RESEARCH

Comparison of the accuracy of intraoral scanning systems with conventional impression in dentate patient

Imadettin Alsayed(0000-0002-3759-029X)[α], Yılmaz Umut Aslan(0000-0003-0500-7546)[α]

Selcuk Dent J, 2020; 7: 72-80 (Doi: 10.15311/selcukdentj.639495)

Başvuru Tarihi: 29 Ekim 2019
Yayına Kabul Tarihi: 04 Aralık 2019

ABSTRACT

Comparison of the accuracy of intraoral scanning systems with conventional impression in dentate patient

Background: Over the last years, different intraoral scanning systems for direct digitalization have been introduced to the dental market. However, the accuracy of these scanners is variable, and little information is available. The aim of this in vivo study was to compare the accuracy of two intraoral scanning systems and the difference between upper and lower jaw on the accuracy.

Methods: 10 patients with full dentition received one conventional impression with polyvinyl siloxane (Elite HD+, Zhermack SpA, Italy) and three scans with CEREC OC (Sirona Dental Systems, Sirona, Bensheim, Germany) and Straumann CARES IOS (Intra oral Scanner, Basel, Switzerland) for upper and lower jaw. The conventional impressions were poured and the casts made from it were scanned and used as the reference model to evaluate precision and trueness of intraoral scanning virtual models provided by each system. Digital models were analyzed with a software (Geomagic Control; Geomagic, Morrisville, USA).

Results: The trueness value was 99.88±42.56 µm in upper jaw and 82.6±26.81 µm in lower jaw for CEREC OC, and 105.53±25.49 µm in upper jaw, and 109.56±36.84 µm in lower jaw for CARES IOS. The differences between these two systems were not statistically significant ($P>0.05$), but statistically significant difference was found in the precision ($P<0.05$). CEREC OC showed higher value in both upper and lower jaws.

Conclusion: CEREC OC was more precise than CARES IOS and at a similar level of trueness. No statistically significant difference was found between upper and lower jaws in both systems.

KEYWORDS

Accuracy, CAD/CAM, intraoral scanning, STL

ÖZ

Tüm dişleri mevcut hastalarda konvansiyonel ölçü ve intraoral dijital taramanın netliğinin karşılaştırılması

Amaç: Son senelerde, direkt dijitalizasyon için farklı intraoral tarama sistemleri ortaya çıkmıştır. Ancak bu tarayıcılarının doğruluğu değişkendir ve hakkındaki bilgiler yetersizdir. Bu çalışmanın amacı, iki farklı intraoral tarama sisteminin, alt ve üst çene arasındaki tarama doğruluğu farkının karşılaştırılmasıdır.

Gereç ve Yöntemler: 10 adet tam dişli hastanın her birinden bir adet PVS (Elite HD+, Zhermack SpA, İtalya) materyali ile ölçü alındı ve 3 adet alt-üst çene taraması CEREC OC(Sirona Dental Systems, Sirona, Bensheim, Almanya) ve Straumann CARES IOS (Intra oral Scanner, Basel, İsviçre) ile yapıldı. Konvansiyonel ölçüden elde edilen alçı modeller taratılarak referans model olarak netlik ve doğruluk kıyaslamasında kullanıldı. Netlik değerlendirilmesindeki deviasyonlar diğer ölçülerin birbiri üzerine çakıştırılması metodu ile gözlemlendi. Dijital ölçü dosyaları STL formatına dönüştürülerek (Geomagic Control; 3D Systems. ABD) işlendi ve analiz edildi**.**

Bulgular: Doğruluk değerleri, CEREC OC için üst çenede 99.88±42.56 µm alt çenede, 82.6±26.81 µm dir. CARES IOS için üst çene doğruluk değeri 105.53±25.49 µm, alt çene doğruluk değeri 109.56±36.84 µm dur. İki sistem arasındaki doğruluk değeri farkı istatistiksel olarak anlamlı değildir ($P>0.05$). Netliğin farkı istatiksel olarak anlamlıdır ($P<0.05$), CEREC OC alt ve üst çenede netlik açısından daha yüksek değerler gösterdi.

Sonuç: CEREC OC netlik olarak CARES IOS sisteminden daha üstün bulunurken, doğruluk seviyesi her iki sistemde de benzerdir. Alt ve üst çeneler arasında her iki sistemde istatistiksel olarak anlamlı fark bulunmamıştır.

ANAHTAR KELİMELER

Doğruluk, CAD/CAM, intraoral tarama, STL

Dental impressions have been used to make impressions of the intraoral structures, then the impression is poured to get the cast on which the restorations are constructed. Impressions are highly used in dentistry field, starting from making casts for diagnosis and making final casts to fabricate the definitive restorations.[1-3]

In the conventional technique, a cast is made after an impression has been taken with a tray filled with impression material, and then poured into stone. There are some disadvantages with this technique such as time consuming to select a tray, distribution and setting of materials, disinfection, and sending of the impression to the technician. Additionally, material distortion, patient discomfort and the cost of impression materials are the other disadvantages of this technique.[2]

With the increasing application of digital impression systems, it became possible to eliminate the physical casts, which used in conventional systems. In a digital

[α] Marmara University, Faculty of Dentistry, Department of Prosthodontics, İstanbul, Turkey

digital system, the intraoral structures are digitally recorded with an intraoral 3D acquisition device, and the obtained details allow the computer to generate a virtual model. Final restorations are made depending on this virtual model.[4]

The digital impression method has a lot of advantages, for example, enhancement of patient acceptance, reduction in terms of deformation of impression materials, the opportunity of providing an enhanced 3D preview of tooth preparations, and potential cost- and time- efficiency.[5,6]

Computer-aided design and computer aided manufacturing (CAD/CAM) have been used in the production of fixed dental prostheses (FDPs) since 1980s.[7] Some published articles have referred that FDPs made with intraoral digital impressions have shown outstanding qualities over those from conventional impressions in many aspects.[8]

Many CAD/CAM systems are in the market to design and produce restorations regarding two ways to fabricate the virtual model:

- Extra-oral scanning: in such cases, a gypsum cast is produced with the silicone impression and sent for extra-oral scanning where the gypsum cast is placed on the platform of the extra-oral scanner.
- Intraoral scanning: the impression is done directly from the patient mouth by intraoral scanner.[9]

The aim of this in vivo study is to compare the accuracy (trueness, precision) of a powder-free, continuous imaging impression system (CEREC OC) and Multi-scan Imaging system with powder (STRAUMANN CARES IOS) to determine the more accurate system and the difference between upper and lower jaw on accuracy of intraoral scanning.

The null hypothesis was (1) because of requiring a layer of powder, the inhomogeneous powder thickness (STRAUMANN CARES IOS) may slightly affect the accuracy comparing with powder-free system (CEREC OC). (2) Significant differences between upper and lower jaws impressions can be found.

MATERIALS AND METHODS

The study includes ten volunteers with good oral hygiene, no temporomandibular joint or periodontal diseases, complete maxillary and mandibular dental arch except the missing third molar, intact hard and soft tissues, with no dental implant. Each volunteer received three digital impressions for both upper and lower jaw (three impressions for the upper and three for the lower jaw) for each intraoral scanning system, and then the participants received one conventional impression for each jaw to serve as a reference to evaluate the trueness. This project was approved by the Ethics Committee of Marmara University in Istanbul, Turkey (Application No:2017-71).

Digital impressions

Two intraoral scanning systems were evaluated in the study: CEREC Omnicam (OC; Sirona Dental Systems, Sirona, Bensheim, Germany); Straumann CARES IOS (Intra oral Scanner, Basel, Switzerland), and one quadrant were scanned from each jaw. The scan process was conducted following the manufacturer's guidelines, before which saliva was removed by cotton rolls and air syringe, and buccal or labial mucosa was pulled by cheek and lip retractor to avoid the negative effects of intraoral conditions as much as possible. Scanning is started with the second molar in the quadrant and ended at the central incisor of the same quadrant. Each tooth was scanned from the occlusal, buccal and lingual surfaces. The camera of the scanner was aimed towards the scanned area. The camera tip was 5-10 millimeters away from the tooth surface. The camera head was slid over the teeth in a single direction gently to generate the successive data into a 3D model. This process was then repeated two times, so every volunteer had three digital impressions for each jaw for each system. A well-trained dentist performed all scans. An STL file format was compatible with and able to be imported into most 3D model processing software (Figure 1 and Figure 2).

Additionally, CARES scanner works in camera image impression and requires a powder coating on the teeth surfaces. For this reason, the teeth in the quadrant were coated with a thin layer of titanium dioxide powder (Dentaco scan liquid, Essen - Germany) before scanning with CARES (Figure 3).

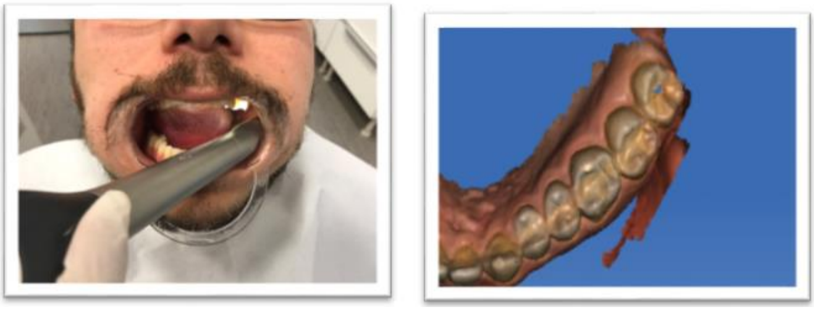

Figure 1.

Intraoral scanning with CEREC and the stereolithography model of the scanned quadrant

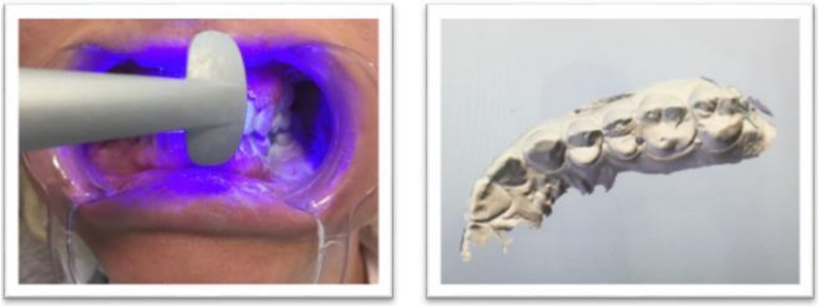

Figure 2.

Intraoral scanning with CARES and the stereolithography model of the scanned quadrant

Figure 3.

Coating the teeth with titanium dioxide powder

Conventional impressions

Volunteer's conventional impression was obtained right after the completion of intraoral digital scanning. Standard perforated metal stock trays were used to generate the conventional impressions. The optimal tray was selected by testing a stock tray in the oral cavity while ensuring adequate space for the impression material. The conventional impressions were made using a poly-vinyl siloxane (PVS) material (Elite HD+, Zhermack, Italy) in one-step.

All impressions were disinfected for 10 minutes (Impresept; 3M ESPE, Seefeld, Germany) and then poured with scannable Type IV dental stone (Vel-Mix™ Die Stone, California, USA). According to manufacturer guidelines, the impression trays were removed from the stone cast after 40 minutes, and the stone casts were stored at room temperature and humidity. Each cast was digitized once by a laboratory scanner (3Shape D700 scanner, Copenhagen, Denmark) after storage of at least 96 hours until the expansion of gypsum was complete to obtain the STL file format and considered as gold standard models (Figure 4). The design of the study is shown in Figure 5.

All STL datasets from intraoral scanner and gypsum casts were imported into the inspection software (Geomagic Control; Geomagic, Morrisville, USA). The STL data from each test group were pre-superimposed using CAD software (Geomagic Control; Geomagic, Morrisville, USA) according to a best-fit algorithm in order to align the orientations of the coordinate systems. To ensure a precise superimposition, the datasets were trimmed to the field of interest (the dental arch, including the tooth surface and about 1 mm of attached gingiva). Therefore, all irrelevant areas were eliminated manually to ensure precise superimposition and equal boundaries of all datasets. The trimmed models were again saved in STL file format and imported into Geomagic Control again for overall 3D compare (Figure 6).

For the 3D analysis, the digital of the control group and the experimental group were superimposed by using the best-fit tool, which the test model would be aligned to the reference model automatically in three dimensions. Color maps to show the differences between two aligned models and deviation information, such as average positive deviation, average negative deviation, and standard deviation, were set to 20 color segments. The maximum and minimum critical values were set to ±50 µm. With these settings, 3D analysis results were derived, and color maps were derived as qualitative results (Figure 7).

Figure 4.

Extraoral scanning of the stone cast by 3shap to obtain the STL format

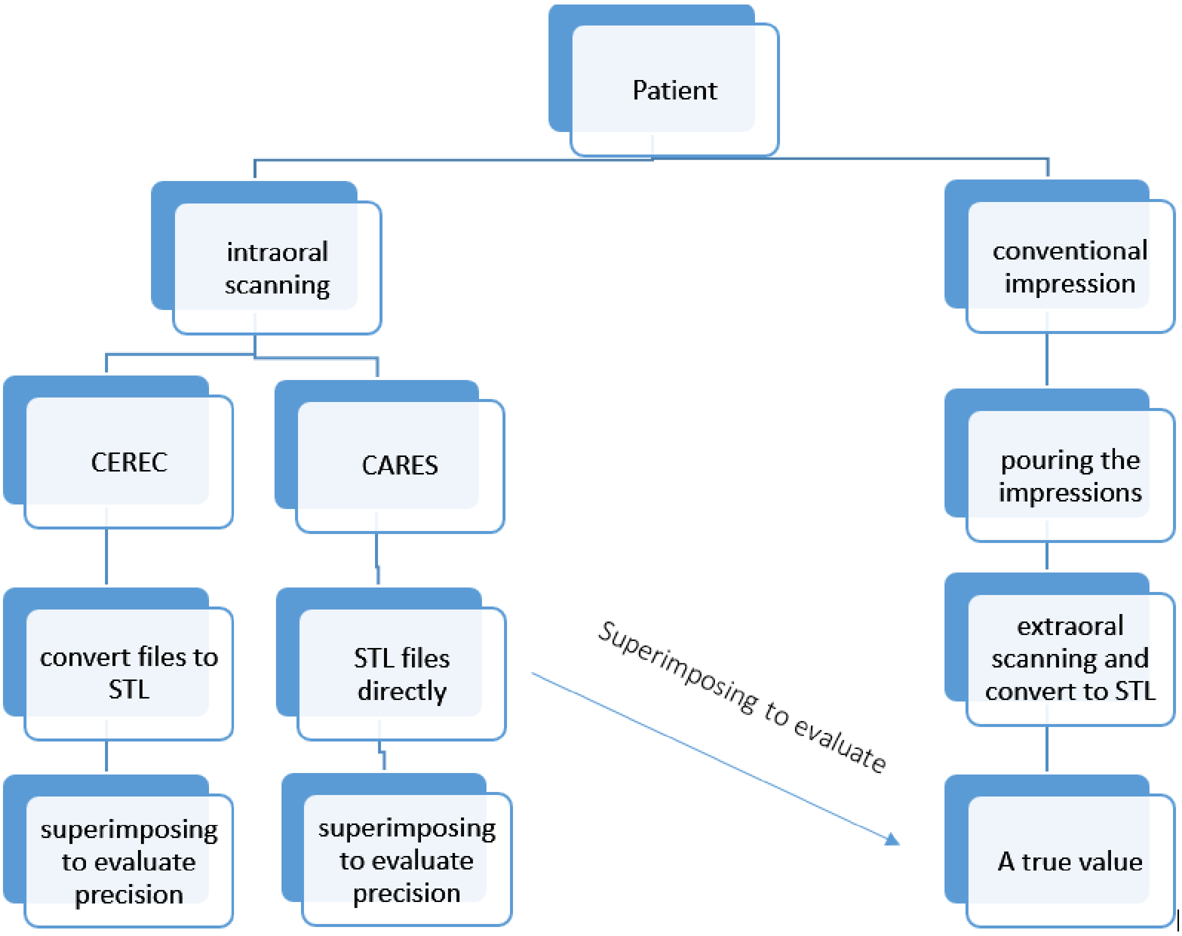

Figure 5.

Diagram of study method

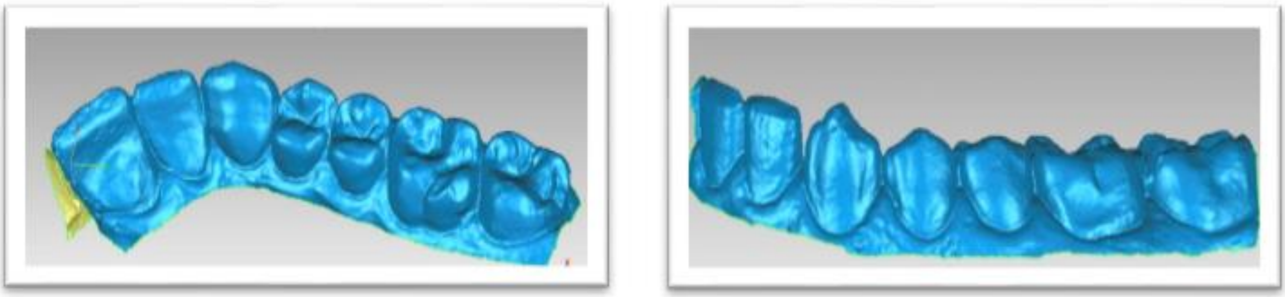

Figure 6.

Trimmed models to ensure precise superimposition

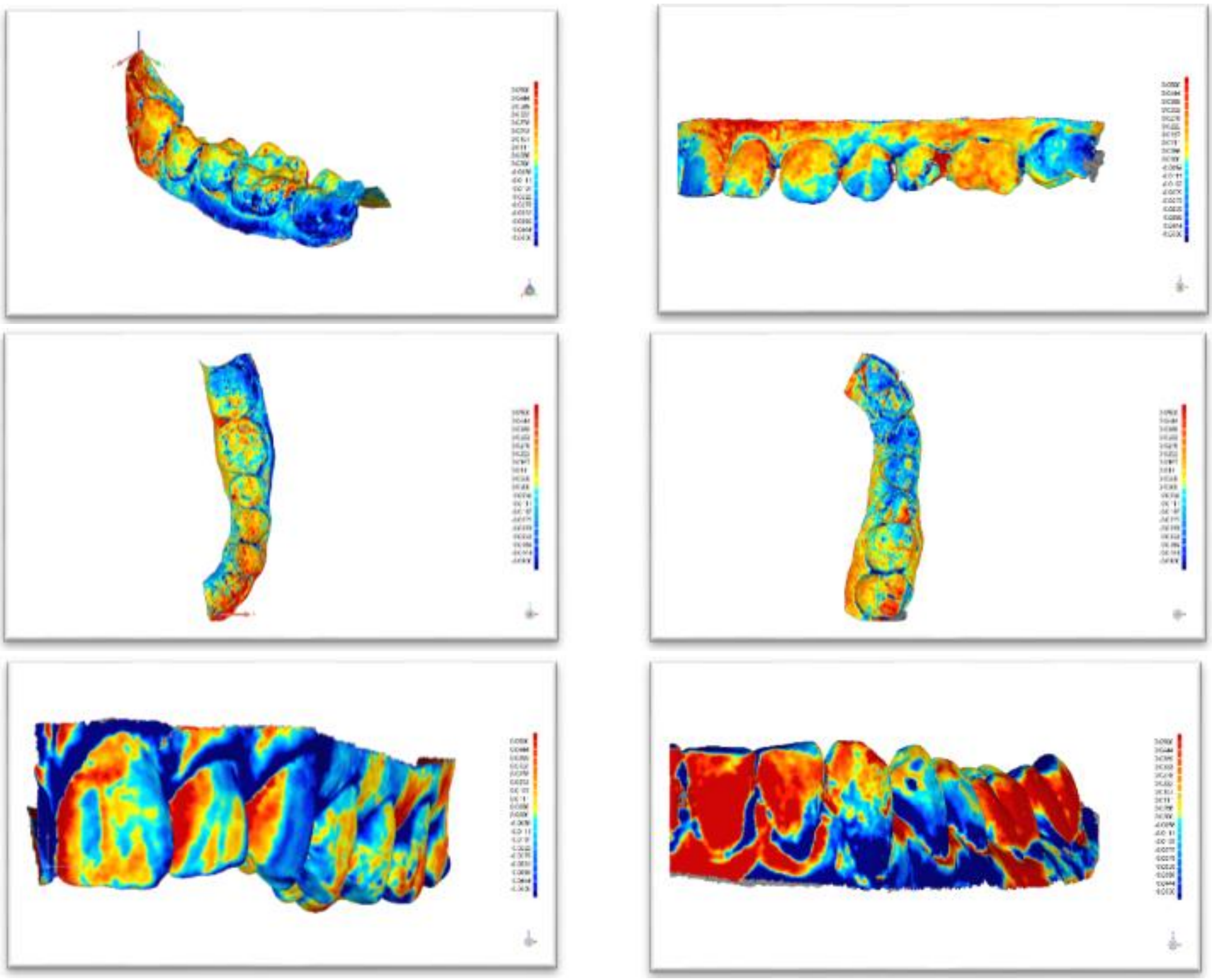

Figure 7.
3D analysis and color maps

Accuracy analysis

Trueness is defined as the comparison between digital impressions (from each system) served as a test model and a conventional impression served as the reference model (true value) of the same volunteer. Precision is defined as the comparison between repeated digital scanning models obtained from one volunteer from the same scanner. Following the 3D compare of every pairs, deviation information expressed as mean absolute deviation (average positive deviation + average negative deviation/ 2) accounting for trueness and standard deviation accounting for precision. The mean deviations of each volunteer were calculated.

Statistical analysis

Statistical analysis were performed with SPSS statistic software (version 21.0, SPSS Inc., Chicago, Illinois, United States). For each group classification, the mean value, the standard deviation (SD), the minimum and the maximum were calculated. For analyzing two and three-dimensional deviations, one-way ANOVA was performed. LSD (least significant difference) test for post hoc comparison was conducted. The statistical significance was set at $p < 0.05$.

RESULTS

Determine trueness

After the models were imported to Geomagic Control software the superimpositions were done, The measurement results (mean ±standard deviation) for trueness were: 99.88±42.56 μm for CEREC OC in upper jaw, 82.6±26.81 μm for CEREC OC in lower jaw, 105.53±25.49 μm for CARES IOS in upper jaw, and 109.56±36.84 μm for CARES IOS in lower jaw (Table 1).

The one-way analysis of variance (ANOVA) test was performed after the descriptive analysis to determine whether there are any statistically significant differences among study groups (Table 2). According to ANOVA, differences in trueness between CEREC OC and CARES IOS in both upper and lower jaw did not differ significantly (P>0.05).

Determine precision

The measurement results (mean ±standard deviation) for precision were: 66.19±16.44 μm for CEREC OC in upper jaw, 83.4±28.98 μm for CEREC OC in lower jaw, 136.25±50.57 μm for CARES IOS in upper jaw, and 126.49±37.36 μm for CARES IOS in lower jaw (Table 3).

The one-way analysis of variance (ANOVA) test was performed after the descriptive analysis to determine whether there are any statistically significant differences among study groups (Table 4). According to ANOVA, differences in precision between CEREC OC and CARES IOS differ significantly (P<0.05). To determine differences among the study groups LSD (least significant difference) test for post hoc comparison was performed. The LSD test results shows the significantly different groups among the study groups according to statistical significance (p < 0.05), and accordingly it indicates that CEREC OC groups (66.19±16.44 μm in upper jaw, 83.4±28.98 μm in lower jaw) was significantly more precise than CARES IOS groups (136.25±50.57 μm in upper jaw, and 126.49±37.36 μm in lower jaw). There were no significant differences between upper and lower jaws in same scanner (Table 5).

Table 1.

Descriptive statistics of trueness groups

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Mean Absolute Deviation	CEREC AC Omnicam-upper jaw	10	99.88	42.57	13,461	69.43	130.33	56.80	201.80
	CEREC AC Omnicam-lower jaw	10	82.60	26.81	8,47939	63.41	101,78	52.60	138.15
	CARES-upper jaw	10	105.53	25.50	8,06328	87.29	123.77	64.35	156.45
	CARES - lower jaw	10	109.56	36.85	11,6513	83.20	135.91	71.90	168.25
	Total	40	99.39	34.10	5,37568	88.52	110.27	52.60	201.80

Table 2.

ANOVA test result to determine trueness

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Mean Absolute Deviation	Between Groups	4232.727	3	1410.909	1.243	0.308
	Within Groups	40848.031	36	1134.668		
	Total	45080.758	39			

Table 3.

Descriptive statistics of precision groups

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Mean SD	CEREC AC Omnicam-upper jaw	10	66.20	16.45	5.20	54.43	77.96	45.80	91.70
	CEREC AC Omnicam-lower jaw	10	83.41	28.98	9.17	62.67	104.14	48.90	130.60
	CARES-upper jaw	10	136.26	50.58	15.99	100.08	172.43	92.55	229.90
	CARES - lower jaw	10	126.50	37.37	11.82	99.76	153.23	85.75	184.85
	Total	40	103.09	45.16	7.14	88.64	117.53	45.80	229.90

Table 4.

Descriptive statistics of precision groups

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Mean SD	Between Groups	33964.515	3	11321.505	8.942	0.000
	Within Groups	45580.924	36	1266.137		
	Total	79545.439	39			

Table 5.

LSD test results on study groups

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Mean SD	CEREC AC Omnicam-upper jaw	CEREC AC Omnicam-lower jaw	-17.21	15.91	0.287	-49.48	15.6
		CARES-upper jaw	-70.06*	15.91	0.000	-102.33	-37.79
		CARES-lower jaw	-60.30*	15.91	0.001	-92.57	-28.03
	CEREC AC Omnicam-lower jaw	CEREC AC Omnicam-upper jaw	17.21	15.91	0.287	-15.06	49.48
		CARES-upper jaw	-52.85*	15.91	0.002	-85.12	-20.58
		CARES-lower jaw	-43.09*	15.91	0.010	-75.36	-10.82
	CARES-upper jaw	CEREC AC Omnicam-upper jaw	70.06*	15.91	0.000	37.79	102.33
		CEREC AC Omnicam-lower jaw	52.85*	15.91	0.002	20.58	85.12
		CARES-lower jaw	9.76	15.91	0.544	-22.51	42.03
	CARES-lower jaw	CEREC AC Omnicam-upper jaw	60.30*	15.91	0.001	28.03	92.57
		CEREC AC Omnicam-lower jaw	43.09*	15.91	0.010	10,8167	75.36
		CARES-upper jaw	-9.76	15.91	0.544	-42.03	22.51

** The mean difference is significant at the 0.05 level*

DISCUSSION

In the light of the results, the null hypothesis was partially rejected, (1) No significant differences were found between two scanning devices concerning the trueness, while there were significant differences ($p < 0.05$) in the precision, CEREC OC showed lower deviation and consequently higher precision than CARES IOS. (2) No significant differences ($p > 0.05$) were found between upper and lower jaw among the study groups.

It is a common method to express the accuracy as trueness and precision. As applied in prior studies, to analyze the trueness: superimposition of the test data with the reference data is done, and superimposition of the test data under each other to analyze the precision.[10]

Although several studies have been made to evaluate the trueness and precision of digital and conventional impression, the design of these studies was made in different ways. Different methods and materials were used in the light of the same aim.

For the scanned field, some researchers create models with prepared teeth, Vecsei et al used PMMA (polymethyl methacrylate) model with four prepared teeth (first premolars, left central incisor and left second molar).[11] Güth et al used a titanium model with prepared premolar and molar teeth.[10] Ender et al; Güth et al; Flügge et al scanned full arch with no prepared teeth in their in vivo studies.[10,12,13] Renne et al made both posterior sextant and full arch scans in their in vitro study.[14] Ender et al selected upper and lower jaw randomly by coin toss in their study of the precision of complete arch impression.[12] In the present in vivo study, one-quadrant impressions for both upper and lower jaws were taken from each patient to examine if there is a difference in the accuracy between upper and lower jaws.

To evaluate the precision, comparison between repeated scanning models obtained from one patient from the same scanner is done. In order to evaluate the trueness, it has to be a reference dataset to compare the STL files gathered from different impression methods to it. In Güth et al; Renne et al; Vecsei et al in vitro studies, after creating the study model they digitized it by an industrial 3D scanner (Capture 3D Company) and used it as master (reference) model, this scanner has been demonstrated to have a high accuracy.[10,11,14,] Gan et al created the reference model in vivo depends on conventional impression after pouring the impression and extra-oral scanning the casts.[15] Similar to Gan et al, in the present study, the dataset provided from the conventional impressions were served as master (reference) model. The exact evaluating of the trueness cannot be achieved in vivo yet because of the missing of the reference structures (true value). But, in vitro trueness results can be integrated with in vivo studies of the reproducibility (precision), so it can give a good image about the performance of the intra oral scanner.

Although the direct comparison with other published results is difficult due to the wide variations in study design, the results of this study are compatible with values presented in the literature for accuracy (precision and trueness) of digital scanning systems. In Renne et al study, the mean value of trueness in sextant for CEREC OC was 56.2 µm and 107.6 µm for the complete arch, while the mean value of precision was 89.8 µm in sextant and 133.4 µm in complete arch.[14] Ender et al showed that, mean precision was 48.6 µm for CEREC OC in their study.[12] According to Güth et al, the mean value of the trueness was 31 µm on two prepared titanium teeth.[10] According to Ender et al, the value of the precision was 37.4 µm on a quadrant. The results of the current study are in accordance with the published studies; the mean values of CEREC OC trueness were 82.6 µm in lower jaw and 99.8 µm in upper jaw, while the precision values were 66.19 µm for upper jaw and 83.4 µm for the lower jaw.

In the systems which need a layer of powder; in a study on complete arch impressions, the precision values were 56.4 µm for CEREC Bluecam, 59.7 µm for True Definition Scanner (T-Def; 3M ESPE), and 82.8 µm for Lava COS (LAV; 3M ESPE).[12] In another study, the mean value of trueness in sextant for CEREC Bluecam was 57.5 µm and 155.6 µm for complete arch, while the mean value of precision was 89.6 µm in sextant and 194.2 µm in complete arch.[14] The results of the current study for CARES IOS as a powder needed scanner were similar to the published studies or a little bit higher, where the deviation of the trueness was 105.53 µm in upper jaw and 109.56 µm in lower jaw, while the precision values were 136.25 µm for upper jaw and 126.49 µm for the lower jaw. These results show that, the CARES IOS has lower accuracy than the other scanners previously mentioned.

The results of the present study provide the knowledge of the nature of deviation in full-arch digital impressions and can help to avoid these errors in future. The study was conducted to provide knowledge for dental professionals to understand and control the digital scanning process. Future studies need to include more dental scanner systems and compare them in different clinical scenarios.

CONCLUSION

Within the limitation of this in vivo study, both of the intraoral scanning systems were capable to give quadrant impression with clinically satisfying accuracy. Although, there were statistically significant differences between the two systems in terms of precision they were in a range that allows producing a successful restoration with the digital workflow.

REFERENCES

1. Hamalian TA, Nasr E, Chidiac JJ. Impression materials in fixed prosthodontics: influence of choice on clinical procedure. J Prosthodont. 2011; 20: 153-60.
2. Wadhwani CP, Johnson GH, Lepe X, Raigrodski AJ. Accuracy of newly formulated fast-setting elastomeric impression materials. J Prosthet Dent. 2005; 93: 530-9.
3. Aslan YU, Ozkan Y2. Comparing volumetric dimensional stability and accuracy of newly formulated polyvinyl siloxanether, polyvinyl siloxane and polyether impression materials using micro-computed tomography. Clin Exp Health Sci. 2019; 9: 94-100
4. Galhano GA, Pellizzer EP, Mazaro JV. Optical impression systems for CAD-CAM restorations. J Craniofac Surg. 2012; 23: 575-9.
5. Christensen GJ. Impressions are changing: deciding on conventional, digital or digital plus in-office milling. J Am Dent Assoc. 2009; 140: 1301-4.
6. Yuzbasioglu E, Kurt H, Turunc R, Bilir H. Comparison of digital and conventional impression techniques: evaluation of patients' perception, treatment comfort, effectiveness and clinical outcomes. BMC Oral Health. 2014; 14: 10.
7. Mormann WH. The evolution of the CEREC system. J Am Dent Assoc. 2006; 137: 7-13.
8. Syrek A, Reich G, Ranftl D, Klein C, Cerny B, Brodesser J. Clinical evaluation of all-ceramic crowns fabricated from intraoral digital impressions based on the principle of active wavefront sampling. J Dent. 2010; 38: 553-9.
9. Seelbach P, Brueckel C, Wostmann B. Accuracy of digital and conventional impression techniques and workflow. Clin Oral Investig. 2013; 17: 1759-64.
10. Güth JF, Runkel C, Beuer F, Stimmelmayr M, Edelhoff D, Keul C. Accuracy of five intraoral scanners compared to indirect digitalization. Clin Oral Invest. 2016; 21: 1445-55.
11. Vecsei B, Joós-Kovács G, Borbely J, Hermann P. Comparison of the accuracy of direct and indirect three-dimensional digitizing processes for CAD/CAM systems – An in vitro study. J Prosthodont Res. 2016; 61: 177-84.
12. Ender A, Attin T, Mehl A. In vivo precision of conventional and digital methods of obtaining complete-arch dental impressions. J Prosthet Dent. 2016; 115: 313-320.
13. Flügge TV, Schlager S, Nelson K, Nahles S, Metzger MC. Precision of intraoral digital dental impressions with iTero and extraoral digitization with the iTero and a model scanner. Am J Orthod Dentofacial Orthop. 2013; 144: 471-8.
14. Renne W, Ludlow M, Fryml J, Schurch Z, Mennito A,Kessler R, Lauer A. Evaluation of the accuracy of 7 digital scanners: An in vitro analysis based on 3-dimensional comparisons. J Prosthet Dent. 2017; 118: 36-42.
15. Gan N, Xiong Y, Jiao T. Accuracy of Intraoral Digital Impressions for Whole Upper Jaws, Including Full Dentitions and Palatal Soft Tissues. Plos One. 2016; 11: 1-15

Corresponding Author:

Yılmaz Umut ASLAN
Marmara University
Faculty of Dentistry
Department of Prosthodontics
Marmara Üniversitesi Başıbüyük Sağlık Yerleşkesi
Başıbüyük Yolu 9/3
34854, Başıbüyük, Maltepe, İstanbul, Turkey
Phone : +90 542 321 65 43
Fax : +90 212 246 52 47
E-mail : umut.aslan@marmara.edu.tr