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Evaluation Of Dimensional Accuracy Of The Implant Impression In Angled Implant With Varying Subgingival Depth" - An In Vitro Study

Research Article

Aashritha Shenava[1*], Piyusha Shankar[2], Chethan Hegde[3]

[1] Reader, Department of Prosthodontics, AB Shetty Memorial Institute of Dental Sciences, Nitte University. Deralakatte, India.
[2] Consultant Prosthodontist, Ceramco Dental Care, Andheri West, Mumbai, India.
[3] Head of the Department, Department of Prosthodontics, AB Shetty Memorial Institute of Dental Sciences, Nitte University. Deralakatte, India.

Abstract

Background: Prosthesis misfit can cause both mechanical as well as biologic complications because of the ankylotic nature of the implant osseointegration. Complications may include screw fracture, screw loosening, failure of osseointegration and marginal discrepancy leading to plaque accumulation. The key to a passive fit is to make accurate impressions.
Objective: Was to evaluate the dimensional accuracy of the implant impression in angled implant with varying subgingival depth. The study compared two different impression techniques i.e. open tray without splinting the impression copings and open tray with splinting the impression copings with a self-curing acrylic resin.
Material and Methods: An aluminium model with three implants was fabricated. Central implant was perpendicular and the two lateral implants were 100 and 200 angulated. The vertical positions were different among the thee implants (3.65mm, 2.145mm 1.24mm). Twenty impressions were made using two impression techniques: a) open tray with splinting the impression copings with self-curing acrylic resin b) open tray without splinting. A coordinate measurement machine was used to measure the depth and the inter-implant distance.
Results: There was a statistically significant difference in splinted and non-splinted groups from the original model ($P<0.05$). The splinting method of impression has lesser distortion values than the non-splinted one. Student's t test showed that the difference between the splinted and non-splinted groups was not statistically significant. ($P>0.05$).
Conclusion: The best method when impressions of multiple implants with different angulations and subgingival depths are to be made, splinting the impression copings with a self-curing resin would result in improved accuracy.

Keywords: Implant Impression; Splinting Impression Copings; Impression Accuracy; Implant Angulations; Implant Subgingival Depths.

Introduction

The long lifespan of osseointegrated implants is a leading cause for its popularity among dentists as well as patients and hence finds frequent use in the rehabilitation of partially and completely edentulous patients.

As implants do not possess the mobility that natural teeth do, during the construction of the framework on osseointegrated dental implants, the main concern should be to achieve an accurate and passive fit on the abutments. Failure to achieve these criteria can lead to generation of stresses which might result in implant integration failure [1].

Prosthesis misfit can cause both mechanical as well as biologic complications because of the ankylotic nature of the implant osseointegration. Complications may include screw fracture,screw loosening, failure of osseointegration and marginal discrepancy leading to plaque accumulation [2].

In implant dentistry, with regards to tray selection, closed tray and open tray have been widely cited in the literature also the materials often used are polyvinylsiloxane and polyether [3, 4].

Majority of studies have investigated the accuracy of impressions

***Corresponding Author**:
Dr. Aashritha Shenava,
Reader, Department of Prosthodontics, AB Shetty Memorial Institute of Dental Sciences, Nitte University. Deralakatte, India.
E-mail: draashrithashenava@nitte.edu.in

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using parallel implants and equal subgingival depths (ideal clinical situations). However, anatomical limitations or aesthetic considerations may preclude the placement of parallel implants.

A few studies have separately evaluated the impression accuracy based on non-parallel implants and different subgingival depths. However, there are many clinical situations (bone availability/aesthetic considerations) which necessitate the placement of non-parallel implants at unequal subgingival depths in such situation chances of distortion of the impression increases while removing the impression.There is a lack of comprehensive literature which evaluates the impression accuracy insuch clinical situations. Therefore, the aim of the study isto evaluate the dimensional accuracy of the implant impression in angled implant with varying subgingival depth.

Material and Method

Fabrication of master model: An aluminium model, 7cm in diameter and 3cm in height was fabricated (Hebich technical training institute). three Implants (Adin dental implant system) with internal hex connection was embedded in the master model at positions A, B and C. (figure 1)

Central implant was perpendicular to the top surface of the master model and the two lateral implants were 100 and 200 angulated to their long axes. The distance between the implants A and B was 33.451mm and the distance between the implants B and C was 32.524mm.

The vertical positions were different among the three implants. Implant A was 3.625mm deep, implant B was 2.145mm deep and implant C was 1.24mm deep from the top surface of the metal model. A semi-circular ledge was created all around the metal model for orienting the tray in the same position.

Fabrication of the open tray and its standardization

Three open tray impression posts were tightened to the implants. All the three metal posts were connected together with self-curing low shrinkage acrylic resin (GC America, Pattern Resin LS). Two layers of base plate wax (Hindustan modelling wax No. 2) was adapted over the metal model which was used as a spacer for fabricating a stainless steel perforated open tray .Three windows were created in the tray at the site of the implants for the pick-up impression and two horizontal handles were made for easy removal of the impressions.

Impression Procedure

In this study, there were two experimental groups and one control group.

Group 1: Consists of ten duplicated casts made with open tray impression technique without splinting the impression posts together. Each cast consists of three implant analogues.

Group 2: Consists of ten duplicated casts made with open tray impression technique with splinting the three impression posts together with self-curing acrylic resin.

Control Group: Consists of a metal model with three implants.

Polyvinyl Siloxane impression materials (Dentsply Aquasil Soft Putty Regular Set, Dentsply Aquasil Ultra LV Light Body) were selected for the impression procedure.

Impression technique for Group 1

Three open tray impression posts were secured on the implants using torque wrench calibrated at 10Ncm. Polyvinyl Siloxane (putty) was hand mixed and loaded on the tray, whereas Polyvinyl Siloxane (Light Body) was auto mixed and injected around the implants and the impression posts. Before the impressions were made tray was coated with tray adhesive and was allowed to dry for 15 minutes. Trays filled with impression material was then placed on the master modeland excess material was removed to uncover the impression posts. Impression was allowed to set after which the three impression posts were loosened using a hex-driver and the impression was removed. The impression was then visually checked. In presence of any inaccuracy, the impression was repeated. Three implant analogues were tightened to the impression posts (Figure 2). Dental Stone, High Strength (Kalrock) was mixed according to the manufacturer's instructions and casts were poured using it.

Figure 1. Metal Master Model.

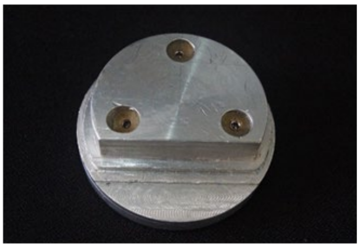
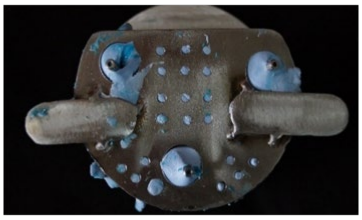


Figure 2. Open Tray method of impression making.



Impression technique for Group 2

All the steps were similar to the Group 1 impression technique except all the three impression posts were splinted using self-curing acrylic resin (GC America, Pattern Resin) before impression making (Figure 3).

A total of 20 casts with 60 implant analogues were made from the metal master model. Prior to measurement, the casts were kept at room temperature for at least 24 hours.

Measurements

CMM (coordinate measurement machine, De meet 220) was used to analyse all the 20 casts with 60 implants analogues.(Figure 4)

The machine has a fine tip probe which measures the dimensions in all the three coordinates (X, Y and Z) with an accuracy range of 0.5 microns. The measuring tip was placed at the centre of each hex implant (A, B and C) and the three Cartesian coordinates were measured. These X-Y-Z coordinates were then sent to a measuring software (Approve for De Meet), which converted these 3D data into distances between implants A-B and B-C. (Figure 5)

For the measurement of the depth, cover screws were placed on all of the three implants and from a fixed point on surface of the model to a fixed point on the cover screw of each implant, the depth was measured.

Two distances between implants three implants and individual depths values of three implants were computed on the master model as well as each duplicated cast i.e. distance AB and distance BC and depth A, B and C. Difference of the distance and the depth values between the master model and the casts gave the distortion values for the duplicated casts.

Statistical Analysis

All the data were statistically analysed by Student t- test with the help of SPSS software.

Results

The mean difference in the inter-implant distance is less in the splinted group than the non-splinted group. (Table 1).Student's t-test revealed that there is a statistically significant difference between the splinted and non-splinted groups from the original model ($P<0.05$). The mean difference in depths from the original model is less in the splinted group than the non-splinted group. (Table 2). Students' t-test revealed that there is no statistically significant difference ($P>0.05$) in Depth A among both the test groups (Splinted and Non-Splinted) from the original model. There is a statistically significant difference ($P<0.05$) in Depth B and C among both the test groups.

The mean difference in distance and depths between the Splinted and Non-Splinted groups. Student's t-test revealed that there is no statistically significant difference between the splinted and the non-splinted groups ($P>0.05$) (Table 3).

Figure 3. Implant Analogues attached to the impression copings.

Figure 4. Casts with implant analogues made from the metal master model.

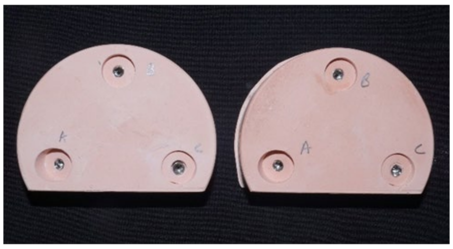


Figure 5. Measurements recorded by the Coordinate Measuring Machine.

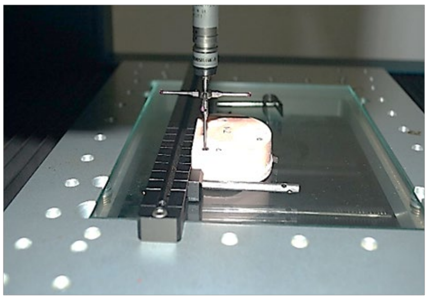


Table 1. Mean and Standard deviations of inter-implant distance and Mean dimensional change in distance among the three implants in different groups. (mm)

Groups	Distance AB	Distance BC	Diff. from the original dist. AB	Diff. from the original dist. BC	P value	P value
	Mean (S.D)	Mean (S.D)	Mean (S.D)	Mean (S.D)	Distance AB	Distance BC
Original	33.451	34.524				
splinted	33.556	34.608	0.106	0.084	0.001	0.001
	-0.64	-0.051	-0.063	-0.051		
Non-splinted	33.581	34.619	0.13	0.095	0	0
	-0.066	-0.038	-0.669	-0.038		

Table 2. Mean and Standard Deviations of Depths and Mean dimensional change in Depth among different implants. (mm)

Groups	Depth A	Depth B	Depth C	Diff. from original Depth A	Diff. from original Depth B	Diff. from original Depth C	P Values		
	Mean (S.D)	Mean (S.D.)	Mean (S.D.)	Mean (S.D)	Mean (S.D)	Mean (S.D)	Depth A	Depth B	Depth C
Original	3.625	2.413	1.234						
Splinted	3.658	2.492	1.299	0.033	0.079	0.066	0.269	0.014	0.021
	(0.089)	(0.082)	(0.074)	(0.06)	(0.075)	(0.074)			
Non-Splinted	3.665	2.534	1.332	0.039	0.122	0.098	0.312	0.001	0.038
	(0.117)	(0.085)	(0.128)	(0.057)	(0.081)	(0.128)			

Table 3. Mean Difference between the Splinted and Non-Splinted groups (mm).

	Difference in Distance AB	Difference in Distance BC	Difference in Depth A	Difference in Depth B	Difference in Depth C
Mean Difference (mm)	0.025	0.011	0.006	0.043	0.033
P Value	0.407	0.607	0.888	0.265	0.495

Discussion

The present study evaluated the accuracy of the implant impressions in angled implants with varying subgingival depth. The impressions were made in an open tray using polyvinyl siloxane with and without splinting the impressions coping.

Polyvinyl siloxane was selected as the impression material of choice among the most used impression materials for implant impression i.e. polyvinyl siloxane (PVS) and polyether. Various studies have shown, in situations where implants are placed deep subgingivally or are non-parallel polyvinyl siloxane is a better choice because of a greater modulus of elasticity [5].

Pick up impression technique was used for this study, Lee et al showed that pick up impression technique is better than the transfer technique, especially in cases with four or more implants as one of the main drawbacks of the transfer technique is that the copings may not return to the original position when reattaching, and this could lead to the generation of errors [6-9].

The results correspond to the available literature by Stimmelmayr et al where the angulation of the implants to each other the systematic error of extra-oral optical measurement systems for scanning stone casts to be 20 µm or less..In the present study, all the distortions in both the splinted and non-splinted groups were within the machining tolerance of the implants i.e. 22um to 100um. The machining tolerance is the horizontal shift in the positions of the different components of the implants when they are screwed together. Distortion values within the range of the machining tolerance of the implants may indicate a passive fit of the prosthesis [10-13].

Assif et has stated that the task is to create as accurate a fit as is clinically possible to avoid the accumulation of stresses and strains that will result in uncontrolled implant loading through the superstructure. The splinted impression technique has been shown to be a primary factor in increasing the fitting precision of the restorative complex [14, 15]. In this study, the distortion values in the splinted groups were lesser than the non-splinted groups. The splint technique uses a rigid material most popularly acrylic resin to connect all the copings together to prevent its movement during impression making. Other materials most commonly employed for splinting are dual-cure acrylic resin, impression plaster, orthodontic wire, prefabricated acrylic resin bars light-curing composite resinand carbon-steel pins. Measures were taken to minimize the distortion of acrylic resin, the splint connection was cut, leaving a small gap in between which was later re-joined using minimal amount of the same material [16-18].

Direct impression technique without splinting the copings together may lead to rotation of the copings when the analogues tightened to the copings.Required time for making an impression with splinting method may be longer than non-splinting method, however splinting the copings together with a rigid material has been advised to avoid the rotation of the copings during the attachment of the analogue and increasing the accuracy of the impression. Papaspyridakos et al have mentioned the precise fit of the implant depends on the accuracy at which the cast is made which in turn depends on the impression of the implant which is in par which the present study [19-25].

Limitations of this study: The rotation of the impression copings around their long axis, if any, has not been evaluated in this study and should be evaluated in the future studies.

Clinical Significance

Splinting the impression copings with a self-curing resin would result in improved accuracy in clinical situations where implants are placed subgingivally with different angulations.

Conclusion

Within the limitation of the study the splinting method of impression making has lesser distortion values than the non-splinted one, although the difference between the splinted and non-splinted groups are not statistically significant.

References

[1]. Herbst D, Nel JC, Driessen CH, Becker PJ. Evaluation of impression accuracy for osseointegrated implant supported superstructures. J Prosthet Dent. 2000 May;83(5):555-61.Pubmed PMID: 10793388.

[2]. Lee H, Ercoli C, Funkenbusch PD, Feng C. Effect of subgingival depth of implant placement on the dimensional accuracy of the implant impression: an in vitro study. J Prosthet Dent. 2008 Feb;99(2):107-13.Pubmed PMID: 18262011.

[3]. Vojdani M, Torabi K, Ansarifard E. Accuracy of different impression materials in parallel and nonparallel implants. Dent Res J. 2015 Jul;12(4):315.

[4]. Balouch F, Jalalian E, Nikkheslat M, Ghavamian R, Toopchi Sh, Jallalian F, et al. Comparison of Dimensional Accuracy between Open-Tray and Closed-Tray Implant Impression Technique in 15° Angled Implants. J Dent (Shiraz). 2013 Sep;14(3):96-102.Pubmed PMID: 24724130.

[5]. Liou AD, Nicholls JI, Yuodelis RA, Brudvik JS. Accuracy of replacing three tapered transfer impression copings in two elastomeric impression materials. Int J Prosthodont. 1993 Jul-Aug;6(4):377-83.Pubmed PMID: 8240649.

[6]. Assif D, Fenton A, Zarb G, Schmitt A. Comparative accuracy of implant impression procedures. Int J Periodontics Restorative. 1992 Apr 1;12(2).

[7]. Carr AB. Comparison of impression techniques for a five-implant mandibular model. Int J Oral Maxillofac Implants. 1991 Winter;6(4):448-55.Pubmed PMID: 1820314.

[8]. Lee H, So JS, Hochstedler JL, Ercoli C. The accuracy of implant impressions: a systematic review. J Prosthet Dent. 2008 Oct 1;100(4):285-91.

[9]. Daoudi MF, Setchell DJ, Searson LJ. A laboratory investigation of the accuracy of the repositioning impression coping technique at the implant level for single-tooth implants. Eur J Prosthodont Restor Dent. 2003 Mar;11(1):23-8.Pubmed PMID: 12705035.

[10]. Stimmelmayr M, Erdelt K, Güth JF, Happe A, Beuer F. Evaluation of impression accuracy for a four-implant mandibular model--a digital approach. Clin Oral Investig. 2012 Aug;16(4):1137-42.Pubmed PMID: 22009182.

[11]. Papaspyridakos P, Lal K, White GS, Weber HP, Gallucci GO. Effect of splinted and nonsplinted impression techniques on the accuracy of fit of fixed implant prostheses in edentulous patients: a comparative study. Int J Oral Maxillofac Implants. 2011 Nov-Dec;26(6):1267-72.Pubmed PMID: 22167432.

[12]. Assuncao WG, Filho HG, Zaniquelli O. Evaluation of transfer impressions for osseointegrated implants at various angulations. Implant Dent. 2004 Dec;13(4):358-66.Pubmed PMID: 15591998.

[13]. Ma T, Nicholls JI, Rubenstein JE. Tolerance measurements of various implant components. Int J Oral Maxillofac Implants. 1997 May 1;12(3).

[14]. Assif D, Nissan J, Varsano I, Singer A. Accuracy of implant impression splinted techniques: effect of splinting material. Int. J. Oral. Maxillofac. Implants. 1999 Nov 1;14(6):885-8.

[15]. Dumbrigue HB, Gurun DC, Javid NS. Prefabricated acrylic resin bars for splinting implant transfer copings. J Prosthet Dent. 2000 Jul;84(1):108-10. Pubmed PMID: 10898848.

[16]. Assunção WG, Tabata LF, Cardoso A, Rocha EP, Gomes EA. Prosthetic transfer impression accuracy evaluation for osseointegrated implants. Implant Dent. 2008 Sep;17(3):248-56.Pubmed PMID: 18784525.

[17]. Naconecy MM, Teixeira ER, Shinkai RS, Frasca LC, Cervieri A. Evaluation of the accuracy of 3 transfer techniques for implant-supported prostheses with multiple abutments. Int J Oral Maxillofac Implants. 2004 Mar-Apr;19(2):192-8.Pubmed PMID: 15101589.

[18]. Inturregui JA, Aquilino SA, Ryther JS, Lund PS. Evaluation of three impression techniques for osseointegrated oral implants. J Prosthet Dent. 1993 May 1;69(5):503-9.

[19]. Burawi G, Houston F, Byrne D, Claffey N. A comparison of the dimensional accuracy of the splinted and unsplinted impression techniques for the Bone-Lock implant system. J Prosthet Dent. 1997 Jan;77(1):68-75.Pubmed PMID: 9029468.

[20]. Phillips KM. The accuracy of three implant impression techniques: A three-dimensional analysis. Int J Oral Maxillofac Implants. 1994;9:533-40.

[21]. Cabral LM, Guedes CG. Comparative analysis of 4 impression techniques for implants. Implant Dent. 2007 Jun 1;16(2):187-94.

[22]. Papaspyridakos P, Benic GI, Hogsett VL, White GS, Lal K, Gallucci GO. Accuracy of implant casts generated with splinted and non-splinted impression techniques for edentulous patients: an optical scanning study. Clin Oral Implants Res. 2012 Jun;23(6):676-681.Pubmed PMID: 21631595.

[23]. Vigolo P, Majzoub Z, Cordioli G. Evaluation of the accuracy of three techniques used for multiple implant abutment impressions. J Prosthet Dent. 2003 Feb;89(2):186-92.Pubmed PMID: 12616240.

[24]. Hariharan R, Shankar C, Rajan M, Baig MR, Azhagarasan NS. Evaluation of accuracy of multiple dental implant impressions using various splinting materials. Int. J. Oral. Maxillofac. Implants. 2010 Jan 1;25(1).

[25]. Conrad HJ, Pesun IJ, DeLong R, Hodges JS. Accuracy of two impression techniques with angulated implants. J Prosthet Dent. 2007 Jun 1;97(6):349-56.