

EVALUATION OF THE PRESENCE AND LOCATION OF OCCLUSAL CONTACT ON RECENTLY INSERTED CROWNS

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ABSTRACT

Background: Occlusion and occlusal surfaces are very important in the fabrication of a crown or fixed partial denture. This study aims to investigate the presence and location of occlusal contacts on recently inserted posterior crowns.

Material and Methods: This cross-sectional study assessed the presence and location of occlusal contacts on a sample of 401 crowns. In regards to the existence of occlusal contacts, Shimstock 8 µm (Hanel-GMH- Dental GMBH, Nurtigen, Germany) was used to check whether the crowns were in contact or out of contact. These contacting crowns were then assessed with AccuFilm II 21 µm (Parkell, Farmingdale, NY, USA), to check whether they were in the Correct location, Incorrect location, or Mixed location.

Results: In this study, 401 crowns were assessed, 255 (63.6%) crowns showed occlusal contacts, while 146 (36.4%) crowns were out of contact. Among those crowns with occlusal contacts, it was found that 147 (36.7%) crowns were in the correct location, while 67 (16.7%) crowns showed contacts in the incorrect location, and 41 (10.2%) crowns indicated contacts in the mixed location. Results of multiple logistic regression analysis indicate that level of education and place of work are significant predictors of the presence/absence of occlusal contacts.

Conclusion: Considering the importance of establishing the occlusal contacts, the study showed a significant percentage of crowns were made out of contact and in the incorrect location. The specialized restorative/prosthodontic dentists working in college/university set-up were able to perform better in establishing the occlusal contacts (presence and location).

Key words: Occlusal contacts, Contacts location, Articulating film.

Introduction

For optimal oral health, it is fundamental to create or provide occlusion that successfully permits efficient masticatory function ¹. In health conditions, the occlusal anatomy of the teeth acts in harmony with structures controlling the movement patterns of the mandible ²⁻⁵. Joints and the anterior teeth are the structures that determine these patterns of the mandible. During any given movement the unique anatomic relationship of these structures continue to dictate a precise and repeatable pathway ⁶.

To keep the harmony of the occlusal condition, the posterior teeth must pass close to, but not contact, their opposing teeth during mandibular movement. It is significant to examine each of these structures carefully and appreciate how the anatomic form of each structure can determine the occlusal morphology necessary to achieve an optimal occlusal relationship. For many years the role of occlusion and its dynamic interactive impact on the periodontium have been a topic of controversy and considerable debate ⁷.

Although several occlusal conditions have purportedly been related to this interaction (e.g. Bruxism, malocclusion), the central focus has been on occlusal trauma (primary and secondary) resulting from excessive forces applied to the periodontium ⁸. The natural tooth comes into occlusion during its eruption by the guidance of lips, cheeks, and tongue. At the same time, a crown is built into occlusion and the variation of its contour or occlusal morphology can change its position and cause the tooth to move ⁹.

When fabricating a crown or fixed partial denture (FPD), occlusal surfaces should be in agreement with the occlusion and they should provide adequate functional contacts, which will determine the quality of prosthetic work ^{10, 11}. Location of the occlusal contact in inter-cuspal position (IP), in anterior teeth there is light contact on the palatal surfaces of maxillary anterior teeth and the labio-incisal angle of mandibular anterior teeth. In posterior teeth their contacts occur on the palatal cusp tips, central fossae, and marginal ridges of maxillary teeth; and the buccal cusp tips, central fossae, and marginal ridges of mandibular teeth ¹².

Understanding the nature of occlusal contacts in IP is highly significant for the correct diagnosis and longevity of the natural dentition, for diagnosis and treatment of the temporomandibular dysfunction, and planning and practice of restorative dentistry. Any changes in the occlusal contacting surfaces can result in movement of the teeth, disrupt the equilibrium, and cause pathologic occlusion¹³.

A high percentage of FPDs usually lacks occlusal contacts, i.e., the occlusal surfaces will be out of contact. The FPD pontics should not exceed the width of the original tooth, which does not mean that it should be placed out of contact. Doing so would affect the occlusal stability, cause supra-eruption, drifting, and bilateral asymmetry causing unilateral chewing patterns which compromise masticatory function and causes disorders of the stomatognathic system^{10, 14}.

It has been reported that occlusal interference in IP such as high crowns or restorations can result firstly in deleterious effects on alveolar and pulpal tissue (with the time the teeth tend to move away from the high occlusal force). Secondly, it can adversely affect jaw function by clicking in Temporomandibular Joint (TMJ) in some subjects and jaw soreness in other subjects¹⁵. Thus, iatrogenic restorations such as high crowns and FPDs can result in tooth mobility, tooth pain, hypersensitivity, TMJ clicking, increased muscle activity, muscle soreness, pain, and bone loss in severe cases¹⁵.

It is very important to evaluate the occlusal contact area before starting any prosthodontic treatment¹⁶ even with a single crown. When the prosthesis is made, it can be checked easily with the use of a combination of Shimstock and articulating films¹⁶. Before inserting the prosthesis, Shimstock is placed between the adjacent teeth and if resistance to removal occurs that means there is contact on that tooth and can be used as a reference. When the new crown is inserted, again Shimstock is placed to the reference tooth and if resistance to removal is present, it indicates that the crown is either in normal contact or out of contact. Shimstock is then placed between the new crowns and if resistance is observed, it indicates that the crown is in good occlusion. If there is no resistance, it implies that the crown is not contacting with the opposing tooth. On the other hand, if the Shimstock is removed without resistance on the reference tooth (while crown in place), it implies that the crown is in supraocclusion and must be adjusted with the help of articulating films and reduction tools.

Due consideration has to be given to the occlusal contact pattern to ensure the new restorations are fabricated in

harmony with the occlusion. Sometimes the patient feels pain and the reason behind that is an excessive force due to high restorations. Thus, it is necessary to evaluate the occlusal contacts during the try-in of the new restoration to detect any high occlusal contacts¹⁷. The present study aimed to evaluate the presence and location of occlusal contacts on recently inserted crowns in posterior teeth.

Material and Methods

This study was a cross-sectional one which was conducted from August 2018 to February 2019. The study was performed in different health sectors in Riyadh, Saudi Arabia (e.g. REU and private dental clinics) on patients with crowns no more than three months after insertion. Only crowns on posterior teeth were evaluated. The crowns provided by the students, general dental practitioners (GP), Restorative/Prosthodontic residents, or Restorative/Prosthodontic specialist were considered. Ethical clearance for the study was obtained from the Research Center at Riyadh Elm University, Riyadh, Saudi Arabia, under registration number FPGRP/43732001/251, and with institutional review board number RC/IRB/2018/1230. Each participant was explained about the study and informed consent was procured.

Participants were randomly chosen from the health sector, namely University hospitals (REU), Government dental clinics, and Private clinics in Riyadh, Saudi Arabia. To avoid clinician bias, a few precautions were taken. Only one crown per patient per clinician was chosen. The clinician was not provided with any information regarding the aims and objectives or the procedure of the study, to avoid them from presenting cases that were provided with precautions taken by them to meet the norm. Sampling was carried out on a random basis and not by a recall of patients according to previous radiographs or database.

The sample size was calculated using the G-power sample size calculator; we considered 95% sample power. Based on this, the required sample size was 386. We had collected the data from 432 individuals. Thirty-one incomplete forms were excluded from the analysis and we used 401 samples for the final analysis. The sample size was 401 unit crowns delivered by 401 clinicians on both male and female patients in Riyadh, Saudi Arabia. Only one crown was selected for each clinician and in the case of multiple crowns, only one crown was chosen for assessment with the most recent and most posterior one.

Inclusion criteria for the present study were recently inserted crowns within 3 months, Angle's Class I molar relationship with 2 contacts between natural teeth on each side, normal tooth alignment (of the opposing and the tooth to be examined), opposing tooth with normal natural morphology, and only one crown per each patient to be included in the study. Exclusion criteria for the study included patients with TMJ disorders, grade II or III mobility of the opposing and the tooth to be examined, supra eruption of the opposing and the tooth to be examined, chipping of porcelain (of the opposing and the tooth to be examined), broken down opposing teeth, implant-supported crowns, and patients who recently finished orthodontic treatment.

Using Data Filing Sheet, the demographic data of the dentists were collected. Data was also collected regarding the crowns. Before examining the occlusal contacts, the patient was seated in an upright position with their head erect and the Frankfort plane parallel to the horizontal plane. In this position, they were trained to occlude the teeth in IP using only a light force. The examination was done by one examiner (Prosthodontic Resident). There were two parts to the examination. In the first part, the presence of occlusal contacts was checked, whether the unit was 'in contact' or 'out of contact'. In the second part, we checked the occlusal contact location and number; whether the unit was in the 'Correct location', 'Incorrect location', or 'Mixed location'.

For the first part, we used Shimstock 8 μm (Hanel-GMH-Dental GMBH, Nürtingen, Germany), which was held with a Miller's forceps and placed between the crown and the opposing tooth and the patient asked to close the jaws in IP and the Shimstock was pulled. If the Shimstock could not be pulled out or was pulled out with resistance, this was considered as a 'contact' and if the Shimstock was pulled out without any resistance it was considered as 'out of contact'.

After checking the presence of occlusal contact, if it was in 'contact' we would continue with the second part and if it was 'out of contact' we would not. For the second part of the examination, the patient continued to be seated as in the first part. The crown in question and the opposing tooth was dried with air and wiped using a gauze. The articulating film, AccuFilm II 21 μm (Parkell, Farmingdale, NY, USA) was carried using Miller's forceps and placed between the crowns and opposing teeth. The patient was asked to make three light taps with his/her teeth, and the teeth were checked for visible markings on them.

The ideal point contacts considered for the present study included mesiopalatal and/or distopalatal cusps of the

maxillary molars, mesiobuccal, and/or distobuccal cusps of mandibular molars, palatal cusps of maxillary premolars, and buccal cusps of mandibular premolars. The contacts on the crowns were considered 'correct location' when the markings appeared only on the ideal point contacts. Mixed location when some of the markings were seen on the ideal point contacts while others were elsewhere; and lastly 'incorrect location' when all the markings did not appear on the ideal point contacts.

Lastly, after checking the occlusal contacts, data was collected and categorized based on whether the crown was fitted by a student, GP, resident, or specialist (Restorative/Prosthodontics). This data was allocated with the finding of occlusal contact to check who could do a better job in placing the correct occlusal contacts on the crowns.

This study was tested by a pilot study on a sample of 30 crown units, in patients at Riyadh, Saudi Arabia, and the results were satisfactory.

The Statistical Package for the Social Sciences (SPSS for Windows, version 24.0) (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The difference between the presence and location of the occlusal contacts and between the dentist's level of education and training, years of experience, and workplace, and between the crown's arch site, teeth site, and the material type was tested with Chi-square test. Multiple logistic regression analysis was performed with the presence or absence of occlusal contacts as a dependent variable. The level of significance was fixed at 5%.

Results

As the study focused on the work of clinicians, the crown was provided by 401 clinicians, from which there were 33 (8%) students, 256 (63.8%) GPs, 57 (14.2%) restorative/prosthodontic residents, and 55 (13.7%) restorative/prosthodontic specialists. Two hundred eighteen (54.4%) clinicians had less than 5 years of experience, while 151 (37.7%) clinicians had 5 to 10 years of experience, and 32 (8%) clinicians had more than 10 years of experience. One hundred forty-six (36.4%) of the mentioned clinicians were working in the government sector, 122 (30.4%) were working in the private sector, and 133 (33.2%) in college or universities.

Out of the 401 crowns assessed, 243 (60.6%) were in the maxillary arch and 158 (39.4%) were in the mandibular arch. Two hundred one (50.1%) were in the premolar and 200

(49.9%) were in the molar. One hundred twenty-one (30.2%) were PFM crowns, 55 (13.7%) were Lithium disilicate crowns, and 225 (56.1%) were zirconia crowns.

During the assessment of the occlusal contacts, it was found that 255 (63.6%) crowns were in contact, where 146 (36.4%) crowns were out of contact. Among the 255 (63.6%) crowns with occlusal contacts, it was found that only 147 (36.7%) crowns had occlusal contacts in the correct location, while 67 (16.7%) were in the incorrect location, and 41 (10.2%) were in the mixed location (correct and incorrect locations) (Table 1). Out of the 401 crowns, 184 (45.9%) had only one occlusal contact point and 71 (17.7%) had more than one contact point (Table 2).

When assessing the level of education and training of the clinicians, the study indicated that specialists performed better in establishing the occlusal contacts (presence and location) compared to the others (students, GPs, and residents); these differences were statistically significant. While the years of experience did not show any statistically significant differences (Tables 3 and 4).

When assessing the crowns provided in different sectors (Government, Private, and College or University), the study didn't show statistically significant differences regarding the presence of the occlusal contacts, but there was a statistically significant difference concerning the location of the occlusal contacts as the clinician working in government performed better (Tables 3 and 4).

When comparing the crowns made in the maxillary arch vs. mandibular arch and molar vs. premolar, the study showed no statistically significant difference in the presence and location of the occlusal contacts. When it comes to the type of crowns, the study showed a statistically significant difference as a crown made in Lithium disilicate shows better occlusal contacts (presence and location) compared to PFM and Zirconia crowns (Tables 3 and 4).

Results of multiple logistic regression analysis indicate that patients gender (OR=0.335, p<0.001), dentists gender (OR=4.609, p<0.001), level of education (OR=0.347, p<0.001), and workplace (OR=1.481, p=0.021), emerged as significant predictors of presence or absence of occlusal contacts (Table 5).

Variable		Frequency	Percent
Presence of occlusal contacts	Contact	255	63.6
	Out of contact	146	36.4
Location of occlusal contacts	Absence*	146	36.4
	Correct location	147	36.7
	Incorrect location	67	16.7
	Mixed location	41	10.2

Table 1: Presence and location of occlusal contacts

* Absent represent out of contacts

Variables		Frequency	Percent
Number of contacts	Absent*	146	36.4
	One	184	45.9
	Two	59	14.7
	Three	4	1.0
	Four	8	2.0

Table 2: Number of occlusal contacts

* Absent represent out of contacts

Variables		Contact		Out of contact	
		n	%	n	%
Education and training	Students	20**	60.6	13**	39.4
	General practitioners	146**	57	110**	43

	Restorative/Prosthodontic residents	37**	64.9	20**	35.1
	Restorative/Prosthodontic specialists	52**	94.5	3**	5.5
Years of experience	<5 years	135	61.9	83	38.1
	5-10 years	97	64.2	54	35.8
	>10 years	23	71.7	9	28.1
Workplace	Government	104*	71.2	42*	28.8
	Private	74*	60.7	48*	39.3
	College/University	77*	57.9	36*	42.1
Arch	Maxillary	152	62.6	91	37.4
	Mandibular	103	65.2	55	34.8
Teeth site	Premolar	126	62.7	75	37.3
	Molar	129	64.5	71	35.5
Material type	PFM	67**	55.4	54**	44.6
	Lithium disilicate	46**	83.6	9**	16.4
	Zirconia	142**	63.1	83**	36.9

Table 3: Comparison of presence of occlusal contacts with various variables

*Significant at 5% level of significance; **Significant at 0.1% level of significance

Variables		Absent		Correct		Incorrect		Mixed	
		n	%	n	%	n	%	n	%
Education and training	Students	13**	39.4	6**	18.2	6**	18.2	8**	24.2
	General practitioners	110**	43.0	103**	40.2	33**	12.9	10**	3.9
	Restorative/Prosthodontic residents	20**	35.1	8**	14.0	15**	26.3	14**	24.6
	Restorative/Prosthodontic specialists	3**	5.5	30**	54.5	13**	23.6	9**	16.4
Years of experience	<5 years	83*	38.1	69*	31.7	47*	21.6	19*	8.7
	5-10 years	54*	35.8	62*	41.1	17*	11.3	18*	11.9
	>10 years	9*	28.1	16*	50.0	3*	9.4	4*	12.5
Workplace	Government	42**	28.8	79**	54.1	13**	8.9	12**	8.2
	Private	48**	39.3	43**	35.2	27**	22.1	4**	3.3
	College/University	56**	42.1	25**	18.8	27**	20.3	25**	18.8
Arch	Maxillary	91	37.4	84	34.6	45	18.5	23	9.5
	Mandibular	55	34.8	63	39.9	22	13.9	18	11.4
Teeth site	Premolar	75	37.3	78	38.8	34	16.9	14	7.0
	Molar	71	35.5	69	34.5	33	16.5	27	13.5
Material type	PFM	54**	44.6	32**	26.4	22**	18.2	13**	10.7
	Lithium disilicate	9**	16.4	30**	54.5	5**	9.1	11**	20.0
	Zirconia	83**	36.9	85**	37.8	40**	17.8	17**	7.6

Table 4: Comparison of location of occlusal contacts with various variables

*Significant at 5% level of significance; **Significant at 0.1% level of significance

	p-value	OR	95% CI	
			Lower	Upper
Patients Age	0.249	1.204	0.878	1.649
Patients Sex (1)	<0.001***	0.335	0.210	0.535
Dentists Nationality (1)	0.910	0.965	0.521	1.787
Dentists sex (1)	<0.001***	4.609	2.180	9.746
Dentists Years of experience	0.911	0.975	0.626	1.520
Level of education	<0.001***	0.347	0.236	0.509
Work place	0.021*	1.481	1.060	2.070
Constant	0.931	1.067		

Table 5: Multiple logistic regression analysis with occlusal contacts as the dependent variable

* Significant at 5 % level of significance *** significant at 0.1 % level of significance

Discussion

To the best of our knowledge, no study had been documented in the 'English Scientific Literature' assessing the presence and location of the occlusal contacts in recently inserted posterior crowns.

The mutually protected occlusion requires an even, simultaneous contact, multiple and bilateral contacts in IP, which help distribute the occlusal forces evenly¹⁸. When providing crowns, they should be in accord with the occlusion and they should provide adequate occlusal contact, this will determine the quality of prosthetic work^{10, 11}. Placing crowns out of contact may result in drifting, rotation, supra eruption of the crowned tooth, or the opposing tooth which may contribute to occlusal interferences, reducing chewing efficiency, right and left asymmetry causing unilateral side chewing pattern which compromises masticatory function^{10, 14, 19}.

When the prosthesis is made it can be checked easily with the use of a combination of Shimstock and articulating films ($\leq 21 \mu\text{m}$). The selection of an appropriate occlusal indicator enables the dentist to work with precision as it provides accurate information about the occlusal contacts¹⁹⁻²¹.

In this study, we found a high prevalence of crowns that were in occlusal contact, from 401 crowns assessed we found 255 (63.6%) crowns in contact and 146 (36.4%) out of contacts. The placement of the crown in contacts in the correct location will ensure that the new crowns are fabricated in harmony with the occlusion¹⁷. The correct location of the occlusal contacts in complete intercuspation is one of the

main elements in charge of maintaining the correct alignment of the teeth and stabilization of the occlusion¹³. When reconstructing the occlusal surfaces of the crowns, the morphology of the occlusal surface of the crown must be in harmony with the rest of the teeth and must relate to the morphology of the natural tooth²². Changes in occlusal morphology of the crown by not providing the correct occlusal contacts with the opposing tooth may result in the movement of the involved teeth to new positions of equilibrium, causing interferences and creating pathologic occlusion^{9, 23}.

The location of the occlusal contacts on buccal cusps of the mandibular posterior teeth and palatal cusps of the maxillary posterior teeth will direct the forces in a vertical direction to the long axis of the teeth. Vertical forces are better tolerated because they are directed around the dense bone at the apex of each tooth. Placing the occlusal contacts of the crown in an incorrect location can direct the forces in a lateral direction causing destructive forces because these lateral forces are directed against the thinner and weaker walls of the buccal, lingual, and interproximal surfaces of the alveolus²⁴.

In the present study from the 401 investigated crowns the location of occlusal contacts were found in the correct location in 147 (36.7%) crowns, while 67 (16.7%) crowns were in the incorrect location and 41 (10.2%) crowns were in the mixed location. Placing the crown in the incorrect location may be due to using thick articulating paper or film more than $21 \mu\text{m}$ which may trigger patient proprioception, increase bite force and cause the mandible to deflects; also the thickness itself can be misleading as it may leave marks in incorrect locations^{20, 25}. In our study, we speculated that a significant number of dentists may pay less attention to

assure that the crown is in occlusal contact and that these contacts are in the correct location.

Mansour et al. stated that crowns made by the specialist dentist have a better quality than those made by GPs²⁶. When comparing the presence and location of occlusal contact with the level of education and training, there was a significant difference showing the restorative/prosthetic specialist did a better job in establishing the occlusal contacts. This is in agreement with the study done by Carossa et al (2000) who evaluated the influence of operator experience between the student and experienced dentist in the dental laboratory and found that experienced dentists performed establishing the occlusal contacts than the students, allowing a better distribution of the occlusal contacts²⁷.

In the comparison of the location of the occlusal contacts with the dentist's workplace, we found that the dentists working in the government did a better job of placing the crowns in the correct occlusal contact location. This difference was statistically significant and could be the reason for these differences, it could be attributed to the quality of the material used in the government. Using the correct type and thickness ($\leq 21 \mu\text{m}$) of articulating film, results in placing the occlusal contacts in the correct location while the thicker articulating film can result in pseudo marks leading to place the crown in an incorrect location^{20,25}.

Results of multiple logistic regression analysis indicate that level of education and place of work are significant predictors of the presence/absence of occlusal contacts. It implies that individuals who are trained restorative/prosthetic specialists are more likely to ensure that there are occlusal contacts. Their specialist training might be the reason for them to ensure that the restored tooth is in functional occlusion. Participants working in college/university set-up were also more likely to ensure the presence of occlusal contacts. Greater theoretical emphasis and training in a university set-up might be the reason for this finding. Further studies are needed to confirm the findings of the present study.

The present study indicated that there are significant differences in the presence and location of the occlusal contacts compared to the material type of crowns, showing that Lithium disilicate crowns performed better concerning the ability of the clinicians to establish the proper occlusal contacts. The present study, as any research, is not without limitations. Although the presence of occlusal contacts was

measured, the magnitude of existing contacts using a T-scan was not. Only single crowns on natural teeth were assessed, thereby omitting the assessment of clinician prowess in establishing occlusal contacts in FPDs and Implant-supported fixed prosthesis. The study was carried out in an urban setup; the influencing factors in a rural setup were not assessed or compared.

Conclusions

Considering the importance of establishing the occlusal contacts, the study showed that significant numbers of crowns were made out of contact. Despite the recommendations of establishing the correct location of the occlusal contacts that direct the forces to the long axis of the tooth, there was a significant number of crowns made with an incorrect occlusal contact location. The Specialized restorative/prosthetic dentists and those working in college/university set-up were able to perform better in establishing the presence and location of the occlusal contact.

There is a definite need to assess the occlusal contacts on an eccentric movement basis. Further research investigating the intensity and magnitude of the force of the occlusal contacts among crowns and assessing the knowledge and attitude of clinicians toward the importance of the occlusal contacts and the method of assessing them will shed more light on the topic.

Conflict of Interest: None

Ethics Committee Approval: Ethical clearance for the study was obtained from the Research Center at Riyadh Elm University, Riyadh, Saudi Arabia, under registration number FPGRP/43732001/251, and with institutional review board number RC/IRB/2018/1230. Each participant got informed about the study and informed consent was procured.

Source of Funding: None

Authors' Contributions

MSA conceived the study and drafted the protocol, handled data collection, data entry, data analysis, and interpretation. MAR and MSA drafted the manuscript, and MAR revised and edited it. Both authors read and approved the final draft of the manuscript for publication.

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