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**Original Research**

# A Comparison of Accuracy of Matrix Impression System with Putty Reline Technique and Multiple Mix Technique: An *In Vitro* Study

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***Abstract:***

**Background:** The difficulty in obtaining an acceptable impression increases exponentially as the number of abutments increases. Accuracy of the impression material and the use of a suitable impression technique are of utmost importance in the fabrication of a fixed partial denture.

This study compared the accuracy of the matrix impression system with conventional putty reline and multiple mix technique for individual dies by comparing the inter-abutment distance in the casts obtained from the impressions.

**Materials and Methods:** Three groups, 10 impressions each with three impression techniques (matrix impression system, putty reline technique and multiple mix technique) were made of a master die. Typodont teeth were embedded in a maxillary frasaco model base. The left first premolar was removed to create a three-unit fixed partial denture situation and the left canine and second premolar were prepared conservatively, and hatch marks were made on the abutment teeth. The final casts obtained from the impressions were examined under a profile projector and the inter-abutment distance was calculated for all the casts and compared.

**Results:** The results from this study showed that in the mesiodistal dimensions the percentage deviation from master model in Group I was 0.1 and 0.2, in Group II was 0.9 and 0.3, and Group III was 1.6 and 1.5, respectively. In the labio-palatal dimensions the percentage deviation from master model in Group I was 0.01 and 0.4, Group II was 1.9 and 1.3, and Group III was 2.2 and 2.0, respectively. In the cervico-incisal dimensions the percentage deviation from the master model in Group I was 1.1 and 0.2, Group II was 3.9 and 1.7, and Group III was 1.9 and 3.0, respectively. In the inter-abutment dimension of dies, percentage deviation from master model in Group I was 0.1, Group II was 0.6, and Group III was 1.0.

**Conclusion:** The matrix impression system showed more accuracy of reproduction for individual dies when compared with putty reline technique and multiple mix technique in all the three directions, as well as the inter-abutment distance.

***Keywords:*** Matrix impression, multiple mix, poly vinyl siloxane, putty reline

## Introduction

The fixed partial prosthesis is one of the well developed and well-accepted treatment modality in the field of prosthodontics. The precise work begins right from the tooth preparation, impression making, cast/die preparation, wax pattern fabrication, casting, finishing, and cementation. If any inaccuracy occurs at any step, it will be carried through to the final stage of the prosthodontic treatment. Making an accurate impression of dental and dentoalveolar structures is important and an essential requirement for the precise fit of the prosthesis. This is one of the important factors that determines the restorations longevity.[1]

The difficulty in obtaining an acceptable impression increases exponentially as the number of abutments increases, because of the problems encountered in controlling the tissue fluids and saliva, while a free flowing impression material is injected simultaneously. The addition type silicone impression materials, polyvinyl siloxanes (PVS) have been reported to be the most accurate and dimensionally stable materials.[1,2] Some authors claim that the extent of accuracy of dies is determined more with the technique than by the material itself and others reporting that the impression accuracy is governed more with the material employed.[2,3]

Stackhouse (1970)[4] studied the accuracy of stone dies made from four rubber base elastomers (one polysulfide and three silicones) in three clinically simulated techniques and found that more uniform dies were produced from the silicone than from the polysulfide rubber impression material. Eames and Sieweke (1980)[5] examined the feasibility of the putty wash system of impressions as an alternative to the custom-made tray of acrylic resin and concluded that putty wash was a better alternative to the custom tray technique. Brown (1981)[6] advocated the twin-mix and two stage with spacer impression technique for better results. Livaditis (1998)[7] compared the methods and effectiveness of traditional fixed partial denture impression systems with the matrix impression system and reported that the matrix impression system controls the four forces (relapsing, retraction, displacement and collapsing) that have impact on the gingiva during the critical phase

of making the impression, when attempting to register the subgingival margins. Thus, it can be supposed that even with the proven accuracy of the material, the technique also has to be considered, especially in cases of fixed partial denture. The purpose of this study was to compare the accuracy of the matrix impression system with conventional putty reline and multiple mix technique for individual dies and to evaluate the inter-abutment distance in master model using the three impression methods.

## Materials and Methods

Table 1 lists the impression materials used in the study. The master model was prepared with typodont teeth embedded in a maxillary frasaco model base. The left canine and second premolar were prepared conservatively to receive a ceramometal fixed partial denture. The first premolar was removed to simulate a clinical case of a three-unit bridge. Four sharp hatch marks were made with a round bur on the finish lines of each prepared tooth. The hatch marks were placed diagonally opposite (i.e. one each on labial/buccal, palatal, mesial, and distal) on each prepared tooth. Two more hatch marks were placed on incisal surface of canine and the occlusal surface of premolar (Figure 1).

Three groups of impressions were made with three different techniques (Group I, II, and III). Each group had 10 impressions and the casts obtained from them were named as Group I, II, and III casts, respectively. The impressions made using matrix impression system were considered as Group I impressions, putty reline technique as Group II impressions and multiple mix technique as Group III impressions. For all the groups before making the impressions, the master model was immersed in the water bath maintained at 37 ± 2°C to simulate the oral temperature. After that, the master model was taken out of the water bath and dried with air. The tray adhesive (3M ESPE, VPS tray adhesive) was coated on the internal surface of the tray and air dried for 5 min, before making the impressions.

Matrix impression system has three series of impression procedures. First, a PVS-putty impression was made and allowed to set for 8 min. The matrix obtained was trimmed on outer and inner surfaces to provide space for second and third impressions. A definitive impression of the prepared teeth was made with a high viscosity elastomer which was injected with an automatic mixing system. Simultaneously, a suitable stock tray was loaded with a medium viscosity elastomeric impression material with an automatic mixing system and inverted over the matrix. In putty-relining technique, initially a putty impression was made with a stock tray and after it was set, the impression surface was scraped to provide space for light body. In multiple mix technique, a custom tray was fabricated and loaded with heavy body while the light body was injected over the prepared teeth and then the tray was impressed against the model.

**Table 1: Impression materials used.**

| Material | Manufacturer |
|---|---|
| Vinyl polysiloxane putty | 3M ESPE, express STD |
| Vinyl polysiloxane – heavy-bodied consistency | 3M ESPE, Imprint II Garant |
| Vinyl polysiloxane- regular-bodied consistency | 3M ESPE, express |
| Vinyl polysiloxane – light bodied consistency | 3M ESPE, express |
| Irreversible hydrocolloid | Imprint-DPI |

### *Measurements and statistical analysis*

The measurements of the master model as well as Group I, II, and III casts were done with a profile projector. In the master model, the tooth no.23 was considered as A and tooth no.25 was considered as B. On the prepared tooth, the distance between the hatch marks on mesio-distal surface was considered as measurement no.1 and the distance between the hatch marks on labio-palatal surface was considered as measurement no.2. The distance between the hatch marks on gingival third of the facial/buccal surface and incisal/

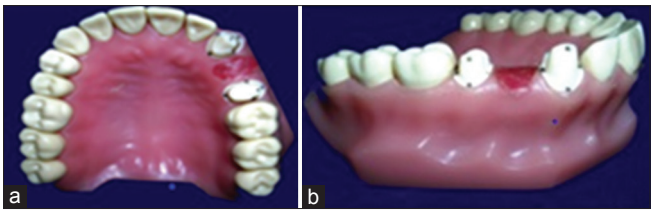


**Figure 1:** (a and b) Master model with hatch marks.

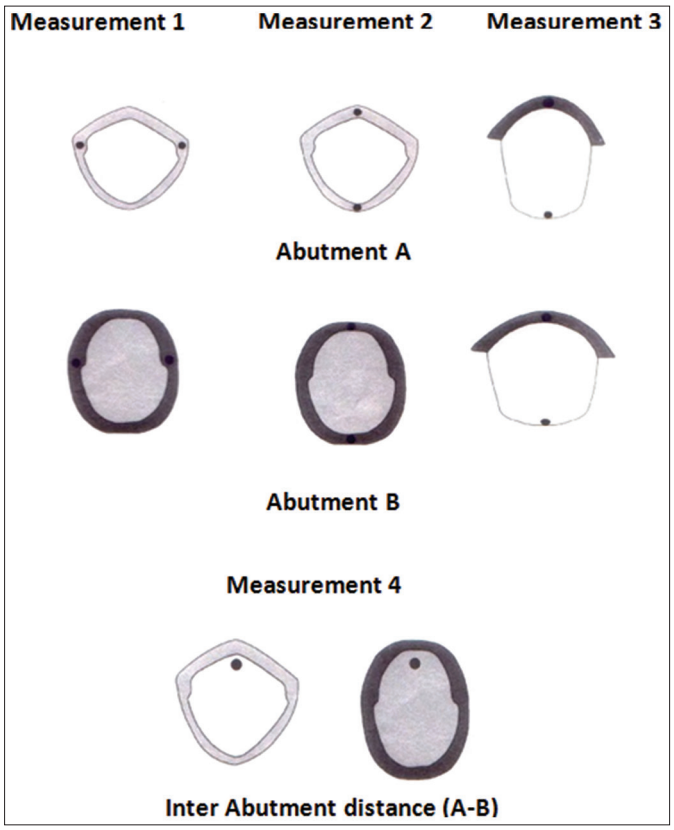


**Figure 2:** Schematic representation of the master model showing the reference points.

occlusal third of the facial/buccal surface was considered as measurement no.3 and the distance between the hatch marks on the incisal surface of A and that on occlusal surface of B was considered as measurement no.4 (inter-abutment) (Figure 2). All the measurements were made 3 times by the same operator and the mean was calculated and noted. Paired *t*-test was used to compare the discrepancy between matrix impression system, putty reline technique, and multiple mix technique. Multiple group comparisons were made by one-way analysis of variance (ANOVA). Unpaired *t*-test was used for group-wise comparisons.

## Results

### *For abutment A (Table 2)*

It was observed that the mean differences between master model and Group I casts in mesiodistal direction was 0.007 mm (expansion), in labio-palatal direction was 0.049 mm (contraction), and in cervico-incisal direction was 0.089 mm (expansion). In between master model and Group II casts, the mean difference observed was 0.062 mm (contraction) in mesiodistal direction, 0.161 mm (contraction) in labio-palatal and 0.310 mm (expansion) in cervico-incisal direction. Between master model and Group III casts the mean difference observed was 0.105 mm (contraction) in mesiodistal direction, 0.189 mm (contraction) in labio-palatal and 0.153 mm (contraction) in cervico-incisal direction. Statistical comparison between the master model and Group I, II, III casts measurements by paired *t*-test showed the significant statistical difference between the various groups except for Group I casts in the mesiodistal direction ($P < 0.05$).

### *For abutment B (Table 3)*

It was observed that the mean difference between master model and Group I casts in mesiodistal direction was 0.014 mm (contraction), in labio-palatal direction was 0.034 mm (contraction), and in cervico-incisal direction was 0.011 mm (contraction). In between master model and Group II casts, the mean difference observed was 0.020 mm (contraction) in mesiodistal direction, 0.121 mm (contraction) in labio-palatal direction, and 0.095 (expansion) in cervico-incisal direction. Between master model and Group III casts the mean difference observed was 0.089 mm (contraction) in mesiodistal direction, 0.188 mm (contraction) in labio-palatal direction, and 0.167 mm (contraction) in cervico-incisal direction. Statistical comparison between the master model, Group I, II, and III casts measurements by paired *t*-test showed no statistically significant difference between master model and Group I casts in mesiodistal and cervico-incisal direction, but in labio-palatal direction there was statistically significant difference. For Group II casts in mesiodistal direction, there was no statistically significant difference, but for labio-palatal and cervico-incisal direction the difference was statistically significant. The Group III cast measurements showed the statistically significant difference from the master model in all the three measurements ($P < 0.05$).

### *For inter-abutment distance AB (Table 4)*

It was observed that the mean difference of inter-abutment distance AB, between master model and Group I casts was 0.016 mm (expansion), for Group II casts it was 0.084 mm (expansion), and for Group III casts it was 0.151 mm

**Table 2: Mean differences of measurements of abutment "A" between the master model and Group I, II, and III casts.**

| Measurements of A | Master model in mm | Group I | | | Group II | | | Group III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Different from master model | Mean | SD | Different from master model | Mean | SD | Different from master model |
| 1 | 6.608 | 6.615 | 0.033 | 0.007 | 6.546 | 0.034 | 0.062 | 6.503 | 0.019 | 0.105 |
| 2 | 8.677 | 8.628 | 0.037 | 0.049 | 8.516 | 0.019 | 0.161 | 8.488 | 0.015 | 0.189 |
| 3 | 7.924 | 8.013 | 0.041 | 0.089 | 8.234 | 0.053 | 0.310 | 7.771 | 0.066 | 0.153 |

SD: Standard deviation

**Table 3: Mean differences of measurements of abutment "B" between the master model and Group I, II, and III working casts.**

| Measurements of B | Master model in mm | Group I | | | Group II | | | Group III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Different from master model | Mean | SD | Different from master model | Mean | SD | Different from master model |
| 1 | 5.876 | 5.862 | 0.041 | 0.014 | 5.856 | 0.104 | 0.020 | 5.787 | 0.042 | 0.089 |
| 2 | 9.268 | 9.234 | 0.039 | 0.034 | 9.147 | 0.088 | 0. 121 | 9.080 | 0.046 | 0.188 |
| 3 | 5.632 | 5.621 | 0.023 | 0.011 | 5.727 | 0.040 | 0.095 | 5.465 | 0.037 | 0.167 |

SD: Standard deviation

**Table 4: Mean differences of measurements of inter-abutment distance "AB" between the master model and Group I, II, and III working casts.**

| Measurement AB | Master model in mm | Group I | | | Group II | | | Group III | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Different from master model | Mean | SD | Different from master model | Mean | SD | Different from master model |
| 4 | 14.946 | 14.960 | 0.032 | 0.016 | 15.030 | 0.102 | 0.084 | 14.795 | 0.039 | 0.151 |

SD: Standard deviation

(contraction). Statistical comparison between master model, Group I, II, and III casts measurements by paired *t*-test showed no statistically significant difference between master model and Group I casts and showed statistically significant difference between master model and Group II, III casts.

Statistical comparison between Group I, II, and III casts (Table 5) measurements by one-way ANOVA (F-test) and unpaired-*t*-test showed the highly significant statistical difference between the three groups from each other.

**Discussion**

Fabrication of a fixed prosthesis is an indirect technique, in which the prosthesis is fabricated in the laboratory and then it is tried and cemented in the oral cavity. For this purpose, accurate replicas of the dental and dentoalveolar structures are required. Making an accurate impression of a single tooth or whole dentition is very vital in obtaining accurate working casts, and for the fabrication of the prosthesis or restorations. For obtaining an acceptable impression and the working casts, various factors have to be considered, like the proper selection of the impression technique, the impression material and the type of trays. Over the past four decades, tremendous progress has been made in procedures for making fixed prosthodontic impressions. These impression procedures involve a wide range of procedures and an even wider range of materials. Many studies reported that the elastomeric impression materials provide accurate and dimensionally stable impressions.

Several factors affect the accuracy of reproduction of an impression material which includes the tray,[8] tray adhesive[9] and the impression technique. Controlling the tissue fluids like gingival sulcular fluids, saliva and displacement of the gingival tissues around the abutments during impression procedure is a challenging task. When multiple abutment teeth are present, the tissue fluid and soft tissue management would be difficult.

PVS impression materials are extremely popular because of their combination of excellent physical properties, handling characteristics, and dimensional stability.[6,10,11] In PVS impression materials, the strength of the bond between the putty and light body is sufficient to overcome stress that might tend to separate the materials at their interface and result in potential errors in the impression.[12] The bond between the putty material and light body is chemical in nature and any bond failure which occurs is a cohesive failure in the weaker material.[13]

Various impression techniques like matrix impression system[7,14] putty reline technique[3,15] multiple mix technique[16] became popular for making fixed prosthodontic impressions. Various authors have reported conflicting results as regard to the superiority of one technique over the other. Livaditis[7,14] reported that matrix impression system is more accurate than the conventional impression techniques. The matrix impression system incorporates the attributes of traditional methods and overcomes important deficiencies in: (a) Registration of subgingival margins, (b) gingival retraction and relapse, (c) hemostasis and sulcular cleansing, (d) delivery of impression material subgingivally, (e) strengthening the sulcular flange of the impression, (f) simplification for making complex impressions.[7] The matrix forming material should register details equal to the best impression materials and should be rapid setting and compatible with the matrix impression and tray impression materials. Ideally, it should bond with the other two materials without the use of an intermediate adhesive layer.[7] The matrix impression material which is used to fill the matrix and generate the critical portion of the impression should be a high viscosity impression material. A high viscosity impression material will facilitate displacement of the gingival tissue and to effectively flush debris out of the sulcus.[7] The tray impression material that is loaded in the stock tray should be compatible with and bond to the matrix forming material and the impression material lining the matrix.[7,14]

For putty reline technique, Fusayama *et al.*[17] and Wassell and Ibbetson[18] reported that one step putty reline technique produced more accurate casts, whereas Dhiman *et al.*,[9] Johnson and Drennon[19] and Nissan *et al.*[1] reported that dimensional accuracy was better with two-step technique. Hung *et al.*,[3] Idris *et al.*,[20] Lacy *et al.*,[21] and Stackhouse[4] did not find any difference between the two techniques.

The objective of this *in vitro* study was to compare the accuracy of matrix impression system with conventional putty reline technique and multiple mix technique for individual dies, and to evaluate the inter-abutment distance in master model using the three impression techniques. The results from this study

**Table 5: Absolute change (μm) and percentage deviation (%) from master model of each impression technique.**

| Teeth | Measurement | Group I | | Group II | | Group III | |
|---|---|---|---|---|---|---|---|
| | | μm | % Deviation | μm | % Deviation | μm | % Deviation |
| Canine | Mesiodistal | 7 | 0.1 | 62 | 0.9 | 105 | 1.6 |
| | Labio palatal | 1 | 0.01 | 161 | 1.9 | 189 | 2.2 |
| | Cervico-incisal | 89 | 1.1 | 310 | 3.9 | 153 | 1.9 |
| Second Premolar | Mesiodistal | 14 | 0.2 | 20 | 0.3 | 89 | 1.5 |
| | Labio palatal | 33 | 0.4 | 120 | 1.3 | 187 | 2.0 |
| | Cervico-incisal | 11 | 0.2 | 95 | 1.7 | 167 | 3.0 |
| | Inter abutment | 15 | 0.1 | 85 | 0.6 | 150 | 1.0 |

*One-way ANOVA (*F*-test), *Unpaired *t*-test

showed that in the mesiodistal dimensions the percentage deviation from master model in Group I was 0.1 and 0.2, in Group II was 0.9 and 0.3, and Group III was 1.6 and 1.5, respectively. This shows that contraction was observed in Group II and Group III whereas the measurements of Group I was almost same as that of the master model. The contraction in Group II may be because the wash material may have hydraulically displaced the preliminary putty impression during impression seating and the putty may then have exhibited some elastic recovery upon removal of the impression and resulted in tendency toward smaller dies.[20]

In the labio-palatal dimensions the percentage deviation from the master model in Group I was 0.01 and 0.4, Group II was 1.9 and 1.3, and Group III was 2.2 and 2.0, respectively. The contraction occurred was more in Group II and Group III whereas in Group I, it was not significant because the small bulk of the impression material within the matrix minimizes the polymerization shrinkage and improves the accuracy of the individual abutments.[22] The contraction in Group II may be due to more polymerization shrinkage or elastic recovery of the putty and in Group III it may be due to the uncontrolled wash bulk, which results in an uneven dimensional change. This may lead to narrow die in a buccolingual direction.

In the cervico-incisal dimensions, the percentage deviation from the master model in Group I was 1.1 and 0.2, Group II was 3.9 and 1.7, and Group III was 1.9 and 3.0, respectively. The putty material will get compressed if the tray is not seated passively and the putty material will show through after the wash impression is made. It may rebound to cause deformation. The wash impression material may hydraulically compress the putty during the seating of the impression. The putty could then exhibit some elastic recovery upon removal of the impression. This may result in an elongated die in cervico-incisal direction.[23,24]

In the inter-abutment dimension of dies, percentage deviation from the master model in Group I was 0.1, Group II was 0.6, and Group III was 1.0. The contraction in the Group III (14.795 mm) may be because of the uncontrolled wash bulk, which allows for differential contraction and results in an uneven dimensional change. This may result in dies which are short mesiodistally, with decreased inter-abutment distance. Increasing the thickness of the wash material increases the distortion of the impression because of greater polymerization shrinkage.[25-28]

The results from this study showed that Group I impressions (matrix impression system) produced the most accurate casts. Group II impressions (putty reline technique) produced more accurate casts than Group III impressions.[13] Most dimensional differences were shown in Group III impressions (multiple mix technique). The matrix impression system is more acceptable to obtain accurate dies with PVS impressions.

**Conclusions**

Within the limitations of this study the following conclusions were drawn:

1. The matrix impression system showed more accuracy of reproduction for individual dies when compared with putty reline technique and multiple mix technique in all the three directions
2. The matrix impression system showed more accuracy of reproduction for inter-abutment distance when compared with putty reline technique and multiple mix technique.

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