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EVALUATION OF THE DIMENSIONAL ACCURACY OF ANGULATED IMPLANTS USING TWO DIFFERENT SPLINTING MATERIALS.

Dental Science

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KEYWORDS

INTRODUCTION

An accurate master cast is a pre requisite in thefabrication of a passive prosthesis. Accuracy of the master cast is criticaland dependent on the clinical and laboratory variables intrinsic to restorative treatment,such as the type of impression material and technique. The success of implant prosthesistherefore depends directly on the accuracy ofthe impression, in order to obtain the originalposition of the implants in the master cast.[1]

Accurate multi-unit implant impression making is a challenging procedure in implant dentistry due to several reasons. The first and foremost is the complexity surrounding theattainment of passive fit of the implant prosthesis, which is directly related to the accuratethree dimensional transfer of the implant positions to the working cast.

Other challengingfactors are impression technique, impression materials, splinting materials and techniques, implant angulations and implant depth. Implant related studies are furthercompounded due to various combinations of implant systems, prosthetic components,impression material, splinting material, accuracy evaluation methods, distortion types(absolute or relative), connection levels (implant level or abutment level impressions),and techniques employed by different studies.

The passive fit of the prosthesis is an advantageous factor for the long term serviceability ofthe restorations. Hence an accurate impression is of paramount importance.Traditionally, there are two different implant impression techniques for transferring theimpression copings from the implant to the impressions. The open tray pick-up techniqueis more precise and predictable than the closed tray technique using repositionablecopings.[2]

The splinting technique has gained popularity with consistent results of higher accuracyas compared to non-splinting technique. Different materials frequently used for splintingare auto polymerizing resin, light cured resin and pattern resin. Each technique and material has its own advantages and disadvantages.

A rigid elastomeric impression material would secure impressioncopings accurately and should have good dimensional stability, and high primary shearresistance with little creep under compressive forces, making it an optimal material formaking implant impressions.VinylPolysiloxaneEthercombining features of both additional silicon and polyether have advantages ofhydrophilicity without surfactants, easier handling and high tear strength. This elastomeric impression material is favourable for implant impressions with goodaccuracy.

With appropriate material and manipulation techniques, accurate impressions canbe obtained for fabrication of implant supported restorations.Variable such as implant angulations, impression material, impression technique andsplinting materials play a major role in the accuracy of an implant impression.

Hence, the purpose of this study is to analyze the effect of implant angulations andsplinting material using VPSE impression material on the accuracy of the casts.

MATERIALS AND METHODS

MASTER MODEL PREPARATION

Three metal matrices of anodized aluminium measuring 3.5 cm in length, 2 cm in breadth and 2 cm in height were fabricated. Two implant analogues (3.75mm X 10mm) were positioned in each metal matrix with an angle of 00, 50, and 150 angles with reference to the vertical axis at a distance of 25 mm.

GROUP I – Two implant analogues with 00 angulations.
GROUP II – Two implant analogues with 50 angulations.
GROUP III –Two implant analogues with 150 angulations.

Each implant analogue was fixed using autopolymerising resin. The midpoint of each implant analogue is considered as a reference point. This reference point is represented by two vertical lines created along the surface of the metal matrix. These lines were established to carry out the measurements through the angular dimension toolbar of coordinate measuring machine. These metal matrices were used as master models for control group.

OPEN TRAY PREPARATION

30 open custom impression trays with winged handles were fabricated. Spacers were prepared of 2mm thickness using modellingwax. The fit of the tray was evaluated and trimming was followed by polishing. Vinylpolysiloxanether elastomeric impression material was used to obtain a master cast.

IMPRESSION PROCEDURE

Square impression transfer copings were secured with flat head screw on the implant analogues using hex driver. The copings were stabilized with 4 complete loops of dental floss and splinted. 30 pairs of square impression transfer copings were splinted with pattern resinand auto polymerizing resin respectively.

GROUP I – 00 implant analogues A – Splinted with pattern resin
B – Splinted with autopolymerizing resin
GROUP II – 50 implant analogues A – Splinted with pattern resin
B – Splinted with autopolymerizing resin
GROUP III – 150 implant analogues A – Splinted with pattern resin
B – Splinted with autopolymerizing resin

Acrylic resin was used to camouflage the four loops of dental floss and square impression transfer copings using an incremental application technique with a brush. Square impression transfer copings were coated with vinylpolysiloxanether tray adhesive of impression material. Tray adhesive was applied to the custom trays and allowed to set for 15 minutes. Vinyl polysiloxanether was auto mixed in PentaMixTM to standardize all impression mixtures. Impression material was loaded on the tray and seated over the master models. The impression material was allowed to polymerize for 10 minutes prior to separation and transfer copings were unscrewed. All the impressions were removed at right angle to the plane of the matrix and checked for accuracy. Inaccuracies such as void, drag or non-homogeneous mix of material if detected, then the impressions were repeated. Thirty accurate impression were thus obtained. Special care was taken to ensure that all components were properly oriented and completely seated. The implant analogues were connected to their corresponding square transfer impression copings.

SPECIMEN FABRICATION

100gms of Type IV dental stone was mixed with 22ml of water and the impressions were poured. Casts were separated from the impression after one hour after the stone sets, followed by trimming and labelling of all cast specimens. All the casts specimens were stored at room temperature (230C – 250C) and 50% relative humidity for minimum of 24 hours prior to the measurements.

MEASUREMENTS

A coordinate measuring machine was used to evaluate the positional accuracy of the specimens. The machine probe having a diameter of 0.8mm moved within its limit in the space and measured the relative distances of the objects. The measurement accuracy of the instrument was 0.001mm for X, Y and Z- axis. The centre of each implant analogue was determined as reference point, the planer surface from this point was regarded X axis or horizontal axis. The imaginary Y axis or vertical axis was considered between the centres of implant analogues. The Z axis was perpendicular to XY plane. Coordinate measuring machine measured Cartesian Coordinates X coordinate; Y coordinate and Z coordinate with respect to determined reference axes, for each analogue in the master models as well as the cast specimens. In order to find the distance between each pair of analogues, the difference between their coordinate values in each dimension were computed. Thus, the distance values ($d = \Delta x2+\Delta y2+\Delta z2$) were measured on the master models as well as the cast specimens.

RESULTS

Table 1 shows comparison of the dimensional accuracy in terms of {Mean (SD)} for pattern resin at different angulations using ANOVA test at 3 different angulations i.e. 00, 50 and 150. There was statistically significant difference observed (< 0.001) compared to 150 to other angulations using, Tukey's post hoc analysis.

Table 2 shows comparison of the dimensional accuracy in terms of {Mean (SD)} for auto polymerizing resin at different angulations using ANOVA test at 3 different angulations i.e 00, 50 and 150. There was statistically significant difference observed (< 0.01between the groups using, Tukey's post hoc analysis.(p< 0.05 - Significant*, p < 0.001 - Highly significant**)

Table 3 shows comparison of the dimensional accuracy in terms of {Mean (SD)} for both the groups at different angulations using unpaired t test. There is statistical significant difference between group A and B for all the angulations suggesting group A having better mean values to group B.

GRAPHS

(Intragroup)

Figures 1: Comparison of the dimensional accuracy in terms of {Mean (SD)} for pattern resin at different angulations using ANOVA test

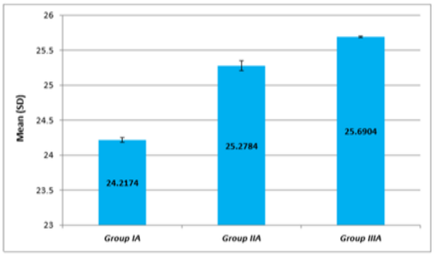
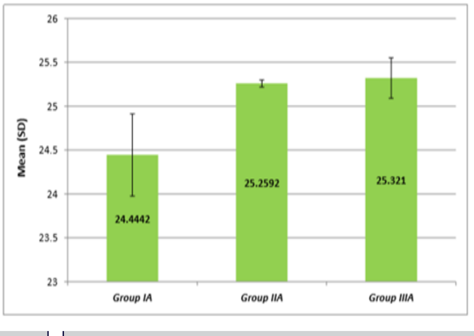


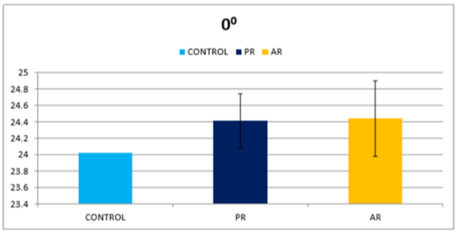
Figure 2: Comparison of the dimensional accuracy in terms of {Mean (SD)} for auto polymerizing resin at different angulations using ANOVA test



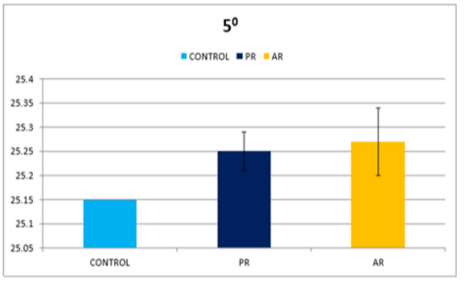
(Intergroup)

Figure 3: Comparison of the dimensional accuracy in terms of {Mean (SD)} for both the groups at different angulations using unpaired t test

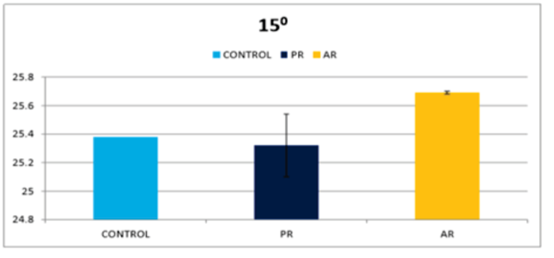
0 degrees



5 degrees



15 degrees



DISCUSSION

In Implant prosthodontics, passive fit is one of the major concern, as it is assumed that misfit of prostheses negatively impact the long term success of implants. The absenceof passive fit may lead to prosthetic failures such as fracture and/or loosening of screws,and retention of bio film caused by poorly fitting components. An impression thatprecisely records the exact 3-dimensional positions of implants is paramount in order toachieve a passively fitting prosthesis. Therefore, comparative accuracy of impressiontechniques and materials become an important issue in the consideration of passive fit.

The first step in fabricating a precise dental implant supported restoration is making anaccurate impression. The accuracy of an ideal impression depends on dimensionalaccuracy and detail reproduction for achieving the above factors. Despite technicalimprovements in the field of 3-dimensional imaging procedures, the convention alimpression procedure plays a major role in transferring information from the patient to the dental laboratory.

Splinting of impression copings is an essential pre-requisite. The underlying principle was toconnect all the impression copings together using a rigid material to prevent individualcoping movement during the impression making procedure. The common practice of joining the direct transfer copings with acrylic resin is an attempt to stabilize the copings against rotation during fixtures or abutment analog fastening, and to control the relationship between implants in a rigid fashion.[37]

Lee et al, evaluated the accuracy of the casts by using different splinting materials. Different materials were autopolymerizing resin, impression plaster and VPS bite registration paste. It has been reported that total shrinkage of acrylic resin is between 6.5% and 7.9% in the first 24 hours, with 80% of shrinkage occurring in the first 17 minutes after mixing. Minimum distortions were found with autopolymerising resin using as splinting material. Adequate polymerization time and process of compensation seemed like the reason of best accuracy.[18]

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Carr et al compared the open and closed tray techniques with a 5 implant mandibularcast where the interimplant divergence angles were all less than 15^0. The open tray technique when used with custom trays was found to be superior as it provided the mostaccurate working casts.

The distortion of an impression is a concern inherent, in a three dimensional way, in allof the procedures involved in implant restorations. It can be regarded as absolute or relative, depending on the point of reference from which it is measured; absolutedistortion is considered when the point of reference is external, whereas relativedistortion is measured from a point that is located internal to system.

In the present study, the relative distortion was considered as a study parameter, since the resultant translational distance was measured from one analogue to another. This kind of measurement can be considered clinically more relevant than the absolute distortion, as implant supported prosthesis usually connects all components to one another.

Hence, this study used a very precise 3 dimensional measuring device, the coordinate measuring machine for recording possible implant replica displacement in 3 axes, which are more clinically relevant and easier to comprehend.

In the present study, the mean value for the master model was 24.0mm where as the mean value of master specimen obtained from splinting with pattern resin was 24.2mm and with autopolymerizing resin was 24.4mm. This significant difference suggests that the splinted technique resulted in more accurate master specimens when multiple implants of 00 angulations were used for implant prosthesis. Siadet et al, presented that straight implants showed less linear and rotational discrepancy when compared with angulated ones using square impression copings at implant or abutment level.[41]

The results of this study for 5^0 and 15^0 show significant difference between mean values of master specimens obtained from pattern resin and autoploymerizingresin,however mean values of the master specimens obtained using pattern resin were lesser when compared toautopolymerizing resin indicating better accuracy.

Yilmaz et al, in his study, stated that angular and coronal deviations increased with the increase in angulation of implants for all impression materials. In 10^0 to 20^0 angulated implants, significantly low deviations were detected in splinted direct technique.[27]

Cerquiera et al, concluded in his study by suggesting that when one-piece splinting method were used, acrylic resin produced high microstrains, instead pattern resin did not significantly affect the microstrain produced. Thus, pattern resin splinting method increases the precision of the working casts when used with one-piece splinting.[23]

Vinylpolysiloxanether,a new impression material commercially introduced in 2009, the composition of which is intended to incorporate the natural hydrophilicity of conventional polyether materials along with the desirable properties of vinylpolysiloxane materials, such as elastic recovery and tear resistance. To further improve the wetting characteristics and flow ability, a surface tension eraser (STFS) and wetting conditioner surfactant (WCS) have also been incorporated into the VPSE. Thomas et al, concluded that VPSE demonstrated acceptable accuracy for clinical use with immersion disinfection, compared to PE and VPS.

Nassar et al evaluated that casts produced from disinfected VPSE demonstrated excellent dimensional stability at different pour times and were comparable to the tested vinylpolysiloxane and polyether impression material.[32]

The different properties of VPSE which makes it a suitable material for implant impression are (1). Intrinsic hydrophilicity without surfactants, (2).Better handling like VPS and detail reproduction of PE, (3). high tear strength with flexibility to get in and out of tight places under unpredictable conditions, (4). predictableflow, minimizes voids and bubbles and (5). Mild, minty tastes.[33]

Hence VPSE was used to evaluate and compare the effect of implant angulations, splinting material and impression material on the accuracy of the casts.

CONCLUSION

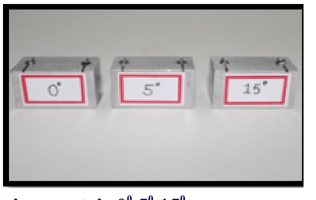
1. The combined effect of impression material, impression technique, implantangulations and splinting materials had effect on the accuracy of the duplicatecasts compared to the definitive casts ($p=0.001$).

2. Based on the results obtained, casts with 0^0 implants have lesser mean valuediscrepancies when compared to 5^0 and 15^0 implants. The lesser the angulations ofthe implants, the more accurate is the impression.

3. Regardless of implant inclination, casts retrieved from pattern resin splinting werestatistically more accurate than casts obtained from autopolymerizing resinsplinting.

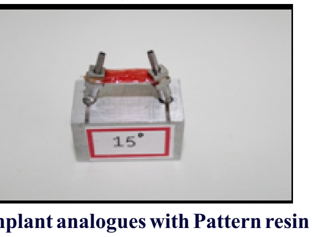
IMAGES

Vinyl polysiloxanether impression material



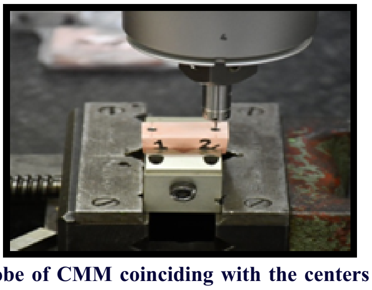
Anodized aluminium matrix 0^0,5^0,15^0

Anodized aluminium matrix 0^0,5^0,15^0



Splinting of 15^0implant analogues with Pattern resin

Splinting of 15^0implant analogues with Autopolymerizing resin.



Machine probe of CMM coinciding with the centers of implant analogues in cast specimens

TABLES

TABLE 1 : Comparison of the dimensional accuracy in terms of {Mean (SD)} for pattern resin at different angulations using ANOVA test

Group	Control values	N	Mean	Std. Deviation	P value
Group IA	24.023	5	24.2174	0.033088	<0.001**
Group IIA	25.15	5	25.2592	0.04029	
Group IIIA	25.383	5	25.3210	0.22952	
Total		15	25.0081	0.49895	

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)

Tukey's post hoc analysis

	Group IA	Group IIA	Group IIIA
Group IA	-	0.003*	0.002*
Group IIA	0.003*	-	0.944
Group IIIA	0.002*	0.944	-

TABLE 2 : Comparison of the dimensional accuracy in terms of {Mean (SD)} for auto polymerizing resin at different angulations using ANOVA test

Groups	Control values	N	Mean	Std. Deviation	P value
Group IB	24.023	5	24.2174	0.46729	<0.001**
Group IIB	25.15	5	25.2784	0.07176	
Group IIIB	25.383	5	25.6904	0.01266	
Total		15	25.0620	0.64370	

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)

(Tukey's post hoc analysis)

	Group IB	Group IIB	Group IIIB
Group IB	-	<0.001**	<0.001**
Group IIB	<0.001**	-	<0.001**
Group IIIB	<0.001**	<0.001**	-

TABLE 3 : Comparison of the dimensional accuracy in terms of {Mean (SD)} for both the groups at different angulations using unpaired t test

Angulations	Control values	Group	N	Mean	Std. Deviation	t value	P value
0 degrees	24.023	Group A	5	24.2174	0.033088	1.083	0.311
	24.023	Group B	5	24.4442	0.467291		
5 degrees	25.15	Group A	5	25.2592	0.040295	0.522	0.616
	25.15	Group B	5	25.2784	0.071769		
15 degrees	25.383	Group A	5	25.3210	0.229523	3.593	0.007*
	25.383	Group B	5	25.6904	0.012661		

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