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# Comparison of Marginal Fit between All-Porcelain Margin versus Alumina-Supported Margin on Procera® Alumina Crowns

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## Abstract

**Purpose:** Procera® Alumina crowns are widely used; however, the effect of crown margin design on marginal fit is unknown. This study measured and compared the precision of fit of Procera® Alumina crowns with two crown margin designs: all-porcelain versus alumina-supported margins.
**Materials and Methods:** Sixteen noncarious extracted human premolars were prepared for Procera® Alumina crowns with an internally rounded shoulder preparation. Impressions were made from all teeth, and master dies were poured with type IV dental stone. The specimens were randomly divided into two groups. Procera® Alumina crowns were fabricated: eight crowns with circumferential porcelain-butt (all-porcelain) margins and eight crowns with coping (alumina-supported) margins (control). Precision of fit was measured at six points on each crown with a profilometer (profile projector). The data were statistically analyzed with an independent-samples *t*-test ($\alpha < 0.05$).
**Results:** The mean marginal gap size ($\mu$m) of coping margins was $68.07 \pm 16.08$ and of porcelain-butt margins was $101.29 \pm 43.71$. There was no statistically significant difference ($p = 0.065$) of the marginal gap size between coping margins and porcelain-butt margins.
**Conclusion:** The results of this study demonstrate that there was no statistically significant difference in the marginal fit of coping and porcelain-butt margins. Both margin designs are within clinically acceptable ranges. Therefore, clinicians may choose to use a coping margin, as it is less labor intensive and requires less time for fabrication, unless there is a specific high esthetic need for a porcelain-butt margin.

All-ceramic restorations have increased in popularity due to the increasing demand for improved esthetics and natural-looking teeth, and metal-free biocompatible options are preferred. The optimal marginal fit of a dental prosthesis is essential for its long-term success in the oral cavity.[1-10] There are many all-ceramic systems on the market today. The Procera® system, commercially introduced in 1994, is based on computer-aided design/manufacturing (CAD/CAM) technology. First, cores of densely sintered alumina or zirconia are fabricated with high accuracy to ensure a close marginal fit. Special veneering porcelains are then applied to the cores to produce the desired esthetic results.

The marginal accuracy of all-porcelain versus feather-edge metal margin designs for metal-ceramic restorations has been discussed, especially in light of possible material interactions when porcelain is fused to the metal.[11] Limkangwalmongkol et al concluded that the porcelain-butt margin performed better than the feather-edge metal margin for metal-ceramic crowns.[12]

The fit of all-ceramic restorations has been investigated by many authors;[13-35] however, there is a lack of information

related to the fit of Procera® crowns to different crown margin designs. There are no accepted standards in regard to clinically acceptable marginal discrepancy.

May et al[24] demonstrated that a marginal gap at the crown–die interface of the Procera AllCeram crown for the posterior dentition was less than 70 $\mu$m. The results of different studies show a high variation within one crown system. In one study,[27] the mean value was 28 $\pm$ 3.13 $\mu$m, and in another study[33] it was 160 $\pm$ 45.98 $\mu$m. Yeo et al[35] showed that the marginal fit of three all-ceramic crown systems was within 120 $\mu$m. All data should be analyzed under the consideration of the study design. McLean and von Fraunhofer[36] concluded that a marginal opening of 120 $\mu$m represents the maximum clinically acceptable gap size.

The evaluation of the marginal discrepancy of crowns depends on multiple factors, measurements of cemented or uncemented crowns, storage time and treatment after cementation, type of abutment used for measurements, type of microscope and enlargement factor used for measurements, and location and quantity of measurement.[15,37]

Holmes et al[38] defined the measurements of the marginal gap of crowns at different locations as internal gap, marginal gap, vertical marginal discrepancy, horizontal marginal discrepancy, overextended margin, underextended margin, absolute marginal discrepancy, and seating discrepancy. They concluded that the best alternative measurement was absolute marginal discrepancy, since this distance would always be the largest measurement of error at the margin and reflects the total crown misfit at that point vertically and horizontally. A profilometer (profile projector) was recommended as a nondestructive and highly accurate method to evaluate the absolute marginal fit of crowns.[6]

The purpose of this study was to investigate with profilometry the absolute marginal discrepancies of Procera® Alumina crowns with two different marginal designs: the porcelain-butt margin and the feather-edge coping margin. The null hypothesis was tested: no difference exists between the marginal fit of porcelain-butt margins and feather-edge coping margins.

## Materials and methods

Sixteen noncarious extracted human premolars were included in this study. The teeth were sterilized by formalin and stored in normal saline solution (0.9%). Tooth preparations were made by one prosthodontist with a round end-tapered diamond bur (Brasseler, Savannah, GA) with water coolant in a standardized manner for all-ceramic crowns with occlusal reduction of 2.0 mm, axial reduction of 1.0 to 1.5 mm, a 10° preparation angle, and a 1-mm circumferentially rounded shoulder; all sharp edges were removed. The 16 specimens were randomly divided into two groups of eight each, as follows:

*Group 1*. Procera® crowns with 360° porcelain-butt margin.

*Group 2*. Procera® crowns with 360° feather-edge coping margin.

Impressions were made of each tooth with a vinylpolysiloxane material (Affinis, Coltene/Whaledent Inc., Mahwah, NJ). A light-body impression material was injected around the teeth and then inserted in custom-made trays of heavy-body material. The dies were fabricated in improved type IV dental stone (Fuji Rock, GC America, Alsip, IL) and trimmed under a 10× power microscope. The dies were scanned with a Procera Sandvik Scanner (MOD 50: 1732, Nobel Biocare, Yorba Linda, CA) that has a sapphire ball tip that reads the die shape by circular scanning. Following scanning, the information was transmitted by modem to Nobel Biocare in New Jersey where the densely sintered aluminum oxide coping was manufactured. The copings were ordered 0.6 mm thick to provide a substructure with optimal support for the veneering porcelain.

The copings were returned from the manufacturer (Fig 1). The veneering porcelain (Nobel Rondo, Nobel Biocare) was applied to the eight copings of group 2 and fired according to the manufacturer's recommendations. The other eight copings of group 1 were trimmed at the margins by a porcelain polishing kit (Dialite Extraoral porcelain polishing kit, Brasseler) to accept a porcelain-butt margin (Fig 2). The margin porcelain (Nobel Rondo) was applied to fabricate a porcelain-butt margin.

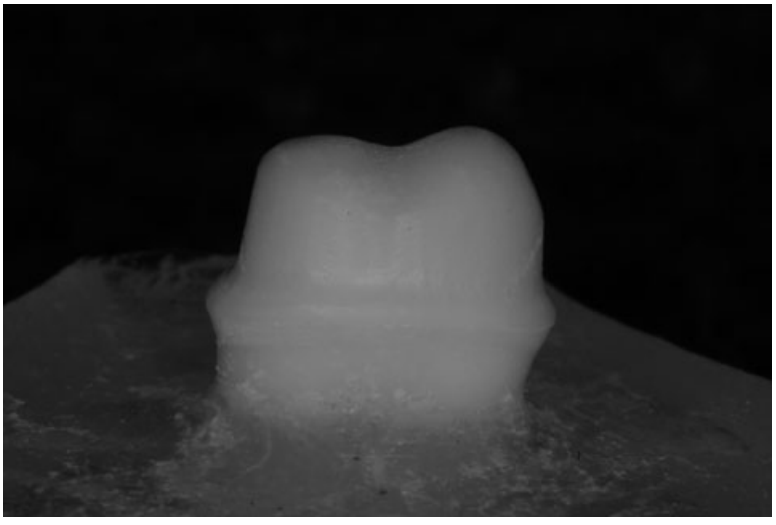

**Figure 1** Coping as milled.

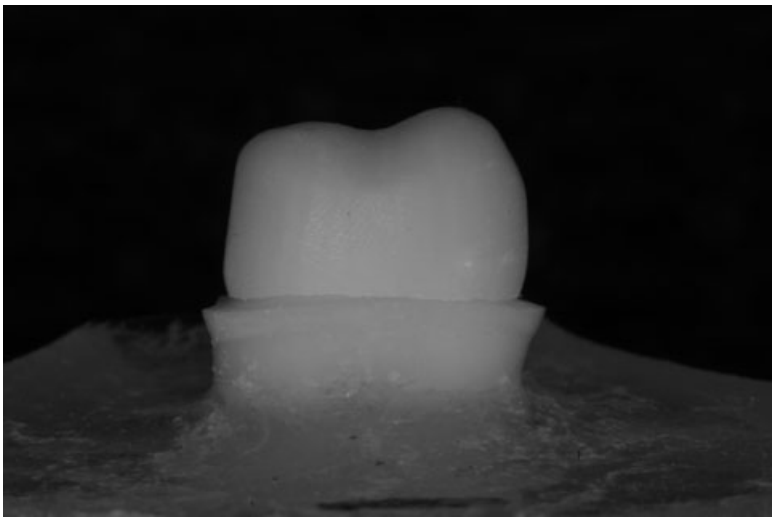

**Figure 2** Cut-back coping.

Then, the veneering porcelain (Nobel Rondo) was applied to the copings and fired following the manufacturer's recommendations. All crowns were fabricated by one dental laboratory technician.

The crowns (Fig 3) were finished and evaluated with a 10× power microscope. After finishing, the crowns were returned to their respective teeth. The fit of the crowns was assessed visually and tactually with a dental explorer by the prosthodontist who prepared the teeth. The intaglio surface of the crowns was checked for fit using a silicone-disclosing medium (Fit Checker, G.C. Dental Industrial Corp., Tokyo, Japan) with the 'cookie-cutter' technique. Any discontinuity in silicone medium, which indicated fitting surface interferences, was transferred to the respective tooth and minor adjustments were performed on the tooth with a small diamond bur. The fit of each crown was repeatedly assessed and the prepared tooth was adjusted until the fit of the crown was judged to be satisfactory both visually and tactually with commonly used clinical techniques.

The teeth were embedded in acrylic resin (Technovit, Heraeus Kulzer, Wehrheim, Germany). The tooth with the crown fully seated was sustained in place with a C-clamp. The marginal opening of each crown was investigated using a profilometer (TalyScan 150, Sarl Digital Surf, Besancon, France). TalyScan 150 is a contact and noncontact scanning instrument. In this study, the contact gauge was used. The instrument is supplied with the Talymap 3D analysis software. The accuracy of the profilometer used in this study was 0.1 $\mu$m.

Six profiles of the mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual surfaces of the teeth were digitized on a profiling system. Three measurements were recorded from mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual margins of each crown. Discrepancy values were calculated as averages of the measurements obtained. The discrepancy value of the porcelain-butt margin for each tooth was the average of 18 measurements of eight crowns. Likewise, the discrepancy value of the

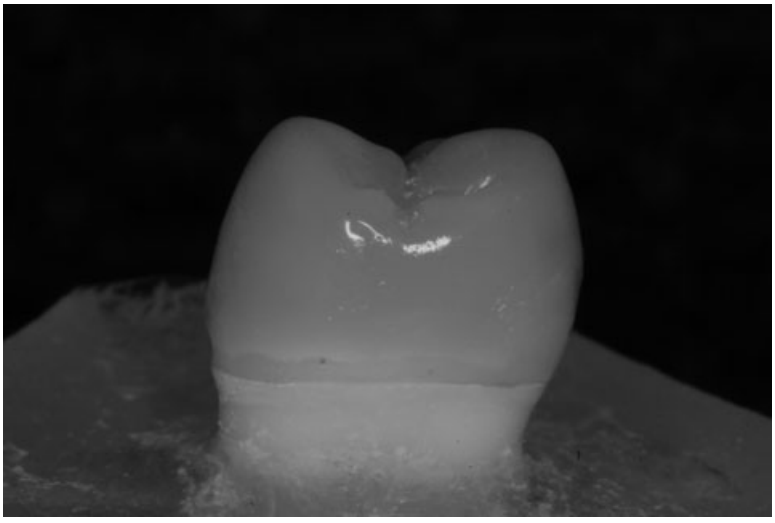

**Figure 3** Complete crown.

feather-edge coping margin for each tooth was the average of 18 measurements of the other eight crowns. The marginal discrepancy values of each marginal design in each group were averaged for a marginal discrepancy value of the entire group.

The data were analyzed with an independent-samples *t*-test ($\alpha = 0.05$).

## Results

Table 1 shows group means and standard deviations. There was no statistically significant difference of the marginal gap size between feather-edge coping margins and porcelain-butt margins ($p = 0.065$).

## Discussion

The null hypothesis was accepted because no significant difference in marginal fit was found between the two margin designs. Rinke et al[30] showed that using a shoulder preparation produced significantly smaller marginal gaps compared to a chamfer preparation. In contrast, Pera et al[27] found smaller marginal gaps when a chamfer preparation was made.

The study by Mitchell et al[6] demonstrated that the edge of the shoulder finish line was easier to visualize during crown fabrication than the chamfer finish line, and thus, the shoulder finish line ensured improved marginal fit. In this study, the rounded shoulder preparation was used. The results revealed that the feather-edge coping margin group produced a smaller marginal gap than the porcelain-butt margin group, but the differences were not statistically significant.

McLean and von Fraunhofer[36] concluded that 120 $\mu$m represented the maximum clinically acceptable marginal opening. Our data indicated that both feather-edge coping margins and porcelain-butt margins were within the range of clinical acceptance. The measurements recorded with a crown seated but not cemented demonstrate the minimal misfit of each crown, which is likely to increase after cementation because of the hydraulic backpressure of cement.[6,26]

The examination of the marginal fit of the nonsectioned specimens is generally performed with a direct microscopic view of the interface. Due to the limited depth of the field, measurements with an optical microscope may be faulty. It is not possible to focus on both points at once unless the two points to be measured are on the same plane.[2] In contrast, the profile projector presents the view of both the die and the specimen in the same plane on the screen, therefore, permitting an accurate focus.[14]

The number of measurement points per crown used in previous studies has varied considerably.[14,21,36–38] In this study the marginal gap values derived from averages of three measurements made at six locations on each crown were considered representative of the groups.

**Table 1** Mean marginal gap values and standard deviation of feather-edge coping margins and porcelain-butt margin in $\mu$m

| Group | n | Mean marginal gap | Std. dev | Std. error mean |
|---|---|---|---|---|
| Group 1 (porcelain-butt margin) | 8 | 101.29 | 43.71 | 15.45 |
| Group 2 (feather-edge coping margin) | 8 | 68.07 | 16.08 | 5.94 |

The results of this in vitro study revealed that the marginal gap of Procera® Alumina crowns with both margin designs are within the clinically acceptable range. Therefore, clinicians may choose to use the coping margin due to the fact that it is less labor and time intensive for the laboratory technician, unless there is a specific high esthetic need for a porcelain-butt margin; however, further investigation with a larger sample size and clinical trials are necessary to validate the results.

## Conclusions

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

1. There was no statistically significant difference ($p = 0.065$) in the marginal fit of Procera® Alumina crowns between the feather-edge coping margin and the porcelain-butt margin; however, a larger sample size could produce a difference.
2. Both margins tested produced marginal gaps within the range of clinical acceptance.

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