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Original Research

Assessment of marginal adaptation of monolithic and layered zirconium crowns with shoulder finish line- An invitro study

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ABSTRACT:
Aim: To assess the marginal gap of monolithic and layered zirconium crowns with shoulder finish line. **Objective:** Assessment of marginal adaptation of monolithic zirconium crowns. Assessment of marginal adaptation of layered zirconium crowns. Comparison of marginal adaptation between monolithic and layered zirconium crowns. **Methodology:** A master metal Die was designed using CAD software and milled using Co-Cr alloy. 3D printer was used to design a customized special tray for making impressions of master die. A total of 40 working dies were duplicated from the master metal die. The study included two groups; Group-A included 20 samples of monolithic zirconium crowns fabricated using CAD-CAM and Group-B included 20 samples of layered zirconium crowns fabricated using CAD-CAM. The direct view technique has been used to measure marginal gap of each crown at eight predetermined measuring points for each sample using axial points(mid -buccal, mid- lingual, mid-mesial and mid-distal)and 4 line angles (mesio buccal , mesio lingual , disto buccal, disto lingual) in stereomicroscope. **Result:** The marginal gap of two groups was within the clinically acceptable range (3.5-120µm). Monolithic zirconium crowns showed less marginal gap than layered zirconium crowns at different stages of fabrication. (The mean value for marginal gap after initial sintering in monolithic zirconium crowns was 17.091 and after glazing was 14.914. The mean value for marginal gap after initial sintering in layered zirconium crowns was 17.111, after layering was 16.851, and after glazing was 15.461. The mean marginal gap after initial sintering in monolithic zirconium crowns was 17.091 and in layered zirconium crowns was 17.111. After glazing, the mean marginal gap in monolithic zirconium crowns was 14.914 and in layered zirconium crowns was 15.468.)**. Conclusion:** According to the study monolithic zirconium crowns showed less marginal gap than layered zirconium crowns at different stages of fabrication. The marginal gap exhibited by both groups were within the clinically acceptable limit.
Keywords: Marginal gap, monolithic zirconium crowns, layered zirconium crowns.

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INTRODUCTION

The use of all ceramic restorations are becoming more popular because of the biocompatibility, good strength and esthetics due to the ability of porcelain to transmit light.

There are different all ceramic restorative options available today. Full contoured zirconium crowns are indicated in posterior teeth as they have good mechanical properties and biocompatibility. To gain optimal esthetics, zirconium copings are layered with feldspathic or conventional ceramics.

During layering zirconium copings are subjected to repeated sintering procedures when compared to monolithic zirconium crowns, which may effect the marginal adaptation.

The grain size of zirconia materials changes with changes in sintering time and temperature. The grain size achieved increases with longer holding times and higher temperatures during sintering, which may enhance zirconia's creep deformation and, thus, result in distortion of the finished crowns. Zirconia loses stability and is more likely to undergo larger phase transformations with grain sizes above 1 m. (tetragonal to monoclinic phase). Conversely, a grain size of less than 0.2 m can result in a material with poorer fracture toughness. The most popular zirconia sintering process uses standard furnaces with holding periods of 2 to 4 hours and temperatures between 1350 and 1600°C.

Several variables affect a full crown restoration's success. The marginal adaption is one of the most crucial elements. For indirect restorations to be successful, marginal and internal adaptability is essential. Hypersensitivity, secondary caries, biofilm buildup, gingivitis, and periodontal issues can all result from margin inadequacy. Marginal misfit also causes a thick cement film that exposes the luting material to the oral environment and speeds up its disintegration over time.Various studies have been conducted to know the marginal integrity of zirconium crowns with different finish lines and concluded that crowns with shoulder finish line showed better integrity among various finish lines.

The present study is aimed at assessment of the marginal integrity of monolithic zirconium crowns and layered zirconium crowns with shoulder finish line.

AIM

To assess the marginal adaptation of monolithic and layered zirconium crowns with shoulder finish line.

METHOD

The first molar of the mandible was selected as the master die for the experiment. Molar tooth was prepared with a 1.0mm circumferential shoulder finish line, an occlusal height reduction of 1.5mm and 6 degree axial inclination was virtually designed and milled using Co-Cr alloy to simulate prepared natural tooth.A custom tray was fabricated using 3D Printing and designing. Double mix elastomeric impression technique was used for making impressions which were then poured in die stone. The procedure was repeated 40 times to obtain forty stone dies of same dimensions.

After die preparation, through CAD-CAM 20 anatomic crowns of monolithic zirconium (Group-A) and 20 copings of zirconium (Group-B) were milled using Rainbow mill ZR.

GROUP-A:

Dies were scanned by using laboratory scanner and STL file was obtained, later crown was designed by using Exocad Valletta version 2.2 software. Zirconia block (Aidite zr block) was used in CAD-CAM (Rainbow mill ZR) , later 20 monolithic crowns were milled. After 8 hours of sintering at 1680 0 celsius in Mihmvogt tabeo 100 zr sintering furnace marginal adaptation was measured between the finish line on the die and the crown margin at eight pre-determined measuring points for each sample using 4 axial points(mid
-buccal , mid-lingual , mid-mesial and mid-distal)and 4 line angles (mesio buccal , mesio lingual , disto buccal , disto lingual) in Stereomicroscope(Magnus MSZ series) and by using Micaps software dimensions were obtained in micrometers. After this glazing was done for monolithic crowns at 9200 c at zero vaccum in Ivoclar programat p310 ceramic furnance by using above mentioned procedure was carried out to measure marginal adaptation and measurements were obtained.

GROUP-B:

Dies were scanned by using laboratory scanner and STL file was obtained, later crown was designed by using Exocad Valletta version 2.2 software. Zirconia block (Aidite zr block) was used in CAD-CAM (Rainbow mill ZR) , later 20 Zirconium copings were milled. After 8 hours of sintering at 1680 0 celsius in Mihmvogt tabeo 100 zr sintering furnace marginal adaptation was measured between the finish line on the die and the crown margin at eight pre-determined measuring points for each sample using 4 axial points(mid
-buccal , mid-lingual , mid-mesial and mid-distal)and 4 line angles (mesio buccal , mesio lingual , disto buccal , disto lingual) in Stereomicroscope(Magnus MSZ series) and by using Micaps software dimensions were obtained in micrometers. For copings layering procedure was carried out using Ivoclae emax A2 zr ceramic and sintered in Ivoclar programat p310 ceramic furnace for 9450c, later by using above mentioned procedure marginal gap was measured. After this glazing was done for layered crowns at 9200 c at zero vaccum in Ivoclar programat p310 ceramic furnance by using above mentioned procedure was carried out to measure marginal adaptation and measurements were obtained.

MARGINAL ADAPTATION

Marginal gap of monolithic crowns(Group-A) were measured after sintering, glazing and were compared. Marginal gap of layered crowns(Group-B) were measured after sintering, layering, glazing and were compared. Marginal gap of monolithic(Group-A)and layered crowns(Group-B) were compared after sintering and glazing.

FIGURE 1 : STEREOMICROSCOPE

FIGURE 2: MASTER METAL DIE CAST WITH C0-CR ALLOY

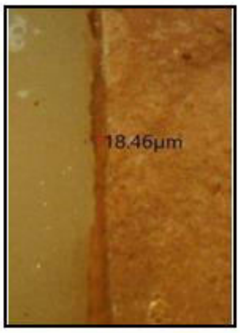

FIGURE 3: MEASUREMENTS DONE USING MICAPS SOFTWARE

RESULT

Data were analyzed using IBM SPSS version 20 software (IBM SPSS, IBM Corp., Armonk, NY, USA). Descriptive statistics, paired t tests $p \leq 0.05$ considered statistically significant, repeated measures analysis of variance, and independent samples t test were done to analyze the study data. Bar charts were used for data presentation. The descriptive statistics for mean marginal gap in monolithic zirconium crowns. The mean value for marginal gap after initial sintering in monolithic zirconium crowns was 17.09±1.97 and after glazing was 14.9±1.47.

Table 1: Multiple pair wise comparisons of marginal gap between different fabrication stages in layered zirconium crowns

Reference	Comparison	Mean difference	t value	P value
Sintering	Layering	0.262	0.51	0.627
	Glazing	1.645	6.471	<0.001*
Layering	Glazing	0.983	5.81	<0.001*

Table 2: Comparison of marginal gap between different fabrication stages in monolithic zirconium crowns

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		t valu e	P value
					Lower Bound	Upper Bound		
Sinterin g	20	17.096	1.9729404	.4411629	16.1736	18.0203	3.988	<0.001*
Glazing	20	14.901	1.4727421	.3293152	14.2119	15.5905		

DISCUSSION

After the porcelain firing cycle, there have been reports of the metal copings losing some of their original fit. Studies on marginal fit have shown that the distortion is caused by a mismatch of porcelain-metal thermal contraction, alloy type, and margin design. All ceramics have progressed to overcome the drawbacks of metal ceramic restorations. Improved biocompatibility, high strength, perfect fit, and superb aesthetics are all desirable qualities in an all-ceramic restoration. The main barriers to widespread usage of conventional glass and alumina ceramics have been their poor flexural strength, low fracture toughness, and intrinsic brittleness. The development of ceramic materials based on zirconia has been a significant advancement in the field of restorative dentistry. Full zirconia was designed to address the drawbacks of layered zirconia, the most widely used all-ceramic material. A zirconia crown's marginal fit hasn't been evaluated or reported, though.The current findings showed that the marginal fit of the monolithic and layered zirconia crowns differed significantly. There are many potential causes for the increased marginal gap of veneered frameworks, including porcelain veneering shrinkage during firing. Melting the porcelain particles, which further collect and fill the voids, is a step in the porcelain veneering. process. Porcelain shrinkage causes the coping to collapse and changes the gap size. Under the tension of the contracting porcelain, the coping deforms along the perimeter. Additionally, the thermal expansion coefficients of the zirconia and veneering ceramic substructures differ, resulting in tension pressure during the cooling process from glass transition to room temperature, which may have an impact on marginal fitness. Monolithic yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) restorations perform clinically well over time and do not degrade under high artificial ageing, in contrast to other ceramics and metal ceramic restorations. But because of its great opacity, it has poor optical qualities than other less durable and more attractive ceramics. Therefore, for aesthetic reasons, physicians frequently fabricate the core and framework of crowns and FDPs using Y-TZP before veneering them with translucent porcelain. However, it was shown that veneered zirconia restorations typically experienced chipping and fracturing of the veneering ceramic because of processing-related residual pressures. According to reports, the ceramic veneering of zirconia core chips at a rate of 37.7% over the course of 10 years, and its success rate is only 57%. To solve these problems, monolithic zirconia (MZ), which has higher aesthetic qualities, was needed. In order to reduce impurities and grain boundaries that result in less light scattering, the opaque Y-TZP was changed utilising more yttria content, less Al_2O_3, and higher sintering temperature and/or duration. But raising the sintering temperature and yttria content would raise the cubic content, lowering the material's mechanical characteristics (flexural strength and fracture toughness).

CONCLUSION

Within the limitations of the study and materials used. Following conclusions can be made:

1. For Monolithic zirconium crowns the marginal gap was decreased after glazing.
2. For Layered zirconium crowns the marginal gap was reduced sequentially after layering and glazing.
3. In between the two groups i.e, monolithic and layered zirconium crowns marginal gap was observed less in monolithic crowns, both after sintering and glazing than layered zirconium crowns.
4. According to the study monolithic zirconium crowns showed less marginal gap than layered zirconium crowns at different stages of fabrication.
5. The marginal gap exhibited by both groups were within the clinically acceptable limit.

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