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ORIGINAL ARTICLE

Identifying marginal adaptation discrepancies of lithium disilicate crowns using seven different vertical X-ray angulations

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Abstract

Purpose: To study the effect of different vertical angulations on the ability to radiographically assess vertical marginal discrepancies of lithium disilicate crowns.

Materials and Methods: Twenty-one lithium disilicate crowns were fabricated for three different prepared natural teeth: incisor, canine, and premolar. Vertical marginal discrepancies ranging from 0 to 300 µm were intentionally created. The seated crowns were radiographed using seven different vertical angulations, totaling 147 images. Thirty experienced evaluators scored each image for marginal discrepancy, and values were statistically analyzed.

Results: Significant differences in the ability to accurately assess marginal discrepancies from radiographs were observed for the study factors of angulation, tooth type, and degree of marginal discrepancy ($p < 0.001$).

Conclusions: The radiographic interpretation of the marginal discrepancies of lithium disilicate crowns is significantly affected by the dimension of the marginal discrepancy. Specifically on premolar crowns, it is significantly affected by different vertical angulations of the X-ray beam. When evaluating marginal discrepancy on lithium disilicate crowns radiographically, vertical beam angulation within ±10° to the cemento-enamel junctionCEJ plane is recommended.

KEYWORDS
angulation, assessment, e.max, evaluation, lithium disilicate, radiograph, X-ray

Complete coverage crowns are one of the most common restorations for severely damaged teeth and one of the most prevalent fixed prosthodontic treatments in the United States.[1] Over the last 30 years, the implementation of computer-aided design and computer manufacturing (CAD-CAM) has decreased manufacturing time and costs while increasing predictability.[2] CAD-CAM restorations additionally provide similar marginal accuracy to those restorations made using traditional techniques.[3]

Marginal adaptation is one of the most important aspects that determines the quality and the longevity of the restoration,[3,4] defined by the Glossary of Prosthodontic Terms as “the degree of fit between a prosthesis and supporting structures or the degree of proximity of a restorative material to a tooth preparation”.[5]

Several factors can play a role in the marginal adaptation of a ceramic restoration such as the fabrication method, the preparation design, the properties of the material, and internal adjustment done before cementation. In a systematic review by Boitelle et al., it was reported that CAD-CAM technology can produce dental restorations with absolute marginal discrepancies ranging from 10 to 110 µm, often with results less than 80 µm.[6] Regarding the preparation design, even though a lithium disilicate restoration with a feather-edge finish line has been claimed to be more conservative,[7] this can create a greater risk for chipping or horizontal fracture or lead to over-contouring at the cervical margin.[8] Studies have reported no significant adaptation differences between chamfer and shoulder finish lines.[9–11] In regard to the material, the mechanical properties can impact the accuracy and precision of the CAD-CAM restorations.[12] However, milling machines can efficiently fabricate accurate lithium disilicate restorations regardless of the hardness and machinability.[13]

Even though some discrepancy between the restoration and the abutment is unavoidable, this discrepancy should be as minimal as possible.[14] However, the degree to which a discrepancy is clinically acceptable remains debatable. Gingival marginal discrepancies from 34 to 119 μm were judged by clinicians to be acceptable according to a report by Christensen.[15] This corroborates the findings of McLean and Von who reported that the values for the marginal discrepancies below 120 μm should be the clinically acceptable threshold.[16] The presence of a marginal discrepancy may be the most common reason for the replacement of a restoration.[17] Open margins expose the cement layer to the oral environment leading to potential dissolution of cement, microleakage, more plaque retention, and secondary caries.[18,19]

To clinically identify a marginal discrepancy during the cementation of a restoration both visual inspection and tactile check with an explorer are recommended.[15] This can be assisted by radiographic examination, especially for subgingival margins.[20] A digital radiograph is the preferred method due to its advantages, especially image processing tools.[21] However, marginal discrepancies on lithium disilicate crowns present differently on radiographic examination when compared to metallic alloys.[22]

Regarding the vertical angulation of the X-ray beam, it has been reported that the best angle to assess mesial and distal defects is from a perpendicular projection. Only a very slight divergence to the perpendicular in the vertical plane (within 10°) is acceptable for metal inlays[20] and for implant abutment radiographic evaluation.[23–26] It has also been reported that it is difficult to determine an optimum angle for the visualization of insufficient proximal crown margins.[27] To date, the ideal vertical angulation of the X-ray beam for radiographic evaluation to detect marginal discrepancies of lithium disilicate crowns has not been reported.

The objective of this study was to evaluate how different vertical angulations of the X-ray beam affect the assessment of different marginal discrepancies using radiographs. The null hypothesis for this study was that there would be no difference in radiographic assessment of marginal discrepancies of lithium disilicate crowns with different vertical X-ray beam angulations among evaluators.

MATERIALS AND METHODS

Three extracted human teeth, one maxillary incisor (I), one mandibular canine (CA), and one maxillary premolar (PM) were obtained (#10, 27, 5). After mechanical debridement, the specimens were placed in a 10% formalin solution for 2 weeks. Once the disinfection protocol was completed, the specimens were placed in a specimen holder made of chemically polymerized polymethylmethacrylate resin (Splint Acrylic Resin, Great Lakes Dental Technologies) and allowed to polymerize for a period of 24 h. The resin specimen holder terminated approximately 5.0 mm from the cemento-enamel junction (CEJ). The specimens then underwent crown preparation to achieve adequate axial and occlusal reduction. For the finish line design, a 1 mm deep chamfer was chosen and a diamond bur was used. The finish line was placed at least 0.5 mm above the CEJ allowing the definitive crown margin to be completely over enamel.

FIGURE 1 Support base for the specimen and beam indicating device (BID).

The specimens were scanned using a Trios D900L desktop scanner (3Shape), the finish lines were identified, and the crowns were designed using 3Shape Dental Designer CAD software (3Shape).[28,29]

A die spacer of 50 μm was utilized, starting 1 mm from the finish line to promote relief in the intaglio surface. Six different marginal discrepancies were intentionally created on the mesial portion of the finish line using Fusion 360 and Meshmixer CAD software (Autodesk Inc.). The discrepancies measured 50, 100, 150, 200, 250, and 300 μm. No alterations were made on the distal, buccal, and lingual surfaces. One unaltered model for each crown was kept resulting in 21 3D models that were subsequently used for fabrication of the lithium disilicate crowns (IPS e.Max CAD; Ivoclar Vivadent). Based on each 3D model, 21 lithium disilicate crowns were milled using a PrograMill PM7 (Ivoclar Vivadent).[30] Crystallization was performed according to the manufacturer's instructions. No finishing and polishing (other than sprue removal), and no staining or glazing were performed on the specimens with the aim of preserving the original design created digitally.

A custom-made support base for the specimen and X-ray beam indicating device (BID) with adjustable clamps were used to center a digital X-ray imaging sensor (XDR Anatomic Sensor; Cyber Medical Imaging Corp) (Figure 1). The primary X-ray beam was aligned perpendicular to the long axis of the tooth, aligning it parallel to the CEJ of the tooth to mimic an optimal intraoral bite wing technique. From the initial angulation, 5 positive and 1 negative angle variations were used by the addition of "5 degree" or "10 degree" prefabricated wedges under the X-ray tube (Figure 2). The BID was positioned 1 inch from the specimen, and the specimen was positioned 3/4 inch from the X-ray sensor to mimic an intraoral radiograph situation. A Step Wedge X-ray film quality assurance phantom (AFP Imaging) was placed next to the specimen in order to ensure consistent image quality. An X-ray source was used (Gendex Expert DC; Gendex Corp) to expose the sensor at 65 kV and 7 mA. An exposure time

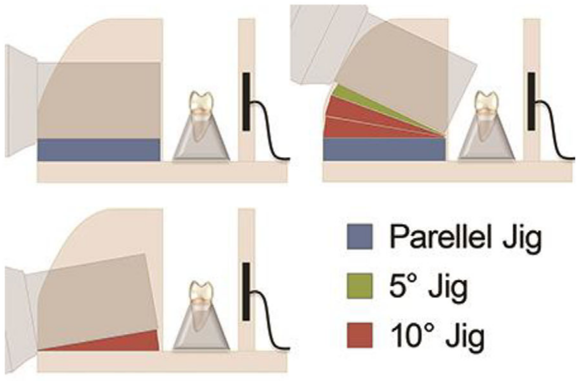

FIGURE 2 Schematic of radiographic device.

of 0.10 s was selected and confirmed using the XDR Twain software Ver 2.1.26.2 for adequate sensor photon dose.

After placement on the corresponding abutment, each crown was examined visually and with a sharp explorer before the exposure, to confirm they were completely seated. A total of 147 radiographs were acquired by repeating this same process for each sample. No image manipulation or filters were applied to the images (Figure 3).

A total of 30 volunteers, 24 male and 6 female, were asked to evaluate the radiographs. All the evaluators were graduate students at the Loma Linda School of Dentistry advanced education programs; nine from prosthodontics, six from implant dentistry, nine from periodontics, and six from endodontics. Among the participants, the ages ranged between 27 and 44 years old (mean 32.1 ± 3.88), and years of experience ranged between 1 and 22 years (mean 5.87 ± 4.53). Each radiograph was cropped and assigned to a number. Then the radiographs were remounted in a PowerPoint presentation in a randomized sequence generated using www.random.org. A laptop computer with a 2.6 GHz Dual Core i5, 8 GB 1600 MHz DDR3, Intel Iris 1536 MB, retina screen, with a resolution of 2560 × 1600 (MacBook Pro; Apple Inc) was used to display the images. No image manipulation tools were available to the participants. The Institutional Review Board determined this study as a non-human subject study (# 5220006).

Evaluators were asked to rate each radiograph on a five-point scale based on their interpretation of the presence or absence of marginal discrepancy (5 = present, 4 = probably present, 3 = uncertain, 2 = probably absent, 1 = absent). Because it was initially established that the purpose of the

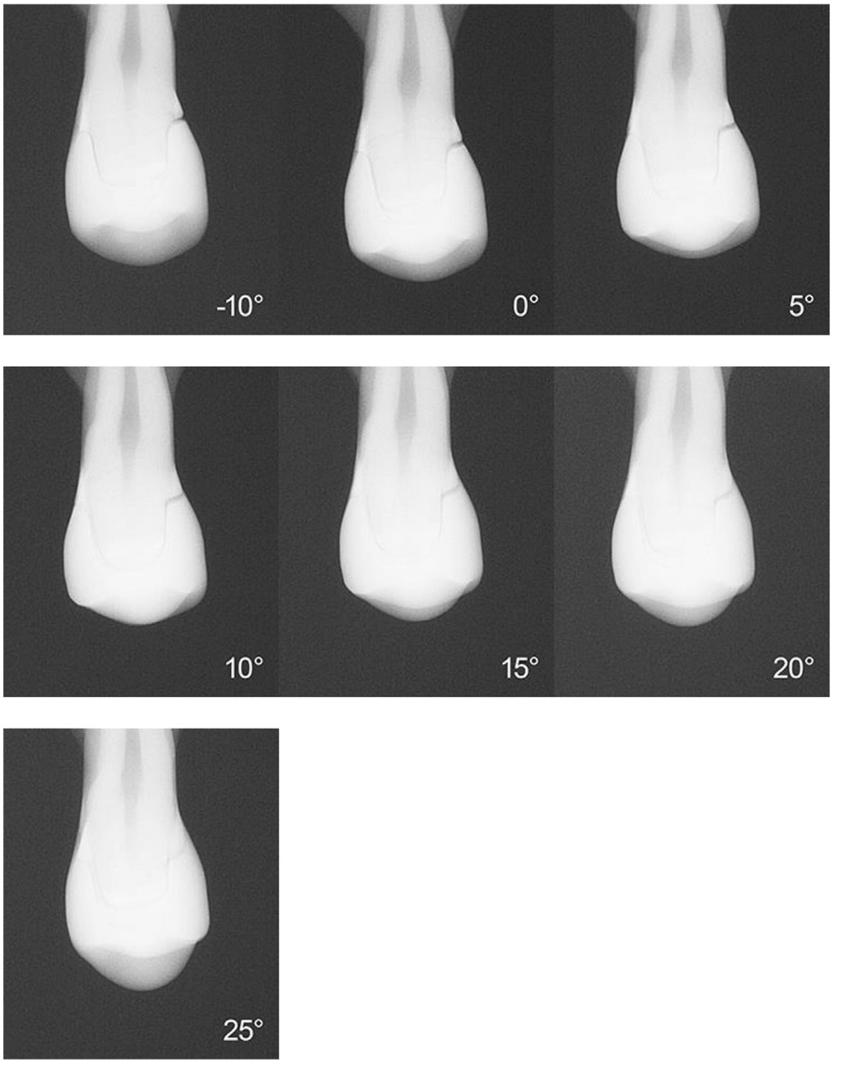

FIGURE 3 #5 Crown with 300 μm marginal discrepancy under seven different vertical angulations (−10°, 0°, 5°, 10°, 15°, 20°, and 25°).

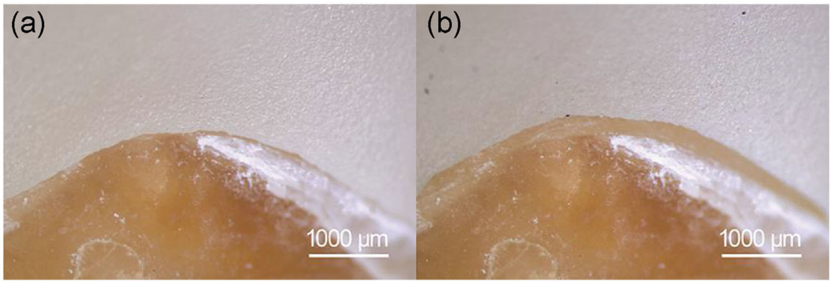

FIGURE 4 Microscopic images with different discrepancies (a) canine – 0 μm; (b) canine – 300 μm.

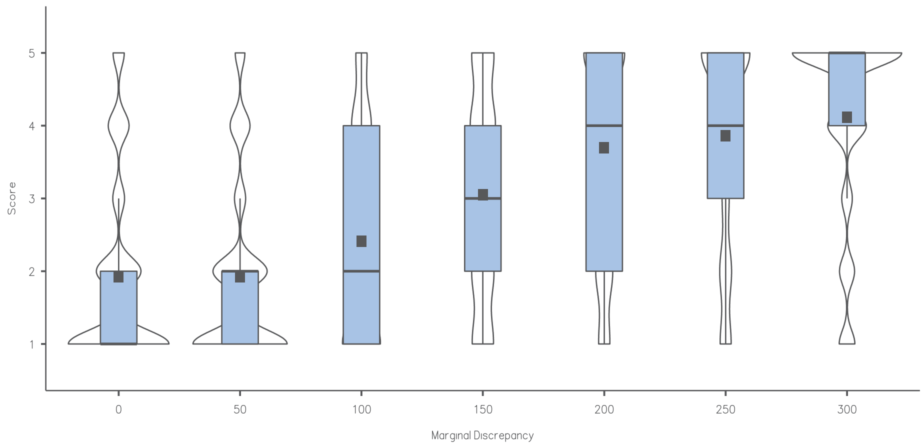

FIGURE 5 Correlation between discrepancy scores and marginal discrepancy.

present study was not to assess dentists' abilities to evaluate ceramic crowns, evaluator calibration was not performed.

After the evaluations were completed the, the specimens were imaged using a combination of a Zeiss Discovery v8 microscope (Carl Zeiss Microscopy, LLC) and a Canon 80D digital camera (Canon USA, Inc) (Figure 4). The marginal discrepancies of the proximal surfaces were measured at 10 fixed locations along the length of the discrepancy. Mean values were calculated using measurements recorded in Adobe Photoshop 21.1.2 (Adobe Inc).[31]

Data analysis was performed using R.v4.2.1. Comparisons were made among the angulations for each marginal adaptation value using a two-way analysis of variance (ANOVA). All tests of hypotheses were two-sided and conducted at an alpha level of 0.05.

RESULTS

Angulation, tooth type, and marginal discrepancy all contributed significantly to the ability to determine marginal discrepancies accurately ($p < 0.001$). The radiographic measurements generally demonstrated consistency with the microscopic examinations. A positive correlation was observed between marginal discrepancy scores and marginal discrepancy sizes (Figure 5). Marginal discrepancies from 0 to 150 μm were rated as "probably absent". The marginal discrepancy scores increased as the size of the marginal discrepancy increased (Spearman rank = 0.521, $p < 0.001$) (Table 1). In contrast, marginal discrepancy scores and vertical angulation of the X-ray beam were negatively correlated (Figure 6). Radiographs with the beam angulation of −10° to 10° were rated as "probably present", and the ones with angulations from 15° to 25° were rated as "probably absent" (Spearman rank = −0.249, $p < 0.001$) (Table 2).

Groups by tooth type showed a similar positive correlation between the marginal discrepancy scores and the size of the vertical marginal discrepancy (Table 3). However, different tooth types scored differently under different angulations. For the I group, angulations from −10 to +20 were rated as "probably present", and the scores dropped to "uncertain" only with a vertical angulation of 25. For the CA group, only the angulation of −10 was scored as "probably present", whereas 5° scored "uncertain" and all the others scored "probably absent". For the PM group, angulations from −10 to +10 were rated "present" and "probably present". Marginal discrepancy decreased outside of this interval of angulations (Table 4).

The marginal discrepancies were categorized into two groups: Group A (clinically acceptable; discrepancies below 120 μm) and Group B (clinically unacceptable; discrepancies above 120 μm). In group A, 65.2% of the I, and 76.0% of the CA crowns were scored as "absent" or "probably absent" using a vertical angulation between ±10°, as opposed to the 74.4% and 88.5% found when these same crowns were radiographed under vertical angulation equal to or above 15° for

TABLE 1 Cross table for dependent marginal discrepancy.

Discrepancy (μm)	0	50	100	150	200	250	300	Test statistic
	($N = 627$)	($N = 628$)	($N = 630$)	($N = 627$)	($N = 630$)	($N = 629$)	($N = 628$)	
	1.0	1.0	1.0	2.0	2.0	3.0	4.0	$F_{1.4397} = 1641.68$, $p < 0.01$[a]
Score ($N = 4399$)	**1.0**	**2.0**	**2.0**	**3.0**	**4.0**	**4.0**	**5.0**	
	2.0	2.0	4.0	4.0	5.0	5.0	5.0	

Top row: 25th percentile; bottom row 75th percentile; bold row: median.
[a]Wilcoxon.

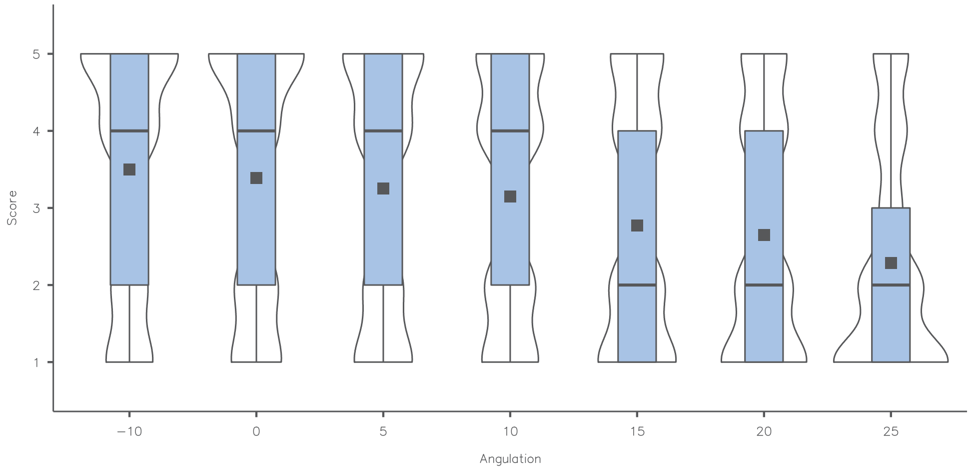

FIGURE 6 Correlation between discrepancy scores and vertical angulation.

TABLE 2 Cross table for dependent vertical angulation.

Angulation	−10°	0°	5°	10°	15°	20°	25°	Test statistic
	($N = 628$)	($N = 628$)	($N = 630$)	($N = 629$)	($N = 627$)	($N = 628$)	($N = 629$)	
	2.0	2.0	2.0	2.0	1.0	1.0	1.0	$F_{1.4397} = 289.83$, $p < 0.01$[a]
Score ($N = 4399$)	**4.0**	**4.0**	**4.0**	**4.0**	**2.0**	**2.0**	**2.0**	
	5.0	5.0	5.0	5.0	4.0	4.0	3.3	

Top row: 25th percentile; bottom row 75th percentile; bold row: median.
[a]Wilcoxon.

TABLE 3 Cross table for dependent marginal discrepancy per tooth.

Discrepancy (μm)	0	50	100	150	200	250	300	Test statistic
	($N = 209$)	($N = 210$)	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 210$)	
	1.0	1.0	1.0	2.0	4.0	4.0	5.0	$F_{1.1464} = 1005.37$, $p < 0.01$[a]
I scores ($N = 1466$)	**2.0**	**2.0**	**2.0**	**4.0**	**5.0**	**5.0**	**5.0**	
	3.0	2.0	4.0	5.0	5.0	5.0	5.0	
	($N = 209$)	($N = 209$)	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 210$)	
	1.0	1.0	1.0	1.0	2.0	2.0	3.0	$F_{1.1465} = 490.28$, $p < 0.01$[a]
CA scores ($N = 1467$)	**1.0**	**1.0**	**1.0**	**2.0**	**4.0**	**4.0**	**4.0**	
	2.0	2.0	2.0	4.0	4.0	5.0	5.0	
	($N = 209$)	($N = 209$)	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 209$)	
	1.0	1.0	1.0	2.0	2.0	2.0	4.0	$F_{1.1464} = 407.43$, $p < 0.01$[a]
PM scores ($N = 1466$)	**2.0**	**2.0**	**2.0**	**4.0**	**4.0**	**4.0**	**5.0**	
	2.0	3.0	4.0	5.0	5.0	5.0	5.0	

Abbreviations: CA, canine; I, incisor; PM, premolar.
Top row: 25th percentile; bottom row 75th percentile; bold row: median.
[a]Wilcoxon.

TABLE 4 Cross table for dependent vertical angulation per tooth.

Angulation	−10°	0°	5°	10°	15°	20°	25°	Test statistic
	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 210$)	($N = 210$)	($N = 210$)	
	1.9	2.0	2.0	2.0	2.0	2.0	1.0	$F_{1.1464} = 4.97, p < 0.03$[a]
I scores ($N = 1466$)	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**3.0**	
	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
	($N = 208$)	($N = 210$)	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 210$)	
	2.0	1.0	1.0	1.0	1.0	1.0	1.0	$F_{1.1465} = 75.51, p < 0.01$[a]
CA scores ($N = 1467$)	**4.0**	**2.0**	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	
	4.6	4.0	4.0	4.0	4.0	4.0	2.0	
	($N = 210$)	($N = 209$)	($N = 210$)	($N = 210$)	($N = 208$)	($N = 210$)	($N = 209$)	
	4.0	2.7	2.0	2.0	1.0	1.0	1.0	$F_{1.1464} = 425.59, p < 0.01$[a]
PM scores ($N = 1467$)	**5.0**	**5.0**	**4.0**	**4.0**	**2.0**	**2.0**	**1.0**	
	5.0	5.0	5.0	4.1	4.0	4.0	2.0	

Abbreviations: CA, canine; I, incisor; PM, premolar.
N is the number of non-missing value. Top row: 25th percentile; bottom row 75th percentile; bold row: median.
[a]Wilcoxon.

TABLE 5 Cross table categorized for defects below 120 µm for incisor.

Score	*N*	−10° to 10° $N = 359$ (57%)	≥15° $N = 270$ (43%)	*p*-value
	629			<0.033
1 and 2		234 (65.2%)	201 (74.4%)	
3		23 (6.4%)	16 (5.9%)	
4 and 5		102 (28.4%)	53 (19.6%)	

TABLE 6 Cross table categorized for defects below 120 µm for canine.

Score	*N*	−10° to 10° $N = 358$ (57%)	≥15° $N = 270$ (43%)	*p*-value
	628			<0.001
1 and 2		272 (76.0%)	239 (88.5%)	
3		16 (4.5%)	16 (5.9%)	
4 and 5		70 (19.6%)	15 (5.6%)	

TABLE 7 Cross table categorized for defects above 120 µm for incisor.

Score	*N*	−10° to 10° $N = 480$ (57%)	≥15° $N = 357$ (43%)	*p*-value
	837			<0.34
1 and 2		62 (12.9%)	58 (16.2%)	
3		20 (4.2%)	17 (4.8%)	
4 and 5		398 (82.9%)	282 (79.0%)	

TABLE 8 Cross table categorized for defects above 120 µm for canine.

Score	*N*	−10° to 10° $N = 479$ (57%)	≥15° $N = 360$ (43%)	*p*-value
	839			<0.001
1 and 2		147 (30.7%)	186 (51.7%)	
3		22 (4.6%)	32 (8.9%)	
4 and 5		310 (64.7%)	142 (39.4%)	

the I and CA, respectively (Tables 5 and 6). In Group B, 82.9% of the I and 64.7% of the CA crowns were scored "present" or "probably present" when radiographed with vertical angulations between ±10°, in comparison to 79% of I and 39.4% of the CA crowns with vertical angulations equal or above 15° (Tables 7 and 8).

For the PM crowns, 54.3% of Group A were scored "absent" or "probably absent" between ±10°, in contrast with the 83.6% found equal to or above 15° (Table 9). In group B, 86.5% were scored "present" or "probably present" using a vertical angulation in between ±10°. This percentage dropped to only 35.5% when these same crowns were radiographed under vertical angulation equal to or above 15° (Table 10).

The reliability of the ratings was assessed using the intraclass correlation coefficient (ICC). A total of 136 subjects were rated by 30 raters. The analysis was performed using the 'R. v 4.4.0'. The results indicated a subject variance of 1.20, a rater variance of 0.309, and a residual variance of 1.10. The consistency of the raters, as measured by the ICC, was 0.520, indicating moderate reliability. The agreement among raters was also moderate, with an ICC value of 0.459. These results suggest that while there is a fair degree of consistency among the raters, there is still notable variability in their ratings. The subject variance indicates significant differences among the subjects, which is expected in a diverse sample. The residual variance highlights the need to account for

TABLE 9 Cross table categorized for defects below 120 μm for premolar.

Score	N	−10° to 10° N = 359 (57%)	≥15° N = 269 (43%)	p-value
	628			<0.001
1 and 2		195 (54.3%)	225 (83.6%)	
3		26 (7.2%)	25 (9.3%)	
4 and 5		138 (38.4%)	19 (7.1%)	

TABLE 10 Cross table categorized for defects above 120 μm for premolar.

Score	N	−10° to 10° N = 480 (57%)	≥15° N = 358 (43%)	p-value
	838			<0.001
1 and 2		50 (10.4%)	193 (53.9%)	
3		15 (3.1%)	38 (10.6%)	
4 and 5		415 (86.5%)	127 (35.5%)	

other sources of variance or measurement error in the rating process.

DISCUSSION

This study investigated the ability of clinicians to radiographically assess the marginal adaptation of complete coverage lithium disilicate crowns prior to cementation. The participants who evaluated the digital radiographs were graduate students who were accustomed to evaluating crowns radiographically.

Image manipulation could have favored a more accurate evaluation of the radiographs and potentially better results. However, it has been reported that image sharpening of radiographic images significantly affects spatial resolution, radiographic noise, and overshoot, which might create artifacts that can be misinterpreted as disease.[21] Therefore, no image adjustment tools were used due to their potential negative effect on the evaluations, especially if not applied properly.

It has been reported that it is hard to establish the ideal angle for the visualization of proximal marginal discrepancy on crowns.[27] However, the data presented in this study shows that the optimum vertical angle to evaluate lithium disilicate crowns should be no more than ±10° from the CEJ plane. The results from this study for lithium disilicate crowns corroborate the existing literature regarding radiographic evaluation of implant abutment adaptation that has found that angulations of the tube head equal to or more than 15° did not allow a proper evaluation of marginal discrepancies.[23–26] As a lithium disilicate crown is more likely to be incorrectly evaluated as unacceptable when minimal to no open margins are present,[22] an optimal radiographic technique is of paramount importance for a proper diagnosis.

The anatomy of the CEJ could have influenced radiographic interpretation of lithium disilicate crown adaptation. The findings indicate that the vertical angulation of X-rays significantly influences the assessment of marginal discrepancies in premolars compared to anterior teeth, likely attributable to variations in CEJ curvature. A less curved CEJ on the proximal side may result in a greater number of X-rays through defects, leading to increased radiolucency in the final image and potentially amplifying the visibility of marginal discrepancies. When clinically unacceptable incisor crowns were evaluated, the accuracy dropped from 82.9% from angulation between ±10° to 79% for angulations equal to or above 15°. Therefore, angulation did not significantly affect the radiographic evaluation of incisor crowns. This difference increased for the clinically unacceptable canine crowns when the same angulations were compared. The accuracy for canines reduced from 64.7% to 39.4% for the ±10° group and the equal to or above 15° group, respectively. However, when the clinically unacceptable premolar crowns were evaluated radiographically, the accuracy dropped from 86.5% to 35.5% for the same vertical angulation intervals.

The data suggests that the less curved the CEJ, the closer to 0° the vertical angulation of the X-ray beam should be to provide an appropriate diagnostic image. This may mean that a larger number of clinically unacceptable crowns are being cemented on premolars than anterior teeth if the clinician determines the proper fit of lithium disilicate crowns relying merely on radiographic examination. The radiographic evaluation of marginal discrepancies on molars might be even more sensitive to the variation in the vertical angulation of the X-ray beam. However, a molar crown was not included in this study, because the most used materials for molar crowns are monolithic zirconia and porcelain fused to metal due to their mechanical properties, whereas this study focused on lithium disilicate.

Future studies should focus on several variables, which were not included in this study such as how different horizontal angulations of the X-rays beam affect the radiographic assessment of different marginal discrepancies on lithium disilicate crowns. Also, how different vertical angulations of X-ray beams affect the radiographic assessment of different marginal discrepancies for various types of materials such as zirconia compared to feldspathic porcelain on metal ceramic crowns on molars.

The limitations of this study include that each evaluation was performed on a single prepared tooth with no adjacent teeth. The presence of other restorations or teeth around the prepared tooth could have affected the evaluators' ability to assess the marginal discrepancies of lithium disilicate crowns.

Since margins between 34 and 119 μm can be detected with a dental explorer, and margins ranging between 2 and 51 μm can be detected visually,[15] the authors recommend that in addition to optimal radiographic images, visual and/or tactile examination should be performed for accurate lithium disilicate crowns marginal adaptation evaluation.

CONCLUSION

Within the limitations of this study, it can be concluded that the radiographic interpretation of marginal discrepancies of lithium disilicate crowns is affected by the dimension of the marginal discrepancy. For premolar crowns, the radiographic assessment of marginal discrepancies is also significantly affected by the vertical angulation of the X-ray beam. When evaluating marginal discrepancy on lithium disilicate crowns radiographically, vertical beam angulation within ±10° to the CEJ plane is recommended.

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CONFLICT OF INTEREST STATEMENT

This research was presented at the CDA convention in Anaheim—CA in April 2022 and was the winner of the 2022 Dennis Shinbori Table Clinics Competition. The authors declare that there are no conflicts of interest (including financial and other relationships) for each author.

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