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Research Article

To Evaluate the Effect of Splinting using Two Different Materials on the Accuracy of Impressions made for All-On-Four Implant Situation Using Open Tray Impression Technique-An *Invitro* Study

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Abstract

Aim: To evaluate the effect of splinting on the accuracy of impressions made for ALL-ON-FOUR Implant situation-A treatment protocol.

Material and Methods: A reference model of an edentulous mandible was made using clear Acrylic Heat cure. Four implants were placed according to all on 4 concepts where two implants that were straight, placed in the anterior region and the other two were placed at posterior region that were placed at an angulation of 45 degree. Impressions were made using regular body addition silicone and the cast were further divided into three groups i.e., Non splinting, splinting using pattern resin and splinting using flowable composite. X axis, Y axis and Z axis were measured using a CMM and the data was collected and analyzed statistically and finally the result was obtained.

Results: splinting showed more accuracy than the non-splinted group. Splinting using pattern resin showed no significant difference in comparison with the flowable composite.

Conclusion: Results showed that pattern resin as well as flowable composite had more accuracy than the non-splinting group and can be recommended for splinting of all on 4 impression copings as they exhibited similar results to the reference model.

Keywords: Splinting, All-on-Four, Pattern Resin, Flowable Composite

Introduction

In patients with complete edentulous arch where there is atrophy of the alveolar ridge specially in the posterior area, the placement of implants without bone augmentation procedure is very difficult as there is no adequate bone height and width and also because of the process of atrophy the anatomic structures such as the mental foramen in the mandible and the sinus wall in the maxilla pose a challenge in placement of implant as there is chances of perforation of the sinus wall or the mental foramen with mental nerves and vessels that might lead to many complications. Studies has suggested an option to avoid all these problems that is using of tilted implants in the posterior region to help to decrease the length of the cantilever and give a better A-P spread of the implants placed in an atrophic jaw which in turn helps to provide a better distribution of the occlusal load to the prosthesis. All these disadvantages and the problems faced in such situations as mentioned earlier have been overcome after the development of all on four treatment protocol [1].

The concept of all on four treatment was introduced by Paulo malo and his colleagues around the year 2003 to utilize as much as possible of the remaining available bone in atrophic jaws. The tilted implants are able to get the better-quality anterior bone which in turns gives better bone to implant contact and the anchorage is improved [2].

Passive fit is considered as the standard fit and the importance of passive fit is that it helps to distribute the forces equally among the components and connections of the prosthesis. For achieving passively fitting prosthesis, replicating the exact third dimensional relation and also the location of the multiunit implants in the impression is needed [3]. Some authors have highlighted the significance of splinting transfer copings together intra-orally before making an impression so as to obtain maximum accuracy. For all these procedures a rigid splinting of the impression copings is required in order to stabilize the implants so that accuracy of the cast is maintained. In order to maintain the primary stability of the impression copings, a cross arch rigid splinting is required. This splinting will help to hold the copings together in the right position. There are two types of impression technique used to transfer the multiunit implants to the lab models and that includes the open tray and closed tray technique. The impression can also be made on an implant level or the abutment level [4]. Various materials are available in the market that have been used as splinting materials however auto-polymerizing acrylic resin is the most frequently used material for splinting the implant [5]. Another material that can be used is flowable composite as the polymerization shrinkage is low compared to auto-polymerizing resin and so here we don't need the splints to be sectioned in between the impression posts [6].

Figure 1: All on 4 Guide.

Figure 2: Reference model.

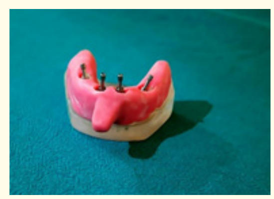

Figure 3: Custom tray.

Material and Methods

Reference model for edentulous mandible was made using clear Acrylic Heat cure. For this study the recommended guidelines for All-On-4 was followed and two dental fixtures were positioned in the anterior region which were straight as well as parallel to each other and other two posterior implants were placed at 45 degree with the help of all on four guide (Figure 1,2) and was further divided into three groups i.e., Group 1: non splinted, Group 2: splinted using pattern resin and Group 3: splinted using flowable composite. The impressions were made at implant level using open tray impression technique. Custom tray was fabricated using self cure acrylic resin with windows in the anterior region (Figure 3)

- **Group 1:** The impression copings are placed but they are not splinted together in this category and then the guide screws were tightened (Figure 4). The custom tray is applied with a tray adhesive and allowed to dry for 15minutes. The regular body addition silicone impression material is manipulated and loaded into the custom tray and the remaining material was syringed around the impression copings and the tray was placed and then material was allowed to set. The screws were then loosened so that when the impression is removed the transfer copings stayed in the impression. The impressions were removed and evaluated. An Implant Analog of the correct size was placed over the impression coping and a cast was poured. Ten such impressions were made for this group.
- **Group 2:** In this group the impression copings were placed and guide screw were tightened according to manufacture recommendation and copings were splinted together using auto polymerizing pattern resin. Splinting was done by using floss that was tied around the transfer copings to stabilize them (Figure 5). Pattern resin was mixed in the ratio of 2g-1ml and then added over the floss and around the impression posts using a BB technique to precisely transfer the spatial relationship of implants to the master cast. Let the resin set for atleast 4 mins (Figure 6). For relieving the stresses that were produced by polymerization shrinkage, the splints were

Figure 4: Non splinted for group 1.

Figure 5: Floss tied around copings for group 2.

Figure 6: Splinted using pattern resin for group 2.

sectioned in between the copings using a disc. Same resin was used to join the cut sections and was allowed to polymerize For taking the impression same steps were followed as in group1.Ten such impressions were made for this group.

- **Group 3:** In this group the impression copings were placed and guide screw were tightened according to manufacturer recommendation and copings were splinted together by flowable composite. Splintings were not cut and reattached because compared to resin, the shrinkage on polymerization is smaller. Dental floss was tied around the transfer copings to provide support for the flowable composite (Figure 7) and then flowable composite was placed over it and cured for 20secs (Figure 8). For taking the impression same steps were followed as in group1.Ten such impressions were made for this group.

Figure 7: Floss tied around copings for group 3.

Figure 8: Splinted using flowable composite for group 3.

Preparation of the master cast

Die stone was used for pouring the implant impression that was hand manipulated according to manufacturer's instructions with the recommended Water to powder ratio. The base was then made by using type II and type III Gypsum products. In this study a total of thirty casts were fabricated (Figure 9-11).

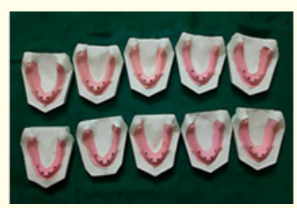

Figure 9: 10 cast made using non splinted copings.

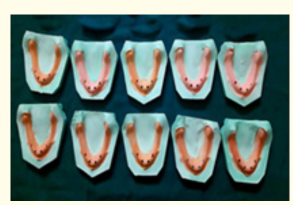

Figure 10: 10 casts made using pattern resin splinted copings.

Figure 11: 10 casts made using flowable composite splinted copings

Measurement

For this study a Coordinate measuring machine was used to record the displacement in x, y, and z directions. The x-axis represents the mesio-distal plane; the y-axis represents the bucco-lingual plane and the z-axis represents the length of the implant relative to the depth of the osseous crest. Before the commencement of the measurement, a midpoint/reference point was marked in the centre of the superior surface of all the cast using a marker pen which was constant for every cast and was considered as the source or the midpoint where the X,Y and Z values were considered zero ($x_0y_0z_0$). From this midpoint the x, y and z coordinates of each implant was measured (Figure 12).

Figure 12: Coordinates measurement using CMM.

Statistical analysis

The data for the present study was entered in the MS Excel 2007 and SPSS statistical software 19.0 Version was used for the analysis. The descriptive statistics included mean, standard deviation. The intergroup comparison was done using One Way ANOVA to find the difference between the individual groups the level of the significance for the present study was fixed at 5%.

Results

X-Axis

The mean values for the Group I was 1.249, 0.1885 for Group II and -0.1626 for Group III. The difference in values for x axis in all the three groups was statistically significant comparing to the control model values. The x values in Group I vs Group II and Group I vs. Group III were significant while Group II vs Group III were non-significant (Figure 13).

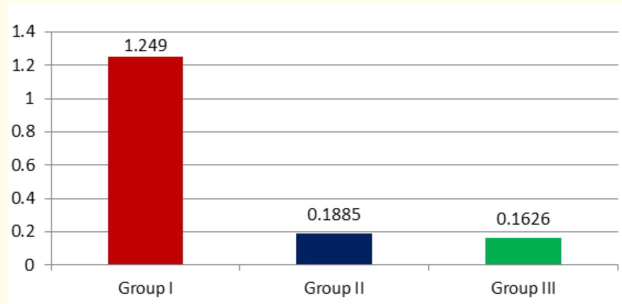

Figure 13

Y-Axis

The mean values for the Group I was 1.2491, 0.1885 for Group II and -0.63592 for Group III. The difference in values for x axis in all the three groups was statistically significant while comparing to control values. The y values in Group I vs Group II and Group I vs Group III were significant while Group II vs Group III were non-significant (Figure 14).

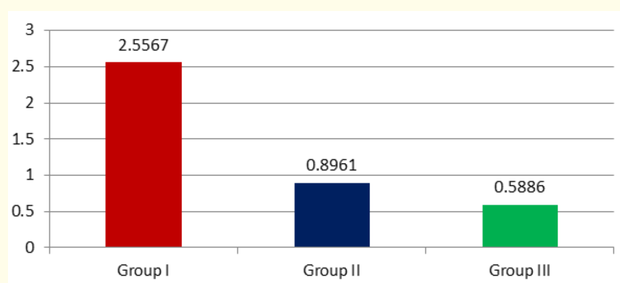

Figure 14

Z-Axis

The mean values for the Group I was 1.3824, 0.2371 for Group II and -0.2662 for Group III. The difference in values for x axis in all the three groups was statistically significant while comparing to control values. The z values in Group I vs Group II and Group I vs Group III were significant while Group II vs Group III were non-significant (Figure 15).

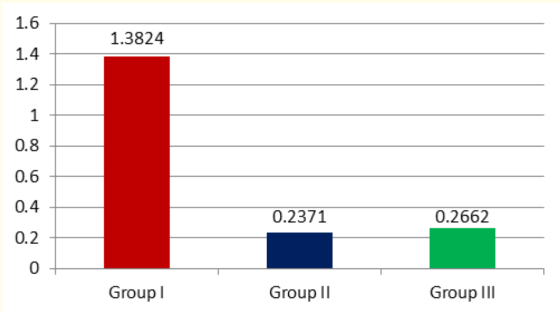

Figure 15

Values of reference cast

	Mean	Range	Minimum	Maximum	Std. Error	Std. Deviation
X axis	-0.0653	42.35	-20.71	21.64	8.91961	17.83922
Y axis	22.6475	15.60	14.94	30.54	4.41423	8.82846
Z axis	27.9145	7.72	24.01	31.73	1.81297	3.62595

Table a

Mean deviation from master cast at X axis

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	P value
					Lower Bound	Upper Bound			
X- axis	Group I	1.249	1.852	.58569	-1.1829	1.4669	-2.38	2.74	0.001 (Significant)
	Group II	0.1885	.71669	.22664	-.3242	.7012	-.64	1.54	
	Group III	-0.1626	.63592	.20109	-.6175	.2923	-1.14	.57	

Table b

Dependent Variable	GPS_	Mean Difference	Std Error	Sig	Significance
X_	Group I vs Group II	1.06061*	.28481	0.001	Significant
	Group I vs Group III	1.41169*	.28481	0.001	Significant
	Group II vs Group III	.35109	.28481	0.228	Non-Significant

Table c

Mean deviation from master cast at Y axis

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	P value
					Lower Bound	Upper Bound			
Y- axis	Group I	1.2491	.54659	.17285	.8581	1.6401	.40	2.32	0.001 (Significant)
	Group II	.1885	.71669	.22664	-.3242	.7012	-.64	1.54	
	Group III	-.1626	.63592	.20109	-.6175	.2923	-1.14	.57	

Table d

Dependent Variable	GPS_	Mean Difference	Std. Error	Sig.	Significance
Y-axis	Group I vs Group II	-1.66052*	.30058	.000	Significant
	Group I vs Group III	-1.96810*	.30058	.000	Significant
	Group II vs Group III	-.30757	.30058	0.315	Non-Significant

Table e

Mean deviation from master cast at Z axis

		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	P value
					Lower Bound	Upper Bound			
Z- axis	Group I	1.3824	.88344	.27937	.7504	2.0144	.38	3.38	0.001 (Significant)
	Group II	0.2371	.99375	.31425	-.4738	.9480	-1.51	1.42	
	Group III	-.2662	.73081	.23110	-.7890	.2566	-1.10	.91	

Table f

Dependent Variable	GPS_	Mean Difference	Std. Error	Sig.	Significance
Z- Axis	Group I vs Group II	1.14525*	.39176	0.007	Significant
	Group I vs Group III	1.64858*	.39176	0.001	Significant
	Group II vs Group III	.50332	.39176	0.210	Non-Significant

Table g

Discussion

The results showed that splinting is better than non-splinting and pattern resin and flowable composite showed similar values to the reference model.

The difference obtained in resin splinted group and flowable composite group splinted group was almost near to the reference model values. Such variations can be due to rigidity of materials that are used for splinting to protect copings movement in vertical dimension when implant replica is connected to impression coping. Maximum accuracy is achieved by splinting the impression copings because it helps to keep the transfer copings stable when force is applied from securing the analogues thereby decreasing the lack of restriction of rotation while using an elastic impression material.

The polymerization shrinkage for composite is lesser as compared to acrylic resin as well as convenient to handle, so flowable composite can be utilized for splinting of multiple implants.

M. Keerthna., *et al.* in the year 2018 did a study to compare the precision of the dimensions for the cast of multiple angled implants by splinting as well as non splinting technique. It was concluded that the splinting is suggested for multiple angled implants [7].

In another study performed by Tamer Omar Ibrahim., *et al.* in the year 2013 to evaluate the impression accuracy of dental implants using Composite Resin versus Two Different Splinting Techniques. They concluded that splinting using flowable composite and acrylic resin did not show much difference with the reference model [8].

Since studies regarding the accuracy of flowable composite for using it as a splinting material have not been tested for therefore the data concerning the accuracy of these materials is deficient.

Limitations

- The results obtained in the my research are restricted to only 4 implants having all on four arrangements furthermore may not be relevant to impressions with higher or lower numbers and various angulations of the implants. Additionally it might be understood that tissue undercuts and different impression angulations may cause larger inaccuracy in procedures for taking implant impression which were not conveyed in present research.
- Accuracy of the master casts was evaluated based only on the coordinates and not on the difference in the angles.
- The present study is done *in vitro* and therefore did not simulate all clinical conditions, so further studies particularly *in vivo* to assess the outcome of the oral environment on the splint materials are required to make more enhancements.

Conclusion

Within the limits of my study and on the basis of the results obtained, the following conclusions can be drawn

- Least variation in positions was observed when the open tray impression copings were splinted using two different materials i.e., PR and FC which were near to the reference model values.
- Flowable composite and pattern resin showed no significant difference between them.
- Non splinted group showed more variation from the reference model.
- Clinically acceptable accuracy could be obtained from using Flowable composite as similar results with the pattern resin were achieved.

Taking into consideration the various aspects of my current research, conclusions can be drawn that pattern resin can still be chosen as the splinting material for producing precision in the impressions for implants. Flowable composite can also be used as a splinting material as it yields similar results like the pattern resin.

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