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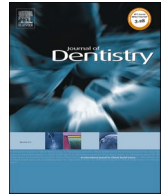
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Accuracy of conventional impressions and digital scans for implant-supported fixed prostheses in maxillary free-ended partial edentulism: An in vitro study

Nada El Osta^{a,*}, Noémie Drancourt^{a,b}, Chantal Auduc^{a,b}, Jean-Luc Veyrone^{a,b}, Emmanuel Nicolas^{a,b}

^a Department of Prosthodontics, UFR d'Odontologie, Centre de Recherche en Odontologie Clinique (CROC), University of Clermont Auvergne, Clermont-Ferrand, France

^b CHU Clermont-Ferrand, Odontology Department, Clermont-Ferrand, France

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ABSTRACT

Objectives: To evaluate the accuracy of conventional polyether impressions and digital scans produced by five intra-oral scanners (IOSs) in maxillary free-ended partial edentulism for long-span implant-supported prostheses. **Methods:** This in vitro study involved the impression of a maxillary model with free-end partial edentulism, in which six implants were placed before digitization using a desktop scanner to generate a digital reference model. Conventional impressions (Impregum Penta Soft, 3M) and digital scans with five IOSs (Trios 3 and 4, 3Shape; Primescan, Dentsply-Sirona; CS 3600, Carestream Dental; and i-500, Medit) were obtained. Conventional impressions were digitized using the same desktop scanner. Each digital STL file of conventional or digital impressions was superimposed over the reference STL file to enable comparison. Trueness was assessed by calculating angles and distance deviations. For precision, dispersions of values around their means were also measured.

Results: The mean distance deviation was significantly higher for conventional impressions ($454.24 \pm 334.70 \mu\text{m}$) than for IOSs (ranging from $160.98 \pm 204.48 \mu\text{m}$ to $255.56 \pm 395.89 \mu\text{m}$) ($p < 0.001$). The mean angular deviation was high with conventional impressions ($1.82 \pm 1.51^\circ$), intermediate with CS 3600 ($1.38 \pm 1.42^\circ$), Primescan ($1.37 \pm 2.54^\circ$) and Trios 4 ($1.30 \pm 0.64^\circ$) scanners, and lower with I500 ($0.97 \pm 0.75^\circ$) and Trios 3 ($1.01 \pm 0.85^\circ$) scanners ($p < 0.001$).

The dispersion of distance values around their means was lowest with Trios 3 and i-500, followed by CS3600, Primescan, and Trios 4, respectively, and higher for conventional impressions ($p < 0.001$). The dispersion of angular values was smallest with i-500, Trios 3, and Trios 4 compared with other groups and was highest with Primescan ($p < 0.001$).

Conclusions: Within the limits of the current study, Trios 3 scanner exhibited the highest accuracy, followed by i-500, Trios 4, CS 3600, Primescan, and conventional impressions respectively. IOSs might be reliable for the fabrication of an implant-supported prosthesis. In vivo studies are required to confirm these findings.

Clinical significance: Passive adaptation of the implant-supported framework is a challenge when rehabilitating patients with maxillary free-end partial edentulism. While Conventional impressions remain a reliable and validated technique, but IOSs demonstrated higher accuracy, suitable for the fabrication of long-span implant-supported prostheses in partially edentulous arch.

1. Introduction

The success and survival of implant-supported prostheses hinge on the passive fit of the implant superstructure, necessitating a high level of

clinical and laboratory precision, starting with an accurate impression [1]. A crucial step in achieving a passive fit is the precise transfer of the three-dimensional relationship of the implant to the master model [2]. Inadequate fit can result in undesirable complications, ranging from the

* Corresponding author at: Université Clermont Auvergne, UFR d'Odontologie, Centre de Recherche en Odontologie Clinique (CROC), F-63000 Clermont-Ferrand, France.

E-mail address: nada.el_osta@uca.fr (N. El Osta).

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fracture of various components of the implant system to marginal bone loss or loss of osseointegration [3].

Conventional impressions using polyether or polyvinyl siloxane materials are standard procedures for multiple dental implants. Various techniques have been proposed to enhance implant impression accuracy, including splinting impression copings, modifying impression copings, designing impression trays, and utilizing rigid materials. However, factors such as impression technique, transportation, impression trays, and mixing techniques significantly impact impression accuracy. Inaccuracy during impression making is challenging to rectify in subsequent laboratory procedures, thereby influencing the internal and marginal fit of prostheses [4].

To overcome challenges associated with conventional techniques, intraoral scanners (IOSs) have been developed [5]. In this approach, a scan body is affixed to the implant, and an IOS is employed to transfer the three-dimensional implant positions into a digital system, capturing raw data in the form of point clouds [6]. Subsequently, a three-dimensional virtual image of the scan body is generated, facilitating the determination of the implant's position [7]. Various IOSs systems employ different capture techniques [8]. For instance, the triangulation technique, used by the I-500 and CS3600 scanners, measures the object's volume by calculating the difference between incident and reflected light upon contact with the object. On the other hand, parallel confocal scanning configurations, employed by scanners such as Trios 3, Trios 4, and Primescan, rely on laser and optical scanning of the tooth and periodontium. Despite these advancements, the accuracy of IOSs systems can be influenced by several factors, including span length, the number of implants, patient movement, humidity, reflective surfaces, and difficulties in capturing complex anatomical structures [9, 10].

IOSs systems are continually evolving, and numerous studies have been conducted to validate their accuracy [11–15]. Despite this progress, the current literature lacks sufficient data on the accuracy of the IOS technique in reproducing multiple implant positions in fixed prostheses when compared to conventional impressions. A prior study suggested that digital scans were less accurate than conventional impressions for full-arch implant-supported prostheses [13]. However, as of now, the literature does not advocate for the use of IOSs in long-span restorations involving teeth or dental implants, where the conventional impressions technique is still recommended [16,17].

The objective of this *in vitro* study was to assess the trueness and precision of conventional impressions compared to those obtained with five IOSs: Trios 3 (3Shape®), Trios 4 (3Shape®), Primescan (Dentsply Sirona®), CS3600 (Carestream®) and I-500 (Medit®), for implant-supported prosthesis in maxillary free-end edentulism. At the time of the study, these IOSs models were the primary ones utilized in our clinical practice. The null hypothesis posited that both conventional impressions and digital scanners yield casts of similar trueness and precision.

2. Material and methods

This *in vitro* study focused on obtaining impressions from a partially dentate maxillary model with free-end partial edentulism. In this model, six implants were strategically placed in the right second molar, first and second premolar sectors, as well as in the left second molar, first and second premolar sectors. The anterior dentate sector extended from the right to the left canines.

Initially, the maxillary working model was generated using a 3D printer, which produced the model from a digital file of a maxillary arch. The printing process employed a Formlabs Form 2® 3D printer, utilizing resin as the printing material. Euroteknika (ETK) brand Naturactis® implant analogs, with a diameter of 3.5 mm, were affixed to the model in the right sector for the second molar (#1), first (#2) and second (#3) premolars, and in the left sector for the second molar (#4), first (#5) and second (#6) premolars. To establish the spatial position of the implant

analog in the working model, scan bodies (ETK NA 35 SB Euroteknika) were fastened to the maxillary working model at 5 N.cm using a ratchet wrench (Fig. 1a). Subsequently, the maxillary working model underwent scanning using a desktop laboratory scanner (3Shape D2000) (Fig. 1b) to generate a digital reference model (Fig. 1c). The laboratory scanner employs multiline scanning with four 5.0-megapixel IOS and 27 blue LEDs, operating on the triangulation principle [18,19]. Its adjustment accuracy is 5 µm according to the ISO 12836 standard.

Two types of impressions were then assessed: (i) conventional impressions made of polyether (Impregum™ Penta™ Soft from 3M®), and (ii) digital impressions produced by five different scanners (Trios 3 and Trios 4 from 3Shape®, Primescan from Dentsply Sirona®, CS3600 from Carestream® and i500 from Medit®) (Fig. 1).

Secondly, impression transfers (ETK Naturactis® short transfers with S-Naturactis screws) were screwed onto the maxillary working model at 5 N.cm. Three calibrated operators took three impressions each, using a customized open tray and a polyether material, resulting in a total of nine conventional impressions. Customized impression trays were generated in the digital file of the maxillary working model using Dental System 3D modeling software (3Shape®), followed by printed using Formlabs' Form 2® 3D printer. Impregum™ pellets (base and catalyst) were placed into the metal cartridge of the 3M® ESPE Pentamix™ 2 automatic mixer with a single-use mixing tip and a 3M® elastomer syringe. Once the customized impression tray was removed, the implant replicas were positioned, and the impressions were cast (Fig. 1d). Scan bodies were then affixed to the model at 5 N.cm. The model underwent scanning using a desktop scanner (3Shape D2000) (Fig. 1e) to generate the digital model from the conventional impressions [18,19] (Fig. 1f).

Thirdly, before conducting the digital scan, scan bodies were attached to the maxillary working model at 5 N.cm. A standardized scanning protocol was established to ensure consistency between operators. Training was provided to ensure compliance with the protocol and scanning techniques. Each of the three calibrated operators took three impressions with each of the IOS following the manufacturers' instructions (Fig. 1g) [20–23]. In total, forty-five digital impressions (nine per IOS) were made, serving as digital models (Fig. 1h). For Primescan, Trios 3 and Trios 4 scanners, the impression was made in a single step. However, for CS3600 and I-500 scanners, the process involved an initial scan of the working model without scan bodies, followed by a second scan specifically focused on capturing the areas with the scan bodies in place. In both cases, the scan began from the vestibular surface of the right canine, extending to the distobuccal surface of the right second molar sector. It then proceeded over the occlusal and palatal surfaces of the same sector. Subsequently, the scanner recorded the anterior tooth sector on the palatal, occlusal and buccal surfaces. Finally, the left sector was recorded in the same manner as the first.

The criterion for evaluating the impressions was accuracy, which combines precision and trueness according to ISO 5725–1 standards [24]. Trueness is defined as the difference between the mean value and the true value, while precision refers to the distribution of values around the mean, ensuring the reproducibility of a measurement. STL files corresponding to the digital reference model, the nine conventional impression models, and the 45 digital impression models were saved. Geomagic® Control X™ (3DSYSTEM®) metrology software was employed to analyze the 3D state of digital impressions and scan bodies [25–27]. It is one of the software packages recommended by International Organization for Standardization (ISO) standard 12 836 [28]. The STL files were imported into the software, and each digital STL file of conventional impressions or digital scans was superimposed over the reference digital STL file for comparison. The alignment of the two scan files occurred in two stages. Common points between the reference and test scans were identified to ensure an accurate overlay for distance measurement. The scan bodies were selected for the second alignment [29]. Corresponding points on the top of the scan bodies and their cylinders in the reference and test scans were determined. Geomagic® Software utilized algorithms to minimize the differences between

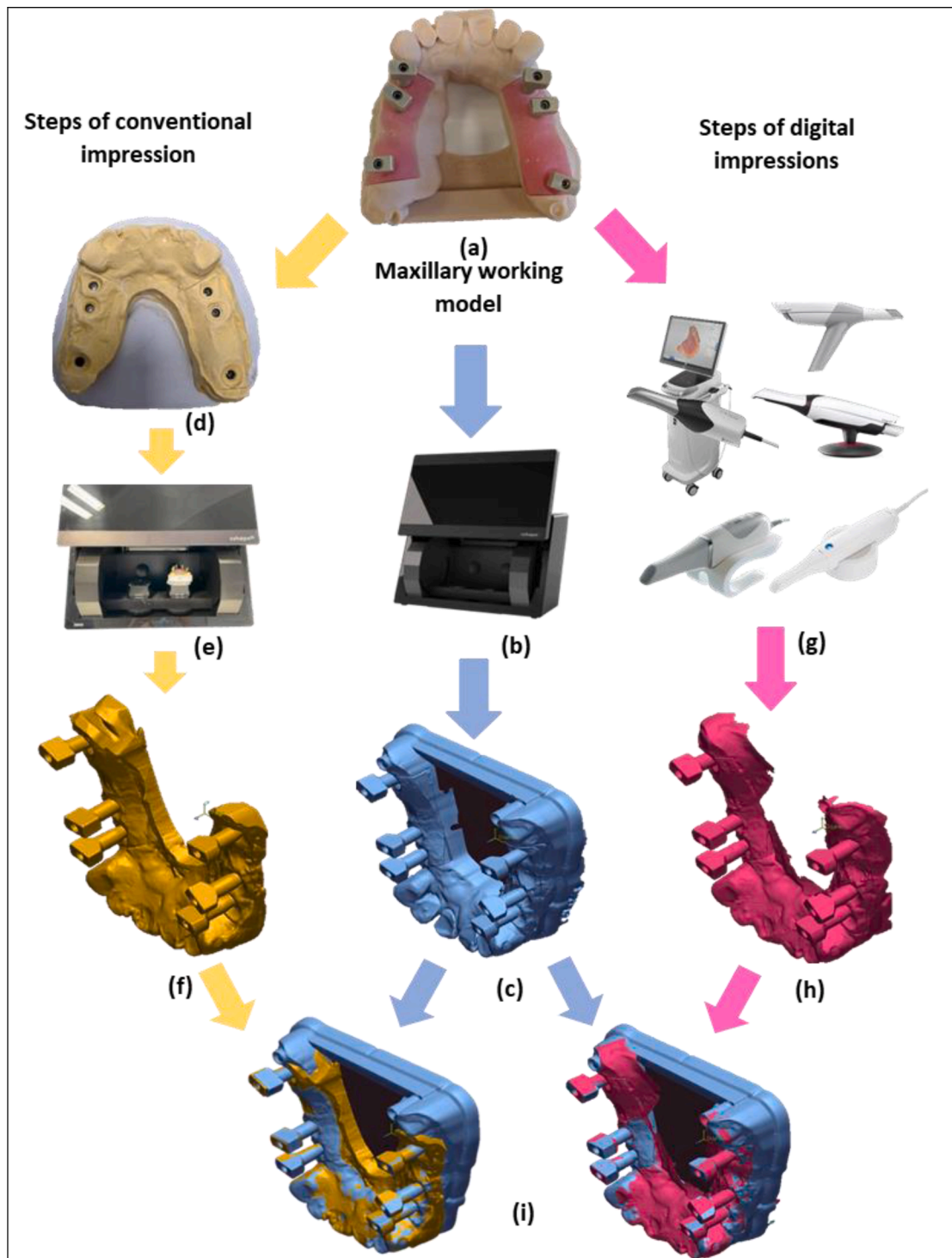


Fig. 1. Diagram illustration of the in vitro study- Digital model obtained by conventional impression of the maxillary working model (f) and digital model obtained by digital impression of the maxillary working model (h) superimposed to the digital reference model (c) to compare the accuracy (i).

corresponding points on the objects, calculating the distance between the points and adjusting the alignment to minimize error. Surfaces to be excluded from the comparison were then removed.

Accuracy was assessed using linear distance and angular deviation (Fig. 2). The distance deviations between the scan bodies (1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6, 1 and 3, 1 and 4, 1 and 5 and 1 and 6) were obtained from the reference file. Distance deviations were evaluated in two ways: (i) in absolute values to obtain an average of the deviations for each impression, and (ii) in negative or positive raw values to assess the

direction of the deviation.

Geomagic® was utilized to create the body axis of the scan modeled by a vector and to calculate the angular deviation with the reference. The angular deviation represents the angle between the vector of the reference and that of the scan being compared.

A method comparing the dispersion of the values (for both angular and distance deviations) around their mean for each scan was also applied to assess precision; the standard deviation was used to quantify this dispersion.

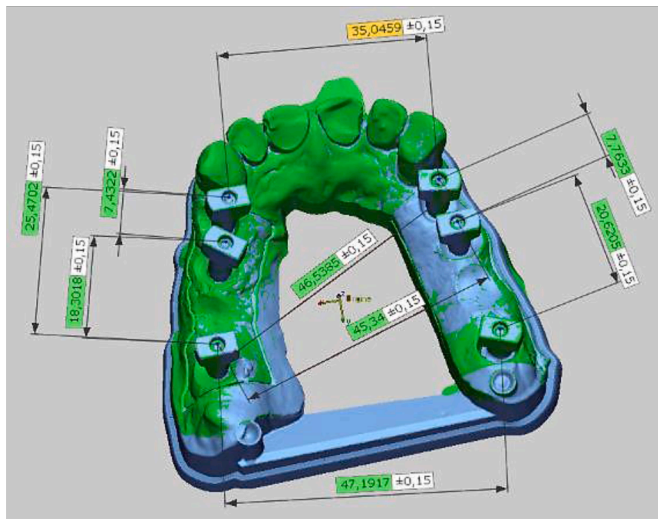


Fig. 2. Calculation of distances and angular deviations from the reference, with digital and reference STL files aligned.

The required sample size was determined based on a preliminary pilot study, assuming a pooled standard deviation of 0.592° . To achieve a power of 80 % and a significance level of 5 % (two-sided) for detecting a mean angular deviation difference of 0.8° between the conventional and I500 scanners, the study necessitates a sample size of 9 for each group.

The intraclass correlation coefficient (ICC) was calculated to assess intra-subject variability in angular and distance deviations. Kruskal–Wallis tests and ANOVA were applied to compare mean angular and distance deviations among the three operators. Measurements for each impression group were averaged for statistical analyses. For trueness, analyses of variance followed by Tukey’s Honestly Significant Difference (HSD) post hoc tests were applied to compare mean distance deviation among the groups of impressions. Kruskal–Wallis tests, followed by Mann–Whitney tests, were applied to compare angular deviations between impression groups. The precision of measurements was compared among the different impression groups. The dispersion of angular and distance deviations was quantified in each group using the standard deviation with its 95 % confidence interval. Fisher test was utilized to compare standard deviations between two groups. Data analyses were conducted using IBM SPSS version 29.0, GraphPad, and MedCalc software. The level of significance was set at a p-value of ≤ 0.050 .

3. Results

The intra-operator ICC was 0.84 for raw distance deviation (95 % confidence interval: 0.63–0.94), 0.79 for angular deviation (95 % confidence interval: 0.51–0.92), and 0.78 for absolute distance deviation (95 % confidence interval: 0.49–0.94), indicating good consistency within operators. There were no significant differences in mean distance and angular deviation between operators ($p > 0.050$).

The mean absolute distance deviation was significantly higher for conventional impressions ($454.24 \pm 334.70 \mu\text{m}$) than for IOSs ($p < 0.001$). However, there was no significant difference among CS3600 ($235.60 \pm 219.46 \mu\text{m}$), Primescan ($205.94 \pm 346.57 \mu\text{m}$), Trios 4 ($255.56 \pm 395.89 \mu\text{m}$), I500 ($160.98 \pm 204.48 \mu\text{m}$) and Trios 3 ($167.06 \pm 121.05 \mu\text{m}$) ($p = 0.362$) (Fig. 3).

Raw distance deviation from the reference digital model was significantly higher for conventional impressions than for IOSs ($p < 0.001$) (Fig. 4). Conventional impressions ($136.16 \pm 549.69 \mu\text{m}$) and CS3600 scanners ($55.91 \pm 318.12 \mu\text{m}$) exhibited positive deviations. In contrast, I500 ($-117.00 \pm 232.79 \mu\text{m}$), Trios 3 ($-61.60 \pm 198.05 \mu\text{m}$), Trios 4 ($-76.80 \pm 465.71 \mu\text{m}$) and Primescan ($-46.68 \pm 401.06 \mu\text{m}$) scanners showed negative deviations, with I500 producing a significantly higher negative distance deviation than other IOSs ($p < 0.05$).

The mean angular deviation differed significantly among impression groups ($p < 0.001$). It was significantly higher for conventional impressions ($1.82 \pm 1.51^\circ$), intermediate with CS3600 ($1.38 \pm 1.42^\circ$), Primescan ($1.37 \pm 2.54^\circ$) and Trios 4 ($1.30 \pm 0.64^\circ$) scanners, and significantly lower for the I500 ($0.97 \pm 0.75^\circ$) and Trios 3 ($1.01 \pm 0.85^\circ$) scanners (Fig. 5).

Dispersions of distance values around their mean are presented in Fig. 6. No significant difference was found between Trios 3 and I500 ($p = 0.211$). However, significant differences were observed between I500 and CS3600 ($p = 0.006$), Primescan and CS3600 ($p = 0.040$), and Primescan and conventional impressions ($p = 0.010$). Hence, Trios 3 ($198.05 \mu\text{m}$; 95 % CI: 166.49–244.50 μm) and I500 scanners ($232.79 \mu\text{m}$; 95 % CI: 201.64 –275.42 μm) exhibited the lowest dispersion, indicating the highest precision, followed by CS3600 ($318.12 \mu\text{m}$; 95 % CI: 275.55–376.37 μm), Primescan ($401.06 \mu\text{m}$; 95 % CI: 347.39–474.50 μm), and Trios 4 ($465.71 \mu\text{m}$; 95 % CI: 403.39–550.99 μm), respectively. Conventional impressions ($549.69 \mu\text{m}$; 95 % CI: 476.13–650.35 μm) showed the highest dispersion among groups, indicating the lowest precision.

Fig. 7 illustrates the dispersion of angular values around their mean. No significant differences were found between Trios 3 and I500 ($p = 0.403$), I500 and Trios 4 ($p = 0.251$), Trios 3 and Trios 4 ($p = 0.061$), and

a, b: different letters indicate the presence of a significant difference between groups with post hoc tests ($p < 0.05$)

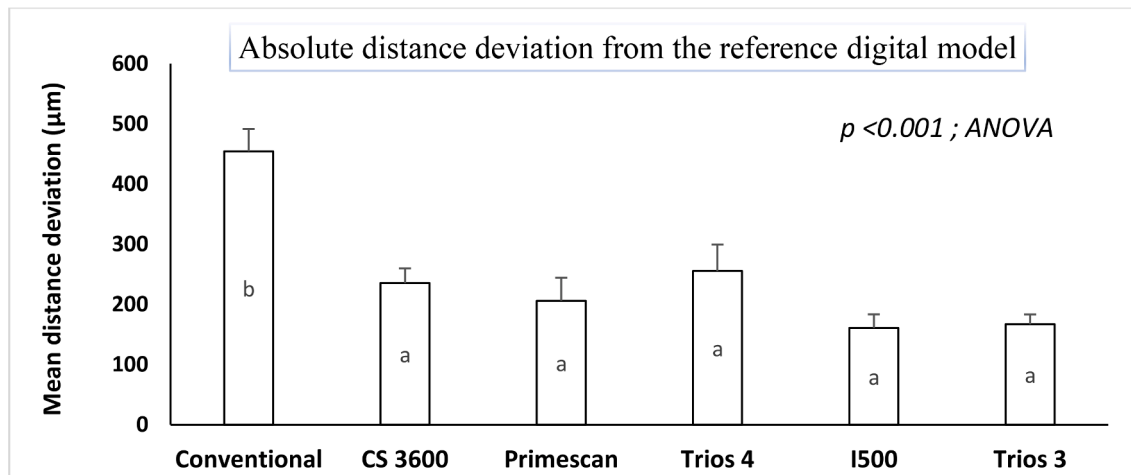


Fig. 3. Mean \pm Standard errors of the absolute distance deviation between conventional impressions and IOSs scanners.

a, b: different letters indicate the presence of a significant difference between groups with post hoc tests ($p < 0.05$)

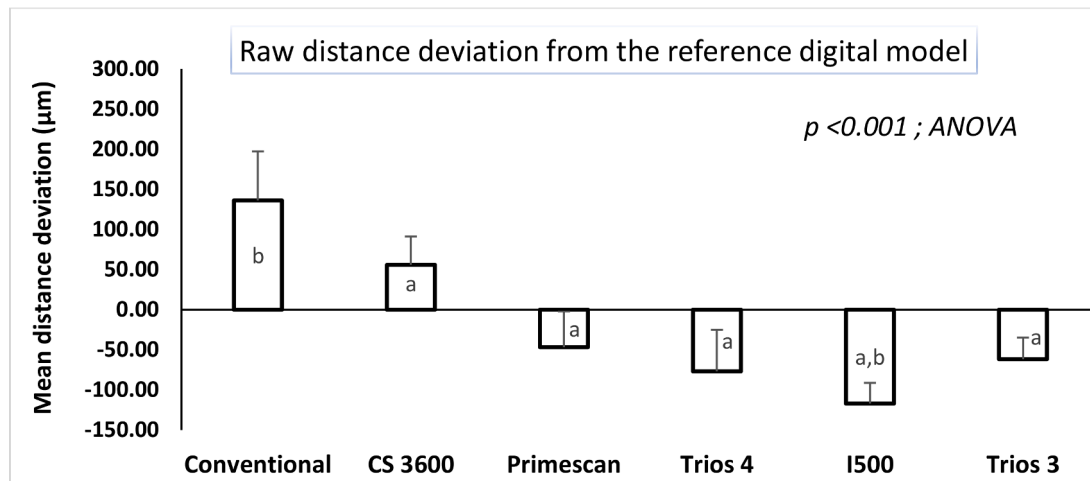


Fig. 4. Mean ± Standard errors of the raw distance deviation between conventional and IOSs scanners.

a, b: different letters indicate the presence of a significant difference between groups with post hoc tests ($p < 0.05$)

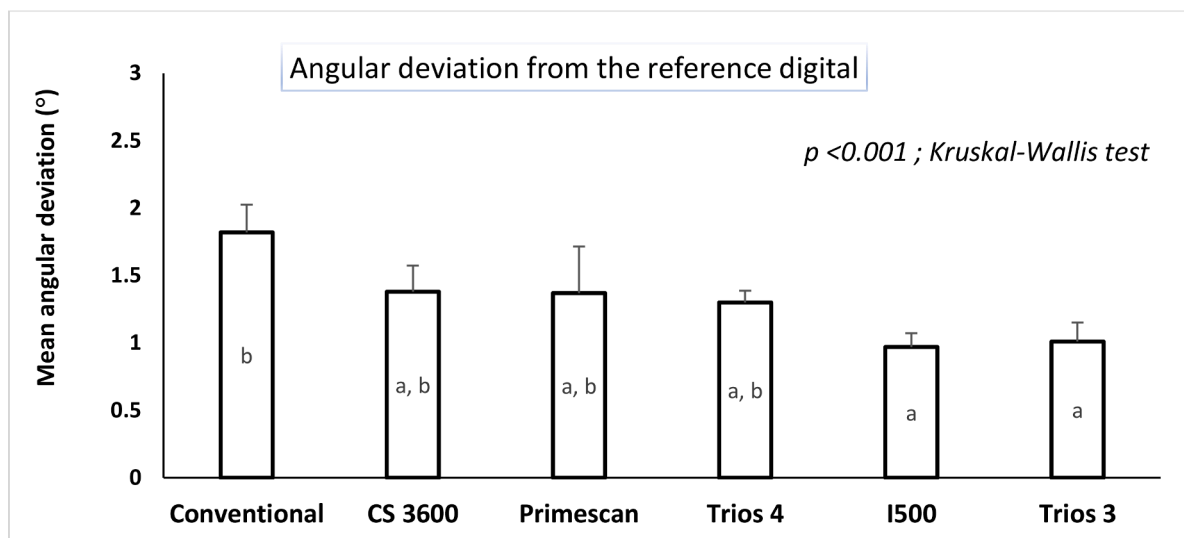


Fig. 5. Mean ± Standard error of the angular deviation between conventional impression and IOSs scanners.

conventional impression and CS3600 ($p = 0.656$). However, significant differences were found between Primescan and conventional impressions ($p < 0.001$), Primescan and CS3600 ($p < 0.001$), Trios 3 (or I500 or Trios 4) and CS3600 ($p < 0.001$), and Trios 3 (or I500 or Trios 4) and conventional impressions ($p < 0.001$).

Hence, Trios 3 (0.85° ; 95 % CI: $0.690 - 1.110^\circ$), I500 (0.75° ; 95 % CI: $0.631 - 0.926^\circ$), and Trios 4 (0.64° ; 95 % CI: $0.538 - 0.790^\circ$) scanners exhibited the lowest dispersion, indicating the highest precision, followed by conventional impressions (1.51° ; 95 % CI: $1.269 - 1.864^\circ$) and CS3600 (1.42° ; 95 % CI: $1.194 - 1.753^\circ$). Primescan scanner (2.54° ; 95 % CI: $2.135 - 3.136^\circ$) showed the highest dispersion, indicating the lowest precision. A summary comparison table of trueness and precision between conventional impressions and IOSs based on statistical results, is presented in Table 1.

4. Discussion

The null hypothesis, positing that conventional impressions and digital scanners would produce casts of similar trueness and precision for long-span implant-supported prostheses, was rejected. Accuracy

varied significantly between IOSs and conventional impressions in maxillary free-ended partial edentulism.

In terms of trueness, conventional impressions exhibited larger deviations in both distance and angle, with Trios 3 demonstrating the smallest deviation. The I-500 displayed larger negative distance deviations than the other IOSs, contributing to a reduction in the distance between scan bodies. The analysis of positive and negative deviation measurements provides manufacturers valuable insights for enhancing scanner properties [30]. CS3600, Primescan, and Trios 4 scanners exhibited a small distance deviation but an intermediate increase in angular deviation.

In terms of precision, Trios 3 and I500 exhibited the lowest dispersion of distance and angle values around their means. However, this was not the case for Trios 4, which showed a high dispersion of distance. Primescan scanner demonstrated the highest dispersion for angular dispersion, while conventional impressions and the CS3600 scanner displayed moderate angular dispersion.

Regarding accuracy, conventional impressions, known for their reliability in implantology [4], were found to be less accurate than IOSs. Trios 3 scanner achieved the best results in terms of distances and

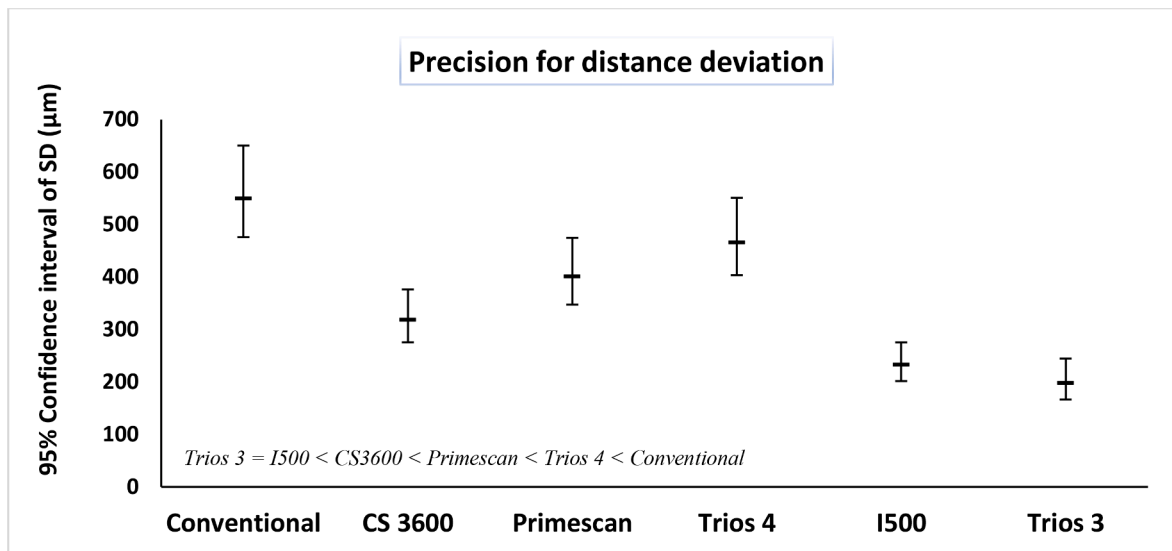


Fig. 6. Dispersion of distance values around the mean for conventional impressions and IOSs.

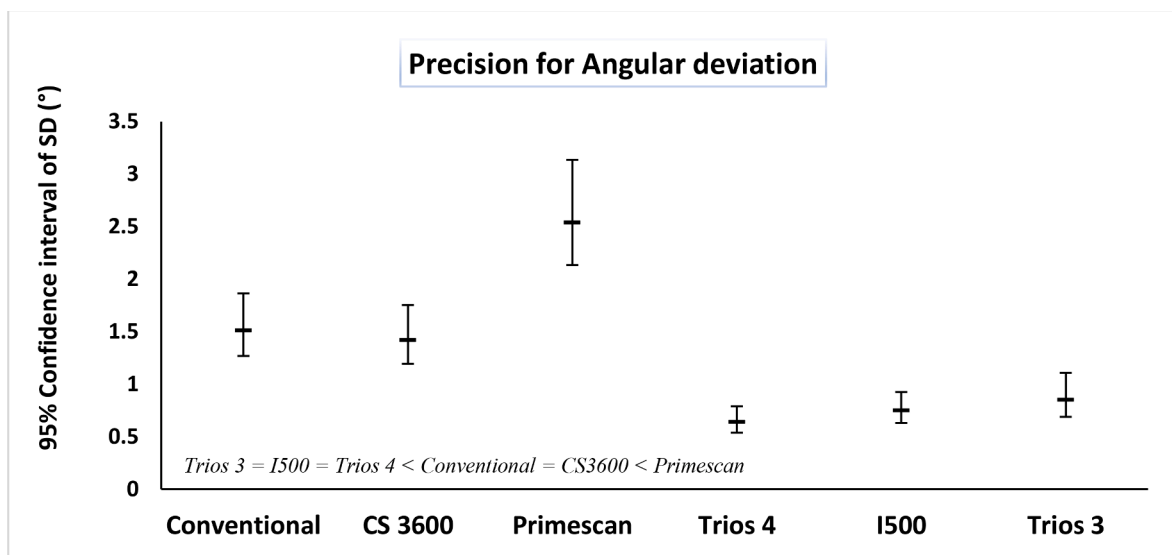


Fig. 7. Dispersion of angular values around the mean for conventional impressions and IOSs.

Table 1

Summary table of accuracy between conventional impressions and IOSs based on statistical results.

ACCURACY		Conventional impressions	CS3600 scanner	Primescan scanner	Trios 4 scanner	I500 scanner	Trios 3 scanner
Trueness	Absolute distance deviation	-	+	+	+	+	+
	Raw distance deviation	-	+	+	+	≈	+
	Angular deviation	-	≈	≈	≈	+	+
Precision	Dispersion of distances around mean	-	≈	≈	≈	+	+
	Dispersion of angular around mean	≈	≈	-	+	+	+

+: the smallest deviation.
 -: the highest deviation.
 ≈: intermediate deviation.

angular deviations, with low dispersion indicating high accuracy. The I-500 ranked among the best performing IOSs. Although Trios 4 scanner performed well, it was outperformed by Trios 3 scanner, despite being more recent scanner. The CS3600 ranked last, followed by Primescan scanner.

Our results align with previous studies demonstrating that digital scans obtained from specific IOSs serve as a valid alternative to conventional impressions for partial arch segments [31]. Among the scanners, the Trios series consistently yields superior scanning results compared to others [18,32]. Notably, Trios 3 scanner exhibited accuracy

comparable to extra-oral scanners like Medit T510, Seoul, Korea or 3shape D700 desktop scanners [18].

Researches have also indicated that IOSs can be useful for simple [33–35] and short-span cases involving 4–5 implants [31,36,37]. IOSs not only reduces impression distortion but also provides a more comfortable experience for patients compared to conventional impression procedures [38–40]. However, for long-span cases with more than 5 implants, the precision of scanning may not be comparable to conventional impressions [41–44]. Specifically, in cases of complete edentulism, the error from digital impressions can be clinically significant, leading to the continued use of conventional impression techniques for long-span restorations [13,45]. To our knowledge, this study is the first to assess the accuracy of long-span implant-supported fixed prostheses in partially edentulous patients, revealing that conventional impressions are less accurate than IOS. Dental markers could significantly improve the accuracy of full-arch digital scans [46].

Our findings need to be considered in light of certain limitations. While, linear distance measurement is a recognized method for assessing accuracy by measuring straight-line distances between points, it may overlook potential discrepancies in angular misalignments. This method focuses solely on point-to-point measurements without accounting for three-dimensional variations [47,48]. The observed discrepancy between raw and absolute distance results, concerning the ranking of IOSs, emphasizes that distance measurement may not be suitable for comprehensive 3D analysis. In the prosthetic workflow, the orientation, displacement, and rotation of objects are crucial. For instance, a scan body intended to support a bridge might rise vertically and move horizontally towards another, resulting in an unchanged distance between the two points. However, there could be a distortion in 3D space affecting the fit of the framework. Additionally, distance measurement does not consider the distortion between the two points. According to the triangular inequality theorem, the difference between two sides (analogous to the master and test distances in this study) of a triangle will always be smaller than the displacement of the third side (representing the true 3D) [49]. Consequently, linear deviation might underestimate the error.

Laboratory scanners are considered the gold standard in dentistry, despite being less accurate than industrial scanners. For example, the ATOS MV120 industrial scanners have a sphere spacing error of 1 μm , whereas the 3Shape E4 scanners, which utilize the same technology as the 3shape D2000, have an accuracy of 12 μm and a precision of 4 μm [19]. The use of laboratory or industrial scanners may present certain limitation as laboratory settings can differ from clinical settings due to variations in lighting, humidity, and other environmental factors, potentially leading to inaccurate representation of clinical conditions.

In addition, the use of the mesh/mesh (virtual model) method to evaluate impressions may present another limitation. Meshes are surface reconstructions and geometric approximations of the scanned model, which could introduce errors in the calculation of distances between scan bodies. However, in the case of implant prostheses, the initial Computer-Aided Design step involves replacing the scan body meshes with the corresponding file from the scan body library. This file is a geometrically perfect representation (NURBS file, Non-uniform Rational B-Splines) that provides more reliable linear distances. A study by Mangano et al. involving STL files, using both mesh and NURBS formats for the same impression, found that distance deviations from the reference were smaller with impressions recorded using a NURBS file [50].

Finally, an in vitro study does not assume the clinical validity of the impressions, as various parameters can affect accuracy. Scanning can generate numerous unwanted points due to patient movement, room brightness, or operator handling errors. Optical properties of the scanned elements and the presence of saliva or blood can also impact data acquisition [51]. However, in vitro studies offer the advantage of limiting confounding factors, evaluating all IOSs in a standardized manner, and under the same conditions [35].

5. Conclusions

In implantology, the conventional impression has long been considered a reliable and clinically validated technique. However, our findings revealed that, in comparison, conventional impressions were less accurate than digital scans. Specifically, Trios 3 and I-500 emerged as the top performers in terms of trueness and precision, followed by Trios 4 which performed well in terms of distance and angular deviation, although it exhibited a high dispersion of distance values around the mean. Primescan and CS3600, while less accurate than the other IOSs, still outperformed conventional impressions. In this comparative analysis, Trios 3 scanners exhibited the highest accuracy, followed by I500, Trios 4, CS3600, and Primescan scanners.

These findings suggest that Trios 3, I500, Trios 4, CS3600, and Primescan scanners could be reliable tools for fabricating implant-supported prostheses in cases of free-end partial edentulism. However, it is important to note that further studies conducted under intraoral conditions are essential to confirm and validate our findings.

All the authors approved the submitted manuscript and gave their agreement for all aspects of the work ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CRedit authorship contribution statement

Nada El Osta: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Noémie Drancourt:** Writing – original draft, Methodology, Formal analysis. **Chantal Auduc:** Methodology, Investigation, Data curation. **Jean-Luc Veyrune:** Supervision, Project administration, Methodology, Data curation, Conceptualization. **Emmanuel Nicolas:** Supervision, Methodology, Data curation, Formal analysis, Visualization, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Disclaimers

The opinions expressed in the article are ours and do not constitute an official position of the institutions.

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