

THE ACCURACY OF DIGITAL VERSUS CONVENTIONAL OPEN TRAY IMPLANT IMPRESSION TECHNIQUE, IN PARTIALLY EDENTULOUS PATIENTS

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ABSTRACT

Abstract: Impression techniques using digital technology seemed to be studied with the accuracy planning to initiate acceptable prosthetic results in implant dentistry. In order to overcome these misfit, digital impression by means of an intra-oral scanner may assist. The purpose of this study was conducted to assess the efficacy of using digital impression technique compared to conventional technique

Material and Methods: 8 patients were examined with a total of 22 implants placed, each patient had undergone two impression techniques: a digital impression: intraoral scan body, and a conventional impression: open tray impression, the total deviation between the two impression techniques was measured. This was done by scanning the scan body in patient mouth in group I and digitalizing the conventional open tray impression by scanning the scan body on the cast produced by the open tray in group 2. The scan body was replaced on the software (Exocad software) with custom made abutment and the deviation between the two groups was measured using (Geomagic Control X; 3D systems) GOM inspection software

Results: Total deviation between groups, the open tray conventional impression was compared to hypothesized reference digital impression and were calculated using GOM inspect software. The total deviation was statistically significantly different among the studied groups.

Conclusions: In partially edentulous patients, intraoral oral scanning using intra oral scan bodies improves over all accuracy, than conventional open tray impression technique.

KEYWORDS: Accuracy, Implants, Digital impressions, Partially edentulous, Scan body

INTRODUCTION

Nowadays with the advent of CAD-CAM technology, prosthetically driven implant placement is promising, by using a digital workflow which can

be either direct or indirect approach. The indirect workflow involves making a conventional implant impression which is then digitized in the laboratory by using an optical benchtop scanner and laboratory

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scan bodies. However, the direct workflow, includes using intraoral scan bodies (ISBs) with an intraoral scanning device which creates a digital scan directly from the patient's mouth.¹

In conventional impression techniques, if only 1 area is incorrect, the clinician must remake the impression. But, with an intraoral scanner (IOS), if the scan is not performed properly in certain areas, pictures can be easily added without any remakes. Therefore, the intraoral scanning procedure would greatly help those patients who have difficulty with the conventional process of prosthetic fabrication as gag reflex or allergic reaction towards the impression material with advantages that include patient acceptance and the storage and reuse of the scanned data.^{2,3}

A digital workflow requires neither conventional plaster nor silicone impressions materials for the manufacturing process of the prosthesis. Consequently, dimensional changes in the physical properties are reduced, and the digital workflow should provide expected permanent dimensional stability. Moreover, faulty impression of conventional technique no more exists, as additive scan and stitching the images with additional scanning through optical impression can be easily achieved allowing the clinician to recognize any deficiencies.⁴

A digital scan is more cost-effective, time-efficient, and easier to adopt than conventional impressions, particularly for inexperienced dentists.⁵

Regarding ISBs, they are implant abutments with varying digitally detectable surface geometry, as long as they are compatible with the designated implant system, IOS and scanner software, the ISB surface is recreated digitally, it then must be exported as a usable file usually in the form of a standard tessellation language (STL) file. A best-fit algorithm is most commonly used to align the CAD geometry with the acquired surface geometry from ISB scanning, this accordingly minimizes the 3dimensional distances between the acquired ISB

point cloud (from scanning) and its corresponding reference ISB stored in the implant library. This best fit algorithm drastically diminishes the root-mean-square errors to below 0.010 mm which is rated as excellent, whereas values above 0.050 mm indicate poor correspondence.¹

Technically speaking, the more point cloud density generated (the more scan points recorded) during scanning, the more precise the virtual surface geometry reconstruction. The opposite is correct as well, in that, absent data points in a point cloud will lead to difficulties when the surface geometry is reconstructed, which might cause multiple errors when attempting to register the image and associate the ISB surface with the implant library which means true image matching is impossible.^{1,6}

IOS systems are known to be open, closed, and semi-closed architectures, which is an indication of the degree of flexibility in importing and exporting digital files. Many authors have recommended open or semi-closed systems as they offer the laboratory and clinician more freedom and flexibility.¹

However, during scanning some reconstructed digital data may be lost, especially when images are stitched together at overlapping areas. When this happens additional chair side adjustments are required.⁷

In other words, the further was the scan from the original situation, the more was the deviation. This outcome is in agreement with former studies approving the reduced trueness of digital implant scans as a result of accumulated errors during image stitching. Such errors usually occur during scanning of long edentulous areas such as fully edentulous arches and free end saddle cases, as there are not enough reference points to help in correct image stitching.⁷

No data are available concerning the accuracy of digital scanning versus conventional impressions particularly for partially edentulous arches. Therefore, the primary purpose of this in vivo study was to compare the accuracy of digital

implant impression by IOS (Medit i500) with the conventional open tray (splinted) impression. The null hypothesis was that splinted open-tray impression has similar accuracy to digital scans for partially edentulous free end saddle arches.

MATERIAL AND METHODS

This study was a comparative study using cone-beam computed tomography (CBCT) imaging and flapless surgical technique to place two mandibular implants under approval of Medical Ethical Committee of Future University; FUE-REC (7)/2-2021. Patients were selected and diagnosed by (CBCT) and enrolled in the trial from the outpatient clinic of faculty of Dentistry, Future University. 8 male patients age ranging from 30-50, partially edentulous patients (free end saddle situations), were installed with 22 implants: Implant planning & placement: Cone beam Computed Topography of the patients were taken by x- ray machine (The Vatech PaX-i Green CT panoramic plus cone beam system delivers 15 x 15 cm large field of view cone beam) to create a DICOM file of the patient. Intraoral scanning of the working arch, the opposing arch & bite registration using Medit i500 to create STL Files of the patient arches.

Digital setting of missing teeth followed by digital articulator were done using Exocad software to accomplish prosthetically driven implant planning. Super imposition of the patient CBCT & STL using designing software (Real guide software). The surgical guides were created and the implants (Neobiotech) were virtually placed according to the designed prosthesis. After that all the surgeries were done in the mandible using surgical guides with copious irrigation. After 4 months the second stage surgeries were done and healing abutments were placed and left for 2 weeks.

Each patient had undergone two impression techniques before restoration construction including; **Conventional impression** (Splinted

open tray impression technique);

A cast was obtained from a preliminary closed tray impression technique, the short impression transfer copings were unscrewed, and the long transfer copings for the open tray impression were screwed. A verification jig was done to splint the two copings using dental floss and Dura lay acrylic, the jig was sectioned into two pieces to decrease polymerization shrinkage and not to affect the copings position. A custom tray was made on the cast using chemical cured resin (Acrostone) with opened holes corresponding with the two copings. The long impression transfer copings with the jig were screwed in the patient mouth over the implant. The two jig parts were joined together in the patient mouth with Dura lay acrylic. A one step impression technique using putty and light rubber base consistencies (polyvinyl siloxane, Zhermack) were taken with the custom tray after applying tray adhesive 10 minutes prior to the impression. The impression was poured into low expansion type IV dental stone (Zhermack) after the implant analogue (Neobiotech) was repositioned on the coping & a gingival replica was injected in the impression, around the analogues neck. as seen in Figure 1.

To digitize the open tray impression technique for future testing, scan bodies were screwed on the analogues of the resultant stone casts, followed by digital scanning using intra oral Medit i500 (intraoral scanner), as seen in Figure 2.

Digital impression (intraoral scanning using scan bodies):

Scan bodies compatible with the implants placed were screwed manually onto the implants intraorally, and then scanned with intra oral scanner. (Medit i500 intraoral scanner) producing a digital representation of the scan bodies and surrounding structures on the software.

During all scanning procedures, the scanning proceeded in continuous mode around scan bodies, and then again, a detailed scan of the scan bodies was done in circular movement to capture all the details.

The scans were done by experienced operators in around 5 minutes for each scan then the scans were exported as open- format STL files.

Using the designing software (Exocad Dental CAD) compatible scan bodies were chosen from the software library and superimposed on the scan bodies. As seen in (Figure 3) which enables determination of exact implant position and the implants were added using digital library.

Custom abutments were fabricated on the implant replica of the two groups, conventional impression group (which was digitized) and digital impression group, as seen in (Figure 4)

These custom abutments could be compared in deviations separately with each other without comparing the whole cast or any irrelevant regions,

which will generate more accurate results. To increase the accuracy during superimposition the two custom abutments in each scan technique were joined together in one STL file using designing software (Blender software).

A comparison was done between different data acquisition techniques (digital and conventional impressions):

The custom abutment generated by the digital impression was set as the reference, on which all the comparisons will be tested, using GOM (Geomagic inspect X; 3D systems) inspection software. The digitized STL of the conventional open tray impressions was imported as mesh. Then pre-alignment registration method was used, as seen in figure 5.



Fig. (1) Open tray impression technique



Fig. (2) Scan body loaded on Open tray cast.

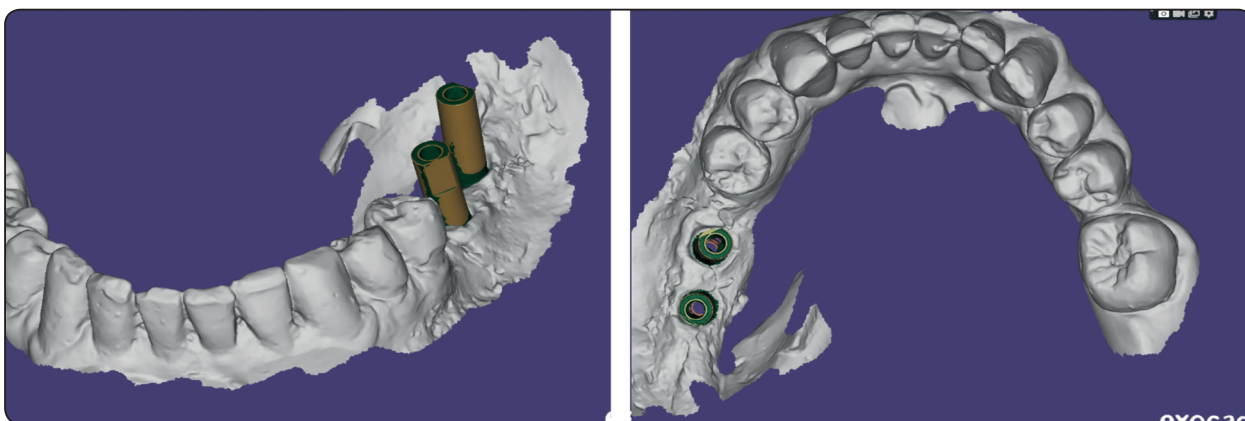


Fig. (3) Registration of scan body from software digital library on cast.

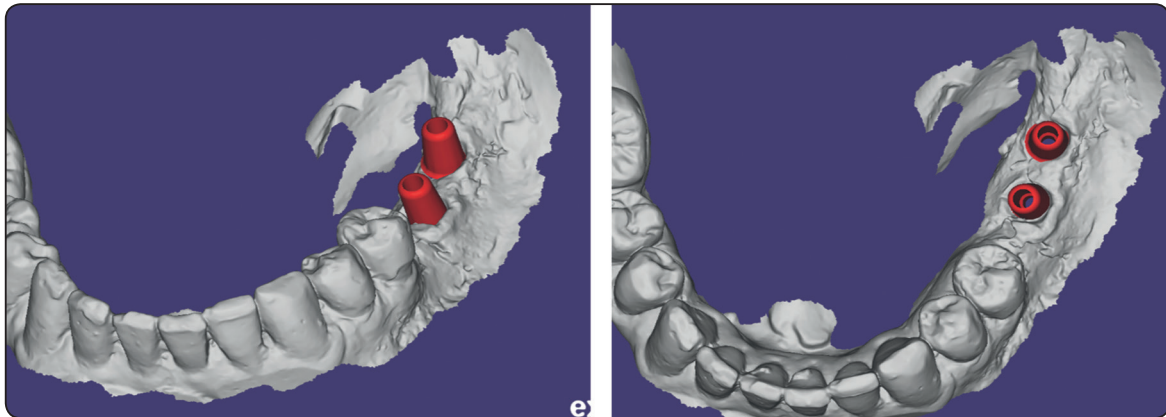


Fig. (4) Virtual designing of custom abutment in the scan body position

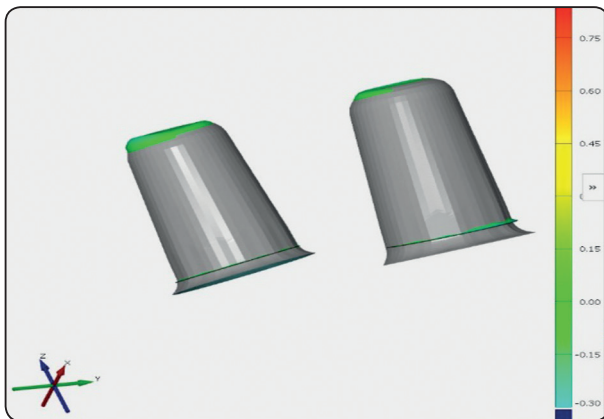


Fig. (5) Scan body comparison: Open tray cast scan body to intra oral scan body

Statistical methodology

Data were collected and entered to the computer using SPSS (Statistical Package for Social Science) program for statistical analysis (ver 21). Kolmogorov-Smirnov test of normality revealed no significance in the distribution of the variables, so the parametric statistics was adopted. Data were described using minimum, maximum, mean, standard deviation and 95% confidence interval (CI) of the mean. Comparisons were carried out between two studied independent normally distributed variables using independent sample t-test.

RESULTS

In the present study, the results in table 1 demonstrated the total deviation in which the digital

impression, the conventional impression, and digital impression custom abutment (hypothesized as reference and gold standard) were compared. These deviations were calculated using GOM inspect software and clarified that the total deviation in the digital impression the mean value was “0.1625±0.0327mm” and 95% confidence interval (CI) of the mean of “0.1351–0.1898mm”, while in the conventional impression the mean value was “0.1461 ± 0.0310 mm” and 95% CI of the mean of “0.1201-0.1720 mm”

The total deviation was statistically significantly different among the two studied groups ($t_{(df=7)}=14.052, p=<.001^*$). (Table 1)

TABLE (1): Deviation results between digital and conventional impressions.

Deviation (mm)	Open tray
- n	8
- Min-Max	0.1134-0.2231
- Mean ± S.D.	0.1625±0.0327
- 95% CI for mean	0.1351–0.1898
One Sample t test (against hypothesized deviation = 0)	$t_{(df=7)}=14.052$ $p=<.001^*$

n : Number of patients

Min-Max: Minimum – Maximum

S.D.: standard Deviation

CI: Confidence interval

*** : Statistically significant ($p<0.05$)

DISCUSSION

Passive fit is an important goal for any implant-supported prosthesis, in order to achieve such passivity an accurate impression free from distortion is crucial.

Balouch et al also compared the discrepancy in accuracy between open tray and closed tray impression techniques in 15° angled implants and concluded that less dimensional changes occurred with the closed tray impression technique. Another study examined the effect of connection type, impression techniques, and positioning angle of the implant on the impression precision. Based on their results, there was no difference in terms of impression exactness, using open and closed tray techniques.^{11,12}

The one step polyvinyl siloxane impression technique using putty and light rubber base in a custom tray was used in this study for recording the open tray impression technique. As recommended in a recent study that polyvinyl siloxane impressions obtained using custom made closed tray technique showed superior accuracy and statistically significant difference ($p < 0.01$) when compared with polyether impressions of non-parallel implants in a partially edentulous arch.¹³

According to a recent systematic review the digital scans are a clinically satisfactory substitute for conventional impression techniques when constructing tooth-borne and implant-supported restorations, especially in short span situations.⁸

Introducing intraoral optical scanners (IOSs) to implant prosthodontics has many benefits, including improved patient comfort and acceptance, dismissal of tray selection; decreased hazard of alteration and distortion during impression making or on removal from patient mouth, stone pouring, disinfecting the impression, and delivery to the dental laboratory besides no cast deformations. Furthermore, the digital scans can be electronically communicated

and stored as digital information, increasing efficiency, and reducing costs.^{1,9} Therefore, an optical impression should produce smaller errors with respect to the deviation between implants than a conventional impression would produce.⁴

The results of our study emphasize these findings as the mean deviations of the open tray impression group was “ 0.1625 ± 0.0327 ” which was statistically significant.

Regarding the discrepancies between the conventional and digital impression this may be attributed to the successive steps that were performed from beginning of the impression till the end of prosthesis construction.¹⁵⁻²²

These successive steps include, impression making stages, master cast, resin verification jig, waxing, investing, casting, veneer addition and finishing, resulting in a distorted the final outcome.¹⁰

CONCLUSIONS

Intraoral scanning using intraoral scan bodies have shown higher accuracy levels than, conventional open tray impression technique, producing a more passive restoration.

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