Al-Rafidain Dental Journal

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A Comparative Evaluation of the Accuracy Between the Extraoral Scanner (Rainbow) and Intraoral Scanner (Medit I500) Digital Impressions(in Vitro)

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Article information

Received: 29 October 2022
Accepted: 8 December 2022
Available online:1September 2024

Keywords

Dimension accuracy
Intraoral scanner
Extraoral scanner
Dgital impressions

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Abstract

Aims: To compare the extraoral and intraoral scanners' accuracy in obtaining implant impressions using an in-vitro reference model. **Materials and methods:** An upper master model was fabricated with two parallel dental implants at the first and second premolars missing regions in size (4.0mm in diameter and 10mm in length); twenty impressions were made using the intraoral and extraoral scanners to produce twenty digital impressions (10 for each one), which will result in twenty digital casts. The linear distance measurements were performed using (Medit Design) digital measurement by using Medit Intraoral Scanner. **Results:** In the digital part there was a highly significant difference between measurements for the oral scanner (MeditI500) and extraoral scanner Rainbow using Medit design, the intra-oral scanner (MeditI500) is the highest value which is at a level of significance p≤0.01. **Conclusion:** The Medit I500 Intra Oral Scanner is a more accurate impression technique than the Rainbow extraoral scanner in transferring implant position.

تقييم مقارن للدقة بين الماسح الضوئي خارج الفم والماسح الضوئي داخل الفم للطباعات الرقمية في المختبر

الملخص

الأهداف: تهدف الدراسة الى مقارنة دقة بين خارج الفم والماسح الضوئي داخل الفم للحصول على الانطباع باستخدام نموذج مرجعي في المختبر. **المواد وطرائق العمل**: تم تصنيع نموذج رئيسي علوي مع غرستين متوازيتين للأسنان في الضواحك الأولى والثانية في المناطق المفقودة في الحجم (قطرها 4.0 مم وطولها 10 مم) ؛ تم عمل عشرين انطباعا باستخدام الماسحات الضوئية داخل الفم وخارج الفم لإنتاج عشرين انطباعا رقمية (10 لكل واحدة) ، مما سيؤدي إلى عشرين قالبا رقميا. تم إجراء قياسات المسافات الخطية باستخدام (تصميم ميديت) القياس الرقمي باستخدام الماسح الضوئي ميديت داخل الفم. **النتائج**: في الجزء الرقمي كان هناك فرق كبير للغاية بين قياسات الماسح الضوئي داخل الفم (ميديتي 500) والماسح الضوئي خارج الفم باستخدام تصميم ميديت ، الماسح الضوئي داخل الفم (ميديتي 500) هو أعلى قيمة والتي اظهرت اختلافا معنويا . **الاستنتاجات**: ميديت إي 500 الماسح الضوئي داخل الفم هو تقنية الانطباع أكثر دقة من الماسح الضوئي الاخرالمستخدم خارج الفم.

DOI: 10.33899/RDENJ.2022.136720.1178

INTRODUCTION

The transfer of the three-dimensional orientation of implant from patient mouth to the cast is one of the most important challenges in implant dentistry. [1]

The main goals of implant impression are capturing the exact position of the implant fixture, build a crown with a good aesthetic emergence profile, connect it to the surrounding structure; and gingival tissue management around the implant fixture [2].

The use of intraoral scanners allows simplifying the workflow for the fabrication of dental restorations by eliminating traditional polyvinyl siloxane impression and preparing stone dies in traditional method, thereby potentially reducing discomfort to patient, introduction of procedural errors and treatment time [3].

Impression of scanning abutment using intraoral scanners digitally allows transferring the 3D position of the implant. Although deviation is inevitable during impression making regardless of the impression technique. [4, 5]

MATERIALS AND METHODS

Experimental Design of the Study (In Vitro): The experimental Design of the study was shown in (Figure 1)

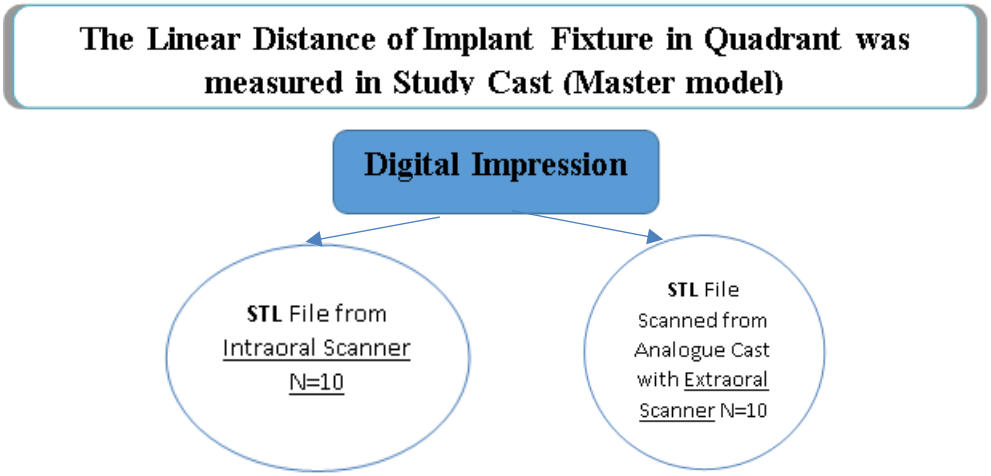

Figure (1): Experimental Design of the Study

For construction of an upper master model, impressions were made using different digital impression technique (exterior-anterior scanning technique for intra oral scanner); twenty impressions were made using the intraoral and extraoral scanners to produce (20) digital impressions (10 for each one), which will result in (20) digital casts.

Digital impression technique is done by either intraoral scanner Medit I500 or by extraoral scanner Rainbow. The Medit I500 was used as shown in figure (2); it employs triangulation-based video-type scanning. Scanning techniques similar to video may pick up moving things. The scanner can follow an object in motion because it can accelerate to the desired pace. [6]

Figure (2): Intraoral Scanners MEDIT I500

The scanning strategies for this study was the **Exterior-interior strategy** [7] as shown in figure(3) Started the scanning while resting on the occlusal surface of the molar waiting three to five clicks and then we moved toward the centrals capturing the occlusal surface slowly wiggled the scanner when passing the centrals and again continued on the occlusal surface until we reach the second molar turning slowly buccal by rotating the scanner 60-90 degrees at the last molar and complete the buccal swipe going along the buccal aspect until we reach the opposing side then roll to the palatal side and completing the swipe to the other side then for capturing the whole palate we swipe back and positioned the scanner behind the centrals and go from side to side across the palate in the distal direction[8].

For the scanning abutment that connected with implant, the scanning of the upper part of the scanning abutment (hexagonal shape with the palatal elevation) is very important to the Medit design to recognize the position and orientation of the implant [9].

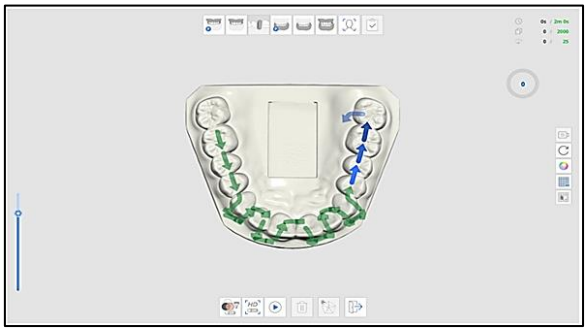

Figure (3): Scanning Strategies in the Study

The usage of extra oral scanner depends on a ray of light or laser to illuminate the object and capture information about the tridimensional surface using triangulation methods [10].

The scanning strategies for the extraoral scanner are computerized and no human control in the movement of extraoral scanner as shown in Figure (4)

Figure (4): Rainbow Extraoral Scanner

The measurement between two implant is done by Medit Design in extraoral scanner as the same procedure in the intraoral scanner [(11)].

The scanning abutment has hexagonal shape with elevation in the palatal part if seen in frontal view when screwed in patient mouth or cast [(12)].The selection of measurement points is essential matter in this study, so selection the points on the outer surface of the scanning abutment at the points of junctions of elevated palatal line with the inclined or diagonal line in the hexagonal shape of the scanning abutment and the same for the parallel buccal line; those are 4 points are selected the mesial and the distal point junctions of the buccal and the palatal elevated line of the hexagonal shape of the scanning abutment as points as shown in figure(5);Then by drawing lines between the selected points (from point A of on the first scanning abutment to the point B on the second scanning abutment) to produce line A and (from point B on the first scanning abutment to the point a on the second scanning abutment) to produce line B and so on to produce other lines as shown in figure 5 and 6 [(12)] .

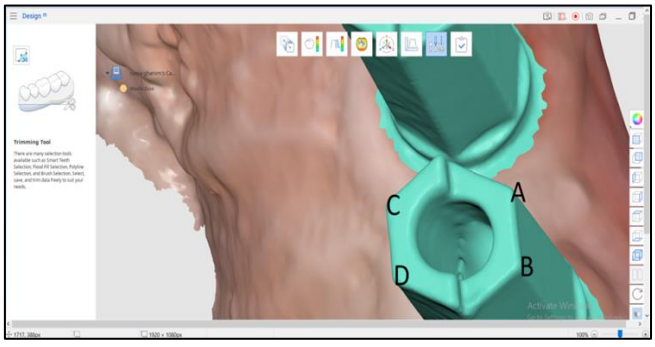

Figure (5): The Selected Measurements Points

Measures the distance between the selected two points; the distance between the select point a in the first scanning abutment to the point B in the second scanning abutment was measure the distance. The same way will continue between the points B, C and D as shown in figure (6)

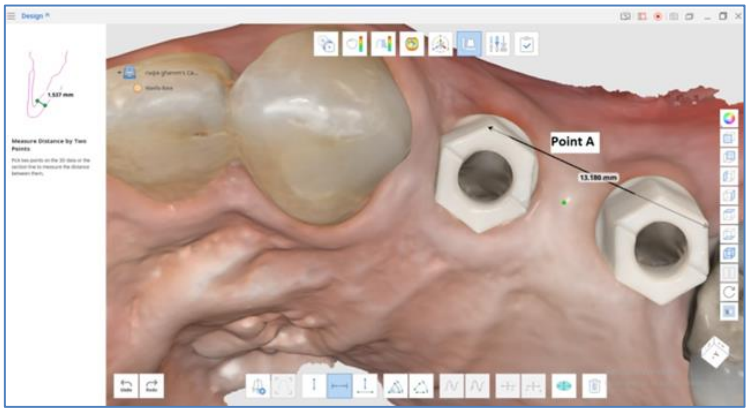

Figure (6): Measurements between Point A and Point B by Medit Design

RESULTS

Table (1) shows the means and standard deviation of the linear distances measurements with digital impression using intraoral and extraoral scanner.

Table (1) Paired T-Test Comparison between the Linear Distances Measurements Using Intraoral and Extraoral Scanners

Technique	N	Mean ± Std. Deviation	T	Sig.
I	10	14.0080 ± 0.02974	3.446	0.002*
E	10	13.9690 ± 0.02378		

I =Introral scanner,E= Extraoral scanner, * means highly significance difference at level of significance p<0.01, T= T value, N=number of impression (in vitro)

This table showed that there was highly significant difference between the measurements for intra oral scanner (MeditI500) and extraoral scanner using Medit design, the intra oral scanner (MeditI500) is the highest value (14.0080 ± 0.02974) at level of significance p≤0.01.

DISCUSSION

The results of this studies for the comparison between intraoral and extraoral scanner, the result showed that the intraoral scanner impression more accurate than the extraoral scanner impression; this was probably due to that intra oral scanner capture the impression from the patient mouth directly while the extra oral scanner need traditional impression taken from patient mouth and then pour it by die stone to produce analogue stone cast [(12)].

This stone cast then scanned by extra oral scanner to convert the stone cast

to digital cast; this long procedure for the conversion from analogue cast to digital cast incorporate many discrepancies and errors during the procedures of conversion like shrinkage of the impression materials, mixing time and ratio, pouring procedure of the cast, during the extraoral scanning than of the tooth by intraoral scanning [13].

However, the intraoral scanner readings also showed some amount of deviation from the control values due to minor errors that might have crept in during image stitching procedure. These findings were disagreed with [14, 15] who they compared the accuracy of digital models resulted from scanning plaster models with those from intraoral scanning of the patients. They also reported that the scanned plaster models had a higher accuracy. The authors mentioned that the inaccuracy of the intraoral scanning in their studies could have been caused by several factors, including movement of the patient during scanning, limited intraoral space, the presence of moisture and saliva, and an inadequate intraoral scanning technique.

CONCLUSION

Medit I500 intraoral scanner is more accurate impression technique than Rainbow extraoral scanner in transferring implant position.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication and/or funding of this manuscript.

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