Al-Rafidain Dental Journal

rden.mosuljournals.com

Comparing between Different Impressions Materials and Techniques for the Accuracy of Implant Position Transfer

Ahmed Abduljawad Ismail Alubaidi*[1], Nagham H Kassab[2], Hasan Khiraldeen Mohialdeen[3]

[1] MSc Student, Department of Prosthodontics, College of Dentistry, University of Mosul, Mosul, Iraq
[2] Department of Prosthodontics, College of Dentistry, Mosul University / Iraq
[3] PhD Candidate, School of Dentistry, University of Sheffield, UK

Article information

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

Keywords
Implant
Impression
Open Tray Technique
Closed Tray Technique
Dimensional accuracy

***Correspondence:**
E-mail:
ahmedalubaidi79@gmail.com

Abstract

Aims: This study aimed to compare the accuracy of implant position transfer using three impression materials with two techniques**. Materials and methods:** A 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); Two traditional impression techniques (open and closed tray); Three silicone impression materials were used which are condensation, Additional (heavy and low) and Additional (medium) consistencies. Sixty conventional impressions were taken, ten impressions for each material and each technique. The linear distance measurements were performed using two methods: Digital Vernier and Digital measurement by using Medit Intraoral Scanner. **Results**: The open tray technique showed significantly fewer changes (P≤ 0.05) with linear distance measurements when compared to the control, while the closed tray technique showed significantly more changes (P≤ 0.05) with linear distance measurements when compared to the control. In comparing Medit Design and digital vernier as methods of measurement for both open and closed tray techniques; there was no significant difference in the accuracy of measurements for both of these two methods of measurement at a level of (P≤ 0.05). **Conclusion**: The additional silicone material is the best in its accuracy in transferring implant position for (open and closed tray) conventional impression technique. The condensation silicone material is the worst in accuracy in transferring implant position for (open and closed tray) conventional impression technique. The open tray technique showed significantly more accuracy than the closed tray technique in transferring implant position in the traditional impression technique.

مقارنة بين مواد وتقنيات الطباعات المختلفة لدقة مواضع الزرعات السنية

الملخص

الأهداف: تهدف الدراسة إلى مقارنة دقة نقل موضع الزرعات باستخدام ثلاث مواد انطباع بتقنيتين. **المواد وطرائق العمل**: تم تصنيع نموذج رئيسي مع اثنين من زراعة الأسنان المتوازية في الضواحك الأولى والثانية في المناطق المفقودة في الحجم (قطرها 4.0 مم وطولها 10 مم) ؛ اثنين من تقنيات الانطباع التقليدية (الطريقة المفتوحة والمغلقة) ؛ تم استخدام ثلاث مواد انطباع سيليكون وهي: التكثيف ، والاتساق الإضافي (الثقيل والمنخفض) والإضافي (المتوسط). تم أخذ ستين انطباعا تقليديا ، عشرة انطباعات لكل مادة وكل تقنية. تم إجراء قياسات المسافة الخطية باستخدام طريقتين: رنيه الرقمية والقياس الرقمي باستخدام الماسح الضوئي ميديت داخل الفم. **النتائج**: أظهرت تقنية الدرج المفتوح تغييرات أقل بكثير مع قياسات المسافة الخطية عند مقارنتها بالتحكم ، بينما أظهرت تقنية الدرج المغلق تغييرات أكثر بكثير مع قياسات المسافة الخطية عند مقارنتها بالتحكم. عند مقارنة تصميم ميديت والورنية الرقمية كطرق قياس لكل من تقنيات الدرج المفتوح والمغلق ؛ لم يكن هناك فرق كبير في دقة القياسات لكل من هاتين الطريقتين للقياس عند مستوى. **الاستنتاجات**: مادة السيليكون الإضافية هي الأفضل في دقتها في نقل موضع الزرع لتقنية الانطباع التقليدية (الطريقة المفتوحة والمغلقة). مادة السيليكون التكثيف هو الأسوأ في الدقة في نقل مواضع الزرعات (بالطريقة المفتوحة والمغلقة) تقنية الانطباع التقليدية. أظهرت تقنية الدرج المفتوح دقة أكبر بكثير من تقنية الدرج المغلق في نقل موضع الزرع في تقنية الانطباعات التقليدية.

DOI: 10.33899/RDENJ.2022.136706.1177

INTRODUCTION

Dental implant rehabilitation is a realistic management option for tooth loss, but it necessitates precise treatment planning, restoratively-driven implant placement, and personalized maintenance to keep technical and biologic issues under control [1].

An accurate impression and definitive cast are fundamental to a successful outcome in any prosthodontic rehabilitation. This remains true for implant-supported prosthesis, for which impression techniques have been directly adapted from traditional prosthodontics. An essential first step in the fabrication process is the accurate three-dimensional (3D) capture and transfer of the implant position from the mouth to the definitive cast via an impression. [2] 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. [3]

The open tray technique is the most well-known method of taking impressions. After the impression solidifies, the impression cope separates from the impression body, giving rise to the term "pick-up"[4,5].

Dentist can use a regular tray to make a closed tray impression for a fixed complete denture. On implants or multi-unit abutments, impression copings for a closed tray approach are placed, and an impression is taken. [6]

MATERIALS AND METHODS

For construction of a master model, impressions were made using different impression materials and technique; (open and closed) tray technique and three types of impression materials were used (condensation silicone, additional silicone, medium body silicone). Sixty conventional impressions were made and one type of impression tray (stock tray) was utilized for taking impressions as shown in figure (1).

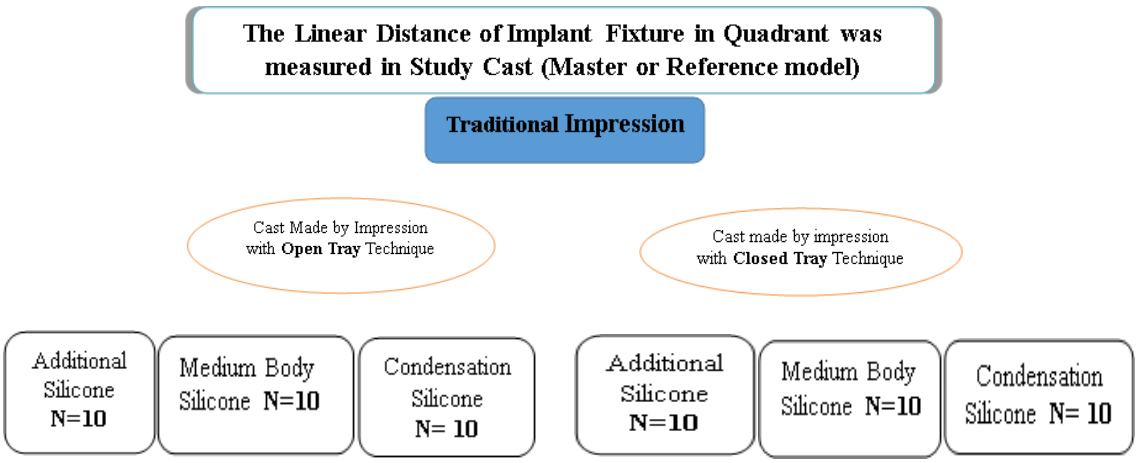


Figure (1): Experimental Design of the Study (In Vitro)

A maxillary implant practice model (Dentium, Co., Ltd., Korea) with the missing teeth area from first premolar to the second premolars replaced by two parallel dental implants (size 4.0 mm, length 10 mm); the process of drilling done by using dental surveyor milling machine (Bio Art, Brazil) [7] as shown in figure 2.

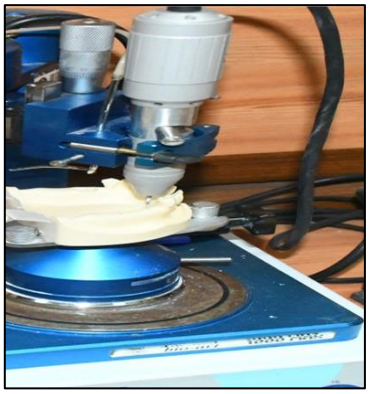


Figure (2): Milling Machine Drilling the Master Model by Pilot Drill.

A test equipment device was used to standardize the impression process and the loading that was given to the impressions. This mechanism held the study model in place and controlled the loading arm, a square metal plate with a tray containing impressions materials, was inserted and removed [8,9].

By this device two techniques were used, these are: open and closed tray technique with three silicone impression materials, these are (additional, condensation and medium body). In the open tray technique, the transfer coping was attached to the implant fixture via a connecting screw (figure 3); after loading the impression materials in the tray, the transfer copings remained inside the impression (pick up) and they were detached from the implant fixture [10].

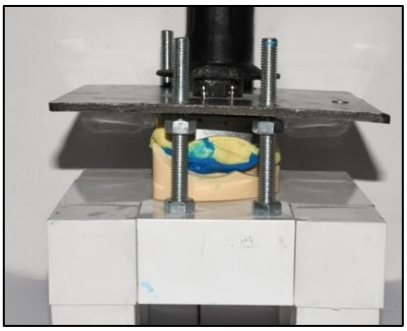


Figure (3): Open Tray Techniques

With closed tray impression technique, the transfer copings were taken off from impression material and secured to the laboratory analog using connecting screws.

The completed transfer copings-analogs were then put into the impression's keyed position (flat surfaces).

The measurements between the two implants were done by Medit Design extraoral scanner as the same procedure in the intraoral scanner. In this study, the measurements between two implants started after selection of four points on the top of the scan abutment (outer surface) [11]. The scanning abutment had hexagonal shape with elevation in the palatal part as seen in the frontal view when screwed in patient mouth or cast [12]. The selection of measurement points is an essential matter in this study, so selecting 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 which were selected in 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(4),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 so on to produce other lines as shown in figure (4 and 5) [12] .

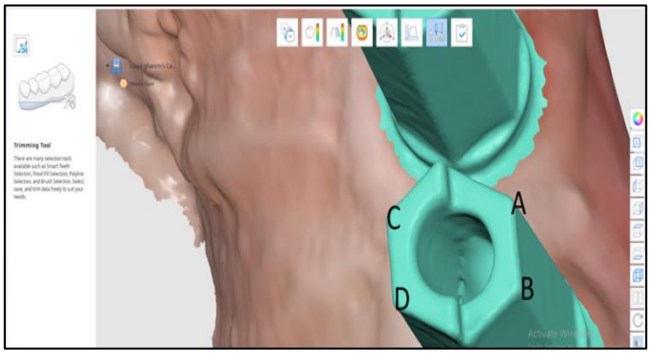


Figure (4): The Selected Measurements Points.

Measuring 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 measured. The same way will continue between the points B, C and D as shown in Figure (5) The measurement was done by two methods: 1- digital vernier. 2- Medit Design.

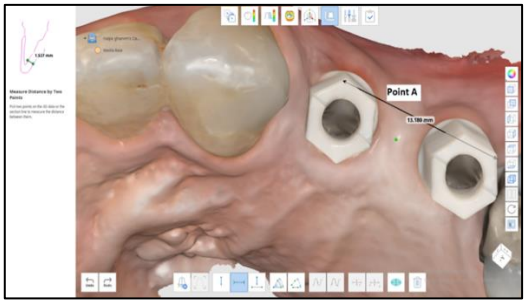


Figure (5): Measurements between Point A and Point B by Medit Design

Figure (6): Digital Vernier Measurements

RESULTS

The result of this comparison showed no significant differences between the two methods of measurements; therefore, the Medit Design measurement was used to complete the statistical analysis for this study.

Table (1) Paired t-test comparison between the accuracy of measurements (digital vernier and Medit design) in open and closed tray techniques

Materials-Technique	**N**	**Mean ± Std. Deviation**	**T**	Sig.
open technique Medit	30	14.0043 ± 0.10757	0.000	1.000
open technique vernier	30	14.0043 ± 0.10757		
Materials-Technique	**N**	**Mean ± Std. Deviation**	**T**	Sig.
closed technique Medit	30	13.8703 ± 0.16859	0.082	0.935
closed technique vernier	30	13.8740 ± 0.17791		

T=T value, N=number of dental impression (in vitro)

Table (2) showed that the means and Standard deviation of the linear distance's measurements with different silicone impression materials with open tray technique by using Medit design measurement.

Table (2): Means and Standard Deviation of Linear Distances for Open Tray Techniques by Using Medit Design Measurement

Materials-Technique	**N**	**Mean ± Std. Deviation**
Control	10	14.01± 0.034
A – open Medit	10	14.0240 ± 0.07196
M – open Medit	10	14.1080 ± 0.04492
C – open Medit	10	13.8810 ± 0.06505

A=Additional silicone, M=Medium body silicone, C=Condensation silicone, N=number of dental impressions (in vitro)

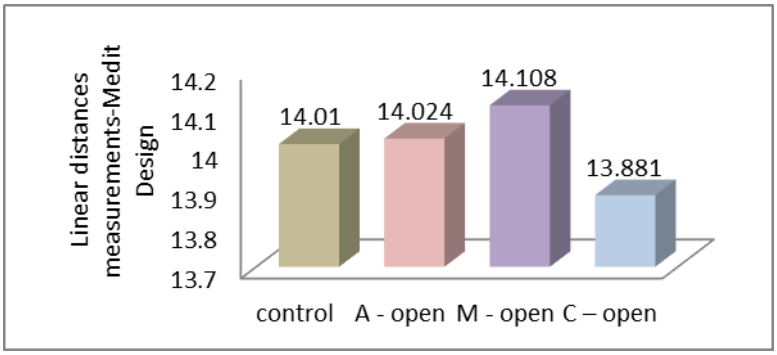
The results in table (3) showed that there was highly significant difference between most of the variable levels at level of significance $p<0.01$.

Table (3): Analysis of Variance (ANOVA) For Casts Produced by Using Open Tray Techniques with Using Medit Design Measurement.

SOV	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.263	2	0.132		
Within Groups	0.072	27	0.003	.49313	0.000
Total	0.336	29			

SOV: source of variance, df: degree of freedom, F= f value

Duncan's multiple range test was performed to detect the most accurate impression materials used in dental implants transferring position, the result in tables (2) and in Figures (7) showed that the additional silicone impression materials (14.0240 ± 0.07196) was the best impression materials used in dental implant.



A=Additional silicone, M=Medium body silicone, C=Condensation silicone

Figure (7): Duncan's Multiple Range Tests of Linear Distances Measurements in Open Tray Impressions Technique Using Medit Design Measurement.

Table (4) showed that the higher values for closed technique was obtained with additional silicone materials (13.9410 ± 0.07172) while the lowest one was condensation silicone materials (13.7630 ± 0.25478)

Table (4) Means and Standard Deviation of Linear Distances for Closed Techniques Using Medit Design Measurement.

Materials-Technique	**N**	**Mean ± Std. Deviation**
Control	10	14.01± 0.034
A - closed	10	13.9410 ± 0.07172
M - closed	10	13.9070 ± 0.04111
C - closed	10	13.7630 ± 0.25478

A=Additional silicone, M=Medium body silicone, C=Condensation silicone, N=number of dental impression (in vitro)

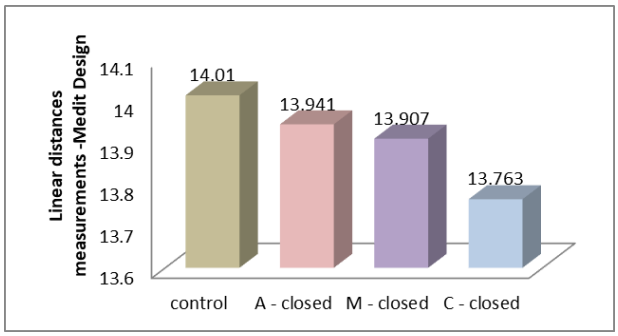
These results in table (5) showed that there is significant difference between most of the variable levels at level of significance ($P \leq 0.05$).

Table (5): One-Way ANOVA of Linear Distances Measurement in Closed Tray Using (Medit Design Measurement).

SOV	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.179	2	0.089		
Within Groups	0.646	27	0.024	3.734	0.037
Total	0.824	29			

SOV: source of variance, df: degree of freedom, F= f value

The result in tables (4) and in Figure (8) showed that the additional silicone impression material (13.9410 ± 0.07172) was the best impression materials used in transferring implant position when compared with the control group (14.01± 0.034mm).



A=Additional silicone, M=Medium body silicone, C=Condensation silicone

Figure (8): Duncan's Multiple Range Tests of Linear Distances Measurements in Closed Tray Impressions Technique Using Medit Design Measurement

Paired t-test was used to compare between the accuracy of best materials in two techniques (open-additional silicone and closed- additional silicone) as seen in table (6). This table showed that there was highly significant difference between open tray technique-additional silicone material and closed tray technique - additional silicone material at level of significance $p \leq 0.01$

Table (6): Paired T-Test Comparison between Accuracy of Two Techniques (Open-Additional Silicone and Closed- Additional Silicone)

Technique-Impression	**N**	**Mean ± Std. Deviation**	**T**	Sig.
A - closed	10	13.9410 ± 0.07172	2.583	0.007*
A - opened	10	14.0240 ± 0.07196		

A=Additional silicone, * means highly significance difference at level of significance $p \leq 0.01$
N=number of dental impression (in vitro)

DISCUSSION

In this study, linear distance measurements were used to detect the accuracy of casts which resulted from each technique (open and closed tray). The results showed that the direct (open tray) technique was the most accurate technique for transferring implant position to the cast. This result was in agreement with [13,14,15,16] studies, these studies reported that, the transfer coping in this procedure still being present in the impression materials after it has been disconnected from the master model and attached to the implant fixture. In contrast to the closed tray impression technique, this involved disconnecting the transfer coping from the impression material during the separation of the impression from the master model and reconnecting it to the implant analog to restore it to its original position inside the impression material.

Distortion in the impression materials at the site of transfer coping was prevented by this method (open tray technique); while by the closed tray technique the distortion of the impression material at the site of transfer coping during removal and reseating again cannot be avoided, and this will affect the accuracy of transferred implant position.

This study disagreed with the results of [10, 4, 17] studies who reported that the indirect impression technique was more accurate than direct impression technique. This disagreement may be due to the using of implant system which differ from the system which was used in this study that exhibited difficulty in connecting the implant fixture to the transfer coping without rotation of the transfer coping in its place inside the impression material [16].

The dimensional changes of the three brands of silicone impression materials (condensation silicone, medium body silicone and additional silicone) showed significant difference especially between additional silicone type and the condensation types.

The results of this study showed that the additional silicone impression material produced the most accurate casts. The explanation for this result was due to its superior properties over the condensation silicone which produces molecule of water and ethanol per chain link, respectively, while the other materials were addition curing, so the dimensional changes and permanent deformation were improved over the condensation silicone. This result is in agreement with [18, 19, 20] studies and disagreed with [21, 22] studies who found that there was no significant difference between the use of the two types of elastomeric impression materials.

The medium body silicone impression material showed no significant difference from the additional silicone impression materials. This could be due to its high viscosity since it is a monophase impression material and can be used with a

one-step impression technique only; unlike the other two types of impression materials, they were two phase impression materials which can be used with one or two steps impression technique [23].

The result of this comparison showed no significant differences between the digital vernier and digital measurement by Medit design methods of measurements ;this result was in agreement with several researchers studies who evaluated the accuracy of digital models made with intraoral scanners, and compared the results of the accuracy that obtained by using of the digital vernier and statistically no significant differences was found ;

the reasons of preferring of using digital measurement (Medit Design) were the simplicity of using the measuring whenever the examiner wants, because the file will be saved; and for standardization of the measurements, because the digital vernier cannot be used it for the digital measurement [24,25,26].

Other studies disagree with the results of this study and they found that digital measurement was highly accurate; however, its application in the clinical setting requires operator's skills and familiarity with digital software programs. So if the operator uses the digital software programs without any experience in using the program, the accuracy of the measurement will be affected [27].

CONCLUSION

The additional silicone material was the best material in accuracy in transferring implant position for (open and closed tray) conventional impression technique. The condensation silicone material was the worst material in accuracy in transferring implant position for (open and closed tray) conventional impression technique. The open tray technique showed significantly more accuracy than closed tray technique in transferring implant position in traditional impression technique.

Conflict of Interest

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

REFERENCES

1. Chatzistavrianou, D., Wilson, P. H. R., & Taylor, P. A guide to implant dentistry Part 2: Surgical and prosthodontic considerations. *Dent Up J*. 2019, 46(6), 514–523.
2. Basaki K., Alkumru H., Souza G., Finer Y. Accuracy of Digital vs Conventional Implant Impression Approach:A Three-Dimensional Comparative In Vitro Analysis ; *Int J Oral Maxillofac.* 2017;32:792–799.
3. Sim, J. Y., Jang, Y., Kim, W. C., Kim Y., Lee, H., & KimH. Comparing the accuracy (trueness and precision) of models of fixed dental prostheses

fabricated by digital and conventional workflows. *J Prosth Res*, 2019,63(1), 25–30.

4. Tarib A., SeongW., Chuen M., Kun S., Ahmad, M., & Kamarudin, H. Evaluation of Splinting Implant Impression Techniques : Two Dimensional Analyses. *Eur J Prosthodont Rest Dent*, 2016, 20(1), 35-39.
5. Cappare, P., Sannino, G., Minoli, M., Montemezzi, P., & Ferrini, F. Conventional versus digital impressions for full arch screw-retained maxillary rehabilitations: A randomized clinical trial. *Int J Envi Res*, 2019, 16(5)1-4.
6. Naik J.,Behera S.,Galagali G. Comparison of three dimensional accuracy of two implant level impression techniques ; using three different elast. *IP Ann Prosth Rest Dent.* 2019, *5*(3), 68–71.
7. Testori, T., Weinstein, T., Scutellà, F., Wang, H.-L. and Zucchelli, G. Implant placement in the esthetic area: criteria for positioning single and multiple implants. *Perio. 2000*,2018, 77: 176-196.
8. Hatim N, Al_Jubori SH The effect of storage time on accuracy and dimensional stability of addition silicone impression materials. Iraqi Dent J,2001,28:235-256.
9. Hatim, N., & Al-Mashaiky, B. Dimensional accuracy of impression techniques for the endosteal implants (An in vivo study): Part II. , *Al-Rafi. Dent. J.*, 2007,7(2), 131–137.
10. Balouch F., Jalalian E., Nikkheslat M., Ghavamian R., Toopchi Sh., Jallalian S. (2013). Comparison of Dimensional Accuracy between Open-Tray and Closed-Tray Implant Impression Technique for 15° Angle Implants. *J Dent Shiraz Univ Med Sci*,2013, 14 (3)1-5.
11. Farhan, A., Sahib, A., & Fatalla, A. Comparison of the accuracy of intraoral digital impression system and conventional impression techniques for multiple implants in the full-arch edentulous mandible. *J. Clinic.and Exp.Dent.*,2021,13(5), 487–492.
12. Alsharbaty, M., Alikhasi, M., Zarrati, S., & Shamshiri, A. A Clinical Comparative Study of 3-Dimensional Accuracy between Digital and Conventional Implant Impression Techniques. *J Prosth*,2019, 28(4), e902–e908.
13. Arieli A, Adawi M, Masri M, Weinberg E, Beitlitum I, Pilo R, Levartovsky S The Accuracy of Open-Tray vs. Snap on Impression Techniques in A 6-Implant Model: An In Vitro 3D Study. *Materials*,2022, 12;15(6):2103.
14. Bedia S, Ghadage M. Comparative Evaluation of the Accuracy of Open Tray, Closed Tray and Snap-on Implant Impression Techniques: An In-vitro

Study , *NeuroQuanto.*,2022,20(7),783 -792

15. Nakhaei, M., Madani, A.S., Moraditalab, A., & Haghi, H.R. Three-dimensional accuracy of different impression techniques for dental implants. *Dent Res J*,2015, 12, 431 - 437.
16. Behera S., S., Naik, J., Galagali, G., & Nidawani, P. Comparison of three dimensional accuracy of two implant level impression techniques; using three different elastomeric impression materials-an in vitro study. *IP Annals Prosth Rest Dentistry*,2019, *5*(3), 68–71.
17. Osman, M., Ziada, H., Suliman, A., & Abubakr H. A prospective clinical study on implant impression accuracy. *Int. J Impl Dent*,2019, 5(38), 1–7.
18. Markovi, D., Puškar, T., Hadžistevi, M., Potran, M., Blaži, L., & Hodoli, J. (2012). the dimensional stability of elastomeric dental impression materials. *Cont. mater.*,2012, 1(4), 105–110.
19. Alexandre, M., Sinhoreti, C., Vitti, R. P., Aurélio, M., & Xediek, R. L. Dimensional Accuracy of Stone Casts Made from Silicone- Based Impression MaterialsThree impression techniques, *Braz Dent J*,2013, 24(5), 498–502.
20. Naumovski B., and Kapushevska B. Dimensional stability and accuracy of silicone–based impression materials using different impression techniques–a literature review. *Prilozi*,2017, 38.2: 131-138.
21. Dorigatti, A., Antonio, L., Barros, B., Antonialli, M., Acqua, D., Maria, S., Dds, C., Assis, F. De, & Jr, M. Comparison of the accuracy for three dental impression techniques and index : An in vitro study. *J Prosthodont Res.*,2013,57(4):268-74.
22. Hafezeqoran A, Rahbar M, Koodaryan R, Molaei T. Comparing the Dimensional Accuracy of Casts Obtained from Two Types of Silicone Impression Materials in Different Impression Techniques and Frequent Times of Cast Preparation. *Int J Dent.* ,2021,27;2021:1-9.
23. Dogan, S., Schwedhelm R., Heindl, H., Mancl, L., & Raigrodski J. Clinical efficacy of polyvinyl siloxane impression materials using the one-step two-viscosity impression technique. *J. Prosth. Dent*, 2015,114(2), 217–222.
24. Grünheid T., McCarthy D., & Larson E. Clinical use of a direct chairside oral scanner: An assessment of accuracy, time, and patient acceptance. *AJO-DO.*, 2014,146(5), 673–682.
25. Camardella, L., Hero, Oswaldo, B., & Vilella, D. V. Accuracy and reproducibility of measurements on plaster models and digital models created using an intraoral scanner. *J*

Orofac Orthop, 2017,78(3), 211–220.

26. Flügge, T., Ludwig, U., Winter, G., Amrein, P., Kernen, F., & Nelson, K. Fully guided implant surgery using Magnetic Resonance Imaging – An in vitro study on accuracy in human mandibles. *Clinic.O.Impl. Res.*,2020 *31*(8),1-8.

27. Rokn, A., Hashemi, K., Akbari, S., Javad Kharazifard, M., Barikani, H., Panjnoosh, M., & Hashemi, K. Accuracy of Linear Measurements Using Cone Beam Computed Tomography in Comparison with Clinical Measurements , *J Dent*,2016,13(5), 5-12.