Type of manuscript: Original article

Comparative Evaluation of Internal Fit and Marginal Fit of Zirconia Copings Obtained From Impression and Die Fabricated using CAD-CAM an In Vitro Study

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Abstract

Aims: To evaluate and compare the internal fit and marginal fit of zirconia copings fabricated using CAD-CAM from impressions and model.

Material and Methods: Using a standardized die, 15 impressions group 1and 15 models group 2 were made with standardized protocol. All impressions and models were scanned and virtual models were made. Using the CAD data, zirconia copings were fabricated and cemented using silicone under finger pressure and standardized sections of the silicone were made and thicknesses were measured at eleven specific points under stereomicroscope.

Statistical analysis used: ANOVA

Results: Mean Internal gap value of Group 1was 292.4µ ± 23.48 and Group 2 was 258.54 µ ± 22.83 µ, Mean Marginal Gap value of group1 was 252.64µ ± 11.86 µ and group2 was 232.18 µ ± 06.24 µ, ANOVA test showed statistical significance with p value >0.05

Conclusions: Within the limitations of the study, mean marginal gaps of both the groups were within clinically acceptable range. Group 2 copings demonstrated comparatively smaller values. Hence fit of the restoration is better in Group 2 (copings fabricated from scanned models)

Key-words: *CAD-CAM, scanner, stereo-microscope*

Introduction

Ceramo -metal restorations has always been considered the gold standard for restoration as it will improve patient's comfort, aesthetics and masticatory ability[1]. Even though ceramo -metal restorations have been in practice for the past four decades, compromised aesthetics and concern for biocompatibility have prompted the clinicians to search for a metal free alternative material that will not induce contact allergy. Zirconia restorations have fulfilled these requirements to a great extent. They have become both a necessary alternative and a preferred choice[2]. Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) was first introduced to dentistry in the mid-1980s. Both chair side and laboratory integrated procedures are available for CAD/CAM restoration fabrication. In selecting which procedure to follow, consideration should be given to aesthetic demands, chair side time, laboratory costs, and required number of visits, convenience and return on investment associated with the CAD/CAM equipment[3, 4, 5]

SUBJECTS AND METHODS:

Depending on the dental CAD/CAM system, different processing techniques may be applied to obtain data for dental restoration, as well as for various digitization methods to convert the planned restoring abutments to virtual abutments. A virtual three-dimensional (3D) model is created based on 3 sets of data (***stone cast, impression body, and intraoral***) acquired from the scanning process. Therefore, the complexity of the overall manufacturing process of a dental prosthesis may increase or decrease depending on the material of the scanned object. The most efficient manufacturing process in fabricating a dental prosthesis would ideally include the necessary steps, but efficiency may not always enhance the fit of the final restoration. Hence, to evaluate the precision & fit of the prosthesis obtained by two different techniques in CAD/CAM processes i.e. scanning the impressions and scanning the models were employed. A maxillary arch metal die was fabricated, containing three abutments located one each in first molar region on either sides and one in mid incisal region [Fig 1]. The abutments were of height 10mm, marginal width 1mm, placed equidistantly. Bucco-lingual & mesiodistal identifications grooves were made in the occlusal surface for orientation. A customised jig was fabricated to orient the Stainless steel dentulous impression tray of standard size to fit over the metal die and impressions were made[Fig 2]. The metal die was separated from the impression tray at a predetermined distance using a vertical stop to make impression to ensure uniform thickness and pressure [Fig 3]. Fifteen Impressions (Group 1) were made with polyvinyl siloxane [Fig 4,5] (Aquasil putty regular set) using two stage technique, scan spray was sprayed (Digiscan, YETI DENTAL) to avoid dryness and enhance clarity of the digital image. The impressions were scanned on a CAD-CAM scanner (ZIRKON ZAHN SCANNER and Zirkon Zahn scan software) [Fig 6]. Fifteen Impressions (Group 2) were poured with die stone and models were scanned [Fig 7]. 3D virtual models were produced using designated software tools (Zirkon Zahn modellier software). Copings of 2mm thickness and cement space 35µ were designed using software. Orientation markings were designed on the outer surface of the copings to identify the buccal and mesial surface [Fig 8]. After designing, the copings were fabricated by milling the pre-sintered zirconia blocks (Zirkon Zahn milling unit) [Fig 9]. A total of 30 crowns were sintered in an electric furnace according to the manufacturer's instructions. To evaluate and compare the gap dimensions between the crowns and the prepared teeth, replicas of the internal gaps of the copings were made by the replica technique described by Boening et al and Reich et al[6, 7]. They were fabricated by repositioning the copings on the prepared teeth with a white silicone indicator paste (Fit Checker; GC, Tokyo, Japan) coated on the inner surface of the coping [Fig 10,11]. Excess silicone material was removed with a cotton pellet. During hardening of the silicone layers, the copings were held on the respective dies with uniform finger pressure. After setting, the copings and the silicone materials were separated. All the replicas were sectioned buccolingually. Sectioned samples were viewed under stereomicroscope (LEICA model M80, Heerbrugg, switzerland) [Fig 12], combined with a computer system to evaluate the thickness of each section at specific points. The camera (Leica IC3D: Leica Microsystems, Germany) reproduced X46 magnification so that a video image of the marginal gap could be examined using special software (Leica Stereo Explorer software; Leica microsystems). Dimensions were measured at eleven specific points as shown in [Fig 13] and readings were noted for Group 1 & Group 2 samples respectively. Marginal gap values were measured in millimeters (later converted to microns) at six specific points from the silicone index of group 1 and group 2 samples and were used to calculate marginal fit. Internal gap values were measured in millimeters (later converted to microns) at five specific points from the silicone index of group 1 and group 2 samples and were used to calculate internal fit. The results were tabulated, statistically analyzed using ANOVA and interpreted.

Results: Scanned data were expressed as mean and standard deviation. Data analysis was performed using SPSS version 17 software for statistics. The mean values were compared among the study groups using t-test and variance between the groups were compared using ANOVA and the p value **p>0.05** was considered statistically significant. Microsoft word and Excel have been used to generate tables and graphs.

Table1 and Bar diagram 1 indicates that Mean Internal gap value of Group 1was 292.4µ ± 23.48 and Mean Internal gap value of Group 2 was 258.54 µ ± 22.83 µ, which was statistically significant with p value >0.05.

Table 2 and Bar diagram 2 indicates that Mean Marginal Gap value of Group 1 was 252.64µ ± 11.86 µ and Mean Marginal Gap value of Group 2 was 232.18 µ ± 06.24 µ, which was statistically significant with p value >0.05.

On comparing the mean values of internal gap among samples within Group-1, the lowest value was 263µ and highest value was 329µ. Whereas on comparing the internal gap of samples within Group-2, the lowest value was 227 µ and highest value was 275 µ. Though significant gap was found among both the groups, Group 2 showed comparatively lesser gap when compared to Group1 [as shown in the bar diagram 1]. This shows that on an average, the copings fabricated from scanned model [Group 2] (as they have less mean value) have better internal fit when compared to that of copings fabricated from scanned impression [Group 1].

On comparing the mean marginal values among the samples of Group 1, the lowest value was 225 µ and highest value was 283µ. Whereas comparing the marginal gap among the samples of Group 2, lowest value was 211µ and highest value was 249µ. Though significant gap was found among both the groups, Group2 showed comparatively lesser values when compared to Group 1 [as shown in Graph 2]. This shows that on an average, the copings made from scanned model [as they have less mean value] have better marginal fit when compared to copings made from scanned impression. These results are similar to results of the studies of kohorst et al and kokubo et al.[8, 9]

Fig 1 Metal Die

Fig 2 Impression tray holder

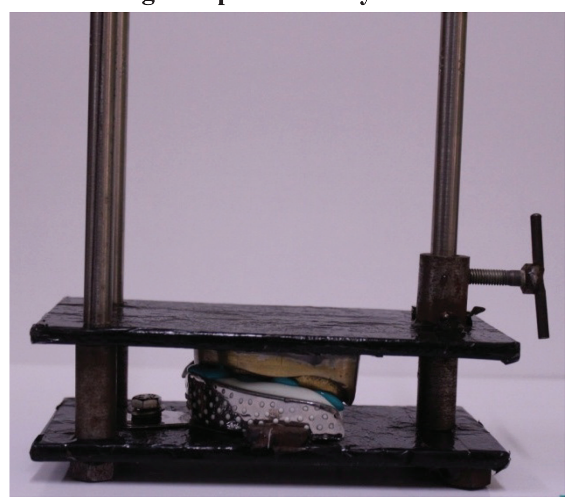

Fig 3 Metal die separated at uniform distance

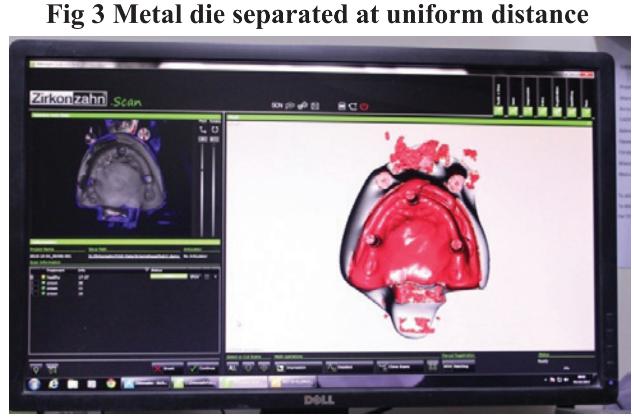

Fig 4 Scan of Impression

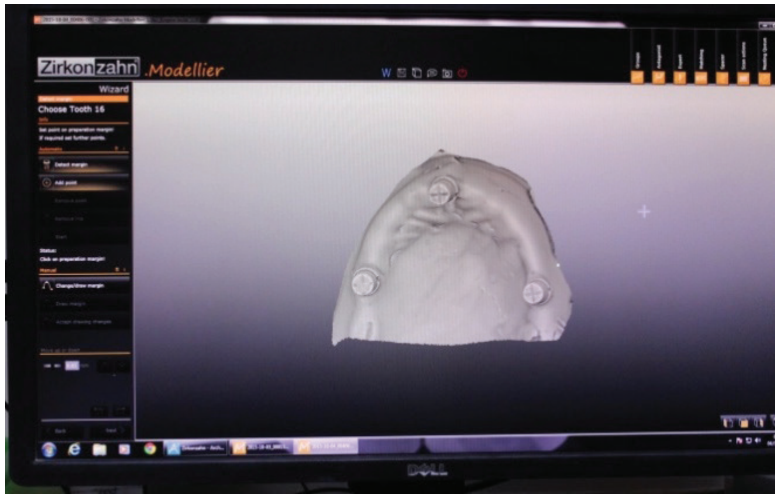

Fig 5 Scan of Gypsum model

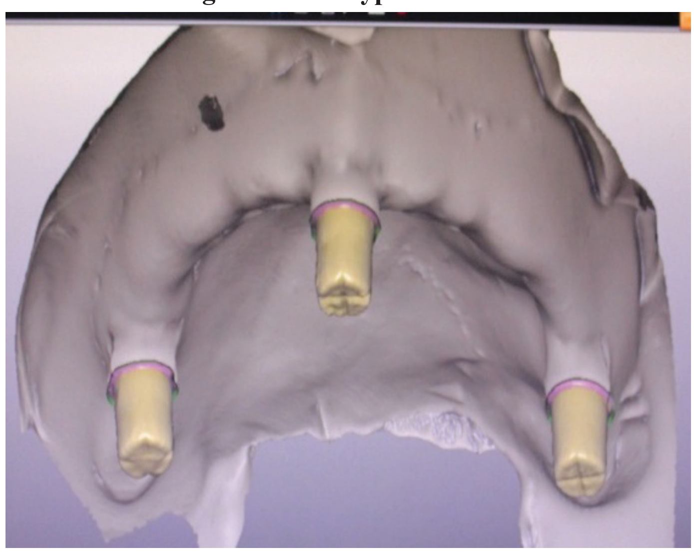

Fig 6 Designed copings

Fig7 Milling unit

Fig 8 Steriomicroscope

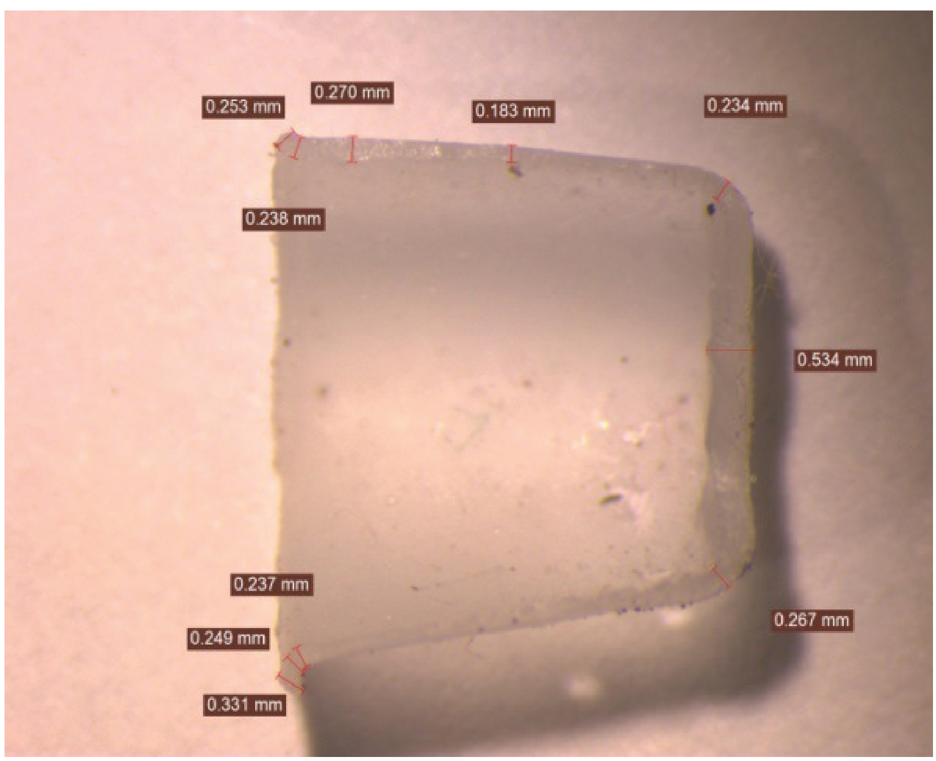

Fig 9 Measurements made from cross sectioned replica

Group 1: copings from scanned impression models

Group 2: copings from scanned models

Tabular column

TABLE: 1 Mean and Standard Deviation for Internal gap between the Group 1 copings and Group 2 Copings

INTERNAL GAP			
GROUP	N	MEAN (μ)	STD DEVIATION
IMPRESSION	15	292.4	023.48
MODEL	15	258.54	022.83

TABLE: 2 Mean and Standard Deviation of Marginal gap values between the Group 1 copings and Group 2 copings.

MARGINAL GAP			
GROUP	**N**	**MEAN(μ)**	**STD DEVIATION**
IMPRESSION	15	252.64	011.860
MODEL	15	232.18	006.240

Discussion

Marginal and Internal fit are two important factors for the success of any extra coronal restoration. Inaccuracy in the fit of the restoration can result in damage of the teeth and its periodontal structures. Marginal inaccuracies causing retention of plaque may lead to marginal gingival inflammation, gingival recession and secondary caries cervical to the margins of the crown [10, 11]. This is the common cause for the failure of restorations. Thus, irrespective of the technique of crown fabrication, the marginal and internal fits are of prime importance for the success of the restoration[12]. A shortcoming of the replica method is the two-dimensional display of a marginal gap. [13] In some cases, interpretation of this gap becomes difficult, especially if a margin is located subgingival. In the present study, some replicas had to be discarded because the interpretation was not possible. However, according to an in vitro investigation by Rahme et al [14], the use of a low viscosity silicone for the replica technique seemed to imitate the film thickness of glass-ionomer cement within a crown. This situation is analogous to clinical conditions where-in, an ideal film thickness of 25-35 microns is necessary for crown cementation. Also, one major advantage is the non-destructive nature of the replica technique. The reliability and validity of the replica method were confirmed by several authors [15]. Hence, the replica technique was used in our study. In this study finger pressure was used during cementation process. Although finger pressure has been questioned by some authors, it has been the considered opinion of weaver et al [16] that, a certain variance of the seating force has no impact on the film thickness within the coping and hence in the present study, finger pressure was applied uniformly by a single operator. The results of the present study are in agreement with studies of Ng et al in 2014[17] and Tamer Abdel- Azim et al[18] who compared fit of crowns fabricated with digital and conventional methods. They concluded that the fully digital fabrication method provided better marginal fit than the conventional method.

SCOPE FOR FURTHER STUDIES:

In the present study, impressions were scanned prior to digital reproduction. To obviate the need for impression making, intra oral scanners can be used to make virtual impressions and this could be taken up for future studies.

Ethical Clearance – Institutional Ethics Committee, Sree Balaji Dental College and Hospital, Committee registered with DCGI. (Registration no: ECR/761/Inst/TN/2015)

Source of Funding – Nil

Conflict of Interest – Nil

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