Influence of Work Time Conditions on Quality of Tooth Preparation for Porcelain Fused to Metal Restoration Performed by Dental Students

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ABSTRACT:

Statement of problem. The relation between the work time conditions and the quality of the work carried out by the undergraduate dental students lacks adequate research.

Purpose. The purpose of this study was to evaluate the impact of work time conditions on quality of clinical tooth preparation for Porcelain fused to metal restorations (PFM) performed by final year dental students at the University of Ibb, Yemen.

Material and Methods. Total 512 posterior abutments teeth in 216 dental casts samples (diagnostic & working casts) for 108 patients, collected from the Prosthodontics department, were gathered for evaluation (between February and June 2015). From among these, 128 abutments on which dental students had prepared teeth during routine clinical procedure was called requirement group (RG). The other 128 abutments on which dental students had prepared teeth for their final practical exams was called examination group (EG). Each prepared teeth had sound diagnostic casts. All samples were evaluated for buccolingual (BL) and mesiodistal (MD) dimensions in millimeters by using a digital caliper. The study used dies to examine occlusal reduction, finishing line position, finishing line continuity, and

smoothness of preparations. The mean values of BL reduction (BLR) and MD reduction (MDR) for all the prepared teeth, RG and EG, were statistically compared with hypothetically calculated ideal range (HCIR) values. Also, a comparison was held between the two groups. The data were analyzed by using the, T-test, Paired sample t-test and Wilcoxon test at (P =.05).

Results. The average of BLR and MDR were 1.988 mm (±.04) and 2.422 mm (±.04). When BLR and MDR were compared with the ideal value of HCIR, the difference was highly significant. BLR of RG was 1.961 mm and 2.016 mm for EG. Comparing theses means with the HCIR, the result showed significance. MDR of RG was 2.344 mm and 2.500 mm for EG with highly significant difference with the HCIR. Comparing EG and RG in position, continuity of finish line, smoothness of preparations and MDR, the finding was higher significant, while there was no significant difference in the BLR and occlusal reduction.

Conclusions. Based on the results of the present study, BLR was less than the ideal value of HCIR, while MDR was higher than it. Work time conditions have positive impact on tooth preparation quality. The EG is significantly higher than the RG, and had higher percentage in most preferred study criteria than the RG.

Key Words: *Tooth preparation, PFM restoration, Conditions, Caliper, HCIR, Dental students*

CLINICAL IMPLICATIONS

To get the best possible results, the steps of clinical tooth preparation for receiving PFM restoration should be assessed step by step. Also, the clinician should be aware of the importance of the recommended sequences of tooth preparation on the quality of the preparation.

INTRODUCTION

Full coverage crowns are well-proven, accepted and routinely used restorations by the dentists to replacement of missing teeth. Porcelain fused to metal crowns (PFM), also called ceramo-metal or metal-ceramic crowns, are certainly most versatile combining strength with aesthetics.[1] The recommended tooth reduction requirements vary depending on the material that will be used for the restoration.[1, 2] For instance, the ideal reduction for PFM restoration, approximately 1.2 mm is needed on the buccal surface and the lingual surface should be reduced by minimum amount of 0.7 mm. When posterior teeth to be crowned, the areas where there will be Porcelain coverage, the reduction should be 1.5 mm to 2.0 mm if the metal will be veneered with Porcelain.[2] The quality of preparation for complete crowns is affected by occlusal and axial preparation.[3]

Tooth preparation is an important procedure in fixed prosthesis. It is an essential technique for dental treatment, but it is a skill not easily learned by

a dental student. To get the best possible results, compromise between the biologic, mechanical and aesthetic considerations of the principles of tooth preparation must be achieved.[1-3] Strict clinical guidelines are emphasized in dental literature, but little information is available on how well these guidelines are followed.[4]

Within the last few decades, there are several investigations which evaluated tooth preparation to identify how much it is far from the ideal. These studies targeted preparations done by dental students and demonstrated different results.[4-9] There are many studies which followed the performance of dental students in tooth preparation for fixed prosthodontics during their preclinical course,[10] and efforts for accurate evaluation of their preclinical work were done.[11] Examining the frequently encountered errors in prepared teeth, should be checked before the work is sent to labs. The problems caused by defective tooth preparations have long been recorded. Other authors have written on the errors commonly observed in tooth preparations.[12, 13] The best time to inculcate good-practice for students is when they are working under supervision of instructor.[14]

It is commonly believed that dental students under training conditions are more comfortable than their situation in the examination conditions. During the examination conditions the dental students are more likely to be exposed to stressful and difficult situations, due to many factors ranging from the patient management to cementation of the definitive prosthesis as during the translation stage between preclinical and clinical stage.[15-17] Although several studies have discussed the importance of ideal tooth preparation techniques that provide optimal integrity and increase longevity of the existing restoration,[18] but the relation between the work time and quality of work have not been studied so far.

The objective of this study was to evaluate the impact of work time conditions on the quality of clinical tooth preparation, for PFM restorations performed by final year dental students at the University of Ibb, Yemen. It mainly focused on measuring the amount of reduction, and compare it with the hypothetically calculated ideal range (HCIR) values, and to examine some frequently encountered errors in prepared teeth.

MATERIALS AND METHODS

Treatment in the Faculty of Dentistry at Ibb University (governmental), performed by dental students (fourth- and fifth-year), is carried out under supervision of a clinical instructor. For the purpose of this study, ethical approval was obtained from the research committee in the faculty. Because the preparation was evaluated by using dental casts and dies, which were used only for the purpose of the present study, so the consent was obtained from the patients to include their dental casts in this study.

Three hundred nineteen abutments (58 anterior and 261 posterior teeth) prepared clinically, for 152 patients as abutments for fixed partial dentures (FPD), by fifth-year dental students, for PFM restorations (veneered with Porcelain), between February and June 2015 were included in the study. Third molars (5) and anterior teeth (58) were excluded from the study, because of a significant deficiency in the numbers of mandibular anterior teeth prepared during the study period. The remaining number was 256 prepared teeth, and in the same time each prepared tooth had sound diagnostic casts.

Total 512 posterior abutments teeth in 216 dental casts samples (diagnostic and working casts within dies) for 108 patients, collected from the Prosthodontics department, were gathered for evaluation. The samples were divided into two equal groups according to the work time conditions, which include: group (1) 128 prepared abutments (66 maxillary and 62 mandibular) on which dental students had prepared teeth during routine clinical procedure (under clinical requirement or training conditions) were called requirement group (RG). Group (2) 128 prepared abutments (62 maxillary and 66 mandibular) on which dental students had prepared teeth for their final practical exam (under clinical examination conditions) were called examination group (EG). Each prepared tooth (in each group) had sound diagnostic casts. For each group, the diagnostic and its working cast were marked by the same number. Using blue marker for RG and red marker for EG. All samples were examined visually and have been found to be sound without defects or cracks. All cross infection control protocols were followed. Each trimmed diagnostic and working cast was evaluated for the following criteria: buccolingual (BL) and mesiodistal (MD) diameters in millimeters. All measurements were done by using a digital caliper (China), held perpendicular to the occlusal plane and in line with the long axis of the tooth. Two investigators carried out each measurement twice and the mean

was recorded to minimize human investigators error. Calibration for zero was checked after each reading.

The total amount of tooth reduction in the BL and MD planes, calculated by deducting the width of the working cast (W) from the diagnostic cast(D) width in the two planes: amount of BL reduction (BLR) = BLD – BLW, and amount of MD reduction (MDR) = MDD – MDW. The mean BLR and MDR values for all the prepared teeth were statistically compared with HCIR values. Also, a comparison was held between the BLR and MDR. HCIR was formulated by combining the preferred: ideal buccal and lingual reduction values, and ideal mesial and distal reduction values.[19] HCIR mean for BLR = 2.15 mm (±0.25) and 2.2 mm (±0.2) for MDR.[19,20] As well, the mean of BLR and MDR values for the RG and EG were statistically compared with HCIR values. Also, a comparison was held between the two groups.

In addition, the dies were also used to examine some frequently encountered errors in prepared teeth such as the occlusal reduction (anatomical or flat), finishing line position (supra, subgingival or with gingival), finishing line continuity (continuous, discontinuity or not apparent), and the smoothness of the preparations (good, moderate or poor). The preparation margin design was assessed visually with the aid of x2.5 magnification (Dental Loupes, China). All these recorded criteria were done by two investigators and randomly rechecked by another investigator. All the obtained data were analyzed by the T-test, Paired sample t-test and Wilcoxon test to identify significant differences (α=.05), by using SPSS Version 23 statistical software.

RESULTS

The average BLR and MDR of all the prepared teeth evaluated in this study were 1.988 mm (±0.04) for BLR and 2.422 mm (±0.04) for MDR. When BLR and MDR were compared with the average (ideal) value of HCIR by using t-test, the difference was highly significant ($p< 0.05$) (Table 1). Also when compared with the upper and lower limit of the range, the result was significant differences ($p< 0.05$) for BLR, while, MDR was significant with lower limit of the range (Table 1). A comparison between the BLR and MDR was carried out by using paired t-test, the result was highly significant (MDR is significantly higher than the BLR).

The BLR mean was found to be 1.961 mm for RG and 2.016 mm for EG. By using t-test for comparison with HCIR, the result was found to be: highly significant with ideal value and the upper limit of the range, while no significant with lower limit of the range. The MDR mean was found to be 2.344 mm for RG and 2.500 mm for EG and by using t-test for comparison with the HCIR, the result was found to be: highly significant differences (P < 0.05) with ideal value and lower limit of the range, while no significant with upper limit of the range (Table 1).

There was no significant difference between RG and EG in BLR (P > 0.05), while there was a significant difference in MDR (P < 0.05) by using Paired sample t-test (Table 2). Also, there was no significant difference between RG and EG in the occlusal reduction (P > 0.05). Whereas there was higher significant difference for the position and continuity of the finish line and the smoothness of the preparation (P < 0.05) by using Wilcoxon test (Table 3).

The frequency and percentage of some frequently encountered errors in prepared teeth are summarized in Table 4. The anatomical occlusal reduction was found in favor of the EG, 55.5%; and the remaining, 44.5%; were found flat, while the RG showed an opposite result. Regarding finish line position variable, the result was also in favor of the EG where the supra-gingival were, 14.8%; for the EG, and only, 1.6%; were found in the RG. The remaining were distributed as, 77.3%; of sub-gingival and, 21.1%; with gingival for the RG, whereas, 72.7%; were of sub-gingival and only, 12.5%; were with gingival for EG. For the continuity of the finish line, the result was also in favor of the EG where, 55.5%; showed continuity, while in the RG, 21.9%; were seen continuous. Only, 17.2%; were observed discontinuous in the EG at a time when, 31.3%; showed discontinuity in the RG. While only, 27.3%; in the EG were found not apparent, the RG had, 46.9%; unapparent.

For the smoothness of the preparation, the result was again in favor of the EG, 48.4%; were found good in comparison to only, 25.0%; in the RG which were found good. The results also revealed, 46.1%; in the EG as moderately prepared in their smoothness, while the RG had, 59.4%; moderate smoothness. The least number of poor cases was for the EG, 5.5%; in comparison to, 15.6%; which were found poor in the RG.

DISCUSSION

The study was an attempt to compare the amount of tooth reduction for PFM restoration, which are recommended in literature with those being performed by the undergraduate students, and to examine some frequently encountered errors in prepared teeth, under two different clinical conditions.

Among the limitations of the study, there were no previous researches to investigate the impact of work time conditions on the quality of tooth preparation, and this study is an attempt to fill this gap in the academic research. The HCIR values used in this study were a novel criterion, used by previous investigators.[19, 20] When the limits of the range were taken into account, the average values of BLR and MDR in the study sample fell within the HCIR. The BLR average was however, closer to the lower limit of the range, while the MDR average was however, closer to the upper limit of the range (Table 1).

Regardless the limits of the range, the BLR means of all samples, RG and EG were found to be significantly less than the ideal value of HCIR. This finding is in agreement with the study of Syed et al,[20] for maxillary posterior teeth. Contrary to the study of Alhouri,[19] who found that the BLR was higher than what was recommended in the dental literature, and also in contrast to the study of Syed et al,[20] who found that the BLR means values fell within the HCIR, and the statistical comparison was not significant for all the prepared crowns except for maxillary posterior teeth. These studies investigated the amount of tooth preparation by comparing the dimensions of prepared crowns to their natural antimeres, not to their original tooth dimensions before tooth preparation as in the present study. The difference in samples type, techniques of tooth preparation, measuring method and tools may have some effect. Tiu et al21 demonstrated that dental students tend to be excessively conservative.

The present study found that MDR was greater than BLR, which may be due to the axial wall is the most difficult stage of the preparation, especially for the distal surface of the posterior teeth, which could be explained with difficulty in positioning of the hand-piece with burs, and the possibility of injury to the adjacent teeth.

MDR means of all samples, RG and EG were found to be significantly higher than the ideal value of HCIR (Table 1). This finding matches the study by Alhouri, 19 and in contrast to the study of Syed et al,[20] who found the average values of MDR of all the prepared crowns were within the

HCIR, which could be explained by lack of experience, limited access and anatomical variation which may have some effect. There is reported variability in literature in the tooth reduction for crown preparation, and it also varies significantly depending on experience of the dentists.[4, 5, 22, 23]

Comparing EG and RG in position, continuity of finish line and the smoothness of the preparations, the finding was highly significant. Also, the MDR revealed statistical significance (EG is significantly higher than the RG), while there was no significant in the BLR (Table 2) and occlusal reduction (Table 3). Lack of improper occlusal reduction consider one of the most frequently encountered problems with preparation of teeth for PFM.[24] Anatomical occlusal reduction was in favor of the EG, 55.5%; and the remaining, 44.5%; showed flat, while the RG showed an opposite result demonstrating no significant difference. This might be due to the occlusal reduction and it is comparatively easy because it can be performed under direct observation in most clinical conditions. However, preparing the axial wall is difficult especially for the distal surface of the posterior teeth, which is difficult for dental students to observe directly.

Ideally, finish line should be placed supra-gingivally. Assessing the finish line position, most of students, 75.0%; were unable to place the finishing line in the recommended position, and only, 8.2%; of stone dies the finishing line was supragingival. The supra-gingival were, 14.8%; for the EG, and only, 1.6%; for the RG. This may be due to the abutments conditions for FPD which makes the preparation difficult for inexpert undergraduate students, they may have least control because the coronal tooth structure may have previously incurred significant damage, or may have received restorations of varying quality,[25] or due to short clinical crown, because the students makes flattened occlusal reduction or they try to extend apically to get more retention for FPD.

With regard to the continuity of the finish line, 38.7%; of students were able to preserve continuity of the finishing line. In, 37.1%; of dies the finishing line was not clear, and the remaining, 24.2%; were of discontinuity. The result was also in favor of the EG where, 55.5%; showed continuity, while in the RG, 21.9%; were continuous. This can be attributed to a lack of optimal tooth reduction by the students or a failure to place the finishing line supragingival or misusing of the retraction cord.

The final preparation must be free from irregularities, sharp line angles and corners. The students had no problems in getting (good to moderate) smooth preparations with rounded angles. The least number of poor cases

was for the EG, 5.5%; in comparison to, 15.6%; which appeared poor in the RG. This might be related to the result of other criteria mentioned above.

Overall, the highly significant discrepancy between RG and EG in most criteria included in this study, can be attributed to multiple factors, one of which is the evaluation rules (the steps of tooth preparation were evaluated separately in EG). There are definite advantages in following a set order of tooth preparation, and ensuring that each element of preparation is complete before starting the next.[1] Thus, the recommended sequences of tooth preparation are ensured to be followed by the students. Also, it can be attributed to the use of proper, suitable and new armamentarium such as retraction cord, diamond and carbide finishing bur by the students during the examination conditions. In addition, possibly other factors such as direct vision, accessibility to the tooth surfaces and absence of adjacent soft tissue structures, might have an impact on the clinical performance of the students.[22] All these factors may ensure good tooth preparations with fewer errors in EG when compared with RG.

The limitations of this study were that the armamentarium, length of clinical crown, and the evaluation rules for the prepared tooth were not taken into account. Further research is required to explore the impact of type and position of the tooth and type of dental arch on quality of tooth preparation for PFM restoration.

CONCLUSION

Based on the findings of this study, the mean amounts of tooth preparation revealed by this study were less than the ideal value of HCIR in the BL direction, while it was higher in MD direction. In general, the means amounts of tooth preparation evaluated for PFM restorations in this study were satisfactory. The quality of the tooth preparation carried out by the undergraduate students under the clinical examination conditions was attained with accurate and satisfactory result, when compared with their preparation under the routine clinical conditions. The main recommendation of this study was that the steps of tooth preparation should be evaluated separately in order to attain accurate and satisfactory result.

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Criteria	sample	N	Mean (mm)	Std. Error of Mean	HCIR Mean (mm)	Sig. p-value for the limits of HCIR		
						Upper limit	Ideal value	Lower limit
BLR	RG	128	1.961	.0634	2.15 (±0.25)	.000	.003	.338
	EG	128	2.016	.0620		.000	.032	.064
	Total	256	1.988	.0443		.000	.000	.047
MDR	RG	128	2.344	.0607	2.2 (±0.2)	.356	.019	.000
	EG	128	2.500	.0652		.127	.000	.000
	Total	256	2.422	.0447		.625	.000	.000

Table 1. Statistical comparison between the HCIR and the means of BLR and MDR for all sample, RG and EG found in the study.

BLR= buccolingual reduction
MDR= mesiodistal reduction
RG= requirement group
EG= examination group
HCIR = hypothetically calculated ideal range

Paired Samples Test								
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
MDR /RG - MDR /EG	-.1563-	.7364	.0651	-.2851-	-.0274-	-2.400-	127	.018
BLR / RG - BLR / EG	-.0547-	.7943	.0702	-.1936-	.0842	-.779-	127	.437

Table 2. Paired sample t-test analysis of the amount of tooth reduction between the RG and the EG in MD and BL dimensions.

MDR= mesiodistal reduction
RG= requirement group
EG= examination group
BLR= buccolingual reduction

	Occlusal reduction	Finish line position	Finish line Continuity	Smoothness of preparation
Z	-1.905-[b]	-3.557-[b]	-4.671-[b]	-4.311-[b]
Asymp. Sig. (2-tailed)	.057	.000	.000	.000

Table 3. Wilcoxon test - p-value for statistical comparison between the RG and the EG for some frequently encountered errors in prepared teeth included in the study

Criteria	Variable	RG		EG		Total	
		Percentage	Count	Percentage	Count	Percentage	Count
Occlusal Reduction	Anatomical	44.5%	57	55.5%	71	50.0%	128
	Flat	55.5%	71	44.5%	57	50.0%	128
Finish Line Position	Supragingival	1.6%	2	14.8%	19	8.2%	21
	Subgingival	77.3%	99	72.7%	93	75.0%	192
	With gingival	21.1%	27	12.5%	16	16.8%	43
Finish Line Continuity	Continuous	21.9%	28	55.5%	71	38.7%	99
	Discontinuity	31.3%	40	17.2%	22	24.2%	62
	Not apparent	46.9%	60	27.3%	35	37.1%	95
Smoothness of Preparation	Good	25.0%	32	48.4%	62	36.7%	94
	Moderate	59.4%	76	46.1%	59	52.7%	135
	Poor	15.6%	20	5.5%	7	10.5%	27
Total		100%	128	100%	128	100%	256

Table 4. Frequency & Percentage of some frequently encountered errors in prepared teeth for the RG and the EG included in the study

RG= requirement group

EG= examination group