Comparing Two Cordless Impression Techniques for Dimensional Accuracy: An *In vitro* Study

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**Abstract**

**Introduction:** For a successful fixed partial prosthodontics, obtaining an accurate impression for making an accurate cast is of prime importance.

**Aim:** The study emphasizes on using modified impression techniques for fixed prosthodontics without using retraction cord. Various mechanical and chemical methods have been used for achieving gingival retraction. Most of them are expensive, time consuming and uncomfortable for the patient. Cordless impression procedures using conventional impression materials are alternative to these methods.

**Methodology:** In the present study, two cordless fixed prosthodontic impression procedures, matrix impression system and prefabricated crown shell technique; have been described and compared in terms of dimensional accuracy. An articulated acrylic resin typodont prepared with reference points was used as a master model. Addition silicon impression materials in various consistencies were used for making impressions. The coordinate measurement machine (Lloyd, Germany) was used for three dimensional measurement of master model and stone casts with an accuracy of 0.0001mm.

**Observations:** When comparing the accuracy of casts as per statistical analysis Group B (prefabricated crown shell technique) casts were less accurate in inter abutment distance whereas all other distances produced statistically insignificant mean deviation from the master model.

**Conclusion:** It can be concluded that prefabricated crown shell technique is not recommended for a long span bridge framework but is well indicated while making cordless impressions for fabrication of single crown.

**Keywords:** Crown lengthening, esthetics, fixed appliance, impression procedures

**Introduction**

An accurate impression that provides the necessary marginal detail is not only required for good fit but also for optimal esthetic results. Management of the gingival tissues while making an impression is one of the most challenging aspects of crown and bridge. This requires the use of various tissue retraction techniques which is expensive, time-consuming, and unpleasant experience for the dentist.[¹²] This can be avoided by using cordless impression methods where gingival retraction and an accurate void-free impression can be made simultaneously. These impression techniques eliminate the use of retraction cords, cordless retraction materials, or any other means of gingival tissue retraction.

Various cordless impression techniques for making impressions of subgingivally prepared margin have been described in literature. These methods make impregnated retraction cords unnecessary and avoid their disadvantages. LaForgia³ studied the cordless tissue retraction for impressions in fixed prosthodontics and described various techniques for making cordless tissue impression such as

1. Relining preliminary impression
2. Beading a cold-cure acrylic resin tray
3. Correcting an unacceptable final impression and
4. Making an impression in an aluminum shell.

A new matrix impression system⁴⁵ was developed that incorporates the attributes of traditional methods and overcomes important deficiencies in the registration of subgingival margins, gingival retraction and relapse, delivery of impression material subgingivally, and simplification for making complex impressions.

Dimashkieh and Morgen⁶ adopted a procedure for a void-free impression of tooth preparations for fixed prosthodontics

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known as prefabricated crown shell technique. A procedure was developed in which an impression was made in a preformed temporary crown shell for each tooth preparation. The result was an atraumatic and uncomplicated complete arch impression that incorporated an accurate impression of each prepared teeth.

In the present study, two cordless impression techniques – matrix impression system and prefabricated crown shell technique – have been compared for dimensional accuracy.

**Aim and objective**
The purpose of the present study is to compare the dimensional accuracy of casts generated from two cordless elastomeric impression techniques and to give clinical recommendations and indications based on the study and observations.

**MATERIALS AND METHODS**

**Preparation of master model**
The master model (typhodont) consisting of articulated dentate maxillary and mandibular arches was used [Figure 1]. The right mandibular first molar was removed to simulate a clinical case of a three-unit bridge. Mandibular second premolar and second molar were prepared as abutments with a finish line width of 1.2 mm. Three sharply defined notches were placed on each prepared tooth as reference points. The reference points were referred as [Figure 2]:
1. Point a - on buccal finish line of the right mandibular 2nd molar
2. Point b - center of occlusal surface of the right mandibular 2nd molar
3. Point c - on lingual finish line of the right mandibular 2nd molar
4. Point d - on buccal finish line of the right mandibular 2nd premolar
5. Point e - center of occlusal surface of the right mandibular 2nd premolar
6. Point f - on lingual finish line of the right mandibular 2nd premolar.

The various distances measured between reference points were:
Distances (a-b) and (d-e) which represented occlusocervical dimension (vertical height) of the right mandibular 2nd molar and right mandibular 2nd premolar, respectively.
Distances (a-c) and (d-f) which represented buccolingual dimension (diameter) of right mandibular 2nd molar and right mandibular 2nd premolar respectively.
Distance (b-e) which represented interabutment distances between right mandibular 2nd molar and right mandibular 2nd premolar.

Addition silicones impressions (Aquasil, 3M ESPE, Germany) materials in various consistencies were used for making impressions. Tray used in the study was a rim lock perforated custom tray and prefabricated crown shells made of tooth-colored acrylic [Figure 3].

Fifteen impressions were made for each group; casts were poured and categorized as follows:

**Group A matrix impression system**
A putty matrix was prepared over the selected abutments including one extra tooth adjacent to each abutment. The matrix was trimmed interdentally for the escape of impression material, and proximal surfaces of adjacent unprepared teeth were relieved to prevent wedging and distortion of matrix while seating. Heavy viscosity impression material was mixed, dispensed into the matrix and placed on the prepared abutments. Simultaneously, a mix of medium body impression material was loaded in the stock tray and seated on the matrix to make a pickup impression. The impression was removed after complete polymerization of impression material [Figure 4].

**Group B prefabricated crown shell technique**
Acrylic resin crowns were prepared on each prepared tooth with 0.75 mm thick base plate wax spacer adapted on each prepared tooth extending slightly apical to finish line of the preparation. A medium body elastomeric impression material...
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was mixed and filled in the preformed crown shell. The crown shells were seated over each tooth preparation to cover the finish line. Simultaneously, a perforated metal stock tray was loaded with medium body elastomeric impression material and placed on the mandibular arch, and a complete arch pickup impression was made [Figures 5 and 6].

Various measurements of master model and stone casts were done with the help of coordinate measurement machine (CMM, Lloyd, Germany) with an accuracy of 0.0001 mm. All 30 casts were measured, and the mean distances were taken as:

Vertical distances: a-b, d-e (molar height and premolar height, respectively)
Horizontal distances: a-c, d-f, b-e (molar diameter, premolar diameter, and interabutment distance, respectively).

**Observations and Results**

After the readings were obtained, they were compared with the dimensions on the master model using one sample t-test and the comparisons in between the groups and within the groups were done by performing ANOVA. The difference between readings of stone casts and model was calculated as follows:

Mean difference = mean distance on the master model – mean distance on the stone model. The distances measured on the master model and casts obtained from two different groups were subjected to statistical analysis for comparisons. The observations and results of the study can be summarized in Tables 1-5.

**Discussion**

All prosthetic rehabilitations are characterized by a sequence of well-structured clinical and laboratory steps, during which different kind of impressions are required. The success of the prostheses depends on the accuracy and dimensional stability of the impression materials used and the impression techniques utilized. The exposure of the preparation margin in the gingival sulcus is a prerequisite for a perfect impression, thereby improving the quality of indirectly fabricated restorations.

Deformation of gingival tissues during retraction and impression procedures involves four forces: retraction, relapse, displacement, and collapse. The aim of gingival retraction is to atraumatically allow access for the impression material beyond the abutment margin and to create space to provide sufficient thickness of impression material in gingival sulcus region.
so that it can better withstand the tearing forces encountered during removal of the impression.\(^5\)\(^,\)\(^7\)

The purpose of the present study was to compare the dimensional accuracy of two cordless elastomeric impression procedures that is matrix impression system (Group A) and prefabricated crown shell technique (Group B). Among the various distances measured, the horizontal distances were measured to know the change in buccolingual dimensions and in interabutment distances, whereas vertical distances signified the oclusocervical measurements.

It was observed from the study that none of the casts obtained from different techniques were similar to the master model in three-dimensional measurements.

All impressions had a tendency to be slightly undersized in vertical dimensions (occlusocervical) and oversized in horizontal dimensions (buccolingual and interabutment). This phenomenon occurred because of contraction of the impression material toward the tray walls, making the stone dies wider in horizontal aspect and shorter in the vertical one.\(^8\)\(^,\)\(^9\)

The increase in horizontal distance seen may also be explained by the linear setting expansion of the die material (Kalrock, 0.1% maximum) throughout the entire bulk of stone model. Tray adhesive effects the uniform shrinkage of addition silicones because of which abutments in the resultant cast may tend to be greater distance apart than they are actually. This discrepancy in behavior may be attributed in part to the difference in the bond strength of tray adhesive. Marcinak et al.\(^9\)\(^,\)\(^10\) reported that the direction of dimensional change in impression material was dependent on the bonding of the material to the tray. It was because of the rigid tray and good adhesion to the tray that the impression shrank toward the tray and produced a larger die.

In the present study from Tables 1 and 2, it can be interpreted that the vertical distances that are molar and premolar height showed a decrease in dimensions as compared to the master model. The vertical dimension was less accurately reproduced by multiple mix impression than prefabricated crown shell technique but was not significant. This can be attributed to the fact that in prefabricated shell technique there is low polymerization shrinkage because of controlled bulk and uniform thickness of medium viscosity impression material in their respective crown shells. In matrix impression technique, lesser accuracy may be because of greater polymerization shrinkage in low-viscosity impression materials compared to medium viscosity impression material.\(^10\)

Tables 3 and 4 summarized that horizontal dimensions that are molar and premolar diameter showed an increase in dimensions as compared to the master model. The horizontal dimensions were most accurately reproduced by Group B prefabricated crown shell technique as compared to Group A matrix impression system because putty is used as a matrix, which is somewhat resilient and hydraulic pressure creates undetectable distortion in the impression. The lesser accuracy of this technique can also be attributed to the fact that due to pressure of stock tray over the matrix, the matrix can flex in buccolingual direction thus increasing the die in buccolingual dimensions.\(^4\)

Table 5 showed an increase in interabutment distance as compared to the master model. The order of accuracy of various distances measured on the stone cast produced by different techniques deviated from the distances on the master model.
The present study showed a statistically significant distortion in prefabricated crown shell technique while recording interabutment distance; hence, it is not recommended for a long-span bridge framework. This technique is indicated while making impressions for the fabrication of single crown. The limitation of the present study is that the dimensional changes in the present study were recorded indirectly by performing measurements on the stone cast; the results include the variables of both impression and die materials. In addition, the results of this investigation might not be directly applied clinically because the oral environment was not simulated in this study.

**Table 5: Basic statistics of inter‑abutment distance (b‑e) measured on casts of different groups, compared with master model by one sample t-test**

| Techniques     | Mean  | SD   | Mean differences | P     | t    |
|----------------|-------|------|------------------|-------|------|
| Master model   | 19.3911 | 0.017 | -                | -     | -    |
| Group A        | 19.3929 | 0.011 | 0.0018           | 0.5184 | 0.6624 NS |
| Group B        | 19.3927 | 0.004 | 0.00165          | 0.1453 | 1.5423 NS |
| Group C        | 19.4246 | 0.029 | 0.0315           | 0.0011 | 4.0988 S |

NS=Not significant ($P>0.05$) df=14. S=Significant ($P<0.05$). SD=Standard deviation

Within the limitation of this in vitro study, it can be concluded that all the impressions had a tendency to be oversized in horizontal dimensions and undersized in vertical dimensions. When comparing the accuracy of casts as per statistical analysis Group B (prefabricated crown shell technique), casts were less accurate in relation to interabutment distance whereas all other distances produced statistically insignificant mean deviation from the master model.

It can be concluded that prefabricated crown shell technique is not recommended for a long-span bridge framework but is well indicated while making cordless impressions for the fabrication of single crown.

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**Conflicts of interest**

There are no conflicts of interest.

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