# The Effect of Different Finishing Lines on the Marginal Fitness of Full Contour Zirconia and Glass Ceramic CAD/CAM Crowns (An *in-vitro* study)

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**Abstract**

**Purpose:** The aim of this study was to evaluate the effect of two gingival finishing lines (90° shoulder and deep chamfer) on the marginal fitness of two types of full anatomic all-ceramic crowns; zirconia crowns (Zikonzhan) and glass ceramic crowns (IPS e-max CAD) milled with CAD/CAM system. **Materials and Methods:** Two dentoform teeth of left maxillary first molar were prepared with chamfer finishing line (CFL) and shoulder finishing line (SFL), respectively and duplicated to Nickel-Chromium master dies. Thirty two crowns were fabricated and grouped as follows: Group I: 8 zirconia crowns on CFL; Group II: 8 zirconia crowns on SFL; Group III: 8 glass ceramic crowns on CFL and Group IV: 8 glass ceramic crowns on SFL. Marginal gaps were measured at 4 indentations, each one was at center of each tooth surface and collectively 16 points were measured by using stereomicroscope (160X). The data were analyzed by One-way ANOVA and student t-tests. **Results:** Group I produced the least marginal gap (73.55µm); followed by Group II (92.60µm), and Group III (151.45µm) and the highest marginal gap was recorded by Group IV (162.34µm). Statistical analysis of the data showed that SFL produced significantly greater marginal gap on zirconia crowns in comparison with CFL. However, in glass ceramic crowns, CFL revealed less marginal gap compared to SFL but statistically was not significant. On the other hand, glass ceramic crowns significantly produced a greater marginal gap in comparison to zirconia crowns regardless type of finishing line. **Conclusions:** deep chamfer margin could be more preferable finishing line than 90° shoulder especially for zirconia full crowns. Furthermore, zirconia crowns could be more advisable than glass ceramic crowns in respect to marginal adaptation.

**Key words:** CAD/CAM system, Marginal fitness, zirconia, glass ceramics, shoulder finishing lines, chamfer finishing lines.

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## Introduction

All-ceramic systems can be used as alternatives to metal ceramic systems in terms of esthetic restorative materials for crowns and fixed partial dentures (FPDs). Increasing expectations of high esthetics, biocompatibility and strength have led to numerous improvements in ceramic restoration. Recently developed yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) and transformation toughening have resulted in a breakthrough in the field of esthetic full-veneer restorations (Zirkonzahn; Zirkonzahn GmbH, Bruneck, Italy). As a result, high-strength zirconia is now being used in the production of fixed partial prostheses, even in load-bearing areas (1-3). On the other hand strong and tough ceramic materials that can be used alone without underlying metal frame are available, such as lithium disilicate-reinforced glass ceramic (IPS e.max CAD; Ivoclar Vivadent, Schaan, Liechtenstein) (3).

IPS e.max CAD (Ivoclar Vivadent) was introduced in 2005 as an improved ceramic material designed for CAD/CAM processing. It consists of a lithium disilicate- reinforced glass ceramic, but its physical properties and translucency are improved (4).

Prettau zirconia is extra translucent zirconia that when used in conjuction with the specific Prettau colouring technique it give 100% aesthetic full-zirconia restorations. It is particularly suitable in cases of heavy occlusion (bruxism). The Zirkonzahn system is a direct ceramic machining system that uses a scanning and machining process. The milled specimen is 20% enlarged to compensate for shrinkage after the sintering process at 1600°C according to manufacture instructions.

Zirconia or alumina-based materials have many advantages such as biocompatibility, low bacterial adhesion, traditional cementation and perfect mechanical properties. However, high durability of dental restoration is not only the result of mechanical properties. Marginal gaps can cause carious teeth, cement resolution, defected margins, subgingival microflora changes, periodontal destruction and periapical lesions resulting in pulpal effect. For these reasons, marginal fit plays a significant role in the longevity of restorations (5,6).

The introduction of computer-aided design/computer-aided manufacturing (CAD/CAM) technology in dentistry enabled dentists to use new treatment modalities and changed the design and application limits of all-ceramic restoration as the demand for esthetics in the posterior region of the mouth has increased (7). CAD/CAM machining for construction of dental restorations are gaining popularity and are clinically proven (8).

Types of finish lines and ceramic manufacturing technique are the factors that have been investigated for all-ceramic crowns. Heavy chamfers and rounded shoulder finish lines have been advocated for all-ceramic crowns (9-11).

The aim of this study was to evaluate effect of two gingival finishing lines (90° shoulder and deep chamfer) on marginal fit of two types of full anatomic all-ceramic crowns, zirconia crowns (Zikonzhan) and glass ceramic crowns IPS e-max CAD milled with CAD/CAM system.

## Materials and Methods

Two dentoform teeth of maxillary left first molar were fixed on the dentoform maxillary dental arch. In order to achieve standardized tooth preparation, a modified surveyor with a suspending arm was used to control the handpiece orientation during tooth preparation in which the movable table of the surveyor was adapted to secure the dentoform maxillary dental arch in such a way, so that the long axis of the ivorine tooth was parallel to the bur to ensure the same angle of convergence for all preparations (Fig. 1).

For deep chamfer finishing line preparation, a diamond bur No. (S 6856) (Komet, Germany) was used for axial reduction of (0.8mm) and a bur No. (8856) (Komet, Germany) for smoothening and finishing the gingival finishing line. For shoulder finishing line preparation, a diamond bur No. (8847KR) (Komet, Germany) was used for axial reduction of (1.2mm) and a bur No.(8372P) (Komet, Germany) for smoothening and finishing the gingival finishing line. The limit of the finishing line was (0.5) mm coronal to the cemento-enamel junction following the cervical anatomy of the tooth. Preparation of occlusal surface was standardized with a height of 4 mm using a disk bur on a straight handpiece adapted to the surveyor (Fig. 2).

The prepared dentoform teeth were used as patterns for the construction of master metal dies. The dentoform teeth were sprued, invested, burned out and casted using type III hard non- precious dental casting alloy. After casting, each metal die was smoothed with a rubber wheel and polished with pumice in a lathe brush followed by rouge to gain smooth polished surface, so that no interference with seating of the all crowns could occur later (Fig. 3). For each preparation type, 16 impressions were taken with a polyvinylsiloxane impression material (3M ESPE, USA), and poured using type IV dental stone (Zhermack, Italy) to get 16 stone die models.

The whole number of 32 teeth with two different gingival finishing lines (sixteen with 90º shoulder finishing line and sixteen with deep chamfer finishing line) were utilized to construct sixteen zirconium full anatomy (Zirkon zahan) and sixteen glass ceramic full anatomy (IPS e-max CAD) CAD/CAM crowns using Zirkonzahan M5-speed CAD/CAM machine.

Measurement of marginal gap

Four indentations on the margin of the die at the midpoint of different surfaces (mesial, distal, buccal and palatal) were selected to measure the marginal gaps along vertical planes by using a stereo-microscope (12-15).

A screw loaded holding device following (16-18) was used during measurements in order to maintain a seating pressure of (13.4N) between the all-ceramic crown and the master metal die during measurements calculation for this purpose.

The marginal gap of the crown was determined by measuring the vertical marginal gap between the margin of the die and the margin of the crown, the measurement were made on four different points on each surface (two on each side of the indentation that means left and right), 1st point will be at the edge of indentation while the 2nd one at (1mm) from the previous one (19). This was achieved by using a stereo microscope provided with a digital camera in the eye lens and connected with the computer (Fig. 4).

The microscope was adjusted its calibration to 0.001mm (1um) at magnification 160X and the measurements were done by placing the sample on the microscope stage, which was adjusted until the image of the marginal area was displayed clearly on the computer monitor, and the digital image of the gaps were then captured. The image was treated with program (Image J), which was used to measure the vertical marginal gap between the crown margin and metal master die finishing line.  The program (Image J) was used to measure the value in pixels mark by drawing a line between the finishing line on the die and the crown margin line. All digital readings were recorded and converted to (um) by a magnification factor (The length of a microscopic image divided by the object length) (15).

Sixteen measurements were continued for all the four surfaces (mesial, palatal, distal, and buccal) of each sample. All measurements were achieved by the same investigator (19,20), for accuracy purposes and to get a precise measures. Repeated measures were made to decrease the possibility of errors (13). The marginal discrepancy value of each crown was the arithmetic mean of these 16 measurements on the four surfaces.

The collected data were analyzed statistically using ANOVA (analysis of variance) test and student t-test. ANOVA test was performed to find if there is any statistical difference among the four groups. Since there are two variables included in this study (type of finishing line, and crown material type) and for each variable not more than two groups of comparison are found, Student t-test was selected to test the difference between these two corresponding groups.

**Figure 1.** Crown preparation on dental surveyor.

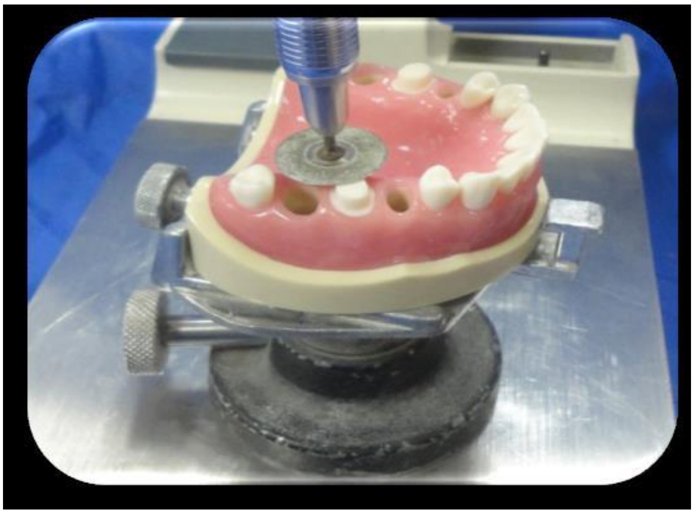

**Figure 2.** Diamond disk bur and straight handpiece adapted to the modified surveyor for occlusal reduction.

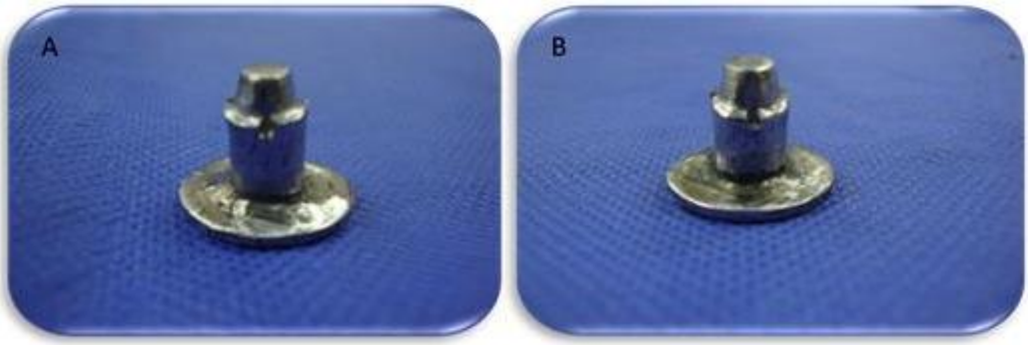


**Figure 3.** Finished master metal die. (A) Shoulder finishing line. (B) Chamfer finishing line.

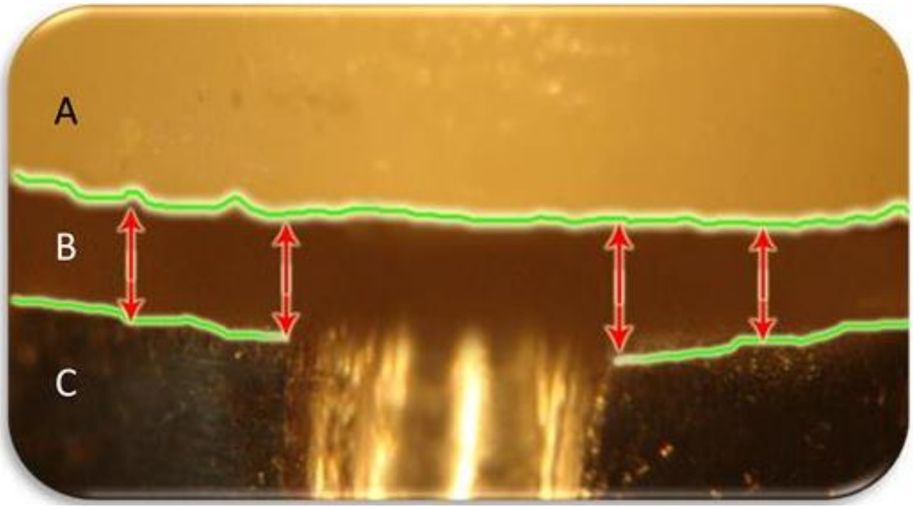


**Figure 4.** Digital image was captured during the measurement at four positions, (A) Crown. (B) Marginal gap. (C) Metal die.

## Results

The lowest mean of vertical marginal gap was scored in Group I (zirconia chamfer group) (73.55µm), while the highest mean was recorded by Group IV (Ceramic Shoulder group) (162.34µm) (Table 1) and (Fig. 5).

ANOVA test results showed that there was statistically significant difference among groups ($P<0.05$) (Table 2).

Shoulder finishing line produced significantly greater marginal gap with zirconia crowns (group I) compared to chamfer finishing line (group II) (Table 3) and (Fig. 6A and 6B). Regarding ceramic groups (III and IV), shoulder finishing line produced greater marginal gap with ceramic crowns in comparison to chamfer finishing lines but statistically the difference was not significant (Table 4) and (Fig. 6C and 6D).

Regarding chamfer finishing line, ceramic crowns produced significantly greater marginal gap (group III) in comparison to zirconia crowns (group I) (Table 5) and (Fig 6A and 6C). Similarly, with shoulder finishing line, t-test results revealed that ceramic crowns (group IV) produced significantly greater marginal gap compared to zirconia crowns (group II) (Table 6) and (Fig 6B and 6D).

**Table 1.** Descriptive statistics (mean, standard deviation, minimum and maximum) of vertical marginal gap for the different groups measured in micrometers.

| Groups | N | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Group I (Zirconium Chamfer) | 8 | 73.55 | 15.56 | 56.31 | 103.5 |
| Group II (Zirconium Shoulder) | 8 | 92.60 | 12.965 | 69.69 | 108.5 |
| Group III (Ceramic Chamfer) | 8 | 151.45 | 33.7625 | 100.10 | 201.6 |
| Group IV (Ceramic Shoulder) | 8 | 162.34 | 31.06375 | 108.30 | 201.3 |

**Table 2.** One way-ANOVA test among the four groups.

| | Sums of Squares | Degree of Freedom | Means of Squares | F | P value Sig |
|---|---|---|---|---|---|
| Between groups | 45520 | 3 | 15170 | -- | -- |
| Within groups | 19750 | 28 | 705.4 | -- | -- |
| Total | 65270 | 31 | -- | 21.51 | 0.0233 (S) |

S: Statistically significant difference.

**Table 3.** Student t-test between Zirconium groups with different finishing lines (Group I and Group II).

| Mean Difference | Degree of Freedom | T | P Value | Summary of Significant | 95% CI of differences | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| 19.06 ± 7.160 | 14 | 2.030 | 0.0186 (S) | P < 0.05 | 3.700 | 34.41 |

S: Statistically significant difference.

**Table 4.** Student t-test between ceramic groups with different finishing lines (Group III and Group IV).

| Mean Difference | Degree of Freedom | T | P Value | Summary of Significant | 95% CI of differences | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| 10.89 ± 17.36 | 14 | 0.627 | 0.5407 (NS) | No significant | -26.35 | 48.13 |

NS: Statistically no significant difference.

**Table 5.** Student t-test between chamfer groups with different crown material (Group I and Group III).

| Mean Difference | Degree of Freedom | T | P Value | Summary of Significant | 95% CI of differences | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| -77.90 ± 13.03 | 14 | 5.981 | 0.00008 (VHS) | P < 0.001 | -105.8 | -49.96 |

VHS: Statistically very highly significant difference.

**Table 6.** Student t-test between shoulder groups with different crown material (Group II and Group IV).

| Mean Difference | Degree of Freedom | T | P Value | Summary of Significant | 95% CI of differences | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| 69.73 ± 13.53 | 14 | 5.154 | 0.0001 (VHS) | P < 0.001 | -98.75 | -40.71 |

VHS: Statistically very highly significant difference.

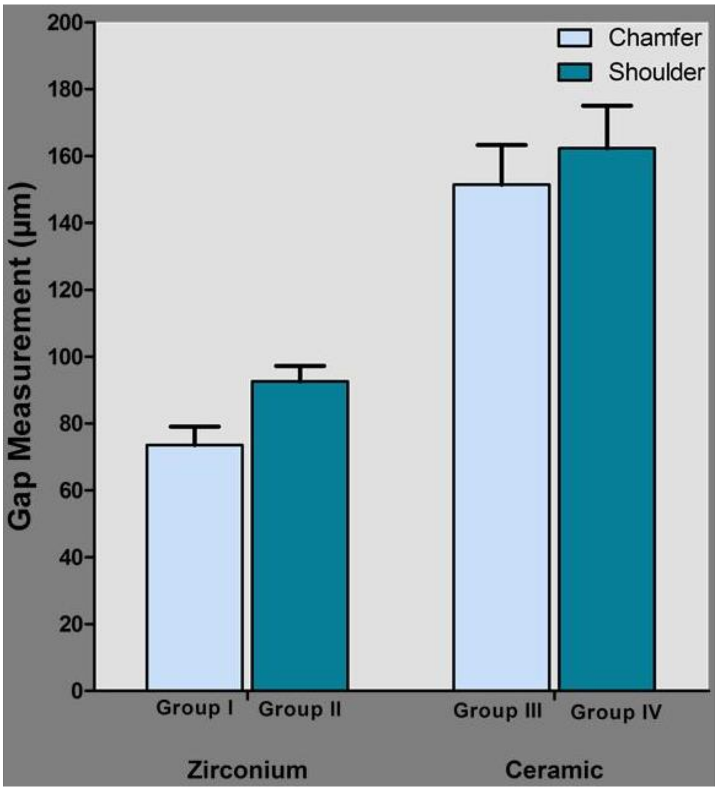

**Figure 5.** Bar-chart showing the mean values of the vertical marginal gap of the four groups.

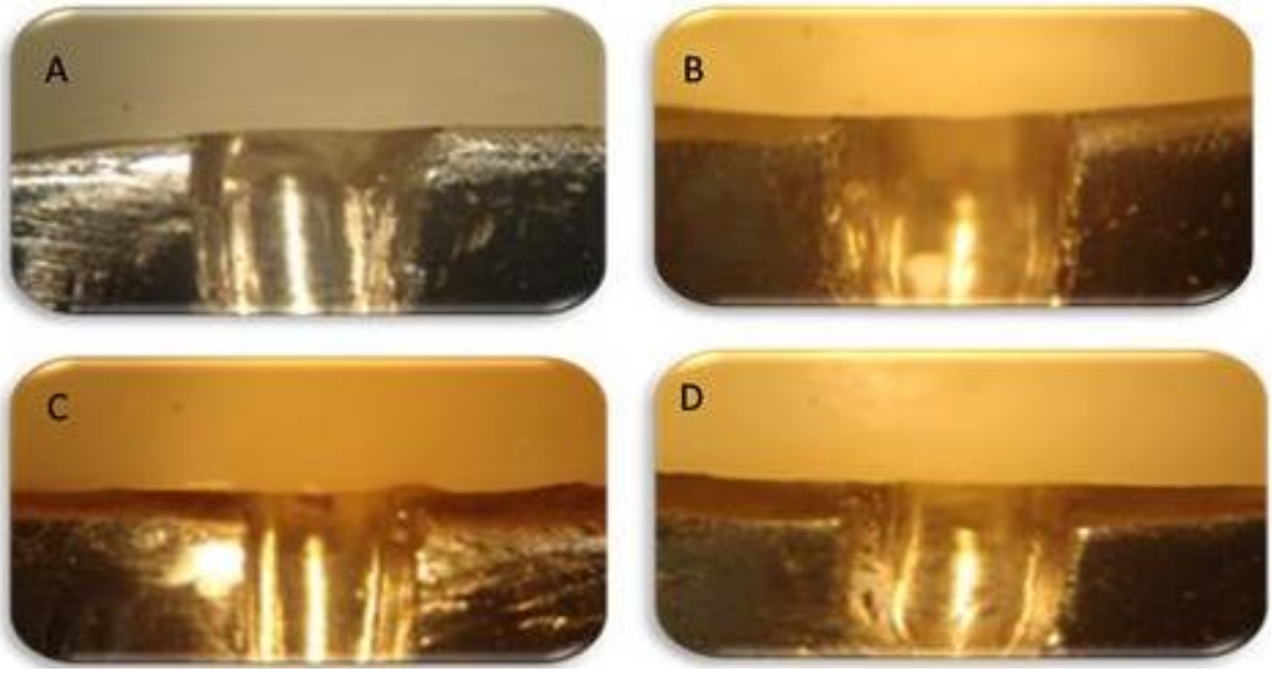

**Figure 6.** Marginal gap differences among the different groups.
(A) zirconium chamfer (B) zirconium shoulder (C) ceramic chamfer (D) ceramic shoulder.

## Discussion

For full ceramic crowns, a marginal gap between 1 and 165 μm is considered acceptable (21,22). However, some authors suggested that 100- 150 μm is acceptable for various restorations (23,24). On the other hand, 120 μm as the maximum acceptable marginal gap value based on the results of a five-year study consisting of 1,000 restorations was recommended by Mclean and Fraunhofer (25). In this study, mean marginal gap values for groups were below 120 μm, except for the ceramic groups, which also had an acceptable borderline value (120.1±43.1 μm).

Many previous studies reported the mean marginal gap for full ceramic crowns created by CAD/CAM between 23-74 μm (5,26,27). Our study, Zirkonzahan zirconia crown on chamfer finishing line created by CAD/CAM (group I) had similar mean marginal gap value, but the other groups had a higher values. The difference in sintering procedures of zirconia crown and ceramic crown created by CAD/CAM could be the reason for difference in the mean marginal gap values among the four groups. Therefore, this may decrease the precision of marginal adaptation and explain the results of the present study.

Other studies on Zirkonzahan (2,3) found higher marginal gap values on both chamfer and shoulder finishing lines compared to this study. In addition, they found smaller marginal gap values for ceramic group on both chamfer and shoulder finishing lines compared to our study. These differences between the present and previous studies may be attributed to the different measurement techniques and reference locations used, the subjective nature of the measurements, and the use of different blank materials.

Effect of finishing line type

In the current study, the marginal gap of zirconia crowns on chamfer finishing line was lower than on shoulder finishing line and this may be due to (a) the difference in the depth of the preparation (0.8mm for chamfer and 1.2 mm for shoulder); (b) the design of finishing line, which was more round angle between the axial and gingival seat for chamfer finishing line that enable more accurate seat for the crown than with shoulder finishing line (90°) with slight round angle lead to incomplete seat of the crown and increase the vertical marginal gap; and (c) it may be due to the accuracy of scanner detection that is being influenced by differences in depth preparation (19,28,29). Other possible causes may be the limited precision of the milling process with increased variation in preparation depth and this was parallel with other study30 which observed that increasing difference in preparation depth would lead to increased marginal gap.

Our finding that related to the superiority of chamfer finishing line is consistent with the results obtained by Karatasli et al (2) and Pera et al (31). However, it disagrees with other studies (18,28,32) which preferred the shoulder finishing line as they suggested that all-ceramic crowns should be supported by shoulder preparation to resist extensive loading whenever it may be expected, moreover our findings disagrees with other previous studies (1,3,10,33) which reported that the type of finish line design did not influence the marginal adaptation of all-ceramic crowns.

For ceramic groups, similar to the zirconia groups, it was observed that the vertical marginal gap of ceramic crown on chamfer finishing line was lower than on shoulder finishing line. The same causes discussed above for zirconia groups could be attributed to this result.

Effect of crowns material type

In current study the zirconia (Zirkonzahan) groups showed lower marginal gap than ceramic (IPS e-max CAD) groups on both chamfer and shoulder finishing lines, this may be due to difference in microstructures of the two materials and different fabrication techniques, so the marginal gap may be affected by the preparation design, milling process, size and type of milling burs which was carbide burs for zirconia and diamond burs for ceramic blocks and material conditions during the milling procedure in CAD/CAM system in which the zirconia blanks milled in dry field and ceramic blocks in wet field this was in agreement with Park and Lee (29) who stated that in the case of CAD/CAM, the scanning, software design, milling process would influence the marginal adaptation.

The above findings were in agreement with previous studies (18,34), which stated that zirconia crown fabricated with CAD/CAM system show better marginal adaptation than other tested groups. Other studies2,35 in which they compared the marginal gap of crowns fabricated with CAD/CAM system by using different materials found that the best results were obtained with ceramic group using CAD/CAM system than with zirconia and this disagrees with present study and this may be attributed to the differences in fabrication process for the tested materials.

In the present study, zirconia (Zirkonzahan) crowns sintering might not affect on the marginal gap because of the high strength of zirconia (33). However, this finding is not in agreement with Balkaya et al. (36). Who found in their study that after firing there was an increase in marginal gap.

For ceramic crowns, the marginal gap would be increased with firing and this was in agreement with two previous studies (33,36), which explained that the ceramic was not strong as zirconia (400Mpa compared with 900Mpa), so the firing would affect the marginal gap. The glaze of ceramic crown would not affect the marginal gap of ceramic (36,37) which reported that the glaze had no significant effect on the marginal gap.

## Conclusion

The findings of this study showed that for zirconia crowns, chamfer finish line significantly reduced the marginal gaps compared to shoulder finish line, also, for glass ceramic crowns, chamfer preparation produced better marginal fit, and no statistical significant differences were found between both finish line designs. Regardless the type of finish line, zirconia crowns produced significantly better marginal fitness than glass ceramic crowns.

## References


1. Komine F, Blatz MB, Matsumura H. Current status of zirconia-based fixed restorations. Journal of Oral Science 2010;52(4):531-9.
2. Karatasli O, Kursoglu P, Çapa N, Kazazoglu E. Comparison of the marginal fit of different coping materials and designs produced by computer aided manufacturing systems. Dent Mater J 2011;30(1): 97-102.
3. Subasi G, Ozturk N, Inan O, Bozogullari N. Evaluation of marginal fit of two all-ceramic copings with two finish lines. Eur J Dent 2012;6: 163-8.
4. Stappert CF, Att W, Gerds T, Strub JR. Fracture resistance of different partial-coverage ceramic molar restorations: An in vitro investigation. J Am Dent Assoc 2006;137(4):514-22.
5. Tinschert J, Natt G, Mautsch W, Spiekermann H. Marginal fit of alumina- and zirconia-based fixed partial dentures produced by a CAD/CAM system. Oper Dent 2001;26:367-74.
6. Beuer F, Aggstaller H, Edelhoff D, Gernet W, Sorensen J. Marginal and internal fits of fixed dental prostheses zirconia retainers. Dent Mater 2009;25:94-102.
7. Kassem As, Atta O, El-Mowafy O. Fatigue resistance and microleakage of CAD/CAM ceramic and composite molar crowns. J Prosthodont 2012;21:28-32.
8. Otto T, De Nisco S. Computer aided direct ceramic restorations: a 10- years prospective study of Cerec CAD/CAM inlays and onlays. Int J Prosthodont 2002;15:122-8.
9. Yeo IS, Yang JH, Lee JB. In vitro marginal fit of three all-ceramic crown systems. J Prosthet Dent 2003;90(5):459-64.
10. Quintas AF, Oliveira F, Bottino MA. Vertical marginal discrepancy of ceramic copings with different ceramic materials, finish lines, and luting agents: an in vitro evaluation. J Prosthet Dent 2004;92:250-7.
11. Naert I, Van der Donck A, Beckers L. Precision of fit and clinical evaluation of all-ceramic full restorations followed between 0.5 and 5 years. J Oral Rehabil 2005;32:51-7.
12. Holmes JR, Bayne SC, Holland GA, Sulik WD. Considerations in measurement of marginal fit. J Prosthet Dent 1989;62:405-8.
13. Groten M, Axmann D, Probster L, Weber H. Determination of the minimum number of marginal gap measurements required for practical in vitro testing. J Prosthet Dent 2000;83(1):40-9.
14. Goldin EB, Boyd NW 3rd, Goldstein GR, Hittelmann EL, Thompson VP. Marginal fit of leucite-glass pressable ceramic restorations and ceramic-pressed-to-metal restorations. J Proshtet Dent 2005;93:143-7.
15. Holden J E, Goldstein G R, Hittelman E L, Clark E A. Comparison of the marginal fit of pressable ceramic to metal ceramic restorations. J Prosthodont 2009;18:645-8.
16. Thiab SS, Zakaria MR. The evaluation of vertical marginal discrepancy induced by using as cast and as received base metal alloys with defferent mixing ratios for the construction of porcelain fused to metal copings. Al-Rafidain Dent J 2004;4(1):10-19.
17. Subhy AG, Zakaria MR. Evaluation of the effects of an Iraqi phosphate bonded investment and two commercial types on the marginal fitness of porcelain-fused-to-metal copings. Mostansiria Dent J 2005;2(2):183-93.
18. Hmedat SJ, Ibraheem AF. A comparison of Vertical Marginal Fit of three different types of All-ceramic

crown restoration. J Bagh Coll Dentistry 2013;25(1):43.
19. Lombardas P, Carbunaru A, McAlarney ME, Toothaker RW. Dimentional accuracy of castings produced with ringless and metal ring investment systems. J Prosthet Dent 2000;84(1):27-31.
20. Tjan AHL, Castelnuovo J, Sshiotsu G: Marginal fidelity of crown fabrication from six proprietary provisional materials. J Prosthet Dent 1997; 77(5):482-5.
21. Schaerer P, Sato T, Wohlwend A. A comparison of the marginal fit of three cast ceramic crown systems. J Prosthet Dent 1988;59:534-42.
22. Sulaiman F, Chai J, Jameson LM, Wozniak WT. A comparison of the marginal fit of In-Ceram, IPS Empress, and Procera crowns. Int J Prosthodont 1997;10(5):478-84.
23. Fransson B, Oilo G, Gjeitanger R. The fit of metal-ceramic crowns: a clinical study. Dent Mater 1985;1:197-9.
24. Boening KW, Walter MH, Reppel PD. Non-cast titanium restorations in fixed prosthodontics. J Oral Rehabil 1992;19:281-7.
25. McLean JW, von Fraunhofer JA. The estimation of cement film thickness by an in vivo technique. Br Dent J 1971;131:107-11.
26. Coli P, Karlsson S. Precision of a CAD/CAM technique for the production of zirconium dioxide copings. Int J Prosthodont 2004;17:577-80.
27. Bindl A, Mörmann WH. Marginal and internal fit of all-ceramic CAD/CAM crown-copings on chamfer preparations. J Oral Rehabil 2005;32: 441-7.
28. Kyu-Bok, Charn-Woon, Kyo-Han and Tae-Yub. Marginal and internal fit of all-ceramic crowns fabricated with two different CAD/CAM systems. Dent Mater J 2008;27(3):422-6.
29. Park SH, Lee KB. A comparison of the fidelity between various cores fabricated with CAD/CAM system. J Kor Acad Prosthodont 2008;43(3): 269-78.
30. Azar MS, Lehmann KM, Dietrich H, Weibrich G, Schmidtmann I, Scheller H. Effect of preparation depth differences on the marginal fit of zirconia crown copings: an in vitro study. Int J Prosthodont 2011;24(3):264-6.
31. Pera P, Gilodi S, Bassi F, Carossa S. In-vitro marginal adaptation of alumina porcelain ceramic crowns. J Prosthet Dent 1994;72:585-90.
32. Penwadee L, Edwin K, Gerard J Ch, Markus B B. Comparison of marginal fit between all-porcelain margin versus alumina-supported margin on procera R - Alumina Crowns, J Prosthodont 2009; 18:162-6.
33. Komine F, Iwai T, Kobayashi K, Matsumura H. Marginal and internal adaptation of zirconium dioxide ceramic copings and crowns with different finish line designs. Dent Mater J 2007;26:659-64.
34. Vigolo P, Fonzi F. An in vitro evaluation of fit of zirconium-oxide-based ceramic four-unit fixed partial dentures, generated with three different CAD/CAM systems, before and after porcelain firing cycles and after glaze cycles. J Prosthodont 2008;17:621-6.
35. Juarez GA, Barcelo SF, Rios SE. Marginal adaptation and microleakage comparison between two zirconia oxide systems with the same cement. Revista Odontológica Mexicana 2011;15(2):101-6.
36. Farid F, Hajimiragha H, Jelodar R, Mostafavi AS, Nokhbatolfoghahaie H. In Vitro Evaluation of the Effect of Core Thickness and Fabrication Stages on the Marginal Accuracy of an All-Ceramic System. Journal of Dentistry, Tehran University of Medical Sciences 2012;9(3):188-94.
37. Balkaya MC, Cinar A, Pamuk S. Influence of firing cycles on the margin distortion of 3 all-ceramic crown systems. J Prosthet Dent 2005;93(4):346-55.

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