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Original Article

Accuracy of Different Technologies for Dental Cast Digitization; CBCT versus Desktop Optical 3D Scanner: An Observational Study.

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Abstract

Aim: To evaluate and compare the accuracy of digital models created by two scanning modalities; CBCT and extraoral optical scanner.

Subjects and methods: Twenty-four stone models were fabricated, and then digital models were created using the "3D model " protocol featured in Planmeca, Promax 3D Mid CBCT machine, and Medit T500 optical scanner. 3-Matic Medical software assessed 6 linear measurements on the digital models including mesiodistal width till the first molars, 2 arch length readings and arch width measured in 3 readings: inter-canine, inter-premolar and inter-molar width. They were then compared to their reference standard "plaster model" using the digital caliper. Numerical data were presented as mean with 95% confidence intervals, standard deviation, minimum and maximum values. Shapiro-Wilk's test was used to monitor data distribution. Normally distributed data was analyzed using repeated measures ANOVA followed by Bonferroni post hoc test to monitor the difference in accuracy between the two modalities. Intra-observer and inter-observer reliability were analyzed using ICC.

Results: The measurement error of the two scanning modalities showed no statistically significant difference except for some readings, however they were clinically irrelevant. For optical scanner models, the average mean error calculated values were (0.58 mm), (0.49mm) and (0.20mm). while for CBCT models, the average mean error values were (0.65 mm), (0.66mm), and(0.29mm) for arch width, arch length and mesiodistal width respectively. The study showed an excellent intra-observer and inter-observer correlation.

Conclusion: Extraoral optical scanner and CBCT showed a high degree of accuracy and reproducibility in arch space analysis compared to the gold standard.

Keywords: Digital model, Extraoral optical scanner, CBCT, Linear measurements, Digital caliper.

Introduction

For the past several years, the collection of diagnostic information for orthodontic analysis was performed using dental study casts obtained from dental impressions along with the patients' radiographic and photographic images. Arch space analysis was performed directly on the study models to evaluate the arch length, arch width, mesiodistal widths, or inter-arch relationship using many measuring tools with the digital caliper being the gold standard. Over time, digital dental technology has been widely introduced to dentistry to replace the conventional techniques of model fabrication. This digital model is expected to provide an easy and accurate diagnostic tool to be used in different branches such as orthodontics and computer-guided implant surgeries **(El-Zanaty et al., 2010; Adindaputri, Kurnia and Sutantyo, 2023; Shin et al., 2024).**

Recently, many newly developed digital techniques have been applied to keep patients' records for case documentation, treatment planning, and follow-up purposes. They are mainly based on either direct scanning of the patient's oral cavity using intra-oral scanners (IOS) or CBCT scanning of the dentition putting into consideration the unnecessary radiation doses the patient will be exposed to in the latter scanning option. Additionally, digital records could be obtained indirectly via scanning of the patient's impressions or plaster casts using either an intra-oral camera, extra-oral optical scanner (EOS), or CBCT, which can be subsequently exported as STL file **(Park et al., 2019; Kardach, Szponar-Żurowska and Biedziak, 2023; Shin et al., 2024).**

According to the literature, an optical scanner (EOS) is an extra-oral method of dental plaster cast digitization using white, LED blue structured light, or laser beam. The surface of the projected object is captured using a special high-resolution camera creating a 3D digital model. Desktop optical scanners are preferred to digital dental laboratories, as they require less acquisition time for scanning when compared to the time required for conventional impression techniques **(Park et al., 2019; Elkersh and Fahmy, 2021; Shaker, Eltayeb and Elkady, 2024).**

Another clinically significant method of digitization is through the fabrication of a digital model using CBCT. This technology has been used previously for generating 3D models via direct scanning of the patient's dentition in the form of a DICOM file. Recently with the improvement of the concept of digital dentistry, many advancements were made by manufacturers to facilitate the addition of an extra tool for stone model digitization in new CBCT machines. These machines allow the scanning of alginate impressions or stone models with specific parameters to generate 3D models that are ready to be exported in the form of STL files. Now it became necessary to compare different model scanning technologies in the assessment of digital models' accuracy and reliability as they have the same capability of generating a digital model through different approaches **(El-din, Medhat and Kandil, 2020; Elkersh and Fahmy, 2021; Shaker, Eltayeb and Elkady, 2024**

Subjects and Methods

A. Study design and setting:

This study is a Cross-Sectional, Observational Study that was conducted to evaluate and compare the accuracy of digital models generated from plaster casts using two different scanning techniques: CBCT and EOS. The study took place in the Faculty of Dentistry -Cairo University where patients' recruitment was done, and alginate Impressions were taken by an experienced prosthodontist. Impression pouring into stone dental casts and extra-oral optical scanning procedures were done at Al Qahera dental group lab in El-Mohandseen, Giza, Egypt. CBCT scanning procedures took place at the outpatients' clinic of the Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University

B. Sample size calculation and Medical Biostatistics Unit approval:

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found in the accuracy between different examined groups (CBCT digitized dental model and optical scanner (EOS) digitized dental model) By adopting an alpha level of (0.05) a beta of (0.2) i.e. power=80% and an effect size of (0.609) calculated based on the results of (da Silva-Dantas et al., 2019) the predicted sample size was found to be (24) dental models in each group. Sample size calculation was performed using G*Power version 3.1.9.72. The sample size calculation was approved by Medical Biostatistics Unit, Faculty of Dentistry, Cairo University.

C. Informed consent:

Before the study and the clinical examination, the aim of the research was clarified to the patients, and written informed consent was obtained.

D. Eligibility criteria and selection method:

Patients were included in the study if they had complete set permanent dentition in one of both arches. Also, partially edentulous patients were included if they had complete dentition from the right first molar to the left first molar.

On the other hand, patients were excluded from the study if the anatomical points of their teeth were affected by fractures, attrition, or erosion as this will affect the accuracy of the measurements. Additionally, patients who had restorations that didn’t restore the normal anatomy of the teeth were excluded to avoid inaccuracy of the measurements.

E. Fabrication of the dental stone cast:

Alginate impressions were obtained using (Cavex, CA37, Normal set, Netherlands) and a suitable metal stock tray. Each plaster cast was examined to ensure it was free from voids, air bubbles, or chipping of teeth at the anatomical points used for taking measurements. In case any of these defects were found, the steps of impression-taking and pouring were repeated. Each plaster cast was labeled with a number from 1-24 before scanning.

F. Dental cast digitization by CBCT scanning:

CBCT scanning of the plaster casts was performed using “3D model capture” protocol featured in Planmeca, Promax 3DMid CBCT machine (Planmeca OY, Helsinki, Finland). The models were properly positioned with the aid of the three positioning laser lights on the Polystyrene disc provided by the machine. The scanning process started following the pre-set exposure parameters of the Planmeca Romexis 3D model capture program which was set on the fast-scanning mode featured in the machine. Scanning was done with the following parameters: (a spatial resolution of 150 µm, Kvp=80, mA=12.5, Volume size=Ø80 x H40 mm, exposure time= 5s). The scanning procedure was done using Planmeca, Romexis software 4.6.2.R version. It is worth mentioning that on operating “3D model capture” tool; the material of the cast to be scanned should be introduced and calibrated on the machine before being scanned for the first time. After scanning, the 3D digital model was reconstructed and ready to be exported in any of the following file formats STL or DICOMS.

G. Dental cast digitization by EOS:

Plaster models were scanned using Medit T500 desktop optical scanner (T500, Medit, Seoul, South Korea). Scanning was done with accuracy <7µm, scan speed: 12 sec (full arch scan), resolution of camera 2x2 MP, scan volume: 90mm x 72mm x 60mm, using structured light (Blue LED). EOS scans of the dental casts were exported in the form of STL file format as done with CBCT scans.

Six linear measurements that are commonly used in arch space analysis have been evaluated on these digital models as compared to their ground truth which were obtained manually on the plaster cast using digital caliper. These measurements are clearly defined in **Table (2)** and **[Fig.1].** For standardization purposes, a great effort was made to ensure a standardized way of measurements by clearly defining the start and end points of each measurement as described in **Table (1) [Fig.1].** Also, through conducting a software training session for the researchers participating in this study.

First, mesiodistal widths (MD) of teeth were measured with the maximum MD diameter measured parallel to the occlusal plane from the mesial to the distal anatomic contact points of each tooth. The hypothetical contact points are assessed on the proximal, mesial, and distal surfaces of poorly aligned teeth. The previously determined measurements were directly obtained on the plaster model to the nearest 0.01 mm to represent the reference standard in this study using high precision sliding digital caliper (DC) (Digital caliper, Series 111, Accud, Vienna, Austria) with accuracy ±0.03mm and resolution: 0.01mm/0.0005".

H. Measurements on digital models: After exporting all digital models in (STL) file format, they were imported into third-party software (3-Matic Medical, Materialise, Leuven, Belgium) where the same measurements were also obtained on the digital models using the "distance" tool available in the software. Measurements were taken to the nearest 0.01 mm using more than one. of the following techniques. For posterior teeth, a standard occlusal view of the model served as the baseline for measuring all teeth. For anterior teeth, measurements were taken from a facial aspect. Finally, a qualitative method where the model was qualitatively rotated in whichever plane the operator required before taking each measurement **[Fig.2].**

All measurements were taken by two investigators of different clinical experience (E.A) and (M.F) to ensure inter-observer reliability. One of the investigators assessed the measurements twice with two weeks interval time between the two sessions to test intra-observer reliability.

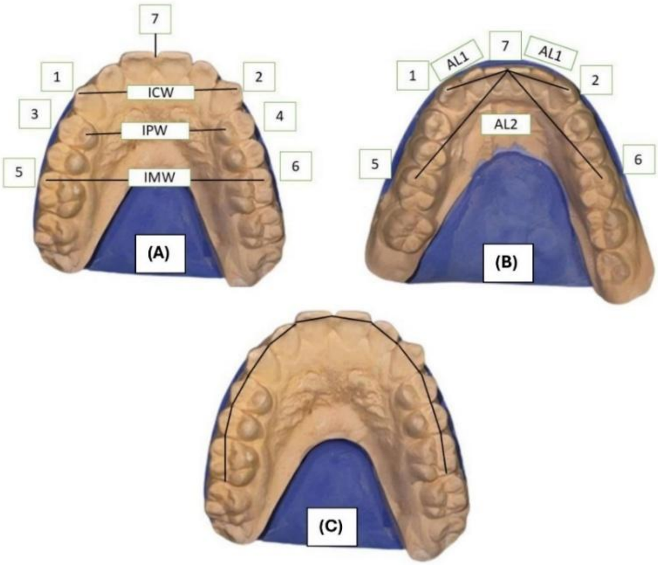


Figure (1): Identification of the landmarks on the stone model and direct linear measurements on conventional dental cast (Reference standard). (A) Showing arch width measurements (ICW,IPW&IMW) .(B) showing arch length measurements (AL1&AL2) .(C) showing MD width till the first molar

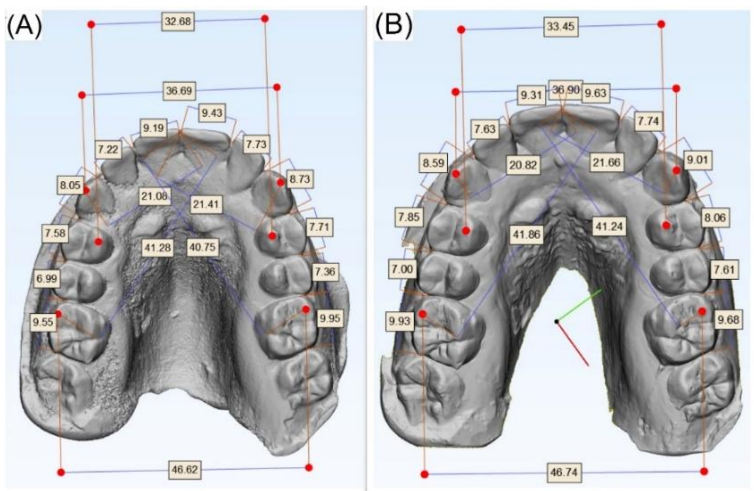


Figure (2): Identification of the landmarks on the digital model. (A) Showing measurements obtained from CBCT. (B) Showing measurements obtained from EOS.

Table (1): Definition of anatomical points used for obtaining linear measurements as shown in **[Fig.1]:**

1	Cusp tip of right canine
2	Cusp tip of left canine
3	Lingual/Palatal Cusp tip of right first premolar
4	Lingual/Palatal Cusp tip of left first premolar
5	Mesio-buccal cusp tip of right first permanent molar
6	Mesio-buccal cusp tip of left first permanent molar
7	The mesial angle of right/left central incisors

Table (2): Definition of Linear measurements shown in **[Fig.1]**

Abbreviation	Linear measurement	Definition
ICW	**Inter-canine width**	The distance between the right and left canine tips. (Points 1,2)
IPW	**Inter-premolar width**	The distance between the lingual/palatal cusps of the first right and left premolars). (Points 3,4)
IMW	**Inter-molar width**	The distance between mesio-buccal cusps of the first right and left permanent molars) (Points 5,6)
AL1	**Arch length 1**	The distance from the mesial angle of central incisors to the cusp tip of the canine. (Points 1,2,7)
AL2	**Arch length 2**	The distance from the mesial angle of central incisors to the mesio-buccal cusp tip of the first molar. (Points 5,6,7)
MD	**Mesio-distal width**	Mesio -distal width of teeth from the right to the left first permanent molars provided that each tooth will be measured separately.

Statistical Analysis:

Numerical data were presented as mean with 95% confidence intervals, standard deviation, minimum and maximum values. They were explored for normality by checking the data distribution using Shapiro-Wilk's test. Data were normally distributed and were analyzed using repeated measures ANOVA followed by Bonferroni post hoc test. Intra-observer and Inter-observer reliability were analyzed using intra-class correlation coefficient (ICC). The significance level was set at $p<0.05$ within all tests. Statistical analysis was performed with R Statistical analysis software version 4.3.1 for Windows.

Result

The present study was conducted on 24 dental casts -16 maxilla and 8 mandibles- that were selected based on the sample size calculation according to certain eligibility criteria. Measurement accuracy and measurement error were calculated for all modalities**.**

Measurement accuracy:

Repeated measures ANOVA test was used to compare between measurement accuracy of EOS and CBCT. Presented in **(Table 3)** and in **[Fig 3]**

Upper arch:

For IPD and arch length 2, there was a significant difference between the two modalities. The digital caliper (DC) showed higher values than CBCT ($p<0.05$). IMD showed a statistically significant difference with DC showing lower values ($p<0.001$). Arch length 1, left first premolar and both second premolars showed a statistical difference that was significant with CBCT having a significantly lower value ($p<0.05$). For right and left first molars, there was a significant difference where DC showed a higher value than other modalities ($p<0.05$). **Lower arch:**There was a significant difference in left central and right first premolar, with DC being higher than CBCT in values ($p<0.05$). For right and left first molars, the difference was significant with CBCT showing a lower value than other modalities ($p<0.05$).

Both arches:

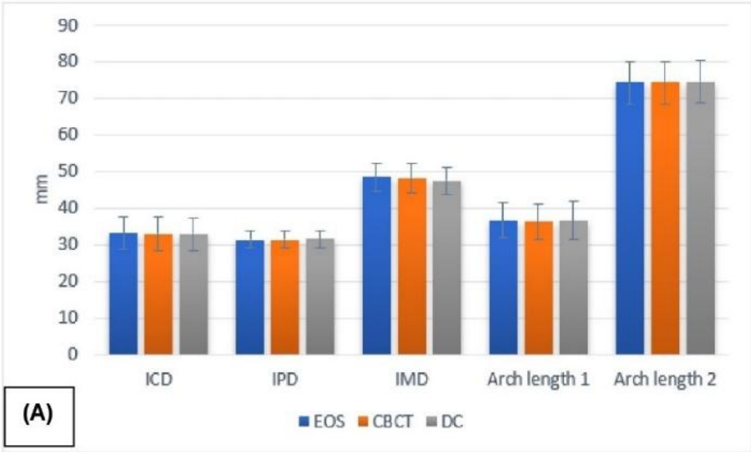
For (IMD), the difference was statistically significant with DC showing a lower value than other modalities ($p<0.001$). For (arch length 1), both first and second premolars, there was a significant difference with CBCT presented with a significantly lower value ($p<0.05$).

For the right and left first molars, there was a significant difference where DC showed a higher value ($p<0.001$). For other parameters, no statistically significant difference was reported ($p>0.05$).

Table (3): Measurement accuracy for both arches:

Parameter	Mean±SD			p-value
	EOS	CBCT	DC	
ICD	33.11±4.64^{A}	33.02±4.47^{A}	32.92±4.52^{A}	**0.344ns**
IPD	31.38±2.24^{A}	31.34±2.29^{A}	31.62±2.37^{A}	**0.068ns**
IMD	48.47±3.73^{A}	48.22±3.89^{A}	47.58±3.66^{B}	**<0.001***
Arch length 1	36.58±4.98^{A}	36.23±4.83^{B}	36.59±5.18^{A}	**0.023***
Arch length 2	74.31±5.86^{A}	74.24±5.83^{A}	74.56±5.79^{A}	**0.095ns**
Right central	7.74±1.59^{A}	7.74±1.62^{A}	7.78±1.58^{A}	**0.742ns**
Left central	7.82±1.72^{A}	7.80±1.77^{A}	7.80±1.65^{A}	**0.947ns**
Right lateral	6.65±0.66^{A}	6.62±0.59^{A}	6.68±0.62^{A}	**0.633ns**
Left lateral	6.71±0.67^{A}	6.72±0.74^{A}	6.63±0.62^{A}	**0.325ns**
Right canine	7.67±0.48^{A}	7.64±0.55^{A}	7.66±0.60^{A}	**0.858ns**
Left canine	7.77±0.54^{A}	7.65±0.59^{A}	7.73±0.52^{A}	**0.218ns**
Right first premolar	7.20±0.41^{A}	7.08±0.41^{B}	7.29±0.46^{A}	**<0.001***
Left first premolar	7.29±0.45^{A}	7.12±0.49^{B}	7.26±0.47^{A}	**0.003***
Right second premolar	6.96±0.43^{A}	6.83±0.49^{B}	6.99±0.45^{A}	**0.005***
Left second premolar	7.01±0.52^{A}	6.80±0.50^{B}	7.05±0.47^{A}	**0.002***
Right first molar	10.58±0.69^{B}	10.61±0.59^{B}	11.04±0.54^{A}	**<0.001***
Left first molar	10.60±0.71^{B}	10.59±0.63^{B}	10.97±0.51^{A}	**<0.001***

Values with different superscript letters within the same horizontal row are significantly different *; significant ($p<0.05$) ns; non-significant ($p>0.05$)



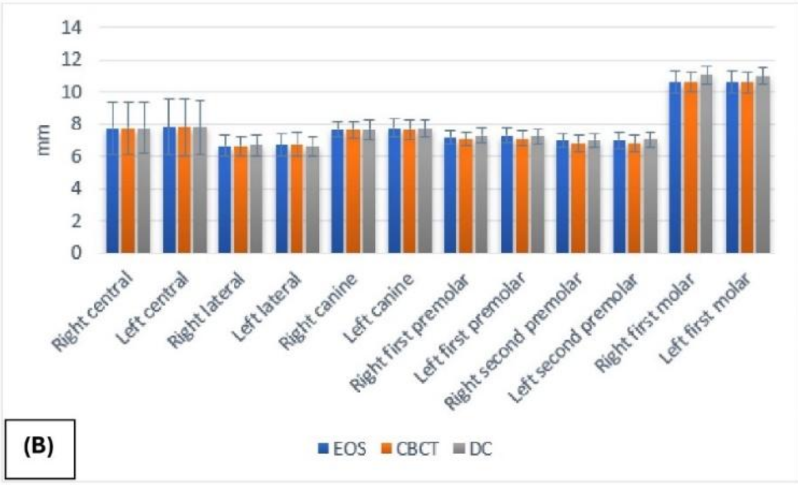


Figure (3): (A)Bar chart showing mean and standard deviation (error bars) values arch width and arch length measurements.
(B) Bar chart showing mean and standard deviation (error bars) values for MD width measurements.

Measurement error:

It was calculated using paired-T test. Results are presented in **(Table 4)**

Upper arch:

For right central and both first and second premolars, CBCT measurement error was significantly higher than EOS ($p<0.05$).

Lower arch:

For the right central and right first premolar, CBCT measurement error was significantly higher than EOS ($p<0.05$).

Both arches:

For (arch length 2), right central, right first premolar and both second premolars, CBCT measurement error was significantly higher than EOS ($p<0.05$). For other measurements, no statistically significant difference was reported ($p>0.05$).

Intra-observer and Inter-observer reliability:

For Intra-observer and inter-observer reliability, Intra-class Correlation coefficient (ICC) was used. For both modalities, a strong agreement was reported between both readings and both examiners which was statistically significant ($ICC>0.9$, $p<0.001$).

Table (4): Measurement error for both arches:

Parameter	Mean±SD		p-value
	EOS	CBCT	
ICD	0.48±0.40	0.55±0.40	**0.249ns**
IPD	0.36±0.37	0.57±0.43	**0.131ns**
IMD	0.91±0.46	0.84±0.48	**0.560ns**
Arch length 1	0.55±0.38	0.63±0.44	**0.327ns**
Arch length 2	0.43±0.33	0.70±0.52	**0.030***
Right central	0.15±0.11	0.31±0.20	**<0.001***
Left central	0.17±0.14	0.25±0.17	**0.051ns**
Right lateral	0.19±0.12	0.23±0.20	**0.253ns**
Left lateral	0.23±0.18	0.23±0.20	**0.865ns**
Right canine	0.21±0.18	0.27±0.17	**0.204ns**
Left canine	0.27±0.17	0.32±0.23	**0.175ns**
Right first premolar	0.16±0.14	0.28±0.19	**<0.001***
Left first premolar	0.17±0.15	0.19±0.14	**0.411ns**
Right second premolar	0.15±0.11	0.24±0.13	**0.004***
Left second premolar	0.20±0.25	0.32±0.30	**0.021***
Right first molar	0.51±0.48	0.45±0.34	**0.429ns**
Left first molar	0.48±0.46	0.41±0.36	**0.512ns**

*; significant (p< 0.05) ns; non-significant (p>0.05)

Discussion

Digital models have proven to be increasingly beneficial, as a result, several studies have assessed the accuracy of digital models and they concluded that linear measurements obtained from digital models seem to be clinically acceptable, reproducible, and far faster than measurements performed manually. In our study, to ensure that the obtained results were true, applicable, and not coincidental, a total of 24 dental models were selected and the accuracy of linear measurements obtained from digital models created by EOS and CBCT were compared to measurements performed using the digital caliper (DC) **(Mladenović et al., 2009; Fleming et al., 2011; Nurazreena et al., 2016; Reuschl et al., 2016; da Silva-Dantas et al., 2019).**

For assessment of measurement error with respect to the dental arch. The means acquired from the measurements of the reference standard (DC) were subtracted from the means obtained from the measurements of the digital models scanned by CBCT and EOS. The calculated measurement error for each modality showed that the highest mean error values recorded in both arches were (0.91 mm) in EOS-generated digital models and (0.84 mm) in CBCT models. The lowest values recorded were (0.15mm) in EOS digital models and (0.19mm) in CBCT models. It is worth mentioning that the highest mean error in both modalities and both arches was recorded in IMD/IMW. This could be attributed to the difficulty in distinguishing the same precise point of landmark which also means that the process has a learning curve. This coincides with **Saravana Priyan Soundappan, 2013; Reuschl et al., 2016; Şakar et al., 2017,** while the lowest error was recorded in the MD width of premolars which coincides with **J. Asquith et al., 2007.**

When comparing the measurement error of CBCT and EOS digital models, there was no statistically significant difference between the two modalities except for five readings representing AL2, MD width of the right central incisor, and premolars. However, they were clinically irrelevant as the mean error in these readings ranged from (0.13mm to 1.03 mm) which is still below the clinically acceptable error reported in other studies for linear measurements as **Bell et al., 2003; J. Asquith et al., 2007** stated that "the clinically acceptable value for the differences between the linear measurements was set at 0.5 mm for single teeth size" or when there is more than a 5% difference from the reference standard in arch length and arch width measurements which could be equivalent to 2.0 mm for linear measurements as stated by **Luu et al., 2012.**

Some results were statistically insignificant but clinically relevant like the MD width of the upper right and left first molars which showed a slight deviation. In EOS models, the range was (0.64 mm - 0.68mm) in the maxilla and 0.51 mm mean error in both arches. such variation could be explained by the narrower ridge, broader interproximal contact along with complex dental anatomy that could make it more challenging to identify the exact anatomical point **(Emara et al., 2020).**

All mean errors were very close in EOS and CBCT models with slightly higher error values in CBCT models. This appears to be attributable to the resolution difference between CBCT (150 μm) and the EOS (7 μm), as well as the smoothing algorithms in the EOS software that is used to generate a uniform surface after scanning as reported by **Park et al., 2019.** As an addition, the mean errors reported in the maxilla were higher than in the mandible which might be linked to the increased inclination of maxillary teeth compared to the mandibular teeth. However, it showed a statistically significant clinically irrelevant difference in the maxillary models rather than in mandibular models. which is similar to studies conducted by **Leifert et al., 2009; Saravana Priyan Soundappan, 2013; Reuschl et al., 2016.**

When comparing the measurement accuracy of both modalities, EOS models showed slightly higher accuracy compared to CBCT models with statistically significant but clinically irrelevant differences in IMW, AL1, and MD width of premolars and first molars in both arches.

Furthermore, our study showed an excellent intra-observer and inter-observer correlation for both devices (ICC>0.9, p<0.001) which indicates higher reliability of both digitization methods and proves the generalizability of the study. Agreeing with **da Silva-Dantas et al., 2019; Park et al., 2019** and disagreeing with a few studies like **De Waard et al., 2014** who concluded that there was poor inter-examiner reliability for the measurements found in the CBCT digital scans.

Comparing the results of our study to previous studies that assessed the accuracy of digital models using different modalities (CBCT) and (EOS), our study coincided with **Park et al., 2019** who reported no statistically significant difference between the CBCT and EOS models except in the MD width of upper molars. These findings also exactly coincide with **Reuschl et al., 2016** who evaluated the accuracy of models generated from EOS only. Similarly, **da Silva-Dantas et al., 2019** found no statistically significant difference between

CBCT and EOS digital models except for arch length measurements. They reported that there were significantly higher error values recorded in CBCT models, which is similar to our findings.

In the same line, **Becker et al., 2018; Emara et al., 2020; Elkersh & Fahmy, 2021** reported that CBCT models can be considered an accurate alternative to EOS models that were used as reference standard in these studies. Becker et al., 2018, also reported that the least variation from EOS reference models was found in the "cast digitization" option implemented in Carestream CBCT machine which is similar to the "3D model capture" feature used in our study.

No further studies were found comparing the accuracy of both EOS and CBCT digital models but there were a lot of studies evaluating the accuracy of digital models created by CBCT or EOS separately or in comparison with other modalities such as **Sousa et al., 2012** who found no statistically significant difference between EOS models when compared to manual measurements on plaster models. On the contrary **Quimby et al., 2004; Mullen et al., 2007; Radeke et al., 2014** reported that there were statistically significant but clinically acceptable differences between manual measurements on plaster cast and EOS digital models. Other studies compared CBCT models to the manual measurements on plaster models like **El-din et al., 2020** who reported that there were no statistically nor clinically significant differences between linear measurements obtained from CBCT models and plaster casts except in the MD width of teeth. While **Şakar et al., 2017** reported statistically and clinically significant differences, especially in IMW of CBCT models when the accuracy of measurements of CBCT and IOS models was assessed by comparing them to plaster models.

Although most of the published studies reported similar findings to our study, few studies reported different findings such as **Zilberman et al., 2003** who reported that EOS models were inferior in accuracy compared to the gold standard plaster cast, but they still can be considered clinically acceptable substitute. Other studies found a statistically significant difference in some linear measurements like IPW, ICW as reported **by Saravana Priyan Soundappan, 2013; Şakar et al., 2017; Park et al., 2019; Shetty et al., 2022** or clinically significant values in ICW, AL, and MD width of premolars as reported by **J. Asquith et al., 2007; Reuschl et al., 2016; El-din et al., 2020.** This could be explained by the higher possibility of attrition of the canines' cusp tip which most probably may interfere with locating the landmark and consequently in the interpretation of ICW as stated by **Camardella et al., 2020.** This could also be attributed to the fact that the clinically acceptable range of error is subjective, and it might slightly differ from one study to another.

Limitations of the study:

Some unavoidable limitations were faced during our study:

- The ability to identify the correct landmarks on the software or dental cast was challenging, especially in areas of crowding, improper teeth alignment, and tight inter-proximal contacts.

- EOS showed a considerable difference in the interproximal area and the tooth cusp which might be due to diffuse reflection that affects the undercut, the line angles and undercuts when using blue LED light EOS.

Conclusion:

- Extraoral optical scanner (EOS) and CBCT showed a high degree of accuracy and reproducibility in arch space analysis as compared to the gold standard stone model.

•Both EOS and CBCT serve as a good digitization tool for plaster models and are reliable for clinical practice.

Conflict of Interest:

The authors declare no conflict of interest.

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This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics:

This study protocol was approved by the Ethical Committee of the Faculty of Dentistry-Cairo University on 27/07/2021, approval number: 20-7-21.

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