models to minimize the accumulation of superimposition errors. Moreover, previous studies have not evaluated the position of implants but the position of scan bodies on the implants.[11-14] As mentioned previously, connecting components themselves could introduce displacements[16]; therefore, the comparison of the scan body positions performed in the previous studies may not replicate clinical and laboratory procedures.

The present study did not compare the scan body positions but the exact positions of the implant replicas in the master model, the definitive casts obtained using conventional open-tray implant impressions, and the digital models obtained by intraoral digital scans. The tested null hypothesis was that no difference would be found in the accuracy of implant-level impressions between conventional open-tray impressions and intraoral digital scans in a maxillary complete-arch model.

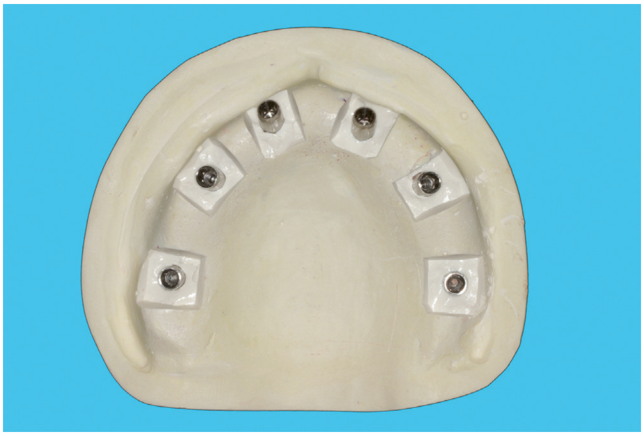

Figure 1. Master model with 6 implant replicas in right first molar, right first premolar, right lateral incisor, left lateral incisor, left first premolar, and left first molar positions.

MATERIAL AND METHODS

A diagnostic cast of a maxillary edentulous patient was chosen to fabricate a master model (control standard) for the present study. A tungsten carbide bur (H 356 RGE 103.031; Komet Dental) was used to make 6 holes (diameter: 5 mm; length: 12 mm) at the locations of the right lateral incisor, right first premolar, and right first molar and at the corresponding contralateral tooth positions. During hole preparation, attempts were made to direct each hole toward the longitudinal axis of each residual ridge. An implant replica (IU analogue; Warantec) was inserted into each hole and fixed using Type IV dental stone (MG Crystal Rock; Maruishi). Efforts were made to locate the platforms of implant replicas at an equicrestal level. An implant-level impression coping (IU pickup impression coping; Warantec) was connected to each implant replica, and then, an open-tray impression was made using low-viscosity silicone impression material (Aquasil XLV; Dentsply Sirona) and high-viscosity silicone impression material (Aquasil EasyMix Putty; Dentsply Sirona) in a prefabricated plastic tray (DentiAnn Plastic Tray; Seil Global). After the impression material had completely polymerized, guide pins were loosened, and the impression tray was removed from the cast. An implant replica was connected to each impression coping, and then, artificial soft tissue (GI-MASK; Coltène) was formed around each impression coping–implant replica complex. Epoxy resin (Poly U rock; Cendres+Métaux) was mixed according to the manufacturer's instructions, poured into the impression,

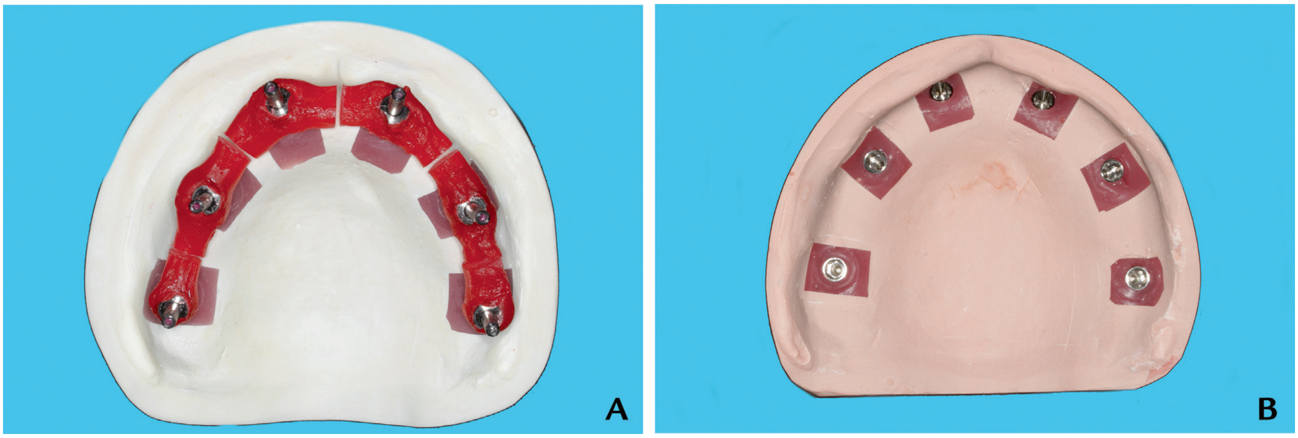

Figure 2. A, Impression copings splinted with autopolymerizing acrylic resin. B, Definitive cast.

and left for 12 hours until it had completely polymerized (Fig. 1).

The present study evaluated 2 different impression techniques: the conventional open-tray impression technique (group CI) and intraoral digital scan (group IOS). Throughout the study, a manual torque wrench (046.049, torque control device for rachet; Straumann) was used to screw and unscrew impression copings, implant replicas, and scan bodies with 15 Ncm torque. For group CI, a pickup impression coping was connected to each implant replica of the master model, and the copings were splinted using autopolymerized acrylic resin (Pattern Resin LS; GC Intl) and left for 10 minutes for complete polymerization. Then, the resin splint was sectioned and rejoined to minimize polymerization shrinkage and strain in the splint. A custom tray was fabricated using autopolymerized acrylic resin (Fastray; Keystone Industries), and the same tray was used 10 times for group CI. Tray adhesive was applied 10 minutes before making the impression, and the definitive impression was made using the custom tray and medium-viscosity polyvinyl siloxane impression material (Aquasil Monophase; Dentsply Sirona). After 10 minutes, the definitive complete-arch impression was recovered from the master model, and implant replicas were connected to the copings. Artificial soft tissue was applied and trimmed. Type IV dental stone (MG Crystal Rock) was mixed according to the manufacturer's instruction and poured into the impression to fabricate a definitive cast. Ten definitive casts were fabricated using this conventional open-tray implant impression procedure (Fig. 2).

For group IOS, an intraoral scanner (TRIOS 3; 3Shape) and scan bodies (TruScan body; TruAbutment) were used to fabricate 10 digital models. The digital scan was started from the occlusal aspect of the scan body at the right molar area, continued to the scan body at the contralateral left first molar area, then to the palatal aspects of the scan bodies, and finally to the buccal aspects of the scan bodies. This sequence was recommended by the manufacturer. The master model was scanned without scan bodies first, and then the master model was scanned again after connecting a scan body to each implant replica. Dental computer-aided design (CAD) design software (exocad DentalCAD; exocad) was used to fabricate a digital model by superimposing the 2 scan images, and the scan bodies were converted to implant replicas using a digital library. To facilitate measurement, all scan images except implant replica images were hidden in the digital model and saved as a standard tessellation language (STL) file. These procedures were repeated 10 times to fabricate 10 digital models (Fig. 3).

A computerized coordinate-measuring machine (Contura; Zeiss) and geometry-measuring software program (Calypso; Zeiss) were used to measure and compute the 3D position of implant replicas in the master model and group CI. The coordinate-measuring machine has an accuracy of 0.7 μm, with a repeatability of 0.55 μm, and was calibrated before every measurement. A 3D inspection software program (Geomagic Control 2015; 3D Systems) was used to compute the position of implant replicas in group IOS. To compute the centroid and long axis of each implant replica, a part coordinate system was defined as follows. The centroid of the implant replica at the right lateral incisor was set as the origin (0, 0, 0), and the XY plane was set by the centroids of implant replicas at the right first molar, left first molar, and right lateral incisor. A straight line that passed through the centroids of both implant replicas at the right lateral incisor and the right first molar was assigned as the x-axis (Fig. 4).

Accuracy consists of trueness and precision.[17] In the present study, trueness was defined as the amount of linear and angular displacements of each implant replica between the master model and test groups (group CI and group IOS). The amount of linear displacement was represented by the amount of centroid coordinate difference in absolute values (Δx, Δy, and Δz). The amount

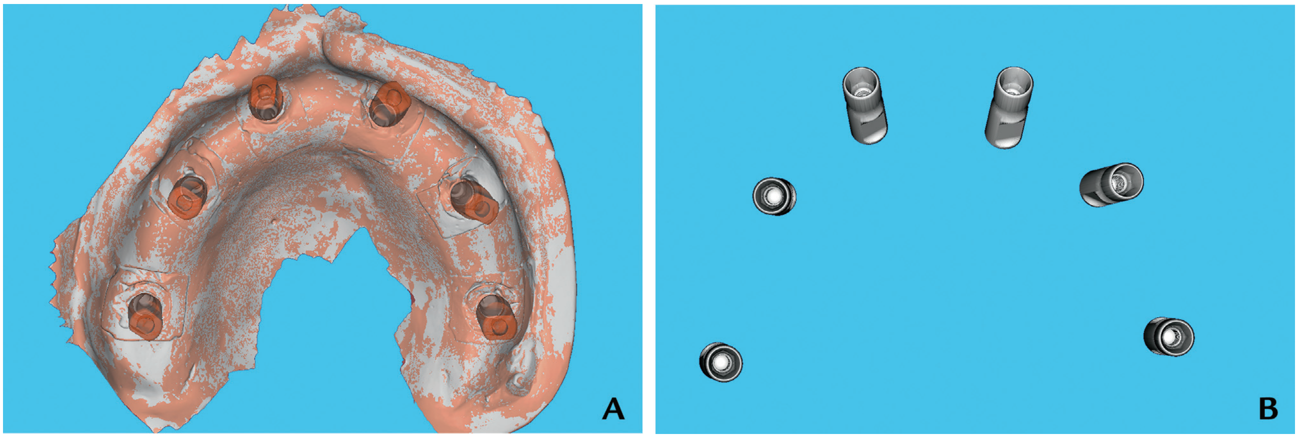

Figure 3. A, Superimposition of intraoral images with or without scan bodies. B, Scan bodies converted implant replicas using digital library; other images except implant replicas hidden for convenience of measurement.

of overall 3D displacement was represented by ΔD, $\Delta D = \sqrt{\Delta x^2+\Delta y^2+\Delta z^2}$. Angular displacement was evaluated using the long-axis angles of the implant replicas. The long axes were projected onto the XY and ZX planes, and the projection angles were expressed as θXY and θZX. The absolute differences between the master model and test groups were represented as ΔθXY and ΔθZX.

Precision is described as the degree of closeness between repeated measurements.[17] Precision values were calculated according to the coordinate difference between 10 specimens in the same test group; therefore, each x, y, and z coordinate had 45 values, and the absolute values were used for statistical comparison.

Statistical evaluation was performed using an analysis software program (IBM SPSS Statistics, v22; IBM Corp). A Levene test was performed first to estimate the normality of data distribution and showed that the data were not normally distributed. A Mann-Whitney U test was performed to evaluate the significance between group CI and group IOS (α=.05 for linear and angular displacements).

RESULTS

The linear and angular displacements of each implant replica were evaluated to compare the accuracies of group CI and group IOS. Table 1 lists the absolute trueness values of each centroid's linear displacement in the x-, y-, and z-axis directions (Δx, Δy, and Δz) and the total amount of 3D displacement of each centroid (ΔD). Group CI resulted in more accurate trueness values in the x-, y-, and z-axis directions than group IOS ($P<.05$), except the Δx of the implant replica at the right first molar and the Δy and Δz of the implant replica at the left first premolar. All the ΔD values for group IOS were also significantly greater for all implant replica positions, except for the implant replica at the right first molar.

Table 2 lists the absolute precision values for the conventional open-tray impression technique and intraoral digital scan. Group CI produced more accurate precision values than group IOS ($P<.001$).

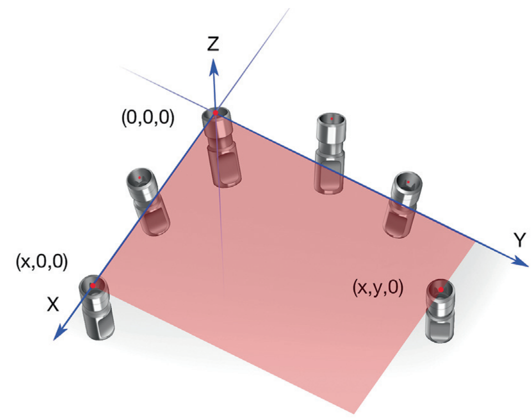

Figure 4. Three-dimensional part coordinate system used.

Table 3 lists the absolute angular displacement of the projection angles onto the planes XY and ZX. Significant differences were found in the projection angles of the right lateral incisor onto the XY plane ($P=.004$) and the projection angles of the left first premolar and first molar onto the ZX plane ($P=.002$ and $P=.007$). However, the differences in angular deviation were less than 1 degree, which was not considered clinically significant.

DISCUSSION

The results of the present study showed that the conventional open-tray implant impression technique produced more accurate absolute trueness and absolute precision values than intraoral digital scanning for most implant replica positions. Therefore, the null hypothesis was rejected.

Previous studies have reported promising results for the accuracy of intraoral scanners for complete-arch implant impressions. Papaspyridakos et al[12] compared

Table 1. Median (Q1, Q3) of absolute trueness values of linear displacement of centroids (Δx, Δy, and Δz) and 3D total linear displacement (ΔD) (μm)

Implant Replica Positions	Δx			Δy			Δz			ΔD		
	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v
IR-RMo	56.2 (50.4, 66.7)	127.7 (12.0, 185.0)	.529							56.2 (50.4, 66.7)	127.7 (12.0, 185.5)	.529
IR-RPm	36.8 (15.7, 57.3)	132.0 (107.3, 140.8)	.001*	10.8 (7.4, 16.8)	52.3 (32.3, 91.5)	<.001*	8.5 (6.2, 9.7)	31.6 (10.8, 51.0)	.023*	39.9 (19.8, 67.7)	158.1 (136.8, 179.5)	<.001*
IR-LLa	20.3 (11.9, 33.8)	81.0 (51.9, 117.6)	.001*	48.2 (33.9, 68.1)	111.1 (70.9, 152.1)	.009*	12.8 (5.9, 26.3)	48.0 (25.9, 90.0)	<.009*	52.9 (37.7, 89.2)	172.4 (123.2, 176.6)	.001*
IR-LPm	13.6 (6.4, 18.8)	139.7 (74.2, 279.9)	<.001*	70.1 (50.0, 81.6)	132.6 (50.2, 187.9)	.218	30.9 (28.1, 36.3)	31.7 (8.6, 62.9)	<.853	85.9 (74.5, 88.6)	216.8 (135.5, 348.8)	<.001*
IR-LMo	26.2 (12.7, 38.2)	257.3 (127.2, 384.9)	<.001*	103.3 (87.4, 124.8)	393.2 (243.0, 491.6)	<.001*				110.4 (92.5, 127.4)	472.7 (301.8, 625.3)	<.001*
overall	30.7 (11.7, 51.2)	125.8 (70.2, 200.9)	<.001*	54.8 (18.6, 87.4)	131.9 (59.3, 221.5)	<.001*	16.6 (8.0, 31.1)	36.5 (14.0, 66.1)	<.01*	72.2 (48.7, 90.7)	177.4 (133.3, 275.9)	<.001*

IR-LLa, implant replica in left lateral incisor position; IR-LMo, implant replica in left first molar position; IR-LPm, implant replica in left first premolar position; IR-RMo, implant replica in right first molar position; IR-RPm, implant replica in right first premolar position; Q1, 25% quantile; Q3, 75% quantile. Mann-Whitney test compared medians between groups CI and group IOS (α=.05). * Statistically significant (*P*<.05).

Table 2. Median (Q1, Q3) of absolute precision values in x-, y-, and z-axis directions of each centroid (μm)

Implant Replica Positions	Δx			Δy			Δz		
	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v
IR-RMo	13.2 (9.9, 25.1)	117.0 (57.4, 178.3)	<.001*						
IR-RPm	26.5 (11.4, 40.5)	59.7 (26.0, 79.0)	<.001*	8.7 (4.7, 11.1)	47.7 (25.9, 86.4)	<.001*	4.5 (2.4, 9.5)	31.5 (18.9, 53.3)	<.001*
IR-LLa	15.7 (8.0, 28.5)	41.8 (23.6, 72.8)	<.001*	34.6 (19.9, 52.8)	58.3 (31.3, 99.6)	<.001*	14.2 (6.6, 25.3)	39.0 (17.0, 80.5)	<.001
IR-LPm	10.4 (6.6, 19.3)	156.0 (65.4, 269.3)	<.001*	26.5 (14.0, 36.1)	105.9 (47.4, 155.6)	<.001*	9.0 (5.3, 17.1)	33.4 (15.9, 64.3)	<.001*
IR-LMo	24.5 (11.3, 36.0)	176.2 (121.1, 331.9)	<.001*	25.7 (17.6, 42.4)	183.4 (97.7, 273.8)	<.001*			

IR-LLa, implant replica in left lateral incisor position; IR-LMo, implant replica in left first molar position; IR-LPm, implant replica in left first premolar position; IR-RMo, implant replica in right first molar position; IR-RPm, implant replica in right first premolar position; Q1, 25% quantile; Q3, 75% quantile. Mann-Whitney test compared medians between groups CI and group IOS (α=.05) . * Statistically significant (*P*<.05).

Table 3. Median (Q1, Q3) of absolute angular deviation of the long-axis projection angles in XY and YZ planes (degree)

Implant Replica Positions	ΔθXY			ΔθZX		
	Group CI	Group IOS	*P* v	Group CI	Group IOS	*P* v
IR-RMo	6.44 (3.07, 9.18)	0.25 (1.17, 6.01)	.28	0.47 (0.15, 0.70)	0.32 (0.17, 0.60)	.739
IR-RPm	0.92 (0.53, 1.11)	1.38 (0.75, 3.33)	.315	0.21 (0.12, 0.35)	0.34 (0.18, 0.86)	.247
IR-RLa	0.10 (0.04, 0.22)	0.70 (0.50, 1.10)	.004*	0.23 (0.20, 0.37)	0.34 (0.26, 0.64)	.247
IR-LLa	0.22 (0.12, 0.51)	0.49 (0.23, 0.89)	.165	0.23 (0.15, 0.33)	0.22 (0.08, 0.57)	.796
IR-LPm	0.83 (0.50, 1.02)	2.61 (0.69, 5.85)	.063	0.17 (0.07, 0.50)	1.08 (0.46, 1.64)	.002*
IR-LMo	4.22 (3.32, 8.34)	10.01 (7.97, 12.74)	.075	0.23 (0.16, 0.31)	0.87 (0.52, 1.03)	.007*

IR-LLa, implant replica in left lateral incisor position; IR-LMo, implant replica in left first molar position; IR-LPm, implant replica in left first premolar position; IR-RMo, implant replica in right first molar position; IR-RPm, implant replica in right first premolar position; Q1, 25% quantile; Q3, 75% quantile. Mann-Whitney test compared the median between groups CI and group IOS (α=.05). ΔθXY denotes absolute value of different projection angles between master model and each test group in XY plane. ΔθZX denotes absolute value of different projection angles between master model and each test group in ZX plane. * Statistically significant (*P*<.05).

the accuracies of complete-arch implant impressions by using different impression techniques and concluded that the accuracy of intraoral digital scanning was comparable with that of the master model and the conventional open-tray impression technique. Furthermore, a recent study reported that 2 intraoral scanners produced more accurate complete-arch implant impressions than the conventional open-tray impression technique.[13] The results of the present study are not consistent with these studies. In the present study, intraoral digital scanning produced significantly greater values of Δx, Δy, Δz, and ΔD for most implant replica positions.

The present study used a different experimental design than previous studies. First, the present study evaluated the 3D displacements of implant replicas, and not those of scan bodies. Previous studies converted physical models (the definitive casts fabricated by the conventional impression and master model) to digital models (standard tessellation language files). Before digitalizing the physical models, scan bodies were connected to the implants or implant replicas, and the position of the scan bodies was evaluated by using the best-fit method to compare the accuracy. As the best-fit method superimposed the 2 different digital images to be best fitted, superimposition errors were inevitable. Considering the inherent superimposition errors, Güth et al[15] suggested that the best-fit method was adequate for short-span evaluation but was not appropriate for complete-arch comparison. To avoid the use of the superimposition technique, 2 different evaluation methods were used in the present study: a method using a coordinate-measuring machine for physical models and a method using a digital inspection software program for digital models. By using physical and digital geometric analyses, the physical models were not digitalized, and there was no need to connect the scan bodies to the implant replicas.

However, inherent errors also arise while converting scan body positions to implant replica positions by using a digital library. Chia et al[16] suggested that the mathematical conversion of a scan body to an implant replica should satisfy the following assumptions between the 2 mating components: perfect fit, perfect coaxiality, and perfect mating surface. They also reported that up to 7 μm of machining tolerance was observed in scan body positions and that the vertical position of each scan body centroid was influenced by the amount of tightening force.[16] The vertical displacement caused by the tightening force could be minimized in external-connection implants or abutment-level impressions. Chia et al[16] used a milled aluminum block to establish a coordinate system. The present study used 3 centroids of implant replicas to establish a 3D part coordinate system; therefore, the amount of displacement could have been exaggerated when the scan bodies and implant replicas did not have a perfect fit, coaxiality, and a perfect mating surface. However, as reported in the previous studies, the amount of displacement of components due to machining tolerance cannot be controlled by clinicians.[4] However, intraoral digital scanning needs only 1 connecting procedure, unlike the conventional implant impression technique that requires 2 connecting procedures.

Considering the results of previous studies comparing the accuracies of intraoral scanners using scan body positions, intraoral scanners could be used for complete-arch scanning.[12,13] Some problems need to be solved while converting scan bodies to implant replicas in the CAD software, especially in the case of 1-piece fixed, complete-arch prostheses. However, this technique should be evaluated and improved considering that implant prostheses were fabricated on the implant or abutment replicas and not on the scan bodies.

The second difference in the current experimental design was the scan area. The present study used widespread implant replicas in the entire edentulous maxillary region, whereas the implant positions in previous studies were limited to the interforaminal areas. The interimplant distances in the present study were longer than those in the previous studies. Modern video-type intraoral scanners have a small scanning head and require a large number of images to construct a digital model. A larger scanning field could introduce greater superimposition errors. Su and Sun[6] compared the repeatability of an intraoral scanner and a laboratory scanner and concluded that the intraoral scanner was not suitable for complete-arch scanning.

Further studies should be conducted with an increased number of specimens, abutment-level impressions, or external-connection implants to prevent the vertical displacement of scan bodies. In addition, more refined scan bodies should be used to confirm the accuracy of complete-arch implant impressions obtained using intraoral scanners.

CONCLUSIONS

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

1. The intraoral digital scan resulted in less accurate trueness than the conventional open-tray impression technique in terms of overall Δx, Δy, Δz, and ΔD ($P<.01$).
2. The conventional open-tray impression technique resulted in more accurate precision than the intraoral digital scan for all the implant replica locations ($P<.001$).
3. The conventional open-tray impression technique produced significantly smaller angular deviations than the intraoral digital scan in 3 of 12 projection angles ($P<.05$); however, the amount of angular displacement was less than 1 degree.

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Noteworthy Abstracts of the Current Literature

Patient-reported outcomes of maxillary edentulous patients wearing overdentures retained by two implants from insertion to 4 years

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Purpose. This cohort study evaluated patient satisfaction for maxillary implant-retained overdentures (IODs) on two implants up to 4 years and assessed the treatment effect over time.

Material and methods. Patients encountering problems with their conventional dentures were included and received maxillary IODs on two titanium-zirconium implants and ball anchors in the canine area. Patient satisfaction was assessed using the oral health impact profile (OHIP-20E) questionnaires both for dentures and IODs. Two months after insertion of IODs (baseline), the patients chose the preferred overdenture design with full or reduced palatal coverage. OHIP-20E questionnaires were followed according to the individual choice at 1 and 4 years, and outcomes were compared with baseline.

Results. Sixteen out of 21 patients were evaluated at a mean follow-up of 4 years (range: 2.4 to 4.8 years). There was no significant difference in the OHIP domains for IODs at 1 year ($OHIP_{\_total\_1y}$: 9.5, SD: 13.0) and 4 years ($OHIP_{\_total\_4y}$: 14.2, SD: 19.1) compared with baseline ($OHIP_{\_total\_BL}$: 12.4, SD: 14.7). Patients were most satisfied with social disability both for IODs ($OHIP_{\_BL}$: 6.0, SD: 7.6; $OHIP_{\_1y}$: 3.4, SD: 5.4; $OHIP_{\_4y}$: 5.7, SD: 9.5) and dentures ($OHIP_{\_CD\_old}$: 28, SD: 29.7; $OHIP_{\_CD\_new}$: 25.4, SD: 28.67). Patients were least satisfied with functional limitation both for IODs ($OHIP_{\_BL}$: 6.0, SD: 7.6; $OHIP_{\_1y}$: 3.4, SD: 5.4; $OHIP_{\_4y}$: 5.7, SD: 9.5) and dentures ($OHIP_{\_CD\_old}$: 28, SD: 29.7; $OHIP_{\_CD\_new}$: 25.4, SD: 28.67).

Conclusions. Patient satisfaction with maxillary IODs on two implants did not change from baseline to 4 years and was high at 4 years of function.