Effect of Scan Body Design on the Accuracy of the Implant Position in Implant Supported Prosthesis

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Abstract

Background: Several treatment options are planned for completely edentulous patients rehabilitation which were developed to meet patients desires and requirements, starting from conventional complete denture till implant supported fixed full arch cases. Each technique has its own indication and limitations. Passive fit is an important factor for the long-term success of implant-prosthesis, which necessitate accurate transfer of the implant position. Recently, digital impressions have been introduced in dental implant treatment. By the use of scan body and different optical scanning methods, the position of scan bodies can be transferred to a virtual implant position within the dental arch.

Material and Methods: a standardized model was used to evaluate trueness, precision and overall accuracy between two types of scan body. The first is a scannable healing abutment. and a second a scannable healing abutment modified by adding plastic cap. A scan was made to four standard long scan bodies, and it was considered a base line of measurement (control group) control baseline.

Results: The results showed that there was a statistically significance difference when comparing trueness between scannable healing abutment
and healing abutment with plastic cap on both occlusal and mid axial direction with a P-value 0.000* and 0.003* respectively.

**Conclusion:** Within limitations of this study it could be concluded that using scannable healing abutment with plastic cap had better accuracy than scannable healing abutment without plastic cap.

**Keywords:** scan body, Implant, Impression, Surgical guide, Lab scanners, Intra oral scanner
Introduction:

The use of dental implants in the rehabilitation of partially and completely edentulous patients is a safe, accepted, and widely used treatment. It is estimated that over 12 million implants are placed each year around the world.(1)

Passive fit is an important factor for the long-term success of implant-prosthesis, which necessitate accurate transfer of the implant position. Recently, digital impressions have been introduced in dental implant treatment. By the use of scan body and different optical scanning methods, the position of scan bodies can be transferred to a virtual implant position within the dental arch.(2)

Many factors influence a digital scan's accuracy such as implant angulation, distance between implants, scanning protocol, and even the geometry of scan body may have influence on scanning accuracy.(3)

Impression accuracy is a combination of precision and trueness. Precision describes how close repeated measurements of the same object are to each other, whereas trueness describes how far the measurement deviates from the actual dimensions of the measured object.(4)

In 2004, the first implant components that could be digitally scanned were released, and they made use of an innovative coded healing abutment. (Encode; Zimmer Biomet Dental).(3)
Materials and Methods:

A-model construction:

Silicon mold was used to make the model.

![Figure 1: Addition silicon duplicating mold](image1)

And then clear epoxy resin was poured into the silicon mold in layers. The epoxy model was left to dry for 24 hours until complete setting.

![Figure 2: The resin model was fabricated to mimic a completely edentulous mandible](image2)
B-Digital work flow:

BI-Model data collection:

The finalized clear epoxy model was scanned using MEDIT I700 intraoral scanner, then The data was exported in (STL file). then(CBCT) was taken to the model to create a Dicom file of the model.

B2-Surgical guide planning:

Using the software Exocad, anatomic pontic with virtual gingival design module to speed up software workflow, unnecessary data from the DICOM image was first removed, and 3D viewing settings were adjusted for better data visualization.

Using the tiny indentations and the anatomy of the frenum region, the STL file was superimposed onto the DICOM file.

Two oval holes were made on the guide to be as a reference for guide complete seating on the model

The implants were planned according to the predesigned denture and were insured to be parallel to each other and to the path of insertion.

Figure 3: Finally designed surgical guide with oval hole to check complete seating
The finished surgical guide was then cleaned with alcohol, placed in the ultrasonic washer, and exposed to the ultraviolet curing unit for 30 minutes to complete the guide's curing.

![Printed and finished surgical guide](image)

**Figure 4: Printed and finished surgical guide**

C-Implant placement using surgical guide:

The four sleeves were inserted into their position in the guide. The guide was placed on the model and checked for its stability and complete seating on the model.

The guided surgery kit was used with 22 mm drill length and with sequential implant drilling till desired implant width.

![Represents implant placement through surgical guide and surgical guide completely seated on the epoxy model](image)

**Figure 5: Represents implant placement through surgical guide and surgical guide completely seated on the epoxy model**
In this study a standard model was used to evaluate trueness, precision and overall accuracy between two types of scan body.

The first is a scannable healing abutment. And the second is a scannable healing abutment modified by adding plastic cap.

The third is a standard long scan bodies, and it was considered a base line of measurement (control group)

Figure 6: Anyridge scannable healing abutment

Figure 7: Scannable healing abutment with plastic cap

Figure 8: Any ridge long scannable abutment
Scan was made by *CERAMIL MAP 400 scanner. The titanium dioxide-free spray (occlutec renfert) was used for recognition of the cast and metal scan body.

All the scan bodies were tightened with the same torque (ten N).

- Scan was done for long scannable abutment

![Figure 9: Long scannable abutment](image)

Then the long scan bodies were replaced with four healing abutments and the 16 scan were made to the scannable healing abutment.

![Figure 10: Scannable healing abutment](image)

After this the plastic caps were added to healing abutment and another 16 scans were made.
Figure 11: Scannable healing abutment with plastic cap.

The recorded scan was compared using the best fit algorithm between virtual abutments using geomagic control X. Measuring of trueness was carried out by comparing each scan with reference (control) while the precision was carried out by comparing the scans with same group each other.

Figure 12: Designing a custom abutment for the digital model of standard scan body
Figure 13: The finalized custom abutment with the same dimension for the whole types of scan body

Figure 14: Super imposition between the digital model of healing abutment with plastic cap and standard scan body using best fit algorithm which demonstrates axial deviation
Figure 15: Occlusal deviation measures in scannable healing abutment

Figure 16: Deviation measurements in the axial surface of the healing scan body with plastic cap
Results:

In this study a comparison in trueness and precision between scannable healing abutment and scannable healing abutment with plastic cap was carried out.

In this study conventional long scannable abutment was used as a reference (baseline).

The results of this study showed that there was a statistically significant difference when comparing trueness between scannable healing abutment and healing abutment with plastic cap on both occlusal and mid axial direction with a P-value 0.000* and 0.003* respectively.

When comparing deviation at occlusal direction, the scannable healing abutment with plastic cap showed less deviation values from the reference and in turn higher trueness values than scannable healing abutment only recording mean values of 52.26 ± 39.77 and 173.13±37.62, respectively.

On the contrary at the axial directions, the scannable healing abutment with plastic cap showed higher deviation values from the reference and in turn less trueness values than scannable healing abutment only recording mean values of 56.56±31.99 and 25.21± 22.94, respectively as seen in table no (1) and fig. (17).

The results of this study also revealed that there was no statistically significant difference when comparing precision between scannable healing abutment and healing abutment with plastic cap on both occlusal and mid axial direction with a P-value 0.052 and 0.153, respectively.
Table (1): Trueness between the two studied groups at various measurement areas by measuring deviation from the standard scan body (reference group) in (micrometer).

<table>
<thead>
<tr>
<th>Areas of measurement</th>
<th>Scannable healing abutment (M±SD)</th>
<th>Healing abutment with plastic cap (M±SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation at occlusal surface</td>
<td>173.13±37.62</td>
<td>52.26 ± 39.77</td>
<td>0.000*</td>
</tr>
<tr>
<td>Deviation in the mid axial surface</td>
<td>25.21± 22.94</td>
<td>56.56±31.99</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

* : Statistically significant (p≤0.05)

NS: Statistically not significant (p≥0.05)
Mean of occlusal and axial deviation in trueness in the two studied groups from the standard scan body in micrometer

Figure 17: Bar chart comparing the trueness in occlusal and axial direction in the two studied groups
Discussion:

Discussion of methodology:
Using scannable abutments (scan bodies) allow high accuracy and few errors as it mimics the position of the implant. However, few studies reported some errors with different types of scan bodies. (5)
Some reports indicated deviation due to different geometry and strategy. (6,7) For digital intraoral scanner very little is known about accuracy of different geometry. Another study reported that the scan bodies with a comparatively flatter and simpler structure were associated with significantly small deviation with digital impression. (8)
The aim of this study was to evaluate trueness and precision of scannable healing abutment with and without plastic cap. Different types of scan bodies were reported to influence the accuracy of the digital impression. (9)
The resin model was fabricated to mimic a completely a dentulous mandible, then four implants were inserted according to prosthetically driven implant placement protocol using a surgical guide to ensure implant parallelism.
Long scan bodies were secured on the implants. To ensure valid results, the scan bodies used in this study were one-piece, screw-retained, with rough surface and has the same linear shape with no undercuts. All the scan bodies were tightened with the same torque (10 N)
After scanning the scannable abutment, the STL files obtained with using control reference data.
The resin model was used to control the variables that encountered in clinical situation and may affect the accuracy of the scan, these factors include saliva, bleeding and movements of surrounding lips, muscles and tongue. Conventional scan bodies were replaced with healing scan bodies with and without plastic cap and scanned. Each type of scan body was scanned 16 times to ensure the accuracy of measuring system with one fixed reference point in each surface.

Using CERAMILL MAP 400 for scanning scannable abutment because it is fast, precise and high resolution scanning data. (10)

This method made it possible to place a virtual standardized center point in the upper vertical plane of each scan body in each digital impression and determine its deviation from the corresponding virtual center point in master model in axial and midaxial direction.

To guard against errors that may result from metallic part showing under the plastic cap this part was sprayed by occlutec renvert spray.

Using occlutec renvert spray to recognition of cast and metal scan abutment because it is very finely granulated with fine, homogenous layering for precise scanning results and exact edge representation and high opacity for exceptionally detailed object digitalization and no titanium dioxide and high separation sharpness with detailed edge representation, especially on delicate structures, for precise scanning results. (11)

In this study a modification of scannable healing abutment was carried out by adding plastic cap to enhance accuracy of the digital impression.

None of the previous studies have examined the accuracy of the healing abutment with plastic cap. however, there were some difficulties in the insertion and removal of the plastic cap.

The best fit alignment method is used to evaluate the accuracy of different digital
impressions by scanning either scannable healing abutment or healing abutment with
can post using a desktop scanner to fabricate a digital model, which was best fit
aligned over the digital models with standard scan body. It was reported that the
best-fit alignment method is suitable for the evaluation of accuracy in implant
impression techniques. This algorithm minimizes the global distances between the
test and reference data, the further the test data was from the reference, the greater
the deviation and the lower the accuracy.(12)

The null hypothesis is there is no difference between scannable healing abutment
with plastic cap and scannable healing abutment without plastic cap.
The results of this study rejected the null hypothesis.

**Discussion of the results:**
The results showed the accuracy of the scannable healing abutment with plastic cap
was higher than scannable healing abutment without plastic cap, this could be due
to the increased height of scannable healing abutment with plastic cap that allowed
more surface area to be scanned that may make the superimposition easier however,
there was a difference between occlusal and mid axial measurements this could be
due to being composed of two parts that may influence the scanning acquisition in
axial wall while the occlusal was not affected by this.
Conclusion:

Within limitations of this study it could be concluded that using scannable healing abutment with plastic cap had better accuracy than scannable healing abutment without plastic cap.
References:


