Accuracy Of Different Impression Technique For Fixed Dental Prosthesis Using Polyvinyl Siloxane Impression Material – A Systematic Review

Dipali L Mungra a, Jayanti R. Patel b, Sareen S. Duseja c, Vilas V. Patel d, Vishal R. Chauhan e,
Mustafa F. Laxmidhar f

a Post Graduate student, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.
b Professor and Dean, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.
c Professor, Department of Prosthetic Dentistry and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.
d Professor and Head, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.
e Professor, Department of Prosthodontics and Crown & Bridge, Govt. Dental College and Hospital, Ahmedabad, Gujarat, India.
f Post Graduate student, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.

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ABSTRACT

Statement of problem: Different impression techniques have been advocated for fixed prosthetic treatment. However there is lack of knowledge regarding impression technique for better dimensional accuracy.

Purpose: The purpose of this systematic review was to compare dimensional accuracy of different impression techniques for fixed dental prosthesis for better fit.

Materials and Method: The published literature was electronically searched using PubMed, Google Scholar, and Ebsco till February 2020. The studies which investigated the accuracy of different impression techniques and are published in an English peer-reviewed journal are included for the review. All the studies carried out by standard method of the assessment for better means of impression were used for this comparison review.

Result: The search identified 940 references. Among them 11 studies met the eligibility criteria and were included for quality assessment.

Conclusion: Dimension accuracy is affected by different impression technique, for fixed dental prosthesis. 2 step and/or multiple mix technique with custom tray is more preferable technique.

Keywords: dimensional accuracy, impression technique, polyvinyl siloxane, addition silicone.
INTRODUCTION
Dental impression is a negative imprint of orofacial structures. An accurate impression is necessary for construction of any dental prosthesis. The relationship between static and mobile oral structures must be reproduced accurately for an optimum cast. Making an accurate impression specially in the finish line is dependent on dimensional stability of impression material and influenced by a number of factors such as impression technique, impression tray and properties of the impression materials. The impression technique determines the restoration of finish line. Moreover, the significance of margin in the longevity of restoration and the effect of impression technique on marginal adaptation of restoration indicate the necessity of applying an accurate impression technique. The accuracy of impression techniques is revealed when restoration with suitable marginal adaptation and minimum gap is obtained. Accuracy of an impression depends on properties of impression materials like thermal contraction, polymerization shrinkage, presence of volatile by products, elastic recovery, bulk and impression technique used.
Final impression for fixed partial denture is usually made using elastomer material. According to ADA specification no 19, elastomer is divided into four groups according to the chemical composition and polymerization reaction, they are polysulfide, polyether, condensation silicone and addition silicone. The dimensional stability of impression material is the ability of the material to maintain the accuracy of the impression. According to ADA Specification no 19, elastomeric material has to obtain details up to 25 μm or less. Addition silicone impression has become the impression material of choice in many clinical situations. They possess excellent physical properties and handling characteristics. Although they are the most expensive materials, they are used in wide variety of clinical situations, in fixed prosthodontics, conservative dentistry; removable prosthodontics complete denture prosthodontics and implant dentistry. The factors affecting dimensional change of the impression are thermal contraction, polymerization shrinkage and contraction due to volatile by products. Addition silicone impression materials have superior dimensional stability and lower polymerization shrinkage. No byproducts result from the curing; therefore shrinkage does not occur with these materials.
Addition silicones are available in four consistencies of viscosities like low, medium, heavy and putty. Making an impression represents a crucial step in processing and fitting dental prosthesis. The various impression techniques used for making an impression are: (1) Putty wash single step, (2) putty wash two-step, (3) single mix and (4) multiple mix techniques. In spite of best available impression materials and advanced impression techniques, we still come across inaccuracy of fit of a dental prosthesis, which may be either due to the inaccuracy of impressions or dimensional changes of impression. Hence, this study is undertaken to compare the dimensional accuracy of addition silicon impression material using different impression techniques.
AIM OF THE STUDY:
To compare the dimensional accuracy of polyvinylsiloxane impression material using different impression techniques.
MATERIAL AND METHODS:
Search strategy:
The following possible clinical questions based on different scenarios were identified for review purposes: Is there any relation between the different impression technique and dimensional accuracy? Is there any relationship of different impression technique with type of tray used? MEDLINE (PubMed), Google Scholar, and EBSCO search were conducted with the purpose of identifying all articles that investigate the relationship of dimensional accuracy of different impression techniques either using stock tray or custom tray. The following MeSH terms, search terms, and their combinations were used: dimensional accuracy, polyvinylsiloxane, addition silicon impression technique, and one − stage impression technique, two stage impression technique, monophase impression technique, and dual arch impression technique.
The search included peer-reviewed publications, limited by English language till February 2020. After duplicate articles were removed, an evaluation of all titles was performed in the first selection stage. The abstracts of potentially relevant studies were reviewed in the second selection stage. Articles that met the inclusion criteria were included in this systematic review.

<table>
<thead>
<tr>
<th>INCLUSION CRITERIA</th>
<th>EXCLUSION CRITERIA</th>
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<tr>
<td>1. Study using polyvinyl siloxane material</td>
<td>1. Materials other than polyvinyl siloxane material.</td>
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<td>2. Study which mentioned the impression technique</td>
<td>2. Literature which compares the brands</td>
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<tr>
<td>3. Article published in English literature</td>
<td>3. Article published in languages other than English</td>
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RESULT:
Among 940 potentially relevant studies, 115 were selected for abstract review. Among them 22 were selected for full text analysis and 12 were included in the systematic review (Fig. 1). The characteristics of the included studies are presented in Table 1. The included articles were published in English literature till February, 2020. All the 12 eligible studies were in vitro studies investigating dimensional accuracy of different impression technique used for FPD.

For all the included studies, the data were tabulated with information about the year of publication, type of material used, technique used, type of the tray used, method of evaluation and the result obtained and are presented in table 1. Because of high heterogeneity present in the included studies with regard to outcome measures and study designs, a meta-analysis was not feasible.
<table>
<thead>
<tr>
<th>NO</th>
<th>AUTHOR</th>
<th>YEAR</th>
<th>POLYVINYL MATERIAL USED</th>
<th>TECHNIQUE</th>
<th>TYPE OF TRAY USED</th>
<th>METHODS OF EVALUATION</th>
<th>MEASUREMENT ONE ON CAST/IMPRESSION</th>
<th>RESULT</th>
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<tbody>
<tr>
<td>1</td>
<td>Fernando et al[15]</td>
<td>2019</td>
<td>Exaflex, GC, America &amp; Examix, GC, America</td>
<td>Group A: One step conventional putty-wash impression technique Group B: One step modification putty-wash impression technique with ethyl vinyl acetate spacer Group C: Two step without spacer putty-wash impression technique</td>
<td></td>
<td>3D Builder application (Microsoft, America)</td>
<td>Stone model</td>
<td>-One step modification putty-wash impression technique using ethyl vinyl acetate as spacer is the most accurate technique in mesiodistal width, abutment height and inter abutment distance dimension as it had the smallest deviation percentage because of controlled uniform bulk (0%). Conventional one step putty wash technique should not be practiced.</td>
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<tr>
<td>2</td>
<td>RP Vitti et al[19]</td>
<td>2017</td>
<td>Aquasil, Dentsply, Petrolinos, Rio de Janeiro, Brazil</td>
<td>Group D: Two step with polyethylene spacer putty-wash impression technique</td>
<td></td>
<td></td>
<td></td>
<td>No significant differences were observed for dimensional accuracy of the 1-step putty/light-body, 2-step putty/light-body, and monophase impression techniques using a partially edentulous mandibular arch. The edentulous side showed more shrinkage than the opposite anteroposterior side. The impression material is more related to dimensional accuracy of partially edentulous arches than impression technique.</td>
</tr>
<tr>
<td>3</td>
<td>Tanushoby et al[22]</td>
<td>2016</td>
<td>Panasil (Ketten Bach, Germany)</td>
<td></td>
<td>a) one-stage impression technique b) 2-step putty/light body with 2 mm polypropylene spacer c) monophase technique</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Steeramdiu Basaqou et al. [13]</td>
<td>2016</td>
<td>Aquasil (Dentsply/Caulk, 78467, Kontanz, Germany)</td>
<td>Variofine (Herzeus Kulzer)</td>
<td>Group 1: hydrophilic VPS (Aquasil) using monophase, 1-step, 2-step using polyethylene spacer</td>
<td>Here measurements were directly performed on impressions with Vertical profile projector</td>
<td>Impression</td>
<td>-Monophase technique is worst in terms of dimensional accuracy and surface defects; both with hydrophilic and hydrophobic materials. -Hydrophilic VPS yielded dimensionally more accurate impressions than Hydrophobic VPS in one and 2 step impression techniques.</td>
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| 5 | Dobos et al. [14] | 2013 | Aquasil, 3M ESPE, Germany | Group A: multiple mix single step impression technique | Coordinate measurement machine (CMM, Lloyd, Germany) with an accuracy of 0.0001mm | Stone model | -The vertical dimension was most accurately reproduced by matrix impression system followed by multiple mix impression technique. For Dual arch impression technique, decrease in vertical distance is more than two techniques but was not significant. |
The horizontal dimensions were most accurately reproduced by Group A multiple mix technique followed by Group B matrix impression system. The Group C dual arch technique showed a statistically significant difference. All impressions had a tendency to be undersized in occlusogingival and oversize in horizontal (buccolingual and interocclusal) dimensions. There was no statistically significant difference between Group A & B.

| 6 | Pandol et al.\(^4\) | 2013 | Reproil (Dentsply Caulk, USA) | a) One-step impression technique using heavy body/light body impression material | Custom tray | Microscope | Stone model | Casts retrieved from One-step technique are sufficiently dimensionally accurate than those obtained from two-step technique in conjunction with addition silicone impression material. |

| 7 | Dugal, R et al.\(^5\) | 2013 | Express, ESPE | Group I - single step putty light body impression | Custom tray | Rhino computer software | Stone model | The two-step double mix putty wash impression technique with 1mm of spacer yielded casts that showed the least dimensional variation as compared to the single step putty wash impression technique. The order for deviation from master model was: Single step putty/light body > 2 step putty/light body |

b) Two-step impression technique using putty/light body addition silicone impression material | Stock tray | |

Statistically significant difference is \(\text{ANCOR} < 0.01\)
<table>
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<tr>
<th>Group IV – Two Step Impression with 1.5 mm of spacer thickness</th>
<th>with 0.5 mm spacer &gt; 2 step putty/light body with 1.5 mm thickness &gt; 2 step putty/light body with 1 mm spacer thickness (p&lt;0.05)</th>
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<tr>
<td><strong>8</strong> S. Mishra and R. Chowdhary&lt;sup&gt;[6]&lt;/sup&gt;</td>
<td>Reprofil Dentsply Milford, DE, USA</td>
</tr>
<tr>
<td>Group 1: putty wash 2 step technique with polyethylene spacer</td>
<td>Stock tray</td>
</tr>
<tr>
<td>Group 2: putty wash one step technique</td>
<td>Stock tray</td>
</tr>
<tr>
<td>Group 3: single mix technique (medium viscosity)</td>
<td>Custom tray</td>
</tr>
<tr>
<td>Stone model</td>
<td>Multiple mix technique in custom tray produced more accurate casts followed by Single mix technique using custom tray and putty wash 2 step technique with polyethylene spacer in stock tray. Putty was single step simultaneous technique in stock tray produced least accurate results. The study emphasised that putty wash two-step impressions made with controlled uniform bulk of impression material in stock tray are as accurate as those obtained from multiple mix technique using custom tray and single mix monophase material using custom tray.</td>
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<tr>
<th><strong>9</strong> Caputi and Varvara&lt;sup&gt;[6]&lt;/sup&gt;</th>
<th>Aquasil Dentsply Intl, York, Pa</th>
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<tr>
<td>a) Monophase impressions using regular body</td>
<td>Stock perforated metal trays</td>
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<tr>
<td>Not mentioned</td>
<td>Stone model</td>
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<tr>
<td>- The accuracy of casts retrieved from these techniques was found to be statistically significant and in following order.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Patil et al[19]</td>
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| | | | | | | | - Statistically significant difference was seen in accuracy with these techniques. However, the
DISCUSSION:
Making an impression represents a crucial step in processing and fitting dental prosthesis. For that reason, the quality of the impression is decisive for final fitting accuracy, and consequently for the success of the dental reconstruction. Several techniques have been developed to improve the accuracy of impressions used in making crowns and fixed partial dentures. Interest has grown in a new group of impression materials called addition silicones since they have shown to be accurate and dimensionally stable. These addition silicone impression materials are currently available in several viscosities leading to at least three choices for impressions (A) putty-wash, (B) single-mix impression, (C) double-mix impression. These three general techniques combined with several combinations for trays and viscosities present a dilemma to the dentist. To date, research on addition silicone has concentrated on the properties of the materials and little information is available on the effect of viscosity and tray selection on the accuracy. In the present study, an effort has been made to find out the most accurate technique.

Putty/wash impressions can be made by either one-step or two-step techniques. Hung et al.[12] used a variety of addition-type silicone impression materials to investigate the effects of technique and choice of material on accuracy and concluded that the choice of the material is important for the accuracy with addition silicone materials. On the other hand, Craig [13] stated that the choice of technique was the more critical factor. This review aimed to systematically review the available literature and to determine the potential benefits of various impression techniques using either stock tray or custom tray for FPD. To the best of the present authors’ knowledge, this study is the first review of its kind as per the searched indexed English literature. In this review following techniques are reviewed: 1) Putty wash single step 2) Putty wash 2 step technique 3) single mix technique 4) multiple mix technique 5) dual arch impression technique. Putty/wash 1 step impressions is the so-called “simultaneous” or “squash” technique. This approach is unacceptable because it is impossible to control the thickness of impression material and excess bulk is used. It is impossible to control what material records the margin detail of the preparation(s). Usually portions of the prepared margin are captured in the putty, and putty materials are essentially deficient in their ability to record marginal detail [14]. These technique has the advantages of simplicity and reasonable economy [15]. In 2 - step putty-wash technique can be successful, but there are two potential pitfalls. It is difficult to confine the wash materials to the area of the relieved impression, and some wash material enters the unrelieved impression. This results in an inaccurate occlusal pattern for the resultant cast. Thus, the entire impression, rather than just the relieved area, should be “washed.” This creates the potential problem of hydraulic distortion of the putty material as the impression is seated in the mouth. This is impossible to detect on a clinical level but may have a deleterious effect on the accuracy if the impression and resulting restoration[14].
These findings are in agreement with most of the studies reviewed here except that done by Pande et al & Fernando et al, they found that one stage technique and one step modification using custom tray is also accurate respectively\textsuperscript{[3,4]}. Pande et al stated that there is more shrinkage with 2 step technique because light body material may have hydraulically displaced the preliminary putty impression during the impression setting and the putty may have then exhibited some elastic recovery upon removal of the impression. Fernando et al stated that more accuracy of modified 1 step technique was possibly caused by the bulk of the impression material as thick as 2 mm \textsuperscript{[4]}.

S. Mishra in his study listed following reasons for more accurate putty wash two step technique with polyethylene spacer than putty wash one step technique\textsuperscript{[8]}:

(a) In the putty wash one-step technique, there is no control of bulk;
(b) In most situations, parts of the prepared teeth, including the margin, are duplicated with putty instead of the syringe materials;
(c) Most bubbles are produced and included in the set impression with this technique;
(d) Mixing the putty material at the same time as the syringe material, the setting distortion of the putty is included in the overall distortion of the impression.

On other hand, Idris, Houston, Claffey and RP Vitti et al stated that there is a no difference in accuracy by using either technique\textsuperscript{[11,5]}.

The advantages of the dual arch technique include its clinical simplicity and the accurate recording of the MIP position. An additional advantage is that a closed-mouth technique is used that eliminates any mandibular flexure that might be associated with opening. Rigid metal trays are ideal for this technique. Rigid PVS or polyether materials should be used as well. Many plastic-mesh trays are available for this technique, but they should be avoided because they are too flexible. Often the buccal-lingual width of the arch is wider than the trays. The resilient tray flexes outward when the impression is made and rebound when the impression is removed from the mouth, thus permanently distorting the impression\textsuperscript{[14]}. These is in agreement with study done by Dabbas et al as there is a significant difference seen in accuracy with dual arch impression technique\textsuperscript{[6]}.

The monophase technique is the easiest to perform, but it has been reported to be the worst in terms of dimensional accuracy and surface defects, as compared to putty/light body techniques, because of the relatively high viscosity and reduced flow of the material used\textsuperscript{[16]}. A study conducted by Caputi et al, S. Mishra et al and RP Vitti et al stated that monophase technique yields casts with minimal accuracy\textsuperscript{[9,8]}. The text book Fundamentals of Fixed Prosthodontics state that custom acrylic resin trays are an important part of rubber base impression techniques, although they later observed that when employing putty-wash technique, a rigid well-fitting stock tray is acceptable\textsuperscript{[17]}. Making a custom tray requires planning a study model, laboratory time, curing interval and finishing time. In contrast, the stock tray can be selected, adapted and used in a single visit for both an anticipated and unanticipated situation.

Many studies have reported that custom trays\textsuperscript{[6,7,8,10]} provide more accurate dental casts than stock trays, but if stock trays are properly oriented, giving uniform impression thickness, they can give better result than custom trays\textsuperscript{[2,5,9,11]}.

Caputi and Varvara (2008) reported that when making impression using one step conventional technique, increase in abutment height can occur because of the shrinkage and constriction of impression material towards impression tray; especially area around abutment\textsuperscript{[9]}.

A significant limitation of VPS impression material is their hydrophobicity. There are two different aspects of the hydrophobic nature of VPS impression materials. The first aspect was related to surface free energy and the high contact angle of the solid polymerized VPS that had formed when polymerized VPS impression materials contact with the wet dental gypsum. The surface free energy of the unpolymerized, liquid phase of the impression material that lacks the ability to wet the oral tissues while impression making, forms the second aspect. Hence, certain intrinsic factors such as nonylphenoxy polyethylene homologues had been added by manufacturers to overcome the limitation of...
VPS hydrophobicity. Sreeramulu Basapogu et al compared hydrophilic VPS and hydrophobic VPS, found that hydrophilic VPS yielded more dimensionally accurate [1].
So, as the majority of the literature supports two stage impression technique using custom tray as bulk of the material can be controlled and margins can be duplicated with lower viscosity material. Moreover it reduces the incorporation of bubbles.

CONCLUSION:
Within the limitation of this review following conclusion can be drawn:
1. Dimension accuracy is affected by different impression techniques, for fixed dental prosthesis.
2. 2 step and/ or multiple mix technique is more preferable technique. However the literature supports that if the bulk of the material is controlled, then single stage technique also gives the good result.
3. The literature also supports that properly oriented stock tray also give better result in comparison to time consuming custom trays.

REFERENCES
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