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Original Research

Digital evaluation of dimensional accuracy at implant abutment level with and without the use impression coping - An invitro study

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ABSTRACT:
Background: replacement of nature tooth structures in case of partially or fully edentulous patients using dental implants has become one of the commonest practices in modern surgical and restorative dentistry. For the long term success of implants, a passively fitting prosthesis becomes an integral part for maintaining osseo-integration. Thus, accurate impression making is a fundamental step for accomplishing a passive fit between the superstructures and the implant. **Aim:** the main of this in-vitro study was to compare and evaluate the efficacy of two implant impression methods at abutment level with or without the use of impression copings. **Material and methodology:** an experimental study was conducted on twenty stone cast models of mandibular arch. A resin model was prepared by taking impressions and two holes were prepared for fixing the implants. These models were randomly divided into two groups of 10 each. In Group A, direct impression was made without impression coping and in Group B, indirect impression was made with impression coping. A distance of around 4 mm and 11 mm was present between two implants. Twenty impressions were prepared for twenty stone casts. Crucial malformation and mal-articulation were used in analyzing the abutment analogs in three dimensions. The differences found in dimensions of final cast were then compared and analyzed using student t test. **Results:** on evaluation, the results did not show a significant difference between the two methods of impression making. The dimensional change in Y and Z axis in absolute transmission (Δr) between direct and indirect method didn't had much difference while in case of X axis, dimensional change in direct method was much higher with a mean and standard deviation of 0.047±0.05 while in case if indirect method a mean of standard deviation of 0.601±0.154 was observed. **Conclusion:** indirect impression with impression coping was found to be more accurate than direct impression without the use of any coping. Reproduction of precise implant position in the process of impression making, with tension free insertion is the most important step in obtaining an accurate and exact prosthesis. Thus, it depends upon the decision of the dentist to either to use direct or indirect method of impression for construction of the implant prosthesis. However, use of impression coping at abutment level impression is somewhat more accurate and beneficial then the one without impression coping.
Keywords: Abutment, coping, implants, impression, three dimensions

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INTRODUCTION

Implantology is an integral and inseparable part of dentistry which has helped in improving the quality of life for substantial number of patients. Implants are known to provide excellent support for removable as well as fixed prosthesis, which in-turn increases functions when compared with conventional partial and complete prosthesis and restores the esthetic of the patients.[1] Prosthodontic rehabilitation using osseointegrated implants ended up being a therapeutic solution of choice for management of completely or partially edentulous arches. Thus, success of implant becomes the most desirable aspect which influences the clinical practice greatly and motivates patient to prefer implant supported prosthesis.[2]

Impression making is one of the most important steps in obtaining a good prosthesis. An acceptable impression usually records three dimensional position of implant in oral cavity. For the success of any implant supported dental prosthesis an exact

impression is an obligation for definite recording of spatial implant position to obtain a proper support for the final prosthesis with a passive fit.[3] The pre-requisite for the maintenance of osseo-integration is a passively fitting prosthesis, whose usage is usually dependent upon the fact that bone implant interface allows only a limited movement of around 10 mm, consequently unlike natural teeth which are usually cushioned in the socket by the presence of periodontal fibers.[4] Misfit of the implant prosthesis persuades strains on the component, thus resulting in biological and mechanical complication. Consequently, accurate and fastidious implant procedure which involves transferring of the intraoral position of implants through impression techniques, are a necessity to achieve a passive fit and undoubtedly making accurate impression a crucial step in this process.[5] An impression should be able to record precisely the anti-rotational mechanism of the implants to ensure that the master cast should duplicate the exact clinical condition.[6] Therefore, the accuracy of the cast is dependent upon the procedures used for impression making and the master cast implant technique.

The basic impression techniques used for implants are abutment level and implant level impression technique. Abutment level impression techniques further involve direct and indirect impressions with or without copings. Thus, the main aim of the study is to evaluate and compare the efficacy of two impression techniques by conducting an experimental study on the resin models.

MATERIAL AND METHODOLOGY

Twenty mandibular stone cast models with partial bilateral edentulism or with class I, class II and/or class III edentulusim (Dr. Mauk classification) [7] were prepared in the Department of Prosthodontic, GDC Srinagar. A flat surface was created with an accuracy of around 0.001 on the stone case models by CNC (Precision Machinekraft) so as to measure Z axis. Computer software along with the mark created provided the location of reference implant analog in the center by passing a hypothetical plate through the surface, while the reference implant evaluated the spatial position which will be the center of next implant. Two holes of 4X5 mm diameter and depth were created using an acrylic bur in the posterior areas, which will in-turn be used as a reference point for making X axis, while Y axis was drawn perpendicular to it on the same plane by computer system attached to coordinate measuring machine.

Two titanium fixture alloys analogs were inserted along with a dental survivor, with a distance of 4 mm between the center of the first analog to the canine analog and 11 mm from second implant to canine teeth. This was followed by determination of a flat surface on the canine for reference surface and zero point evaluation. A prefabricated plastic tray along with additional silicon impression material was used for impression taking in our study. A solid type abutment was used and secured to the cast model with a force of 30N/cm before starting the procedure. Impression with impression coping at first abutment and without the coping at the second abutment was made for the comparison.

IMPRESSION TECHNIQUE

A two stage putty wash method was used for impression making in our study. Teeth and abutment were initially covered by an aluminum foil with a thickness of around 12 micrometers, followed by placement of additional silicone impression material with putty consistency onto the impression tray and an equal force (putting one kg weights) of 20 N/cm^2 was placed on the trays. The impression was removed from the cast after setting and left for 24 hours until the completion of dimensional changes. Light consistency of additional silicone impression material was injected to both the abutments, with and without coping also inside the tray. Placement of tray was done on the cast model, until the material sets followed by its separation.

In the first hole of the abutment with impression coping an abutment analog was placed, it was placed in such a manner that its flat surface would be on the lingual side. A proper placement will be indicated by a click sound. In case of second hole, a metal rod is first placed which is filled with a self cure acrylic resin until it's similar to fixture analog in height and diameter. The procedure was repeated for each cast model (N=20), and final pouring of the preparation was done using type 4 stone.

THREE DIMENSIONAL ANALYSIS

The samples prepared were placed inside the coordinate miracle NC-685. The stone casts were fixed to the metal plate using a liquid adhesive, followed by movement of the device arm by the operator. At first the measurements of the cast's model was done by touching the four internal walls of the right cavity, with the measurement of the center. The data was registered on the machine's computer automatically. The procedure was followed for the left cavity, so that a direction for the creation of X axis would be created from right to left. Y axis was drawn perpendicularly to X axis in the same horizontal and posterior anterior direction. The estimation of the contact area which was approximately 2mm below the highest point was done using a probe on all the four walls of the abutment. Two coordinates X and Y were calculated, to the right reference hole with X and Y equal to zero. The measurement of Z axis was done using the flat surface created in the edentulous ridge. The distance between the two analogs was measured by touching the device probe to the upper end of the analog, and the distance was measured as Z dimension representing the height of the analog from the cast.

All the three coordinated thus obtained (X, Y and Z), were used as a reference for the cast in the study. Calculation obtained of the plaster cast using acrylic

analog 1 and titanium analog 2 were registered similarly based on the method used in cast models.

STATISTICAL ANALYSIS

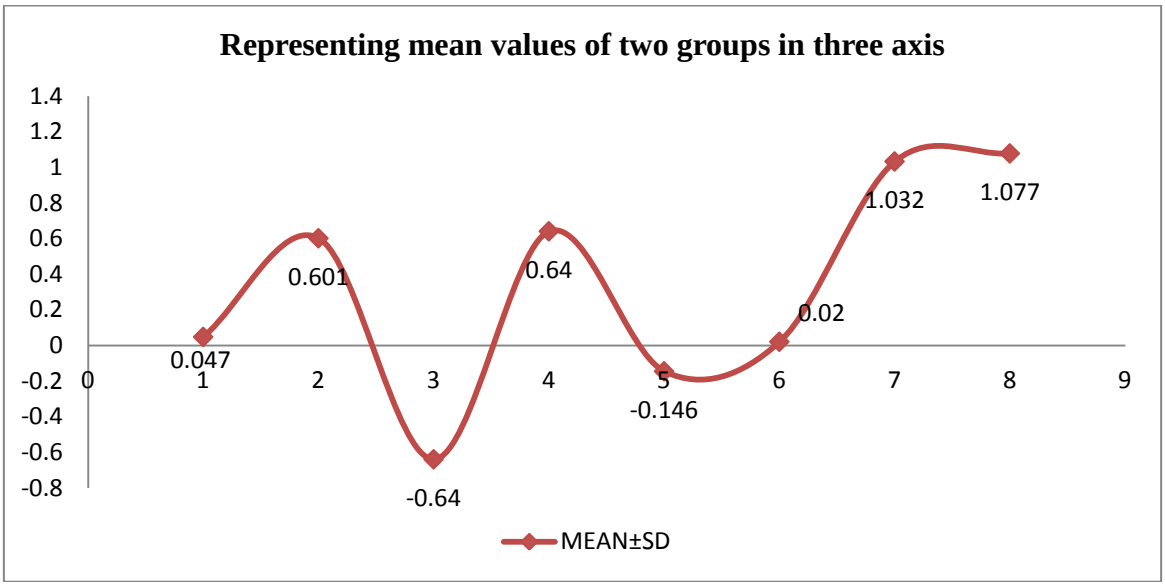
The data was collected and transferred into an excel sheet, where statistical analysis was performed using SPSS software version 20.0. Mean and standard deviation was used for the descriptive analysis while student t test was done for the comparison between the measurements obtained from the two analogs. Total linear movements (Δr) and individual movements of three axis (in millimeter), were also calculated. A two tailed p- value was considered significant only and when p>0.05.

RESULTS

On evaluation of results, the variations in X-axis, without the use of impression coping had a mean and standard deviation of 0.047±0.05mm and with the impression coping was 0.601±0.154 mm, and the difference between them was statistically significant p=0.02. The change in Y axis was found to be -0.64±0.218 mm without impression coping while the variation was 0.64±0.239 mm with coping with no statistically significant result p=0.130. In case of Z axis, the change in the method with and without the use of coping was found to be -0.146±0.214 mm and 0.020±0.543mm respectively with statistically significant results of p value of 0.04. When evaluation of infinite dimensional variation was done with and without the use of coping, the mean and standard deviation was found to be around 1.032±0.328 and 1.077±0.134 mm respectively with a non significant value of 0.49. The changes when compared to the standard reference in the study with and without the use of impression coping from right to left was found to be in X, Z and Y axis respectively, while with the impression coping methods most significant differences compared to standard was in X,Y and Z respectively.

TABLE: Representing the mean and mean difference of two groups in three axis (X, Y AND Z)

Parameters	Group (N)	Mean±SD	SE	Mean difference	P-value	Significance
Variation in x-axis	With impression coping (n=20)	0.047±0.05	0.076	-0.554	0.02	S
	Without impression coping(n=20)	0.601±0.154				
Variation in y-axis	With impression coping (n=20)	-0.64±0.218	0.128	-1.28	0.13	NS
	Without impression coping (n=20)	0.64±0.239				
Variation in z-axis	With impression coping (n=20)	-0.146±0.214	0.121	-0.166	0.04	S
	Without impression coping (n=20)	0.020±0.543				
Absolute variation in all axis	With impression coping (n=20)	1.032±0.328	0.215	-0.045	0.49	NS
	Without impression coping (n=20)	1.077±0.134				



DISCUSSION

Precision of fit is usually influenced by the accuracy of impression. Transferring of intraoral positions of implants and abutments to the definitive casts in prosthodontics is of utmost importance to achieve a passive fitting prosthesis.[6] A large number of studies focused on the factors affecting precision of the impression, and critical issues like registering the three dimensional orientation, which creates details necessary for successful treatment of implant prosthesis.[8]

The main aim of our study was to evaluate and compare two methods of impression making at abutment levels with and without the use of impression copings with two parallel implants. The abutment analogs used in our study were made of self polymerization material and titanium. In a study conducted by **Mojon et al,** revealed that the dimensional changes result in contraction of acrylic resin polymerization that usually affects the outcome. It was reported that shrinkage of the resin would be around 6.5-7.9% within first 24 hours along with 80% shrinkage after first 17 minutes after mixing.[9] On considering that shrinkage of acrylic decreases the volume of acrylic analog in the study without impression copings, the probable results achieved in our study by analyzing CMM machine in Y and X axis and the observed difference was due the shrinkage as reason.

Sorrentino et al in their study found that additional silicon showed more precise results compared to poly-ether in presence of non-parallel implants.[10] In a similar study conducted by **Hatim** and **Al-Mashaiky,** recommended that silicon impression material of additional type produces the most accurate results n die-stone with most successful treatment for the patients.[11] This was the reason for using additional silicon impression material in our study, two light and putty consistencies were used for impression making.

A contraction of impression space is observed in a two step impression procedure due to an increase in putty volume and a mild volume increase of wash contraction. Based on the result, two step direct impression technique was used in our study and is considered as the most accurate impression method for producing the implant position from patient's mouth to laboratory cast. This was in consistent with the study conducted by **Hatim** and **Al-Mashaiky**, who concluded that a two step procedure is more accurate than one step for producing an accurate casts.[11]

Jahandide and **Pournasiri** in their study compared the accuracy of open tray impression through connection method with an acrylic pattern. In their study four implants were placed on the surface of acrylic model of the mandible, and impression was made using open tray and additional silicon impression material. The results of their study, reveled a non significant difference between the different methods of impression with a deviation in general dimension of Y and X.[11] These results supported our study where solid abutments and casts were used and the results were similar in Y axis but dissimilar in Z and X axis.

The main reason behind the results following X axis is due to the change in volume due to contraction at the time of polymerization in case of acrylic analogs, along with the errors at the time of analog preparation and its substitution. A plaster cap can be used as an aid for creating space in impression coping method, but the direct method, the space cannot be created and the volume change of analogs in the final casts would be inevitable.

CONCLUSION

Within the limitation of our study, it can be concluded that the abutment level impression with the use of impression coping are found to be more accurate than without the use of impression coping for transferring the position of abutment. In general at the end, it can be culminated that for a three dimensional positioning of implant abutment, no significant differences were observed in impression making with two techniques.

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