

ACCURACY OF DIGITAL IMPRESSION TECHNIQUES VERSUS CONVENTIONAL TECHNIQUES FOR COMPLETELY EDENTULOUS PATIENT : A CONTROLLED CLINICAL TRIAL

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ABSTRACT

Objectives: now a days recent intraoral scanners (IOS) are ready for digital scans of long-span edentulous patients and completely edentulous patients ; however, there is lacking of evidence.

In recent years there is vigorously promoted of digitization in the dental field there is a significant transformation in the future of dentistry by using the intra oral scanner to have digital impression. The aim of this article to evaluated the deviation between of intraoral scanning (IOS) impression and conventional impression in completely edentulous patient and to analyze the accuracy of IOS in completely edentulous maxillary arch.

Materials and methods: Two types of impression technique were made for eight completely edentulous patients. Intra oral scanning and conventional impression technique of the maxilla was done for each patient, the two-impression techniques were compared for accuracy using GOM inspect software.

Result: Total deviation between two groups were compared to hypothesized zero representing conventional impression I group and then calculated using special inspection software. The total deviation was statistically significantly different among the studied groups.

Conclusion: The accuracy of IOS not reliable for completely edentulous arches

INTRODUCTION

There is a great demand of Digital technologies in daily life, which is a trend that can also be found in dentists' daily routine.¹ In dentistry, the using the expression computer-aided design (CAD) and computer-aided manufacturing (CAM) not only express for prosthesis fabrication but the whole

digitalization process. But CAD-CAM procedures express only one part of the digitalization processes, as it not represent other parts like intraoral scanning (IOS), radiography, and patient recording.²

Now a days The IOS devices different a lot from since their first inception in dentistry in the 1980s³.

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The first step in dental procedures is the dental impressions.⁴ However, a lot of studies have shown a lot of drawbacks in this conventional impressions studies such as voids or bubbles^{5,6}. Moreover, while pouring the impression to obtain a cast this procedure itself reduces the accuracy that is obtained from expansion of the gypsum casts that affect the final restoration.⁷

Nowadays, a dentist can use intraoral scanners as an alternative to conventional impressions to do digitalization in clinical practice by using it for final impressions in partially edentulous patients and fixed prosthesis.⁸⁻¹⁰

The reasons for this shift and use of intraoral scanners are the benefits of using an intraoral scanner to obtain digital impressions such as being used for patients with vomiting reflexes, and it being possible to capture and correct only the part where the impression is not perfect. That was reported to reduce total clinical treatment time.¹¹⁻¹³

Although with the advanced technological IOS devices with higher accuracy, shorter scanning time, that increase dentist and patient comfort.¹⁴ Consequently, using intraoral scanner for the short-span or single fixed partial dentures fabrication are a verified option today, with the same or even better outcomes regarding the accuracy versus normal impression taking.¹⁵⁻¹⁹

Furthermore, in a partially edentulous patient the extent of the edentulous area affects the scan time and accuracy.²⁰, however scanning extended edentulous areas shows greater inaccuracies.^{20,21}

Regarding a patient's perspective, IOS appears to be more preferable to normal impression taking, as it is more comfortable.²² Also, there is improvement in complete-arch scanning of dentate patients, and IOS can be used in those scenarios.^{23,24}. However, the accuracy of scanning of complete denture still seems to remain inferior compared to conventional impressions.^{24,25}

Several reports have reported the accuracy and feasibility of digital scans for complete arches.²⁶⁻²⁹

But when it is used for removable partial or complete dentures, it remains vague whether IOS is a proper option regarding scan accuracy and time.³⁰

Nevertheless, digital workflows for the fabrication of removable partial and complete dentures based on IOS data are presented in the literature.³¹⁻³³ The major issue for intraoral scans in edentulous arches is the recording of the movable and non-attached mucosa in functional impression, as in conventional workflows.³⁴ Due to the image-based nature of functional impression, as IOS device considered passive muco-static conditions.³⁵

However, inadequate published studies have assessed using intraoral scanners in digital scanners of edentulous jaws because it is challenging to scan edentulous sites that are smooth and lacking of features.^{36,37}

Recently, manufacturers presented new generation of intraoral scanners that claimed for being appropriate for scanning of completely edentulous ridges,^{38,39}

The present study aimed to analyze the accuracy of IOS in completely edentulous maxillary arch.

MATERIALS AND METHODS

Study setting

Controlled clinical trial study was conducted to compare the accuracy between conventional and digital impression technique using intraoral scanner for upper completely edentulous patients.

The minimum required sample size was found to be 8 patients per group (number of groups=2) (self-controlled) (Total sample size=8 patients). The sample size was calculated using G Power version 3.1.9.2

All the data required for impression comparison were collected using Medit i500 (Nobel Bio-care USA, LLC) intraoral scanner dividing the data into 2 groups:

Group I: Digital scan of poured cast for upper completely edentulous patients obtained by Conventional impression technique.

Group II: Digital intra oral scanning for upper completely edentulous patients.

Sixteen digital upper completely edentulous patients scans, eight for each impression technique. This study followed the Declaration of Helsinki for the ethical principles for medical research involving human subjects and was approved by the research ethics committee. The study was registered on clinicaltrials.gov with registration number NCT04908618. The study was performed on Eight male completely edentulous patients, age ranging from 50/70 selected and diagnosed then enrolled in the trial from the outpatient clinic of of the prosthodontics department- faculty of Dentistry, zagazig University.

A) Maxillary Conventional impression

Conventional upper completely dentulous impression Uses custom tray constructed with less relief in the primary denture stress bearing area and greater relief in the nonbearing areas, was taken using addition silicon (Zhermack SpA; Badia Polesine, Italy) which has a good flow and ability to record surface details in the following steps:

- 1- Special tray borders were checked for proper extension and stability.
- 2- Border molding was done using low fusing impression compound then the impression was made with medium body addition silicone.
- 3- Secondary impression was checked for proper extension and the borders were checked for adequate width and depth. (Figure 1)

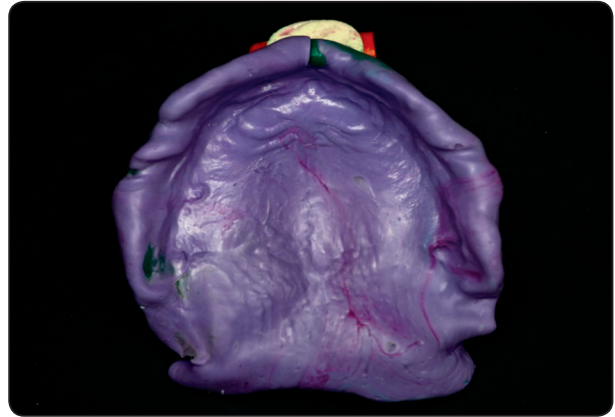


Fig. (1): Conventional maxillary completely edentulous secondary impression.

Boxing of the impression was performed to grantee proper border reproduction in the cast, then cast was poured with type III dental stone. The resulted cast was trimmed and finished and then scanned using medit i500 intraoral scanner. the scanned file was exported as a stereolithography (STL) file format. (Figure 2).

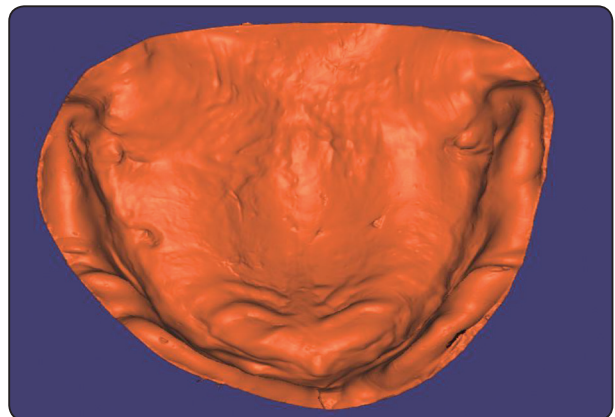


Fig. (2): Digital scan of the cast of the Conventional impression technique (DCI).

B) Intraoral scanning of the completely edentulous maxilla

Using air syringe and cotton rolls the rugae area and all hard palate were dried and cleaned before the scanning procedure. The Scan was done with an intraoral scanner in the following steps

- 1- Careful retraction of the soft tissues was performed to avoid stretching which could affect the border extensions of a complete denture.
- 2- The cheek /lip were lightly grasped between the thumb and index finger
- 3- The pattern for scanning edentulous maxilla was started with scanning the rugae area, which is the reference point in maxilla scanning, the scan procedure was done as following:
 - a- From the rugae area through the alveolar ridge on both the left and right sides,
 - b- From the rugae area to the buccal side including the vestibule and frenum.
 - c- From the rugae area to the palate by moving the scanner tip between the left and right alveolar

ridges and heading towards the posterior palate until complete palatal scanning.⁴⁰ (Figure 3) the scanned data was exported in the form of STL file. (Figure 4)

C) Digital comparison of different data acquisition techniques.

Any irrelevant data on the scanning were removed using exocad-dental cad software. using GOM inspect software, the conventional cast were imported as CAD body to be set as a reference in all the upcoming comparisons. Then intra oral scanning was imported as mesh. Then 3-point alignment registration method was used to register the cad body and mesh on each other followed by surface comparison on cad. Figure (5)

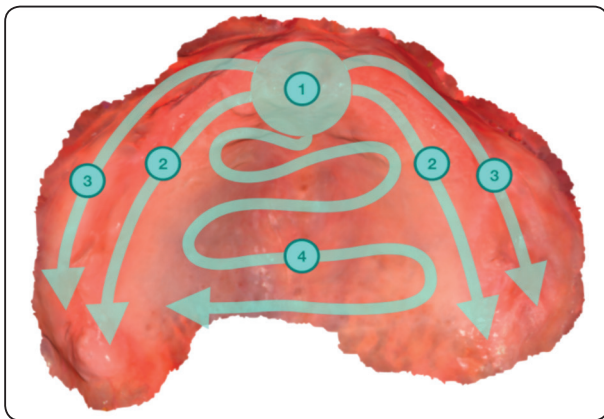


Fig. (3): Intra oral scanning pattern for completely edentulous maxilla

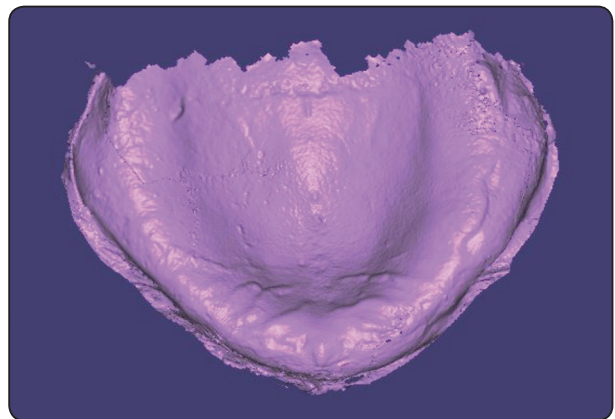


Fig. (4): Digital Scanning of upper arch using intra oral scanner

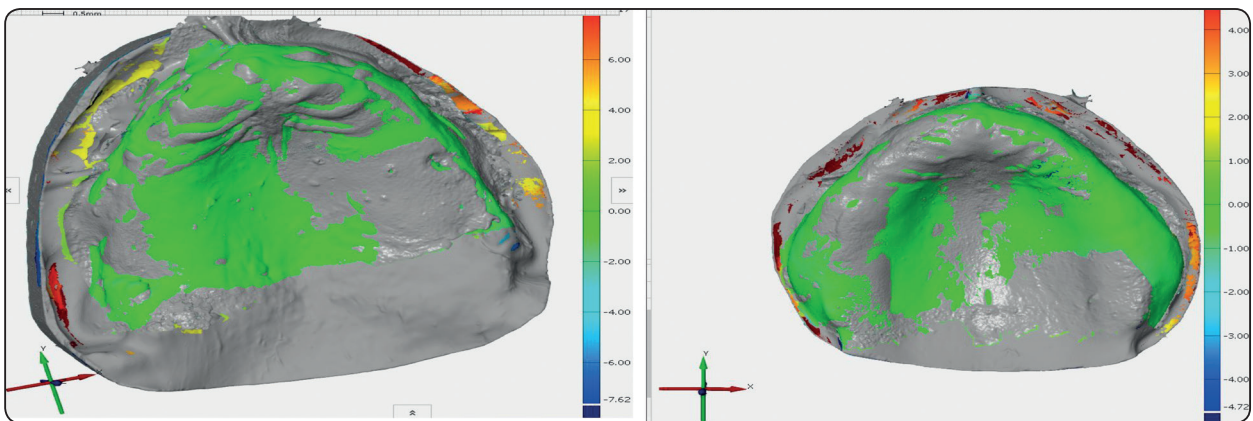


Fig. (5): Deviation in between conventional and digital impression

D) 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% CI of the mean.
- The one-sample t-test is used for comparing sample results with a known value.
- Comparisons were carried out between two studied independent normally distributed variables using independent sample t test
- An alpha level was set to 5% with a significance level of 95%.

RESULTS

In the present study, the total deviation between scanning and conventional ranged from 0.2156 to 0.3421 mm with a mean value of 0.2946 ± 0.0397 mm and 95% CI of the mean of 0.26149-.32779 mm. The total deviation was statistically significantly different when compared to hypothesized deviation of 0 ($p < .001$) (Table 1).

TABLE (1): The total deviation in between conventional and digital impression

| Deviation (mm) | Digital impression |
|--|---|
| - n | 8 |
| - Min-Max | 0.2156-0.3421 |
| - Mean \pm S.D. | 0.2946 ± 0.0397 |
| - 95% CI for mean | 0.26149-.32779 |
| Test of significance One Sample t test (against hypothesized deviation = 0) | $t_{(df=7)} = 21.017$ $p = < .001^*$ |

n : Number of patients *Min-Max*: Minimum – Maximum
S.D.: standard Deviation *CI*: Confidence interval

* : Statistically significant ($p < 0.05$)

DISCUSSION

Digital implant impressions shows a great advantages over normal impressions including as reducing distortion during the fabrication phases; enhanced patient comfort , improved efficiency and acceptance.⁴¹

Using of intraoral optical scanners (IOSs) in implant and fixed prosthodontics have advantages, including the exclusion of tray selection; minimize the risk of distortion during impression making, pouring, disinfecting, and shipping to the dental laboratory; and raise patient comfort and acceptance. Additionally, the digital scans can be communicated and stored electronically as digital information, improving efficiency, and reducing costs.^{41,42}

In optical impression, there are pouring cast so no cast deformations , and no distortions on get out and in from the oral cavity. Therefore, an optical impression should get more accurate result wit a smaller error than a conventional impression would get.⁴³ but in case of completely edentulous patient our result was different

The results of our study emphasize these findings as the mean deviations of the digital impression for upper complete edentulous is (0.2946 ± 0.0397) and 95% CI of the mean of 0.26149-.32779 mm from conventional impression was statistically significantly

These results concede with Kanchan Aswani et al that discussed scanning for complete arch with the IOS is susceptible of more deviation. And the accuracy of IOS systems are still susceptible to inaccuracies.⁴⁴

Also Luigi Federico D'Arienzo et al and lucio etal stated that scanning of edentulous jaws with the use of IOS appeared to be practicable , but peripheral tissue were not effectively recorded ., the authors could not recommend the use of IOS for scanning of edentulous jaws ⁴⁵

Also Acquiring accurate digital scan with an intraoral scanner is difficult, especially for patients with a broad palate.¹⁴

These should be as a result from stitching the images acquired from intraoral scanners because of the lack of definite anatomic landmarks.¹⁷ The smooth surface of palatal areas translates into poorly traceable structures.¹⁴ connecting areas are essential for correct stitching of needed images that result in a 3-dimensional (3D) dataset.¹⁴

Ill differentiated structures as edentulous space will likely lead to improper matching errors for the entire data set.^{18,19} Stitching errors can cause significant deviations in scanned images.¹⁴

So to fabricate maxillary complete dentures intraoral scanner can be used to record data for edentulous arch. But not possible to record all the borders of the mandibular denture accurately, it can be used to produce a stable trial denture base or using a conventional reline impression technique that will accurately record border effect.

Further experimentation is needed to determine how this process can be accomplished solely with a digital impression of the mandibular arch.

Also in conventional impressions there are many techniques aimed to remove forces applied to the tissue during the impression,¹³⁻¹⁵ but they still produce some forces on mobile tissue. Therefore, one additional advantage to the use of an intraoral scanner is its capability to capture movable tissue at rest. So an intraoral scanner used as a true muco-static impression. Muco-static impressions have been used in edentulous patients with hypermobile soft tissue.⁴⁶

Another benefit of the modern-day intraoral scanner is its ability to capture not only surface texture, but also color. This distinction allows the marking of the posterior extension of the maxillary denture base so as to be evident in the intraoral scan

CONCLUSION

The accuracy of IOS not reliable for completely edentulous arches

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