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Original Research

To evaluate and compare the vertical marginal fit of metal copings fabricated from free hand wax patterns and milled wax patterns using conventional casting technique with CAD milled copings - An in vitro study

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ABSTRACT:

Background: Marginal adaptation of coping over an implant abutment gauges the overall cast restoration acceptability for favorable clinical outcome. Fabrication of metal copings over implant abutments is technique sensitive. Paucity of comparative studies evaluating vertical marginal fit of metal copings made-up by CAD/CAM with conventional technique exist. This invitro study evaluate and compare between vertical marginal fit of Metal copings fabricated by three different techniques over Implant abutments through Milled CAD/CAM technique, Milled wax, and Free Hand Wax method by Conventional Casting Technique. **Methods:** To conduct this invitro comparative study a total of 45 metal coping samples 15 in each of three groups were prepared under standard laboratory conditions. Group I, copings were fabricated from Milled Co-Cr (*MC*) blocks by the CAD/CAM technique, Group II copings were fabricated from Milled wax with Conventional Casting technique. Group III, copings were fabricated from Free Hand Wax pattern *(FW)* and Conventional Casting technique. The Vertical marginal fit of samples was evaluated by Stereomicroscope (50x). Data entry & scrutiny was done by SPSS Version 15.0. ANOVA &Tuckey test showed Intragroup and intergroup variation set at P<0.05 (95% CI) as significant.**Results:** CAD/CAM milled copings showed better marginal fit when compared with copings fabricated by conventional casting technique. **Conclusions:**Milled CAD/CAM technique for coping over implant abutment having least vertical marginal discrepancy is substantiated in this invitro study directing further studies on this perspective.

Keywords: Implant abutment, Metal coping, CAD/CAM milled coping, Vertical marginal fit, Stereomicroscope.

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INTRODUCTION

The accuracy of marginal fitting of prosthetic restorations is appreciated as one of the most crucial criteria for the clinical quality and success of prosthetic restorations. The completed restoration should go into place without binding of its internal aspect against the occlusal surface or the axial walls of the tooth preparation. In other words, the best adaptation should be at the margins. Marginal adaptation is believed to be a primary and substantial factor in the prevention of secondary caries in natural teeth and is a crucial indicator of the gross acceptableness of the cast restoration, as implant dentistry continues to develop, it is more widely distinguished that implant restorations require a different operations equated to traditional crown and bridge prosthodontics.[1, 2]

The construction of metallic complex body part with an inactive adaptation on their individual abutments is considered as a prerequisite for the long-run success of implant-based restorations. Osseointegrated implants exhibit a significantly distinct mobility compared with the natural teeth abided with periodontal ligaments. Therefore minor aberration of framings forced out stress from frameworks attached to osseointegrated implants. Natural dentition have the ability to adapt to the misfit since of the mobility of the periodontal ligament. The difference in mobility between implants and natural teeth means that the precision meet of the framing is more authoritative when fixed prostheses are attached to implants than to natural teeth.[3- 6]

The outcomes of a deficiency of fit admit micromovement that might break away the cement implant attachment and, with a screw-in prosthesis, loosing of the coping screw propeller. When the prosthesis is loosed from the implant port, physiologic masticatory foci are elaborated at that interface and can consequence in shift or screw break and periimplant bone loss, and even deprivation of osseointegration.[7]

Hence; under the light of above obtained data, the present study was undertaken for comparing the vertical marginal fit of metal copings fabricated from free hand wax patterns and milled wax patterns using conventional casting technique with CAD milled copings.

MATERIAL AND METHODS

The present study acquitted in the Department of Prosthodontics Including Crown and Bridge, Maxillofacial Prosthodontics and Oral Implantology, I.T.S Centre for Dental Studies and Research (CDSR), Muradnagar, Ghaziabad (Uttar Pradesh-INDIA) to evaluate and compare the vertical marginal fit of metal copings fabricated from Free Hand wax patterns and Milled wax patterns using conventional casting technique with CAD/CAM made copings.

A total of 45 samples of metal copings were fabricated using three different techniques. They were equally distributed into three groups of 15 each. The wax patterns were made-up using three different techniques i.e. Free Hand wax Patterns (*FW*) (Bego Dipping wax USA); Milled wax pattern (*MW*) (Ceramill wax: AmannGirrbach) using the CAD/CAM machine (Roland DW-50X, 5Axis Milling Machine, Delhi). Casting was done using Conventional Casting technique. Milled Co-Cr copings (*MC*) were made using a 'D' shaped milled Co-Cr disc (Ceramillsintron) with the help of CAD/CAM Milling machine (Ceramill Motion 2 :AmannGirrbach, Karnataka). The Vertical marginal fit was evaluated using Stereomicroscope (50x).

Groups were as follows; GROUP I - Copings made from CAD/CAM technique, (MC); GROUP II - Copings made from Milled wax Pattern Followed By Conventional CastingTechnique, (MW); and GROUP III - Copings Made From Free Hand wax pattern Followed By Conventional Casting technique, (FW).

A rectangular stainless steel master model of 1 inch side was fabricated for this study. One implant analogue was stabilized in the model using a low-fusing metal. Screw welding from beneath the model was done to provide additional stability to the analogue. Fabrication of coping was done which included copings fabricated from milled metal disc *(MC)*; copings fabricated from milled wax pattern *(MW)*; and copings Fabricated from Conventional Casting method (F*W*). Die Spacer Application was done followed by Die Lubricant Application. This was followed by spruing and surface treatment of Completed Wax Patterns. Investment of Wax Pattern was done followed by casing and divesting. Each coping was seated on the abutment. The measurement was done with the help of Stereomicroscope [Olympus SZX-7] at 50X magnification. All the results were assessed by SPSS software.

RESULTS

In Group I, The average marginal gap values ranged from 15.75 µm to 32.25 µm with a mean value of 22.83 and a standard deviation of 4.58 µm. Median gap was 22.50 µm. On evaluating the distribution for normality using Kolmogorov-Smirnov test (K-S test), the distribution was establish to be symmetric and normal (K-S=0.099; p=0.906).In Group II, the average marginal gap values ranged from 22.50 µm to 36.25 µm with a mean value of 28.28 and a standard deviation of 4.24 µm. Median gap was 27.75 µm. In Group III, the average marginal gap values ranged from 115.75 µm to 135.25 µm with a mean value of 123.15 and a standard deviation of 6.01 µm. Median gap was 123.0 µm. On comparing, Group III v/s Group I with respect to all the given sides, the mean difference *(MD)* 95.20, & Standard Error *(S.E)* was 2.50. '*p*' value was found to be highly significant. Group II v/s Group I with respect to all the given sides, the mean difference *(MD)* 5.45, & Standard Error *(S.E)* was 1.83 *'p'*value was found to be highly significant.

Although mean values of Group II were higher as compared to that of Group I for all the sides as well as for average value yet the difference was significant statistically only for side 2 and average values ($p<0.05$). For other sides as well as for average value, differences between two groups were not significant statistically ($p>0.05$).Group III v/s Group II with respect to all the given sides, the mean difference *(MD)* 94.87 & Standard Error *(S.E)* was & 1.83. *'p'* value was found to be highly significant. In Groups III and II, mean value of Side 2 was significantly higher as compared to other sides, however, no significant difference was observed between other sides.Thus, none of the between group comparisons were significant statistically ($p>0.05$).For none of the comparisons the difference between sides was significant ($p>0.05$), and hence mean value could be considered as the representative value.

Table 1: Between Group {Group I, Group II, Group III} comparison of Marginal gap at different sides and mean value (Tukey HSD test).						
Groups		Side 1	Side 2	Side 3	Side 4	Average value/side
Group III v/s Group I	MD	95.20	106.87	99.27	99.93	100.32
	SE	2.50	2.47	2.61	3.19	1.83
	P	<0.001	<0.001	<0.001	<0.001	<0.001
Group II v/s Group I	MD	3.93	12.87	2.27	2.73	5.45
	SE	2.50	2.47	2.61	3.19	1.83
	P	0.269	<0.001	0.664	0.671	0.013
Group III v/s Group II	MD	91.27	94.00	97.00	97.20	94.87
	SE	2.50	2.47	2.61	3.19	1.83
	P	<0.001	<0.001	<0.001	<0.001	<0.001
Outcome		III >II~I	III >II>I	III >II~I	III >II~I	III >II>I
Group I - CAD/CAM Technique (*MC*), Group II - Milled Wax, followed by Conventional Casting technique (*MW*), Group III - Conventional Casting technique (*FW*).						

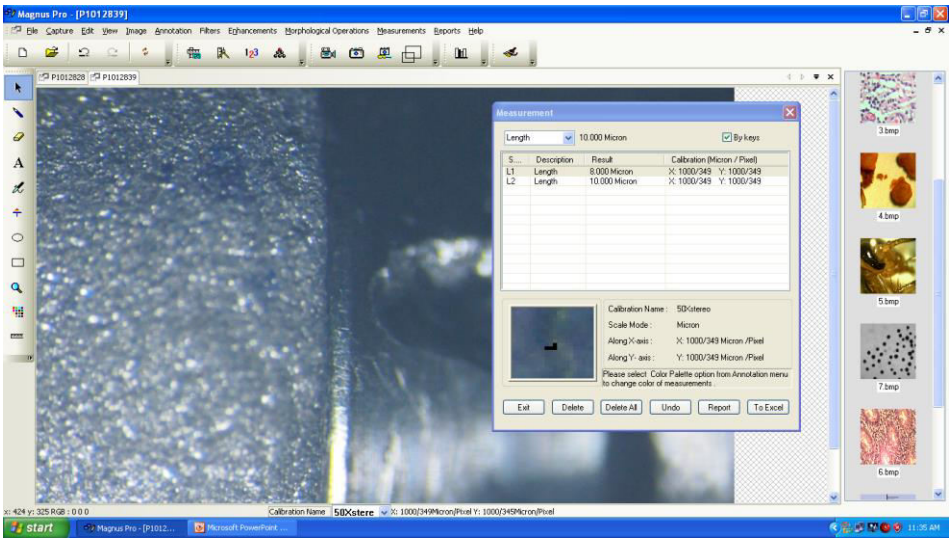

Figure 1: Snapshot showing measurement of Vertical Marginal gap of Coping under a Stereomicroscope (50x) in Group I (MC).

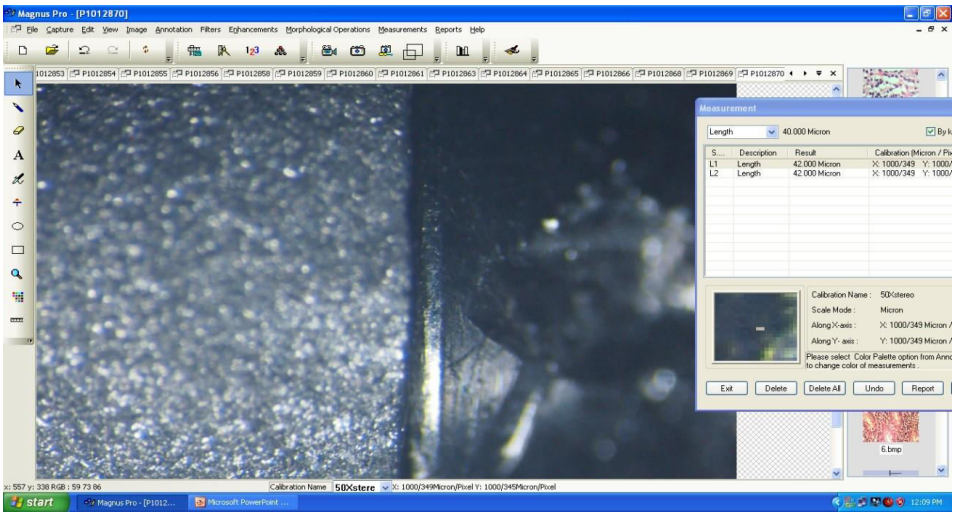

Figure 2: Snapshot showing measurement of Vertical Marginal gap of Coping under a Stereomicroscope (50x) in Group II (MW).

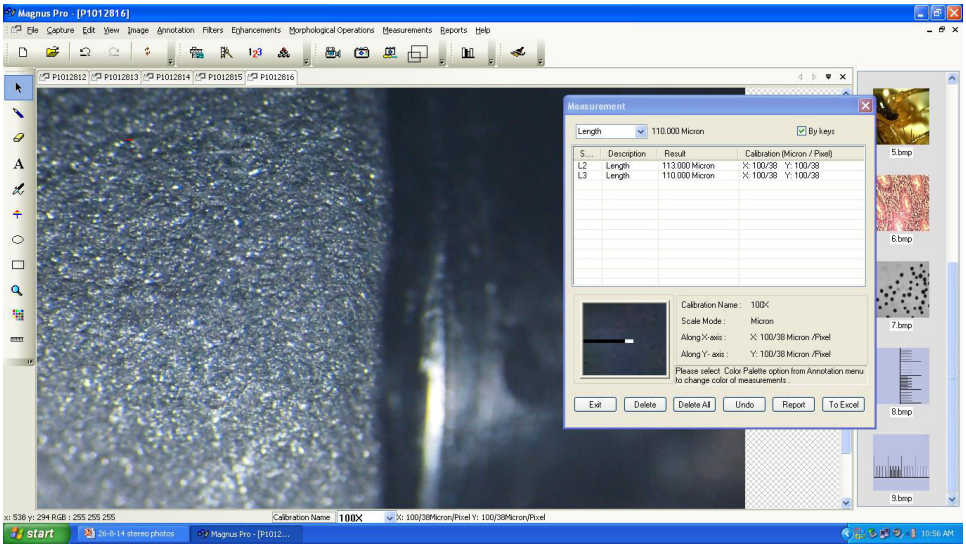

Figure 3: Snapshot showing measurement of Vertical Marginal gap of Coping under a Stereomicroscope (50x) in Group III (FW).

DISCUSSION

Metal ceramics is wide employed material for constructing complete coverage crowns and fixed dental prosthesis. They are believed as the touchstone treatment in dentistry. The traditional technique for fabricating the metal foundation is the lost-wax method and using different metallic admixtures for casting. However, the technical operations of investing wax patterns and casting metal alloys require numerous technical variables and a significant number of operative footsteps and firing cycles, constituting the final calibre of the restorations highly technique-sensitive.[8]

The results of this study on comparative evaluation of vertical marginal fit of metal copings over implant abutments fabricated by three different techniques were discussed with previous reported studies. In the present in vitro study marginal gap is chosen for measuring the marginal discrepancy as this is most critical due to cement solubility.[5] A total of forty five metal copings were fabricated over implant abutments. They were divided equally into three groups with sample size of 15 each. Nobel Biocare abutment was used as it had a prefabricated margin and there were two orientation grooves on the surface of abutment which ensured a single path of insertion of copings over the abutment. Two abutments of the same company and same model (Nobel Biocare, Snappy Abutment) were used, one for working model and other for testing model. Marginal gaps were assessed for the four sides of the each metal coping using stereomicroscope measured at side 1, 2, 3, and side 4. Average value was calculated for all copings and represented as single value for all the four sides. Cobalt - Chromium alloy was used as of its low cost and material properties such as high stiffness and rigidity. The material is considered as a viable alternative for crowns and fixed partial dentures (Eliasson, Arnelund, Johansson 2007) and producing more precise fitting crowns than titanium (Oruç, Tulunoglu 2000).[9, 10]

For metal copings made from CAD/CAM technique, the average marginal gap values ranged from 15.75µm to 32.25µm with a mean value of 22.83. The marginal precision of CAD/CAM copings were in the parameters stated by ADA specific #8. (25-40µ) (Romeo, Iorio, Storelli, Camandona, Abati, 2009).[11]The copings produced using CAD/CAM technology shows smaller gaps at the margins. The copings produced using lost wax technique show larger gaps at the margin. Chandrashekar, Savadi, Dayalan, Reddy (2012) proved that the marginal adaptation of copings was improved on using CAD/CAM technique.[12]

Thus from the findings of the study it can be observed that the null hypothesis was not accepted. Thus, it can be concluded that it is the astute clinician's ability to follow the fabrication instructions and the technique which plays a crucial role in the final outcome. There remains a need for greater study both in vitro and in vivo involving larger sample size and using more parameters or fabrication techniques and evaluation methods before a particular method of coping fabrication over implant abutment can be declared as supreme.

CONCLUSIONS

The field of study constituted to relatively appraise the vertical marginal fit of copings made from Free Hand wax patterns and Milled wax patterns and CAD/CAM Milled copings.Milled wax pattern fabrication is a suitable alternative to Free Hand Wax pattern fabrication.

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