# THE RESULT IMPRESSION MATERIAL CONSISTENCY AND OF TRAY FORM ON PRECISION OF ENTIRE ARCH IMPLANT GUIDED FIXED DENTAL PROSTHESIS MASTER CASTS

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**Abstract**

**Introduction-** Oral rehabilitation of partially and completely edentulous patients with dental implants currently involves routine prosthodontic and implant procedures.

**Methodology-**The study was carried out in Department of Prosthodontics and Crown & Bridge, School of Dental Sciences, Sharda University, Greater Noida. Biohorizons implants and implant components were utilized in this study. A reference model was fabricated by attaching an open-tray abutment level impression coping to each abutment replica; resembling an all-on-4 clinical prosthetic situation. Atotal sample size of 108, nine samples per group, was determined to be sufficient to detect an effect size of 0.67 with 80% power at a 5% significance level.

**Results-**Root mean square (RMS) for group I ranged from 0.046-0.1 mm (46-100µm). RMS for group II ranged from 0.058-0.58mm (58-580µm). RMS for group III ranged from 0.036- 0.078 mm (36-78µm). RMS for group IV ranged from 0.041-0.067mm) (41-67µm).

**Conclusion-** Custom tray impression groups showed better results in comparison to the stock tray impression groups. The average value for both stock tray groups was 120 µm while the average for both custom tray impression groups was 55µm. There was asignificant difference between stock tray and custom tray impression groups.

**Keywords-** ISFDPs, edentulous arches, Impression Material

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## 1. Introduction

Oral rehabilitation of partially and completely edentulous patients with dental implants currently involves routine prosthodontic and implant procedures. Longitudinal clinical studies have proven the effectiveness of these treatment modalities.[1,2] Implant supported fixed dental prostheses (ISFDPs) have been a successful treatment for patients with severely compromised/debilitated dentitions or resorbed edentulous jaws. The prostheses are either screwed onto individual abutments that have been screwed into endosseous dental implants to rehabilitate edentulous arches, or prostheses may also be screwed directly into implants without abutments.[1,2]

ISFDPs require accurate transfer of implant positions to make a definitive casts in order to fabricate prostheses that accurately and passively fit the implants.[3] Implants do not have a resilient connection to bone, and lack the mobility that the periodontal ligament provides for natural teeth. It has been reported that movement of implants within bone is limited to 50-150 µm, and this movement is usually caused by bone deformation.[4] Due tothis rigid connection and lack of periodontal ligaments between implants and bone, any stress imparted to the prosthesis will be directly transmitted to implant components and surrounding bone.[5] Hence, a macroscopic misfit of the prostheses will result in continuous static stress transfer to implants. Obtaining an accurate fit between implants and definitive prostheses is the primary goal of any impression technique.The clinically acceptable misfit of one-piece implant supported FDPs has yet to be established; however, Jemt and Book reported that a range from 91 to 111 µm is acceptable.[6]

The first and most critical step toward achieving a passive fit for ISFDPs is making accurate impression which correctly transfers the inter-implant relationships in three dimensions. An accurate impression technique is needed to produce accurate definitive casts on which frameworks will be fabricated. There are several considerations involved in fabrication of implant master casts that affect accuracy and precision. These include impression technique, impression material, implant angulation and/or parallelism, depth of implant placement, implant number, distance between implants, setting expansion of dental stone, design and rigidity of impression trays, and splinting impression copings.[7]

## 2. Methodology

The study was carried out in Department of Prosthodontics and Crown & Bridge, School of Dental Sciences, Sharda University, Greater Noida. Biohorizons implants and implantcomponents were utilized in this study. A reference model was fabricated by attaching an open-tray abutment level impression coping to each abutment replica; resembling an all-on-4 clinical prosthetic situation. (Figure 1).

Figure 1 Impression Copings attached to acrylic resin model.

The acrylic resin model was not used as a reference model to prevent reflection from the polished resin to the scanner due to material differences which might have affect the results. Implants and multiunit abutments were used in this study to resemble clinical conditions instead of implant/abutment replicas or analogs. After the stone set, and the cast was removed from the impression, 5 round depressions were made in the palatal area to help with the superimposition procedure (scanning) to come later.

G*Power 3.1 was used to calculate the required sample size. Determination of effect size was based upon outcomes reported in the literature where the means were ~30-40 µm and the standard deviation was ~15 µm. A total sample size of 108, nine samples per group, was determined to be sufficient to detect an effect size of 0.67 with 80% power at a 5% significance level.

**Group I: Heavy and light body PVS with stock tray (Stock Tray without support of splinting device segments).**

Heavy body impression material was injected into the stock tray and at the same time light body PVS was injected under and around the splinting impression devices and the stock trays were seated. (Figure 2) After 7 minutes of polymerization, the impressions were separated from the reference cast and abutment analogs were attached to the impression copings; the impressions were poured immediately.

Figure 2 Group I: Stock Tray with no support

**Group II: Light body PVS with heavy body PVS supporting the splinting device in stock trays (Stock tray with support to splinting device segments with heavybody PVS).**

\-Heavy body PVS was injected between the splinting impression device and the peri- implant soft tissues around the four impression copings. It was allowed to polymerize for 5 min. After polymerization, light body PVS was injected into stock trays and around the heavy body PVS/splinting impression devices; the trays were seated. After 7 minutes of polymerization, the impressions were separated from the reference cast and abutment analogs were attached to the impression copings; the impressions were poured immediately. (Figure 3) Stock trays for groups I and II were modified by providing 4 openings to accommodate and provide access to the impression coping screws.

Figure 3 Group II: Stock tray with support

**Group III: Heavy and light body PVS with custom tray and 3 mm spacer. (Custom Tray without support of splinting device segments).**

Heavy body impression material was injected into the custom tray and at the same time light body PVS was injected under and around the splinting impression devices and the custom trays were seated. (Figure 21) After 7 minutes of polymerization, the impressions were separated from the reference cast and abutment analogs were attached to the impression copings; the impressions were poured immediately.

Figure 4 Group III: Custom tray without heavy body PVS support

**Group IV: Light body PVS with heavy body PVS supporting the splinting device with custom tray and 3 mm spacer. (Custom tray with support to splintingdevice segments with heavy body PVS)**

Heavy body PVS was injected between the splinting impression device and the peri- implant soft tissues around the four impression copings. It was allowed to polymerize for 5 min. After polymerization, light body PVS was injected into the custom tray and around the heavy body PVS/splinted impression devices; the tray was seated. After 7 minutes of polymerization, the impressions were separated from the reference cast and abutment analogs were attached to the impression copings;the impressions were poured immediately. (Figure 4).

Figure 4- Group IV: Custom tray with heavy body PVS support Cast Pouringprocedure

After making the first impression, and before separation from the cast, silicone putty wasused to fabricate a model for uniform pouring of impressions. Two silicone molds were fabricated, one for the custom tray groups, and the other for the stock tray groups. After making the impression, the impression was inserted into the silicone mold (Figure 5) and low expansion (0.09%) Type IV die stone (Silky Rock; Whipmix Corp) was usedto pour the impression according to manufacturer's recommendations. Casts were separated from the impressions 24 hours after pouring.

Figure 5 Impression inserted into silicone mold for the custom tray groups.

After the casts were separated from the impressions, Scan bodies (Elos Accurate Multi-unit Scan Body) were attached to the abutment analogs (Figure 6) in the cast and an extraoral scanner (E3, 3Shape, Denmark) was used to scan and digitize all casts. The scanned files were exported as STL files. An occlusal index made of light cure impression tray material was used to ensure the top part of all scan bodies were inserted inthe same direction.

**Comparison**

The acquired STL files were imported into a mechanical Computer-Aided Design software (Geomagic control 2015, Morrisville, NC, USA). The best fit algorithm was used to superimpose the STL files of the master cast onto the STL file of the sample casts using the five palatal depressions as fiducial landmarks.

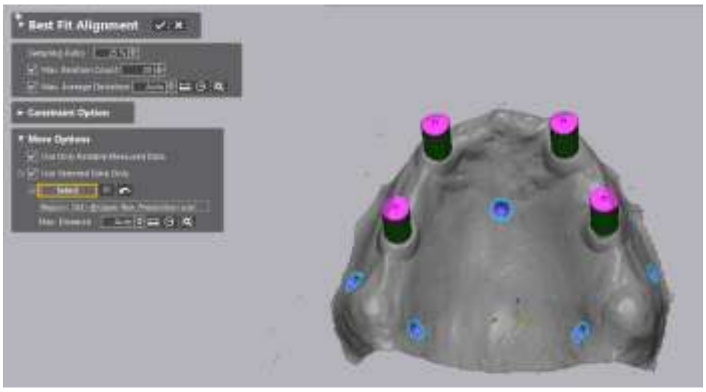


Figure 6 Fiducial landmark for superimposition (Purple)

**Data analysis**

Statistical analysis was done using Microsoft Excel. The results were expressed as average errors and standard deviations in the master cast relative to the sample casts. To account for having both positive and negative values in the data set, in terms of errors, the Root Mean Square (RMS) value was calculated for each sample. The RMS value is the square root of the arithmetic mean of the squares of the values. It gives a measure of the relative magnitude of a data set while eliminating the negative and positive signs. This is beneficial for 3D analysis since having positive and negative values for errors may cancel each other out and lead to misinterpretation of the data. 2-way ANOVA was utilized.

## 3. Results

Root mean square (RMS) for group I ranged from 0.046-0.1 mm (46-100µm). RMS for group II ranged from 0.058-0.58mm (58-580µm). RMS for group III ranged from 0.036- 0.078 mm (36-78µm). RMS for group IV ranged from 0.041-0.067mm) (41-67µm). RMSfor all groups is shown in Table 1.

Table 1. RMS for all groups in mm (1 mm equals 1000 µm).

| | RMS (mm) | | | |
|---|---|---|---|---|
| | Group I | Group II | Group III | Group IV |
| #1 | 0.0635 | 0.0577 | 0.0524 | 0.0538 |
| #2 | 0.1055 | 0.0921 | 0.0551 | 0.0669 |
| #3 | 0.0647 | 0.0643 | 0.044 | 0.0573 |
| #4 | 0.0757 | 0.0661 | 0.0489 | 0.0573 |
| #5 | 0.076 | 0.3337 | 0.0361 | 0.0559 |
| #6 | 0.0626 | 0.1349 | 0.0677 | 0.0583 |
| #7 | 0.0544 | 0.0878 | 0.0442 | 0.0418 |
| #8 | 0.0534 | 0.0878 | 0.0784 | 0.0414 |
| #9 | 0.0457 | 0.5802 | 0.0723 | 0.0593 |

Table 2. RMS (mm) for No Support/Support groups.

| | **No Support** | **Support** |
|---|---|---|
| **Stock Tray** | 0.0635 | 0.0577 |
| | 0.1055 | 0.0921 |
| | 0.0647 | 0.0643 |

| | | |
|---|---|---|
| | 0.0757 | 0.0661 |
| | 0.0760 | 0.3337 |
| | 0.0626 | 0.1349 |
| | 0.0544 | 0.0878 |
| | 0.0534 | 0.0878 |
| | 0.0457 | 0.5802 |
| **Custom Tray** | 0.0524 | 0.0538 |
| | 0.0551 | 0.0669 |
| | 0.0440 | 0.0573 |
| | 0.0489 | 0.0573 |
| | 0.0361 | 0.0559 |
| | 0.0677 | 0.0583 |
| | 0.0442 | 0.0418 |
| | 0.0784 | 0.0414 |
| | 0.0723 | 0.0593 |

The summary for stock tray groups is shown in Table 3. The average for stock tray impressions without heavy body PVS support was 0.067mm (67µm), while the average for stock tray impressions with heavy body PVS support was 0.168mm (168µm). The overall average for both tray groups was 0.12mm (120µm).

Table 3. Stock tray groups summary.

| Stock Tray | No support | Support | Total |
|---|---|---|---|
| **Count** | 9 | 9 | 18 |
| **Sum** | 0.6015 | 1.5046 | 2.1061 |
| **Average** | 0.066833 | 0.16717778 | 0.117005556 |
| **Variance** | 0.000309 | 0.03129789 | 0.017539216 |

The summary for the custom tray impression groups is shown in Table 4. The average forcustom tray impressions without heavy body PVS support was 0.055mm (55µm). The average for custom tray impressions with heavy body PVS support was 0.054mm (54µm). The average for both tray groups was 0.055mm (55µm).

Table 4. Custom tray groups summary.

| Custom Tray | No support | Support | Total |
|---|---|---|---|
| **Count** | 9 | 9 | 18 |
| **Sum** | 0.4991 | 0.492 | 0.9911 |
| **Average** | 0.055456 | 0.05466667 | 0.055061111 |
| **Variance** | 0.000206 | 6.7753E-05 | 0.000128819 |

A summary for no support and supported groups is shown in Table 5. The average for theno support group was 0.06mm (60µm), and the average for the impressions supported with heavy body PVS was 0.11mm (110µm).

Table 5. Support and no support groups summary.

| Total | No support | Support |
|---|---|---|
| **Count** | 18 | 18 |
| **Sum** | 1.1006 | 1.9966 |
| **Average** | 0.061144 | 0.11092222 |
| **Variance** | 0.000277 | 0.01811115 |

Two factor Anova test with replication is shown in Table 6. There was no significant difference between groups with and without heavy body PVS support (P=0.1). The average for the no heavy body PVS supported groups was 0.061 mm (61µm), while the average for the heavy body PVS supported groups was 0.11mm (110µm). However, there was a significant difference (P=0.045) between types of tray. The average for the custom tray impression group was 0.055 mm (55 µm), while the average for stock tray impression group was 0.117 mm (117µm). There was no interaction between groups combination (P=0.1).

Table 6. Two factor Anova test with replication.

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| **Sample** | 0.034534 | 1 | 0.034534028 | 4.332947 | 0.045464368 | 4.149097 |
| **Columns** | 0.0223 | 1 | 0.022300444 | 2.798012 | 0.104131901 | 4.149097 |
| **Interaction** | 0.023013 | 1 | 0.02301289 | 2.887402 | 0.098977957 | 4.149097 |
| **Within** | 0.255043 | 32 | 0.007970102 | | | |
| | | | | | | |
| **Total** | 0.334891 | 35 | | | | |

## 4. Discussion

The Root Mean Square (RMS) for all groups was (36-100µm) which is within the clinical acceptable range of 150 µm [6] except for Group II stock tray with heavy body PVS support and light PVS impression material. This group had a higher range than the clinical accepted level (58-580 µm). [8,9] This could be explained by the increase of polymerization shrinkage in low viscosity PVS impression material compared to high viscosity impression material because of the reduced amount of filler in the earlier as volumetric polymerization shrinkage decreased with increasing filler content.[10] Custom tray impression groups showed better results in comparison to stock tray impression groups. The average for both stock tray impression groups was 120µm, while the average for both custom tray impression groups was 55µm. There was a significant difference between the stock tray and custom tray impression groups (P-value=0.045). Therefore, the first null hypothesis that indicated there would be no differences between stock tray and custom tray impression groups was rejected. The difference could be considered clinically irrelevant because both groups were still within the clinically acceptable levels. Less accurate results in the stock tray impression group could be related to increased polymerization shrinkage of the impression material. There are several contributing factors for increased polymerization shrinkage in the stock tray impression groups[11],including an increase in thickness and volume of impression material in stock trays which contributes to an increase in polymerization shrinkage. The rigidity of custom trays also plays an important role in impression accuracy as it minimizes impression material distortion.[11] A uniform thickness of impression material generates equal pressure on teeth and oral structures during tray seating and is a contributing factor to the accuracy of the created cast.[8] A study by Cho GC and Chee WW[12] found that plastic stock tray deforms significantly when used with putty viscosity PVS when compared to metal stock tray. Couple studies indicate that the rigidity of the metal stock tray ensured better results than plastic stock tray for natural teeth and implant impressions with a high-viscosity impression material. This present study yielded results consistent with a study by Burn et al, it was concluded that there were differences between impressions made in stock trays versus custom trays with 2 different amounts of spacer (3 mm and 10 mm). A 10 mm spacer custom tray was designed to provide the same internal dimensions with that of a stock tray. It was found that impressions in rigid custom trays produced significantly more accurate casts when compared to impressions made in stock trays regardless of the thickness of impression material. However, the difference was clinically insignificant (10 µm) as it is difficult to measure gaps less than 60 µm clinically.[13] In an in vitro study of the complete arch closed tray impression technique for implant supported prostheses, Gökçen-Rohlig et al found no significant differences in implant impression accuracy when medium-viscosity PVS was used with 3 different types of impression trays: perforated metal stock, custom acrylic resin, and perforated plastic stock trays. However, all plastic stock trays are not alike. Some are made with varying thicknesses of plastic that may distort upon removal of the impression trays from the mouth. Also, the open tray technique includes drilling holes into the trays, which may also have an impact on strength and deformation properties of the trays.[14] Therefore, the results were not affected by the slanted portions of the scan bodies. There were two incidences in Group II were the best fit algorithm was thought to be inaccurate. The hard palate fiduciary areas were used to compensate for this. These two incidences might contribute to the increased RMS for Group II as both of them had a higher RMS than average (samples 5 and 9, 330 and 580 µm respectively). If these two samples were excluded, the highest RMS for Group II would be 135 µm, which is still within the acceptable range. This might indicate that a rigid splinting device will reduce an accurate impression regardless if impression material and technique.

## 5. Conclusion

The Root Mean Square (RMS) for all groups was (36-100 µm) which is within the clinically acceptable range of 150 µm. [6, 7, 8,9] This was not true for the Group II stock tray impressions with heavy body PVS supported segments and light PVS impression material; the range exceeded accepted levels (58-580 µm). Custom tray impression groups showed better results in comparison to the stock tray impression groups. The average value for both stock tray groups was 120 µm while the average for both custom tray impression groups was 55µm. There was a significant difference between stock tray and custom tray impression groups. There was no difference between supporting and not supporting the splinting device segments with heavy PVS impression material before making impressions.

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