Original Research Paper

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A COMPARATIVE EVALUATION OF THE ACCURACY OF MASTER CAST FABRICATED BY FOUR DIFFERENT MODIFICATIONS OF IMPLANT LEVEL OPEN TRAY TRANSFER IMPRESSION TECHNIQUE FOR SINGLE-TOOTH REPLACEMENT: AN IN-VITRO STUDY

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ABSTRACT

Statement of problem: Minor rotation of impression coping secured during implant impression is an avoidable error that needs to be minimized to ensure precise positioning of implant analog in master cast.

Purpose: The aim of this study was to check and compare the accuracy of master casts obtained by modification of impression coping by using four different techniques and to compare these master casts with reference model.

Methods & material: A total of 80 master casts were made (20 for each group). Group I samples were prepared with original virgin surface impression copings, Group II samples with impression copings surface modified by sandblasting with 50 µm aluminum oxide powder. Group III included samples which were fabricated with impression copings modified by coating of adhesive only. Group IV samples which with impression copings sandblasted and coated with adhesive. Profile projector (Dynascan PT 300E) was used to evaluate the rotational and positional accuracy of the internal hexagon implant analog by comparing Molar Implant Angle (MIA) and Premolar Implant Angle (PIA) of test samples with reference model.

Result: Statistical comparisons were made using ANOVA test, post hoc test, and unpaired t-test that showed non-significant results. Sandblasted with adhesive coated impression coping produced the master casts accuracy closest to the reference resin model.

Conclusion: Sandblasted and adhesive coated impression copings showed minimum amount of variation followed by sandblasted and adhesive coated impression copings.

KEYWORDS : impression coping, implant analog, sandblasting, profile projector.

INTRODUCTION

The original implant position and orientation must be reproduced in the working cast so that best prosthesis fit could be achieved without interfering in the path of prosthesis placement. The prosthetic rehabilitation with implants is a challenging job. With the predictable integration of implants, the emphasis is shifted towards precise prosthesis. Precise working casts are essential to fabricate passively fitting implant prostheses. Also as Ganz quoted "Proper impression technique remains as one of the foundations for proper prosthetic reconstruction." [1] Assif and colleagues [2] proposed that the discrepancies might be less than 10 µm at each abutment. Because discrepancies of less than 30 µm in the fit of an implant-retained framework on multiple abutments cannot be detected clinically; so this value could serve as a criterion between acceptable and inacceptable frameworks. As per Aparicio C [3] the implant does not have a periodontal ligament and cannot adapt its position to a non-passive framework.

Accurate implant impressions play a significant role and serve as a starting point in the process of producing good working casts. Impression procedure for single-tooth replacement differs from multiple teeth replacement. Minor movements of the impression coping can be possible inside the impression material during all clinical and laboratory steps. Inaccuracies introduced during impression technique can cause misfit of the prosthesis [4,5] which may lead to uneven force distribution and possible prosthesis complications such as abutment screw loosening and occlusal inaccuracies. Thus the selection of a particular impression technique greatly influences the outcome of the treatment and still remains as a tough task.

MATERIALS AND METHODS

Fabrication of the samples was done in Department of Prosthodontics and Crown & Bridge, Postgraduate Institute of Dental Sciences, Rohtak, and the evaluation of the samples on Profile projector (Dynascan PT 300E) was done at Laxmi Precision Screw Ltd. Bossard, Rohtak (Haryana, India). This in vitro study was carried out in following three phases:

(1) Fabrication of reference model,
(2) Fabrication of test specimens and
(3) Testing of samples under Profile Projector to evaluate the accuracy of the implant analogs in test samples.

Test specimens were divided into four groups depending on the type of surface treatment of impression coping. Group I: Samples with non-modified impression copings, Group II: Samples with impression copings sandblasted with 50 µm aluminum oxide powder, Group III: Samples with impression copings coated with adhesive only recommended for poly- vinyl siloxane impression material, Group IV: Samples with impression copings sandblasted with 50 µm aluminum oxide powder and coated with recommended adhesive for poly-vinyl siloxane impression material.

1) FABRICATION OF REFERENCE MODEL

A dentulous die stone maxillary model with partially edentulous at site of right maxillary first molar region was prepared in type IV die stone. Adjacent maxillary second molar and maxillary second premolar were cut in bucco-palatal plane with the help of die trimmer (Confident) to get two parallel reference planes for measurement of the angles formed with sides of the implant hexagon serving as corresponding second plane of respective side.

A transparent heat cure polymeric resin model was prepared after duplication of die stone model. An Implant fixture of size 3.75x10 mm (internal hex) was placed at required site 16 with the help of surveyor. This model was standardized by measuring the MIA & PIA on profile projector ten times and then the mean reference angles were obtained.

1) FABRICATION OF TEST SPECIMEN

I) Fabrication of custom tray:

A polyvinyl siloxane impression of the reference model was made and poured in Type IV dental stone. Double layer wax spacer of total thickness of about 2 mm (Modeling wax, Rolex India), was adapted to the stone model and four tissue stops of 2x2 mm were cut to allow consistent thickness of impression material and prevent the over-

seating of custom tray. A uniform layer of auto-polymerizing PMMA resin (DPI Heat Cure Resin, Bombay India) was dispensed extending to the vestibule but not covering the palate. After completion of the curing, the wax spacer was removed and a window was made with tungsten carbide bur no.4 in the region of implant to allow access for the impression coping.

II) Preparation of impression coping

(I) Group I (Non-modified impression coping).

(ii) Group II (Sandblasted / Surface abraded coping): Transfer impression copings were treated in sandblaster, (Unident) with blasting media 50 µm Al_2O_3 (Aluminium Oxide) at 2.5 atmospheric pressure. Sandblasting was done till the favorable rough surface was achieved.

(iii) Group III (Adhesive coated coping): Impression copings modified by the application of adhesive (Caulk Dentsply). Liquid paint-on adhesive method was used for adhesive application and the impression procedure started only after 30 minutes of applied adhesive got dry.

(iv) Group IV (Sandblasted with adhesive coated impression coping): Sandblasted impression coping with adhesive coated (Caulk Dentsply); preparation of impression coping similar to Group II & Group III. Sandblasted transfer coping was screwed to the reference model and then adhesive application was done with liquid paint on technique.

III) Impression procedure

Impression copings (non modified/ modified) were secured to implant on reference model. The custom trays were coated with tray adhesive according to the manufacturer's recommendation before each impression was made. Light body was syringed around the implant and impression coping with an automixing syringe and dispensing gun. Customized tray loaded with unset putty & with light body, placed immediately and one step impression was made. After completion of polymerization of impression, hex driver was used to loosen the impression coping and the impression was removed. Prior pouring of impression, the impression was examined after removal from the reference resin model.

Fig 2: (a) Non-modified coping b) Sandblasted coping (c) Adhesive coated coping d) Sandblasted & adhesive coated coping

Then transfer coping was screwed with analog together while holding the analog in place to prevent any rotation of impression coping. Debubblizer (Unicoat, Delta labs) was applied with the help of brush; to reduce the surface tension and prevent porosity & voids formation in master cast. Impression was poured with Type IV improved die stone. Die stone was mixed according the manufacturers' directions (30ml water and 100 gm powder). The master casts were allowed to set for one hour before being removed from the impressions. The elastomeric impression material specification ADA/ ANSI 19 was used as an instructional guide. The poured impressions were stored in at room temperature (23.0±2.0°C) and 50±10% relative humidity for 30 minutes. All master casts were checked for defects related to the pouring and removal.

TESTING OF SAMPLES UNDER PROFILE PROJECTOR

A total of 80 samples were made and were measured 48 hours after retrieval from the impressions. All master casts were analyzed under Profile projector to evaluate the micro-rotation of internal hex of the implant analogs. The profile projector consist of a projection screen of fine grain ground glass 300mm diameter with horizontal and vertical cross reference lines "+" , has a movable table that enable one to position the model. A light source allowed the projection of a magnified image of the object onto the screen.

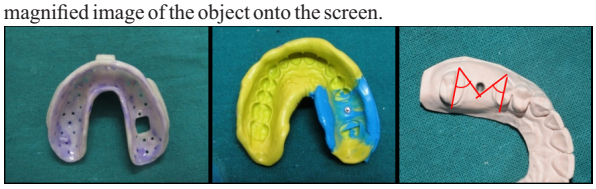


Fig 3: a) Adhesive coated custom tray b) Pick up impression with open tray coping c) master cast showing reference angles

This Profile projector Dynascan PT 300E was used in study has 0.05% accuracy on profile and surface with resolution of 0.001mm.

The master model was focussed by focussing wheel until; a sharp image was not obtained on the monitor screen.

After getting a sharp image of master model; MIA angle measurement was done by coinciding the reference molar plane and one of lines of cross line of "+" on monitor screen. After the perpendicular line coincide with molar plane, zeroing was done by pressing x^0, y^0, z^0 on the display board.

After zeroing, monitor screen rotation was done that made the same perpendicular line of "+" to coincide with the distopalatal side of implant analog hexagon. The measurement has come on the display board in x, y, z planes. PIA angle measured in same way. Later MIA and PIA angles of reference model were compared with those formed in test specimen. Since these angles involved the distopalatal and mesiopalatal sides of internal hex of implant, any micro-rotation, either clockwise or anticlockwise was detected by profile projector and evaluated for accuracy of its position along its long axis. MIA & PIA were reference angles formed by molar plane and premolar plane with internal hex implant.

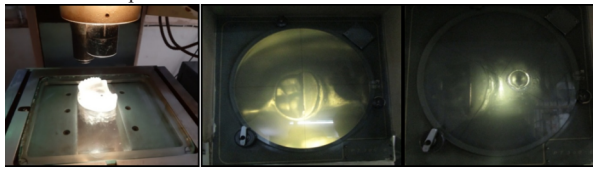


Fig 4. a) Testing of model under profile projector b) Projection of reference molar plane on monitor screen c) Perpendicular line on monitor screen coinciding with disto-palatal side of implant hexagon

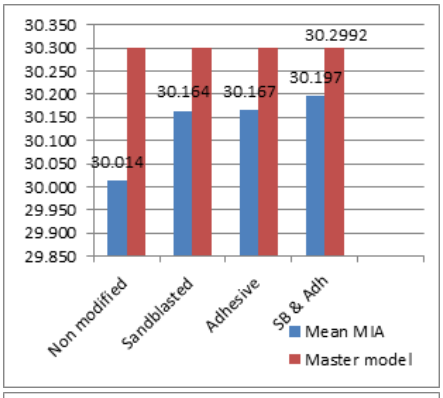
RESULTS

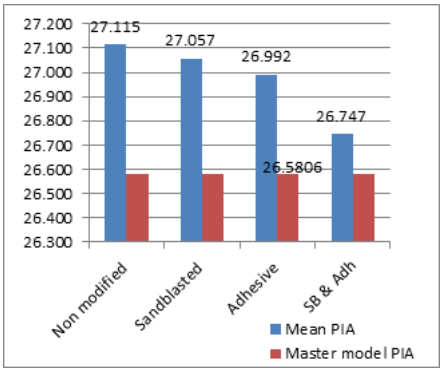
The angles MIA and PIA were measured in all master casts and compared with mean MIA and PIA angle of 30.299892º and 26.580º of reference resin model respectively. Since these angles involved the distopalatal and mesiopalatal sides of internal hex of implant, any micro-rotation, either clockwise or anticlockwise was detected by profile projector and evaluated for accuracy of its position along its long axis. There was a non significant difference seen for the values between the groups ($p > 0.05$). Pair wise Comparison of the mean of molar plane angles (MIA) and premolar plane angles (PIA) of all the four groups revealed non-significant statistical difference between the non-modified group (Group I) and modified groups (Groups II, III and IV). In this study $P < 0.05$ was considered as the level of significance. There was a statistically non-significant difference seen on comparison of the values between all pairs of groups was done ($p > 0.05$) as shown in table 1.

Table 1: Pair wise comparison using tukey's post hoc tests

Dependent Variable	(I) groups	(J) groups			
			Mean Difference (I-J)	Std. Error	p value
MIA	1	2	-.1507222	.6673563	.996#
	1	3	-.1529306	.6673563	.996#
	1	4	-.1837361	.6673563	.993#
	2	3	-.0022083	.6673563	1.000#
	2	4	-.0330139	.6673563	1.000#

	3	4	-.0308056	.6673563	1.000#
PIA	1	2	.0576667	.6705579	1.000#
	1	3	.1232361	.6705579	.998#
	1	4	.3682500	.6705579	.947#
	2	3	.0655694	.6705579	1.000#
	2	4	.3105833	.6705579	.967#
	3	4	.2450139	.6705579	.983#





DISCUSSION

The objective of this invitro study was to evaluate the significance of the surface treatment of impression coping before the final impression procedure in case of the single-tooth replacement with implant supported prosthesis. The passive fit of an implant-retained prosthesis is an important factor in prosthetic rehabilitation success. The objective of implant placement in the jawbone is to obtain long-term anchorage for dental prosthesis that restores the original lost function while maintaining or improving the implant-bone junction. To achieve this objective, it is necessary to reach a non-destructive stress level on the peri-implant bone by controlling the masticatory load distribution on the implants. [3] The impression's accuracy is one of the factors that can interfere in the osseointegrated implant's treatment. Transfer of the precise position of implants to a master cast is a prerequisite for accurate and passive fit of the superstructure. Inaccurate frameworks can cause stress at the implant/bone interface.

Among the various steps involved in fabrication of implant prosthesis, accurate impression and working casts are essential to conventional prosthodontic procedures. In implant dentistry, the goal in making impression is to record and precisely transfer the position of implant in relation to its spatial orientation. Most of implants have an internal or external geometrical configuration that helps securing the implant analog to precise position by preventing rotation.

The direct or the open tray impression technique was used in the present study which involves unscrewing of the implant analog intraorally after the impression material has set and then securing the implant analog to its position before pouring the working cast. This step is very critical, failure to which can lead to further complications.
Various studies have shown that there is always some possibility of rotation of the impression coping which can lead to error in precise fitting of the prosthesis. This led to the idea of improving the retention and stability of impression coping by altering the surface of impression coping. Surface treatments have proved to cause surface roughness increasing the surface area which indeed leads to better mechanical interlocking thereby resulting in more retention. This has shown by incorporating the external surface treatments of impression copings with lead to improved retention between the coping and the impression material, thus minimizing the risk of rotational movement during impression making.[6,7] Considering this fact, more studies were required to validate the use and benefits of surface treating impression copings for accurate records of transfer copings. The results of the study found no significant difference in the mean PIA and mean MIA of non modified group (Group I) and modified groups (Groups II, III and IV) when compared with standard measurement of resin reference model.

In the present study, the mean MIA and PIA values of the master casts showed variations from those recorded on the resin reference model. This gives an idea that there is always a possibility of microrotation while using transfer copings which can lead to three-dimensional spatial inaccuracies in the master casts. The results also show that the surface modification definitely reduces the error of microrotation and hence improves the accuracy of the master cast. Result of this present study are in accordance with the study conducted by Vigolo P et al. [2] The master casts obtained with the roughened and adhesive-coated impression copings showed a significantly lower amount of rotational movement than the master casts achieved with the non-modified impression copings (P<.01) relative to the position of the hexagon head of the implant on the reference resin model

LIMITATIONS

It was an in-vitro study. The oral environment was not included in the study and hence the level of difficulty might be different from in-vitro setup. Sample size was limited. The sample size can be increased to decrease the chances of error. Under clinical conditions these differences may vary if the discrepancies are present in other spatial planes. Thus, such discrepancies may clinically result in an improper fit of the prosthesis. Further studies may be required to evaluate the clinical relevance of the three dimensional movements of impression copings inside the impression material with large sample size.

SUMMARY & CONCLUSION

There was a statistically non-significant difference seen on comparison of the values between all pairs of groups was done (p> 0.05).Comparison of the mean of molar plane angles (MIA) and premolar plane angles (PIA) of all the four groups revealed no significant statistical difference between the non-modified group (Group I) and modified groups (Groups II, III and IV). While comparing the results, the variation in MIA & PIA from group I to IV, the amount of rotational movement or discrepancy reduced.

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