

Accuracy of Digital Impressions Obtained Using Six Intraoral Scanners in Partially Edentulous Dentitions and the Effect of Scanning Sequence

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Purpose: To compare the accuracy of six intraoral scanners in two different partially edentulous maxillary models and to evaluate the effect of scanning sequence on accuracy. **Materials and Methods:** Maxillary Kennedy Class I and Class IV situations were used as reference models. The reference datasets were obtained by scanning the models using a highly accurate industrial scanner (ATOS Core 80, GOM). The following six intraoral scanners were evaluated: Trios 3 (3Shape), iTero Element 2 (Align Technology), Emerald (Planmeca), CEREC Omnicam (Dentsply Sirona), CEREC Primescan (Dentsply Sirona), and Virtuo Vivo (Dental Wings). A total of 120 scans from both models were obtained using the six intraoral scanners and divided into two groups based on scanning sequence. Accuracy was evaluated by deviation analysis using 3D image processing software (Geomagic Studio 12, 3D Systems). Kruskal Wallis and Mann-Whitney *U* tests were performed ($P \leq .05$) for statistical analysis. **Results:** There were significant differences in the accuracy of digital impressions among intraoral scanners and scanning sequences. The trueness of the Trios scanner and the precision of the Trios, Primescan, and iTero scanners were significantly higher than for the other scanners. The Emerald had the lowest accuracy among the six intraoral scanners tested. Accuracy was affected by scanning sequence when using the Virtuo Vivo, Emerald, Primescan, and iTero. **Conclusion:** In Kennedy Class I and Class IV partially edentulous cases, it is useful to consider that the intraoral scanner used may affect the accuracy of the digital impression. *Int J Prosthodont* 2021;34:101–108. doi: 10.11607/ijp.6834

The use of digital technology in dentistry has been increasing in recent years. CAD/CAM systems have been used in the fabrication of fixed and removable dentures. The use of CAD/CAM techniques for the manufacturing of removable partial dentures (RPDs) was limited before an additive material manufacturing technique and a specific software for denture design were developed.¹ Nowadays, RPD frameworks are fabricated by using the additive material manufacturing technique,^{1–3} and CAD/CAM systems have been used in a combined analog-digital workflow or in a completely digital workflow. In the completely digital workflow, an intraoral digital scanner is used to obtain a digital model.²

It is necessary to take digital impressions that accurately reproduce the surface structure of the scanned area in order to fabricate dentures with excellent fit.⁴ There are two different structures that need to be accurately scanned for partially edentulous dentitions: the teeth and the edentulous area. The teeth have a more complex geometric shape than the edentulous area; thus, the acquired images from the teeth can be stitched together with less error.⁵ However, long edentulous areas with smoother surfaces make it difficult to obtain accurate scans because of a difficult stitching process, lack of clear anatomical landmarks, and poorly differentiated structures.^{6–9} Therefore, new hardware and software developments aim to increase the accuracy of digital impressions.

Accuracy is specified as “trueness” and “precision.” Trueness is the closeness of agreement between the mean value obtained from a large series of test results and

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an accepted reference value, while precision is the closeness of agreement between independent test results obtained under stipulated conditions, according to the International Organization for Standardization (ISO 5725-1:1994).¹⁰ In other words, precision is reproducibility, while trueness is closeness to reality. The real dimensions of the scanned subject must be known to achieve trueness measurements. *In vitro* studies^{11–14} have commonly used a highly accurate industrial or laboratory scanner as a reference scanner, but trueness measurements cannot be performed *in vivo* because a digital reference dataset cannot be obtained.¹⁵

There are only a few studies on the accuracy of digital impressions for a partially edentulous dentition in the literature. In a previous study,⁴ the accuracy of intraoral scanners was investigated using Kennedy Class I and Class III models. It was reported that digital impressions showed superior trueness compared to conventional impressions. Lee et al⁵ found that the precision of intraoral scanners varied depending on the size and position of the edentulous area. However, there is no consensus in the literature regarding the effect of the length and anterior vs posterior positioning of the edentulous area on scanning accuracy.

Each manufacturer provides an intraoral scan strategy for scanning of the complete arch. Nevertheless, manufacturers have not provided any guidelines concerning the quadrant where scanning should ideally begin during complete-arch scanning. The effect of scanning sequence on the accuracy of a digital impression of a complete-arch model was shown in a previous study¹⁶; however, there is no evidence in the literature on whether the quadrant where the scan starts has an effect on the accuracy of digital impressions.

The purpose of the present study was to evaluate the accuracy of digital impressions of two partially edentulous dentitions with anterior and/or posterior missing teeth using six intraoral scanners, as well as the effect of scanning sequence. The null hypotheses were that no differences would be found among the intraoral scanners in scanning accuracy in anterior and posterior partially edentulous dentitions and that the scanning sequence would not be related to the accuracy of the scanners.

MATERIALS AND METHODS

A maxillary complete-arch model (ANA-4 V, Frasco) was used in the present study. Two different models were created according to the type of missing teeth: a Kennedy Class I model (the right premolars and molars and the left molars missing) and a Kennedy Class IV model (the right incisors, canine, and first premolar and the left incisors missing). The sockets of removed teeth were filled up by using a silicone-based gingival mask

(Gingifast Elastic, Zhermack) to ideally prepare gingival contours of the edentulous area.

First, the Class I and Class IV models were scanned using a highly accurate industrial reference scanner (ATOS Core 80, GOM) to create a digital reference dataset. According to the manufacturer's data, the ATOS Core 80 uses a stereo camera setup working on the principle of triangulation and scans with blue light technology.¹⁷

Six intraoral scanners were used to investigate the precision and trueness of different intraoral scanning systems: the Trios 3 version 1.4.7.5 (3Shape), the iTero Element 2 version 1.9.3.3 (Align Technology), the CEREC Omnicam version 4.6.1 (Dentsply Sirona), the Emerald version 6.0 (Planmeca), the CEREC Primescan version 5.0.0 (Dentsply Sirona Dental Systems), and the Virtuo Vivo version 3.0 (Dental Wings). One investigator (B.D.) performed all scans with each intraoral scanner according to the protocols described by each manufacturer. The minimum sample size was determined as 2 (power: 0.90) using a power analysis software (G*Power version 3.1.9.4). Ten scans were taken of each model using each intraoral scanner for a total of 120 scans. The first 5 scans per scanner were started from the maxillary right quadrant (Scan Right [ScanR]), and the following 5 scans were started from the maxillary left quadrant (Scan Left [ScanL]) to evaluate the effect of scanning sequence. The scan strategies for ScanR and ScanL are demonstrated in Fig 1.

For standardization and subsequent digital processing, datasets from each scan were converted into standard tessellation language (STL) file format. All of the datasets were loaded into a 3D evaluation software (Geomagic Studio 12, 3D Systems) to evaluate the trueness of each partially edentulous dentition model. The whole maxillary arch, including the dentition, the soft tissues from the teeth to the sulcus, and the palatal soft tissues, was selected from each digital dataset using the "trim with curve" function. The trimmed models were then saved in STL file format. For the trueness measurement, these models were superimposed with a best-fit algorithm on the reference model. For precision evaluation, three scans were selected from both ScanR and ScanL and superimposed within groups. A two-way pairwise comparison was performed because the reference scan data were not certain in the intragroup comparison; for example, ScanR 1 was determined as a reference scan and compared to ScanR 2; then, ScanR 2 was determined as a reference scan and was again compared to ScanR 1. There were a total of six combinations in both the ScanR and ScanL groups for the precision measurement.

After the 3D comparison analysis, SDs and mean positive/negative deviations were recorded in micrometers. The ScanR and ScanL values were recorded separately for each intraoral scanner. The absolute mean deviations were obtained by calculating the arithmetic mean of

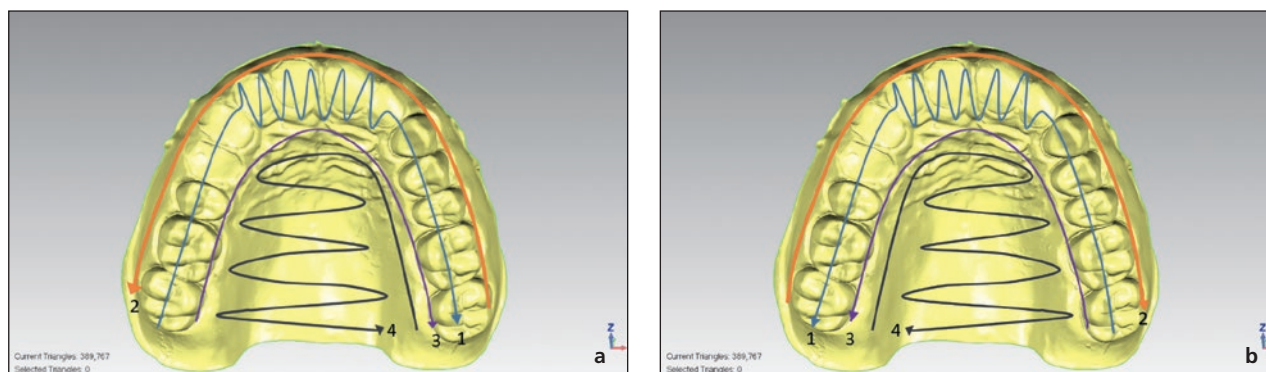


Fig 1 Scan strategies for two scanning groups on the Trios. (a) The ScanR strategy. The scan was started from the occlusal side of the right molars to the left occlusal side (1), continued on the buccal side in the reverse direction (2), and then toward the palatal side (3), finishing with the soft tissues (4). (b) The ScanL strategy. The scan was started from the left side in the reverse direction.

the absolute values of the positive and negative deviations.¹⁸ The absolute mean deviation values were used to determine trueness, and the SD values were used to determine precision.

All scan data were analyzed statistically to measure trueness and precision. The homogeneity and normality of distributions were tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. Nonparametric Kruskal-Wallis test was performed to compare the differences between the groups ($n = 10$). Intergroup comparisons were performed with Mann-Whitney U test, which was also used to compare differences among scanning sequences ($n = 5$). All statistical analyses were performed using statistical software (PASW Statistics 18.0, SPSS, IBM). The statistical significance level was set at .05.

RESULTS

There were significant differences in the trueness and precision of digital impressions among the intraoral scanners in both partially edentulous dentition models ($P < .05$).

Trueness of Digital Impressions

In the Class I model, the lowest deviation value for trueness was obtained using Trios ($58.3 \pm 5.9 \mu\text{m}$), followed by Primescan ($72.2 \pm 2.8 \mu\text{m}$), iTero ($78.8 \pm 3.8 \mu\text{m}$), Omnicam ($84.9 \pm 12.5 \mu\text{m}$), Virtuo Vivo ($86.8 \pm 15.4 \mu\text{m}$), and Emerald ($133.0 \pm 27.3 \mu\text{m}$). The Trios had a statistically significant difference from all other intraoral scanners. Separately, the Primescan had statistically lower deviation values for trueness than the other intraoral scanners, except for Trios. There were no statistically significant differences in the trueness values obtained from iTero, Omnicam, and Virtuo Vivo; however, the Emerald had the statistically highest deviation values of all six intraoral scanners.

In the Class IV model, the lowest deviation value for trueness was obtained using Trios ($50.2 \pm 3.9 \mu\text{m}$), followed by Primescan ($74.1 \pm 1.8 \mu\text{m}$), Omnicam ($74.5 \pm$

7.4), iTero ($75.9 \pm 4.5 \mu\text{m}$), Virtuo Vivo ($79.1 \pm 7.2 \mu\text{m}$), and Emerald ($131.8 \pm 19.2 \mu\text{m}$). As seen in the Class I model, the Trios had, statistically, the lowest deviation values, while the Emerald had the highest deviation values among all intraoral scanners. However, there were no statistically significant differences in trueness values obtained from the Primescan, Omnicam, iTero, and Virtuo Vivo.

The mean trueness values of the ScanR, ScanL, and total scans for each intraoral scanner are shown in Table 1. In the Class I model, the trueness was significantly influenced by scan sequence when using the Virtuo Vivo and Emerald. ScanR had a statistically higher deviation value than ScanL for the Virtuo Vivo ($P = .009$); however, ScanL had a statistically higher deviation value than ScanR for the Emerald ($P = .028$). No significant difference was found between the trueness values of ScanR and ScanL obtained from the Trios, iTero, Omnicam, and Primescan.

In the Class IV model, there was no significant difference between the trueness values of ScanR and ScanL obtained from any intraoral scanner.

Precision of Digital Impressions

When comparing the precision of the intraoral scanners for the Class I model, the lowest deviation value was obtained from Trios ($39.4 \pm 6.2 \mu\text{m}$), followed by Primescan ($42.9 \pm 6.9 \mu\text{m}$), iTero ($46.9 \pm 13.9 \mu\text{m}$), Virtuo Vivo ($59.5 \pm 16.8 \mu\text{m}$), Omnicam ($92.3 \pm 20.2 \mu\text{m}$), and Emerald ($175.7 \pm 26.9 \mu\text{m}$). A statistically significant difference was not observed in the precision of Trios, Primescan, and iTero; however, these scanners showed statistically lower deviation values than Virtuo Vivo, Omnicam, and Emerald. Further, there were statistically significant differences between Virtuo Vivo and Omnicam and between Omnicam and Emerald.

In the Class IV model, Trios showed the best precision values ($34.4 \pm 7.8 \mu\text{m}$), followed by iTero ($34.9 \pm 7.6 \mu\text{m}$), Primescan ($36.7 \pm 6.0 \mu\text{m}$), Virtuo Vivo (74.9 ± 14.4),

Table 1 Trueness Values (μm) of ScanR, ScanL, and Total Scans for Each Intraoral Scanner in Kennedy Class I and Class IV Models

Scanner	Class I									Class IV							
	ScanR			ScanL			Total			ScanR			ScanL			Total	
	Mean \pm SD	Min	Max	Mean \pm SD	Min	Max	Mean \pm SD	<i>P</i>	Mean \pm SD	Min	Max	Mean \pm SD	Min	Max	Mean \pm SD	<i>P</i>	
Trios	61.0 \pm 7.2	52.5	70	55.7 \pm 3.1	52.5	59.5	58.3 \pm 5.9	.310	52.2 \pm 3.7	47.5	58	48.3 \pm 3.3	44.5	52	50.2 \pm 3.9	.151	
iTero	79.2 \pm 3.8	73	82.5	78.4 \pm 4.2	74	83	78.8 \pm 3.8	1	76.6 \pm 3.7	74	83	75.2 \pm 5.6	69.5	81.5	75.9 \pm 4.5	.690	
Emerald	113.1 \pm 11.9	104	133.5	152.9 \pm 23.3	113	172.5	133 \pm 27.3	.028*	134.3 \pm 21.1	106	165.5	129.4 \pm 19.3	111.5	159	131.8 \pm 19.2	.690	
Omniscam	85.3 \pm 16.8	68.5	110	84.5 \pm 8.1	75	97.5	84.9 \pm 12.5	.841	74.2 \pm 5.7	68	82	74.8 \pm 9.5	58	81	74.5 \pm 7.4	.690	
Primescan	70.9 \pm 2.4	68.5	75	73.6 \pm 2.6	70.5	77.5	72.2 \pm 2.8	.151	73.2 \pm 2.1	70.5	76	75.0 \pm 1.2	73.5	76.5	74.1 \pm 1.8	.151	
Virtuo Vivo	101.0 \pm 3.3	98	106	72.6 \pm 4.2	66.5	78.5	86.8 \pm 15.4	.009*	78.0 \pm 6.6	71	87	80.3 \pm 8.3	70.5	92	79.1 \pm 7.2	.841	

*Statistically significant difference ($P < .05$) between ScanR and ScanL.

Table 2 Precision Values (μm) of ScanR, ScanL, and Total Scans for Each Intraoral Scanner in Kennedy Class I and Class IV Models

Scanner	Class I									Class IV							
	ScanR			ScanL			Total			ScanR			ScanL			Total	
	Mean \pm SD	Min	Max	Mean	Min	Max	Mean \pm SD	<i>P</i>	Mean \pm SD	Min	Max	Mean \pm SD	Min	Max	Mean \pm SD	<i>P</i>	
Trios	41.6 \pm 5.9	37	53	37.1 \pm 6.2	31	45	39.4 \pm 6.2	.394	38.0 \pm 7.7	31	48	30.8 \pm 6.5	24	40	34.4 \pm 7.8	.093	
iTero	46.3 \pm 16.7	28	64	47.5 \pm 12.2	37	68	46.9 \pm 13.9	.699	30.5 \pm 5.8	23	37	39.3 \pm 6.9	27	46	34.9 \pm 7.6	.020*	
Emerald	164.6 \pm 21.8	139	188	186.8 \pm 28.6	158	231	175.7 \pm 26.9	.180	142.6 \pm 37.3	100	192	116.3 \pm 19.8	91	141	129.5 \pm 31.6	.240	
Omniscam	93.6 \pm 23.1	62	126	91.0 \pm 16.2	63	108	92.3 \pm 20.2	.937	86.1 \pm 22.8	55	123	92.0 \pm 7.5	83	102	89.0 \pm 16.5	.485	
Primescan	40.5 \pm 6.8	28	49	45.3 \pm 6.6	34	54	42.9 \pm 6.9	.180	32.5 \pm 3.7	26	36	41.0 \pm 4.7	36	49	36.7 \pm 6.0	.006*	
Virtuo Vivo	69.1 \pm 15.0	44	85	50.0 \pm 13.2	35	66	59.5 \pm 16.8	.037*	74.0 \pm 8.3	62	87	75.8 \pm 19.6	42	97	74.9 \pm 14.4	.699	

*Statistically significant difference ($P < .05$) between ScanR and ScanL.

Omniscam ($89.0 \pm 16.5 \mu\text{m}$), and Emerald ($129.5 \pm 31.6 \mu\text{m}$). There was no statistically significant difference in the precision of Trios, iTero, and Primescan. Conversely, there was a statistically significant difference between Virtuo Vivo and both Omniscam and Emerald. Emerald, statistically, showed the lowest precision value among all intraoral scanners.

The mean precision values of ScanR, ScanL, and total scans for each intraoral scanner are shown in Table 2. The precision of the ScanR and ScanL obtained from Virtuo Vivo had a statistically significant difference ($P = .037$) in the Class I model; however, the precision of ScanR and ScanL obtained from iTero ($P = .020$) and Primescan ($P = .006$) showed a statistically significant difference in the Class IV model. There were no statistically significant differences between ScanR and ScanL obtained from other intraoral scanners when considering precision.

Figures 2 and 3 show a representative sample from each scanner displaying the color map of the deviations between the test scan and the reference scan for the

Class I and Class IV models. The deviation spectrum was set at 15 color segments. Blue represents negative deviation of the reference scan, while yellow, orange, and red represent positive deviations, and green represents deviation within the range of the nominal values. The deviations were mostly seen in the palatal soft tissue and posterior regions.

DISCUSSION

The present study investigated the accuracy of digital impressions obtained using six different intraoral scanners for two partially edentulous dentition models. The null hypothesis was rejected because the accuracy of digital impressions differed between intraoral scanners in both partially edentulous dentition models. In addition, significant differences in the accuracy of the intraoral scanner were observed depending on scanning sequence.

The best-fit alignment method has been used to evaluate the accuracy of partial and complete-arch digital impressions in several studies.^{4,5,13,14,16,18,19} The

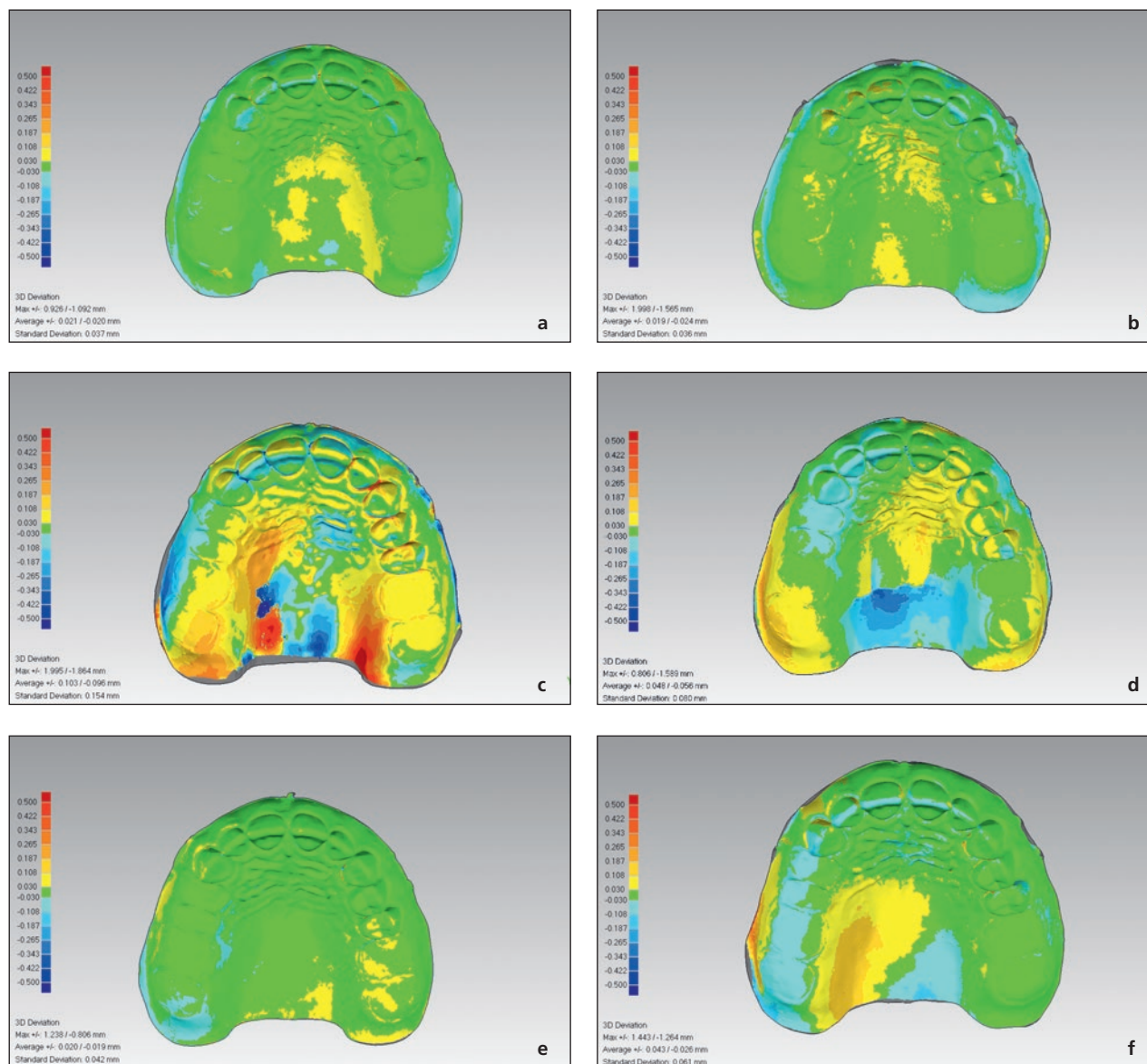


Fig 2 Representative color map images for evaluation of precision in the Kennedy Class I model from each intraoral scanner. Max/min nominal $\pm 30 \mu\text{m}$ and max/min critical $\pm 500 \mu\text{m}$. (a) Trios. (b) iTero. (c) Emerald. (d) Omnicam. (e) Primescan. (f) Virtuo Vivo.

superimposition procedure aligns a test scan with a reference scan by using an iterative closest-point algorithm, and this algorithm determines the minimal distance between two scans.²⁰ This method enables the deviations of any point of the dental arch to be observed through a color map.¹⁹ However, different methods were used to evaluate the accuracy of complete-arch impressions in a few studies.^{21–23} The linear and angular distortion values of the metal bar or spheres fixed on the teeth were calculated to determine the accuracy of impressions. These methods are useful to evaluate distortion in the x, y, and z coordinates of the determined points, but the deviations can be registered only on the determined points. Nevertheless, the tendency for distortion

of the complete arch may be toward the distal end or anterior region, with its many steep surfaces.²⁴ In order to observe deviations of the complete arch and compare the results clearly to those in the available literature, the best-fit alignment method was used to evaluate the accuracy of digital impressions in the present study.

There are only a few studies that have evaluated the accuracy of intraoral scanners in partially edentulous dentitions without implants. Hayama et al⁴ investigated the accuracy of digital impressions obtained from one intraoral scanner (Carestream) with two different scanning head sizes and compared it to conventional impression-taking for Kennedy Class I and Class III models. The trueness value of the digital impression was found to be 105

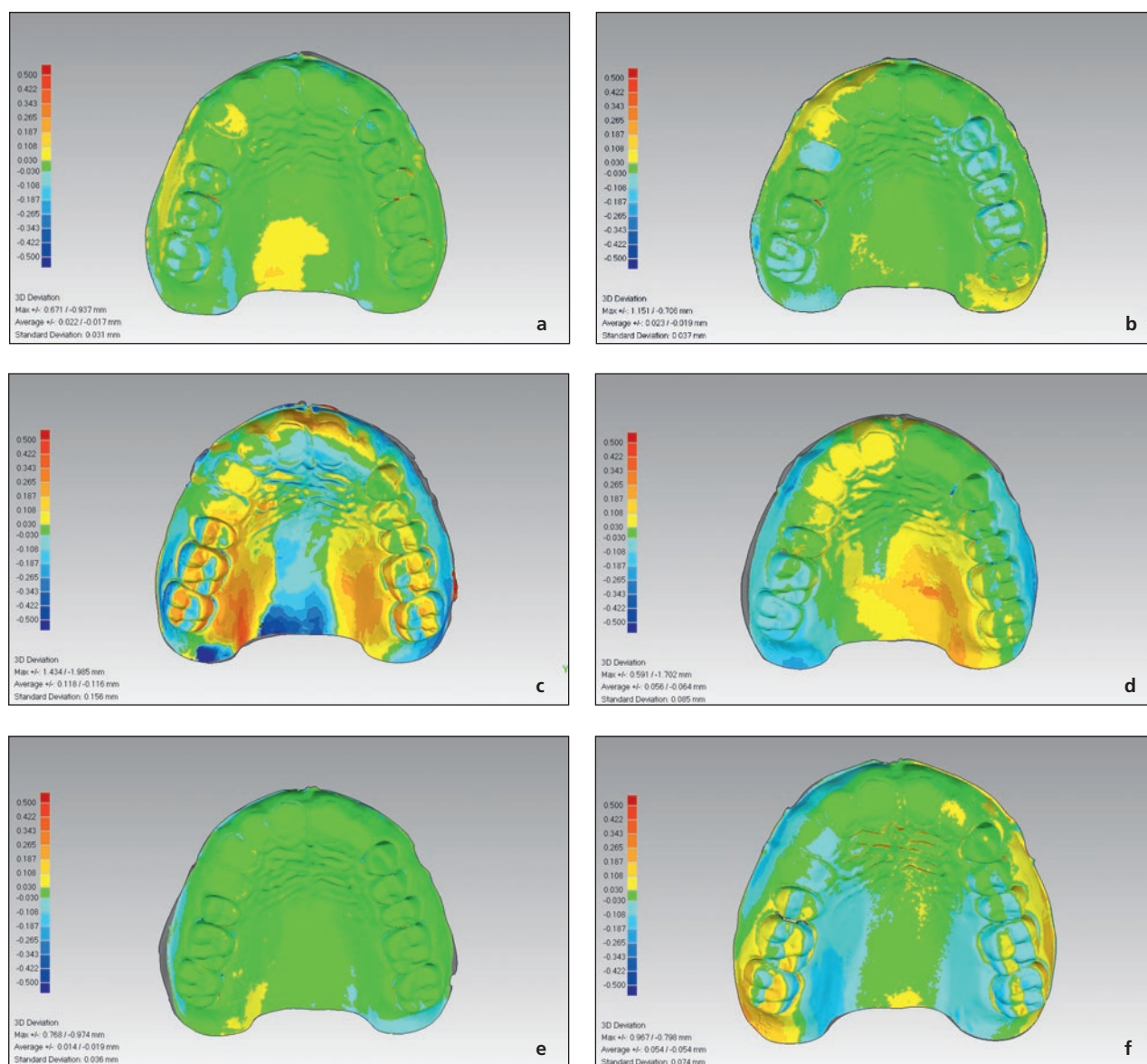


Fig 3 Representative color map images for evaluation of precision in Kennedy Class IV model from each intraoral scanner. Max/min nominal $\pm 30 \mu\text{m}$ and max/min critical $\pm 500 \mu\text{m}$. (a) Trios. (b) iTero. (c) Emerald. (d) Omnicam. (e) Primescan. (f) Virtuo Vivo.

to $158 \mu\text{m}$, and the precision value was found to be 100 to $192 \mu\text{m}$. However, in the present study, Kennedy Class I and Class IV models were used as reference models. The trueness of all intraoral scanners was in the range of 50 to $133 \mu\text{m}$, and the precision was in the range of 34 to $175 \mu\text{m}$. Using different intraoral scanners and different types of partially edentulous dentition models may lead to a lower range of deviation values than that reported by Hayama et al. In another study investigating the precision of two intraoral scanners, it was concluded that the precision differed between the anterior and posterior regions.¹⁶ Therefore, partially edentulous dentition models with both anterior and posterior missing tooth

types were used in the present study. Lee et al⁵ evaluated the precision of two intraoral scanners (Carestream and Medit i500) for four partially edentulous dentition models of Kennedy Class III or Class IV and found that the precision was significantly lower among the models with five or more missing teeth than with two missing teeth. However, the precision deviation values of the two intraoral scanners did not have a statistically significant difference. Contrary to these findings, the present study found statistically significant differences between intraoral scanners. Reference models with six missing teeth were used. The right premolars and molars were missing in the Kennedy Class I model, while the right



incisors, canine, and first premolars and the left incisors were missing in the Kennedy Class IV model, so there were different lengths of the edentulous area in the right and left quadrants. For both the Kennedy Class I and Class IV models, Trios, iTero, and Primescan showed similar precision results and statistically higher precision than Virtuo Vivo, Omnicam, and Emerald. The Emerald showed the lowest precision among all intraoral scanners. Regarding trueness, Trios had statistically higher trueness with lower deviations when compared to all intraoral scanners for both Kennedy Class I and Class IV models. Primescan showed statistically higher trueness than the Omnicam and Virtuo Vivo for the Kennedy Class I model, whereas the trueness for the Kennedy Class IV model was not statistically different. The Emerald had the highest deviation value, similar to the precision. The differences in the accuracy of intraoral scanners may be related to their scanning technologies and meshing procedures. The accuracy of intraoral scanners varies with the quality of the point cloud obtained, depending on the hardware and software algorithms.²⁵ Therefore, different STL triangle resolutions and configurations from the same surface are obtained.^{24,26}

The manufacturers describe a scan strategy for each intraoral scanner. However, the quadrant where the scanning will begin is not specified in the manufacturer's instructions. During digital impression-taking, multiple scanned images are superimposed. If a local error occurs during scanning, cumulative errors may be seen with stitching as the scanning continues toward proximal areas.²⁴ Therefore, the accuracy of a digital impression may differ between the regions where the scanning starts and ends. The effect of the scanning sequence on accuracy was evaluated in the present study. The 10 scans performed with each intraoral scanner were divided into two groups based on scanning sequence, starting from the right quadrant or left quadrant. For the Class I model, the trueness and precision of ScanR and ScanL obtained from Virtuo Vivo showed statistically significant differences. In addition, the trueness of Emerald differed between ScanR and ScanL. For the Class IV model, only the precision of iTero and Primescan differed between ScanR and ScanL. Hayama et al⁴ reported that lower deviations were observed in the quadrant where scanning started, while in the present study, deviations were seen regardless of the initial scanning quadrant. This difference may be due to the different length of the edentulous area in the left and right quadrants of the model. Anh et al¹⁶ evaluated the precision of digital impressions obtained from iTero and Trios together with the effect of scanning sequence and showed that the precision of iTero decreased when scanning started

from the right rather than from the left, similar to the iTero precision results of the Class IV model in the present study. However, the precision of the complete-arch digital impression obtained from Trios did not show a difference, which is similar to the present study. The differences between the accuracy of ScanR and ScanL were not related to the length of edentulous area in the quadrant. In clinical practice, it may be useful to consider the sequence when scanning the complete arch with scanners where the accuracy varies according to the scanning sequence.

There are several limitations in the present study. Intraoral factors such as saliva, movement of the patient, different reflective properties of the teeth and gingiva, and movement of the soft tissue area were not considered. The results of the present study should be confirmed by future clinical studies. Kennedy Class I and Class IV models were used as partially edentulous dentition models. Further studies might focus on the impact of different lengths and locations of the partially edentulous area on the accuracy of digital impressions.

CONCLUSIONS

Within the limitations of the present study, the accuracy in anterior and posterior partially edentulous models differed depending on intraoral scanners and scanning sequence. Trios showed the highest accuracy for all test groups in anterior and posterior partially edentulous models, while Emerald had a lower accuracy with significantly higher deviations when compared to the other intraoral scanners. The accuracy of partially edentulous models was affected by the scanning sequence when using Virtuo Vivo, Emerald, Primescan, and iTero. The manufacturers may also need to develop a new scan strategy for partially edentulous cases to prevent the effect of scanning sequence on the accuracy of digital impressions. Based on the results of the present study, scanner and scanning sequence have an important role in the success of digital scanning. It could be considered that deviations on the digital impression may affect the accuracy of RPD frameworks and, consequently, the success of the dentures in the digital workflow. These results should be confirmed via fitting of the framework fabricated from the digital model and further clinical studies.

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Literature Abstract

Lack of Clinical Benefit of Implantoplasty to Improve Implant Survival Rate

The objective of this study was to compare the postsurgical outcomes of resective treatment for peri-implantitis with and without implant surface modification (ie, implantoplasty [IP]). This was accomplished with a retrospective analysis of data from patients with one or more implants who were surgically treated for peri-implantitis with resective therapy. Patients were divided into two groups regarding treatment approach: IP (test) and no IP (control). Retrospective data were obtained after implant placement (T_0) and on the day of peri-implantitis surgical treatment (T_1). Patients were then recalled (≥ 1 year after T_1) for clinical and radiographic examination (T_2). The findings were conclusive. A total of 41 patients (68 implants; mean \pm SD follow-up: 41.6 \pm 24.4 months) were included in this study. The survival rates at the implant level were 90% in the test group and 81.6% in the control group ($P > .05$). Multilevel regression analysis showed that the probability of implant failure was influenced by marginal bone loss (MBL) at T_1 and not by surgical modality. For example, peri-implantitis defects with $\geq 50\%$ or with 25%–50% MBL were 18.6 and 8.86 times more likely to lose the implant, respectively, when compared to $< 25\%$ MBL. Nonetheless, MBL changes were similar in the test and control groups ($P = .592$). Similarly, changes in bleeding on probing, probing pocket depth, and suppuration at T_2 did not differ between groups ($P > .05$). Multilevel regression analysis indicated that clinical improvement of these parameters was influenced by the number of supportive peri-implant therapy visits ($P < .01$). The results demonstrate little difference between the procedures. Regardless of the implant surface modification (IP), the survival rate of implants treated for peri-implantitis was primarily influenced by the amount of bone loss at the time of treatment. Other clinical parameters (MBL, probing pocket depth, bleeding on probing, suppuration) were influenced by the frequency of supportive peri-implant therapy visits and not by the IP procedure.

Ravidà A, Siqueira R, Saleh I, Saleh MHA, Giannobile A, Wang HL. *J Dent Res* 2020;99:1348–1355. References: 35. Reprints: HL Wang, homlay@umich.edu —Carlo Marinello, Switzerland