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EFFECT OF SPLINTING ON THE ACCURACY OF IMPRESSIONS OF MULTIPLE STRAIGHT IMPLANTS IN FULL ARCH REHABILITATION: AN IN VITRO-STUDY

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ABSTRACT

Objectives: This study was conducted to assess the effect of different splinting techniques (with and without sectioning of the splinting material) on the accuracy of impressions of multiple straight implants in full arch rehabilitation cases.

Materials and methods: A maxillary resin printed study model with five straight fixtures was used as the master model. Open tray impression technique was done for all groups. Three groups were defined according to splinting of the impression copings: Group A: Impression copings were splinted to each other using autopolymerizing acrylic resin. Group B: Impression copings were splinted to each other using autopolymerizing acrylic resin which was sectioned with a 0.3 mm thickness disc and reconnected with a second mix of resin. Group C: Impression copings were not splinted to each other. For each group, five different impressions were prepared. The impressions were poured to create the casts that were digitally scanned. The accuracy of the positions and angulations of the implants was evaluated using a computer-graphics coordinate measurement system.

Results: Group A showed higher angular deviation compared to group B and group C. One way ANOVA showed statistically significant difference between the studied groups, P value was <0.001. However, Tukey post hock test showed statistically significant difference between group A and the other groups and no statistically significant difference between group B and group C. On the other hand, regarding linear deviation one way ANOVA showed no statistically significant difference between the studied groups.

Conclusion: Both split acrylic-splinted and non-splinted implant impression techniques yield more accurate master casts regarding angular deviation compared to splinted impression technique without splitting.

KEY WORDS: Splinting, Implant impressions, Accuracy of impressions.

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INTRODUCTION

The clinical success of implants is highly dependent on the passive fit of the overlying prosthesis. Failure of achievement of a passive fit of the implant prosthesis may lead to several complications such as screw loosening or facture, occlusal discrepancies, and increased plaque buildup. It may also induce loss of osseointegration and implant fracture. [1,2]

The accuracy of implant impressions is a major factor to help achieve passive fit through the precise assembly of the implant or abutment in relation to the other structures in the dental arch. Moreover, it depends on the selection of the tray, suitable impression technique and type of impression material. [3-5]

Selection of an appropriate impression technique is important to obtain an accurate master cast which depends on the number, position, angulation of the implants, as well as, the interarch space, impression material, and the operator's choice.[6] There are two primary techniques: The indirect (closed tray) technique and the direct (open tray) technique. [7]

In the closed tray technique, a single-piece impression coping that is attached to the implant intraorally is utilized which is carefully repositioned into the impression after it is removed from the mouth. It may be indicated in patients with limited interarch space, with tendency to gag, or with implants with limited accessibility. [8,9] This technique may be clinically simple, however, it may not be highly accurate in transferring the implant position to the final cast. [9]

The open tray technique involves screwing of the impression coping to the implant which projects through an opening in a custom impression tray, which is later unscrewed and removed from the mouth within the impression. [8,10] The direct technique could be divided into splinted and non-splinted techniques. The splinting technique is indicated in cases with multiple implants to reduce the distortion of the impression and to ensure its accuracy.[11-13] Splinting of the transfer copings prevents their rotation in the impression during attachment of the analogues. [14]

Auto-polymerizing acrylic resin is the most commonly used material for splinting. However, it shows polymerization shrinkage that may result in inaccurate transfer of spatial relationship of implants from oral cavity to the master cast. [15] The most important factor to ensure an accurate impression using the splint technique is to minimize the dimensional changes of the acrylic resin. Some suggested to section the splint material then rejoin it again with a minimal amount of the same material to reduce the shrinkage. [16]

There are many controversies regarding the importance of splinting the impression copings together before registration of impressions of multiple implants. Some studies showed no significant difference in the accuracy between splinted and un-splinted impression techniques. [17,18] While others reported that the splinted technique was more accurate than the non-splinted one. [19,20] Hence this study was conducted to evaluate the effect of splinting on the accuracy of impressions of multiple straight implants in full arch rehabilitation as well as to assess the effect of sectioning acrylic splints then reuniting them on the accurate transfer of the position and angulation of the dental implants.

MATERIALS AND METHODS

A dental study model of the edentulous upper jaw was used as the original model. It was scanned using a 3D desktop scanner (3shape D850). The 3 D model of the cast was imported into the Meshmixer. The 3D model was edited to create slots to receive five straight equidistant implant analogues. A resin study model with five slots for straight fixtures was printed using the Dent2 3D printer. (Mogassam)

Five implant analogs (Analolgo impianto JDEvolution Plus+, Jdentalcare system, Italy) were

secured in the holes with autopolymerizing acrylic resin. Open tray impression technique was done for all groups. Three groups were defined according to splinting of the impression copings:

Group A: Impression copings were splinted to each other using autopolymerizing acrylic resin. (Duralay, Reliance Dental Manufacturer, Worth, IL)

Group B: Impression copings were splinted to each other using autopolymerizing acrylic resin (Duralay, Reliance Dental Manufacturer, Worth, IL) which was sectioned with a 0.3 mm thickness disc and reconnected with a second mix of resin.

Group C: Impression copings were not splinted to each other.

Acrylic resin custom trays were fabricated with a window opposing the positions of the implants to allow access to the coping screws during open tray impression procedures. All the custom trays were uniformly spaced. The trays were left undisturbed for 24 hours prior to impression making to ensure their dimensional stability.

Five open tray impression copings were used to transfer the position and angulation of the implants. They were inserted and hand tightened with screw driver. (Fig.1)

Impregum polyether material (3M Espe, Seefeld, Starnberg, Germany) was used for the impressions. It was mixed and meticulously injected using an impression syringe (JON, São Paulo, SP, Brazil), around the impression copings to ensure their complete coverage.

Impression copings in group A and B were connected with dental floss (Oral B waxed dental floss) and autopolymerizing acrylic resin was then mixed according to the manufacturer's instructions and used to cover the dental floss. The acrylic splint in group A was left unsectioned. In group B, the bulk of the acrylic splint was sectioned with a 0.3 mm sectional disc into two fragments after it's initially set. Another mix of resin was applied at the sectioned areas and was left to set. Impression copings in group C was left unsplinted. Impressions were done after 20 minutes to ensure full polymerization of acrylic resin .

Copings were removed from the cast together with the set impressions. All procedures were performed by the same operator following the manufacturer's instructions.

For each group, five different impressions were prepared. All impressions were left to set on the master model for five minutes to ensure the impression material was fully polymerized.

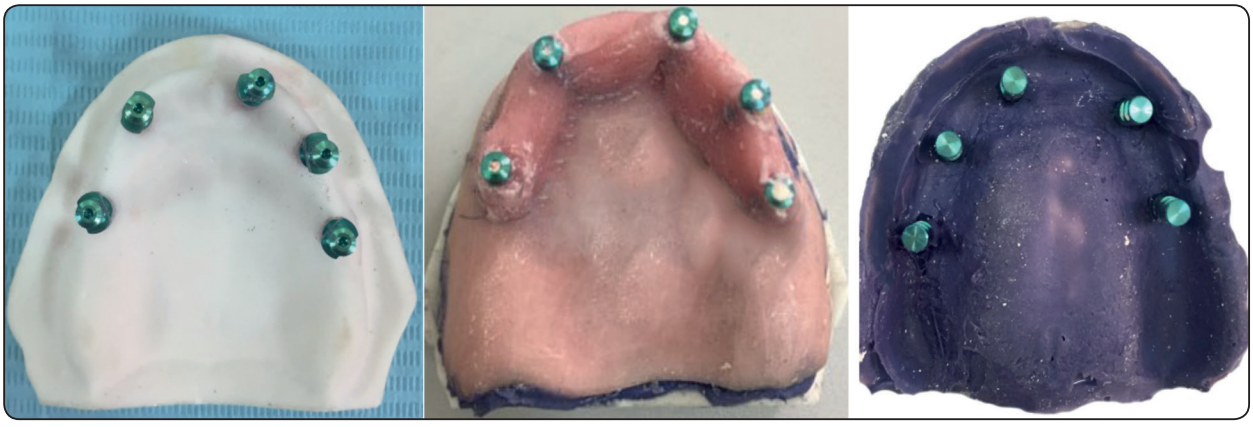

Fig. (1): Original printed model, open tray impression with resin splinted impression copings.

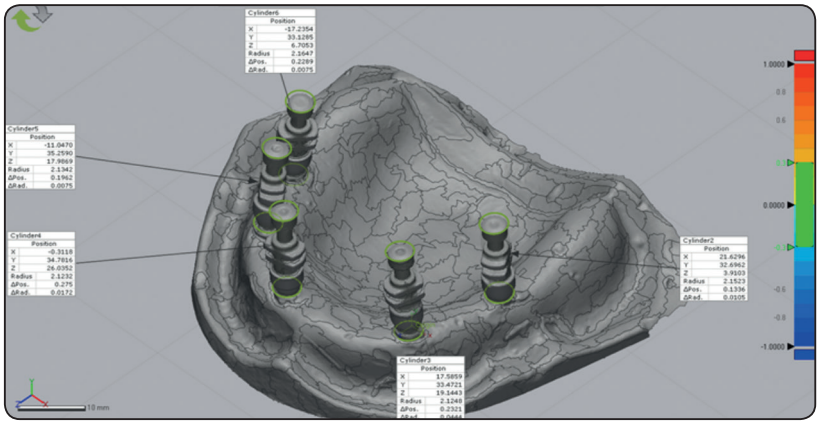

Fig. (2): Impression copings converted into cylinders.

Implant analogues were fastened to the impression copings in the impression. Then the impressions were poured to create the models using type IV die stone (Polidental, Cotia, SP, Brazil), according to the manufacturer's recommendations. All duplicate casts were stored at room temperature for minimum 24 hours before they were scanned. The impression copings were screwed to the implants in the master models which were sprayed with scanable spray (Shera scanspray, Werkstoff Technologie, Germany) to reduce the reflection of their surfaces before they were scanned.

The desktop scanner was used to scan the master models and the original resin model with the impression copings screwed to the implant analogues using the 3 shape software. The casts were fixed on a plate inside the scanner with their labial surface facing the inside of the scanner. A STL file of the scanned image of the cast was created and imported to the measurement system.

A 3D data analyzing software (Geomagic Control X) was used to evaluate the presence of discrepancies between STL files of the original cast and the experimental master casts. The STL file of the original cast was used as a reference. Five STL files were obtained from every experimental group. They were matched with the reference file respectively by the best fit algorithm. Selecting and cutting tools inside the software were used on the matched imaging data to eliminate the irrelevant areas. Thus, the 3D data of the impression copings were generated for discrepancy analysis.

Two points were located (x-, y-, z-coordinates) on the long axes of each impression coping of the implants in both the master cast and the original resin cast and the copings were converted into cylinders. The first point was located at the center of the bottom of impression coping whereas the second point was located at the center of the top of impression coping. (Fig.2)

The linear differences between the centers of the impression copings in both the master cast and the original resin model for the bottom point (liner deviation) were measured and the angles between the long axes of copings in the master cast and original resin model in x-, y-, z-axes (angular deviation) were evaluated. (Fig. 3).

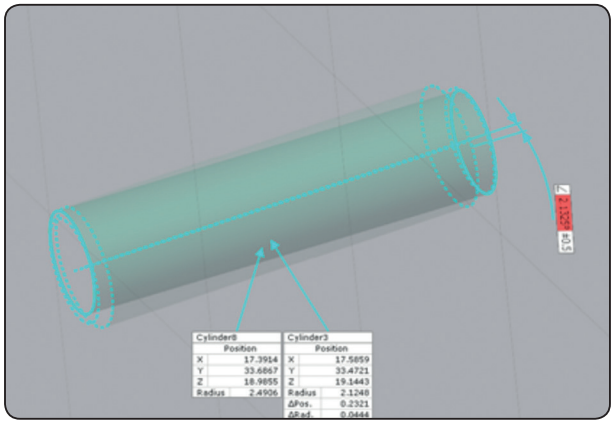

Fig. (3): Angular deviation between two cylinders representing impression copings.

RESULTS

Collected data were tested for normality by checking the data distribution, calculating the mean and median values, evaluating histograms and normality curves and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data were presented by mean and standard deviation (SD). One way ANOVA was used for comparison between the groups regarding angular and linear deviation and when the results were statistically significant, Tukey post hock test was used for pair wise comparison. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

As shown in table (1), regarding angular deviation group C showed the lowest value 0.68˚±0.16 followed by group B 1.41˚±0.38, while group A showed the highest value 3.26˚±0.78. One way ANOVA showed statistically significant difference between the studied groups, P value was <0.001 and Tukey post hock test showed statistically significant difference between group A and the other groups and no statistically significant difference between group B and group C. Linear deviation for group A, group B, and group C were 35μm±12.69, 33μm±7.82, and 26μm±10.65 successively. One way ANOVA showed no statistically significant difference between the studied groups.

DISCUSSION

The splint technique used in implant impressions was introduced with the use of multiple implants with an overlying fixed prosthesis for rehabilitation of edentulous jaws. The aim was to connect all impression copings together using a rigid material to avoid the movement of individual copings during impression making thus ensure accuracy of the impression. The effect of splinting has been investigated in many studies for evaluation of accuracy of impressions yet results have been controversial. [21]

Branemark et al highlighted the importance of splinting impression copings with dental floss and covering it with autopolymerizing acrylic resin for transfer impressions. Minimizing the shrinkage of the resin is the most important factor to ensure an accurate impression using the splint technique. [22]

Accuracy of the splinted impression technique depends on its resistance to deformation under the forces of the impression material, thus the use of a rigid splint material is important for an accurate master cast. Distortion of the splint material or fracture of the connection between it and the impression copings may affect accuracy of this technique. Moreover, polymerization shrinkage of autopolymerizing acrylic resin results in inaccuracy of the definitive impression. Shrinkage ranges between 7% and 9%, where 80% of it occurs

TABLE (1): Descriptive statics and p value of angular and linear deviation from the reference cast.

		Mean	Std. Deviation	Minimum	Maximum	P value
Angular deviation	Group A	3.26	.78	1.80	4.50	<0.001*
	Group B	1.41[a]	.38	.77	1.74	
	Group C	.68[a]	.16	.41	.86	
Linear deviation μm	Group A	35	12.69	20	50	0.155
	Group B	33	7.82	22	45	
	Group C	26	10.65	13	43	

within 17 minutes of mixing the material at room temperature. [15,16]

While various studies showed no statistical significant differences between the results obtained with acrylic-splinted versus non splinted groups in impression techniques. Some reported that the splinted technique was more accurate than the non-splinted technique. However, other studies showed that the non-splinted technique was more accurate than the splinted one. [1,9,19,21,23]

The overall accuracy of impressions depends on all the four parameters in the X, Y, Z axis, and the angulation of implant axis to its horizontal plane. Measurement of linear distortion at specific reference points is the mostly used technique for assessment of accuracy of implant impressions. [1]

Angular distortion could be classified into two categories which are rotation of the implant head around its long axis and translational rotation of the implant long axis to a specific reference axis or plane. A specific implant was chosen as a reference axis, the angles between the reference axis and the long axis of the implants were measured and the difference between the measurements in the master casts and the original model were evaluated.

Angular deviation was highest in group A in comparison to the other two groups which could be attributed to the polymerization shrinkage of auto-polymerizing acrylic resin which results in inaccurate transfer of spatial relationship of implants to the master cast.[15] However, post-setting sectioning, and rejoining of the acrylic resin splints with a second mix in group B, yielded better results regarding angular deviation. On the other hand, there was no significant difference between the three groups regarding linear deviation of the implants.

The time consumed for splinted impression technique is considerably greater when compared to the non-splinting impression technique. This study showed no significant differences between the values obtained with acrylic-splinted versus non splinted groups in impression techniques of straight implants.

This in vitro study has several limitations. The structure, hardness and wettability of the acrylic resin surface of the original model is different from the oral tissues. Moreover, all impressions were taken under ideal conditions without the presence of soft tissues, blood, saliva and sulcular fluid which may affect the accuracy of the impressions. Furthermore, the results are limited to five internal connection implants and may not be relevant with different number of implants and different connection geometries.

Further studies testing different number of implants, different angulations and connection geometry are recommended to evaluate the accuracy of implant impressions.

CONCLUSION

Both split acrylic-splinted and non-splinted implant impression techniques yield more accurate master casts regarding angular deviation compared to splinted impression technique without splitting.

REFERENCES

1- Kim J.H., Kim R.K. and Kim S.: Critical Apprasial of implant impression accuracies: A Systematic Review, J. Prosthet Dent., 2015, 114(2):185-192.

2- Pjetursson B.E., Thoma D., Jung R., Zwahlen M., Zembic A.: A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years, Clin Oral Implants Res, 2012, 23(6):22-38.

3- Al Quran F.A., Rashdan B.A., Zomar A.A., Weiner S.: Passive fit and accuracy of three dental implant impression techniques, Quint Int, 2012,43:119-25.

4- Akalin Z.F., Ozkan Y.K., Ekerim A.: Effects of implant angulation, impression material and variation in arch curvature width on implant transfer model accuracy, Int J Oral Maxillofac Implants, 2013, 28:149-157.

5- Holst S., Blatz M.B., Bergler M., Goellner M., Wichmann M.: Influence of impression material and time on the 3-dimensional accuracy of implant impressions, Quint Int, 2007, 38:67-73.

6- Debbabi I., Saafi J., Harzallah B., Cherif M.: Implant Impression: What about Splinted Impression Copings? , Mod App Dent Oral Health, 2018, 2(3).

7- Del'Acqua M.A., Chavez A.M., Amarat A.L., Compagnoni M.M., Mollo F.A.: Comparison of impression techniques and materials for an implant-supported prosthesis, Int J Oral Maxillofac Implants, 2010, 25(4):771-776.

8- Carr A.B.: Comparison of impression techniques for a five-implant mandibular model, Int J Oral Maxillofac Implants, 1991, 6:448-455.

9- Singh S., Kumar A.: Implant Impression Techniques in Dentistry, J Dent Sci Oral Rehab, 2016, 7(3):137-141.

10- Carr A.B.: Comparison of impression techniques for a two-implant 15-degree divergent model, Int J Oral Maxillofac Implants, 1992, 7:468-475.

11- Del'Acqua M.A., Chávez A.M., et all.: The effect of splint material rigidity in implant impression techniques, Int J Oral & Maxillofac Implants, 2010, 25(6):1153-1158.

12- Cabral L.M., Guedes C.G.: Comparative analysis of 4 impression techniques for implants, Implant Dent, 2007, 16:187–194.

13- Vigolo P., Majzoub Z., Cordioli G.: Evaluation of the accuracy of three techniques used for multiple implant abutment impressions, J Prosthet Dent, 2003, 89:186–192.

14- Wee A.G.: Comparison of impression materials for direct multi-implant impressions, J Prosthet Dent, 2000, 83:323–31.

15- Deogade S.C.: An alternative procedure of splinting multiunit implant copings to minimize the resin shrinkage, J Dent Implant, 2015, 5:124-127.

16- Assif D., Fenton A., Zarb G., Schmitt A.: Comparative accuracy of implant impression procedures, Int J Periodontics Restorative Dent, 1992, 12: 112-121.

17- Herbst D., Nel J.C., Driessen C.H., Becker P.J.: Evaluation of impression accuracy for osseointegrated implant supported superstructures, J Prosthet Dent, 2000, 83:555-561.

18- De La Cruz J.E., Funkenbusch P.D., Ercoli C., Moss M.E., Graser G.N., Tallents R.H.: Verification jig for implant-supported prostheses: A comparison of standard impressions with verification jigs made of different materials, J Prosthet Dent, 2002, 88:329-336.

19- Jalalian E., Balouch F., Samiei N., Ghane H.K., Iranpoor B., Ebrahimian K.: A comparative analysis of splinted and non-splint in opentray impression techniques on different angled implants, Biosci. Biotech. Res. Comm., 2017, 10(1): 109-113.

20- Papaspyridakos P., Lal K., White G.S., Weber H.P., Gallucci G.O.: Effect of splinted and non-splinted impression techniques on the accuracy of fit of fixed implant prostheses in edentulous patients: A comparative study, Int J Oral Maxillofac Implants, 2011, 26(6): 1267-1272.

21- Prithviraj D.R., Pujari M.L., Garg P., Shruthi D.P.: Accuracy of the implant impression obtained from different impression materials and techniques: review, J. Clin Exp Dent., 2011, 3(2): 106-111.

22- Lee H., So J.S., Hochstedler J.L., Ercoli C.: The accuracy of implant impressions: A systemic review, J. Prosthet Dent, 2008, 100:285-291.

23- Lee H.J., Lim Y.J., Kim C.W., Choi J.H., Kim M.J.: Accuracy of a proposed implant impression technique using abutments and metal framework, J Adv Prosthodont, 2010, 2:25-31.