Original Research

Radiographic Assessment of Dental Crowns in Posterior Teeth

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ABSTRACT:

Introduction: Dental radiography is the most critical tool besides the clinical evaluations in long-term prognosis of single crowns. This study aimed to radiographically evaluate and assess the dental crowns in posterior teeth. **Methods:** In this descriptive observational retrospective study, Digital Bitewing radiographs were retrieved from patients' electronic files from 2017 – 2019 (period of 3 years) and evaluated. **Results:** Analysis of data by descriptive statistics revealed that 38.3% of the cases are acceptable and 68.3% with mishaps (under\over contoured, open margin, excess cement and open contact). **Conclusion:** The most common reason of crown failure is the open margin followed by over-contoured crowns. With the aid of dental radiography, crowns examination is much easier and treatment plans will be accurate according to our evaluations radiographically and clinically. Accordingly, case's prognosis will be better.

Key words: Open margin, over under contoured, open contact, excess cement, dental crowns, radiography.

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INTRODUCTION

Fixed dental prosthesis is a common treatment for replacing missing teeth, it's given satisfaction for the patient and the dentist because of its stability, retention and availability. Fixed dental prosthesis is reasonable to improve patient comfort as well as the patient's psychological status. Furthermore, to maintain the health and integrity of the remaining alveolar ridge in addition to optimize mastication efficiency.[1,2] There are usually two options to restore the endo-treated teeth which are intracoronal or extra-coronal restorations. Ceramic and metal-based crowns are types of extra-coronal restorations.[3] Moreover, advantages of the ceramics over the metal-based crowns, they are more biocompatible and more esthetic.[4] However, ceramics are fragile. Because of its nature, they are under high risk of fracture. Broken ceramics are main concern specially on posterior teeth due to higher masticatory loads and continues function.

Nowadays, ceramic crowns became more convenient and efficient by increasing their fracture resistance. [5]As well as, Zirconia is a high-strength ceramic material with high fracture toughness, decent aesthetic properties and chemical inertness, which is mainly used as a core material for single and (FDPs) and abutments.[6,7] Metal ceramic crown has always been the most popular complete veneer restoration in dentistry, because it derives its aesthetics from the highly translucent natural appearance of porcelain and the strength from the metal substructure.[8]

But optimum aesthetics is not achieved consistently with conventional ceramic-metal restorations, particularly in area of labio-gingival margin.[9] In addition, Other causes of failures include poor aesthetics, failure of root canal treatment of the abutment teeth, periodontal diseases and technical problems (fractures of the fixed connector, porcelain fractures, wear of occlusal surfaces).[10,18] Walton and coworkers in 1986 reported that 8 years was the mean

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length of service of all prosthesis evaluated in the study. The most observed cause of failure was dental caries, affecting 22% of the units failed and leading to the necessity for replacement.[11] Accordingly, dental explorers, radiographs, and impression materials proposed for the identification of misfit in dental prostheses and restorations.[12] Jornand coauthors in 1970 reported that the distance between the crown margin and the bone crest can measure the size of overhang and the marginal gap by using radiograph. [13]In addition, adopted marginal discrepancies from 0.01 to 0.5 mm between the restoration and the tooth a number of in-vitro studies have used conventional and digital radiography to evaluate the diagnosis of gaps.[14,15] Although an "adequate marginal fit" has never been clearly defined, data suggest that overhanging restorations and readily detectable (clinically and/or radiographically) open margins may increase the risk of dental caries, cause detriment to surrounding periodontal tissues, and perhaps have a negative effect on the esthetic result of anterior restorations.[16,17] Therefore, the successful rate of the posterior teeth crowning depends on several factors include, the excellency of work, crown's type and the host related factors for example the structure of tooth remaining and it varies among patients.[4] Accordingly, to achieve a high standard and excellent job, the dentists must have a great knowledge and high-quality training.[3] It is important to document the success or failure of the crown's, in order to learn more about failure causes to achieve higher successful rates and better results.[18]

Therefore, the aim of our study is to radiographically evaluate and assess the dental crowns in posterior teeth.

MATERIAL AND METHODS:
Type of study: observational retrospective study
Sample size: 1200

Data was retrieved from patients' electronic files from 2017 – 2019 (period of 3 years) and digital radiographs (bitewings) was evaluated by nine examiners blindly for dental crowns of posterior teeth.datawas collected by Excel sheet then analyzed using SPSS version 23.

Inclusion criteria:
➢ Posterior permanent teeth
➢ Patients who opened their file from 2017-2019
➢ Male/female
➢ Saudi/non-Saudi
➢ Age range from 20 to 80
➢Digital Bitewing radiographs
➢ Vital/non-vital teeth
➢ Single full crowns (zirconia, all metal, all ceramic, metal-ceramic crowns)
➢With or without post and core.

Exclusion criteria:
➢ Cases not meeting all inclusion criteria was excluded from this study.

RESULTS
Frequency distribution and percentages were calculated for the patient's characteristics and teeth and treatment related variables. Chi-square test was applied to assess the relationship between age, gender and nationality with the treatment related variables. A binary logistic regression analysis was performed to predict the occurrence of crown failure by considering predictor variables. All the statistical analysis was performed by using SPSS version 25 (Armonk). A p value of less than 0.05 was considered significant for all the statistical analysis.

Table 1: Patient's characteristics (n=1200)

Variables		n	%
Nationality	Saudi	895	74.6
	Non-Saudi	305	25.4
Age	20-30	160	13.3
	31-40	392	32.7
	41-50	373	31.1
	Above 50	275	22.9
Gender	Male	504	42.0
	Female	696	58.0

A total of 1200 radiographs were screened for the identifying the various reasons for the failure of the crown. Most of the radiographs belonged to the females 696 (58%) mainly aged between 31-40 years 392 (32.7%) having Saudi nationality 895 (74.6%) (Table 1)
Radiographic evaluation indicates that most of the crowns were placed in 627 (52.3%) maxillary molar teeth 689 (57.4%). Ceramo-metal crowns 986 (82.2%) were most commonly placed on non-vital teeth 1094 (91.2%) without post 791 (65.9%). Mishap was observed with 820 (68.3%) cases. Evaluation of the total number of crowns showed that the 459 (38.3%) crowns were of acceptable quality (Table 2).

Table 2: Teeth and treatment related factors

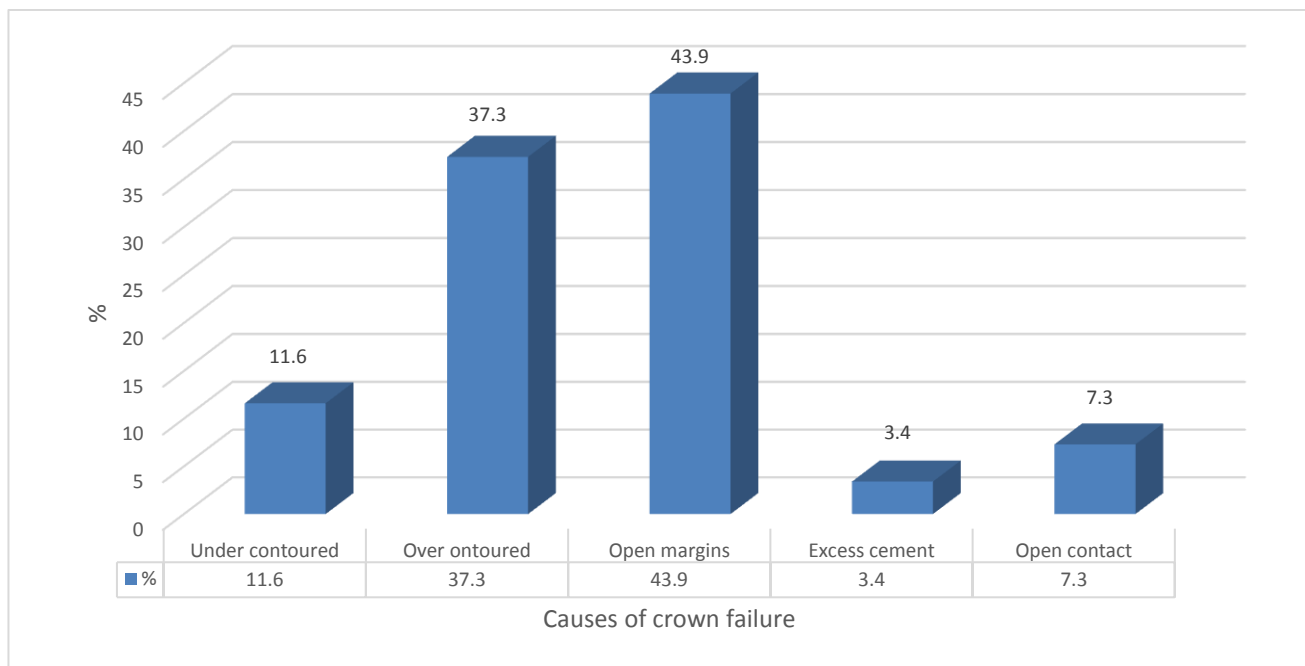| Variables		n	%
Tooth Position	Maxilla	627	52.3
	Mandible	573	47.8
Tooth Type	Premolar	511	42.6
	Molar	689	57.4
Type of Crown	Ceramic	101	8.4
	Full metal	102	8.5
	Ceramo-metal	986	82.2
	Zirconia	10	0.9
Vital / Non vital	Vital	106	8.8
	Non-Vital	1094	91.2
Post placement	With post	409	34.1
	Without post	791	65.9
Acceptable crown	Yes	459	38.3
	No	741	61.8
Mishap	Yes	820	68.3
	No	380	31.7

Figure 1: Causes of crown failure

Figure 1 shows the various causes for the failure of the crowns. Open margin (43.9%) was the common cause of failure of the crowns followed by over contour (37.3%), under contour (11.6%), open contact (7.3%) and excess cement (3.4%) placement.

Saudi had a greater number of ceramics [78(8.7%) vs 23(7.5%)], full metal [57(6.4%) vs 45(14.8%)], Ceramo-metal [752 (84.1%) vs234 (76.7%)] and zirconia [7(0.8%) vs 3(1.0%)] crowns being placed than non-Saudi's and the difference was statistically significant (χ^2 = 20.765, df= 3, p = 0.000). Similarly, Saudi's had significantly higher post placement [(332 (37.1%) vs 77(25.2%) compared to the non-Saudi's (χ^2=14.216, df=1, p=0.000) as shown in (Table 3)

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Table 3: Relationship between Nationality and treatment factors

Variables		Saudi		Non-Saudi		χ^2	df	p
		n	%	n	%			
Tooth Position	Maxilla	474	53.0%	153	50.2%	0.713	1	0.398
	Mandible	421	47.0%	152	49.8%			
Tooth Type	Premolar	383	42.8%	128	42.0%	0.063	1	0.801
	Molar	512	57.2%	177	58.0%			
Type of Crown	Ceramic	78	8.7%	23	7.5%	20.765	3	**0.000***
	Full metal	57	6.4%	45	14.8%			
	Ceram metal	752	84.1%	234	76.7%			
	Zirconia	7	0.8%	3	1.0%			
Vital / Non vital	Vital	73	8.2%	33	10.8%	2.004	1	0.157
	Non-Vital	822	91.8%	272	89.2%			
Post placement	With post	332	37.1%	77	25.2%	14.216	1	**0.000***
	Without post	563	62.9%	228	74.8%			
Acceptable crown	Yes	343	38.3%	116	38.0%	0.008	1	0.928
	No	552	61.7%	189	62.0%			

Table 4: Relationship between age and treatment factors

		20-30		31-40		41-50		Above 50		χ^2	df	p
		n	%	n	%	n	%	n	%			
Tooth Position	Maxilla	78	48.8	212	54.1	201	53.9	136	49.5	2.575	3	0.462
	Mandible	82	51.3	180	45.9	172	46.1	139	50.5			
Tooth Type	Premolar	69	43.1	165	42.1	160	42.9	117	42.5	0.073	3	0.995
	Molar	91	56.9	227	57.9	213	57.1	158	57.5			
Type of Crown	Ceramic	21	13.1	39	9.9	28	7.5	13	4.7	15.313	9	0.083
	Full metal	10	6.3	40	10.2	27	7.3	25	9.1			
	Ceram metal	127	79.4	310	79.1	315	84.7	234	85.1			
	Zirconia	2	1.3	3	0.8	2	0.5	3	1.1			
Vital Nonvital	Vital	10	6.3	29	7.4	26	7.0	41	14.9	16.542	3	**0.001***
	Non-Vital	150	93.8	363	92.6	347	93.0	234	85.1			
Postplacement	With post	56	35.0	137	34.9	124	33.2	92	33.5	0.356	3	0.949
	Without post	104	65.0	255	65.1	249	66.8	183	66.5			
Acceptable crown	Yes	45	28.1	156	39.8	**155**	**41.6**	103	37.5	9.140	3	**0.027***
	No	115	71.9	236	60.2	218	58.4	172	62.5			

When vitality of the teeth receiving crowns was compared across different age groups it was found that high number of non-vital teeth at the age of 20-30 years [(150 (93.8%) vs 10 (6.3%)], 31-40 years [363(92.6%) vs 29 (7.4%)], 41-50 years [347(93%) vs 26(7%)] and above 50 years [234(85.1%) vs 41(14.9%)] compared to the vital teeth. A statistically significant difference was observed with regards to the teeth receiving crowns at different age groups (χ^2=16.542, df=3, p=0.001) as shown in (Table 3).

Acceptable crowns varied across different age groups with 45(28.1%) in 20-30 years, 156(39.8%) in 31-40 years, 155 (41.6%) in 41-50 years and 103(37.5%) in above 50 years age groups. Comparison of acceptable crowns across different age groups showed statistically significant difference (χ^2=9.140, df=3, p=0.027) as shown in (Table 4).

Table 5: Relationship between gender and treatment factors

Variable		Male		Female		χ^2	df	p
		n	%	n	%			
Tooth Position	Maxilla	281	55.8%	346	49.7%	4.276	1	.039*
	Mandible	223	44.2%	350	50.3%			
Tooth Type	Premolar	206	40.9%	305	43.8%	1.040	1	0.308
	Molar	298	59.1%	391	56.2%			
Type of Crown	Ceramic	38	7.5%	63	9.1%	4.082	3	0.253
	Full metal	51	10.1%	51	7.3%			
	Ceramo-metal	412	81.7%	574	82.6%			
	Zirconia	3	0.6%	7	1.0%			
Tooth vitality	Vital	58	11.5%	48	6.9%	7.719	1	0.005*
	Non-Vital	446	88.5%	648	93.1%			
Postplacement	With post	155	30.8%	254	36.5%	4.287	1	0.038*
	Without post	349	69.2%	442	63.5%			
Acceptable crown	Yes	177	35.1%	282	40.5%	3.607	1	0.058
	No	327	64.9%	414	59.5%			

Males showed 281(55.8%) maxillary and 223 (44.2%) mandibular teeth being placed with crowns. While females showed 346 (49.7%) maxillary and 350 (50.3%) mandibular teeth receiving crowns. Comparison between gender and position of teeth receiving crowns showed statistically significant difference (χ^2=4.276, df=1, p=0.039). Similarly, male received crowns on 58 (11.5%) vital teeth and females had crowns on 48 (6.9%) vital teeth. Most of the females had crowns on non-vital teeth [648(**93.1%**) vs 446 (88.5%)] compared to the males and the difference was statistically significant (χ^2=7.719, df=1, p=0.005). Females showed higher percentage of post treated teeth [254 (36.5%) vs 155(30.8%)] compared to the males. While males demonstrated higher teeth without post [349 (69.2%) vs 442 (63.5%)] compared to the females. Comparison of post placement between gender showed statistically significant difference (χ^2=4.287, df=1, p=0.038) (Table 5)

Table 6: Factors affecting failure of the crown

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1ᵃ	Nationality(1)	-.025	.151	.028	1	.868	.975	.725	1.312
	Age			5.413	3	.144			
	Age (1)	-.360	.223	2.608	1	.106	.698	.451	1.080
	Age(2)	-.516	.222	5.373	1	.020	.597	.386	.923
	Age (3)	-.396	.237	2.798	1	.094	.673	.423	1.070
	Gender (1)	-.269	.134	4.037	1	.045	.764	.588	.993
	Tooth Position (1)	.312	.134	5.429	1	.020	1.366	1.051	1.776
	Tooth_Type(1)	.500	.135	13.823	1	.000	1.649	1.267	2.147
	Type_of_Crown			.734	3	.865			
	Type_of_Crown(1)	.181	.325	.309	1	.579	1.198	.633	2.267
	Type of Crown (2)	.143	.228	.392	1	.531	1.153	.738	1.803
	Type of Crown (3)	-.232	.695	.111	1	.739	.793	.203	3.096
	Vital Nonvital(1)	-.027	.254	.011	1	.915	.973	.592	1.601
	Postplacement (1)	.390	.139	7.935	1	.005	1.478	1.126	1.939
	Constant	.637	.395	2.596	1	.107	1.891		
a. Variable(s) entered on step 1: Nationality, Age, Gender, Tooth Position, Tooth_Type, Type_of_Crown, Vital_Non vital, Post_Placement.									

A logistic regression analysis was performed to ascertain the effects of nationality, age, gender, tooth position, tooth type, type of crown, tooth vitality, and post placement on the likely hood of failure of the crowns. Age group (p=0.020), gender (p=**.045**), tooth position (p=**.020**), tooth type **(p=0.000)** and post placement **(p=0.005)** added significantly to the model prediction.

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DISCUSSION

The purpose of this study was to identify the various reasons for the failure of the crown and we examined a total of 1200 radiographs. Where we found 741 non-acceptable crowns due to many significant factors we will discuss in details. For gender there was slightly statistically significant difference, female is most commonly affected and we find Post-and-core placement is an important factor for the success of crowns in endodontically treated teeth, mostly posts increase strength of the teeth by increasing the resistance to fracture of the supra-ferrule-margin, [19]

This factor did show significant difference in this study with (p=0.005), In line with the study of de backer and coworkers in 2006which they found FPDs without post-and-core abutment compared to FPDs with at least one post-and-core abutment tooth (P = .002).[20] The opposite off which they found in (de backer et al, at 2007) where there is no statistically significant difference in the long-term survival of post-and-core crowns.[21]

Also, Good margin adaptation is the most important technical factors for the long-term success of any restoration. sizeable marginal opening concedes more plaque accumulation, gingival sulcular fluid flow, and bone loss, following in microleakage, recurrent caries, periodontal disease and a decrease in the longevity of the prosthetics restorations. This problem might complicate by fixed crown.[22,23,24] Radiographs may be helpful in evaluating interproximal margins between abutments.[11]

The result of this study revealed that open margin was the common cause of failure of the crowns (43.9%), agree with Farnaz and coworkers while he found the presence of marginal gap in 75.5% in his study.[25] Also, in line with Al Refai and Saker in 2018 where they find defective margin in 90.4% of examined restoration in a total of 249 failed fixed dental prostheses.[26] In addition to this dental cement, the primary function of dental cement is to fill the place between the tooth and the restoration, as well as to increase the resistance to restoration displacement during function. [27] The failure of dental crown caused by excess cement has not been reported yet, but in this study, we found excess cement in (3.4%) of cases.

The appropriate use of dental cement insures the success of restoration and help in protecting the surrounding anatomical structures in addition to preventing the postoperative complications related to residual cement.[27] Removal of excess cement is significantly preventing of gingival bleeding, soft tissue inflammation and crestal bone loss. [28]

Multiple aspects should be taken in consider during cementation in order to reduce the chance of postoperative complications. A thin layer of cement, should be applied (about 3% of the volume of the crown). Applying of the cement near but not on the restoration margins.Excess cement can be easily removed when using the retraction cord prior to cementation. [29]

There is a difference in working and setting times for each cement manufacturer because of that reading of the instructions is necessary.[27] Eliminating of excess cement must begin before cement reach a gel stage, floss it could be useful in that situation. Besides we and a group of researchers have agreed that, the finish and fit of full crown restoration is an important factor for healthy gingiva and for the success of the FPD. [30]Ideal contour provides access for hygiene, also it creates the desired gingival form. [31] We found multiple mishaps as over contour (37.3%), under contour (11.6%), open contact (7.3%) that inlines with Nagarsekar and coauthors in 2016reported that the major contributing factors were improper contact relation with adjacent teeth (73%), improper crown contour (44%), and poor margin adaptation (45%).

As Nagarsekar and coworkers in 2016 reported in their study that the majority of the dentists (98%) considered faulty FPD design as the most likely reason for food impaction.[32] Also, they revealed that 91% of the dentists considered the ideal treatment option is repeating the FPD prostheses.[32]

CONCLUSION:

Within the limitations of our study, we concluded that: The most common reason of crown failure is the open margin followed by over-contoured crowns. With the aid of dental radiography, crowns examination is much easier and treatment plans will be accurate according to our evaluations radiographically and clinically. Accordingly, case's prognosis will be better.

RECOMMENDATIONS:

Long-term clinical follow up of cases are suggested whenever is possible. Further similar evaluation studies are suggested to be carried out with larger number of samples.

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