Comparison of the Marginal Fit of Procera AllCeram Crowns with Two Finish Lines

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Purpose: The purpose of this study was to determine the influence of two finish line configurations on the marginal accuracy of Procera AllCeram crowns. **Materials and Methods:** Twenty mechanized specimens of brass were fabricated for complete-coverage crowns. Two finish line designs were used: chamfer and rounded shoulder. AllCeram crowns were fabricated, and the fit of the crowns to the dies was recorded from the buccal and lingual margins. An image-analysis program was used to measure the gap. The results were subjected to statistical analysis using a Student's *t* test for separate samples and Student's paired *t* test. **Results:** No significant differences were observed between the buccal and lingual measurements. When the values of the buccal and lingual measurements were averaged, there were no significant differences in the marginal gap, horizontal discrepancy, or internal adaptation of the axial wall, but there were significant differences in the vertical discrepancy, absolute marginal discrepancy, and internal discrepancy between the two finish line designs. **Conclusion:** The marginal gap was within the range of clinical acceptability. Some of the variables were influenced by the two finish lines tested. *Int J Prosthodont 2003;16:229–232.*

The desire for optimal esthetics has increased the demand for all-ceramic crowns for anterior and posterior restorations, but all-ceramic restorations must satisfy clinical requirements of strength, precision of fit, and color stability to be successful.[1–3] Recently, several types of all-ceramic restorations have been developed: conventional powder-slurry ceramics (Optec HSP, Jeneric/Pentron; Duceram LFC, Degussa), castable ceramics (Dicor, Dicor Plus; Dentsply), pressable ceramics (IPS Empress, Ivoclar; Optec OPC, Jeneric/Pentron), infiltrated ceramics (In-Ceram, Vita), machinable ceramics (Cerec, Sirona; Celay, Vident; Dicor MGC, Dentsply), and high alumina–reinforced ceramic (Procera AllCeram, Nobel Biocare).[1,4]

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The Procera AllCeram crown was developed by Andersson and Odén.[5] It is composed of a coping of densely sintered high-purity aluminum oxide veneered with a low-fusing dental porcelain. The system uses computer-aided design/manufacturing (CAD/CAM) technology to produce an all-ceramic restoration with many improved physical properties over existing all-ceramic systems.[4–7] The content of aluminum oxide in the copings is 99.9%, and the strength for this ceramic material is the highest among all-ceramic restorations.[6–9]

Marginal fit is one of the most important criteria for the long-term success of all-ceramic crowns. Accuracy of fit has been extensively investigated in the dental literature. Marginal openings of between 50 and 120 μm are considered clinically acceptable with regard to longevity.[10–13] Misfit in all-ceramic crowns can affect fracture strength and thus reduce longevity, in addition to other known adverse effects of poor fit such as damage to the adjacent tissues, caries near the margin, and increased dissolution of the cement agent.[14,15]

Different finish line designs have been advocated for tooth preparations for several reasons, but it is not clear which finish line, if any, may offer the greatest

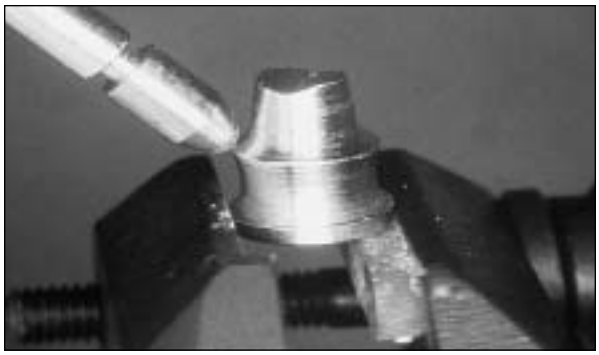

Fig 1 Sapphire probe stylus with the brass die in situ (chamfer preparation).

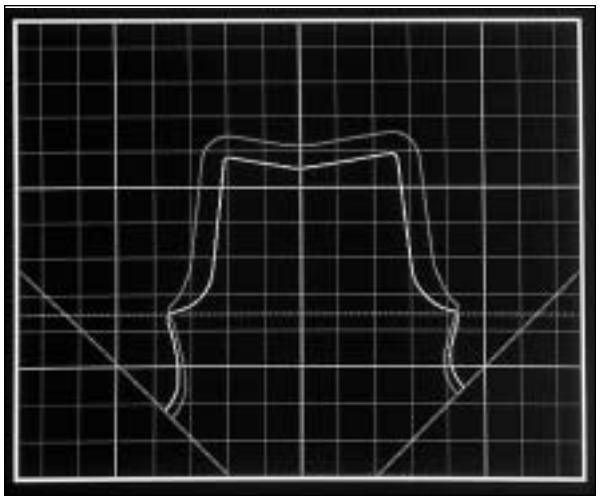

Fig 2 *(right)* Cross-section of digital image of die and coping for chamfer finish line.

advantage.[16] Because the Procera system requires machine duplication of a master die, it is especially important to identify the accuracy at which finish line designs are duplicated.[17]

The hypothesis for this study was that because of the scanner characteristics, the best marginal fit would be achieved with a chamfer finish line. The purpose of this investigation was to determine the influence of rounded shoulder and chamfer finish line designs on the marginal adaptation of Procera AllCeram crowns. The axial wall space created between the die and coping was also analyzed.

Materials and Methods

Twenty individual dies with approximately the same dimensions as a premolar were made of brass. Specimen preparations were standardized with occlusal reduction of 2.0 mm, axial reduction of 0.8 mm, height of 7.0 mm, total convergence angle of 6 degrees, and rounded line angles. Two finish lines designs were used: *(1)* 10 dies received a chamfer 1 mm circumferentially, and *(2)* 10 dies received a rounded shoulder 1 mm circumferentially.

Procera CAD/CAM technology was used to fabricate all-ceramic restorations. The brass die was mounted on a rotating platform in a digital scanner device that is attached to a computer and modem. The specimen rotates, and a scanning probe, which incorporates a sapphire stylus, approaches the die at a 45-degree angle (Fig 1). At each angle of rotation, the position of the stylus is recorded, and 360 recordings are registered for each rotation. Following each complete rotation, the stylus is elevated by 200 µm, and another cycle of recordings is taken until the entire preparation has been digitized. The average preparation requires around 50,000 readings for accurate digitization. Following digitization, the coping is designed on a PC. The finish line is refined manually at 10-degree intervals around the finish line of the preparation (Fig 2). The information is transmitted by modem to Nobel Biocare in Göteborg, Sweden, where the densely sintered aluminum oxide coping is manufactured.

The copings were returned from the laboratory and not veneered in this study. Each coping was cemented to the brass die with a dual-cured resin cement (Calibra Esthetic Resin Cement, Dentsply/Caulk). A standardized load was applied, and the cement was polymerized for 20 seconds with a light-curing unit. The copings were fitted and cemented as received from the manufacturer, with no adjustments made by the investigators.

Once set, any excess cement was removed, and the 20 specimens were embedded in epoxy resin (Epofix, Struers). Specimens were sectioned longitudinally buccolingually, and the sections were polished on a metallurgic polishing wheel using increasingly fine carbide papers. The following sites were evaluated, both buccally and lingually in the longitudinal sections according to previous studies[17,18]:

- *Marginal gap:* the shortest distance from the coping to the die surface
- *Horizontal marginal discrepancy:* the horizontal marginal misfit measured perpendicular to the path of draw of the coping
- *Vertical marginal discrepancy:* the vertical marginal misfit measured parallel to the path of draw of the coping
- *Absolute marginal discrepancy:* measured from the margin of the coping to the cavosurface angle of the die

Table 1 Means and Standard Deviations (SD) of Measurements of Fit of Copings with Chamfer and Rounded Shoulder Finish Lines (in μm)

Measurement of discrepancies	Chamfer		Rounded shoulder	
	Mean	SD	Mean	SD
Marginal gap	26	12	40	53
Horizontal	64	33	44	21
Vertical	81	70	–13	50
Absolute	143	49	71	42
Internal	79	21	279	49
Axial	101	18	87	23

- *Internal adaptation:* the perpendicular misfit measured from the internal surface of the finish line to the die
- *Axial adaptation:* the perpendicular measurement from the internal surface of the coping to the axial wall of the preparation, 2 mm coronal to the cavosurface line angle

An image-analysis program (Leica Qwin color RVA) connected to a Leica MZ 12 magnification loupe with a built-in Sony charge-coupled device (CCD) camera was used for measurements.

Each side was measured three times on every crown, and a mean value was calculated. The mean gap dimension at each measurement location was determined by calculating the means and standard deviations (SD). A Student's *t* test for separate samples and Student's paired *t* test were applied to determine statistically significant differences between the two finish lines studied at a level of $P < .05$.

Results

No significant differences ($P > .05$) were determined between the buccal and lingual measurements for the marginal gap, horizontal discrepancy, vertical discrepancy, absolute discrepancy, internal discrepancy, or axial wall discrepancy, nor between the chamfer and rounded shoulder finish lines. Therefore, the values obtained from the buccal and lingual measurements were averaged and analyzed as combined data (Table 1).

No significant differences ($P > .05$) were found in the marginal gap, horizontal discrepancy, or internal adaptation of the axial wall between the chamfer and rounded shoulder finish lines. In both groups, there were horizontal overcontoured surfaces. There were significant differences ($P < .05$) in the vertical, absolute, and internal discrepancies between the chamfer and rounded shoulder finish lines. These results suggest an undercontoured surface for the rounded shoulder finish line (–13 μm) and an overcontoured surface for the chamfer one (81 μm).

Discussion

Marginal accuracy is an important criterion in quality of fixed prosthodontics. The marginal fit of different all-ceramic crowns has been studied, but the results show great variation within crown systems.[19,20] Generally, evaluation of the margin discrepancy of crowns depends on several factors.[20–22] The reference points for measurements and definition of fit vary greatly among investigators, and many studies draw conclusions based on their own definitions. Often, the same term is used to refer to different measurements, or different terms are used to refer to the same measurement. This is a constant source of confusion in reporting and comparing studies.[18]

In vitro studies of the fit of Procera AllCeram crowns reveal mean marginal openings of less than 63 μm (56 to 63 μm).[3] Other investigators found marginal discrepancies of between 80 and 120 μm,[10,13,23] with 120 μm suggested as the maximum clinically acceptable marginal opening. The data indicate that the Procera AllCeram system is clinically acceptable, independent of the finish line. The mean marginal gap recorded in the present study (38 μm) was better than previously reported. Some authors reported that the magnitude of the marginal discrepancy is dependent on the type of preparation used,[18,24,25] but not concerning fit of Procera AllCeram crowns comparing several finish lines. In the present study, no statistically significant differences in marginal gap were found between the two finish line designs studied. These results are in agreement with previous studies of conventional crowns where the marginal fit was not influenced by the type of finish line.[16]

In this study, the chamfer showed horizontal and vertical overcontouring, whereas the rounded shoulder only produced horizontal overcontouring, but the data were within the established clinically acceptable range (120 μm or less).[10] Overcontouring has been considered more deleterious than undercontouring because it elevates plaque formation and may increase the possibility of gingival inflammation and loss of periodontal ligament attachment.[26,27] Access for patient plaque

removal has been suggested as actually being enhanced with an undercontoured margin.[28] A clinically rounded shoulder, rather than a chamfer finish line, is preferred for Procera AllCeram restorations.

Previous studies reported a great range of marginal gap widths within individual crowns,[13,29] but in this study, there were no differences between the two points of measurement (buccal and lingual). The data obtained in this study revealed a difference in the internal adaptation, with greater discrepancy for the rounded shoulder. Additional studies are needed to determine if these discrepancies can affect the strength of Procera AllCeram crowns. The recorded values for the marginal fit were lower than those for the axial wall. This might be explained by the fact that the marginal zone of the crown was manually corrected.[12]

Conclusions

The following conclusions were drawn:

- The accuracy of fit achieved by the Procera AllCeram coping was within the range of clinical acceptability.
- Influences of localization measurements within the tooth preparation on marginal and axial gap widths were not discovered.
- Marginal fit was not influenced by the type of finish line (chamfer or rounded shoulder).
- The chamfer finish line showed horizontal and vertical overcontouring.
- The rounded shoulder showed horizontal overcontouring and fit well vertically.
- The internal adaptation varied significantly depending on the finish line used. A poor internal adaptation was produced with the rounded shoulder finish line. Further studies about this factor are necessary.
- The recorded values for the marginal fit were lower than those for the axial wall.

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