

CLINICAL AND RADIOGRAPHIC ASSESSMENT OF THE MARGINAL FIT AND PROXIMAL CONTACTS OF DENTAL RESTORATIONS

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ABSTRACT

The purpose of the current study was to investigate the detection of marginal discrepancy clinically and radiographically inserted in patients treated by sixth-year (senior year) dental students. The null hypothesis was that clinical and radiographic assessments are similar. A retrospective observational study was conducted in 2019. Forty-five dental restorations were examined by both dentists independently for the presence of a marginal catch by using a sharp explorer and a bitewing radiograph. Proximal contacts were assessed by using dental floss. The Pearson Chi-square statistical test was used to determine the difference ($\alpha=.05$). The inter-examiner reliability (Kappa) ranged from .431 to .911. Margins were ranked clinically as catch ranging from 4 (8.9%) on the mesial margin to the highest on the buccal margin 25 (55.6%). Radiographically, margins were ranked open from 4 (8.9%) to 7 (15%), not open 32 (71.1%) to 35 (77.8%). When comparing radiographic ranking to the clinical evaluation, the acceptability of clinically marginal catch based on radiographs ranged between 2 (4.4%) to 4 (8.8%) of the restorations. Ranking a margin with no catch clinically as open radiographically occurred in 2 (4.4%) to 6 (13.3%) of the restorations. Proximal contacts were tight 77% of the time and were open 13.3% and were not applicable in 8.4% of the restorations. Nearly half of the restorations presented with marginal discrepancy detected as a catch on the buccal surfaces. Proximal open contact detection using the dental floss technique was within the average percentages.

Key words: Dental marginal adaptation, Dental restoration, Dental prosthesis, Dental radiography.

Introduction

Accurate marginal adaptation is of essential importance for the health and function of hard and soft tissue surrounding restorations and oral health in general [1, 2]. Clinical methods for evaluation of marginal discrepancy include using a sharp dental explorer and conventional or digital bitewing radiographs [3-6]. Baldissara *et al.* [3] examined the reliability of tactile perception using sharp or dull explorers and reported that using a sharp explorer on a smooth metal surface, tactile perception is a reliable means of detecting open margin defects over 36- μ m wide. Christensen [7] reported that dentists accept margins below 34 μ m and as large as 119 μ m.

The marginal gap of ceramic restorations, including computer-aided design and computer-aided manufacturing (CAD-CAM) fabricated ones have been assessed [8-17]. However, the majority of marginal adaptation studies have been in vitro with few clinical studies [12]. A comparison between cast titanium and CAD-CAM crowns reported that the mean marginal gap of the cast group was smaller than the CAD-CAM group and the knife-edge margin has a higher

marginal gap in the proximal surface than the chamfer or shoulder margin [14].

A clinical study of the marginal and internal gap of lithium disilicate CAD-CAM crowns (LDC) and conventional metal-ceramic crowns reported a higher internal gap in LDC than metal-ceramic, but the marginal gaps were not significantly different between systems [15]. In an in vitro study, no statistically significant differences were reported in the marginal discrepancy of conventionally produced ceramic crowns when compared to the CAD-CAM produced ceramic crowns [18]. Both groups had marginal discrepancies less than 120 μ m, which has been considered clinically acceptable [4]. Crown margin ratings and marginal gap acceptability have been reported to be correlated among predoctoral students and prosthodontists, with increased gaps leading to poor ratings [19]. Proximal contacts were studied and rated in a few studies using the dental floss technique [20-22]. The purpose of the current study was to investigate the detection of marginal discrepancy clinically and radiographically inserted in patients treated by sixth-year (senior year) dental students. The null hypothesis was that clinical and radiographic assessments are similar.

Materials and Methods

The ethics committee's approval was obtained for the study from King Abdulaziz University Faculty of Dentistry Number (121-09-19). Each participating patient signed the informed consent form. This cross-sectional retrospective observational study enrolled a sample of 8 participants provided with 45 dental restorations (single crowns or dental partial denture abutments) that were treated by sixth-year dental students. Only patients treated by sixth-year students in the past 6 months were included in the study other patients were not included. Patients who were treated for more than 6 months were excluded to limit having open margins due to recurrent caries caused by bad oral hygiene. Two recently graduated dentists (AA, and MA) examined an additional 2 participants for the marginal discrepancy to determine intra-examiner and inter-examiner reliability. Those 2 participants were not subsequently included in the study. The 45 restorations in the 8 participants were clinically examined by using the sharp explorer technique [3] and the participants were interviewed by 2 investigators (AA, and MA) with a questionnaire to obtain demographic data and oral hygiene information to ensure that the participants are following oral hygiene instructions given previously in prosthesis insertion stage. Oral hygiene information was noted to exclude patients who were not conforming to given oral hygiene instructions that would lead to open margin caused by recurrent caries.

A representative disposable dental explorer (Jaan™ Dental Kit, Guangzhou Jaan Medical Co., Ltd, Guangzhou, China) was measured from a scanning electron microscope image and determined to have an $a173.3 \mu\text{m}$ tip width (**Figure 1**).

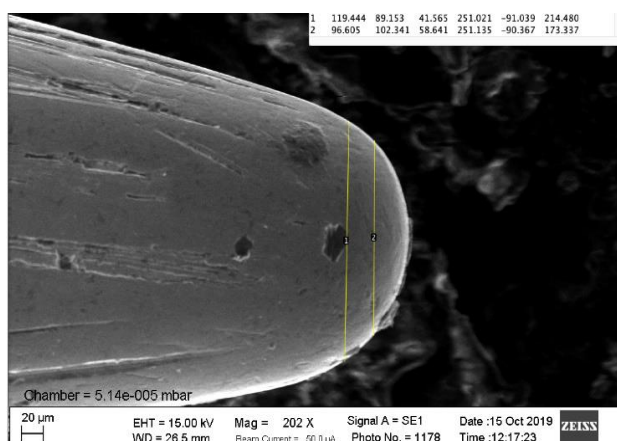


Figure 1. The scanning electron microscope image

Each crown margin was examined clinically, and separately by each examiner, at 4 different surface areas (buccal, lingual, mesial, and distal) with a new disposable explorer, to assess marginal gap or discrepancy with the assessment catch, no catch.

The radiographic examination was made within 6 months from the insertion of the prosthesis, using repeatable bitewings radiographs made with an x-ray film holder (Rinn XCP holder, Dentsply International, York, PA, USA) and positioned with polyvinyl siloxane (PVS) occlusal recording material (Variotime™ Putty Index Material, Kulzer, South Bend, IN, USA). The radiographic assessment categories were marginal gap, no marginal gap, or acceptable. The data were collected and recorded using the questionnaire in a survey format with a survey software program (Survey Monkey; SVMK Inc, San Mateo, CA, USA) by the 2 investigators. The power of the study was measured by using a software program (G*Power Software; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). Descriptive statistics, inter-examiner reliability (Kappa), counts, and percentages of the restorations' margins clinically by explorer (catch, no catch) or (open, closed, acceptable) margins radiographically were assessed with the Pearson Chi-square statistical test with a statistical software program (IBM SPSS Statistics, v25; IBM Corp, Armonk, NY, USA).

Results and Discussion

The numbers of restorations types, materials, foundation restoration type, location of restorations, and the margins' gingival level are shown in (**Table 1**).

Table 1. Counts of restorations characteristics

Restorations characteristics	Count (N)
Restoration Type	
complete-coverage crowns	36
fixed partial denture abutments	7
Veneer	2
Restoration material	
Tooth color / Ceramics	19
Metal ceramic	26
Foundation restoration	
no foundation restoration	36
non-precious metal post and core	3
fiber post and composite resin core	6
Location in the mouth	
Maxillary	33
Mandibular	12
Anterior	16
Posterior	29
Margins gingival level	
Supragingival	29
Subgingival	16
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The power of the study was 0.95 for a sample size of 45 and $\alpha=.05$. The inter-examiner reliability (Kappa) of the examiners ranged from .431 to .911 (**Table 2**).

Table 2. Ranking margins clinically by two examiners and inter-examiner reliability (Kappa)

Margins Clinically	Examiner 1		Examiner 2		Intra examiner reliability	Significance
	Yes (%)	No (%)	Yes (%)	No (%)	Kappa Value	P
Buccal surface catch	25 (55.6)	20 (44.4)	23 (51.1)	22 (48.9)	.911	<.001*
Mesial surface catch	8 (17.8)	37 (82.2)	4 (8.9)	41 (91.1)	.622	<.001*
Distal surface catch	7 (15.6)	38 (84.4)	4 (8.9)	41 (91.1)	.487	<.001*
Lingual surface catch	14 (31.1)	31 (68.9)	13 (28.9)	32 (71.1)	.784	<.001*

Margins were ranked clinically as catch ranging from 4 counts (8.9%) on mesial margin to the highest on the buccal surface 25 counts (55.6%). Marginal catch detection clinically was highest on the buccal surfaces, followed by

lingual and then proximal surfaces. Radiographically, margins were ranked open from 4 counts (8.9%) to 7 counts (15%), not open 32 counts (71.1%) to 35 counts (77.8%) (**Table 3**).

Table 3. Ranking interproximal margins radiographically by two examiners and inter-examiner reliability (Kappa).

Margins Radiographically	Evaluator 1			Evaluator 2			Intra examiner reliability	Significance
	Yes (%)	No (%)	Acceptable (%)	Yes (%)	No (%)	Acceptable (%)	Kappa Value	P
Mesial marginal gap	4 (8.9)	35 (77.8)	6 (13.3)	6 (13.3)	34 (75.6)	5 (11.1)	.431	<.001*
Distal marginal gap	4 (8.9)	33 (77.3)	7 (15.6)	7 (15.6)	32 (71.1)	6 (13.3)	.792	<.001*

When comparing radiographic ranking to the clinical evaluation, the acceptability of clinically marginal catch counts based on radiographs ranged between 2 (4.4%) to 4 (8.8%) of the restorations (**Tables 4 and 5**). Ranking a

margin with no catch clinically as open radiographically occurred in 2 counts (4.4%) to 6 counts (13.3%) of the restorations (**Tables 4 and 5**).

Table 4. Crosstabulation of radiographic and clinical ranking of mesial margins

Examiner 1		Radiographically			Total
		Open	Closed	Acceptable	
Clinically	Catch	1	3	4	8
	No Catch	3	32	2	37
Total		4	35	6	45
Examiner 2		Radiographically			Total
		Open	Closed	Acceptable	
Clinically	Catch	0	2	2	4

	No Catch	6	32	3	41
Total		6	34	6	45

Table 5. Crosstabulation of radiographic and clinical ranking of distal margins

Examiner 1		Radiographically			Total
		Open	Closed	Acceptable	
Clinically	Catch	2	3	2	7
	No Catch	2	31	5	38
Total		4	34	7	45
Examiner 2		Radiographically			Total
		Open	Closed	Acceptable	
Clinically	Catch	1	1	2	4
	No Catch	6	31	4	41
Total		7	32	6	45

The Chi-square test showed that there was a statistically significant difference between the ceramic and metal-ceramic restorations in the buccal and lingual clinical gap detection ($P < .05$). No statistically significant difference was

found between the 2 systems in the proximal surface clinical gap detection ($P = .054$ mesially and $P = .817$ distally) (**Table 6**).

Table 6. Count of catches and percentage per system in different surface locations

Prosthesis system	Buccal Surface		Lingual Surface		Mesial Surface		Distal Surface		Total per system
Catch	Yes count (%)	No count (%)	Yes count (%)	No count (%)	Yes count (%)	No count (%)	Yes count (%)	No count (%)	
Tooth color / Ceramic	10 (26.3)	28 (73.7)	3 (7.9)	35 (92.1)	2 (5.3)	36 (94.7)	5 (13.2)	33 (86.8)	
Metal-ceramic	38 (73.1)	14 (26.9)	24 (46.2)	28 (53.8)	10 (19.2)	42 (80.8)	6 (11.5)	46 (88.5)	52
Total per surface count	48	42	27	63	12	78	11	79	

Proximal contacts were tight 77% of the time and were open 13.3% and were not applicable in 8.4% of the restorations.

The P -values and ranking counts of marginal discrepancy clinically and radiographically according to location, foundation restoration, and margin level for both dentists. There were no statistically significant differences between the 2 dentists when assessing and ranking the marginal discrepancy as far as location, foundation restoration, and margin level, except where denoted in

The results of the study indicated that the null hypotheses were rejected and the clinical and radiographic assessments of the margins were not similar. The study showed moderate to high inter-examiner reliability between the 2 evaluators, despite their inexperience. The high counts of ranking the open margin in the buccal area compared with the lingual and proximal areas are explained by improved accessibility of the margins and might be reduced in more experienced examiners. However, a study reported no statistically significant difference between predoctoral students and

consultants in the assessment of marginal gaps [19]. Predoctoral level educational programs should concentrate on teaching the task of discerning and separating the visual and tactile detection skills early in the educational program.

The rate of ranking an open margin in this study was between 8.9% and 15%. There was a 4.4% to 13.3% discrepancy in matching the radiographical presentation to the clinically detected open margins. Published guidelines for detecting and the acceptance rates of open margins from radiographs of cemented or non-cemented restorations and the consistency of that to the clinical presentation of the margins are lacking. This study was an attempt to address the gap in the literature in that regard.

Open contacts were found in 13.3% of the restorations, which is similar to the open contact rate of 13.2% in a Saudi Arabian study [21]. Another study of proximal contacts has reported a rate of open contacts of 28.8% [20]. Another study reported open contacts between 15.6% to 17.8% [22].

With regard to the restoration system, metal systems showed significantly more explorer catch than tooth color systems, which is contradictory to Nam *et al.* [15] Tooth color systems showed lower marginal gap detection, which is in accordance with the studies that measured the marginal gap in tooth color restorations clinically [10, 11, 13, 17, 18].

It can be noted that the accessibility, because of the location of the tooth being upper, lower, anterior, posterior, supra- and/or sub-gingival margin, will also affect clinical marginal discrepancy evaluation. Radiographically, only the upper distal margins are significantly different from the lower distal margins when evaluated for the marginal discrepancy.

Limitations of the present study included that no attempt was made to compare the results of different levels of experience, which would be the subject of a future study. Additionally, the retrospective design of cemented restorations done in the previous year has limitations. Future studies will include larger sample sizes for prospective studies and clinical trials of premeasured marginal gaps or discrepancies and comparisons of different levels of experience and variable detection methods or instruments, and margins configuration effects on the radiographic presentation of interproximal margins.

Conclusion

Based on the findings of this retrospective clinical study, the following conclusions were drawn:

1. Nearly half of the restorations presented with marginal discrepancy detected as a catch on the buccal surface.
2. Depending on radiographic evaluation alone for detection of marginal discrepancy may not identify deficiencies and should be verified clinically.
3. Proximal open contacts as detected by using dental floss were found at a similar rate as in previous studies.

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Conflict of interest: None

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Ethics statement: Ethical approval was obtained from the Research Ethical Committee at Faculty of Dentistry in King Abdulaziz University, Jeddah, Saudi Arabia (Ethical approval number: (121-09-19).

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