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Original Research

Marginal fit of zirconia copings fabricated after conventional impression making and digital scanning

¹Udfer Hameed, ²Muzzamil Gulzar Jan, ³Sandeep Kour Bali, ⁴Shabir Ahmed Shah, ⁵Qazi Shazana Nazir

^{1,2}MDS, Prosthodontics;

³Professor & Head, ⁵Associate Professor, Department of Prosthodontics, Crown & Bridge, Govt. Dental college & Hospital, Srinagar, J&K, India;

⁴Professor, Department of Prosthodontics, Crown & Bridge and Head Dental Materials, Govt Dental college & Hospital, Srinagar, J&K, India

ABSTRACT:

Background: To study the marginal discrepancy of zirconia copings fabricated after conventional impression making and digital scanners. **Materials & methods:** A mandibular premolar typhodont was prepared for full veneer crown. Fifteen impressions were made in each experimental group: conventional impression with PVS and TRIOS 3 group. The mean value of discrepancy was calculated for each location and each group. Statistically significant differences among the impression techniques were tested and results were analysed using SPSS software. **Results:** The mean ±standard deviation values of vertical marginal discrepancy were 110 ±85 µmfor the PVS group, and 51 ±54 µm for the TRIOS 3 group. Statistically significant differences were found between the PVS group and TRIOS 3 group (P value <0.001*). **Conclusion:** Digital scanning with the TRIOS 3 showed lower values of marginal discrepancy than the conventional impression making with an elastomer.

Keywords: zirconia, TRIOS 3, PVS.

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Corresponding author: Udfer Hameed, MDS, Prosthodontics

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INTRODUCTION

Conventional impression techniques require no special expensive machinery and accurate results can be achieved if working steps are conducted properly. ¹ Impression materials frequently used for this technique are polyvinyl siloxane, polyether or polysulfide based materials. For attaining a perfect cast these materials must demonstrate properties like accuracy, elastic recovery and dimensional stability as well as rheological and thixotropic characteristics. ² Various factors like uncontrolled saliva flow during the procedure, undercuts, storing for extended periods of time, moisture, material deformations and incompatibilities with other materials can influence the accuracy of the impression and subsequently lead to inaccuracies and misfit of restorations. ³

With continuous developments over several years, present-day technological advancements allow the use of different systems with computer-aided design/computer-aided manufacture (CAD/CAM) technology for the fabrication of removable dentures, including milling and rapid prototyping (RP).⁴ CAD/CAM technology refers to digital design and manufacture. CAD software recognizes the geometry of an object while CAM software is used for the manufacture. The CAD/CAM manufacturing process can either include additive (RP) or subtractive manufacturing (computer numerical control [CNC] machining; milling). RP has been used for industrial purposes and was developed from CAD/CAM technology. It is used to create automatically physical models from computerized three-dimensional (3D) data. ^{5,6} RP, also known as solid freeform fabrication or layered manufacturing, has been used for creating 3D complex models in the field of medicine since the 1990s and has recently become popular for the 7,8 fabrication of removable dental prostheses. CAD/CAM and RP have been used for several years for the fabrication of inlays, onlays, crowns, fixed partial dentures, implant abutments/prostheses, and maxillofacial prostheses. 9

The marginal fit in restorations is of utmost importance for their quality and longevity, and was one of the main initial concerns of the CAD/CAM systems.¹⁰ The marginal fit is theoretically represented by a linear contact line or a gap-free transition between the preparation and the restoration margin. For clinical use, Christensen et al. concluded that visible margins wider than 39 µm are clinically unacceptable. ¹¹ However, due to various factors, it seems almost impossible to achieve these ideal values in the clinical setting. ^{12,13} According to literature, a marginal gap between 50 and 100 µm is considered to be technically feasible¹⁴. When compared to the traditional impression technique, intraoral scanners are more efficient. The current intraoral scanner systems differ in terms of work principle, light source, and operational process. Hence, this study was conducted to evaluate the marginal discrepancy of zirconia copings fabricated after conventional impression making and digital scanners.

MATERIALS & METHODS

A mandibular premolar typhodont was prepared for full veneer crown. Fifteen impressions were made in each experimental group: conventional impression with PVS and TRIOS 3 group. 30 zirconia copings were fabricated with computer-aided design and computer-aided manufacturing (CAD-CAM) technology, and the marginal discrepancy was measured in four locations. Additionally, the marginal discrepancy of each coping obtained in the PVS group was measured on the stone die produced, creating the PVS A group. The mean value of discrepancy was calculated for each location and each group. Statistically significant differences among the impression techniques were tested and results were analysed using SPSS software. Comparison of the marginal fit of complete crowns made by using the TRIOS 3 (3Shape) and that of restorations made with polyvinyl siloxane (PVS) was done.

RESULTS

Fifteen impressions were made in each experimental group: conventional impression with PVS and TRIOS 3 group. 30 zirconia copings were fabricated with computer-aided design and computer-aided manufacturing (CAD-CAM) technology. The mean \pm standard deviation values of vertical marginal discrepancy were 110 \pm 85 µmfor the PVS group, and 51 \pm 54 µm for the TRIOS 3 group. Statistically significant differences were found between the PVS group and TRIOS 3 group (P value <0.001*).

Table 1: mean and standard deviation of PVS group

| Group | Mean | Standard deviation |
|--------------------|------|--------------------|
| PVS Group | | |
| Buccal | 120 | 90 |
| Lingual | 164 | 79 |
| Mesial | 90 | 105 |
| Distal | 82 | 60 |
| Total (mean value) | 110 | 85 |

Table 2: mean and standard deviation of TRIOS 3.

| Group | Mean | Standard deviation |
|--------------------|------|--------------------|
| TRIOS 3 | | |
| Buccal | 35 | 60 |
| Lingual | .33 | 54 |
| Mesial | 93 | 42 |
| Distal | 75 | 31 |
| Total (mean value) | 51 | 54 |

Table 3: comparison of p- value in groups with location

| Surface location | p- value |
|------------------|----------|
| Lingual | |
| PVS vs TRIOS 3 | < 0.001 |

DISCUSSION

With the advances in computer technology, digital dental models are now being widely used for diagnosis and treatment planning. The use of digital models alleviates many of the challenges posed by plaster models made from conventional impressions, which include the burden of storage, the risk of damage or breakage, and the difficulties in sharing the data with other clinicians involved in the patients' care.^{15,16} Digital dental models can be created through either indirect or direct techniques. Indirect methods involve laser scanning or computed tomographic imaging of the alginate impressions or plaster models, and direct methods involve intraoral scanners. With the introduction of chairside intraoral scanners, interest in obtaining digital dental model using the direct method has increased. ¹⁷⁻¹⁹ Hence, this study was conducted to evaluate the marginal discrepancy of zirconia copings fabricated after conventional impression making and digital scanners.

In the present study, fifteen impressions were made in each experimental group: conventional impression with PVS and TRIOS 3 group. 30 zirconia copings were fabricated with computer-aided design and computer-aided manufacturing (CAD-CAM) technology. The mean ±standard deviation values of vertical marginal discrepancy were 110 ±85 µm for the PVS group, and 51 \pm 54 μ m for the TRIOS 3 group. A study by CarrilhoBaltazarVaz IM et al, in vitro study was to compare the marginal fit of zirconia copings fabricated by using a conventional impression and 2 digital scanning techniques. The marginal discrepancy of each coping obtained in the PVS group was measured on the stone die produced, creating the PVS A group. The mean value of discrepancy was calculated for each location and each group. Statistically significant differences among the impression techniques were tested with 1-way ANOVA, repeated measures ANOVA, and the t test (α =.05). The mean ±standard deviation values of vertical marginal discrepancy were 106 $\pm 87 \ \mu m$ for the PVS group, $34 \pm 49 \ \mu m$ for the PVS A group, 53 $\pm 56 \ \mu m$ for the TRIOS 3 group, and 93 $\pm 69 \ \mu m$ for the CS 3600 group. Statistically significant differences (P<.05) were found between the PVS group and TRIOS 3 group and between the CS 3600 group and TRIOS 3 group. 20

In the present study, statistically significant differences were found between the PVS group and TRIOS 3 group (P value $< 0.001^*$). Another study by Akhlaghian M et al, in vitro study was to compare the marginal accuracy of zirconia copings fabricated with 4 different scanning methods. Scans (n=10) of a brass master die were made with a direct method (ISD) in which the die was directly digitized by using an intraoral scanner (IOS) and 3 indirect scanning methods, a conventional impression with polyvinyl siloxane material digitized with either the same IOS (ISI) or with a laboratory extraoral scanner (ESI), or a cast from the impression was scanned by using a laboratory extraoral scanner (ESC). The mean ±standard deviation of the vertical marginal gap was 73 \pm 7 µm in the ISD group, 109 \pm 36 µm in the ISI group, 42 \pm 4 μ m in the ESI group, and 97 \pm 5 μ m in the ESC group. The lowest marginal gap was seen in the ESI group, which was significantly different from the 3 other groups (P \leq .001). The copings in the ISD group had a significantly lower marginal gap than those in the ISI (P=.04) and ESC (P<.001) groups. However, the ISI and ESC groups were not significantly different (P=.69).²¹ After the introduction computer-aided design/computer-aided of manufacturing (CAD/CAM) concepts into dental applications by Dr. Francois Duret at the Chicago Midwinter Meeting in 1989 22,23, several intraoral scanners have been introduced. Recently, a few intraoral scanners have been released on the market, including the iTero (Align Technologies), TRIOS (3Shape), True Definition (3M ESPE), CEREC Omnicam (Sirona), and CS 3600 (Carestream Dental). ²⁴ The accuracy of intraoral scanners has been evaluated for both single abutment and short-span fixed dental prostheses. ^{25,26}

CONCLUSION

Digital scanning with the TRIOS 3 showed lower values of marginal discrepancy than the conventional impression making with an elastomer.For fabricating single-unit restorations with clinically acceptable marginal fit, the digital workflow may be an alternative to the traditional technique.

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