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RESEARCH ARTICLE

RADIOGRAPHIC EVALUATION OF OVERHANGING RESTORATIONS AMONG YEMENI PATIENTS USING CONE-BEAM COMPUTED TOMOGRAPHY (CBCT)

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Abstract

Background and aims: Overhanging restorations which is extension of restorative material beyond the confines of a cavity preparation may lead to various complications and risks, including increased gingival fluid flow and oral inflammation. The study aim is to use cone-beam computed tomography (CBCT) to radiographically assess the incidence of overhanging restorations in Yemeni patients.

Methods: A retrospective comparative study was conducted on 404 randomly selected CBCT images dor ≥ 18 years male and female Yemeni patients referred to private radiology centers in different Yemeni cities (i.e., Sana'a, Ibb, Hodeida, Aden and Hadhramout) during the period from January 2021 to June 2022. The overhang was evaluated regarding arch (upper or lower), side (right or left), tooth location, and tooth type (central incisor (I1), lateral incisor (I2), canine (C), 1st premolar (P1), 2nd premolar (P2), 1st molar (M1), 2nd molar (M2) and 3rd molar (M3). The tooth surface was considered the statistical unit to allow an accurate comparison of periodontal variables for each restored surface. The evaluated surface points of class II restorations were mesial and distal, while those of crown restorations were mesial, distal, buccal, lingual, mesiobuccal, mesiolingual, distobuccal, and distolingual.

Results: The prevalence rate of overhang was 59.8% in class II and 51.5% in crown restorations. Class II restoration overhang had no significant association with arch, side, tooth type, and tooth location; however, it had a significant association with tooth and surface point ($p<0.05$), indicating that it was more significantly observed in the 2nd premolar (67.5%) than the other teeth as well as in the distal surface than the mesial one (73.1% vs. 26.9%, $p<0.05$

Conclusion: The prevalence of class II and crown restoration overhang is considered high among Yemeni patients. Overhangs observed on class II restorations are more than those observed on crown restorations. Class II restoration overhangs are more commonly observed on the 2nd premolar as well as the distal surface.

Keywords: Class II restoration, Cone-Beam Computed Tomography (CBCT), crown restoration, overhang, Yemen.

INTRODUCTION

Bacterial plaque along with predisposing factors, including radiation therapies, calculus, restoration materials, iatrogenic factors, designs of removable partial dentures (RPDs), overhangs, orthodontic treatments and smokeless tobaccos, has been considered the primary cause of gingival inflammation[1]. Restoration materials are placed into dental cavities after their preparation. The function of restorations is to replace the dental tissues damaged by caries processes or other reasons for preventing the relapse of caries, maintaining approximal space and contact points and returning mastication, occlusion and

esthetic functions. Besides, cast metal, amalgam or composite are the restoration materials that are used for approximal cavities[2]. Restoration procedures must be carefully carried out for avoiding trauma and decreasing potential risks as much as possible. Plaque accumulation could be stimulated by the restorations. Moreover, imperfect restorations which include rough surfaces or over contours make the plaque easily deposited despite of the cleaning efforts. In addition, those with defects, overhangs or rough surfaces could increase the gingival irritation[2,3]. Furthermore, imperfect restorations usually cause mechanic stimulus in forms of iatrogenic irritants in gingival tissues causing gingival inflammation after the emergence of plaque retention areas. Additionally, periodontal diseases could be resulted from overhanging proximal restorations as concluded by previous studies[4].

Some requirements that should be available for achieving good restorations include good contact points, anatomical shapes, and restoration surface smoothness[4]. However, big restorations or those which do not match the aforementioned criteria are called overhanging restorations. The overhanging restoration refers to "the extension of the restorative material beyond or after the confines of the prepared cavity"[5,6]. It is described as "permanent calculus" and leads to caries, plaque accumulation and periodontal diseases. Additionally, it alters the oral environment in specific ways, upsetting the delicate balance between pathogens and healthy bacterial flora. This increases the chance of developing periodontal disorders. With an estimated occurrence rate of more than 76%[6], the overhanging restoration is a major concern in the relevant research. When compared to sound teeth, several studies reported that teeth with overhanging restorations had higher attachment loss and inflammation[6,7]. Such inflammatory responses are exaggerated by overhanging restorations through raising plaque retention and causing increased destruction of surrounding tissues[8,9]. The overhang not only causes increased plaque accumulation, it also decreases the accessibility of proximal cleaning devices, including interdentally toothbrushes and tooth sticks. Dental embrasures and biologic widths can be also damaged by the overhang. Findings revealed that the overhanging restorations may lead to increased gingival fluid flows as well as historical and clinical inflammation. Limited supporting tools and poor filling procedures are considered the primary causes of overhanging restorations[10].

Due to the aforementioned complications and risks of overhanging restorations, further research is needed for detecting to what extent this problem is prevalent among various populations so as to provide information which would assist in overcoming such complications and risks. Consequently, the present study was conducted to radiographically evaluate the prevalence of overhanging restorations among Yemeni patients using cone-beam computed tomography (CBCT) which is the most promising and accurate technology available for representing high resolution cross-sectional images[11], and making multiple continuous sectional view in different dimensions (sagittal, axial, and coronal) to give the best view for each soft and hard tissue[12].

MATERIALS AND METHODS

Study design: This is a retrospective radiographic cross-sectional study to assess the prevalence rate of overhanging restorations among Yemeni patients using CBCT.

Study population: The study population included 13500 CBCT images of male and female patients referred to private radiology centers at different Yemeni cities (i.e., Sana'a, Ibb, Hodeida, Aden and Hadhramout) during the period from January 2021 to June 2022.

Sample size: After calculating the sample size using Open Epi as an open-source epidemiologic statistics for public health, a total of 385 CBCT images with at least one restoration were randomly selected as the study sample. For avoiding any missing in data, 30 cases were included. Therefore, the total sample became 415 CBCT images.

Sample selection: The sample size was carefully selected according to the inclusion of CBCT images with at least one restoration. Exclusion criteria including, incomplete or poor-quality CBCT images, CBCT images with low-density restorations. After applying the exclusion criteria, 11 CBCT images were excluded. Consequently, 404 CBCT images were included for data collection and analysis.

Data collection: CBCT images were stored in an external hard disk for observation. The period of observation and data collection took a period of one year; from February 2022 to January 2023. Data were collected into a developed case sheet.

Radiographically technique: Using the following exposure parameters: kVP = 77 - 90, mA = 4.7–5.7, t = 15–24 seconds, field of view = (12×8.5) cm, and voxel size of 0.160 –0.20 mm for full views and 0.06–0.02 mm for other field of views (FOVs), all images used in this study were radiographically taken by CBCT system units (PaX-Flex3D P2, Vatech, Korea). Additionally, the software's tools (Ez3D plus with Ez3D-I software) were used to examine the photographs and make the observations. All CBCT images were accessed from a personal laptop by a single observer (the researcher) in order to prevent errors caused by different practitioners.

Study variables: The study variables included , overhang (presence or absence), type of restoration (crown or Class II), overhang surface points of Class II (mesial and distal), overhang surface points of crown (mesial, distal, buccal, lingual, mesiobuccal, mesiolingual, distobuccal, distolingual), side (right or left), jaw (upper or lower) and tooth [central incisor (I1), lateral incisor (I2), canine (C), 1st premolar (P1), 2nd premolar (P2), 1st molar (M1), 2nd molar (M2) and 3rd molar (M3)]. In the data analysis, "tooth surface" was used instead of "tooth" as the statistical unit to allow an accurate comparison of periodontal variables for each restored surface. The decision of using tooth surfaces is derived from the concept that periodontitis is a site-specific process[13].

Reliability: For evaluating the reliability of the study data, 40 radiographic images were analyzed by the researcher (intra-observer). Two weeks later, the same 40 radiographic images were analyzed by the researcher and an inter-observer, whose results were separately compared with that of the researcher's previous analysis using Cohen's kappa analysis[14]. The findings showed a substantial concordance between both results of all variables which confirms the internal consistency of data.

Statistical analysis: Data were analyzed by the Statistical Package for Social Sciences software (SPSS Statistics for Windows v28.0; IBM Corp) by which the following tests were used: Descriptive statistics were reported using frequencies and percentages; Chi-square test was used to compare the overhang frequency with respect to gender, age, restoration type, tooth type, tooth, jaw, side, location, and surface point; and *p*-value < 0.05 was considered statistically significant.

Ethical Consideration: The Medical Ethics and Research Committee of the Sana'a University Faculty of Dentistry has approved this study under the number 327, dated October 28, 2022. Every process followed the ethical guidelines set forth by the review committee.

RESULTS

The frequency distribution of class II restoration surfaces according to the study variables (gender, arch, side, tooth type, tooth and surface) is shown in Table 1. The results showed that there are 520 class II restoration surfaces in the study cases. They were more observed in females than males (60.0% vs. 40.0%) and in the maxilla than the mandible (62.3% vs. 37.7%). Almost they were relatively similar in the right and left sides (51.9% vs. 48.1%). The majority of them were observed in molars (61.0%) followed by premolars (39.0%). Regarding tooth, they were mostly observed in 1st molars (36.7%) followed by 2nd premolars (22.5%), 2nd molars (19.2%), 1st premolars (16.5%), then 3rd molars (5.0%). Finally, they were mostly observed in the mesial surface compared to the distal surface (56.3% vs. 43.7%). The frequency distribution of crown restoration surfaces according to the study variables (gender, arch, side, tooth type, tooth and surface) is shown in Table 2.

Table 1: Distribution of class II restoration surfaces according to the study variables.

Variables		Class II restoration surfaces
		N (%)
Gender	Male	208 (40)
	Female	312 (60)
Arch	Maxilla	324 (63.3)
	Mandible	196 (37.7)
Side	Right	270 (51.9)
	Left	250 (48.1)
Tooth type	Premolar	203 (39)
	Molar	317 (61)
Tooth	P1	86 (16.5)
	P2	117 (22.5)
	M1	191 (36.7)
	M2	100 (19.2)
	M3	26 (5)
Surface	M	293 (56.3)
	D	227 (43.7)
Total		**520 (100)**

Table 2: Distribution of crown restoration surfaces according to the study variables.

Variables		Crown surfaces N (%)	Variables		Crown surfaces N (%)
Gender	Male	5416 (44.6)	Tooth type	Incisor	3320 (27.3)
	Female	6728 (55.4)		Canine	1696 (14)
Arch	Maxilla	6752 (55.6)		Premolar	3720 (30.6)
	Mandible	5392 (44.4)		Molar	3408 (28.1)
Side	Right	6336 (52.2)	Surface	M	1518 (12.5)
	Left	5808 (47.8)		D	1518 (12.5)
Tooth	I1	1592 (13.1)		B	1518 (12.5)
	I2	1728 (14.2)		L	1518 (12.5)
	C	1696 (14)		MB	1518 (12.5)
	P1	1800 (14.8)		ML	1518 (12.5)
	P2	1920 (15.8)		DB	1518 (12.5)
	M1	1696 (14)		DL	1518 (12.5)
	M2	1440 (11.9)	**Total**		**12144 (100)**
	M3	272 (2.2)			

Table 3: Association of class II restoration overhang with study variables.

Variable		No.	Overhang (n=311) N (%)	No overhang (n=209) N (%)	*p*-value
Arch	Maxilla	324	198 (61.1)	126 (38.9)	0.612
	Mandible	196	113 (57.7)	83 (42.3)	
Side	Right	270	158 (58.5)	112 (41.5)	0.533
	Left	250	153 (61.2)	97 (38.8)	
Tooth type	Premolar	203	133 (65.5)	70 (34.5)	0.068
	Molar	317	178 (56.2)	139 (43.8)	
Tooth	P1	86	54 (62.8)	32 (37.2)	0.038*
	P2	117	79 (67.5)	38 (32.5)	
	M1	191	118 (61.8)	73 (38.2)	
	M2	100	47 (47.0)	53 (53.0)	
	M3	26	13 (50.0)	13 (50)	
Surface	M	293	145 (49.5)	148 (50.5)	0.000*
	D	227	166 (73.1)	61 (26.9)	

*=highly significance

The results showed that there are 12144 crown restoration surfaces in the study cases. They were more observed in females than males (55.4% vs. 44.6%) and in the maxilla than the mandible (55.6% vs. 44.4%). Almost they were relatively similar in the right and left sides (52.2% vs. 47.8%). About one third of them were observed in premolars (30.6%), followed by molars (28.1%), incisors (27.3%) then canines (14.0%). Regarding tooth, they were mostly observed in 2nd premolars (15.8%), followed by 1st premolars (14.8%), 2nd incisors (14.2%), canines and 1st molars (14.0% each), 1st incisors (13.1%), 2nd molars (11.9%), then 3rd molars (2.2%). Finally, all crown restorations had 8 surfaces equally distributed (12.5% each). Chi-square test was run to investigate the association of class II restoration overhang with the study variables, including arch, side, tooth type, tooth and surface point, as shown in Table 3. The results revealed that class II restoration overhang had no significant association with arch, side and tooth type ($p>0.05$). However, class II restoration overhang had a statistically significant association with tooth and surface ($p<0.05$).

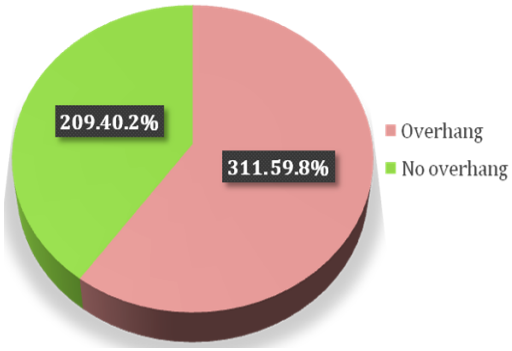

Figure 1: Prevalence of class II restoration overhang.

This indicates that the class II restoration overhang was mostly observed in 2nd premolars (67.5%), 1st premolars (62.8%), 1st molars (61.8%), 3rd molars (50.0%) then 2nd molars (47.0%). Besides, it was more significantly observed in distal surfaces than mesial surfaces (73.1% vs. 26.9%, $p<0.05$).

Table 4: Association of class II restoration overhang with tooth location.

Arch	Side	Tooth	No.	Overhang N (%)	No overhang N (%)	*p*-value
Maxilla	Right	P1	34	22 (64.7)	12 (35.3)	0.737
		P2	46	30 (65.22)	16 (34.78)	
		M1	54	34 (62.96)	20 (37.04)	
		M2	21	11 (52.4)	10 (47.6)	
		M3	8	4 (50.0)	4 (50.0)	
	Left	P1	27	15 (55.6)	12 (44.4)	0.523
		P2	33	22 (66.7)	11 (33.3)	
		M1	58	38 (65.5)	20 (34.5)	
		M2	36	19 (52.8)	17 (47.2)	
		M3	7	3 (42.9)	4 (57.1)	
Mandible	Right	P1	12	7 (58.3)	5 (41.7)	0.091
		P2	20	14 (70.0)	6 (30.0)	
		M1	47	26 (55.3)	21 (44.7)	
		M2	19	5 (26.3)	14 (73.7)	
		M3	9	5 (55.6)	4 (44.4)	
	Left	P1	13	10 (76.9)	3 (23.1)	0.448
		P2	18	13 (72.2)	5 (27.8)	
		M1	32	20 (62.5)	12 (37.5)	
		M2	24	12 (50.0)	12 (50.0)	
		M3	2	1 (50.0)	1 (50.0)	

Table 5: Prevalence of crown overhang.

Restoration type	Overhang	No overhang	Total
	N (%)	N (%)	N (%)
Crown	6251 (51.5)	5893 (48.5)	12144 (100.0)

Table 6: Association of crown overhang with study variables.

Variable		No.	Overhang (n=6251) N (%)	No overhang (n=5893) N (%)	*p*-value
Arch	Maxilla	6752	3359 (49.7)	3393 (50.3)	0.000*
	Mandible	5392	2892 (53.6)	2500 (46.4)	
Side	Right	6336	3238 (51.1)	3098 (48.9)	0.395
	Left	5808	3013 (51.9)	2795 (48.1)	
Tooth type	Incisor	3320	1366 (41.1)	1954 (58.9)	0.000*
	Canine	1696	733 (43.2)	963 (56.8)	
	Premolar	3720	2018 (54.2)	1702 (45.8)	
	Molar	3408	2134 (62.6)	1275 (37.4)	
Tooth	I1	1592	604 (37.9)	988 (62.1)	0.000*
	I2	1728	762 (44.1)	966 (55.9)	
	C	1696	733 (43.2)	963 (56.8)	
	P1	1800	939 (52.2)	861 (47.8)	
	P2	1920	1079 (56.2)	841 (43.8)	
	M1	1696	1107 (65.3)	589 (34.7)	
	M2	1440	869 (60.3)	572 (39.7)	
	M3	272	158 (58.1)	114 (41.9)	
Surface	M	1518	730 (48.1)	788 (51.9)	0.000*
	D	1518	835 (55.0)	683 (45.0)	
	B	1518	969 (63.8)	549 (36.2)	
	L	1518	857 (56.5)	661 (43.5)	
	MB	1518	647 (42.6)	871 (57.4)	
	ML	1518	730 (48.1)	788 (51.9)	
	DB	1518	717 (47.2)	801 (52.8)	
	DL	1518	766 (50.5)	752 (49.5)	

*=highly significance

Table 5 shows that the prevalence rate of crown overhang according to the restored surfaces is 51.5%. Chi-square test was run to investigate the association of crown overhang with study variables, including arch, side, tooth type, tooth and surface point, as shown in Table 6. The results revealed that crown overhang had no significant association with side ($p>0.05$). However, crown overhang had a statistically significant association with arch, tooth type, tooth and surface ($p<0.05$). This indicates that the crown overhang was more significantly observed in the mandible than the maxilla (53.6% vs. 49.7%). Also, it was mostly observed in molars (62.6%), followed by premolars (54.2%), canines (43.2%) then incisors (41.1%). Besides, it was mostly observed in 1st molars (65.3%), followed by 2nd molars (60.3%), 3rd molars (58.1%), 2nd premolars (56.2%), 1st premolars (52.2%), canines (43.2%), lateral incisors (44.1%) then central incisors (37.9%). In addition, it was mostly observed on buccal surfaces (63.8%), followed by lingual surfaces (56.5%), distal surfaces (55.0%), distolingual surfaces (50.5%), mesial and mesiolingual surfaces (48.1% each), distobuccal surfaces (47.2%), then mesiobuccal surfaces (42.6%).

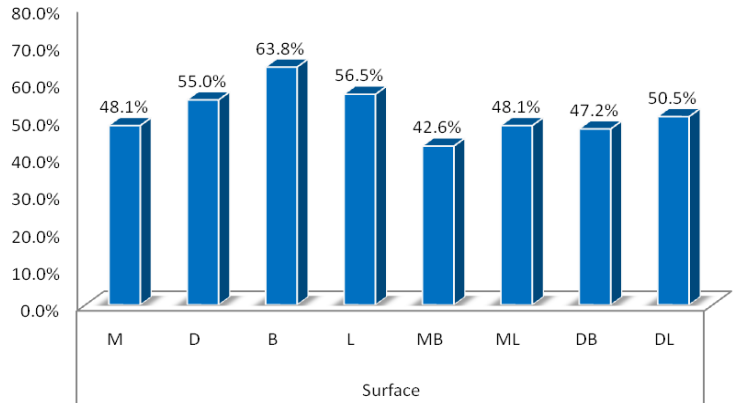

Figure 2: Prevalence of crown overhang according to restored surface.

Table 7: Association of crown overhang with tooth location.

Arch	Side	Tooth	No.	Overhang N (%)	No overhang N (%)	*p*-value
Maxilla	Right	I1	520	186 (35.8)	334 (64.2)	0.000*
		I2	480	185 (38.5)	295 (61.5)	
		C	416	182 (43.8)	234 (56.3)	
		P1	528	288 (54.5)	240 (45.5)	
		P2	560	320 (57.1)	240 (42.9)	
		M1	512	315 (61.5)	197 (38.5)	
		M2	352	220 (62.5)	132 (37.5)	
		M3	56	36 (64.3)	20 (35.7)	
	Left	I1	488	149 (30.5)	339 (69.5)	0.000*
		I2	496	187 (37.7)	309 (62.3)	
		C	440	169 (38.4)	271 (61.6)	
		P1	456	241 (52.9)	215 (47.1)	
		P2	568	289 (50.9)	279 (49.1)	
		M1	392	279 (71.2)	113 (28.2)	
		M2	424	280 (66.0)	144 (34.0)	
		M3	64	33 (51.6)	31 (48.4)	
Mandible	Right	I1	280	136 (48.6)	144 (51.4)	0.000*
		I2	376	186 (49.5)	190 (50.5)	
		C	440	189 (43.0)	251 (57.0)	
		P1	456	211 (46.3)	245 (53.7)	
		P2	448	255 (56.9)	193 (43.1)	
		M1	464	288 (62.1)	176 (37.9)	
		M2	360	192 (53.3)	168 (46.7)	
		M3	88	49 (55.7)	39(44.3%)	
	Left	I1	304	133 (43.8)	171 (56.3)	0.000*
		I2	368	204 (55.4)	164 (44.6)	
		C	400	193 (48.3)	207 (51.8)	
		P1	360	199 (55.3)	161 (44.7)	
		P2	352	215 (61.1)	137 (38.9)	
		M1	328	225 (68.6)	103 (31.4)	
		M2	304	177 (58.2)	127 (41.8)	
		M3	64	40 (62.5)	24 (37.5)	

*=highly significance

Association of crown overhang with tooth location: Chi-square test was run to investigate the association of crown overhang with tooth location, as shown in Table 7. The results revealed that crown overhang had a statistically significant association with tooth location ($p<0.05$). This indicates that the crown overhang in the right maxilla was most prevalent in the 3rd molar (64.3%), followed by the 2nd molar (62.5%), while it was least prevalent in the central incisor (35.8%), and followed by the lateral incisor (38.5%). Moreover, the crown overhang in the left maxilla was most prevalent in the 1st molar (71.2%), followed by the 2nd molars (66.0%), while it was least prevalent in the central incisor (30.5%), and followed by the lateral incisor (37.7%). In addition, the overhang in the right mandible was most prevalent in the 1st molar (62.1%), followed by the 2nd premolar (56.9%), whereas it was least prevalent in the canine (43.0%), followed by the 1st premolar (46.3%). Finally, the overhang in the left mandible was most prevalent in the 1st molar (68.6%), followed by the 3rd molar (62.5%), whereas it was least prevalent in the central incisor (43.8%), followed by the canine (48.3%).

DISCUSSION

The present study revealed that the prevalence rate of overhang is 59.8% in the class II restorations and 51.5% in the crown restorations. This result is in line with that of Miller and Blake[15] who reported that overhangs observed on class II restorations were more than those observed on crown restorations (82.1% vs. 17.9%). However, 59.8% of class II restoration overhang surfaces in the present study is higher than that reported by Alfalahi *et al.*,[5] (25.4%), Kheyzaran *et al.*,[8] (22.2%). In addition, the present study result is roughly similar to that reported by Ibraheem and Al-Safi[16] (51%), Hakkarainen and Ainamo[17] (50%), Coxhead *et al.*,[18] (57%), Quadir *et al.*,[19] (58%) and Wright[20] (52%). Also present study result is lower than that reported by Sikri and Sikri[21] (64.12%), Gorzo *et al.*,[22] (76%), Coxhead *et al.*,[18] (74%) and Lervik *et al.*,[23] (87%). In addition, the prevalence rate of crown overhang surfaces in the present study (51.5%) is relatively similar to that reported by Hakkarainen and Ainamo[17] (50%). However, it is higher than that reported by Kuonen *et al.*,[24] (14.1%), Kells and Linden[25] (25%), Burch[26] (30%), and Tarcin *et al.*,[13] (32.4%). On contrary, it is lower than that reported by Coxhead *et al.*,[18](76%).

Overhang is the most frequent procedural issue in class II restorations. This condition may occur up to 87% of the time[23]. It has frequently been stated that inappropriate restoration techniques, such as ignoring the use of matrix band and wedge, are the primary cause of overhanging restoration. The morphologic

diversity in the cervical side of teeth has also been mentioned as a contributing factor. This variation can make it difficult to properly place the matrix band and wedge in a way that fully complies with the gingival cavo-margin[6,27]. Larger overhangs (>1 mm) should thus be removed as soon as possible, especially in the molar regions where faster bone loss may result in fraction involvement, which has a major effect on the advancement of periodontal destruction[15]. It might be challenging to place, examine, adjust, or polish the interproximal margin once proximal restorations are placed since there is typically limited access to the margins. A restoration overhang, which is described as "an extension of restorative material beyond the confines of a cavity preparation," may be produced as a result of this[28]. Techniques to limit overhangs with crown/indirect restorations and class II are well known and may be effective if well executed. Finally, overhang removal is highly recommendable. It is advisable to replace the entire faulty restoration rather than removing the overhang only[9].

The present study revealed that class II restoration overhangs had no significant association with arch (p>0.05). This result is inconsistent to that reported by Dindar *et al.*,[29] and Tavangar *et al.*,[30] where amalgam overhang is significantly higher in the maxilla (p<0.05). They attributed this result to the difficulty of indirect sight and limited access to this area during treatment. Besides, the present study showed that class II restoration overhang had no significant association with side (p>0.05). This result is also similar to that reported by Gilmore and Sheiham[3], where there was almost an equal distribution of class II overhang surfaces on the right and left sides of each arch (26.9% vs. 33.8% in the maxilla and 19.4% vs. 20.0% in the mandible).

In the present study, class II restoration overhang also had no significant association with the tooth type (p>0.05), where the class II overhangs were more insignificantly observed in premolars than molars (65.5% vs. 56.2%, p=0.068). This result is different than that reported by Dindar *et al.*,[29] where molars were significantly more affected by class II amalgam overhang than premolars (80.8% vs. 19.2%, p<0.001). Likewise, Miller and Blake[15] showed that molars had the most common frequency of class II amalgam overhang. Regarding the tooth, the present study showed that class II restoration overhang also had a significant association with tooth (p=0.038), where the highest and lowest overhang frequency was significantly observed in the 2nd premolars (67.5%) and the 2nd molars (47.0%). This result does not comply with that reported by Tavangar *et al.*,[30] where the highest and lowest class II overhang frequency was significantly observed in the 1st molar and 1st premolar teeth (p=0.006). Concerning the restored surface, the present study showed that class II restoration overhang also had a significant association with the tooth surface (p=0.000), where class II restoration overhangs were more significantly observed in distal surfaces than mesial surfaces (73.1% vs. 49.5%). This result is consistent to that reported by Dindar *et al.*,[29] where the disto-occlusal cavity had significantly more amalgam overhanging surfaces than mesio-occlusal and mesio-occluso-distal cavities (54% vs. 35.6% and 10.4%, respectively) (p=0.000). Likewise, Quadir *et al.*,[19] showed that the amalgam overhangs were significantly more observed in distal surfaces than mesial surfaces (p<0.000), and they attributed this result to the fact that there is better clinical visibility and access on the mesial aspect as compared to the distal surfaces of the posterior teeth. When combining both arch and side, class II restoration overhangs in the present study were not significantly associated with the location of the teeth (p>0.05). This result is similar to that reported by Quadir *et al.*,[19] where the relationship between tooth location and amalgam overhangs was not statistically significant (p<0.063).

The present study showed that crown overhang had no significant association with side (p>0.05), which also indicates that both right and left sides had essentially similar percentages of crown overhanging surfaces (51.1% vs. 51.9%, respectively). These results are similar to that reported by Tavangar *et al.*,[30] where the overhang frequency was assessed with respect to side and jaw, and no significant difference between groups was observed (p>0.05). Besides, the present study revealed that crown overhang had a statistically significant association with arch, indicating that crown overhang is roughly similar in the mandible than the maxilla (53.6% vs. 49.7%, p<0.001). This result is inconsistent to that reported by Tarcin *et al.*,[13] where the frequency of crown overhanging surfaces in the maxilla was significantly higher than in the mandible (61.1% vs. 38.9%, p<0.05). They attributed their result to the difficulty of indirect sight and limited access to this area during treatment. This proposition could be prone to some bias since it depends more on subjective judgment because they evaluated the overhang from only two crown-restored surfaces (mesial and distal). However, the crown overhang in the present study was evaluated from eight crown-restored surfaces (mesial, distal, buccal, lingual, mesiobuccal, mesiolingual, distobuccal, and distolingual), which gives the current research results more objectivity.

In the present study, crown overhang also had a statistically significant association with the tooth type, where the crown overhang was most significantly observed in molars (62.6%), followed by premolars (54.2%), canines (43.2%) then incisors (41.1%) (p<0.001). This result is consistent to that reported by almost all previous studies, where a higher overhang frequency in molars compared to premolars was detected, which was attributed to the limited access during restorative procedures[13,15,25,31].

Regarding the tooth, the present study showed that crown overhang also had a significant association with tooth, where the crown overhang was most significantly observed in 1st molars (65.3%), followed by 2nd molars (60.3%), 3rd molars (58.1%), 2nd premolars (56.2%), 1st premolars (52.2%), canines (43.2%), lateral incisors (44.1%), then central incisors (37.9%). This result is consistent to that reported by almost all previous studies, where posterior teeth had the highest frequency of overhang[17,18,30,31]. Concerning with the crown-restored surface, the present study

showed that crown overhang also had a significant association with the tooth surface (p<0.001), where it was most significantly observed in buccal surfaces (63.8%), followed by lingual surfaces (56.5%), distal surfaces (55.0%), distolingual surfaces (50.5%), mesial and mesiolingual surfaces (48.1% each), distobuccal surfaces (47.2%) then mesiobuccal surfaces (42.6%). When evaluating the association of crown overhang with tooth location, the current study showed that crown overhangs had a statistically significant association with tooth location (p<0.001), where the most affected tooth in the right maxilla is the 3rd molar and in the left maxilla as well as the right and left mandible is the 1st molar. This result is consistent to that reported by Quadir *et al.*,[19] Tavangar *et al.*,[30] Millar and Blake[15] and Dindar *et al.*,[29] where the maxillary molars were the most frequently affected area by overhang. The more intricate anatomical structure, the trifurcation, and the indirect sight and access in the maxillary region[15,29,31] all contribute to this explanation.

CONCLUSIONS

In light of the study results, the following conclusions can be drawn: The prevalence of Class II and crown restoration overhang is high among Yemeni patients. Class II restoration overhangs are most commonly observed on the second premolar as well as on the distal surface. Crown restoration overhangs are most commonly observed on the mandible as well as the molars, and are most commonly observed on the buccal surface and on the maxillary left first molar followed by the mandibular left first molar.

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AUTHOR'S CONTRIBUTIONS

Alsada'a WAA: oversaw the research for this study, had the original idea, produced the first draft of the article. **Al-Hamzi MA:** data analysis, interpretations. **Al-Khawlani AI:** methodology, investigation. **Al-Shamahy HA:** supervision, review. All authors revised the article and approved the final version.

DATA AVAILABILITY

The data and material are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

None to declare.

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