Composite Resin versus Two Different Splinting Techniques on Evaluation of Impression Accuracy for Dental Implants

Tamer Omar Ibrahim[1] and Wael Aly Ghuneim[2]

[1]Department of Prosthodontics, Faculty of Dentistry, Ain Shams University, Cairo, Egypt
[2] Department of Removable Prosthodontics, Faculty of Oral and Dental Medicine, Nahda University, Beni Suef, Egypt.
drtamomar@yahoo.comwael_ali_gh@yahoo.com

Abstract: Background: Major objective of fabricating implant-supported restorations was the production of superstructures that exhibit passive fit when connected to multiple abutments. An accurate impression was one of the crucial steps to produce a well-fitting prosthesis. This study aimed to compare three different splinting techniques to evaluate the accuracy of impression through studying the changes in the poured master casts containing implants with different angulations. **Materials and methods:** This study was carried out on a model constructed from aluminum which was used as a control. A total of forty polyether (Impregum, medium body, ESPE, Germany) impressions were made to the model aided by three different splinting methods. The impressions were equally divided into four groups: Group A included transfer caps left without splinting, group B included transfer caps splinted with light cure flowable composite resin, group C included transfer caps splinted with castable self-cured acrylic resin, and group D included transfer caps splinted with addition silicone. The impression procedure was done for the four groups and fabrication of casts was performed. The angle was measured for each implant/analogue and each measurement was repeated three times to obtain an average of the single measurement. **Results:** The difference of implant angulations at 65º degree and 75º degrees with different splints were statistically significant while difference in implant angulations at 80º and 90º degrees with different splints were statistically non-significant. Splinting with composite resin and castable self-cured acrylic resin showed better impression accuracy than other groups at all angulations degrees and gave closer mean values to the control model, although the difference was not statistically significant between groups at 80º and 90º degrees inclination. **Conclusions:** Significant differences were found among groups as to implant/analog inclination and the interaction between them. Splinting with composite resin followed by acrylic resin did not present significant difference from the control model regardless of the implant inclination giving the smallest error and hence, could be considered more accurate than the other two groups. Impression accuracy for implant increased with decreasing inclination regardless of the efficiency of the splinting materials used. Therefore, patient selection and proper treatment planning with better clinical solution for implant placement inclination should be considered.

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1.Introduction

Investigations studied the parameters of superstructure accuracy showed impression and master cast accuracy as one of the major determinants. Furthermore, machining tolerances of the components provided by the manufacturer and the accuracy of laboratory process were identified as additional factors. It seems prudent to use a stiff elastomeric impression material such as polyether, since it maintains impression coping positions accurately and is dimensionally stable. In addition, it presents good resistance to permanent deformation, low strain compression, and high initial shear strength. [1-3] The indirect technique may be less difficult clinically; however, it has been shown to have greater instability in transferring the implant position. On the other hand, the direct transfer technique with splinted impression copings exhibits greater transfer precision, although splinting advantages have not been established.[1,4] Distortion associated with splinted transfer techniques can be related to residual polymerization contraction of the acrylic resin used for splinting. Different techniques for splinting impression copings with acrylic resin have been tested, such as a scaffold of dental floss, prefabricated acrylic resin bars, and stainless steel burs. [4]

Therefore, this study aimed to compare three different splinting technique to evaluate the accuracy of impression through studying the changes in the poured master casts containing implants with different angulations.

2.Materials and methods

I. Preparation of the control model:

A metal model of aluminum (3.5cm x 2cm x 2 cm) was milled from aluminum block. Four holes were drilled with a diameter of 3.7 mm and length of 11.2 mm was prepared to accommodate the implant* size, 3.5 mm Diameter and 11 mm Length. Milling rotating calibrated table was used to adjust the 90°, 80°, 75° and 65° degrees inclinations of the holes in relation to the horizontal surface of the model. After cleaning and polishing the preparations, the implants were fixed by the use of epoxy resin (Epoxysteel, bondo, Atlanta, USA). The epoxy resin adhesive comes in two joined tubes having clear base and catalyst gel. The epoxy resin was mixed according to the manufacturer's instructions; a small amount was applied inside each preparation with a disposable plastic stick that was used to spread the adhesive evenly on the walls of the preparations to avoid overfilling. The epoxy resin was also applied on the surface of the training implants evenly. Four implants of 3.5 mm x 11 mm (Ankylos Regular C/X Prosthesis, DENTSPLY Friadent, Germany) positioned at 90º, 80º, 75º, and 65º degrees in relation to the horizontal matrix surface. The implants were placed into the preparations with constant pressure by the aid of dental surveyor for five minutes till complete setting. This metal model was used as a control. Four straight abutments (Ankylos Standard abutment a/3.0/6.0, DENTSPLY Friadent, Germany) were connected to the fixtures. The transfer caps (Ankylos Transfer caps a/3.0/6.0, DENTSPLY Friadent, Germany) were adapted to the implants on the model. The custom impression tray was made from autopolymerizing acrylic resin (Formatray, Kerr Mfg Co, Romulus, Mich, England). Three millimeters thickness of modeling wax spacer (Anutex toughened pink dental modeling wax ADP-LTD-England) was adapted over the model and the abutment areas were blocked out to provide a uniform thickness of impression material.

Grouping of impressions:

A total of forty polyether (Impregum, medium body, ESPE, Germany) impressions were made to the model aided by three different splinting methods. The impressions were equally divided into four groups as follows: **Group A**: polyether impressions including transfer caps positioned over the implants and left without splinting. **Group B** : polyether impressions including transfer caps splinted with Nano based light cure flowable composite resin (CharmFil Flow, DentKist, Inc. #265 Dangjeongdong Gunpo Gyeonggi 435-831 Korea) with a shade of A3. The transfer caps were linked together by applying first a layer to cover the four transfer caps, then cured with LED Bre.Lux Power Unit (BreDent, GmbH & Co.KG · Weissenhorner Str. 2 · 89250 Senden · Germany) for twenty seconds each, the composite resin where build up by incremental technique to assure rigidity and cured to be connected (Figure 1). The tray was tried and checked to detect any interferences caused by the acrylic resin splint. **Group C**: polyether impressions including transfer caps splinted with castable self-cured acrylic resin. The transfer caps were linked together by scaffolding of unwaxed dental floss (Figure 2). Castable self-cured acrylic resin (Pi-Ku-Plast HP 36, bredent, Germany) was mixed according to the manufacturer's instructions and applied to the scaffolding of dental floss by incremental technique to assure complete coverage of the dental floss by the castable acryl, and to obtain enough thickness to assure rigidity (Figure 3). The acrylic resin was made 20 minutes before the impression were made to allow for optimal polymerization. The tray was tried and checked to detect any interferences caused by the acrylic resin splint. **Group D**: polyether impressions including transfer caps splinted with addition silicone. The transfer caps were splinted with addition silicon (AFFINIS, putty super soft, Coltene Whaledent, Switzerland). The additional silicone block splint was cut using lancet so that a thickness of 2 mm will be around each transfer cap. The silicone surface was scratched to provide mechanical retention for the impression material (Figure 4).

Impression procedure:

Rubber adhesive (Polyether adhesive, ESPE, Germany) was thinly and evenly applied over the inner surface of the tray to extend approximately 2 mm onto the outer surface of the tray along the periphery. The adhesive was allowed to dry for 15 minutes before the impression was made. Polyether impression material was mixed according to the manufacturer's instructions. Then, the tray was loaded with impression material and then seated on the metal model using finger pressure. The impression material was allowed to set for twice the recommended setting time to allow for optimal polymerization. The tray was removed with the impression and the transfer caps and left for 40 minutes before pouring with type IV dental stone to assure complete elastic recovery of the impression. The laboratory analogues (Ankylos laboratory analogue one-piece a/3.0/6.0 straight, DENTSPLY Friadent, Germany) were positioned in transfer caps and the firm fit was checked (Figure 5).

Image Cytometric Analysis:

For each specimen, an image was captured for the four implants and then images were transferred to the computer system for analysis (Figure 6). All the steps performed for angle calculation were carried out using image analysis software (Image J, 1.41b, NIH, USA). An arbitrary line was drawn parallel to the long axis of the implant and dissecting a horizontal line at an angle. This angle was measured for each implant/analogue. This measurement was then compared to the control model (Figure 7), and any changes in implant angulation resulting from impression accuracy in the three groups were detected and calculated. Each measurement was repeated three times to obtain an average of the single measurement.

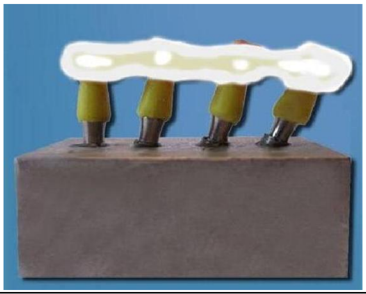

Figure 1: Application of composite resin by incremental technique.

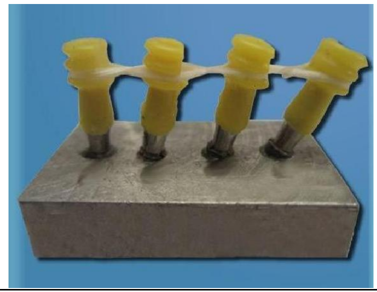

Figure 2: Connection of transfer caps by dental floss.

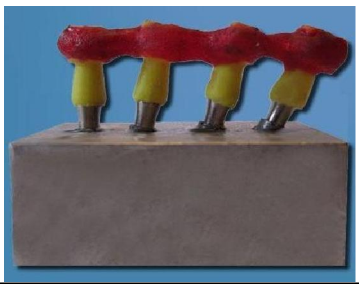

Figure 3: Application of castable resin to the scaffolding of dental floss by incremental technique.

Figure 4: Scratching of addition silicone surface provides mechanical retention for impression material.

Figure 5: Positioning of analogues to snugly fit the caps.

Figure 6: A sample of stone cast ready to be measured by image cytometric analysis.

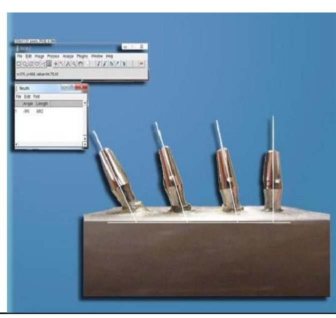

Figure 7: Implants inclination measurments (The control model).

Statistical analysis:

The collected data were tabulated using Microsoft Excel (Microsoft Office 2007). Statistical analysis was then performed to compare the degree of angulations of different implants among various groups under study. Data were presented as means and standard deviation (SD) values. One Way-ANOVA was used to study the effect of different groups and angulation on mean implant angulation and percentage of change in implant angulation. Tukey's post-hoc test was used for pair-wise comparison between the means when ANOVA test is significant. *P* value ≤ 0.05 was considered statistically significant in all analyses.

Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 21 for Windows.

3.Results

1-Effect of different angulations and groups on mean implant angulations:

Mean and standard deviation (SD) for the implant angulations values for different angulations and groups tested were presented in table (1) and figure (8). An insignificant difference between tested groups for 90º and 80º angulations at $p \geq 0.5$.

Master model and composite resin produced the highest mean implant angulation in 75º. Castable acrylic resin also showed the highest mean angulation with master model and composite resin for 65º angulation.

Table 1: Mean implant angulations values for different angulations and groups tested.

		Angulation							
		90º		80º		75º		65º	
		Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
Group	Master Model	90.02	0.13	80.00	0.11	76.06 ^{B}	0.19	66.76 ^{B}	2.16
	Composite resin	90.36	0.4	80.06	0.41	76.50 ^{B}	0.03	66.24 ^{B}	1.38
	Castable Acrylic resin	90.13	0.6	80.56	0.22	75.14 ^{A}	0.06	65.84 ^{B}	1.68
	Addition Silicon	90.59	0.67	80.64	0.45	75.26 ^{A}	0.64	65.50 ^{A}	2.56
	polyether impressions without splinting	90.49	0.45	80.09	0.6	75.32 ^{A}	0.74	65.70 ^{A}	2.16
p- value		0.729 NS		0.85 NS		0.015 *		0.043*	

Means with the same uppercase letter within each column are not significantly different at p=0.05.
**= Significant, NS= Non-significant*

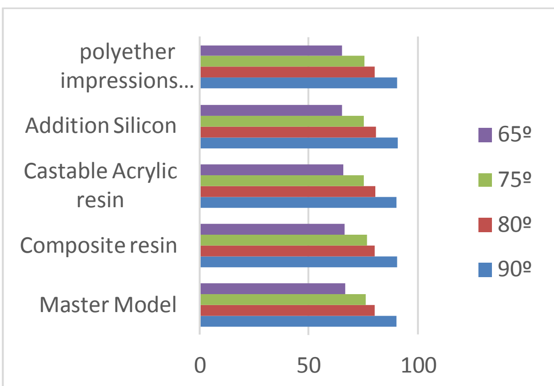

Figure 8: Histogram showing the Mean implant angulations values for different angulations and groups tested

2. Effect of different angulations and groups on mean percentage of implant angulations:

Mean and standard deviation (±SD) for the different percentage of implant angulations values for different angulations and groups tested were presented in table (2) and figure (9).

An insignificant difference between tested groups for 90º and 80º angulations at $p \geq 0.5$ for mean percentage of implant angulations. Composite resin and castable acrylic showed a lower significant values compared to other groups for 75º and for the 65º angulations, the composite resin showed a lower significant values compared to other groups.

Also; the different angulations tested produced an insignificant difference between different tested angulations at $p \geq 0.5$.

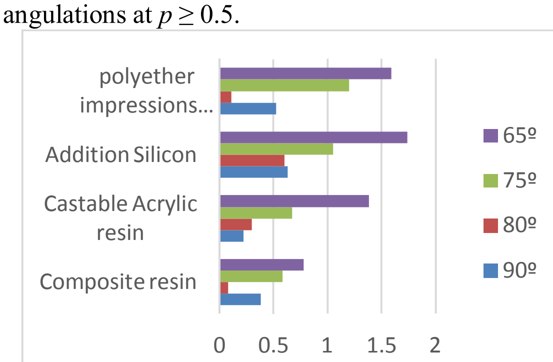

Figure 9: Histogram showing the Mean percentage of implant angulations values for different angulations and groups tested.

Table 2 : Mean percentage of implant angulations values for different angulations and groups tested.

		Angulations								*p*-value
		90º		80º		75º		65º		
		Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	
Group	Composite resin	0.38	0.23	0.08	0.01	0.58^{a}	0.36	0.78^{a}	0.5	0.148 NS
	Castable Acrylic resin	0.22	0.09	0.30	0.72	0.67^{a}	0.65	1.38^{b}	0.65	0.512 NS
	Addition Silicon	0.63	0.23	0.60	0.42	1.05^{b}	0.76	1.74^{b}	0.96	0.907 NS
	polyether impressions without splinting	0.52	0.23	0.11	0.54	1.2^{b}	0.89	1.59^{b}	0.89	0.573 NS
p-value		0.09 NS		0.07 NS		0.024*		0.046 *		

Means with the same uppercase letter within each column are not significantly different at p=0.05.
**= Significant, NS= Non-significant*

4. Discussion

The present study showed non-significant differences between implant angulation of the four studied groups and the control model at various degrees. However, there were significant differences among the studied groups as regards implant/analogue inclination and the interaction between them. Moreover, it was found that implant inclination has affected implant impression accuracy at certain inclinations (65º and 75º degrees) while the differences between impression accuracy of different splints were non-significant at 80º and 90º degrees angulation.

Splinting with composite resin and castable self-cured acrylic resin showed better impression accuracy than other groups at all angulation degrees and gave closer mean values to the control model, although the difference was not statistically significant between groups at 80º and 90º degrees inclination. In addition, regardless of implant inclination, Composite resin and castable self-cured acrylic splints were more accurate than splinting with addition silicone and the no splint group showing the smallest error followed by the other two groups as proved by its significantly lower total mean absolute percent error.

Several authors have found that square copings connected with acrylic resin provide the best results of making impressions. [5,6,7] while other studies demonstrated that this splinting process is unnecessary. [8,9] However, the encouraging results obtained from splinting with acrylic resin in our study were similar to the findings of other studies. [4,9,10,11] It has reported that the differences between splinting techniques used could be attributed to the rigidity of the splinting material that was used to prevent the movement of copings in the vertical direction during connection of the implant replica to the impression coping. Although splinting might rigidly hold the impression copings together, the time consumed in impression making was considerably greater when compared to the non-splinted technique. The reason that silicone splinting showed larger differences could be a result of relatively lower rigidity of the material when compared to acrylic resin. [10]

In this study, splinting with addition silicone and the non-splinting technique gave variable results. Generally, the no splint group has much different values than the control model except at 80º degree angulation. Splinting with castable acrylic showed closer values to the master model except at 75º degree inclination but yet, the difference was non-significant at any examined inclination.

Moreover, the mean values of both the silicone splint and the no splint groups were closer to each other except at 80º degrees inclination where the no splint group showed much lower values. Furthermore, their mean absolute percent error values were nearly similar denoting similar effect on impression accuracy regardless the implant inclination. However, the perpendicular inclination could be considered the favorable implant position giving the best impression accuracy and nearest values to the control model regardless of the efficiency of the impression material used.

In this context, it has been shown that certain techniques resulted in accurate reproduction of inter-implant relationships in one or more axes but not all the three axes and reported that although significant difference might not be present in individual axis measurements, the collective error occurring because of dimensional changes in all the axes that might play a role in the fit (or misfit) of the prosthesis. [10]

These findings are somehow similar to those obtained in a recent study. [10] Which concluded that the casts obtained from copings splinted with acrylic resin were closest to the reference model followed by those obtained via non-splinting or addition silicone splinting. However, the results of non-splinting and addition silicone splinting in our study did not follow this order in all inclinations.

Our results also supported the findings of another study. [4] Which demonstrated that the impression transfer techniques would affect master cast accuracy and found a significant difference between both splinting techniques used in their study (Duralay and condensation silicon) compared to the control group at 75º degrees implant/analog inclination. However, in agreement with our findings, they proved that the direct impression technique with impression copings splinted with acrylic resin had no statistically significant difference from the metal matrix regardless of implant/analog inclination.

Similarly, it was found that addition silicone gave variable impression accuracy at high inclination degrees and therefore, further studies are warranted to assess its effectiveness for impression splinting.

The contradictory results for transfer accuracy that have been reported in some studies may be partially explained by the use of different methodologies to assess accuracy. Some experiments used microscopy to measure the displacement of analogs in the test specimens in comparison with the definitive cast at selected points. [12] However, because inaccuracy was expressed in only two dimensions, information was lost. Furthermore, the assessment of complete fit was impossible. [7] Under clinical conditions, these differences may be greater if the discrepancies are present in other special planes and if they occur in opposite dimensions. [5]

In this study, splinting with composite resin and acrylic resin showed the smallest error and closer results to the control model regardless of implant/analog inclination, whereas splinting with addition silicon or no splint differed from control group except at 80 degrees and the perpendicular position. These results were in line with those obtained by other studies. [4,11,13] which suggested that implant inclination may affect impression accuracy because less leaning/angulated implants produce more accurate casts than leaning implants regardless the efficiency of splinting material. When the impression was totally recovered by plaster, perpendicular analogs are exposed to minor vertical forces as compared to leaning analogs which results in lesser displacement of less leaning analogs. So, in this study, the favorable position of perpendicular implants may be able to overcome the inefficiency of addition silicone or non-splinting on master cast accuracy. Therefore, patient selection and proper treatment planning with better clinical solution for implant placement inclination should be considered. However, further studies are needed to verify the impression accuracy when splinting with composite resin in relation to other splinting techniques, improve impression and laboratory procedures and determine the amount of discrepancy tolerable physiologically and mechanically.

References

[1] **Di Felice R, Rappeli G, Camaioni E, Cattani M, Cattani JM and Belser UC:** Cementable implant crowns composed of cast superstructure frameworks luted to electroformed primary copings: An invitro retention study. Clin Oral Implants Res, 18: 108, 2007.

[2] **Hariharan R, Shankar C, Rajan M, Baig MR and Azhagarasan NS:** Evaluation of accuracy of multiple dental implant impressions using various splinting materials. Int J Oral Maxillofac Implants, 25: 38, 2010.

[3] **Assunção WG, Gennari-Filho H, Zaniquelli O:** Evaluation of transfer impressions for osseointegrated implants at various angulations. Implant Dent, 13: 358, 2004.

[4] **Assunção WG, Britto RC, Ricardo Barão VA, Delben JA, and dos Santos PH:** Evaluation of impression accuracy for implant at various angulations. Implant Dent, 19: 167, 2010.

[5] **Vigolo P, Majzoub Z, and Cordioli G.:** Evaluation of The Accuracy of Three Techniques Used for Multiple Implant Abutment Impressions. J Prosthet Dent, 89:186, 2003.

[6] **Phillips KM, Nicholls JI, Ma T, and Rubenstein J:** The accuracy of Three Implant Impression Techniques: A three dimensional analysis. Int J Oral Maxillofac Implants, 9: 533, 1994.

[7] **Naconecy MM, Teixeira ER, Shinkai RS, Frasca LC, and Cervieri A:** Evaluation of The Accuracy of 3 Transfer Techniques for Implant-supported Prostheses with Multiple Abutments. Int J Oral Maxillofac Implants, 19: 192, 2004.

[8] **Inturregui JA, Aquilino SA, Ryther JS, and Lund PS:** Evaluation of Three Impression Techniques for osseointegrated Oral Implants. J Prosthet Dent, 69: 503, 1993.

[9] **Carr AB:** Comparison of Impression Techniques for a Two-implant 15degree Divergent Model. Int J Oral Maxillofac Implants, 7: 468, 1992.

[10] **Hariharan R, Shankar C, Rajan M, Baig MR, and Azhagarasan NS:** Evaluation of Accuracy of Multiple Dental Implant Impressions Using Various Splinting Materials. Int J Oral Maxillofac Implants, 25: 38, 2010.

[11] **Rached RN, Powers JM, and Del Bel Cury AA:** Efficacy of Conventional and Experimental Techniques for Denture Repair. J Oral Rehabil, 31: 1130, 2004.

[12] **Humphries RM, Yaman P, and Bloem TJ:** The Accuracy of Implant Master Casts Constructed from Transfer Impressions. Int J Oral Maxillofac Implants, 5: 331, 1990.

[13] **Assuncao WG, Filho HG, and Zaniquelli O:** Evaluation of Transfer Impressions for Osseointegrated Implants at Various Angulations. Implant Dent, 13: 358, 2004.

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