

Primescan™ Intraoral Scanner Study Overview 2019-2021



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Overview Primescan™ Studies*

Study Name	Author/Date	Method	Claims
Accuracy of complete- and partial-arch impressions of actual intraoral scanning systems in-vitro	Ender, Zimmermann, Mehl (2019)	In-vitro	In certain aspects, Primescan™ was viewed as the most accurate among the tested intraoral scanners that were compared in an in-vitro study.
The effect different substrates have on the trueness and precision of eight different intraoral scanners	Dutton et al. (2019)	In-vitro	Primescan™ was ranked number 1 in 11 out of 15 categories, for the remaining 4 categories a top rank was achieved.
Do “cut out-rescan” procedures have an impact on the accuracy of intraoral digital scans?	Reich, Yatmaz, Raith (2019)	In-vitro	Primescan™ ranked top in trueness and precision.
Impact of different scanning strategies on the accuracy of two current intraoral scanning systems in complete-arch impressions: an in-vitro study	Passos, Meiga, Brigagão, Street (2019)	In-vitro	For trueness and precision of complete-arch scans, group M was the dominant scanning strategy in Primescan™, while there was no dominant strategy in Omnicam®. OC and PS had very good results.
In-vitro study on digital splint effect to the accuracy of digital dental implant impression	Gedrimiene et al. (2019)	In-vitro	Primescan™ showed the best results of trueness and precision of distance and angle measurements.
Local accuracy of actual intraoral scanning systems for single-tooth preparations in-vitro	Zimmermann, Ender, Mehl (2020)	In-vitro	Results showed that PS had higher trueness and values were statistically significantly different from the other IOS systems, except TRIOS®.
Accuracy of digital and conventional full-arch 2 impressions in patients: an update	Schmidt, Klussmann, Wöstmann, Schlenz (2020)	In-vivo	Primescan™ yielded the lowest deviation for digital impressions in-vivo.
Digital versus conventional impression taking focusing on interdental areas: a clinical trial	Schlenz, Schubert, Schmidt, Wöstmann, Ruf, Klaus (2020)	In-vivo	Primescan™ can display a higher percentage of Interdental Areas (IA) than CVI. Amongst the powder-free IOS, Primescan™ displayed the highest percentage of IA together with Carestream CS 3600.
Congruence between meshes and library files of implant scanbodies: an in-vitro study comparing five intraoral scanners	Mangano, Lerner, Margiani, Solop, Latuta, Admakin (2020)	In-vitro	Primescan™ showed the lowest mean absolute deviation. The difference to the other IOS systems was statistically significant, except Carestream CS-3700.
Accuracy of intraoral scanning in completely and partially edentulous maxillary and mandibular jaws: an in-vitro analysis	Schimmel, Akino, Srinivasan, Wittneben, Yilmaz, Abou-Ayash (2020)	In-vitro	The accuracy of Primescan™ for partially and completely edentulous arches in in-vitro settings was high. The operator’s experience with intraoral scanners had small influence on the accuracy of the scans.
Accuracy of three intraoral scans for primary impressions of edentulous jaws	Cao, Chen, Deng, Wang, Sun, Zhao (2020)	In-vitro	The precision of CEREC Primescan™ scanner was significantly better than that of the other two scanners for maxilla. There was no significant difference in trueness of the three scanners when scanning the maxilla and mandible.

Overview Primescan™ Studies*

Study Name	Author/Date	Method	Claims
Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in-vitro study	Mangano, Admakin, Bonacina, Lerner, Rutkunas, Mangano (2020)	In-vitro	Primescan™ belonged to the group of IOS with the highest accuracy (together with iTero® Elements® 5D, Carestream CS 3700, Carestream CS 3600, TRIOS® 3, Medit i-500) In the analysis of the overall trueness with the nurbs/nurbs method Primescan™ belonged to the three best IOS (together with iTero® Elements® 5D and TRIOS® 3)
Comparing the accuracy of six intraoral scanners on prepared teeth and effect of scanning sequence	Diker, Tak (2020)	In-vitro	Primescan™ showed statistically the highest trueness. The highest precision value was also measured for Primescan™ but with no statistically significant difference to TRIOS®, iTero®, and Omnicam®.
In-vitro analysis of intraoral digital impression of inlay preparation according to tooth location and cavity type	Kim, Son, Lee, Kim, Park (2020)	In-vitro	The overall accuracy of digital impressions with Primescan™ for inlay preparations was clinically acceptable. Small differences were observed depending on tooth location (< 2 µm) and inlay cavity type (< 1 µm).
Accuracy and repeatability of different intraoral scanners on shade determination	Ebeid, Sabet, Bona (2020)	In-vitro	There was no statistical difference for shade detection between Primescan™, Omnicam® and TRIOS® 3.
Effect of pulp chamber depth on the accuracy of endocrown scans made with different intraoral scanners versus an industrial scanner: an in-vitro study	Gurpinar, Tak (2020)	In-vitro	CEREC Primescan™ was found to have the best trueness and precision among the evaluated IOSs (P<.05). Statistically significant differences were found for all tested pulpal chamber depths.
Influence of preparation design, marginal gingiva location, and tooth morphology on the accuracy of digital Impressions for full-crown restorations: an in-vitro investigation	Bernauer, Müller, Zitzmann, Joda (2020)	In-vitro	The overall accuracy of Primescan™ for all abutment teeth was very high whereby Primescan™ and TRIOS® 3 revealed homogenous results.

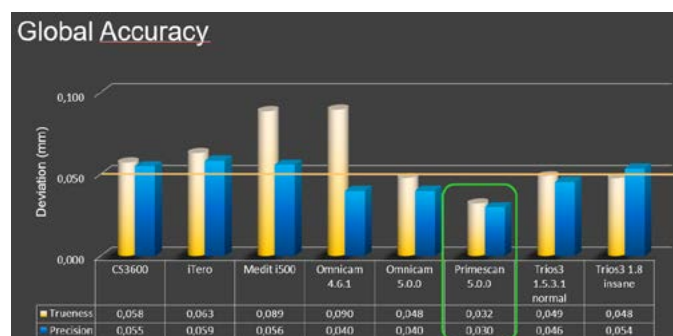
TRIOS®, Carestream CS 3600, Carestream CS-3700, iTero®, and Medit i500 are not registered trademarks of Dentsply Sirona Inc.

* The summaries are mere abstracts of the studies. For complete details, please see the full studies noted at the bottom of each summary page.

Accuracy of complete- and partial-arch impressions of actual intraoral scanning systems in-vitro

Study Background

- In-vitro study with local and global accuracy
- Translucent, ceramic tooth model was used
- Primescan™, Omnicam®, TRIOS® 3, Medit i500, Carestream CS3600, iTero®



Talking Points

- In certain aspects, Primescan™ was viewed as the most accurate among the tested intraoral scanners that were compared in an in-vitro study
- In the peer group of intraoral scanners, which did not cover several systems commercially available today, Primescan™ showed the best median and mean values across complete arch, anterior and posterior segments, few statistical limitations apply
- Omnicam® results have significantly improved with the latest CEREC SW 5

Abstract

Objective

Intraoral scanners (IOSs) are widely used for obtaining digital dental models directly from the patient. Additionally, improvements in IOSs are made from generation to generation. The aim of this study was to evaluate the accuracy of new and actual IOS devices for complete- and partial-arch dental impressions in an in-vitro setup.

Materials and methods

A custom maxillary complete-arch cast with teeth made from feldspar ceramic material was used as the reference cast and digitized with a reference scanner (ATOS III Triple Scan MV60). One conventional impression technique using polyvinylsiloxane (PVS) material (President) served as the control (CO), and eight different IOS devices comprising different hardware and software configurations (TRn: TRIOS® 3; TRi: TRIOS® 3 insane; Carestream CS: Carestream Dental Carestream CS 3600; MD: Medit i500; iT: iTero® Element® 2; OC4: CEREC Omnicam® 4.6.1; OC5: CEREC Omnicam® 5.0.0; PS: Primescan™) were used to take complete-arch impressions from the reference cast. The impressions were repeated 10 times ($n = 10$) for each group. Conventional impressions were poured with type IV gypsum and digitized with a laboratory scanner (inEos X5). All datasets were obtained in standard tessellation language (STL) file format and cut to either complete-arch, anterior segment, or posterior segment areas for respective analysis. Values for trueness and precision for the respective areas

were evaluated using a three-dimensional (3D) superimposition method with special 3D difference analysis software (GOM Inspect) using (90-10)/2 percentile values. Statistical analysis was performed using either one-way analysis of variance (ANOVA) or Kruskal-Wallis test ($\alpha = 0.05$). Results are given as median and interquartile range [IQR] values in μm .

Results

Statistically significant differences were found between test groups for complete- and partial-arch impression methods in-vitro ($p < 0.05$). Values ranged from 16.3 [2.8] μm (CO) up to 89.8 [26.1] μm (OC4) for in-vitro trueness, and from 10.6 [3.8] μm (CO) up to 58.6 [38.4] μm (iT) for in-vitro precision for the complete-arch methods. The best values for trueness of partial-arch impressions were found for the posterior segment, with 9.7 [1.2] μm for the conventional impression method (CO), and 21.9 [1.5] μm (PS) for the digital impression method.

Conclusion

Within the limitations of this study, digital impressions obtained from specific IOSs are a valid alternative to conventional impressions for partial-arch segments. Complete-arch impressions are still challenging for IOS devices; however, certain devices were shown to be well within the required range for clinical quality. Further in-vivo studies are needed to support these results.

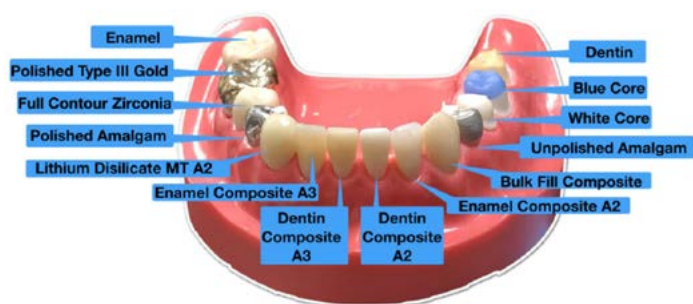
Go to study: https://ijcd.quintessenz.de/ijcd_2019_01_s0011.pdf

[Back to Table of Contents](#)

The effect different substrates have on the trueness and precision of eight different intraoral scanners

Study Background

- In-vitro study with local and global accuracy
- Primescan™, Omnicam®, TRIOS® 3, Element2, Medit i500, Emerald™, Emerald™ S
- Dentin, Enamel, Gold, Amalgam, Resin, Zirconia, Lithium Disilicate, Enamel/Dentin Composite, White/Blue Core, Bulk Fill Composite
- 3D best fit alignment
- Average of the absolute values of the average positive and negative deviations of the IOS data.



Talking Points

- Except for TRIOS® 3, substrate influences trueness and precision -> doesn't say anything about the level of accuracy
- Different scanners show different accuracy for same substrate
- Latest generation scanners more accurate than older scanners
- Primescan™ ranked #1 in 11 out of 15 categories
- Amongst those the important categories: Enamel, Dentin, Cross arch
- Primescan™ ranked within top 4 for remaining 4 categories
- Omnicam® was used with an old SW version, results are expected to be significantly better with latest version
- Study supports the proven accuracy of Primescan™ once again

Abstract

Objective

This in-vitro study compares the newest generation of intraoral scanners to their older counterparts, and tests whether material substrates affect the trueness and precision of intraoral scanners (IOS).

Material and methods

A custom model, used as the reference standard, was fabricated with teeth composed of different dental materials. The reference standard scan was obtained using a three dimensional (3D) optical scanner, the ATOS III. Experimental scans were obtained using eight different IOS, operated by experienced clinicians, using the manufacturer's recommended scanning strategy. A comprehensive metrology program, Geomagic Control X, was used to compare the reference standard scan with the experimental scans.

Results

For all scanners tested, except TRIOS® 3, the substrate does influence the trueness and precision of the scan. Furthermore, differences exist when comparing the same substrate across different scanners with some of the latest generation scanners clearly leaping ahead of the older generation regarding both trueness and precision.

Conclusions

Substrate type affects the trueness and precision of a scan. Active Triangulation scanners are more sensitive to substrate differences than their parallel confocal counterparts. Some scanners scan certain substrates better, but in general the new generation of scanners outperforms the old, across all substrates.

Clinical significance

The substrates being scanned play an important role in the trueness and precision of the 3D model. The new generation of scanners is remarkably accurate across all substrates and for complete arch scanning.

Go to study: <https://onlinelibrary.wiley.com/doi/full/10.1111/jerd.12528>

[Back to Table of Contents](#)

Do “cut out-rescan” procedures have an impact on the accuracy of intraoral digital scans?

Study Background

- Complete-arch scan data of a maxillary master cast were generated 10 times with 3 intraoral scanners: TRIOS® 3 [TR], CEREC Primescan™ [PR], and CEREC Omnicam® [OM].
- For the “cut-out-rescan”:
 - all complete arch scans were duplicated
 - the posterior area from the right lateral incisor was cut out from the duplicated scan data and rescanned
 - superimposition of the rescanned area onto the cut-out scan ([TR_rs], [PR_rs], [OM_rs])
- As reference the master cast was scanned with a high precision industrial structured light scanner
- Evaluation of trueness and precision
- To evaluate statistical differences, either the Mann-Whitney U test or the t test was used ($\alpha=.05$)

Talking Points

- The t test revealed statistically significant differences among the different scanners
- The comparison of the trueness values of the complete arch scan data with those of the corresponding “cut out-rescanned” data of each scanner system did not reveal statistically significant differences in any scanner system
- Significant differences were found between the precision results of the OM and PR as well as for the pairs OM_rs/TR_rs and TR_rs/PR_rs

Table 1. Trueness values

Types of STL Data Sets	N	Minimum (μm)	Maximum (μm)	Mean \pm Standard Deviation (μm)
OM	9	48	59	53 th \pm 4
OM_rs	9	48	69	55 th \pm 6
TR	10	36	51	42 nd \pm 5
TR_rs	10	31	46	38 th \pm 5
PR	10	26	34	29 th \pm 3
PR_rs	10	26	40	31 st \pm 5

Table 2. Precision values

Types of STL Data Sets	N	Min. (μm)	Max. (μm)	Mean \pm Standard Deviation (μm)	Median (μm)
OM	36	12	31	20 \pm 4	19 ^a
OM_rs	36	16	63	28 \pm 11	25 th
TR	45	12	24	18 \pm 3	19
TR_rs	45	12	28	17 \pm 4	16 ^d
PR	45	8	29	15 \pm 5	14 ^a
PR_rs	45	8	27	16 \pm 5	14 ^a

Abstract

Statement of problem

The software of digital intraoral scanners typically offers the option to cut out areas from 3D casts, to do rescans, and to merge them with the initial scan. However, evidence of whether this procedure has an impact on the accuracy of the scan is lacking.

Purpose

The purpose of this study was to determine whether “cut out-rescan” procedures change the accuracy of a 3D cast.

Material and methods

A maxillary master cast was digitized with an industrial structured light scanner to obtain a digital reference cast. This master cast was repeatedly scanned by 3 intraoral scanners: TRIOS® 3 [TR], CEREC Primescan™ [PR], and CEREC Omnicam® [OM]. The scan data were duplicated, and the posterior area from the right lateral incisor was cut out and rescanned to obtain complete-arch casts containing the rescanned data [TR_rs], [PR_rs], and [OM_rs]. The trueness and precision of the scans were evaluated by superimposing procedures of the relevant data sets. To evaluate statistical differences, either the Mann-Whitney U test or the t test was used ($\alpha=.05$).

Results

The median precision values of the complete-arch scan data was 19 μm for [OM] and [TR], whereas the median for [PR] was 14 μm . In the “cut out-rescanned” data group, the values were 25 μm for [OM_rs], 16 μm for [TR_rs], and 14 μm for [PR_rs]. Statistically significant differences were found among the scanners [OM]/[PR], [OM_rs]/[TR_rs], and [TR_rs]/[PR_rs]. The mean \pm standard deviation values of trueness for the complete-arch scan data were 54 \pm 4 μm for [OM], 42 \pm 5 μm for [TR], and 30 \pm 2 μm for [PR]. In the group of the “cut out-rescanned” data, the mean trueness results were 55 \pm 6 μm for [OM_rs], 38 \pm 5 μm for [TR_rs], and 31 \pm 5 μm for [PR_rs]. Significant differences were found among the complete-arch scan data and the “cut out-rescanned” data of the different scanners, but not between the complete-arch scan data and the “cut out-rescanned” data within one scanning system.

Conclusions

Significant differences were found among the scanners, but “cut out-rescan” procedures did not affect the accuracy within each scanning system.

Go to study: <https://www.sciencedirect.com/science/article/abs/pii/S0022391319307553> Back to Table of Contents

Impact of different scanning strategies on the accuracy of two current intraoral scanning systems in complete-arch impressions: an in-vitro study

Study Background

- A customized complete-arch maxillary cast was scanned
- A master reference scan was obtained through an ATOS III Triple Scan 3D optical scanner
- Omnicam® (CEREC SW 5.1.0) and Primescan™ (CEREC SW 5.0.2) were used for complete-arch scanning with 13 different scanning strategies
- Best fit alignment of the scans with master scan
- Evaluation of trueness and precision
- Statistical analyses utilized Welch's unequal variances t test

Talking Points

- This scan strategy has very good value and is easy to use.
- Primescan™ featured a better trueness index (4.79 μm) than that of Omnicam® (19.13 μm). Primescan™, also featured a better precision index (4.67 μm) than Omnicam®, group B (16.75 μm), with a statistically significant difference.

Abstract

Aim

To determine the scanning strategy that obtains the most accurate results for two intraoral scanners (IOS) in complete-arch digital impressions. Scan time was evaluated and correlated with scan strategies.

Materials and method

A custom model used as the reference standard was fabricated with teeth having dentin- and enamel-identical refractive indices simulating natural dentition. A reference scan of the custom typodont was obtained using an ATOS III Triple Scan 3D optical scanner. Two IOS setups - Omnicam® v 5.1.0 and Primescan™ v 5.0.2 - were used for complete-arch scanning, each using 13 scanning strategies, obtaining 260 digital files (n = 10 per group), recording each scan time, converting all experimental scans to standard tessellation language (STL) format, and using a comprehensive metrology program to compare the reference standard scan with the experimental scans. Statistical analyses utilized Welch's unequal variances t test.

Results

Group M exhibited the lowest trueness and precision values (P < 0.05) for Primescan™ (47.5% of the average among all other groups) and the lowest trueness value (P < 0.05) for Omnicam® (53.4% of the average among all other groups), where group B exhibited the lowest precision value (65.6% of the average among all other groups) with P < 0.05. Primescan™ featured a better trueness index (4.79 μm) than that of Omnicam® (19.13 μm), with a statistically significant difference (P < 0.00001). Primescan™, group M, also featured a better precision index (4.67 μm) than Omnicam®, group B (16.75 μm), with a statistically significant difference (P < 0.00001).

Conclusion

For both IOS systems, group M provided the lowest scanning times. For trueness and precision of complete-arch scans, group M was the dominant scanning strategy in Primescan™, while there was no dominant strategy in Omnicam®. Group M had the best scanning time for both IOS systems.

Go to study: <https://www.ncbi.nlm.nih.gov/pubmed/31840139>

[Back to Table of Contents](#)

In-vitro study on digital splint effect to the accuracy of digital dental implant impression

Abstract

Background

Digital implant impressions (DII) with intraoral scanners (IOS) are a relatively novel, but continuously improving technique. Since IOS devices can only capture part of the object at a time, images have to be stitched together to form a 3D object and therefore it is the source of possible errors of the scan. Digital splinting at edentulous areas can possibly improve the accuracy of DII.

Aim/Hypothesis

The aim of this in-vitro study was to compare the trueness and precision of three different IOS scanning partially and fully edentulous models with 2 or 4 implants with attached scan bodies and digital splints.

Material and Methods

Two types of maxilla models were printed with Asiga™ Max 3D printer. The first model was missing both premolars and molars on the right side, so Straumann BL dental implants were inserted instead first premolar (straight) and second molar (tilted 20° mesially). Four implants were inserted in the second edentulous model symmetrically at second incisors (straight) and first molar areas (tilted 20° mesially). Scan bodies were attached to the implants and models were scanned with Nikon Altera 10.7.6. coordinate measurement machine (CMM) to form a reference scan. DII was taken with a Primescan™ (version 5.0.1), Carestream CS 3600 (version 3.1.0), TRIOS® 3 (version 1.18.2.10) IOS ten times each (n = 10) without digital splint. After that, tablets

of hardened Fuji Plus® cement was glued in edentulous areas to form digital splint and all models were scanned with three different IOS. Scanning data were exported in standard tessellation language format for analysis.

Results

Trueness of distance and angle in Carestream partially edentulous models was 185 µm in the group with splint and 280 µm without one and 0.22° in the group with splint and 0.29° in the group without respectively. Precision of distance and angle measurements in the splint groups were 87 µm and 0.13°, in the groups without –202 µm and 0.25°. In fully edentulous models trueness of distance varied 53–106 µm in the groups with splint and 67–8 µm in the groups without. Trueness of Primescan™ in partially edentulous models with splints was 21 µm and 0.16° in distance and angular measurements. Without splints –27 µm and 0.21°. For fully edentulous models trueness and precision of distance and angle was better in groups with splint than without. Trueness of distance and angle of TRIOS® 3 in partially edentulous splinted models was 15 µm and 0.3°; 53 µm and 0.11° in unsplinted models respectively.

Conclusion and Clinical Implications

Primescan™ showed the best results of trueness and precision of distance and angle measurements. Since digital splints improve the accuracy of DII, the impact of their forms and materials should be more researched.

Carestream CS 3600 (version 3.1.0), TRIOS® 3 (version 1.18.2.10), Asiga Max™ and Fuji Plus® are not registered trademarks of Dentsply Sirona Inc.

Go to study: https://onlinelibrary.wiley.com/doi/pdf/10.1111/clr.322_13509

[Back to Table of Contents](#)

Local accuracy of actual intraoral scanning systems for single-tooth preparations in-vitro

Study Background

The authors evaluated the local accuracy of intraoral scanning (IOS) systems for single-tooth preparation impressions with an in-vitro setup.

Talking Points

“We found statistically significant differences of CO for all IOS systems except PS. Among the IOS systems, our results showed that the PS group had higher trueness for SU parameter, with median (IQR) of 19.4 (5.0) mm; values were statistically significantly different from the other IOS systems, except TRn and TRi.”

Table 1. Test groups including indication of software versions, manufacturers, and postprocessing protocols to obtain STL* data sets for the evaluation of accuracy of impression methods for local accuracy of tooth preparations.

TEST GROUP	SYSTEM	MANUFACTURER	SOFTWARE	POSTPROCESSING
CO*	PRESIDENT 360 Heavy Body and PRESIDENT Light Body	Coltène AG	Not applicable	Printed with type IV gypsum, digitized with iEOS XS, direct export to STL
TRn	TRIOS 3 Rod normal scan mode	3Shape	TRIOS 3 software, Version 1.18.2.6	Direct export to STL
TRi	TRIOS 3 Rod insane speed scan mode	3Shape	TRIOS 3 software, Version 1.18.2.6	Direct export to STL
CS	CS 3600	Carestream Dental	CS IO 3D acquisition software, Version 3.1.0	Direct export to STL
MD	Medit 500	Medit	Medit Link, Version 1.2.1	Direct export to STL
IT	iTero Element 2	Align Technology	iTero Element 2 software, Version 1.7	Direct export to STL
OC4	CEREC Omnicam	Dentsply Sirona	CEREC software, Version 4.6.1	Direct export to STL
OC5	CEREC Omnicam	Dentsply Sirona	CEREC software, Version 5.0.0	Direct export to STL
PS	Primescan	Dentsply Sirona	CEREC software, Version 3.0.0	Direct export to STL

* STL: Standard tessellation language; † CO: Conventional impression method

VARIABLE	PREPARATION SURFACE, MICROMETERS		PREPARATION MARGIN, µm	
	Median (IQR) ^a	Mean (SD) ^b	Median (IQR)	Mean (SD)
Trueness				
Group				
CO ^c	11.8 (2.0)	12.2 (2.3) ^d	11.7 (2.6)	18.2 (3.0) ^e
TRn ^f	23.9 (4.2)	22.6 (2.7) ^{g,h}	31.9 (7.0)	32.0 (4.6) ^{g,h}
TRi ^f	23.6 (5.4)	23.6 (3.0) ^{g,h}	30.7 (6.0)	31.5 (4.6) ^{g,h}
CS ^g	28.9 (9.4)	31.1 (7.9) ^{h,i}	34.9 (8.4)	35.8 (6.0) ^{h,i}
MD ^g	31.4 (5.1)	32.0 (3.2) ^{h,k}	34.5 (6.2)	34.6 (4.3) ^{h,k}
IT ^g	34.6 (8.6)	36.3 (7.8) ^{h,l}	38.1 (11.1)	40.0 (6.9) ^h
OC4 ^h	36.7 (10.1)	36.6 (6.4) ^h	54.3 (9.0)	53.4 (6.2) ^h
OC5 ^h	40.5 (10.9)	41.7 (7.0) ^h	55.9 (15.5)	58.0 (10.6) ^h
PS ^h	19.4 (5.0)	18.7 (2.8) ^{h,m}	21.4 (2.7)	22.4 (2.4) ^h
Precision				
Group				
CO	8.7 (2.2)	9.3 (3.9) ⁿ	14.3 (9.0)	17.7 (8.8) ⁿ
TRn	15.8 (3.8)	14.0 (2.4) ⁿ	18.9 (8.7)	21.2 (6.7) ⁿ
TRi	15.8 (3.5)	16.0 (2.3) ⁿ	22.5 (12.4)	24.4 (6.9) ⁿ
CS	18.3 (6.7)	19.5 (6.1) ⁿ	38.0 (17.7)	38.5 (12.0) ⁿ
MD	13.4 (3.4)	13.6 (3.5) ⁿ	21.0 (7.6)	21.6 (6.9) ⁿ
IT	17.8 (7.7)	19.6 (8.0) ⁿ	47.0 (14.9)	47.6 (11.3) ⁿ
OC4	21.1 (6.0)	20.3 (4.0) ⁿ	39.0 (15.7)	38.5 (10.6) ⁿ
OC5	23.9 (8.8)	24.7 (5.3) ⁿ	48.8 (24.4)	50.2 (15.4) ⁿ
PS	8.3 (2.4)	8.3 (1.5) ⁿ	15.5 (8.4)	17.9 (7.6) ⁿ

Abstract

Background

The authors evaluated the local accuracy of intraoral scanning (IOS) systems for single-tooth preparation impressions with an in-vitro setup.

Methods

The authors digitized a mandibular complete-arch model with 2 full-contour crowns and 2 multisurface inlay preparations with a highly accurate reference scanner. Teeth were made from zirconia-reinforced glass ceramic material to simulate toothlike optical behavior. Impressions were obtained either conventionally (PRESIDENT Micosystem™, Coltène) or digitally using the IOS systems TRIOS® 3 and TRIOS® 3 using insane scan speed mode (3Shape), Medit i500, Version 1.2.1 (Medit), iTero® Element® 2, Version 1.7 (Align Technology), Carestream CS 3600, Version 3.1.0 (Carestream Dental), CEREC Omnicam®, Version 4.6.1, CEREC Omnicam®, Version 5.0.0, and Primescan™ (Dentsply Sirona). Impressions were repeated 10 times per test group. Conventional (CO) impressions were poured with type IV gypsum and digitized with a laboratory scanner. The authors evaluated trueness and precision for preparation margin (MA) and preparation surface (SU) using 3-dimensional superimposition and 3-dimensional difference analysis method using (95% - 5%) / 2 percentile values. Statistical analysis was performed using Kruskal-Wallis test. Results were presented as median (interquartile range) values in micrometers.

Results

The authors found statistically significant differences for MA and SU among different test groups for both trueness and precision (P < .05). Median (interquartile range) trueness values ranged from 11.8 (2.0) µm (CO) up to 40.5 (10.9) µm (CEREC Omnicam®, Version 5.0.0) for SU parameter and from 17.7 (2.6) µm (CO) up to 55.9 (15.5) µm (CEREC Omnicam®, Version 5.0.0) for MA parameter.

Conclusions

IOS systems differ in terms of local accuracy. Preparation MA had higher deviations compared with preparation SU for all test groups.

Practical implications

Trueness and precision values for both MA and SU of single-unit preparations are equal or close to CO impression for several IOS systems.

Go to study: <https://www.sciencedirect.com/science/article/abs/pii/S0002817719307664> Back to Table of Contents

Accuracy of digital and conventional full-arch impressions in patients: an update

Study Background

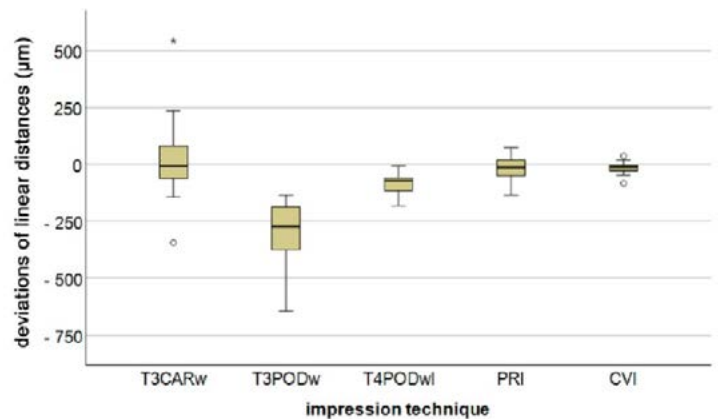
- Five patients with a complete lower dental arch were included in this *in vivo* study.
- Four bearing steel spheres with a diameter of 5 mm were reversibly luted on the teeth of the lower jaw using a flowable composite
- Subsequently, in every patient four digital full-arch impressions were taken using TRIOS® 3 Cart wired, TRIOS® 3 Pod wired, TRIOS® 4 Pod wireless and Primescan™ as well as a high precision conventional impression was taken
- Distances between the single spheres were compared



Figure 1. Metallic reference aid with four steel spheres.

Talking Points

- For the two short distances in the posterior segments (i.e., spheres D1_2 and D3_4), digital had more precise results were found using digital compared with conventional impressions.
- For long-span distances, the CVI technique provided the lowest deviation, although no significant difference was demonstrated for PRI and T4PODwl.
- Hardware components of the TRIOS® scanner exhibited an influence on accuracy.



Abstract

The aim of this clinical study was to update the available data in the literature regarding the transfer accuracy (trueness/precision) of four current intraoral scanners (IOS) equipped with the latest software versions and to compare these data with conventional impressions (CVI). A metallic reference aid served as a reference dataset. Four digital impressions (TRIOS® 3 Cart, TRIOS® 3 Pod, TRIOS® 4 Pod, and Primescan™) and one CVI were investigated in five patients. Scan data were analyzed using three-dimensional analysis software and conventional models using a coordinate measurement machine. The transfer accuracy between the reference aid and the impression methods were compared. Differences with $p < 0.05$ were considered to be statistically significant. Overall, mean \pm standard

deviation (SD) transfer accuracy ranged from $24.6 \pm 17.7 \mu\text{m}$ (CVI) to $204.5 \pm 182.1 \mu\text{m}$ (TRIOS® 3 Pod). The Primescan™ yielded the lowest deviation for digital impressions ($33.8 \pm 31.5 \mu\text{m}$), followed by TRIOS® 4 Pod ($65.2 \pm 52.9 \mu\text{m}$), TRIOS® 3 Cart ($84.7 \pm 120.3 \mu\text{m}$), and TRIOS® 3 Pod. Within the limitations of this study, current IOS equipped with the latest software versions demonstrated less deviation for short-span distances compared with the conventional impression technique. However, for long-span distances, the conventional impression technique provided the lowest deviation. Overall, currently available IOS systems demonstrated improvement regarding transfer accuracy of full-arch scans in patients.

Go to study: <https://www.ncbi.nlm.nih.gov/pubmed/32143433>

[Back to Table of Contents](#)

Digital versus conventional impression taking

Focusing on interdental areas: a clinical trial

Study Background

- Overcome limitations of in-vitro study
- Compare the ability of one conventional and four digital impression techniques to reproduce Interdental Areas (IA) of periodontally compromised dentitions (PCD)
- In-vivo, 30 patients, 1 experienced operator
- Four digital impressions were taken for each jaw with 3M True Definition, Primescan™, Carestream CS 3600, TRIOS® 3
- Comparison against digitized conventional impression
- 3D best-fit alignment
- Calculation of percentage of displayed IA in relation to absolute IA

Talking Points

- IOS can display higher percentage of IAs than CVI
- IAs in the anterior area of the jaw are better displayed than in the posterior area by IOS
- A higher percentage of IA was displayed for class III PCD
- True definition displayed a higher percentage of IAs but requires application of optical powder for impression taking
- Primescan™ and Carestream CS 3600 displayed the highest percentage of IA amongst the powder-free IOS
- TRIOS® 3 displayed the lowest percentage of IA compared to all other IOS

Abstract

Due to the high prevalence of periodontitis, dentists have to face a larger group of patients with periodontally compromised dentitions (PCDs) characterized by pathologic tooth migration and malocclusion. Impression taking in these patients is challenging due to several undercuts and extensive interdental areas (IAs). The aim of this clinical trial was to analyze the ability of analog and digital impression techniques to display the IAs in PCDs. The upper and the lower jaws of 30 patients (n = 60, age: 48-87 years) were investigated with one conventional impression (CVI) using polyvinyl siloxane and four digital impressions with intraoral scanners (IOSs), namely 3M True Definition (TRU),

Primescan™ (PRI), Carestream CS 3600 (CAR), and TRIOS® 3 (TIO). The gypsum models of the CVIs were digitalized using a laboratory scanner. Subsequently, the percentage of the displayed IAs in relation to the absolute IAs was calculated for the five impression techniques in a three-dimensional measuring software. Significant differences were observed among the impression techniques (except between PRI and CAR, p-value < 0.05). TRU displayed the highest percentage of IAs, followed by PRI, CAR, TIO, and CVI. The results indicated that the IOSs are superior to CVI regarding the ability to display the IAs in PCDs.

Go to study: <https://www.mdpi.com/1660-4601/17/13/4725>

[Back to Table of Contents](#)

Congruence between meshes and library files of implant scanbodies: an in-vitro study comparing five intraoral scanners

Study Background

- Assess and compare reliability of five different IOS in the capture of implant Scanbodies (SB)
- Verify dimensional congruence between meshes of SB captured during scan of a complete arch model with six implants and the corresponding library file
- In-vitro
- Gypsum cast representing a fully edentulous maxilla with 6 implant was scanned with: Primescan™, Carestream CS 3700, Medit i-500, iTero® Elements® 5D, Emerald™ S
- 3D analysis of the congruence between scanned mesh of SB and SB library file, best fit alignment
- Calculation of quantitative and qualitative deviation between scanned mesh of SB and SB library file

Talking Points

- Primescan™ and Carestream CS 3700 showed the highest congruence between SB MEs and LF, with the lowest mean absolute deviations
- Statistically significant difference between these two scanners and the other three
- Primescan™ was the IOS with the lowest mean absolute deviation but the difference to Carestream CS 3700 was statistically not significant

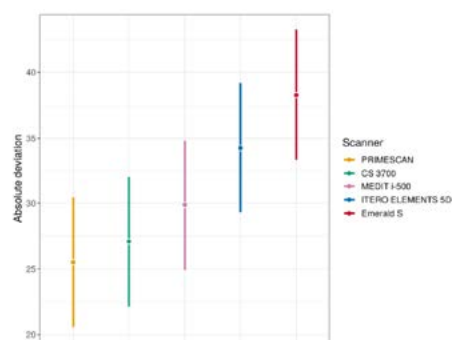


Figure 5. Mean absolute deviations estimates (with 95% confidence interval (CI)) for each type of IOS (these quantities were estimated using linear mixed effects model).

Abstract

Purpose

To compare the reliability of five different intraoral scanners (IOSs) in the capture of implant scanbodies (SBs) and to verify the dimensional congruence between the meshes (MEs) of the SBs and the corresponding library file (LF).

Methods

A gypsum cast of a fully edentulous maxilla with six implant analogues and SBs screwed on was scanned with five different IOSs (Primescan™, Carestream CS 3700, Medit i-500, iTero® Elements® 5D, and Emerald™ S). Ten scans were taken for each IOS. The resulting MEs were imported to reverse engineering software for 3D analysis, consisting of the superimposition of the SB LF onto each SB ME. Then, a quantitative and qualitative evaluation of the deviations between MEs and LF was performed. A careful statistical analysis was performed.

Results

Primescan™ showed the highest congruence between SB MEs and LF, with the lowest mean absolute deviation ($25.5 \pm 5.0 \mu\text{m}$), immediately followed by Carestream CS 3700 ($27.0 \pm 4.3 \mu\text{m}$); the difference between them was not significant ($p = 0.1235$).

Primescan™ showed a significantly higher congruence than Medit i-500 ($29.8 \pm 4.8 \mu\text{m}$, $p < 0.0001$), iTero® Elements® 5D ($34.2 \pm 9.3 \mu\text{m}$, $p < 0.0001$), and Emerald™ S ($38.3 \pm 7.8 \mu\text{m}$, $p < 0.0001$). Carestream CS 3700 had a significantly higher congruence than Medit i-500 ($p = 0.0004$), iTero® Elements® 5D ($p < 0.0001$), and Emerald™ S ($p < 0.0001$). Significant differences were also found between Medit i-500 and iTero® Elements® 5D ($p < 0.0001$), Medit i-500 and Emerald™ S ($p < 0.0001$), and iTero® Elements® 5D and Emerald™ S ($p < 0.0001$). Significant differences were found among different SBs when scanned with the same IOS. The deviations of the IOSs showed different directions and patterns. With Primescan™, iTero® Elements® 5D, and Emerald™ S, the MEs were included inside the LF; with Carestream CS 3700, the LF was included in the MEs. Medit i-500 showed interpolation between the MEs and LF, with no clear direction for the deviation.

Conclusions

Statistically different levels of congruence were found between the SB MEs and the corresponding LF when using different IOSs. Significant differences were also found between different SBs when scanned with the same IOS. Finally, the qualitative evaluation revealed different directions and patterns for the five IOSs.

Go to study: <https://pubmed.ncbi.nlm.nih.gov/32660070/>

[Back to Table of Contents](#)

Accuracy of intraoral scanning in completely and partially edentulous maxillary and mandibular jaws: an in-vitro analysis

Study Background

- Analyze the accuracy (trueness and precision) of IOS in completely and partially edentulous maxillary and mandibular models
- Evaluated the influence of the operators' experience with this new generation IOS device on the scan accuracy and scan time
- Resin models: edentulous and partially edentulous, mandibular and maxillary models
- Digital scans were performed by two specialist prosthodontists, one experienced and one inexperienced in IOS. Neither of the clinicians had ever used the tested IOS device before
- For the reference data, all models were digitized using an industrial high-precision scanner
- Determination of trueness and precision

Talking Points

- Overall median trueness comprising of all digital scans by the two operators was 24.2 μm (IQR 20.7 μm -27.4 μm)
- Significantly higher trueness was found in the scans of the edentulous mandibular model by the inexperienced operator
- No differences were detected among the other scans
- Overall median precision was 18.3 μm (IQR 14.4-22.1 μm)
- A significantly higher precision was found for the scans of the edentulous maxillary model by the inexperienced operator
- No differences were detected among the other scans
- Overall median scan time was 100.5 s (IQR 72.0,139.2 s)
- Scans of experienced operator were faster than the scans of inexperienced operator
- Longer scan times could be associated with a higher level of trueness

Abstract

Objectives

New generation intraoral scanners are promoted to be suitable for digital scans of long-span edentulous spaces and completely edentulous arches; however, the evidence is lacking. The current study evaluated the accuracy of intraoral scanning (IOS) in partially and completely edentulous arch models and analyzed the influence of operator experience on accuracy.

Materials and methods

Four different resin models (completely and partially edentulous maxilla and mandible) were scanned, using a new generation IOS device (n = 20 each). Ten scans of each model were performed by an IOS-experienced and an inexperienced operator. An industrial high-precision scanner was employed to obtain reference scans. IOS files of each model-operator combination, their respective reference scan files (n = 10 each; total = 80), as well as the IOS files from each model generated by the same operator, were superimposed (n = 45; total = 360) to calculate trueness and precision. An ANOVA for mixed models and post hoc t tests for mixed models were used to assess group-wise differences ($\alpha = 0.05$).

Results

The median overall trueness and precision were 24.2 μm (IQR 20.7-27.4 μm) and 18.3 μm (IQR 14.4-22.1 μm), respectively. The scans of the inexperienced operator had significantly higher trueness in the edentulous mandibular model ($p = 0.0001$) and higher precision in the edentulous maxillary model ($p = 0.0004$).

Conclusion

The accuracy of IOS for partially and completely edentulous arches in in-vitro settings was high. Experience with IOS had small influence on the accuracy of the scans.

Clinical relevance

IOS with the tested new generation intraoral scanner may be suitable for the fabrication of removable dentures regardless of clinician's experience in IOS.

Go to study: <https://pubmed.ncbi.nlm.nih.gov/32812098/>

[Back to Table of Contents](#)

Accuracy of three intraoral scans for primary impressions of edentulous jaws

Abstract

Objective

To provide a reference for using intraoral scanners for making clinical diagnostic dentures of edentulous jaws by comparing the accuracy of three intraoral scanners for primary impression and jaw relation record of edentulous jaws.

Methods

This study contained 6 primary impressions of the edentulous patients. Each of the impressions consisted of the maxillary primary impression, the mandibular primary impression and the jaw relation record. For each of them, a dental cast scanner (Dentscan Y500) was used to obtain stereolithography (STL) data as reference scan, and then three intraoral scanners including Medit i500, TRIOS® 3 and CEREC Primescan™ were used for three times to obtain STL data as experiment groups. In Geomagic Studio 2013 software, trueness was obtained by comparing experiment groups with the reference scan, and the precision was obtained from intragroup comparisons. Registered maxillary data of the intraoral scan with reference scan, the morphological error of jaw relation record was obtained by comparing jaw relation record of the intraoral scan with the reference scan. Registered mandibular data with jaw relation record of intraoral scan and the displacement of the jaw position were evaluated. Independent samples t test and Mann-Whitney U test in the SPSS 20.0 statistical software were used to statistically analyze the trueness, precision and morphological error of jaw relation record of three intraoral scanners. The Bland-Altman diagram was used to evaluate the consistency of the jaw relationship measured by the three intraoral scanners.

Results

The trueness of Medit i500, TRIOS® 3 and CEREC Primescan™ scanners was (182.34±101.21) µm, (145.21±71.73) µm, and (78.34±34.79) µm for maxilla; (106.42±21.63) µm, and 95.08 (63.08) µm, (78.45±42.77)

µm for mandible. There was no significant difference in trueness of the three scanners when scanning the maxilla and mandible ($P>0.05$). The precision of the three scanners was 147.65 (156.30) µm, (147.54±83.33) µm, and 40.30 (32.80) µm for maxilla; (90.96±30.77) µm, (53.73±23.56) µm, and 37.60 (93.93) µm for mandible. The precision of CEREC Primescan™ scanner was significantly better than that of the other two scanners for maxilla ($P<0.05$). TRIOS® 3 and CEREC Primescan™ scanners were significantly better than Medit i500 scanner for mandible ($P<0.05$). The precision of the Medit i500 and TRIOS® 3 scanners for mandible was superior to maxilla ($P<0.05$). The upper limit of 95% confidence intervals of trueness and precision of three scanners for both maxilla and mandible were within ±300 µm which was clinically accepted. The morphological error of jaw relation record of the three scanners was (337.68±128.54) µm, (342.89±195.41) µm, and (168.62±88.35) µm. The 95% confidence intervals of i500 and TRIOS® 3 scanners were over 300 µm. CEREC Primescan™ scanner was significantly superior to Medit i500 scanner ($P<0.05$). The displacement of the jaw position of the three scanners was (0.83±0.56) mm, (0.80±0.45) mm, and (0.91±0.75) mm for vertical dimension; (0.79±0.58) mm, (0.62±0.18) mm, and (0.53±0.53) mm for anterior and posterior directions; (0.95±0.59) mm, (0.69±0.45) mm, and (0.60±0.22) mm for left and right directions. The displacement of the jaw position of the three scanners in vertical dimension, anterior and posterior directions and the left and right directions were within the 95% consistency limit.

Conclusion

Three intraoral scanners showed good trueness and precision. The Medit i500 and TRIOS® 3 scanners had more errors in jaw relation record, but they were used as primary jaw relation record. It is suggested that three intraoral scanners can be used for obtaining digital data to make diagnostic dentures and individual trays, reducing possible deforming or crack when sending impressions from clinic to laboratory.

Go to study: <https://www.ncbi.nlm.nih.gov/pubmed/32071476>

[Back to Table of Contents](#)

Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in-vitro study

Study Background

- Assessment and comparison of the trueness of 12 different IOSs in full arch (FA) impression: (iTero® Elements® 5D, Primescan™, Omnicam®, Carestream CS 3700, Carestream CS 3600, TRIOS® 3, Medit i-500, Emerald™ S, Emerald™, Virtuo Vivo™, DWIO, RUNEYES QUICKSCAN)
- Using a type IV gypsum model representing a totally edentulous maxilla with 6 implant analogues and PEEK ScanBodies screwed on
- Reference virtual models in STL were acquired by a desktop scanner
- A single operator captured the scans with each of the IOSs
- Evaluation of overall general trueness via mesh/mesh and nurbs/nurbs method
- The evaluation of the linear and cross distances between the different SBs, for analysis of the local trueness of the intraoral scanning models

Talking Points

- Primescan™ belonged to the group of IOS with the highest accuracy (together with iTero® Elements® 5D, Carestream CS 3700, Carestream CS 3600, TRIOS® 3, Medit i-500)
 - With average intrinsic error < 40 µm with the mesh/mesh method and < 25 µm with the nurbs/nurbs method, representing a theoretically compatible solution for taking impressions for FA restorations.
- In the analysis of the overall trueness with the nurbs/nurbs method Primescan™ belonged to the three best IOS (together with iTero® Elements® 5D and TRIOS® 3)
 - With no statistically significant difference between the IOS (for $\alpha=00.05$)
- The best absolute performance with mesh/mesh method was obtained by Carestream CS 3700, iTero® Elements® and Medit i-500
 - Only iTero® Elements® 5D was significantly different to Primescan™ (for $\alpha=00.05$) with a mean difference of 7 µm
 - Carestream CS 3700 and Medit i-500 were not significantly different to Primescan™ (for $\alpha=00.05$)
- For the cross-distance method, the distance category S2-S4 is missing which could cause a bias in the results.
- Primescan™ has the lowest mean error value in „Linear distances method“ (see table 5)
- Best performance for the cross-distance method was obtained by iTero® Elements® 5D and Medit i-500 but with no statistically significant difference to Primescan™ (for $\alpha=00.05$)
- In general, the selected model type (gypsum) enables good scanning results for all intraoral scanners applied in this study
- Other factors are important in determining the reliability of an optical impression including the operator, patient, environmental conditions and SB. Further studies are therefore necessary to understand the weight of each factor.

Go to study: <https://bmcoralhealth.biomedcentral.com/track/pdf/10.1186/s12903-020-01254-9>

[Back to Table of Contents](#)

Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in-vitro study

Abstract

Objective

The literature has not yet validated the use of intraoral scanners (IOSs) for full-arch (FA) implant impression. Hence, the aim of this in-vitro study was to assess and compare the trueness of 12 different IOSs in FA implant impression.

Materials and methods

A stone-cast model of a totally edentulous maxilla with 6 implant analogues and scanbodies (SBs) was scanned with a desktop scanner (Freedom UHD®) to capture a reference model (RM), and with 12 IOSs (iTero® Elements® 5D; Primescan™ and Omnicam®; Carestream CS 3700 and Carestream CS 3600; TRIOS® 3; Medit i-500; Emerald™ S and Emerald™; Virtuo Vivo™ and DWIO®; RUNEYES QUICKSCAN®). Ten scans were taken using each IOS, and each was compared to the RM, to evaluate trueness. A mesh/mesh method and a nurbs/nurbs method were used to evaluate the overall trueness of the scans; linear and cross distances between the SBs were used to evaluate the local trueness of the scans. The analysis was performed using reverse engineering software (Artec Studio software, Geomagic software, and Materialise Magics software). A statistical evaluation was performed.

Results

With the mesh/mesh method, the best results were obtained by Carestream CS 3700 (mean error 30.4 µm) followed by iTero® Elements® 5D (31.4 µm), Medit i-500 (32.2 µm), TRIOS® 3 (36.4 µm), Carestream CS 3600 (36.5 µm), Primescan™ (38.4 µm), Virtuo Vivo™ (43.8 µm), RUNEYES® (44.4 µm), Emerald™ S (52.9 µm), Emerald™ (76.1 µm), Omnicam® (79.6 µm) and DWIO® (98.4 µm). With the nurbs/nurbs method, the best results were obtained by iTero® Elements® 5D (mean error 16.1 µm), followed by Primescan™ (19.3 µm), TRIOS® 3 (20.2 µm), Medit i-500 (20.8 µm), Carestream CS 3700 (21.9 µm), Carestream CS 3600 (24.4 µm), Virtuo Vivo™ (32.0 µm), RUNEYES® (33.9 µm), Emerald™ S (36.8 µm), Omnicam® (47.0 µm), Emerald™ (51.9 µm) and DWIO® (69.9 µm). Statistically significant differences were found between the IOSs. Linear and cross distances between the SBs (local trueness analysis) confirmed the data that emerged from the overall trueness evaluation.

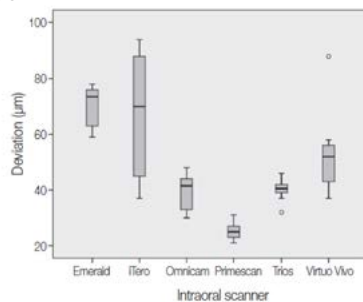
Conclusion

Different levels of trueness were found among the IOSs evaluated in this study. Further studies are needed to confirm these results.

Comparing the accuracy of six intraoral scanners on prepared teeth and effect of scanning sequence

Study Background

- Using a maxillary complete arch model, right and left canine teeth prepared for single crowns
- Using a highly accurate industrial reference scanner to create digital reference
- Six IOSs (TRIOS[®] 3, iTero[®] Element[®] 2, CEREC Omnicam[®], Planmeca Emerald[™], Primescan[™], Virtuo Vivo[™]) were used to investigate precision and trueness
- Ten scans were taken of the model using each intraoral scanner. The first 5 scans started from the right maxillary quadrant (Scan Right-ScanR) and the following 5 scans started from the left maxillary quadrant (Scan Left- ScanL) to evaluate effect of scanning sequence
- For trueness, models were superimposed on the reference model using a best-fit algorithm
- For precision, a two-way pairwise comparison was performed



Talking Points

- The statistically higher trueness was obtained from Primescan[™] (25 µm), followed by TRIOS[®] (40.5 µm), Omnicam[®] (41.5 µm), Virtuo Vivo[™] (52 µm), iTero[®] (70 µm), and Planmeca Emerald[™] (73.5 µm)
 - There was no statistically significant difference between TRIOS[®], Omnicam[®], Virtuo Vivo[™], and iTero[®] (P > .003)
- The highest precision was obtained from Primescan[™] (10 ± 2 µm), followed by TRIOS[®] (11 ± 3 µm), iTero[®] (12 ± 3 µm), Omnicam[®] (18 ± 5 µm), Virtuo Vivo[™] (37 ± 19 µm), and Planmeca Emerald[™] (60 ± 27 µm).
 - There was no statistically significant difference between Primescan[™], TRIOS[®], iTero[®], and Omnicam[®].
 - The difference between Primescan[™] and Planmeca Emerald[™] and Virtuo Vivo[™] was statistically significant.
- No significant difference was found between the precision and trueness values of the ScanR and ScanL obtained from each IOS for the prepared teeth

Abstract

Objective

The aim of this study was to evaluate the accuracy of six recently introduced intraoral scanners (IOSs) for single crown preparations isolated from the complete arch, and to determine the effect of scanning sequence on accuracy.

Materials and methods

A complete arch with right and left canine preparations for single crowns was used as a study model. The reference dataset was obtained by scanning the complete arch using a highly accurate industrial scanner (ATOS Core 80, GOM GmbH). Six different IOSs (TRIOS[®], iTero[®], Planmeca Emerald[™], CEREC Omnicam[®], Primescan[™], and Virtuo Vivo[™]) were used to scan the model ten times each. The scans performed with each IOS were divided into two groups, based on whether the scanning sequence started from the right or left quadrant (n=5). The accuracy of digital impression was evaluated using three-dimensional

analyzing software (Geomagic Studio 12, 3D Systems). The Kruskal Wallis and Mann-Whitney U statistical tests for trueness analysis and the One-way ANOVA test for precision analysis were performed (α=.05).

Results

The trueness and precision values were the lowest with the Primescan[™] (25 and 10 µm), followed by TRIOS[®] (40.5 and 11 µm), Omnicam[®] (41.5 µm and 18 µm), Virtuo Vivo[™] (52 and 37 µm), iTero[®] (70 and 12 µm) and Planmeca Emerald[™] (73.5 and 60 µm). Regarding trueness, iTero[®] showed more deviation when scanning started from the right (P=.009).

Conclusion

The accuracy of digital impressions varied depending on the IOS and scanning sequence used. Primescan[™] had the highest accuracy, while Planmeca Emerald[™] showed the most deviation in accuracy for single crown preparations.

Go to study: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7604233/>

[Back to Table of Contents](#)

In-vitro analysis of intraoral digital impression of inlay preparation according to tooth location and cavity type

Study Background

- Evaluate influence of tooth location and inlay cavity type on the accuracy of digital intraoral impression
- Teeth with inlay cavities were screw-retained on four typodont sets which were mounted on a phantom head during the scanning procedure
- 10 scans of each tooth with Primescan™
- Reference scan data was obtained by scanning with a laboratory scanner (E3, 3Shape) which has an accuracy of 7 µm.
- Assessment of accuracy by trueness and precision.
- Best fit alignment

Talking Points

- Overall trueness for tooth 16 (average deviation: 10.43 µm ± 0.39 µm) was higher than for tooth 46 (12.42 µm ± 0.59 µm)
- Precision was similar between the teeth (tooth 16: 3.08 µm ± 0.92 µm; tooth 46: 3.08 µm ± 0.76 µm)
- The cavity type affected the trueness and precision but with differences < 1 µm
- In contrast to other in-vitro studies intraoral scanning was performed on the phantom head what might have permitted less freedom while placing the scanning walls. A greater degree of freedom ensures a direct-line of sight, favorable angle of incidence which can affect the quality of scan.
- The overall accuracy of digital impressions for inlay preparations was clinically acceptable, but positive deviations were observed at the margins of the proximal boxes

Abstract

Objective

This study aimed to evaluate the influence of tooth location and inlay cavity type on the accuracy of intraoral digital impressions.

Materials and methods

Class II inlay preparation was performed on anatomical models of the maxillary first molar (16) and mandibular first molar (46). Mesio-occlusal and disto-occlusal cavities were prepared, such that the axial wall of the proximal box measured 1 mm or 2 mm in height. Thus, four types of inlay cavities were prepared in 16 and 46, respectively. Ten digital impressions of each cavity were obtained using CEREC Primescan™ (Dentsply Sirona).

Reference scans were obtained with a laboratory scanner (E3, 3Shape). All scan data were exported for comparative analysis of the three-dimensional models. Mean absolute deviation values were calculated to evaluate the trueness and precision of the digital models. Color-coded maps were used for the qualitative analysis of deviations.

Results

The overall results showed that the trueness for 16 (10.43 ± 0.39 µm) was higher than that for 46 (12.42 ± 0.59 µm) ($p < 0.05$), while the precision was similar between 16 (3.08 ± 0.92 µm) and 46 (3.08 ± 0.76 µm). The cavity type affected the accuracy of the digital impressions. The highest deviation was observed in positive directions at the margins of the proximal boxes regardless of the cavity type.

Conclusion

Tooth location and cavity type affected the accuracy of intraoral digital impressions. Positive deviations were observed at the margins of the proximal boxes.

Accuracy and repeatability of different intraoral scanners on shade determination

Study Background

- Evaluate the accuracy and repeatability of different intraoral scanners on shade determination in comparison to a dental spectrophotometer
- Ten different shades (A1, A2, A3, A3.5, A4, B2, B3, C2, C3, and D3) of VITABLOCS® Mark II monochromatic CAD-CAM block were used
- One disc-shape specimen per ceramic block was milled and polished
- Color measurements (n = 10) were performed to each specimen using an intraoral spectrophotometer (VITA Easyshade® V) and three intraoral scanners (3shape TRIOS®, CEREC Omnicam®, CEREC Primescan™)

Talking Points

- No statistical difference was found on the overall accuracy between the spectrophotometer Easyshade® V (78%) and the scanner 3Shape TRIOS® (66%) ($p > 0.05$), with the latter being similar to the other scanners Primescan™ (63%) and Omnicam® (57%) ($p > 0.05$)
- Scanner's accuracy was only significantly different on reading a specific shade (A4), with the Primescan™ (90%) showing greater accuracy than 3Shape TRIOS® (50%)
- There was no statistical difference on the overall repeatability for the evaluated devices, ranging from 44.3% for Easyshade® V to 51.9% for Omnicam®

Abstract

Objective

To evaluate the accuracy and repeatability of different intraoral scanners on shade determination.

Materials and methods

Ten different shades of VITABLOCS® Mark II monochromatic CAD-CAM block were used. A disc-shape specimen (10 mm in diameter and 1 mm thick) per ceramic block was fabricated. Ten color measurements per specimen were performed by each instrument (VITA Easyshade® V [control], 3shape TRIOS®, CEREC Omnicam®, CEREC Primescan™) and recorded in VITA Classic color system. The number of correct shade match per instrument for each shade was recorded. Instrumental accuracy was compared using Cochran Q test and repeatability was analyzed using Cronbach's alpha.

Results

There was a significant difference in the instrumental accuracy for shade determination ($p < 0.001$). There was no statistical difference between the Easyshade® V (78%) and the 3Shape TRIOS® (66%) ($p > 0.05$), with the latter being similar to the other scanners Primescan™ (63%) and Omnicam® (57%) ($p > 0.05$). No significant difference was found ($p > 0.05$) when different shades were evaluated by the same instrument. Similar repeatability was found for the different devices, ranging from 44.3% for VITA Easyshade® V to 51.9% for Omnicam®.

Conclusion

The evaluated instruments showed less than expected repeatability and accuracy on measuring different dental shades. Therefore, caution should be exercised when using instrumental shade determination, which should be accompanied by experienced human visual assessment.

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[Back to Table of Contents](#)

Effect of pulp chamber depth on the accuracy of endocrown scans made with different intraoral scanners versus an industrial scanner: an in-vitro study

Study Background

- Evaluate the effect of different pulpal chamber extension depth (PCEDs; 2, 3.5, 5 mm) and IOSs on the scanning accuracy of endocrown preparations
- Master reference scans of a model with specimens were created by using an industrial structured blue light 3D scanner (ATOS; GOM Technologies)
- Experimental scans were made with 6 IOSs (TRIOS® 3, Primescan™, Omnicam®, iTero® Element® 2, Planmeca Emerald™, Virtuo Vivo™, Rhinoceros®, Telio® and ATOS)
- Trueness and Precision measurement

Talking Points

- A statistically significant difference in the accuracy of endocrown cavities with different PCEDs was found among compared IOSs, and PCED affected the scanning accuracy significantly
- For all PCEDs evaluated, Primescan™ was found to have the best results among the tested IOSs with regard to trueness and precision
 - Trueness and precision of Primescan™ were significantly different in all cases.

Increasing the pulpal chamber extension depth of endocrown preparations can reduce scanning accuracy. CEREC Primescan™ appears to be the best IOS choice for scanning endocrowns with deep pulpal chamber extensions.

Abstract

Objective

The purpose of this in-vitro study was to assess the effect of pulpal chamber extension depth (PCED) on scanning accuracy and to compare the accuracy of different IOSs on scanning different PCEDs.

Materials and methods

Six different IOSs were compared: TRIOS® 3, CEREC Omnicam®, CEREC Primescan™, Planmeca Emerald™, iTero® Element® 2, Virtuo Vivo™, Rhinoceros®, Telio® and ATOS. Endocrown preparations were digitally designed with a computer-aided design and computer-aided manufacturing (CAD-CAM) software program (Rhinoceros®), and the PCEDs of preparations were 2, 3.5, and 5 mm. Designed preparations were milled from a polymethylmethacrylate block (Telio® CAD) with a milling unit. Reference scans were obtained from an industrial scanner (ATOS), and 5 test scans of each cavity were made with 6 IOSs. All scans were converted into standard tessellation language (STL) files. The data sets obtained from the IOSs were superimposed on the reference scan to evaluate trueness and on each other within groups to determine precision by using a 3D analysis software program (Geomagic Control X). Obtained data were analyzed with 1-way ANOVA and Tukey HSD tests ($\alpha=.05$).

Results

CEREC Primescan™ was found to have the best trueness and precision among the evaluated IOSs ($P<.05$), while Planmeca Emerald™ was found to have the lowest trueness ($P<.05$). For all tested PCEDs, statistically significant differences were found among IOSs. A PCED with a 2-mm depth ($18.57 \pm 4.80 \mu\text{m}$) showed significantly better scanning trueness than that with a 5-mm depth (23.81 ± 6.53), while no significant differences were found between 2 and 3.5 mm ($P>.05$).

Conclusion

Deep pulpal chamber extensions of endocrown restorations could negatively affect scanning accuracy, and scanning accuracy varies depending on the selected IOS. CEREC Primescan™ appears to be the best IOS choice for scanning endocrowns with deep pulpal chamber extensions.

Go to study: <https://pubmed.ncbi.nlm.nih.gov/33309210/>

[Back to Table of Contents](#)

Influence of preparation design, marginal gingiva location, and tooth morphology on the accuracy of digital Impressions for full-crown restorations: an in-vitro investigation

Study Background

- Analyze the influence of different finish lines for complete crown preparations, their locations related to the gingival margin, and tooth morphology on the accuracy of digital impressions
- Maxillary dental training model was used as reference, a maxillary central incisor (FDI 11) represented the anterior tooth morphology, a first maxillary molar (FDI 16) represented posterior sites
- Prepared typodonts were digitized with a laboratory desktop scanner and served as the basis for the digital designs of the virtual modifications to create the test specimens, involving four different finish-line designs for both morphologies
- 16 virtual tooth preparations were 3D-printed and mounted in the reference model
- Scanning with Primescan™ and TRIOS® 3.5 times
- Accuracy determination

Talking Points

- The overall accuracy for all abutment teeth was very high, without significant differences in the performance of 3Shape TRIOS® 3 Pod versus Primescan™
- The supragingival finishing lines were captured significantly better than the epigingivally located margins using IOS. If the clinical situation allows, a supragingival margin should be chosen accordingly
- The tooth morphology seems to be a negligible factor for IOS accuracy in terms of single-unit complete crown restorations

Abstract

Objective

Intraoral optical scanning (IOS) has gained increased importance in prosthodontics. The aim of this in-vitro study was to analyze the IOS accuracy for treatment with full crowns, considering possible influencing factors.

Materials and methods

Two tooth morphologies, each with four different finish-line designs for tooth preparation and epi- or supragingival locations, were digitally designed, 3D-printed, and post-processed for 16 sample abutment teeth. Specimens were digitized using a laboratory scanner to generate reference STLs (Standard Tessellation Language), and were secondary-scanned with two IOS systems five times each in a complete-arch model scenario (TRIOS® 3 Pod, Primescan™ AC). For accuracy, a best-fit algorithm (Final Surface) was used to analyze deviations of the abutment teeth based on 160 IOS-STLs compared to the reference STLs (16 preparations × 2 IOS-systems × 5 scans per tooth).

Results

Analysis revealed homogenous findings with high accuracy for intra- and inter-group comparisons for both IOS systems, with mean values of 80% quantiles from $20 \pm 2 \mu\text{m}$ to $50 \pm 5 \mu\text{m}$. Supragingival finishing lines demonstrated significantly higher accuracy than epigingival margins when comparing each preparation ($p < 0.05$), whereas tangential preparations exhibited similar results independent of the gingival location. Morphology of anterior versus posterior teeth showed slightly better results in favor of molars in combination with shoulder preparations only.

Conclusion

The clinical challenge for the treatment with full crowns following digital impressions is the location of the prospective restoration margin related to the distance to the gingiva. However, the overall accuracy for all abutment teeth was very high; thus, the factors tested are unlikely to have a strong clinical impact.

Go to study: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7763051/>

[Back to Table of Contents](#)

The summaries stated herein are mere abstracts of the studies and for complete details please see the full studies noted at the bottom of each summary page.

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[Back to Table of Contents](#)