IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 8 Ser.6 (August. 2023), PP 18-25
www.iosrjournals.org

An In Vitro Study To Compare The Accuracy Between Conventional And Digital Impression Using Two Different Materials Of Scan Body (Compartive In Vitro Study)

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ABSTRACT
Aim:
The aim of this in-vitro study was to compare the accuracy between conventional and digital impression using two different materials of scan body.
Methodology: *A printed resin model of a completely edentulous mandible was constructed then A complete denture was made on the printed resin model following the conventional methods. The resin cast was then modified and prepared to receive four implants at the second premolar and the lateral areas bilaterally. The first group (Group 1) used the printed resin model screwed on it PEEK scan bodies and the second group (Group 2) used the printed resin model screwed on it titanium scan bodies which were used for scanning the four installed implants. Both groups used the same extraoral scanner. For the comparator group, A fabricated Custom-made tray was used for taking 10 open tray conventional implant impressions then 10 stone casts were poured with the four implants installed at the lateral incisors and second premolars in each cast. Then all stone casts with the two different scanbodies were used for scanning each model once with peek scanbody and once with titanium scanbody then all STL files were saved and were tested for accuracy with the resin casts for each group*
Results: *Group 2 (titanium scan body) showed a greater overall angular deviation than Group 1 (PEEK scan body) and was statistically significant at the lateral incisors. Regarding, the linear deviation it was found that it is greater in group 2 (titanium scan body) than in group 1 (PEEK scan body) and showed a statistically significant difference between them in both the lateral incisor and second premolar areas.*
Conclusion: *Within the limitation of this in-vitro study, it can be concluded that the implant scan body material significantly influenced the scanning accuracy of complete-arch digital impression. PEEK scan body showed the highest accuracy on both linear and angular perspectives compared to the titanium scan body.*
Keywords: *Completely edentulous, Scan bodies, Peek, Titanium, Open tray, Angular deviation*

Date of Submission: 10-08-2023 Date of Acceptance: 20-08-2023

I. Introduction

Patients have experienced loss of retention and stability despite Branemark and his colleagues developing and introducing titanium dental implants in the 1950s and 1960s, particularly in the mandibular atrophic ridge. Subsequently, dental implants have been considered as a reliable treatment modality, and they are now routinely used. Studies have shown that dental implants have been successful at restoring both function and appearance for completely and partially edentulous patients. *(Moraschini et al., 2015*)(1)

For completely edentulous patients, implant-retained or implant-supported prostheses have several advantages. They are especially useful in the mandibular jaw, where significant alveolar ridge atrophy causes a patient's complete denture to be unstable and would affect the patient's quality of life and satisfaction. Insufficient bone support, typically in the posterior areas of the mandible, may necessitate bone augmentation treatment and further hinder implant placement in such instances. The overdenture treatment option has resolved all related problems by installing implants anteriorly and constructing implant-supported or implant-retained prostheses. (*Tutak et al., 2013 and Asawa et al., 2015*) (2)(3)

A key part of any implant treatment is obtaining an accurate dental impression. However, the accuracy of the impression depends on a number of factors, such as whether it is a digital or conventional impression. Unfavorable complications may be mechanical or biological in nature if the impression is inaccurate and the implant-supported superstructure does not fit correctly.

Conventional impression for implant restorations can be open or closed techique, based on the type of impression copings: open tray (direct pick-up) or closed tray (indirect transfer). A less common approach is the "snap-on" technique (closed tray, direct transfer), which is a hybrid of the other two. The open-tray impression technique was found to be more accurate than closed-tray impressions for completely edentulous .(*Papaspyridakos et al., 2014*) (4)

Digital impression technique have also been introduced and they have several advantages over conventional impression, they would eliminate tray selection, impression material and polymerization shrinkage, as well as disinfection and shipping to the laboratory, and improve patient comfort in addition to that all data saved electronically which improve efficiency.

Intraoral scanbody (ISB) is necessary in order to accurately capture the implant position with a digital impression. According to *karthhik et al., 2022 (5)* scanbody material and geometry greatly affected accuracy of full arch digital impressions.

In the present invitro study the aim is to compare between two different scanbody materials on the accuracy of the impression

Sample size calculation

In a previous study the response within each subject group was normally distributed with standard deviation 4.6. If the true difference in the experimental and control means is 6, we will need to study 10 experimental subjects and 10 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05.

Resin model selection

To stimulate a clinical situation a stone model of a completely edentulous mandible was used to fabricate the master acrylic resin cast. The mandibular cast was then scanned by inEos X5 extraoral scanner, the stl files were then exported and the cast was then printed with PHOTON SE 3D printer. **(Figure 1,2,3)**

Fig. 1 Mandibular Cast

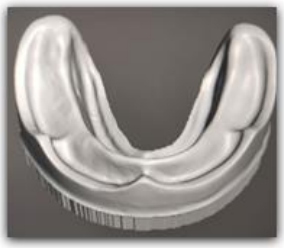

Fig. 2 Virtual planning of the 3D resin model on software

Fig. 3 3D Printed Resin Cast

Complete denture construction following conventional method

A trial denture base was constructed and adjusted and properly adapted on the resin cast. Acrylic teeth of suitable size were set on the trial denture base for the resin model. Then a complete denture was constructed following the conventional methods. **(Figure 4)**

Fig. 4 Setting of suitable size teeth on the trial denture base

Implant insertion

The denture was then modified at the second premolar and the lateral areas bilaterally. Four implants were installed in the resin printed model at the laterals and second premolars bilaterally. Drilling was initially performed using drills of diameter size of 2.3 mm (pilot drill). Followed by 2.8mm drills and finally 3.4 mm drills for the placement of implants 3.7x10mm in dimension. Dental surveyor was used to insert each implant using implant driver which was attached to the surveyor. **(Figure 5)** The drilling site was cleaned and the fixture Implant direct was inserted in place carefully. **(Figure 6)** Each implant was then secured to its place by adding small amount of cyanoacrylate adhesive

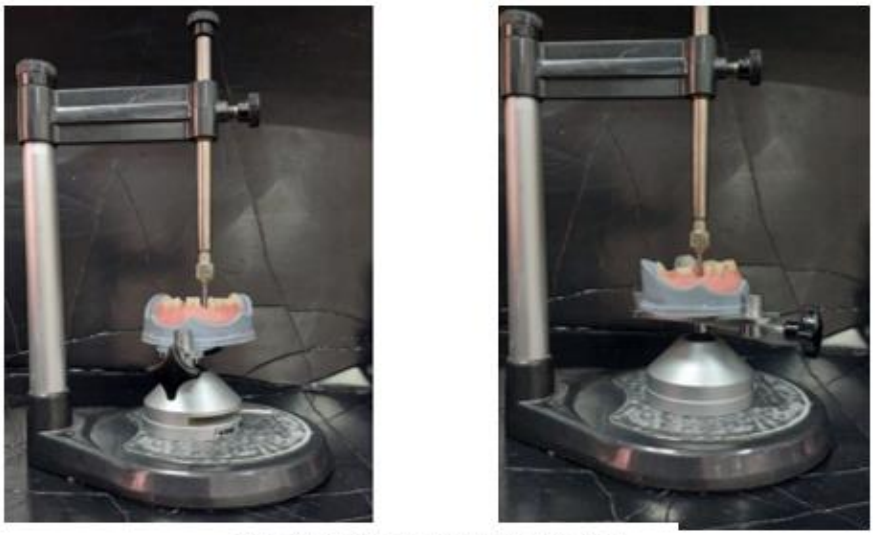

Fig. 5 Resin cast on the dental surveyor

Fig. 6 Resin cast after implant insertion

In the present invitro study, the same resin printed model was used for both groups. The first group (Group1) used the printed resin model screwed with peek scan bodies and the second group (Group 2) used the printed resin model screwed with titanium scan bodies which was used for scanning of the four installed implants.

The control group

In this invitro study the control for group 1 was the resin cast with peek scanbody **figure (7)** and the control for group 2 was the resin cast with titanium scanbody **figure (8).** Each scan body was screwed in to the implants using the screw driver. The resin cast was then scanned with the extraoral scanner once with peek scanbody **figure (9)** and once with the titanium scanbody **figure (10).** Then the two virtual cast scans were checked and any deficiencies were rescanned. Finally, the scanned data were exported as STL (standard tessellation language) files.

Fig. 7 Peek Scanbody

Fig. 8 Titanium Scanbody

The peek scanbody contains a small flat surface related to the top third of the scan region , while the titanium scanbody contains small extention also related to the top third the scan region.

Fig. 9 Resin model with peek scanbody

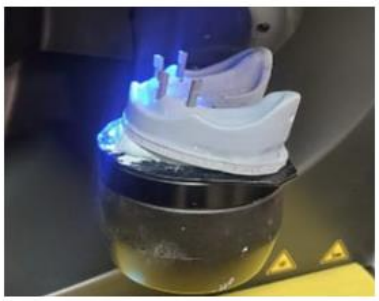

Fig. 10 Resin cast with titanium scanbody during scanning

Comparator group

Conventional impression

Custom made tray fabrication

A two-millimeter wax spacer was used on the resin cast that will allow uniform proper amount of impression material, and a self-cured acrylic resin was used to fabricate the custom tray 2 mm away from the depth of the sulcus. The custom-made tray was modified by cutting four holes at the lateral and second premolar areas. Figures **(11,12)** The fabricated Custom-made tray was used for open tray conventional implant impressions.

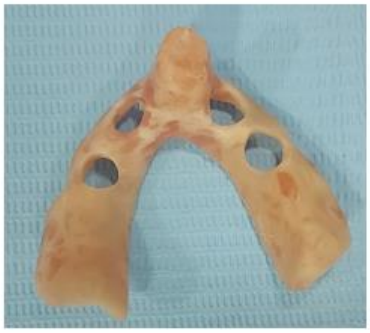

Fig. 11 Custom tray

Fig. 12 Custom tray placed on the cast

Open tray conventional impression

The open impression copings were connected to the implants of the resin cast. Adhesive was applied on the custom tray. The adhesive was then allowed to dry for 7 minutes. The impression material used was addition silicon using one step technique. light body was applied around the implant impression coping while the putty was inserted to fill the custom tray. The impressions were checked for any defects then were finally poured using type IV die stone after connecting the implants analogs to the impression copings. This entire procedure was then repeated 10 times, which resulted in 10 stone casts. Figure **(13,14,15,16)**

Fig. 13 open impression copings in place

Fig. 14 After impression taking

Fig. 15 Impression

Fig. 16 Stone cast containing the analogues

II. RESULTS

I- Comparison between different groups

a) **Angular deviation**

Mean and standard deviation of RMS regarding angular deviation of both groups in lateral and premolar were presented in table (1) and figure (22). Group 2 (titanium scanbody) showed a greater overall angular deviation than Group 1 (PEEK scanbody) and was statistically significant at the laterals.

Table (1): mean and standard deviation of RMS regarding angular deviation of lateral and premolar of both groups and comparison between them.

	Group 1 (PEEK SCANBODY)		Group 2 (TITANIUM SCANBODY)		P value
	M	SD	M	SD	
Lateral	1.740	0.116	2.805	0.223	<0.0001*
Second premolar	1.631	0.250	2.371	0.701	0.06

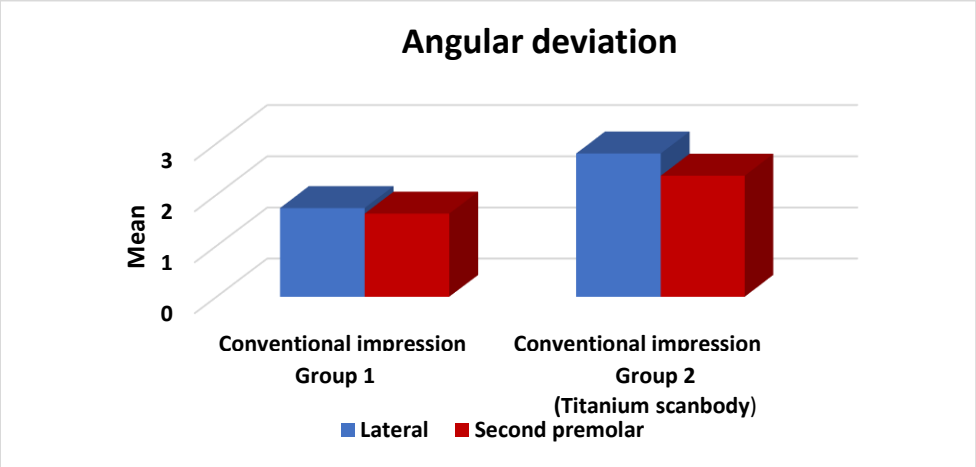

Figure (22): bar chart showing mean of RMS regarding angular deviation of lateral and second premolar of both groups.

b) Linear deviation

Mean and standard deviation of RMS regarding linear deviation of both groups in lateral and second premolar were presented in table (2) and figure (23). Results revealed that the linear deviation is greater in group 2 (titanium scanbody) than group 1 (PEEK scanbody) and showed statistically significant difference between them in both lateral and second premolar

Table (2): mean and standard deviation of RMS regarding linear deviation of lateral and premolar of all groups and comparison between them.

	Group 1 (PEEK SCANBODY)		Group 2 (TITANIUM SCANBODY)		P value
	M	SD	M	SD	
Lateral	0.297	0.163	0.574	0.102	0.01*
Second premolar	0.230	0.044	0.487	0.152	0.006*

*M: mean SD: standard deviation *Significant difference as P<0.05.*

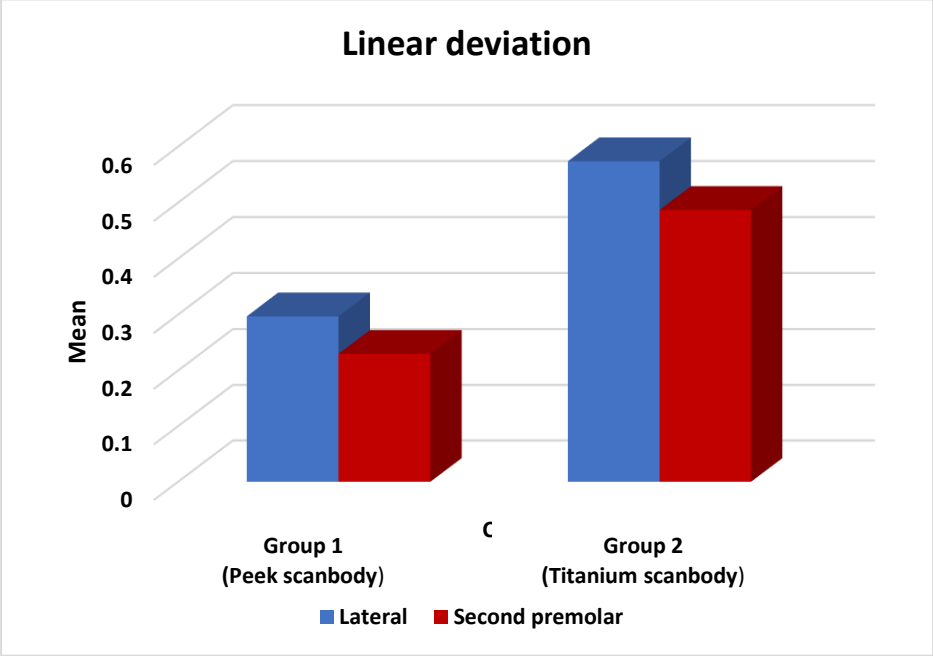

Figure (23): bar chart showing mean of RMS regarding linear deviation of lateral and premolar of both groups.

III. Discussion

There tends to be a great controversy when denoting between the digital and conventional impression techniques for implant prosthesis. According to a review conducted by ***Ahlholm et al.,2018 (6)*** the accuracy of digital impression is comparable to that of conventional impression techniques. Digital impression technique proved to manufacture a clinically acceptable fit for implant-supported crown manufacturing, while on the other hand conventional impression techniques manufactures full-arch fixed prosthesis with improved accuracy than the digital technique, thus they might be recommended in such situations. However, further investigations is necessary to confirm these findings.

Alsharbaty et al., 2019 (7) and Ender et al., 2016 (8) recommend the use of conventional impressions as they would result in more accurate results than digital impressions. While ***Hayama et al., 2018 (9), Nedelcu et al., 2018 (10) and Papaspyridakos et al., 2016 (11)*** reported that digital impressions exhibited the same degree of precision as conventional impressions.

In the present in vitro study the digital impression technique using extra oral scanner was used as a control group and the conventional open tray impression technique was used as an intervention which comes in to an agreement with ***Kamimura et al., 2017 (12) and Menini et al., 2018 (13),*** who proved that digital impressions were more accurate than conventional impression techniques.

In the following in-vitro study, all aspects of comparison were standardized in both groups except the material of the scanbody (peek and titanium), which was the point of comparison in this study. Also, the shape was different because it was difficult to find the same scanbody shape with different materials However, our chosen scan bodies were similar in the geometry with cylindrical shape but there were still not identical that was the reason the control group was different in each group.

According to the results of this invitro study, there was a statistically significant difference between the angular and linear deviations when using different materials of scanbody. This was consistent with the findings of ***Arcuri et al., 2020 (14)*** who investigated the influence of the Scanbody material, with PEEK reporting the best outcomes on both linear and angular measurements, compared to titanium. This could be explained by the fact that the use of PEEK materials may have limited the problem of light reflection that can occur in the metal alloy and promoted optimal scanning properties, resulting in more precise optical scanning. Conversely, the reflective surface of titanium would have reduced the number of spots required for scanning.

The results also comes in agreement with ***Karthhik et al., 2022 (5), Michelinakis et al., 2021(15), Motel et al., 2020 (16) and Mizumoto and Yilmaz, 2018 (17),*** studies that concluded that a peek scanbody was more accurate than a titanium scanbody.

IV. Conclusion

Within the limitations of this invitro study, it can be concluded that the implant Scanbody material and geometry would greatly affect the scanning accuracy of full-arch digital impressions. Peek scanbody demonstrated greater accuracy in both linear and angular perspectives, when compared to the titanium scanbody

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