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EVALUATION OF ACCURACY OF MULTI IMPLANT IMPRESSIONS USING DIFFERENT SPLINTING AND IMPRESSION MATERIALS: AN IN VITRO STUDY

*Pragya Bali, ** Archana Nagpal, *** Rajeev Gupta, * Payal Kashyap, * Farhat Jabeen

*PG Final Year student, **Professor and Head, ***Professor, Department of Prosthodontics, Crown and Bridges, Himachal Dental College, Sundernagar | Corresponding author: Dr Pragya Bali, E mail: pragyabali9090@gmail.com

Abstract:

Statement of problem: Movement of impression copings inside the impression materials prevents transfer of the 3-dimensional spatial orientation of intra-oral position of implant fixtures to the working cast. .So for the long term success of implant an accurate and passive operation is required.

Purpose: This in vitro study evaluated the accuracy of the master cast using different splinting and impression materials.

Methodology: A reference mandibular model with 4 internal connection implants was fabricated. Thirty six custom trays were fabricated using autoplymerizing resin. Polyether and poly vinyl siloxane impression material were used. These trays were randomly divided between the two groups, with eighteen trays in each group. Impression techniques were divided into two groups namely: Group I: Direct impression technique with open tray impression copings splinted with autopolymerizing acrylic resin (GC pattern resin). Group II: Direct impression technique with open tray impression copings splinted with Pro-temp TM 4 (bis-GMA) syringable temporization material. Thus, final impressions were made. Master casts were fabricated and evaluated using profile projector. These measurements were compared to the measurements calculated on the reference mandibular model which served as control. Data were analyzed with a one way analysis of variance at α =.00, followed by post hoc Tukey's test test (α=.00).

Results : Statistical comparisons were made using ANOVA test and post -hoc test. Same amount of deviation values obtained with resin splinted and bis-GMA splinted impression copings. There was a significant difference in-- while using Polyether and poly vinyl siloxane as impression material.

Conclusion: The master cast obtained by both the splinting material exhibited no difference from the reference model. In the direct techni¬que, polyether showed better results in terms of accuracy. Splinting provided more accuracy of transfer in multiple abutments using both the impression materials included in the study .Both splinting materials showed comparable amount of deviation from the reference model, any one of the material based on the ease of handling, time consumption, technique sensitivity and availability can be chosen.

Key Words: Accuracy, Open tray implant impression, Master cast, Splinting materials

Introduction

Dental Implants have bought revolutionary changes in treatment of partially and completely edentulous patients. Implants are different from natural teeth as osteointegrated. Implants have no periodontal ligament to compensate for any accuracy. As implants are functionally ankylosed with direct contact to the bone, they lack the inherent mobility of periodontal ligament. Hence, they cannot accommodate distortion or misfit at the implant abutment interface.[1] Consequently recording the intraoral three-dimensional position of implant is more challenging in the realization of implant-supported than in tooth-supported prosthesis to ensure an accurate relationship on the master cast. A successful result can be achieved only when passively fitting prosthesis are fabricated.[2] Poor fit of framework connected to implants may lead to bone loss and failure of implants causing problems ranging from screw loosening to loss of osteointrigation.[3]

The adaptation precision, between prosthetic infrastructure and implant or tooth is one of the great challenges of oral rehabilitators.[4]

Impression materials and techniques are fundamental in precision of fit and passivity of implant supported FDP's[5]. Accuracy of impression is affected by the selection of impression tray that might be a stock tray or custom tray. Impression techniques like close tray or open tray and type of impression material also attributed to accuracy. In case of impression procedures, most of the researchers reported that the open-tray pick-up technique is more precise and predictable than the closed tray technique using repositionable copings[6].

A factor that can contribute to the imprecise transfer of impression copings is a deficient splinting technique. Theoretically, splinting is done to prevent the copings from becoming dislodged during impression making and during tray removal.

Therefore the purpose of this study was to compare the implant cast accuracy of multiple implants using different splinting and impression material combinations.

Materials and methods

A reference model with four implants (Bio TEC, Dental implant system,Germany) in the mandibular anterior region in overdenture situation were placed using surveyor for proper orientation of implants. The implants were numbered 1,2, 3 and 4 for reference purpose. Custom impression trays were made with autopolymerizing methacrylate resin (DPI Self cure resin). For this purpose, the 4 implants (Bio TEC, Dental implant system, Germany) in the model were covered by 2 layers of wax sheet (Charminar Dental Products, Hydrabad, India) to allow a consistent thickness of impression material, and an irreversible hydrocolloid impression (Alginax, DPI, Mumbai) was made to obtain a single cast on which all custom trays were fabricated. Tissue stops were incorporated between each implant. Three location marks (circular depressions 2mm wide and 1mm deep) were made on the base of model and included in the impression trays to standardize tray positioning during impression making. Windows were made in the impression trays for open tray technique to allow access for the copings screws. (Fig: 1)

Splinting was done with different materials to fabricate specimens Group Io samples were fabricated, with polyether impression material without splinting square impression copings. Groping of samples and material details as follows :

For groups Io, Ia & Ib 18 medium-consistency polyether impressions (Impregum Penta, 3M ESPE, Germany) were made. For obtaining impressions, impression trays were coated with tray adhesive (Impregum, 3M ESPE) 1 hour before each impression was made. The impression

material was mixed using penta elastomer syringe (3MESPE pentamix 2 Germany), and part of the material was meticulously syringed around the impression copings to ensure complete coverage of the copings. The remaining impression material was used to load the custom tray. The custom trays were fully seated over the resin model with finger pressure, and the position was maintained throughout the polymerization time.

In the group Io, impression copings as supplied by the manufacturer were used (square impression copings, without splinting) Polyether was used as an impression material. Each custom tray was seated, and the material was allowed to polymerize. The guide pins were released so that the transfer copings remained in the impression when the impression was removed.

In the group Ia, impression copings were splinted with autopolymerizing acrylic resin (GC Pattern resin, Osaka, Japan) .For this copings were splinted with dental floss (Oral B waxed dental floss, India) (Fig-2). Autopolymerizing resin (GC pattern resin, Osaka, Japan) was mixed in the ratio of 2 g–1 ml. When the resin reached the dough stage, it was packed around the impression posts and the dental floss thus they were splinted together. The splint was allowed to polymerize for 4 min. The splint was then sectioned in between the impression posts using a thin separating disc to relieve the stresses caused due to polymerization shrinkage. The cut sections were joined using the same resin by applying it using brush bead method(Fig-3). This was again allowed to polymerize for 4 min. The impression copings, custom tray, and the splint were coated with polyether adhesive and allowed to dry for 15 min. The impression procedure was accomplished as previously described.

In the Ib group, impression copings were splinted with Bis-GMA (Pro-temp 4 3M ESPE, India) and the impression procedure was accomplished as previously described (Fig-4).

For the open tray technique, the guide pins were loosened with a hex driver (EZ Hi-Tec, Life Care Devices) and removed, the tray was separated from the definitive model, and the impression copings along with the guide pin remained locked in the impression. The implant analog was connected to the hex at the bottom of the impression coping, and the guide pins were tightened with the hex driver.

In the IIo, IIa, and IIb groups VPS impression material was used. The procedure for these 3 techniques was the same as for the first 3 groups. The custom trays were painted with VPS adhesive

Table-1 Groping of samples

Groups	Sub-Groups	Samples	N
I	Io	Square impression copings with polyeter impression material (This acted as a control group)	6
	Ia	Square impression copings splinting together with autopolymerising resin(G.C Pattern resin,Osaka japan) with polyeter impression material	6
	Ib	Square impression copings splinting together with Bis-GMA (Pro-temp 4 3M ESPE, India) with polyether impression material	6
II	IIo	Square impression copings with Poly vinyl siloxane (VPS) impression (This acted as a control group)	6
	IIa	Square impression copings splinted together with autopolymerizing acrylic resin(GC Pattern resin, Osaka, Japan) with Poly vinyl siloxane (VPS) impression material.	6
	IIb	Square impression copings splinting together with Bis-GMA (Pro-temp 4 3M ESPE, India) Poly vinyl siloxane (VPS) impression material	6

N= No. of samples

(VPS Tray Adhesive, 3M ESPE, St Paul, Minn) and allowed to dry for 15 minutes. The custom trays were filled with VPS impression material, (Imprint II Garant, 3M ESPE). The custom trays were seated on the definitive model, and any excess material from the open tray windows was removed with a finger swipe to expose the guide pins.

An ADA type IV die stone (Kalrock, Kalabhai Karson Pvt Ltd, Mumbai, India) was used to pour the impressions in accordance with the manufacturer's instructions. The casts were retrieved from the impressions after 24 hours. All of the casts were stored at room temperature for a minimum of 24 hours before measurements were made. All definitive casts were evaluated for the positional accuracy of the implant replica heads using a profile projector. A profile projector is an optical instrument that can be used for measuring linear dimensions in x and y axis. The projector magnifies the profile of the specimen and displays this on the built-in projection screen (Fig-7). All of the casts were secured to a universal movable surveyor table (Unident New Delhi,India), and the

Table 1 :Descriptive statistics of the effect of different combination of impression material and splinting materials on X and Y axis deviations

						95% Confidence Interval				ANOVA resullt	
AXIS	Combi-nations	N	Mean	Std. Dev	Std. Error	Lower Bound	Upper Bound	Min	Max	F	p
Anterior X- axis	Gr Ia	6	0.25	0.10	0.04	0.14	0.36	0.14	0.42	43.17	0.0
	Gr Ib	6	0.33	0.15	0.06	0.17	0.49	0.12	0.54		
	Gr IIa	6	0.97	0.09	0.04	0.87	1.07	0.84	1.11		
	Gr IIb	6	0.91	0.18	0.07	0.72	1.10	0.65	1.17		
Poste-rior X-axis	Gr Ia	6	0.68	0.11	0.04	0.15	0.38	0.14	0.42	37.0	0.0
	Gr Ib	6	0.71	0.23	0.09	0.47	0.95	0.45	1		
	Gr IIa	6	1.28	0.19	0.08	1.07	1.48	1.10	1.64		
	Gr IIb	6	1.19	0.07	0.03	1.11	1.26	1.11	1.3		
Right Y axis	Gr Ia	6	0.31	0.13	0.05	0.17	0.44	0.14	0.42	37.31	0.0
	Gr Ib	6	0.46	0.16	0.06	0.29	0.63	0.24	0.67		
	Gr IIa	6	0.86	0.23	0.09	0.62	1.11	0.53	1.12		
	Gr IIb	6	1.06	0.18	0.07	0.86	1.25	0.87	1.3		
Left Y axis	Gr Ia	6	0.31	0.12	0.05	0.18	0.44	0.12	0.45	20.92	0.0
	Gr Ib	6	0.41	0.25	0.10	0.44	0.97	0.42	1.04		
	Gr IIa	6	0.80	0.27	0.11	0.52	1.08	0.53	1.12		
	Gr IIb	6	0.91	0.09	0.03	0.82	1.00	0.82	1.05		

N=No. of samples

Gr Ia=P.E&G.C Pattern Resin, Gr Ib=P.E &Pro-Temp

Gr IIa=PVS&G.C Pattern Resin, Gr IIb=PVS &Pro-Temp

3-dimensional position was adjusted so that the horizontal reference plane of the profile projector coincided with the plane connecting the highest points located at the periphery of the 2 implants.

The following measurements were evaluated on the reference model and the definitive cast replicas: posterior x-axis (1 and 4); and anterior x-axis (2 and 3), left y-axis (1 and 2) and right y-axis (3 and 4) (Fig-8).

Data were analyzed with 2-way analysis of variance (ANOVA) followed by Post hoc tukey

Results

In the present study there were a total number of 36 test samples, divided into 2 groups and 4 subgroups of 6 sample each.

From this table it appears that for all measurements, a significant variation exists in the magnitude of deviations created by the different combinations of splinting with impression materials. The interaction between the combination Gr Ia produced the minimum variation mean (0.25±0,10) and maximum deviation with Gr IIa (0.97±0.09) combination. The deviation obtained with Gr Ib (0.33±15) is closer to Gr Ia (0.33±45). Gr IIa (0.97±0.09) is closer to Gr IIb (0.91±0.18). Inter group comparison of maximum values of variations in anterior x- axis obtained with all these groups appeared to be highly significant. This was evaluated with one way

Fig :1 Custom trays for open impression technique


Fig: 2 Mandibular model with dental floss

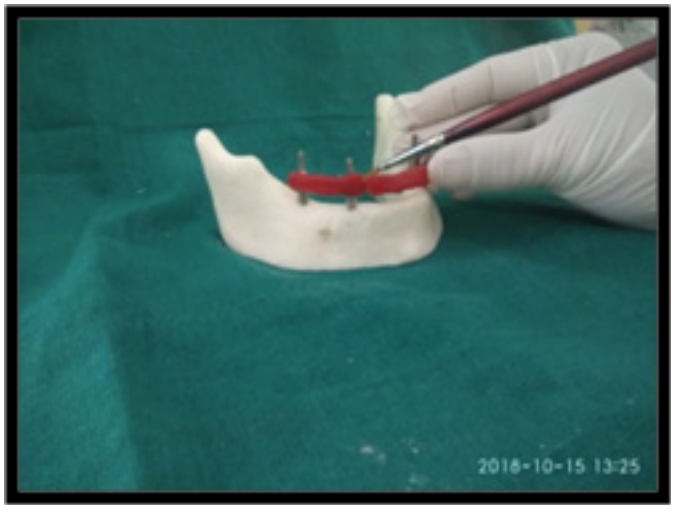


Fig:3 Splinting done with G.C pattern resin

ANOVA results appeared to be highly significant ($F=43.17$, $p \leq 0.00$)

A multiple comparison followed by post hoc Tukey's test was performed to assess the extent of variation made by different combinations in different measurements revealed that subgroups comprising of Gr Ia and Gr Ib showed significantly less variations ($p \leq 0.00$) as compared to Gr IIa and Gr IIb. The results are presented in table 5.

Discussion

In Implant Prosthodontics, a successful result can be achieved only when passively fitting prostheses are fabricated. A passively fitting prosthesis is a precondition for the maintenance of osseointegration, and its use is dependent upon the fact that the bone-implant interface allows limited movement of 10 mm; therefore, it is unlike natural teeth, which are cushioned in alveoli by periodontal fibers[3]. The impression must be accurate to obtain the resulting master cast which precisely duplicates the clinical situation. The accuracy of the implant cast depends on many factors; the type of impression material, implant impression technique, the implant angulation, the die material accuracy, and the master cast.[7]

Most research indicates that direct techniques produce less distortion than indirect techniques[11]. Polyether and poly vinyl siloxane impression materials were used in present study as they are known to provide superior reproduction in comparision with other impression materials in accordance with study carried by Sorrentio, Alikhasi and Martin-Rus[8,9,10]. Because splinting

Fig :4 Splinting done with Pro- temp

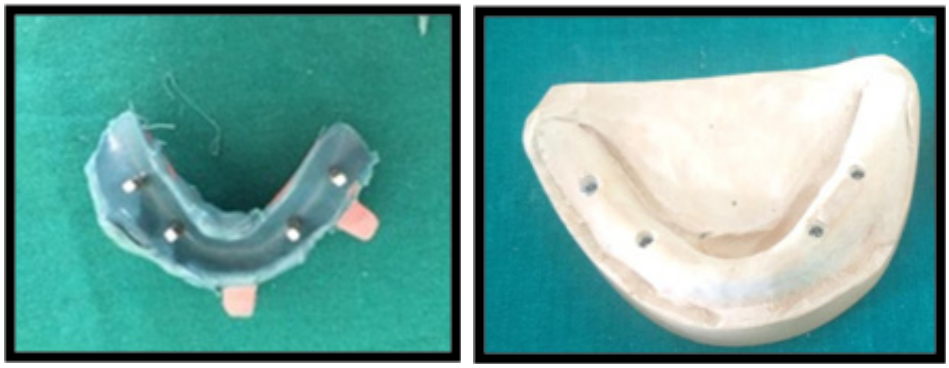

Fig :5 Impression and cast made with Poly Ether

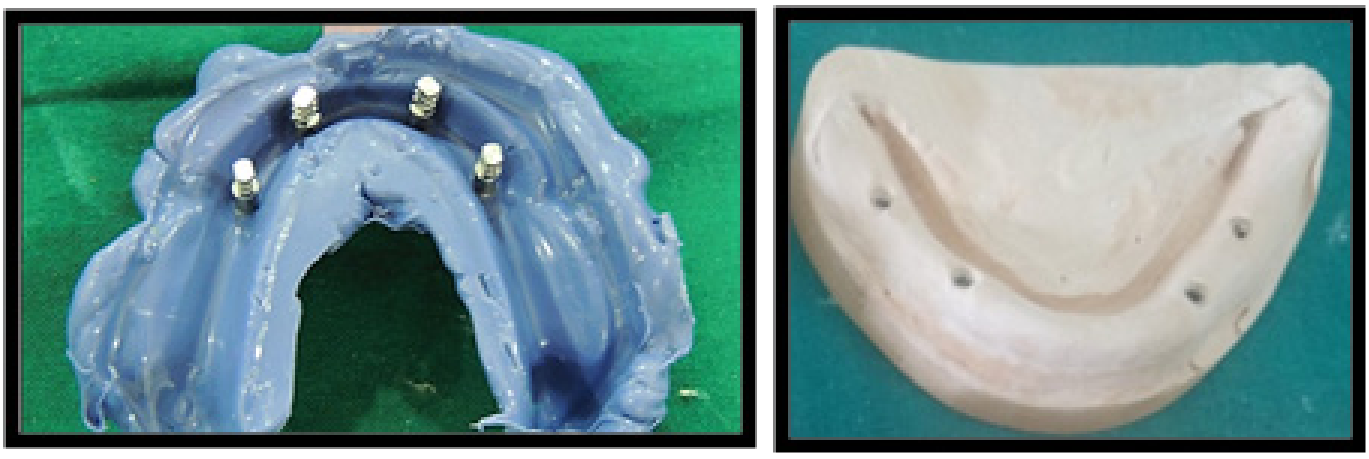

Fig: 6 Impression and cast made with poly vinyl siloxane

with acrylic resin has yielded conflicting results. This is an attempt made to evaluate the reliability of bis-GMA (Pro-temp 4), and GC pattern resin as splinting material. Polyether and poly vinyl siloxane has been advocated as an impression material for multiple implant -supported prosthesis for edentulous patients. Both of these were used as the impression materials. The overall accuracy of the impression depends on deviation in the X and Y axis. One of the drawbacks of direct impression technique is rotation of impression copings in the impression during fastening of the implant analog. In X and Y axis both the Groups I and Group II exhibits no differences with the reference model. Possible limitations of the present study design were that the measured distortion did not completely evaluate the actual three –dimensional distortion of the impressions. Only the linear discrepancies in two planes were evaluated and angular axis discrepancies were not included in the study. Under clinical conditions these differences may vary if the discrepancies are present in other spatial planes .Thus, such discrepancies may clinically result in a improper fit of the prosthesis. However the results may vary in clinical situations, therefore further clinical studies may be required to evaluate and rectify the problem in more depth considering the limitation of previous and our present study to achieve some other methods for the clinical applications.

Only two combinations of impression materials were included in the study. Further studies may be conducted using different combinations as well.

Conclusion

The surgical and prosthetic procedures for the placement of implant fixtures require a strict protocol to ensure osseointegration. Prosthesis should have a passive fit; an implant protected occlusion and made of a material which is biocompatible. An accurate impression that will ensure correct three-dimensional spatial orientation of the implant hex is of paramount importance to achieve prosthetic success. This study was conducted to compare the implant cast accuracy of multiple implants made with different splinting and impression materials. The following conclusions were arrived within the limitations of this in vitro study:

- In the direct technique, out of the two impression materials used for making samples control group, polyether showed better results.
- Splinting provided more accuracy of transfer in multiple abutments using both the impression materials included in the study.
- Both splinting materials showed comparable amount of deviation from the reference model.

Fig:8 Measurements done in different axis

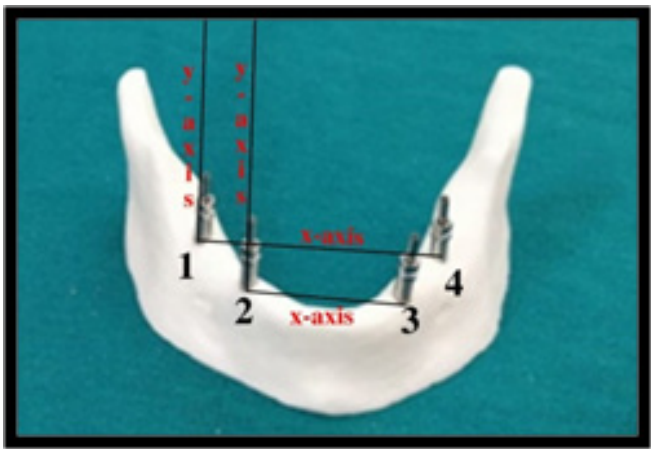

Fig:7 Profile Projector

- As both the splinting material exhibited almost similar accuracy in impression, any one of the material based on the ease of handling, time consumption, technique sensitivity and availability can be chosen.

Possible limitations of the present study design were that the measured distortion did not completely evaluate the actual three –dimensional distortion of the impressions. Only the linear discrepancies in two planes were evaluated and angular axis discrepancies were not included in the study. Under clinical conditions these differences may vary if the discrepancies are present in other spatial planes. Therefore further clinical studies may be required to evaluate and rectify the problem in more depth. Only two combinations of impression and splinting materials were included in the study. Further studies may be conducted using other combinations of impression and splinting materials as well.

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