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"Comparative Evaluation Of Accuracy Of Two Impression Techniques And Materials For An Implant-Supported Prosthesis"

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ABSTRACT :

Aim: To identify the most accurate impression technique and the ideal impression material to transfer the intra-oral position of implant fixtures to the working cast. Materials and methods: Forty impressions of the master model were made using direct technique with polyvinyl siloxane (Group D-PVS), and polyether (Group D-PE); and indirect technique with polyvinyl siloxane (Group ID-PVS), and polyether (Group ID-PE), 10 impressions each. Specified dimensions of the resultant casts were measured using stereomicroscope with digital software. Mean actual cast error and subgroup's actual cast error was calculated and statistically analyzed using Student Unpaired't' test, ANOVA and Tukey Multiple comparison test. Results: The group's mean actual cast error observed in Group D-PVS, D-PE. ID-PVS and ID-PE was 0.02825 ± 0.0091, 0.01679 ± 0.0055, and 0.08442 ± 0.01516 mm, respectively. Statistically significant variation was found in mean dimensional accuracy in four groups. Conclusions: The dimensional accuracy of the casts obtained by pouring the impressions made by using direct technique were significantly more accurate as compared to the indirect technique.

INTRODUCTION -

A major objective in making an implant-supported prosthesis is the production of superstructures that exhibit a passive fit when connected to multiple abutments. Passivity is the quality or condition of inactivity or rest assumed by the teeth, tissue, and denture when the implant framework is in place but not under pressure. Incorrect dissipation of stresses due to a lack of passivity has been proposed to be associated with mechanical failure of the restorative components, and of the implants themselves, due to peri-implant bone loss.[1] The first and the most crucial step in achieving an accurate, passively fitting prosthesis is making an accurate impression. The impression registers its

three-dimensional position, which includes the depth, axis or angulations, and rotation or position relative to other implants, adjacent teeth, and dentition of the opposing arch. An accurate transfer of the hexagon position of the implant to the working cast is mandatory to achieve a functional and esthetic restoration. The accuracy of the implant cast depends on the type of impression material and tray, the implant impression technique, die material accuracy, and the implant master cast technique.

It has been suggested that the direct technique is more accurate while there are conflicting results for the same, indicating that the indirect technique is better[2,3]. In addition, clinicians often prefer the indirect methods. Although polyether and addition silicones both have received more attention in research and practice, the potential variance within and/or between impression material groups demands complete evaluation[4]. In an era of evidence-based dentistry, however, the parameters of clinical acceptability should be considered as the standard by which techniques are evaluated. Therefore, this study was undertaken to evaluate and compare the most accurate impression technique and the influence of the impression material and method of transfer in reproducing the intra-oral position of implant fixtures to the working cast.

MATERIALS & METHOD - In this study, two elastomeric impression materials: Polyvinyl siloxane (putty and light bodied) and, polyether (medium bodied) along with two transfer techniques – indirect and direct were used to record impressions of the master model simulating the intraoral situation. For this, a master model representing human mandible was made in clear, heat-cure polymethyl methacrylate resin with four implant replicas of 3.75 × 11 mm placed at A, B, D and E positions from right to left, by using implant surveyor(Fig.1). Also, standardized custom stainless steel trays of two types – open and closed (Fig.2), were specially prepared for this study. Open tray was fabricated with window for the direct implant analogue transfer method or pick-up technique to expose the transfer copings and closed tray was designed without window for the indirect implant analogue transfer method or repositioning technique. A special metal stand with handle was fabricated, to hold the custom tray in the desired position in relation to the master model, while impression making and maintain an even space of 3 mm between the master model and the inner surface of the tray at the same load of 1kg for all impressions(Fig.3).

Two groups of impressions were made with two sub-groups each according to two parameters (impression materials and transfer

techniques). The grouping of samples was as follows :

a. Group D-PVS (Direct technique - Polyvinyl siloxane impression material)
b. Group D-PE (Direct technique - Polyether impression material)
c. Group ID-PVS (Indirect technique - Polyvinyl siloxane impression material)
d. Group ID-PE (Indirect technique - Polyether impression material)

Before making the impressions, transfer impression copings were secured on the master model according to the type of impression to be made either open tray transfer coping or closed tray transfer coping, . To simulate intraoral conditions, the master model was kept in a humidor at 37˚C for 10 minutes before making the impressions. Each tray was coated with the dedicated tray adhesive according to the type of the impression material being used, 15 minutes before impression was made according to the manufacturer's instructions.

In Group D-PVS, polyvinyl siloxane impressions were made using direct technique with open custom tray. Impressions were made with putty and light body using double mix single phase technique was used. The implant impression technique used in this group was direct technique/pick-up technique. Thus, for the impression copings to be picked up with the impression material, excess material was removed through the open window to expose upper portion of the copings. The impressions were allowed to set for 5 minutes under a standard load of 1 kg using the impression stand. After the impression material was set, the transfer copings were unscrewed and picked along with the impression. Implant replicas were connected to the respective transfer copings into the impressions and the impressions were poured. While in Group D-PE, medium-bodied (monophase) polyether impression material was used for making the impressions, for which the base and catalyst paste of equal lengths (7:1 by volume) were manipulated and were allowed to set for 6 minutes. The technique was same used for D-PVS group.

While for group ID-PVS, the material manipulation was similar as described for D-PVS group. Indirect technique of implant analogue transfer was used, thus the closed tray transfer copings on the master model were not separated throughout the procedure of impression making . The impressions were separated from the master model, leaving behind the transfer copings. Then, the transfer copings were disconnected from the master model and connected with implant replicas. The transfer coping and implant replica assemblies were positioned into their respective sites in the impression, and were poured to obtain the definitive cast. In group ID-PE, the impressions for this group were made using polyether impression material – medium bodied

and indirect technique (closed tray technique). The technique employed was same as for the previous group.

All the impressions were poured using the same quantity of Type IV die stone i.e, 100 grams of powder was mixed with 22 ml of distilled water according to the manufacturer's instructions by hand for 15 seconds to incorporate water and then mechanically mixed under a vacuum mixer for 30 seconds with a mechanical spatulator vibrated into the impressions. An acrylic resin frame was made for pouring the impression base with Type – II, dental plaster. After allowing to set for 1 hour, the cast was carefully separated from the impression . The casts were trimmed and marked with a code for the measurements. Finally, all models were stored for 24 hours at 23°C and 50% relative humidity prior to measuring.(fig 4)

The master model and casts obtained were measured by means of a stereomicroscope (Leica, Microsystems S8APO, Switzerland) with software (LAS-E2,Leica,ApplicationSuite,Version 1.6.0, Leica Qwin, Leica Imaging Systems, Switzerland limited) (Fig.5).these measurements were analyzed using software that received the images from a video camera (JVC, 0.5-inch CCD, model TK-C1380) coupled to a Leica stereomicroscope at 10× magnification. Three linear inter-coping distances were measured on the control acrylic resin master model and on the definitive study casts :

(1) AB – the distance between the mesial-most point on the external sharp edge of the buccal surface of the coping placed on the implant replica in A position (right most) and the distal-most point external sharp edge on the buccal surface of the coping placed on the implant in B position. (Fig.5a)

(2) BD – the distance between the mesial-most points on external sharp edge of the buccal surface of the coping placed on the implant replicas in B position and D position. (Fig.5d)

(3) DE - the distance between the distal-most point on the external sharp edge (buccal surface) of the coping placed on the implant replica in position-D and the mesial-most point on the external sharp edge (buccal surface) of the coping placed on the implant in E position. (Fig.5c)

The values of experimental casts were then be subtracted from the corresponding inter-coping linear distance of the master model at AB, BD and DE, to get the deviation in millimeters. The values of experimental casts were then be subtracted from the corresponding inter-coping linear distance of the master model at AB, BD and DE, to get the deviation in millimeters.

RESULTS – Mean cast error and subgroup cast error was calculated for all the 4 groups as shown

in table 1 and 2 . They were statistically analyzed using one-way ANOVA and Multiple Tukey test the result obtained is shown in Table 3 and 4. It was found that indirect technique (closed custom tray) was superior when used PVS impression material and when open-window custom tray was used polyether impressions were superior. Comparison of dimensional accuracy of Group D-PVS, D-PE, ID-PVS and ID-P is shown in graph 1.

Group	N	Average Inter-coping distance AB	Average Inter-coping distance BD	Average Inter-coping distance DE
Group D-PVS	**10**	**0.045**	**0.052**	**0.053**
Group D-PE	**10**	**0.042**	**0.047**	**0.046**
Group ID-PVS	**10**	**0.079**	**0.076**	**0.073**
Group ID-PE	**10**	**0.091**	**0.088**	**0.082**

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
D-PVS	10	0.05	0.002	0.0008	0.04	0.05
D-PE	10	0.04	0.002	0.0009	0.04	0.04
ID-PVS	10	0.07	0.002	0.0008	0.07	0.07
ID-PE	10	0.08	0.002	0.0007	0.08	0.08

Table 1and 2 Comparison of dimensional accuracy of Group D-PVS, D-PE, ID-PVS and ID-PE

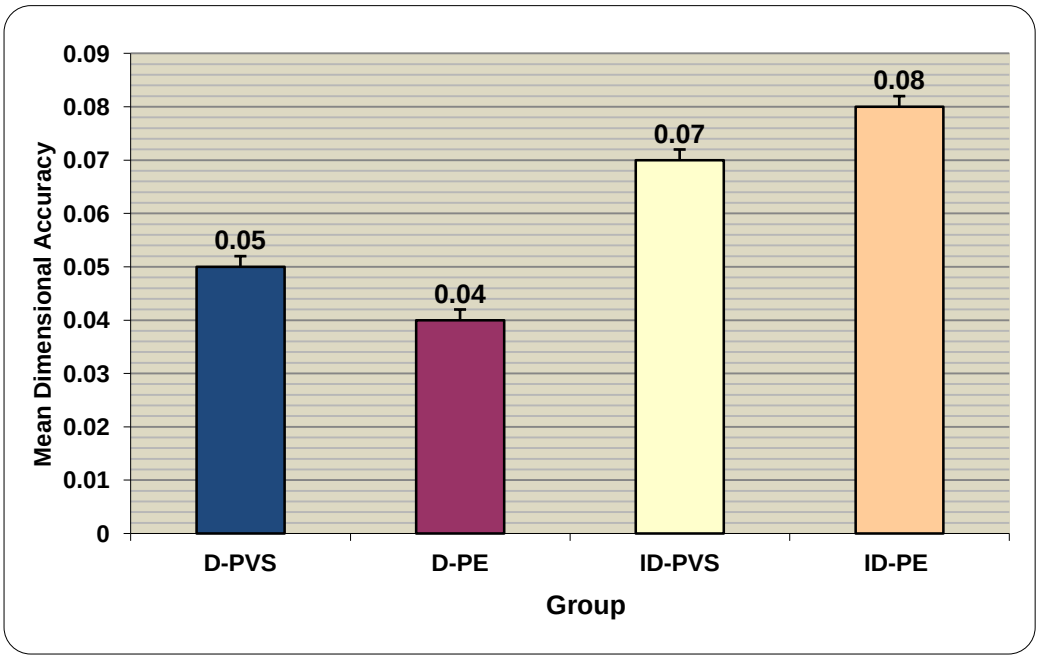
Source of variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	0.012	3	0.004	585.75	0.000

Within Groups	0.000	36	0.000		S,p<0.05
Total	0.013	39			

Table 3- One-way ANOVA

Group		**Mean Difference (I-J)**	**Std. Error**	**p-value**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
D-PVS	D-PE	0.004	0.001	0.002 S,p<0.05	0.001	0.007
	ID-PVS	-0.026	0.001	0.000 S,p<0.05	-0.029	-0.023
	ID-PE	-0.037	0.001	0.000 S,p<0.05	-0.040	-0.034
D-PE	ID-PVS	-0.031	0.001	0.000 S,p<0.05	-0.034	-0.027
	ID-PE	-0.042	0.001	0.000 S,p<0.05	-0.045	-0.038
ID-PVS	ID-PE	-0.011	0.001	0.000 S,p<0.05	-0.014	-0.007

Table 4 -MULTIPLE Tukey test



Graph 1- Comparison of dimensional accuracy of Group D-PVS, D-PE, ID-PVS and ID-PE

DISCUSSION- As polyethers and addition silicones have been recommended to be suitable as impression materials for multiple implant restorations. The mechanical properties of these impression materials such as accuracy and rigidity may influence the precision of the impression, cast and consequently the final framework. These are validated for clinical use by Wee AG et al[5], keeping the thickness of the elastomeric material as uniform as possible. In this study, the results obtained for polyvinyl siloxane impression material suggested that there was a mean cast error of 0.063mm , as compare to 0.066mm of polyether impression material.

While comparing, polyvinyl siloxane impression material for the two impression techniques, the mean distance using the direct technique at AB, BD and DE was 5.50mm, 9.498mm and 5.339mm respectively; whereas for the indirect technique, it was 5.501mm, 9.515mm and 5.367mm at AB, BD and DE respectively. These were compared to the measurements obtained from the master model which were 5.504mm, 9.501mm and 5.351mm at AB, BD and DE respectively. Thus, the mean cast error for D-PVS group at inter-coping distances AB, BD and DE were 0.045±0.0033mm, 0.052±0.0043mm and 0.053±0.0042mm respectively. Similarly, the mean cast error for ID-PVS group was also calculated which was 0.079±0.0036 mm, 0.076±0.0048mm and 0.073±0.0040mm at inter-coping distances AB, BD and DE respectively. So, it was found that polyvinyl siloxane gave better results with the indirect technique with group mean cast error of 0.076mm as compared to polyether used with the same technique (group mean cast error 0.087mm) in agreement with the studies quoted by Cieso[6] and Lee.[7] It may be explained as, the use of an elastic material may hypothetically reduce the permanent deformation of impression material determined by the stress between the material and impression copings created when an impression with the copings is removed from internal connection implants.[8]Thus, properties favoring the addition silicones are the higher yield strength, modulus of elasticity and high tear strength when compared with the polyethers for the indirect technique. Similar results were obtained by Madhan et al,[9] which were 0.08442 ± 0.1516mm of group mean cast error and standard deviation of the error for the impressions made by using polyvinyl siloxane with direct technique and 0.0167 ± 0.0055mm of group mean cast error for the impressions made with polyvinyl siloxane and indirect technique.

As for polyether impression material, it was observed that polyether impression material is more precise using direct technique with group mean cast error of 0.045mm than indirect impression technique with group mean cast error

of 0.087 mm. The mean cast error for D-PE group at inter-coping distances AB, BD and DE were 0.042±0.0053mm, 0.047±0.0048mm and 0.046±0.0038mm respectively. Similarly, the mean cast error for ID-PE group was also calculated which was 0.091±0.0041mm, 0.088±0.0038mm and 0.082±0.0057mm at inter-coping distances AB, BD and DE respectively. Relating the technique with the impression material for the direct technique, it is required that the impression material should be provided with a sufficient rigidity in order to hold the copings in their position during the removal force application, thus preventing accidental displacements and ensuring a minimal positional distortion between the laboratory components, which were fulfilled by the polyether impression material.[10]

CONCLUSIONS –

1. All the four impression procedures studied showed some distortion in transferring the implant positions. Exact reproduction of implant position was not accomplished with any of the technique and material combination.
2. Among the four subgroups, the highest level of dimensional accuracy was observed with impressions made by using direct impression technique and polyether impression material.
3. Among the four subgroups, the lowest level of dimensional accuracy was observed with impressions made by using indirect impression technique and polyether impression material.
4. The dimensional accuracy of the casts obtained by pouring the impressions made by using direct technique were significantly more accurate as compared to the indirect technique.

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Fig 1 Master model with 4 implant replica

Fig 2 : standardized custom stainless steel trays of two types – open and closed

Fig.3a Impression making using impression stand

[HP-Horizontal platform, V-Vertical arm, J-Joint between vertical arm & metal handle, MH-Metal handle, W- Weight, C-Metal cube, MM – Master model,

IT – Impression tray]

Fig.4 - Implant sample cast

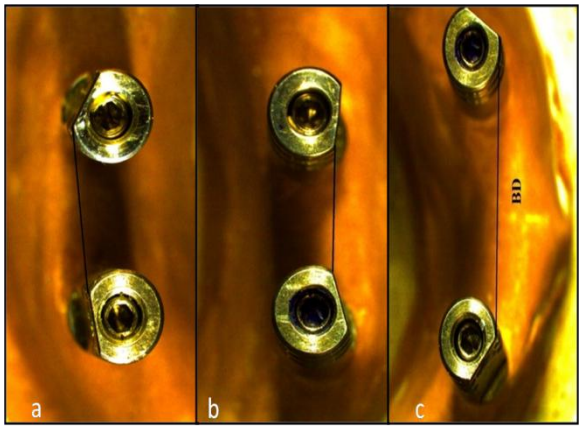

Fig 5 Inter-implant distance AB

a) AB, b) BD , c) DE