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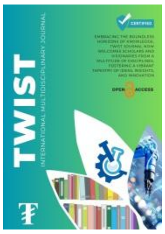

An In-Vitro Assessment of Marginal Fit of Zirconia Crowns:
A Comparative Study

Amuthavalli Velayutham*
Associate Professor, Department of Dentistry, Sri Lakshmi Narayana Institute of Medical Sciences,
Affiliated to Bharath Institute of Higher Education and Research, India
[**Corresponding author*]

Balaji Subramaniyan R.
Professor and Head of the Department, Department of Dentistry, Sri Lakshmi Narayana Institute of Medical Sciences,
Affiliated to Bharath Institute of Higher Education and Research, India

Abstract
The marginal fit of the crown is not proper, then there may be a cause for the gingival inflammation of the tooth or teeth. To evaluate the marginal fit of all ceramic crowns fabricated with zirconia cored crowns with layering and monolithic crowns. From a standardized die of a prepared tooth 20 dies were poured with type IV gypsum product. Zirconia copings with layering as group I and Monolithic crowns as group II were fabricated on the dies with 10 samples in each group. 20 crowns were cemented with resin cement. Marginal fit of the sectioned crowns were measured using stereomicroscope. Points will be taken in the marginal area of mesial and distal surface of the crowns. Mean values will be compared in two groups I, II for better marginal fit of the sectioned crowns. Marginal fit of monolithic crown have better marginal fit than zirconia coping with layering crowns. It was concluded that mean marginal fit of zirconia copings with layering crowns group I, and monolithic crowns group II significantly differ.

Keywords
Zirconia crown, CAD/CAM, Monolithic crowns, Metal die

INTRODUCTION

Tooth replacement with fixed partial denture have been changed drastically nowadays with advent of newer materials. Mostly of the crown replacements are done with the ceramic materials. Zirconium oxide is considered superior esthetic restorative material in terms of superior esthetic appearance[1]. Metal free prosthetic restorations are preferred in order to improve esthetic outcomes[2]. In this regard, Zirconia ceramics are having superior properties when compared to other ceramics in bonding strength and fracture toughness, and yttrium oxide partially stabilized zirconia (Y-TZP) is used as reinforced zirconia which has its own advantages over the other ceramics. This ceramic material has the properties of the metal and it is unique material among the other ceramics which are used for dental restorations[3].

The excellent esthetics of the restorations is accomplished by successive application and firing of layers of translucent veneering dentin and enamel porcelains onto a core made of zirconia. However, recently Monolithic zirconia crowns have been introduced which do not require porcelain veneering. Fitting accuracy and especially marginal fit are crucial aspects for a successful dental restoration[4]. However, restorations can be distorted during the veneering process. Distortions may create a space between restoration and preparation. As this space increases, luting material is exposed to the oral environment. Because of the solubility of most dental cements, bacterial plaque can easily accumulate in this defective area which in turn, can result in gingival inflammation, caries and pulpal lesions. This will result in failure of the restoration.

Marginal discrepancies between 50 and 100 microns have been reported to be clinically acceptable with regard to the long-term success of the restoration[4]. There is limited literature which compares the marginal fit of Monolithic Zirconia crowns and Zirconia copings with layered crowns. Hence, this study is being conducted to evaluate marginal fit of Monolithic Zirconia crowns and Zirconia coping with layering crowns using a stereomicroscope by comparing the marginal fit of zirconia crowns.

METHODOLOGY

A metal die is fabricated with cobalt chromium material which is prepared using CAD/CAM with classic tooth preparation specification of the die, which is includes 6˚ taper mesio - distally and 6˚ taper bucco -lingually with a circumferential shoulder of 1.0 mm and height of 5 mm and flat occlusal surface, was performed on a mandibular first molar acrylic model tooth[1]. The occlusal reduction was 1.5 mm and the axial reduction of 1mm the die base should be flat and cylindrical in shape with diameter of 10mm and height of about 15mm from the finish line to the base. Designed using CAD software (CATIA V5) and milling using 5 axis milling machine - (Figure-1 Design - STL file). A base was made for the metal die. The preparation was scanned using 3D white light scanner and a master metal die is made using milling. Then over the master metal die silicone impression is made.

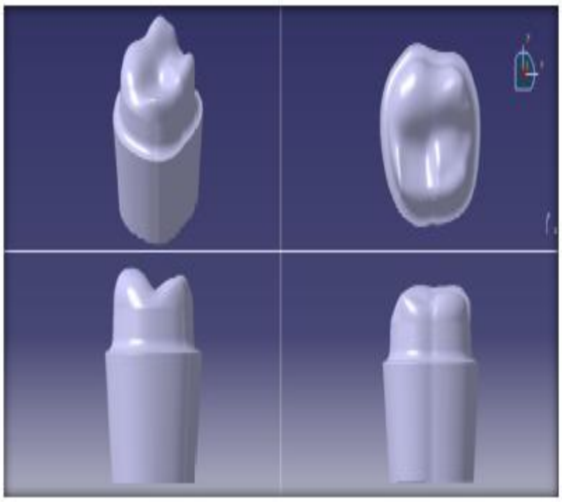

Fig. 1 Design - STL file

An impression was made with elastomeric impression materials (Poly vinyl siloxane–FLEXEED – GC) and it was made by putty wash technique. A cold cure tray was fabricated with pours as standard trays which is used make the impression in prepared tooth to get exact replica of the metal die (Figure- 2).

Fig. 2 Metal die and self cure tray with putty impression

Putty wash technique using a two separating sheet as spacer in two stages. Light body impression material was used in an auto mixing injectable gun[14].Before making each impression the surface of the metal die was cleaned. Specimens of metal die were prepared by compressing the impression material between a custom made stainless steel and self-cure tray. 20 specimens were made from 20 impressions of the die.20 impressions were poured with the die stone (Pearl stone, Asian Chemicals, India) using following manufacturer's recommended settings for the Water Powder ratio. The dies were separated from the impressions.

20 dies were numbered and scanned in 3M ESPE optical scanner (Figure-3) [Shining 3DScanner DS 200] and data was transferred to the modellier software [SYNTEC], using zirconia blanks (METOXIT).20 dies were divided into 2groups. With the veneer layer of 1.0 mm uniform thickness minimum from the central fossa (Group I), 10 conventional zirconia copings were made using CAD/CAM technology of uniform thickness of 0.6mm evenly with collar of 2.0mm thickness then ceramic crowns which are made flat with minimal concavity in the central fossa region were fabricated using manually layered sintering technique (Figure-4) [Ivocolar Vivadent]. Standard protocols by a single operator were followed for layering of zirconia coping.10crowns were made as monolithic crowns (Group II) were milled using CAD-CAM milling unit (SYNTEC) to a uniform thickness and fabricated in a private dental laboratory.

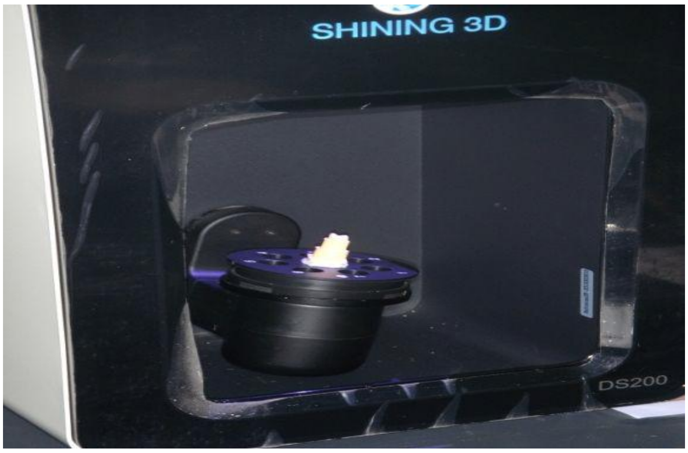

Fig. 3 Shining 3D scanner (DS 200 Scanner) Used for quick and simple capturing of models, models can berotated 360˚ Die for scanning

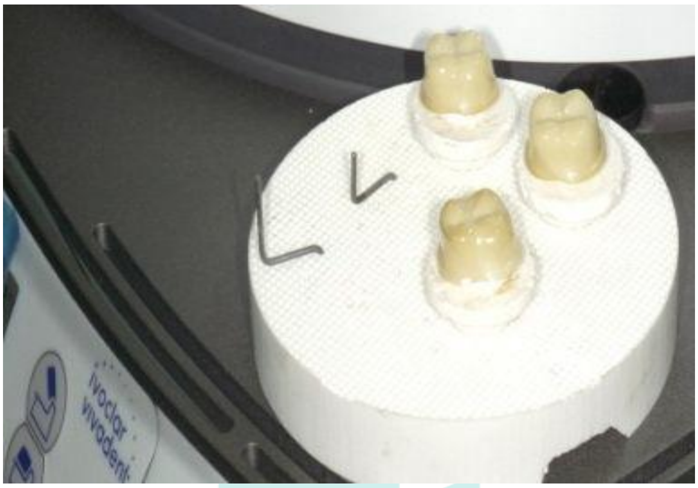

Fig. 4 Zirconia crowns with manual sintering technique

Before cementing the crown to the resin die the inner surface is dried completely and AZ primer applied (SHOFU INC. JAPAN). After that, crowns were luted to their respective dies by adhesive resin cement. After mixing, the cement was poured inside the crowns, and seated on the model using finger pressure initially. Then excess cement was removed, and crowns were placed under static load of 22N for 5 minutes. The luted crowns were light cured for about 2 minutes.

The luted crowns are sectioned. Zirconia crowns were placed in the stereomicroscope to check for marginal fit of zirconia crowns to the die[3]. The accuracy range of magnification of the stereomicroscope was 7.5% - 60%. The stereomicroscope was used to measure each crowns marginal fit in mesial and distal points of both zirconia copings with layering (group I) and monolithic crowns(group II)[9].

RESULTS

The mean mesial value of, zirconia coping with layering and monolithic crown were, 53.3±8.9 and 39.4±10.6 respectively. The difference between the mean was found statistically significant (P=0.019). The marginal fit of monolithic crowns had better marginal fit than zirconia coping with layering. The mean distal value of, zirconia coping with layering and monolithic crown were 55.3±15.4 and 38.2±6.3 respectively. The difference between the mean was found statistically significant (P=0.028). The marginal fit of monolithic crowns group II have better marginal fit than zirconia coping with layering group I (Table 1).

Table 1 One Way ANOVA Table

Comparison between the groups and within the groups						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
MESIAL	Between Groups	1012.952	2	506.476	4.566	.020
	Within Groups	2994.768	27	110.917		
	Total	**4007.720**	**29**			
DISTAL	Between Groups	1587.462	2	793.731	7.373	.003
	Within Groups	2906.726	27	107.657		
	Total	**4494.188**	**29**			

Hence, it may be concluded that mean marginal fit of zirconia copings with veneering group I and monolithic crowns group II significantly differ. Bonferroni test evidence that the difference between Zirconia coping with layering and Monolithic crowns in distal were significant (*p<0.01*) (Figure 5).

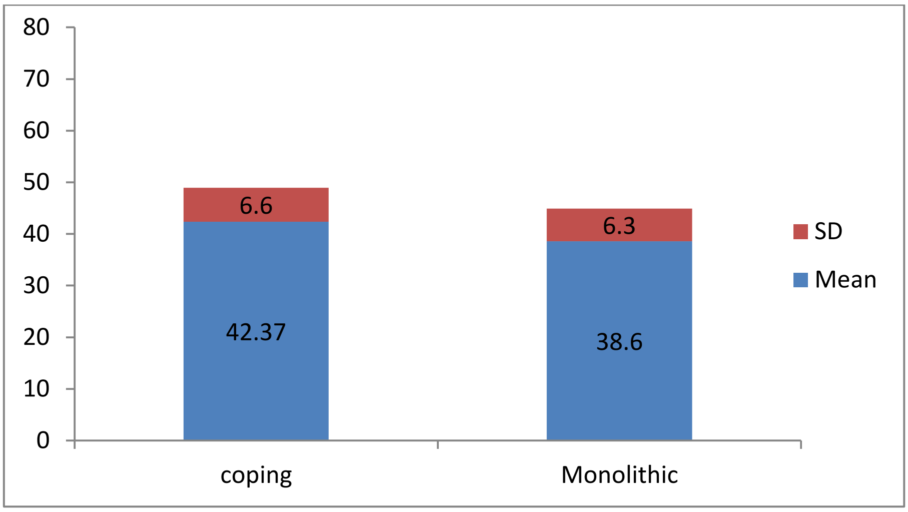

Fig. 5 Graph: Comparison of marginal fit of mesial aspect of zirconia coping and monolithic crown

DISCUSSION

The data obtained in this study showed statistically significant differences in the marginal fit of all – ceramic crowns zirconia coping with layering and monolithic crowns. The marginal fit of monolithic crowns showed superior marginal fit than zirconia coping with layering group. There were studies done to compare the marginal fit of metal ceramic restorations and all ceramic restorations but very minimal studies have been done on comparison of marginal fit of all – ceramic crown fabricated using CAD/CAM technology.

In the current study, metal die with specification of 6degree taper mesio-distally and 6 degree taper bucco-lingually with a circumferential shoulder of 1.0mm and height of 5 mm was used which served the advantage of standardised preparation of the die abutment similar to a study which was conducted by Rinke et al[4]. Assadi et al [2015] had compared the marginal fit of porcelain veneered zirconia crown and full contour zirconia crown using three different CAD/CAM systems[20]. The marginal fit of the full contour crown showed better marginal fit than porcelain veneered zirconia crown. In this present study, marginal fit of monolithic crowns showed better marginal fit than zirconia layered crowns.

Soon Pak et al [2010] compared the marginal fit of Digident and LAVA CAD/CAM zirconia ceramic crowns[13]. All –ceramic crown prepared in central incisor, the influence of porcelain veneering after the coping fabrication was measured for marginal fit. Porcelain veneering showed that the LAVA CAD/CAM zirconia crown showed better marginal fit than the Digident crown. In the present study, significant changes were observed between the zirconia coping with layering and monolithic crowns.

McLean and Von Fraunhofer (1971) examined more than 1,000 crowns for its marginal fit and concluded that restoration would be successful if marginal gaps and cement thickness of <120 μm could be achieved[6]. The literature showed that in the all ceramic crowns mean marginal discrepancy that ranged from 19 μm to 160μm. In the present study, the marginal fit values lowest of 39 μm to 55 μm. All the values obtained were within the acceptable limit. In vitro study has advantage of providing standardized condition with respect to design preparation and standardization of metal die, material specifications, technique and experimental performance by skilled person which results in more repeatable performance.

CONCLUSION

Within the limitations of this in vitro study, the following conclusions can be drawn:

1. The full – contoured zirconia crowns showed better marginal fit than the zirconia copings with layering.
2. There is a marked difference between marginal fit all – ceramic crowns of zirconia with layering and monolithic crowns with the influence of firing cycles.

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DECLARATION OF CONFLICT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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