Original Article

Accuracy of Different Implant Impression Techniques with Elastomeric Impression Materials - An *In Vitro* Study

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Abstract

Aim: The aim of the study was to compare the accuracy of three different implant impression techniques using two elastomeric impression materials. **Materials and Methods:** An epoxy resin master cast was fabricated with implants screwed in the right canine, right first molar, left canine, and left first molar regions. Impressions of this epoxy resin cast were made with polyether and polyvinyl siloxane impression material using open tray non splinted impression technique, open tray splinted impression technique and closed tray impression technique to prepare the working casts. The linear distance of the implants on the epoxy resin master cast was compared with linear inter implant analog distance on all the working casts. The data obtained were then statistically analyzed. **Results:** The mean difference from the control group with respect to the four linear measurements made was least for the open tray splinted impression technique, followed by the open tray non- splinted impression technique and maximum for the closed tray impression technique. While comparing the two impression materials polyether and polyvinyl siloxane, the results were statistically insignificant. **Conclusion:** Open tray splinted impression technique is more accurate than the open tray non-splinted and closed tray impression technique. Both polyether and polyvinyl siloxane impression materials are suited for complete-arch impressions and have comparable accuracy.

Keywords: Elastomeric, Implant, Impression, Material.

Introduction

An impression for implant prosthesis aims at accurately relating the position of the most coronal portion of the implant to other structures within the oral cavity.[1] Inaccurate impression may result in mechanical and biological complications causing prosthesis misfit and failure of the restoration. Screw loosening, screw fracture, implant fracture, and occlusal inaccuracies are mechanical complications. Biological complications include unfavorable soft and hard tissue reactions due to marginal discrepancy and increased plaque accumulation.[2]

Several variables that affect the accuracy of an implant definitive cast and fit of the prosthesis are impression technique, impression material, splinting, degree of parallelism of implants, impression type, depth of implant placement, connection level, type of impression tray, alveolar bone undercuts, die stone properties, and machining tolerance of prosthetic components.[2,3-5]

Numerous studies have focused on the accuracy of multiple-implant impressions in completely edentulous arches, and there is a number of contradictory claims in the literature regarding the accuracy of implant level impressions.

Hence, the present *in vitro* study was designed to evaluate the accuracy of polyether and polyvinyl siloxane impression material with open tray non splinted, open tray splinted, and closed tray impression technique and their relevance to the passive fit of the prosthesis.

Materials and Methods

Preparation of the master model

A dental stone mold of the edentulous maxilla was prepared. An epoxy resin and hardener (Huntsman Advanced Materials

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LLC, USA) mixture, prepared in the ratio of 10:1 by volume (as recommended by the manufacturer) was poured into the mold and was allowed to set at room temperature for 24 h. The epoxy resin cast was removed from the mold, and then finished and polished. Four holes measuring 3.5 mm × 8 mm were milled parallel to the vertical plane of the cast in the right canine, right first molar, left canine, and left first molar regions with CNC Milling machine (UME-600, Mikron). The implants (Touareg- S, Adin Dental Implant Systems Ltd, Israel) measuring 3.75 mm in diameter and 8mm in length were placed in their respective positions (Figure 1).

The linear distance of the implants on the master cast, between the right molar and right canine region, right canine and left canine region, left canine and left molar region, and left molar and right molar region was measured using a traveling microscope.

Fabrication of the custom trays

Custom trays were fabricated with light-cured acrylic resin (Plaque Photo, Willmann and Pein GmbH, Germany). The top and the underside of the trays were cured for 10 min in the light cure unit (LiWa Light, Willmann and Pein GmbH, Germany) as recommended by the manufacturer. The trays were stored for 24 h to allow for maximum polymerization shrinkage before impression making.

Impression procedure

Group I – Polyether impression material was used for making impressions.

Group II – Polyvinyl siloxane impression material was used for making impressions.

For each subgroup 30 impressions were made of the epoxy resin model.

Subgroup Ia – 30 impressions of the epoxy resin cast with implants screwed in their respective positions were made with open tray (direct) non-splinted technique. Open tray impression transfer copings were screwed in the implants on the master cast with an internal hex driver. A uniform layer of polyether tray adhesive (3M ESPE, Germany) was applied on the custom tray and allowed to dry for 15 min before making an impression. Polyether impression material (Impregum Soft, 3M ESPE, Germany) was mixed with base paste to the catalyst mixing ratio of 7:1 by volume as recommended by the manufacturer. A uniform layer was placed onto the custom tray. The tray was then seated on the master cast to make an impression. It was allowed to set for 6 min (as recommended by the manufacturer). After setting time of the polyether impression material, the screws on the open tray impression copings were loosened and the impression was removed from the master model. The implant analogs were screwed to the impression posts with an internal hex driver.

Figure 1: Epoxy resin master cast with implants placed in the right canine, right first molar, left canine and left first molar regions

All the impressions were poured with Type IV dental stone (Ultrarock, Kalabhai, India). The linear distance of the implant analogs on all the thirty casts, between the right molar and right canine region, right canine and left canine region, left canine and left molar region, and left molar and right molar region was measured using a traveling microscope.

Measurment protocol

The linear distance of the implants measured on the epoxy resin master cast was compared with linear inter implant analog distances between the right molar and right canine region, right canine and left canine region, left canine and left molar region, and left molar and right molar region on all the 180 working casts. The data thus obtained were statistically analyzed.

Observations and Results

The data thus obtained upon measurements on the working casts and epoxy resin master cast was put to statistical analysis and results were obtained using one-way ANOVA and *post hoc* test.

Table 1 compares the mean distances between the right molar and right canine in Group I and Group II. The difference was statistically significant.

Table 2 compares the mean distances between the right canine and left canine in Group I and Group II. The differences were statistically significant between subgroup Ia and subgroup Ic and also between subgroup Ib and subgroup Ic in Group I. The differences were statistically significant between subgroup IIa and IIb and between subgroup IIb and subgroup IIc in Group II.

Table 3 compares the mean distances between left canine and left molar in Group I and Group II. The differences were statistically non-significant in Group I and statistically significant between subgroup IIa and IIb and between subgroup IIb and subgroup IIc.

Discussion

The endosseous implants are functionally ankylosed through direct contact with the bone; hence, they lack the inherent

Table 1: *Post hoc* analysis for right molar – right canine in Group I and Group II

Subgroup comparison	Mean difference	Standard error	*P*-value
Ia versus Ib	0.0037	0.0016	0.084^{NS}
Ia versus Ic	0.0050	0.0016	0.013*
Ib versus Ic	0.0088	0.0016	<0.001**
IIa versus IIb	0.0056	0.0011	<0.001**
IIa versus IIc	0.0043	0.0011	0.001*
IIb versus IIc	0.0099	0.0011	<0.001**

NS: *P*>0.05; Not Significant; * *P*<0.05; Significant; **P<0.001; Highly Significant

Table 2: *Post hoc* analysis for right canine – left canine distance in Group I and Group II

Subgroup comparison	mean difference	Standard error	*P*-value
Ia versus Ib	0.0026	0.0022	0.511^{NS}
Ia versus Ic	0.0118	0.0022	<0.001**
Ib versus Ic	0.0092	0.0022	<0.001**
IIa versus IIb	0.0100	0.0017	<0.001**
IIa versus IIc	0.0006	0.0017	0.946NS
IIb versus IIc	0.0094	0.0017	<0.001**

NS: *P*>0.05; Not Significant; *P<0.05; Significant; **P<0.001; Highly Significant

Table 3: *Post hoc* analysis for left canine –left molar distance in Group I and Group II

Subgroup comparison	Mean difference	Standard error	*P*-value
Ia versus Ib	0.0001	0.0023	0.998^{NS}
Ia versus Ic	0.0056	0.0023	0.066^{NS}
Ib versus Ic	0.0058	0.0023	0.058^{NS}
IIa versus IIb	0.0089	0.0015	<0.001**
IIa versus IIc	0.0052	0.0015	0.005*
IIb versus IIc	0.0141	0.0015	<0.001**

NS: *P*>0.05; Not Significant

mobility of the periodontal ligament and cannot accommodate distortions or misfit at the implant-abutment interface.[6]

The key procedure under the control of the clinician is the implant impression. The accurate registration of the implant position is a significant factor in establishing a passive fit of the prosthesis.[7]

In the present study, the linear distance of the implants on the master cast acted as the control. The mean difference from the control group with respect to the four linear measurements made was minimum for the subgroup Ib, and, maximum for the subgroup Ic. For subgroup Ia, the mean difference from the control group was in between the values obtained for subgroup Ib and Ic. The results were statistically non-significant ($P > 0.001$) between the subgroup Ia and subgroup Ib and also between subgroup Ia and subgroup Ic. The results were statistically significant ($P < 0.001$) between the subgroup Ib and subgroup Ic, suggesting high degree of accuracy with open tray splinted impression technique, followed by open tray non splinted impression technique and least accuracy with closed tray impression technique.

The mean difference from the control group with respect to the four linear measurements made was minimum for the subgroup IIb and maximum for the subgroup IIc. For subgroup IIa, the mean difference from the control group was in between the values obtained for subgroup IIb and subgroup IIc. The results were statistically significant between the subgroup IIa and subgroup IIb, between subgroup IIa and subgroup IIc, and also between the subgroup IIb and subgroup IIc, suggesting high degree of accuracy with open tray splinted impression technique, followed by open tray non- splinted impression technique and least accuracy with closed tray impression technique.

The results are in accordance with the study conducted by Al Quran *et al*.[7] and Naconecy *et al*.[8] in which results showed the lowest mean difference in dimensional accuracy with the open tray splinted technique.

However, results were not consistent with the findings reported by Inturregui *et al*.[9] who concluded that there appears to be no clinical advantage in using the more time-consuming techniques of splinting impression transfer copings as the polyether alone resulted in the closest duplication of the master cast. This difference can be explained on the basis of the setting expansion of impression plaster, polymerizing shrinkage of acrylic resin, and rigid fixation of the impression transfer copings in splinted techniques that may have altered the setting expansion of the improved dental stone and, therefore, distorted the inter abutment relationship from that of the master cast.

The results of the present study, however, varied from findings reported by Burawi *et al*.[10] in which the splinted technique exhibited more deviation from the master model than the non-splinted technique. This was primarily advocated to be associated with rotational discrepancies around the long axes of the implants for the splinted technique.

The least accuracy with the closed tray or transfer type impression technique can be explained on the basis of lack of predictability with the possibility of coping dislodgement during impression making.[11] The transfer coping does not become an integral part of the impression. It can be easily moved and due to the friction between the surfaces of the transfer coping and the impression material, it does not return back to its original position. That displacement cannot be avoided when the clinician engages analogs into the impression.[12] In the direct technique, the maintenance of the transfer copings in the impression is an advantage, as this procedure avoids the replacement of the copings in the impression and hence minimizes errors. In addition, splinting provides stabilization of transfer copings under the torque

from analog tightening and reduces rotational freedom within a resilient impression material.

While comparing the two impression materials polyether and polyvinyl siloxane, the results were statistically insignificant; suggesting both polyether and polyvinyl siloxane impression materials are suited for complete-arch impressions and have comparable accuracy. This is attributed to their increased linear stability, lower residual polymerization shrinkage, greater rigidity, and lack of rotation resistance of coping inside the impression leading to a more accurate cast.

The results were in conformity with the study conducted by Holst *et al*.[13] who investigated the effect of time on the 3-dimensional accuracy of open-tray implant impression copings made of polyvinyl siloxane and polyether impression materials and concluded that although polyether materials are considered the standard material for implant impressions in edentulous patients, polyvinyl siloxane materials transfer the spatial orientation of implants with equal precision.

The distortions of multi-unit implant impressions measured in studies, under controlled experimental conditions, may not actually cause misfit of the prostheses on their own, but the combined effect of several factors, clinical and laboratory, may lead to unsatisfactory fit in the final prosthesis. Much of the current available evidence in the area is *in vitro* in nature and clinical studies are required to validate the results obtained from the laboratory studies.[4]

SUMMARY AND CONCLUSION

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 the attainment of passive fit of the implant prostheses, which is directly related to the accurate three-dimensional transfer of the implant positions to the working cast. Second, there are various factors influencing the accuracy of impressions, and the results are conflicting or inconclusive with regards to the various recommendations. Third, there is a lack of homogeneity of research conducted in the area.[4]

Within the limitations of the study, it is concluded that the open tray splinted impression technique is more accurate than the open tray non-splinted impression technique as well as closed tray impression technique. The open-tray non-splinted impression technique is more accurate than the closed-tray impression technique and the accuracy of implant impressions is not affected by the impression materials used and both polyether and polyvinyl siloxane impression materials are suited for complete-arch impressions and have comparable accuracy.

References

1. Bhakta S, Vere J, Calder I, Patel R. Impressions in implant dentistry. Br Dent J 2011;211:361-7.
2. Wenz HJ, Reuter HU, Hertrampf K. Accuracy of impressions and casts using different implant impression techniques in a multi-implant system with an internal hex connection. Int J Oral Maxillofac Implants 2008;23:39-47.
3. Lee H, So JS, Hochstedler JL, Ercoli C. The accuracy of implant impressions: A systematic review. J Prosthet Dent 2008;100:285-91.
4. Baig MR. Multi-unit implant impression accuracy: A review of the literature. Quintessence Int 2014;45:39-51.
5. Baig MR. Accuracy of impressions of multiple implants in the edentulous arch: A systematic review. Int J Oral Maxillofac Implants 2014;29:869-80.
6. Jemt T, Hjalmarsson L. *In vitro* measurements of precision of fit of implant-supported frameworks. A comparison between "virtual" and "physical" assessments of fit using two different techniques of measurements. Clin Implant Dent Relat Res 2012;14:e175-82.
7. Al Quran FA, Rashdan BA, Zomer AR, Weiner S. Passive fit and accuracy of three dental implant impression techniques. Quintessance Int 2012;43:119-25.
8. 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;19:192-8.
9. Inturregui JA, Aquilino SA, Ryther JS, Lund PS. Evaluation of three impression techniques for osseointegrated oral implants. J Prosthet Dent 1993;69:503-9.
10. 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;77:68-75.
11. Sharma A, Chhabra A, Madan N, Madan N. Contemporary impression techniques in implant prosthodontics. Indian J Dent Sci 2010;2:61-2.
12. Fudim Z. Implant impression techniques comparative review: Transfer impression versus direct abutment level. Dental Tribune 2012;8:A10.
13. Holst S, Blatz MB, Goeliner M, Wichmann M. Influence of impression material and time on the 3-dimensional accuracy of implant impressions. Quintessance Int 2007;38:67-73.