Radiographic Evaluation of the Marginal Adaptation of Lithium Disilicate Crowns Using Seven Different Vertical Angulations

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Introduction

- Complete coverage crown is one of the most common fixed prosthodontic treatment option for the restoration of teeth with significant loss of structure.
- Even though marginal discrepancy in single crowns is unavoidable, it should be as minimal as possible[1]. The classical literature reports 120 µm of marginal discrepancy as clinically acceptable threshold[2].
- One of the most common methods of assessing marginal adaptation is through a radiographic assessment, especially in subgingival finish line teeth preparations.
- It is hypothesized that the best X-ray beam angulation for accurately assessing and diagnosing mesial and distal marginal defects is a perpendicular projection and only a very slight divergence to the perpendicular in the vertical plane (10° or less) is acceptable[3]. However, it has been reported that the optimum vertical angle for assessment remains unreported[4].
- **Objective:** The primary objective of this study was to evaluate how different vertical angulation with X-rays affects the detection of different marginal discrepancies assessment with radiographs.
- **Null Hypothesis:** 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 Method

- 21 lithium disilicate crowns were fabricated on 3 prepared extracted human teeth (premolar, canine, and central incisor) and imaged using 7 different vertical angulations (-10°, 0°, 5°, 10°, 15°, 20°, 25°) between the CEJ (cemento-enamel junction) and the BID (beam indicating device) (Fig. 1). Intentional marginal discrepancies ranging from 0 to 300µm were created.
- 147 radiographic images were generated and randomized (Fig. 2).
- These images were assessed by 30 evaluators (24 male and 6 female) and marginal discrepancy scores were given (5 = present, 4 = probably present, 3 = uncertain, 2 = probably absent, 1 = absent). Evaluator ages ranged between 27 and 44 years with dental experience ranging from 1 to 22 years (mean 5.87).
- Values/Scores given for each marginal adaptation for each image/ angulation were assessed statistically.
- Sample images were made using a scanning electron microscope (SEM) for illustration purpose (Fig. 3).
- The Institutional Review Board determined this study as a non-human subjects study (# 5220006)

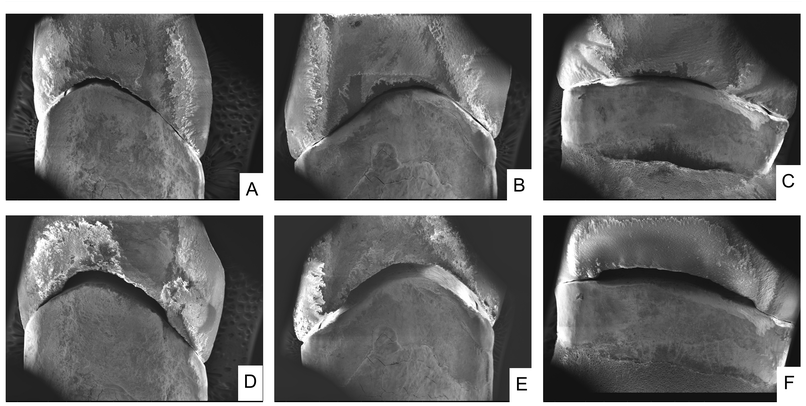

Fig 3. SEM imagens with different discrepancies A) Incisor - 0µm B) Canine - 0µm C) Premolar - 0µm D) Incisor - 300µm E) Canine - 300µm F) Premolar - 300µm

Fig 1. A) Support base for the sample and BID . B and C) Sample positioning

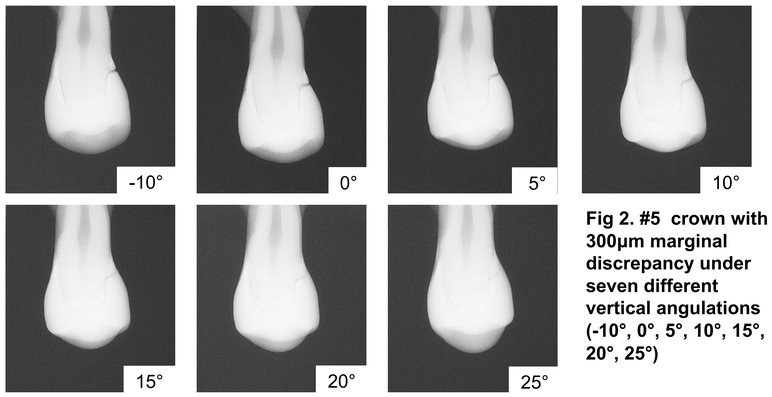

Fig 2. #5 crown with 300µm marginal discrepancy under seven different vertical angulations (-10°, 0°, 5°, 10°, 15°, 20°, 25°)

Results

- The ability to accurately assess marginal discrepancies by the study variables of angulation, tooth type, and marginal discrepancy ($P < 0.001$). (Fig. 4 and 5).
- Angulations -10 degrees to 10 degrees were rated as 'probably present', while angulations 15 thru 25 degrees were rated as ''probably absent' (Spearman Rank = .521, $P < .001$) (Table 1).
- Marginal discrepancies from 0 to 150 µm were rated as 'probably absent' and the presence of the marginal discrepancy increased thereafter as the size of the marginal discrepancy increased (Spearman Rank = .521, p < .001). (Table 2).
- Only **51%** of the discrepancies over 120 were diagnosed as "present" or "probably present" under vertical angulation ≥ 15 degrees (Table 3).

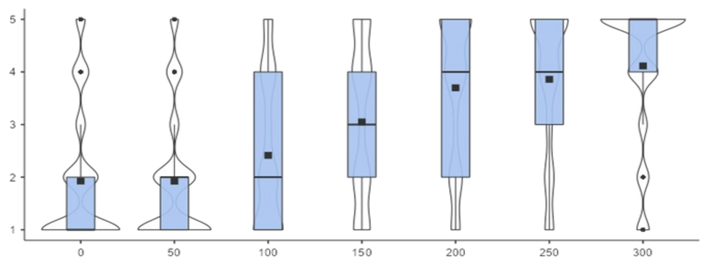

Fig 4. Correlation between Discrepancy Scores and Marginal Discrepancy

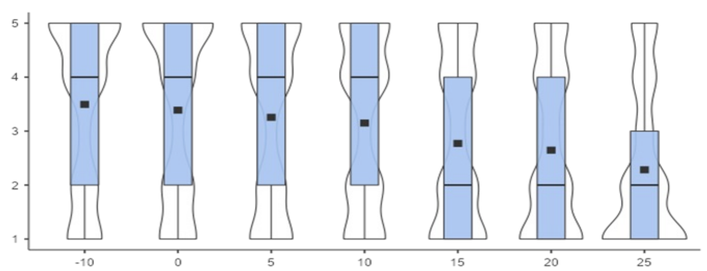

Fig 5. Correlation between Discrepancy Scores and Vertical Angulation

	N	-10 (N=628)	0 (N=628)	5 (N=630)	10 (N=629)	15 (N=627)	20 (N=628)	25 (N=629)	Test Statistic
Level	4399	2.0 **4.0** 5.0	2.0 **4.0** 5.0	2.0 **4.0** 5.0	2.0 **4.0** 5.0	1.0 **2.0** 4.0	1.0 **2.0** 4.0	1.0 **2.0** 3.3	$F_{1,4397}$=289.83, P<0.01[3]

N is the number of non-missing value. [1]Kruskal-Wallis. [2]Pearson. [3]Wilcoxon.

Table 1. Cross Table for dependent Vertical Angulation

	N	0 (N=627)	50 (N=628)	100 (N=630)	150 (N=627)	200 (N=630)	250 (N=629)	300 (N=628)	Test Statistic
Level	4399	1.0 **1.0** 2.0	1.0 **2.0** 2.0	1.0 **2.0** 4.0	2.0 **3.0** 4.0	2.0 **4.0** 5.0	3.0 **4.0** 5.0	4.0 **5.0** 5.0	$F_{1,4397}$=1641.68, P<0.01[3]

N is the number of non-missing value. [1]Kruskal-Wallis. [2]Pearson. [3]Wilcoxon.

Table 2. Cross Table for dependent Marginal Discrepancy

		< 120 µm			> 120 µm		
Level	N	-10 to 10° N = 719 (57%)	> 15° N = 539 (43%)	N	-10 to 10° N = 1439 (57%)	> 15° N = 1075 (43%)	p-value
	1,258			2,514			<0.001
1 & 2		442 (61%)	442 (82%)		259 (18%)	437 (41%)	
3		49 (6.8%)	34 (6.3%)		57 (4.0%)	87 (8.1%)	
4 & 5		228 (32%)	63 (12%)		1,123 (78%)	551 (51%)	

[1] n (%) [2] Pearson's Chi-squared test [3] False discovery rate correction for multiple testing

Table 3. Cross Table Categorized

Discussion

- The null hypothesis that there is no difference in radiographic assessment of marginal discrepancies of lithium disilicate crowns with different vertical X-ray beam angulations was rejected.
- As a lithium disilicate crown is more likely to be incorrectly evaluated as unacceptable when minimal to no open margins is present[5], an optimal radiographic technique is of paramount importance for a proper diagnosis.
- It has been reported that it is hard to establish the ideal angle for visualization of insufficient approximal crown margins[2]. However, the presented data shows that the optimum angle to evaluate lithium disilicate crowns should be no more than ± 10 degrees from the CEJ.
- Based on our results, in addition to, optimal radiographic images we recommend that visual and tactile examination should be performed for lithium disilicate crowns marginal adaptation evaluation.
- Additional studies should focus on several facets not covered in this study such as differences in various types of materials (e.g. lithium disilicate Vs zirconia Vs noble metal) and variance in the horizontal angulation of radiographs, will be valuable asset to the current literature.

Conclusion

- Within the limitations of our study, it is concluded that the radiographic interpretation of the marginal discrepancies of lithium disilicate crowns is significantly affected by the vertical angulation of the X-ray beam and the dimension of the marginal discrepancy. Caution should be used when evaluating crowns with vertical angulation more than ± 10 degrees.

Clinical implication

- Clinicians should be aware of the effect of x-ray beam vertical angulations when using radiographs to assess marginal adaptation of lithium disilicate crowns.

References

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