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THE EFFECT OF ACCURACY OF ALL ON 4 MANDIBULAR IMPLANT HYBRID PROSTHESIS FABRICATED BY TWO DIFFERENT IMPRESSION TECHNIQUES (DIGITAL VERSUS CONVENTIONAL) ON BONE LOSS

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ABSTRACT

Objectives: Comparing the accuracy of all on four implants supported hybrid prosthesis which gained from two different impression techniques (digital versus conventional) in order to show its effect on marginal bone loss.

Materials and Methods: 16 completely edentulous patients with age range above 60 years were participated in this study received new upper and lower dentures. Placement of four implants in the inter-foraminal area of the mandible were done according to the concept of "All on four implants" followed by immediate loading with the lower denture. Three months later, the patients were divided in a random manner into two equal groups: Group I: performed a digital intraoral scanning for lower arch, Group II: performed an open tray abutment level impression technique for lower arch then a hyprid prosthesis were fabricated and measure the level of bone loss in 0,3,6,12 months radiographicaly.

Results: The results of this study showed statistically insignificant less bone height changes in Group I in comparison to Group II according to the radiographic outcomes.

Conclusion: All on 4 mandibular implant hybrid prosthesis fabricated from digital impression prove to be more precise and more reliable than that fabricated from conventional impression and regarding bone height changes the group of digital impression showed less marginal bone loss that enhance prognosis of dental prosthesis and implant survival rate.

KEYWORDS: All on four implants, Hybrid prosthesis, Intraoral Digital scanning, Open tray impression technique, Marginal bone loss.

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INTRODUCTION

It was a big challenge to rehabilitate the severely resorbed mandible by using implant-supported prosthesis due to the poor quality and quantity of residual jawbone. The majority of complete denture wearers faced problems related to stability of their dentures and difficulties in mastication[1] Malo et al introduced the concept of All On 4 Implants. [2,3] that reduced the used number of implants to four implants inserted in the interforaminal area from the right second premolar to left second premolar of the lower jaw for immediate supporting of provisional prosthesis which is finally substituted by defintive prosthesis after osteointegration. The placement of the two anterior implants is parallel to each other and to the midline and the two posterior implants are placed in the second premolar sites in each side tilted 30°-45° distally. [3,4] It turns out to be an efficient and cost effective treatment for the esthetic and functional rehabilitation of a completely edentulous arch. [5] There were several advantages for mandibular all on four implant concept including the use of a few number of implants, the cantilever length is more short, as a result for placement of implant with angle there is no need for complicated surgery like mandibular nerve repositioning operations and augmentation of crestal bone. Due to these advantages, mandibular all on four implants are favored over traditional methods for implant placement[6,7,8] unfortunately it was concluded that several complexity result from implant angulation, extension of the cantilever, resorption of the bone, and the material of superstructure have been reported.[9,10]

The final prosthesis used with the all on four implants can be with several type, including ceramometralic or metal with acrylic permanent prosthesis, or acrylic resin final prosthesis.[11,12] The superstructure must be passive and It has been reported that if the goal of passivity not achieved, superstructure causes static loading of the restorations,the supporting implants and bone. Beside technical complications [13] such as screw loosening and component fracture biological problems including bone loss have also been attributed to lack of passivity.[14]

The passivity of an implant-supported restoration relies on many factors,that include how accurate the impression technique and the accuracy of produced master model.[15,16] therefore a good impression is essential to obtain a precise master model, which is the key to the success of the future implant-supported prosthesis.[17]

The digital revolution, which is becoming more and more imposing. This powerful and sophisticated evolution offers very significant productivity gains in the field of dentistry.[18] Recently, digital implant impressions gained from intraoral scanners (IOS) have been advanced. It depends on technologies like triangulation, confocal lasers, and active wavefront sampling to locate the exact implant position. [19,20] Comparing it with conventional impression, IOS impressions can facilitate the procedure and decrease time needed, material and costs. [21] In theory, it decrease the deviation of the model amassed by conventional impression technique (such mixing of impression material, disinfection, storing, transportation of impression, and pouring of the cast) and can promote the accuracy of the final prosthesis. [22]

This technology increases the chance for the implant-supported prosthesis to be more passively fit, that considered as fundamental prerequisite to preserve osseointegration.[23] The impression is in fact the main vector of information between the practitioner and the lab. Hence, a comparative synthesis of the two methods is necessary before considering the use of the intraoral scanner as a reliable alternative to conventional impressions.

MATERIALS AND METHODS

16 patients had maxillary and mandibular edentulous arches with age range above 60 were chosen from the outpatient clinic of the prosthetics department Faculty of Dentistry Fayoum University. Patients with parafunctional habits, metabolic bone disorders, or a history of head and neck radiation therapy were excluded. Patients were informed of all treatment steps and the need for recalls, and then signed a written consent. The suggestion of the study was accepted by the Ethics Committee of the Faculty of Dentistry Fayoum University.

All the steps of construction of upper and lower complete denture were made which began from preliminary impression, final impression, jaw relation record,try-in and final insertion of the denture; one month After delivery of complete denture, a tissue-supported stereolithographic surgical guide for implant placement which provide precise location and angulation of dental implants was constructed using Dual scan protocol, then all the raw data were converted into 3D information using blue sky software*for designing of the surgical guide.

Broad spectrum antibiotic** 24 hours before the surgery with non-steroidal anti-inflammatory***analgesics to reduce pain and rinse with chlorohexidine mouth wash****twice per day for plaque control after the surgery were given for all patients.

A rubber base occlusal index***** was utilized to allow supporting of the surgical guide intraorally, then tissue punching and the fixative pins used for fixation of the surgical guide. The preparation of osteotomy was done by using the universal surgical kit (NaviGuide) according to the instructions of the manufacture.

Four implants were inserted in interforminal area with the posterior implants tilted 30 degrees******. Sequential drilling was done after sterile copious irrigation with saline used during the drilling procedure. Countersinking was performed when needed to create space for the head of the tilted implants. The aim was to place the implant head neck at bone level for achieving the true access to attain an objective of parallelism and to make the prosthesis passively seat. During insertion of the implants the torque should be at least 35 Ncm for achieving good initial stability allowing immediate loading. Multiunit abutments were threaded into implant fixtures (two straight abutments with anterior vertical and parallel implants and two 30° abutments were used with posterior angled implants). The site of the multiunit abutments over the posterior angled implants was the area of the first molar teeth that result in shorter cantilever length and enhance anteroposterior spread.[24] All abutments were torqued at 25Ncm (fig 1). Using titanium temporary cylinders which threaded to the multiunit abutments, then some modification was made for the provisional complete denture by removing the labial and buccal flanges and the second molar artificial teeth[25] (fig 2). Relief is made in the fitting surface of the denture then using self-cure acrylic resin to fix the titanium cylinders of the multiunit abutments. All patients received instructions to undergo oral hygiene measurements and preserve soft diet during the healing period. Postoperative cone beam radiograph was performed. All adjustment for the dentures and the occlusion were made during follow-up visits. After three months all patients were randomly divided into two equal groups using randomly generated numbers

* Blue Sky Plan® V3, Blue Sky Bio, n® LLC, USA.

** Augmentin 1g- Beecham MUP

*** Ibuprofen, Knoll, Ludwigshafen, Germany

**** Hexitol mouthwash, Arab Drug company, Cairo, Egypt.

***** Zeta Plus, putty. C-silicone impression material-zhermack company-Italy

****** New Biotech Dental Implant, Guro-gu, Seoul, 08381, Republic of Korea.

prepared by a computer program* Group I for digital intraoral scanning technique and Group II for open tray impression technique at the abutment level were made to fabricate the definitive prosthesis.

Group I: The scanbodies** were positioned on a way that their bevels were buccally oriented, They should not be torqued down but should be hand-tightened (fig 3). Ten digital impressions were taken by a single operator with standardized scanning technique was used according to the recommendation of the manufacture, which consisted of occlusal, buccal, and then lingual surfaces scanning. The time from start till complete the scan was recorded, once it captured all the surfaces of the scan body without major defects a scan is considered complete. Before each scan the device should be calibrated in order to decrease error biases. After complete the first scan, a splinting of all scan bodies was performed by using orthodontic power chain and dura lay acrylic resin***. Then after the setting of the material, the splint was sectioned and then reattached intraorally. To improve the procedure, notches were made on the splint. After that, another intraoral scan was made for the scan bodies with the splinting material in the same standardized manner which described before, then splinting and the scan bodies were removed, The soft tissue was then recorded, The data from both the abutment scan and the soft tissue scan were exported as an open-format STL file to serve as a reference then sent to the digital Dental Lab.

Group II: The impression copings were screwed to the multiunit abutments and splinted together rigidly by using orthodontic power chain and dura lay acrylic resin to prevent mobility of the copings then an open tray impression was taken using medium-body polyether rubber base impression material****. The abutment analogues were attached to the impression copings before pouring and then a verification jig was constructed to confirm the impression accuracy and examine it intraorally by periapical radiograph.

The design of the mandibular screw retained hybrid prosthesis was with 12 teeth (from the first molar tooth on the right side to the other on the left side). The prosthesis restore both missing teeth, lost bone and gave the shape and color of the gingiva by using pink porcelain. Using prototyping method to print the design in castable resin then checked it intraorally for passive fit and occlusion (fig 4). The resin pattern was invested and cast in cobalt-chromium alloy, then check the passive fit of the frame intraorally by using single screw test at the try in visit (fig 5). The opaquer was painted on the frame, then porcelain powder was mixed and added over the opaquer, fired, and finished. After the fine occlusal adjustments the prostheses were delivered to the patients. Postoperative radiograph were made to guarantee the passive fit of the final prosthesis. Follow up and checked the oral hygiene of the patients.

Radiographic parameters (crestal bone loss)

Using digital periapical radiography***** with paralleling technique for assessments of the crestal bone height changes around each implant. During dental films exposure a bite jig was used to ensure standardized method to preserve the same position of the plastic film holder during consecutive film exposures. The real measurements of bone loss at mesial and distal aspects of each implant can be evaluated without magnification errors by using the recognized dimensions of the implant. The implant abutment junction (point A) is a reference points for the linear measurements and (point B) is the most coronal point of bone implant contact (fig 6).To calculated the crestal bone loss we can subtracting crestal bone levels After 3, 6, and 12 months from values at baseline (day of final loading).

* Excel spreadsheet

** Neobiotech Co Ltd, Seoul, Republic of South Korea

*** inlay pattern resin - Reliance Dental Mfg.co.

**** 3M ESPE ImpregumTM Soft,poly ether impression materials.

***** Digora, Soredex

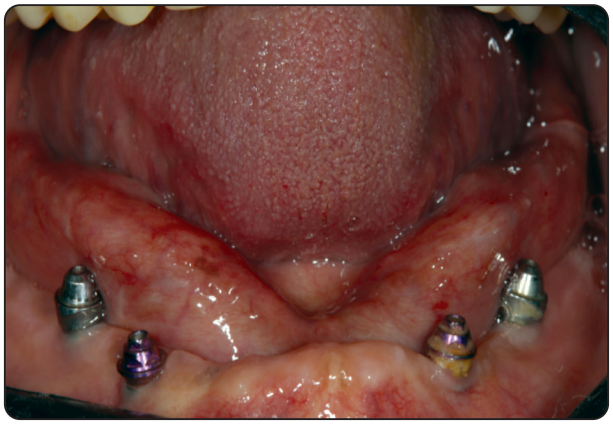

Fig (1) Placement of straight and angled multiunit abutments.

Fig (2) immediate loading for the modified denture.

Fig (3) Showing a patient with four implants and intraoral scan bodies.

Fig (4) Intraoral verification of try in for screw retained hyprid prosthesis.

Fig (5) Try in for metal framework of hypried prothesis interaorally.

RESULTS

Statistical analysis

All data were presented as mean and standard deviation of bone resorption of group I & II were presented in table (2) and figure (7). Statistical analysis was performed with SPSS 16® (Statistical Package for Scientific Studies), Graph pad prism & windows excel.

Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality which revealed that the significant level (P-value) was insignificant as P-value >0.05

which indicated data originated from normal distribution (parametric data) resembling normal Bell curve. Accordingly, comparison between different intervals within each group was performed by using Repetitive One-Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons, comparison between 2 groups was performed by using independent t test.

Intragroup comparison

Mean and standard deviation of bone at baseline, after 3 months, 6 months and 12 months in group 1 and 2 were presented at table (1) and figure (6).

Comparison between different intervals demonstrated that:

In group 1: there was a significant increase in bone resorption regarding right and left implants, canine and second premolar, mesial and distal surfaces as P =0.0001.

In group 2: there was a significant increase in bone resorption regarding right and left implants, canine and second premolar, mesial and distal surfaces as P =0.0001, except distal surface of second premolar of left implant as there was insignificant increase between 6 months and 12 months.

TABLE (1) Intragroup comparison regarding bone resorption in group 1 and 2, using Repetitive One-Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons:

Bone resorption				Baseline		After 3 months		After 6 months		After 12 months		P value
				Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Group 1	Right implants	Canine	Mesial	1.15 a	0.09	1.35 b	0.12	1.58 c	0.05	1.88 d	0.05	0.0001*
			Distal	1.15 a	0.09	1.35 b	0.09	1.63 c	0.05	1.78 d	0.09	0.0001*
		Second premolar	Mesial	1.03 a	0.05	1.38 b	0.07	1.65 c	0.05	1.88 d	0.16	0.0001*
			Distal	1.19 a	0.04	1.39 b	0.04	1.68 c	0.05	1.88 d	0.16	0.0001*
	Left implants	Canine	Mesial	1.28 a	0.05	1.58 b	0.07	1.78 c	0.07	2.00 d	0.13	0.0001*
			Distal	1.18 a	0.07	1.48 b	0.05	1.78 c	0.05	1.93 d	0.14	0.0001*
		Second premolar	Mesial	1.28 a	0.05	1.53 b	0.15	1.75 c	0.14	1.98 d	0.14	0.0001*
			Distal	1.16 a	0.07	1.55 b	0.09	1.88 c	0.07	1.95 c	0.09	0.0001*
Group 2	Right implants	Canine	Mesial	1.15 a	0.09	1.45 ab	0.09	1.64 bc	0.18	1.90 c	0.45	0.0001*
			Distal	1.18 a	0.09	1.43 ab	0.05	1.64 bc	0.24	1.80 c	0.32	0.0001*
		Second premolar	Mesial	1.05 a	0.05	1.45 bc	0.09	1.68 c	0.28	1.90 d	0.18	0.0001*
			Distal	1.18 a	0.05	1.45 ab	0.09	1.69 bc	0.30	1.90 c	0.30	0.0001*
	Left implants	Canine	Mesial	1.23 a	0.09	1.63 bc	0.05	1.79 c	0.17	2.18 d	0.25	0.0001*
			Distal	1.23 a	0.05	1.65 b	0.05	1.80 c	0.14	1.98 d	0.13	0.0001*
		Second premolar	Mesial	1.34 a	0.07	1.63 b	0.05	1.78 c	0.14	2.01 d	0.04	0.0001*
			Distal	1.24 a	0.11	1.58 b	0.14	1.90 c	0.18	2.03 c	0.18	0.0001*

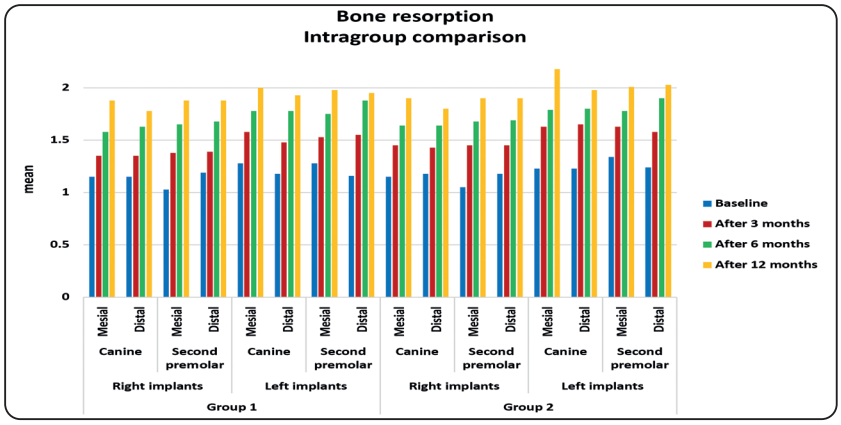

Fig. (6) Bar chart showing Intragroup comparison regarding bone resorption in group 1 and 2.

Intergroup comparison:

Comparison between different groups demonstrated insignificant difference between them regarding all intervals as P>0.05, as presented in table (2) and figure (7).

TABLE (2) Intergroup comparison regarding bone resorption in group 1 and 2, using Independent t test:

Bone resorption				Group 1		Group 2		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P value
				Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Baseline	Right implants	Canine	Mesial	1.15	0.09	1.15	0.09	0.00	0.05	-0.10	0.10	1.00
			Distal	1.15	0.09	1.18	0.09	-0.02	0.05	-0.12	0.07	0.59
		Second premolar	Mesial	1.03	0.05	1.05	0.05	-0.03	0.03	-0.08	0.03	0.33
			Distal	1.19	0.04	1.18	0.05	0.01	0.02	-0.03	0.06	0.55
	Left implants	Canine	Mesial	1.28	0.05	1.23	0.09	0.05	0.04	-0.03	0.13	0.18
			Distal	1.18	0.07	1.23	0.05	-0.05	0.03	-0.11	0.01	0.12
		Second premolar	Mesial	1.28	0.05	1.34	0.07	-0.06	0.03	-0.13	0.00	0.06
			Distal	1.16	0.07	1.24	0.11	-0.08	0.05	-0.17	0.02	0.12
3 months	Right implants	Canine	Mesial	1.35	0.12	1.45	0.09	-0.10	0.05	-0.21	0.01	0.08
			Distal	1.35	0.09	1.43	0.05	-0.08	0.04	-0.15	0.00	0.06
		Second premolar	Mesial	1.38	0.07	1.45	0.09	-0.08	0.04	-0.16	0.01	0.09
			Distal	1.39	0.04	1.45	0.09	-0.06	0.04	-0.14	0.01	0.10
	Left implants	Canine	Mesial	1.58	0.07	1.63	0.05	-0.05	0.03	-0.11	0.01	0.12
			Distal	1.48	0.05	1.65	0.05	-0.18	0.03	-0.23	-0.12	0.00
		Second premolar	Mesial	1.53	0.15	1.63	0.05	-0.10	0.06	-0.22	0.02	0.09
			Distal	1.55	0.09	1.58	0.14	-0.03	0.06	-0.15	0.10	0.68
6 months	Right implants	Canine	Mesial	1.58	0.05	1.64	0.18	-0.06	0.06	-0.20	0.08	0.35
			Distal	1.63	0.05	1.64	0.24	-0.01	0.09	-0.20	0.18	0.89
		Second premolar	Mesial	1.65	0.05	1.68	0.28	-0.03	0.10	-0.24	0.19	0.81
			Distal	1.68	0.05	1.69	0.30	-0.01	0.11	-0.25	0.22	0.91
	Left implants	Canine	Mesial	1.78	0.07	1.79	0.17	-0.01	0.07	-0.15	0.13	0.85
			Distal	1.78	0.05	1.80	0.14	-0.02	0.05	-0.14	0.09	0.64
		Second premolar	Mesial	1.75	0.14	1.78	0.14	-0.03	0.07	-0.19	0.12	0.64
			Distal	1.88	0.07	1.90	0.18	-0.03	0.07	-0.17	0.12	0.72
12 months	Right implants	Canine	Mesial	1.88	0.05	1.90	0.45	-0.03	0.16	-0.37	0.32	0.88
			Distal	1.78	0.09	1.80	0.32	-0.03	0.12	-0.28	0.23	0.83
		Second premolar	Mesial	1.88	0.16	1.90	0.18	-0.02	0.08	-0.21	0.16	0.77
			Distal	1.88	0.16	1.90	0.30	-0.03	0.12	-0.29	0.23	0.82
	Left implants	Canine	Mesial	2.00	0.13	2.18	0.25	-0.18	0.10	-0.39	0.04	0.10
			Distal	1.93	0.14	1.98	0.13	-0.05	0.07	-0.19	0.09	0.47
		Second premolar	Mesial	1.98	0.14	2.01	0.04	-0.04	0.05	-0.15	0.07	0.47
			Distal	1.95	0.09	2.03	0.18	-0.07	0.07	-0.23	0.08	0.32

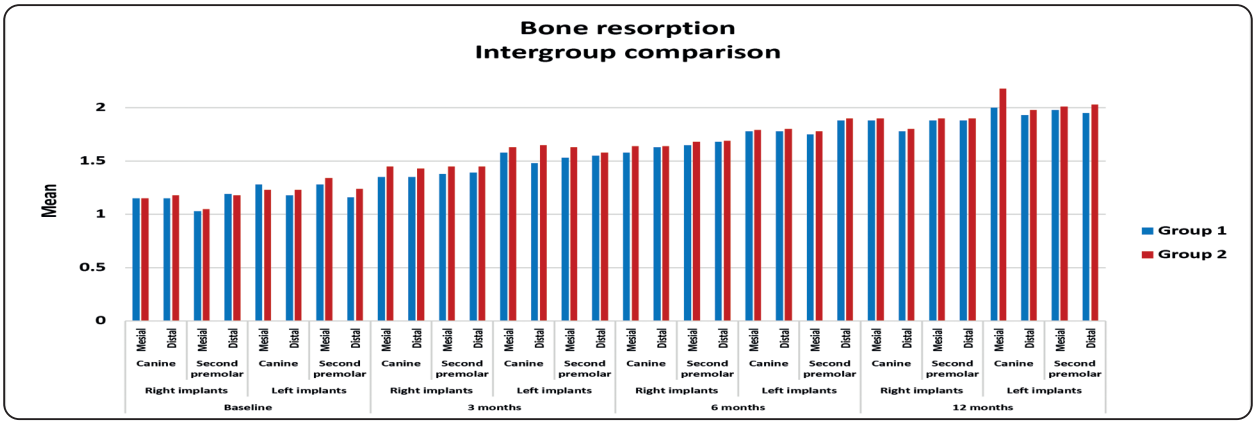

Fig. (7) Bar chart showing Intergroup comparison regarding bone resorption in group 1 and 2.

DISCUSSION

The guided surgery is a very prices for implant placement. It decreases the operation chair time, the surgery become more precise and less painful, and the implants are placed in a restoratively driven manner through surgical guide fast and simple. So all information obtained from a virtual planning can be transferred for the surgical field through manufacturing of surgical guides.[26, 27]

Using dual scan technique, where the patient's existing lower denture was used for the two scans after being modified into a radiographic guide, ensure the proper planning of implants with consideration of the anatomy like the location of mandibular nerve. Also, this technique provides artifact free and high-resolution digitalization of radiographic guide. [28-29]

In a comparative study Papaspyridakos et al. concluded that for full-arch implant rehabilitations the use of intraoral scanners is significantly more accurate when compare to conventional impressions[30].An in vitro study comparing impression techniques for dental implants in a clinical situation it revealed that conventional impression is more accurate with less than 3 implants, while in cases of 4 implants the IOS is more accurate.[31]

A recent randomized control trial by Cappare et al [32] that compare the different accuracy of digital versus conventional impressions; the study concluded that the digital manner to fabricate screw retained full arch fixed prosthesis resulted in acceptable accuracy and marginal fit. But There were many difference between maxilla and the mandible such as surface area and topography, the amount of movable tissue, the absence of the tongue movement and mandibular movement.[33] Also it is challenging due to absence of rugae area in the mandible which considered a big advantage in maxilla which improve scanning procedure as well as mandibular deformation when opening.[33] However, one study by patzelt and others revealed different results as the maxillary jaws showed up the greatest deviations.[34]

In 2020 a systmatic review concluded that for completely edentulous patients and based on 5 in vitro studies, the mean 3D implant deviation between conventional and digital impressions was 8.20 μm; the digital scans showed nominally better 3D accuracy, but the difference was not statistically significant ($p = 0.72$).[35]

It was concluded that the 3D implant deviations found between the full-arch digital and conventional impressions lie within the clinically acceptable threshold. No statistically significant difference was identified between maxillary and mandibular jaws in terms of 3D deviations.[36]

And these opinions agree with the results of our study but it require more and more in vivo studies to confirm the accuracy of digital scanning which will replace the conventional impression in the near future.

CONCLUSION

Within the limitations of this study, we can conclude that their were an insignificant difference of marginal bone loss between the All on 4 mandibular implant hybrid prosthesis fabricated from digital impression and that fabricated from conventional impression which means that the IOS slightly accurate and result in more passive prosthesis.

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