Marginal Adaptation of Cerec 3 CAD/CAM Composite Crowns Using Two Different Finish Line Preparation Designs

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Purpose: **The purpose of this study was to compare marginal discrepancies of Cerec 3 CAD/CAM composite crowns, fabricated on human prepared teeth with two different finish line designs, chamfer and shoulder.**

Materials and Methods: **Sixteen human molar teeth were used to prepare full crowns. Eight teeth were prepared with a 1-mm-wide chamfer finish line and the other eight with a 1.2- to 1.5-mm circumferential shoulder. Cerec 3 crowns were fabricated from optical impressions using Paradigm MZ100 composite polymer. Marginal adaptation was evaluated in two ways: (1) using modified United States Public Health Service (USPHS) criteria to evaluate eight preselected sites on each crown margin, and (2) using scanning electron microscopy (SEM) to measure marginal gaps on all four axial walls with 15 measurements on each wall (60 measurements per crown). An evaluation of the number of acceptable crowns, determined by having all measured sites per tooth with margin gap size less than 100 μm, as a function of finish line design was also conducted.**

Results: **In both chamfer and shoulder groups, there were only two crowns (out of eight) with clinically acceptable ratings for all eight measurement sites according to USPHS criteria. Fisher's chi-square analysis showed that there was no statistically significant difference in marginal adaptability as a function of finish line design ($p > 0.05$). With SEM imaging, overall mean marginal gaps for the chamfer group were 65.9 $\pm$ 38.7 μm (range 35.0 to 130.0 μm), and for the shoulder group were 46.0 $\pm$ 9.2 μm (range 26.3 to 55.6 μm); this difference was not found to be statistically significant ($p > 0.05$). While crown assessment based on mean marginal discrepancy measurements indicated that both the chamfer and shoulder groups were considered clinically acceptable (<100 μm); crown acceptability based on all measurement sites being less than 100 μm indicated that in the chamfer and shoulder groups there were four and three acceptable crowns out of eight, respectively. The Fisher's chi-square test indicated no statistically significant difference between the groups ($p > 0.05$). An agreement rate of 81.2% was calculated between the two evaluation methods, modified USPHS criteria and SEM measurements.**

Conclusions: **Based on mean marginal discrepancy measurements, the typical marginal assessment technique, Cerec 3 Paradigm MZ100 crown restorations appear to have acceptable marginal adaptability (mean discrepancies <100 μm). Thus, the evidence from this investigation would suggest that the finish line preparation design had no effect on marginal adaptation for Cerec 3 composite crowns.**

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INDEX WORDS: marginal gap, chamfer, shoulder, SEM, Paradigm MZ100, composite milling blocks

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THE CEREC system (Sirona Dental Systems, Bensheim, Germany) is a computer-assisted design/computer-assisted manufacturing (CAD/CAM) system designed for the fabrication of indirect restorations.[1-3] Since its development in 1984, the Cerec system has undergone several technical modifications. The first generation system, Cerec 1, was designed for chairside fabrication of intracoronal restorations such as inlays, onlays, and/or veneers, whereas the Cerec 2 was introduced in 1994 with redesigned software and hardware to fabricate complete crowns in addition to intracoronal restorations.[3,4] The Cerec 3 system was introduced to the dental profession in 2000[3] and has several improvements over the Cerec 2 system. These improvements include: an enhanced intraoral optical camera able to reproduce finer detail and depth of scale and improved software capable of recording the preparation much faster.[2-5] Additionally, the Cerec 3 system allows more flexible and more true-to-detail grinding than the Cerec 2, which in turn should lead to a better fitting crown with improved occlusal morphology and design.[3,4]

The marginal integrity of CAD/CAM restorations has been evaluated in numerous investigations using modified United States Public Health Service (USPHS) criteria[6] by means of visual inspection and tactile perception with a sharp explorer.[3,7-12] In these studies, the majority of the CAD/CAM restorations were found to have acceptable marginal integrity according to USPHS criteria.

Numerous studies of CAD/CAM restorations have also used light microscopy or scanning electron microscopy (SEM) to actually measure the marginal gap between the restoration and the tooth either directly or from epoxy replicas.[7,13-20] A wide range of marginal gaps has been reported for these restorations. In clinical studies, mean marginal gaps for Cerec 1 intracoronal restorations varied from 191 (48) to 308 (95) μm[2,15] whereas mean marginal gaps of 85 (40) to 207 (63) μm have been reported for Cerec 2 intracoronal restorations.[15,18] In laboratory studies, the reported mean marginal gaps range from 63 (71) to 228 (68) μm for Cerec 1 intracoronal restorations[13-15,20] and from 56 (27) to 121 (46) μm for Cerec 2 intracoronal restorations.[14,15,17] A recent in vitro investigation of Cerec 3 crowns reported marginal gaps ranging from 53 to 162 μm.[19] Although there is no preestablished level of acceptable marginal gap, based on a study of optimum ceramic-cement mechanical conditions,[21] a marginal gap of 50 to 100 μm was considered ideal.

In fixed prosthodontics, several investigators have reported that the finish line design, i.e. chamfer, shoulder, beveled shoulder, etc., has no effect on the marginal discrepancy of conventional full crowns.[22-24] For the Cerec system, several investigators have examined the effect of different tooth preparation designs in the marginal fit of restorations.[7,13,16,17,19] Different finish line preparation designs,[7] rounded versus sharp internal line angles,[13] Class I versus Class II inlays,[16] and differences in the degree of axial wall convergence,[17,19] and luting space[19] may have an effect on marginal adaptation of Cerec indirect restorations. Results from the above studies imply that even though the finish line preparation design does not appear to have an effect on the marginal fit of ceramo-metal restorations, it may be an influencing factor on the marginal adaptation of Cerec-fabricated crowns.

To date, ceramic-based materials have been used with all CAD/CAM systems; however, Paradigm MZ100 (3M/ESPE, St. Paul, MN) is the most recently introduced machinable material for use with the Cerec 3 system. Paradigm MZ100 is a polymer ceramic based on Z100 composite chemistry using a processing technique to maximize the degree of cross-linking; however, there are no reported investigations that examined marginal adaptation of Cerec 3 crowns fabricated from Paradigm MZ100. The purpose of this study was to examine the marginal fit of Cerec 3 MZ100 crowns and to investigate whether two different types of finish line preparation designs would differentially affect the marginal adaptation. The finish line preparation designs were 1.0 mm chamfer and 1.2 to 1.5 mm shoulder. Marginal discrepancies were investigated with two methods: using modified USPHS criteria[6] and with SEM imaging.

Materials and Methods

Appropriate methodology and sample size were determined by a pilot study and power analysis. It was determined that a sample of eight specimens per group (for a total sample of 16) was needed for a 20% effect size change to represent a clinically significant difference in marginal discrepancies. The sample size was calculated with $\alpha = 0.05$ and power = 0.80.

Specimen Preparation

Sixteen extracted human molar teeth with no caries or anatomical defects were obtained from the Oral Surgery Clinic at Truman Medical Center, Kansas City, MO, and were randomly assigned to two groups. A random combination of both maxillary and mandibular third molars was used; all teeth were relatively comparable in size. The teeth were stored at 4°C in 0.9% normal saline solution with 0.002% sodium azide until they were used for the study. Institutional Review Board Exempt approval was obtained prior to initiation of the study.

The teeth were mounted in a block of light polymerized resin (Triad TruTray Custom Tray Material, Dentsply/Caulk, Milford, DE) and were randomly assigned to one of two finish line design groups. Teeth in Group A received a 1-mm-wide chamfer finish line preparation; whereas teeth in Group B received a 1.2- to 1.5-mm-wide circumferential shoulder. Teeth in both groups had similar occlusal and axial reductions of 2.0 and 1.5 mm, respectively. A poly(vinyl siloxane) matrix (Reprosil putty, Dentsply/Caulk) was made for every tooth prior to any preparation and was sectioned in half in the buccolingual direction. The matrix served as a guide to verify the amount of tooth reduction for each preparation (Fig 1). All preparations were performed by one investigator, and new diamond burs (Brasseler, Savannah, GA) were used for each preparation.

Optical impressions of the completed tooth preparations were made using the intraoral camera (Cerec 3). Preparations were uniformly covered with antireflecting powder (Vita Cerec Powder, Patterson Dental Company, St. Paul, MN) to facilitate the scanning process, and after the scan was evaluated for clarity, data were stored via the computer software (CEREC 3D, E.G. V2.40 R1800). The same computer software was used for designing each crown. The internal gap and the marginal gap size were set to 25 μm. Once the design of each crown was completed, the information was sent to the milling unit through a wireless connection. The milling unit was used with both a flat-ended and cylindrical diamond bur to fabricate crowns from Paradigm MZ100 milling blocks (lot number 27143A2, 3M/ESPE), composed of Bis-GMA and TEGDMA resin with zirconia silica filler at 85% weight and with an average particle size of 0.6 μm. Each crown was fabricated with a uniform space of 25 μm (internal and marginal gap setting) between the prepared tooth and the internal surface of the crown, to accommodate the thickness of the luting agent. New diamond burs were used for the milling of each crown.

The completed crowns were tried on the respective prepared teeth using a disclosing medium, (Fit Checker, GC Dental Products Corp., Aichi, Japan) as indicated by the manufacturer, and necessary adjustments were made to ensure complete seating. To stabilize the crowns prior to margin gap evaluation, the crowns were attached to their respective prepared teeth by means of cyanoacrylate (Aron Alpha Industrial Krazy Glue, Elmer's Products Inc., Columbia, OH). Care was taken to ensure that cyanoacrylate was present only on the occlusal surface of the tooth preparation and not on the margins since this could make gap measurement unreliable. After each crown was attached to the respective prepared tooth, an alphanumeric coding system was used to ensure blind evaluation. The base of the resin block was marked with a number that, when matched with a master sheet, corresponded to the finish line design group. Blinded evaluation was used for both the clinical evaluation of marginal adaptation and the evaluation of marginal adaptation using SEM imaging.

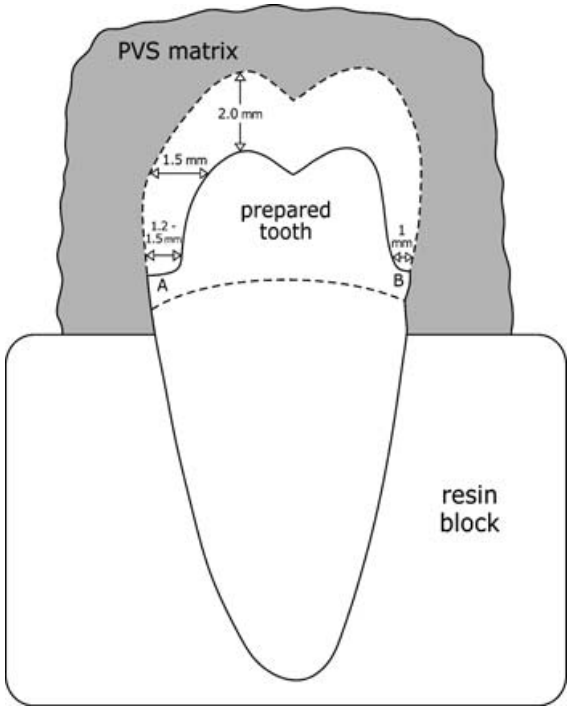

Figure 1. Poly(vinyl siloxane) (PVS) matrix to verify axial wall and occlusal reductions. Each tooth received a 1.5-mm axial reduction and 2.0-mm occlusal reduction. (*A*) An example of the 1.2- to 1.5-mm-wide shoulder finish line used in eight teeth; (*B*) An example of the 1-mm chamfer finish line prepared in the other eight teeth.

Clinical Evaluation of Marginal Adaptation

Two evaluators examined the marginal adaptation of the Cerec 3 crowns using modified USPHS criteria.[6] The evaluators were calibrated to 81.25% intrarater agreement and 87% interrater agreement during the pilot study. Margins on each crown were evaluated on eight preselected sites using a dental explorer (EXD 11/12,

Table 1. Marginal Integrity of the Cerec 3 Crowns Using Modified USPHS Criteria

Rating	*Characteristic*
Alfa	Explorer does not catch when drawn across the restoration margin, or if the explorer does catch, there is no visible crevice along the margin of the restoration
Bravo	Explorer catches at the restoration margin or there is visible evidence of crevice into which the explorer will penetrate; however, the dentin is not exposed
Charlie	The explorer penetrates into crevice and the dentin is exposed
Delta	The restoration is fractured

Hu-Friedy, Chicago, IL) and magnification loupes with a power of 2.5 ×. The eight sites, one at each axial line angle and one at the midpoint of each axial surface, were indicated with a black marker prior to marginal evaluation. A new explorer was used for the evaluation of each crown. Evaluators were blinded to the finish line design group, and the crowns were evaluated in random order. Based on USPHS criteria, margins at each site were rated as alfa, bravo, charlie, or delta according to characteristics described in Table 1.

Evaluation of Marginal Adaptation Using SEM imaging

After the clinical evaluation was completed, the specimens were sputter coated with gold-palladium alloy for SEM imaging. For each crown, all axial surfaces, buccal, mesial, lingual, and distal, were viewed and photographed at 50 × magnification. Using the photomicrographs, 15 sites were randomly selected along the marginal finish line on each of the four axial walls for a total of 60 marginal adaptation evaluation sites for each crown.

The absolute marginal discrepancy (mm),[25] distance from the internal surface of the crown margin to the preparation finish line, was measured from point x on the crown margin to point x′ on the edge of the finish line (Fig 2A). A representative SEM image is presented in Figure 2B; potential measurement sites are indicated by arrows. The 15 measurements of marginal discrepancies on each of the four axial walls were averaged to yield a single measurement for each wall. All measurements were made by one evaluator, blind to the finish line design group, using Image Tool software (v 3.0, University of Texas Health Science Center, San Antonio, TX). To minimize variation in the measured values, the evaluator was calibrated by measuring a code line of known dimensions in each photomicrograph.

Data Analysis

For assessing the USPHS clinical evaluation data, a median sample score was computed for each specimen

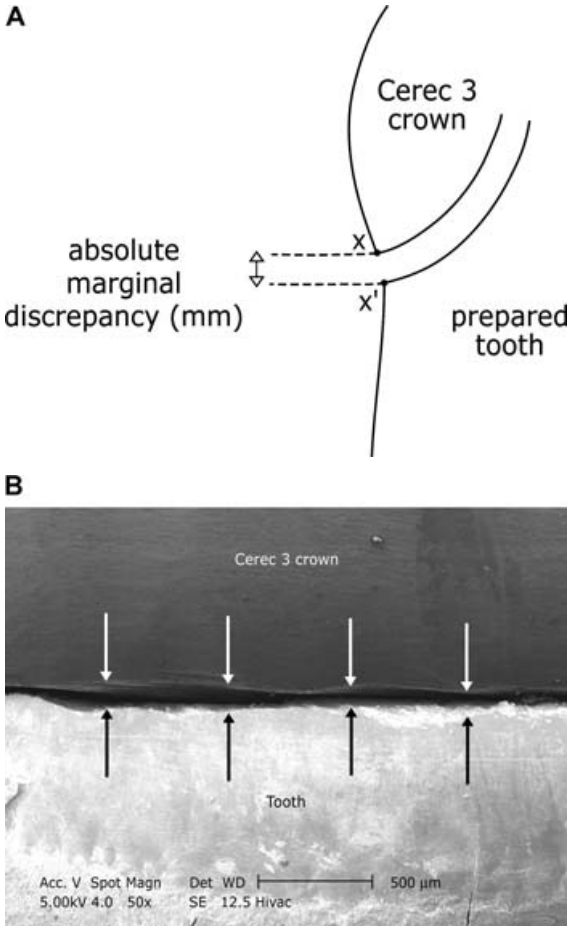

Figure 2. (*A*) Absolute marginal discrepancy, distance between the internal surface of the crown margin (x) and the preparation finish line (x′), was measured in millimeters from SEM photomicrographs of each Cerec 3 crown; (*B*) Representative SEM photomicrograph (50 × magnification) with arrows showing potential measurement sites of absolute marginal discrepancy. Fifteen measurements were made on each axial wall for a total of 60 measurements for each Cerec 3 crown.

from the eight preselected sites and analyzed using Mann-Whitney U-test ($\alpha = 0.05$). In addition, each site was categorized as acceptable, ranking of 1 or 2 (alfa or bravo rating, respectively) or unacceptable, ranking of 3 or 4 (charlie or delta rating, respectively). The number of acceptable sites between the two preparation groups was compared using Fisher's chi-square analysis ($\alpha = 0.05$).

A similar strategy was used to assess marginal gaps as measured with SEM imaging. The four mean axial measurements for each tooth were used to calculate an overall mean for each tooth. These overall mean gap sizes per specimen were compared using an independent *t*-test ($\alpha = 0.05$). In addition, the number of total sites with marginal gaps of less than 100 μm, in each of the two preparation groups was counted and compared using an independent *t*-test. In order to be able to assess clinical acceptability, the sites were dichotomized into acceptable and unacceptable based on the premise that a crown with even one site with marginal gaps of over 100 μm would be clinically unacceptable. These data were compared using Fisher's chi-square analysis ($\alpha = 0.05$).

Concordance between clinical and SEM assessments was evaluated descriptively using a two-by-two contingency table.

Results

Table 2 displays results of the USPHS clinical evaluation of crowns as a function of finish line design. The median clinical ranking for the chamfer finish line and the circumferential shoulder groups were 2 (SI = 0.04) and 2 (SI = 0), respectively. Mann-Whitney U-test determined that these groups were not significantly different from one another in clinical evaluation ($p > 0.05$). The clinical acceptability of crowns as a whole was also evaluated. Crowns were determined to be acceptable if all margin sites had clinical rankings of ≤ 2. In each preparation group, there were only two crowns (out of eight total crowns) with clinically acceptable ratings for all eight measurement sites. Fisher's chi-square analysis showed that there was no statistically significant difference in acceptability as a function of the finish line design ($p > 0.05$).

Table 3 displays data from the SEM evaluation of overall mean marginal gap size and the proportion of margins that exceeded 100 μm. In the chamfer group, the mean axial wall measurements, based on 15 measurement sites for each axial wall, buccal, mesial, lingual, and distal, ranged from 12.2 to 256.6 μm while in the shoulder group, the mean axial wall measurements ranged from 15.0 to 78.7 μm. The four axial wall means were then used to calculate a mean for each tooth in each group. In the chamfer group, mean results for the eight teeth ranged from 35.0 to 130.0 μm with an overall mean of 65.9 (38.7) μm, while the mean marginal gap for the eight teeth in the shoulder group ranged from 26.3 to 55.6 μm with an overall mean of 46.0 (9.2) μm; this difference was not found to be statistically significant with an independent *t*-test comparison ($p > 0.05$). Even though the mean marginal gap size for both groups was below 100 μm, there were several sites that exceeded 100 μm. The proportion for total sites with marginal gaps that exceeded 100 μm for both chamfer and shoulder groups were 13.4% and 2.9%, respectively. An independent *t*-test was used to compare the two proportions and showed no statistically significant difference ($p > 0.05$).

An evaluation of the number of acceptable crowns, determined by having all measured sites per tooth with margin gap size less than 100 μm, as a function of finish line design was also conducted. In the chamfer and shoulder groups, there were four and three acceptable crowns out of eight, respectively. Fisher's chi-square test was used to compare the data and determined that there was no statistically significant difference ($p > 0.05$).

Concordance between clinical ratings and SEM evaluation was assessed by examining the total number of crowns determined to be acceptable for each method. Thirteen of the 16 crowns had

Table 2. Clinical Evaluation of Cerec 3 Crowns: Margin Ranking Medians (Semiinterquartile Range) and Proportion of Clinically Acceptable Crowns

Group	*Median*	*SI*	*Proportion Acceptable*
Chamfer	2.0	0.04	25%
Shoulder	2.0	0.00	25%

$p > 0.05$ for all comparisons.

Table 3. Mean Marginal Gaps and Proportion of Sites Exceeding 100 μm

Group	*Marginal Gap Mean (SD)*	*Proportion of Sites ≥ 100 μm*
Chamfer n = 8	65.9 μm (38.7)	13.4 %
Shoulder n = 8	46.0 μm (9.2)	2.9 %

$p > 0.05$ for all comparisons.

concordant ratings of acceptability for both clinical evaluation and SEM evaluation, resulting in an 81.2% agreement rate between the two assessment methods.

Discussion

In this in vitro investigation, marginal integrity of Cerec 3 MZ100 crowns with two different finish lines, chamfer and shoulder, was evaluated using modified USPHS criteria based on visual inspection and tactile perception with an explorer. It was established in a previous study that tactile perception is a reliable means of detecting open margin defects up to 36 μm wide when using a sharp-tipped explorer.[26] In this study, an effort was made to control for instrument wear and subsequent decreased accuracy by using a new explorer for each crown. According to the modified USPHS classification, alpha and bravo ratings are considered clinically acceptable, while charlie and delta ratings are not. The modified USPHS criteria have been shown by several studies to be reliable for classifying the margin integrity of CAD/CAM restorations.[3,7-12]

Results from this study showed a median of 2 (bravo) for both finish line designs. Statistically significant differences were not found between the two finish line designs ($p > 0.05$). An attempt was also made to compare the number of clinically acceptable crowns in each group since the median for all sites in a group does not reflect the clinical acceptability of the crowns. Results showed that only two crowns from each group of eight were clinically acceptable. Clinically acceptable crowns had all eight measurement sites with either an alpha or bravo rating. Again, there was no difference between the two finish line designs ($p > 0.05$). These results agree with several other studies reported that the marginal fit of CAD/CAM inlay and crown restorations was not dependent on preparation design; however, these studies also indicated that no matter what kind of preparation design was used, the restoration's marginal adaptation was clinically acceptable.[7,16,17] This is in contrast with the results of the current study, which indicated that the majority of the crowns were clinically unacceptable regardless of the finish design; however, it must also be noted that in all previous investigations, the restorations were fabricated from ceramic-based materials, not a polymer-based material as was used in this investigation.

Light microscopy and SEM imaging have been compared as marginal gap measurement techniques for milled and CAD/CAM restorations.[27,28] One investigation[28] concluded that SEM imaging was better than light microscopy and dye penetration to evaluate marginal gaps of Class II CAD/CAM inlays, especially with smaller gaps; while another investigation[27] reported that there was no significant difference between the accuracy of the two techniques. However, those authors[27] also concluded that SEM imaging provided more appropriate and realistic observations than light microscopy analyzing systems.

In this investigation, SEM imaging was used to compare the marginal gaps of CAD/CAM crowns prepared with either a chamfer or shoulder finish line. Although there have been numerous investigations using light microscopy or SEM imaging to actually measure the marginal gap of CAD/CAM inlays and onlays,[13-18] there are fewer investigations measuring the marginal gap of CAD/CAM crowns,[7,19] and to date, none that specifically compared CAD/CAM crown marginal adaptation as a function of chamfer versus shoulder finish line design.

In the current investigation, in the chamfer group, the mean axial wall measurements, based on buccal, mesial, lingual, or distal sites, ranged from 12.2 to 256.6 μm; while in the shoulder group, the mean axial results ranged from 15.0 to 78.7 μm. The buccal, mesial, lingual, and distal means were then used to calculate a mean for each tooth in each group and overall mean for each group. The overall mean marginal gap in the chamfer group was 65.9 (38.7) μm, while the overall mean marginal gap in the shoulder group was 46.0 (9.2) μm. Both of these mean marginal gap values would be considered clinically acceptable (less than 100 μm). When these results were compared, there was no statistically significant difference ($p > 0.05$) in the mean marginal gaps as a function of the finish line.

In an investigation[7] of Cerec 2 fabricated crowns with butt-margin finish lines, the reported overall mean marginal gap was 59.9 (7) μm. Another investigation[19] compared the effects of the occlusal convergence angle of the abutment and the luting space setting on the marginal fit of Cerec 3 fabricated crowns. The results of that investigation suggested that occlusal convergence

angle had no significant effect on the marginal gap width; however, the luting space setting did affect the marginal adaptation. Mean marginal gaps were unacceptable when the luting space was set at 10 μm; the gaps ranged from 95 (20) to 108 (17) μm. However, when the luting space was set at 30 or 50 μm, the mean marginal gaps ranged from only 53 (5) to 67 (3) μm. It should be noted that the luting space setting used in this investigation was 25 μm, which also yielded acceptable mean marginal gap results. Therefore, in comparing the mean marginal gaps recorded in this investigation with the results from other investigations, the evidence would suggest that both ceramic- and polymer-based Cerec crowns can be fabricated with mean marginal gaps below 100 μm, which is considered an acceptable measurement.

Previous investigations and the current investigation have used mean marginal gaps as an assessment tool of marginal integrity; however, if the data are analyzed more critically, although both the overall means for the shoulder and chamfer group were below 100 μm, there were only four crowns in the chamfer group and three crowns in the shoulder group that had all sites which measured below 100 μm. The proportion of sites that exceeded 100 μm was 13.4% and 2.9% in the chamfer and shoulder groups, respectively. While the proportion of sites between chamfer and shoulder preparations was not significantly different ($p > 0.05$), from a clinical perspective, use of a shoulder preparation would be preferable given these results; however, when choosing between a shoulder and a chamfer finish line preparation, the clinician needs to evaluate additional parameters, such as the additional amount of tooth structure reduction required for a shoulder preparation, and the difficulty in preparing a shoulder finish line on teeth that have a great curvature of cemento-enamel junction. Certainly, additional studies need to be conducted to verify the use of chamfer versus shoulder finish line preparation for these types of restorations.

It is also interesting to note that the results of this study showed an agreement of 81.2% between the two methods of marginal integrity evaluation—USPHS clinical evaluation and SEM imaging. This high an agreement between the two evaluation techniques would support that marginal gap clinical evaluation with visual inspection and a tactile perception with a sharp explorer is a reliable assessment technique, which is in agreement with a previous study.[26] The 18.8% difference can be most likely explained by the difficulty of classifying a marginal catch when detected. This also agrees with the previous study that pointed out the difficulty of distinguishing when a catch was detected in some situations.[26]

The results of this in vitro investigation should be viewed cautiously, because laboratory testing cannot exactly model clinical situations. For example, recording the optical impression in the oral environment would be more complicated than in the laboratory. In addition, the marginal gap was measured in this study without resin composite luting cement, which potentially could affect the marginal gap dimension.[28,29] Due to the limitations of the SEM imaging, only measurements of absolute marginal discrepancy in a vertical dimension (distance from the edge of the crown margin to the edge of the finish line)[25] could be made; this evaluation did not account for any horizontal marginal discrepancies. However, the evaluation of vertical discrepancies was chosen as potentially more clinically significant, since this discrepancy, if undetected prior to crown cementation, will result in a vertical crown/tooth interface with wider zones of exposed luting agent. In contrast, while horizontal discrepancies result in a crown or tooth structure step defect that may affect cleanability and plaque retention, the crown/tooth vertical interface should have minimal areas of exposed luting agent. In addition, the investigation did not assess the internal fit of the crowns; however, this assessment would require cross-sectioning the crowns, which would limit the marginal gap measurement to only a certain number of sites. In this investigation, an attempt was made to evaluate each crown margin in 360°.

While this investigation was not a comparison of CAD/CAM systems, it was noted that a potential software improvement would be three-dimensional viewing of the proposed restorations. The fundamental focus of this investigation was to measure the marginal gap of Cerec 3 fabricated crowns using a polymer-based material (Paradigm MZ100, 3M/ESPE) and to determine whether there was a differential effect of the finish line design on the marginal gap dimension. Based on the mean marginal gap results, the polymer-based material appears to be a viable alternative for fabricating crowns with acceptable marginal gap values with either a chamfer or

shoulder finish line. The Paradigm MZ100 material represents a departure from the ceramic materials previously used with CAD/CAM technology. The polymer-based material presents some advantages, such as easier intraoral adjustments and polishing as compared with ceramic material, and surface additions such as occlusal or interproximal contacts could also be accomplished more easily. However, such a polymer-based material may also have some disadvantages, such as decreased wear resistance and flexural strength.[30] Future clinical investigations would be necessary to evaluate the clinical predictability and longevity of Cerec restorations fabricated from MZ100.

Conclusions

Within the limitations of this in vitro investigation, the following conclusions were drawn:

1. There was no statistically significant difference ($p > 0.05$) in marginal gap acceptability for Cerec 3 Paradigm MZ100 crown restorations as a function of finish line design when examined clinically using visual assessment and tactile perception with a sharp explorer.
2. When measured via SEM imaging, there was no statistically significant difference ($p > 0.05$) in the mean marginal gap size for Cerec 3 Paradigm MZ100 crown restorations as a function of chamfer, 65.9 (38.7) μm versus shoulder, 46.0 (9.2) μm, finish line.
3. Clinical evaluation, using a sharp explorer, was a reliable method of evaluating crown margins, as compared with SEM imaging technique (81.2% concordance between evaluation methods).
4. Further research and evaluation of Cerec 3 Paradigm MZ100 crowns is necessary to better predict clinical success.

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