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Assessment of Porcelain Fused to Metal Crown Preparations by General Practitioners in Saudi Arabia

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Authors' contributions

This work was carried out in collaboration between all authors. Author MMAM designed the study, wrote the manuscript. Author NSAH collected samples from Dammam, author KAA collected samples from Abha, author EAAM collected samples from Jizan and managed the measurements with photos, author NMAA collected samples from Jeddah and author ST made the data analysis, results and read the final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Principles for fabricating prosthetic restorations include sufficient axial preparation and adequate occlusal clearance of the prepared teeth. This study measured the convergence angles in the prepared teeth for porcelain fused to metal (PFM) crowns done by general practitioners in different regions of Saudi Arabia. In addition, the presence of planar occlusal reductions, functional cusp bevels and rounded angles in prepared casts were evaluated.

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Methods: Sixty dies were selected from the working casts of prepared PFM crowns by general dental practitioners. The dies were divided into four equal groups according to the region. All the measured dies were mounted with the occlusal plane of the prepared teeth parallel to the floor. Photographs of buccal and proximal aspects of the dies were taken and then transferred into a personal computer. An AutoCAD software program was used to measure the mesiodistal and buccolingual convergence angles. The planar occlusal reduction, functional cusp bevel and presence of rounded angles of each preparation were evaluated. The data were recorded, then analyzed using SPSS version 20.0.

Results: The mean convergence angles were high above the ideal range (4º-14º) in all of the selected regions. The mean mesiodistal convergence angle nearest to the ideal range was registered in teeth prepared in Dammam region, which was lower than tooth preparations from Jeddah, Abha and Jazan regions. Statistically significant differences with buccal, lingual taper and buccolingual convergence existed between the regions. Also significant differences were observed between the teeth preparation samples from four regions with distal taper and mesiodistal convergence angles.

Conclusion: The achieved convergence angles of tooth preparations for PFM crowns by different general practitioner were out of the recommended range mentioned in dental literature.

Keywords: Porcelain fused to metal; tooth preparation; general practitioners; functional cusp; planar reduction; Saudi Arabia.

1. INTRODUCTION

The preparation of porcelain fused to metal (PFM) crowns is a common procedure in general dental practice. Therefore, it is essential that dental graduates develop optimum skills and expertise during the studying period [1].

PFM crowns are mostly recommended restorations for extensively damaged posterior teeth. The ability of general practice dentists to adequately prepare teeth is fundamental to the success of these crowns [2-4].

Among the fundamental principles of tooth preparation is the retention and resistance forms, retention features prevent the dislodgment of the restorations along the path of insertion, whereas resistance features prevent restoration dislodgment when oblique, non-axial forces act on the tooth [2,3].

The angle formed between opposing walls of the tooth preparation is called the degrees of taper [5]. Retention of castings decreases with increasing taper and has been shown to be inversely proportional to the taper angle [6].

The ideal convergence degrees mentioned in literature reviews of fixed Prosthodontics textbooks and different dental schools are 2◦ to 7◦ per axial wall [2-4].

One of the problems most frequently encountered with preparation of teeth for PFM crown is lack of improper occlusal reduction [7]. The structural durability of the restoration is improved by making planar occlusal reduction, functional cusp bevel and rounded angles. This feature makes the bulk of the restorative material, to adequately withstand forces from occlusion [2,3]. Many techniques have been described for evaluating degree of tapers preparations. Devices such as geometric microscopes [8], three- dimensional laser scanners [9], photocopy machines [10] overhead projectors [11] diamond rotary cutting instruments [12] and metrology equipment [1] have been used to measure the degree of the tapers of working dies. In our study technique using the Auto-CAD software to measure the taper angle was used, which isreliable and with a high degree of accuracy that can be used for research measurements [13,14].

The objectives of this study were to evaluate the quality of tooth preparation carried out by different general practitioners in different locations of the kingdom of Saudi Arabia: To measure the obtained converge angles for different groups and compare it with the recommended values mentioned in the literature. To evaluate the structural durability features such as presence of occlusal planar reduction, the functional cusp bevel and rounded line angles in the prepared teeth.

2. SUBJECTS AND METHODS

This Cross sectional study was undertaken with a total number of 105 PFM preparations, working

casts, after cementations of the crowns in patient's mouths. Working casts were obtained from different clinics in different regions of the kingdom of Saudi Arabia. Only sixty dies of PFM crowns for maxillary first molars were selected. The prepared dies were divided into four equal groups according to preparation of general practitioners collected from Jeddah, Abha, Jizan and Dammam respectively (15 PFM prepared cast from each region). The data were collected using a convenience sampling technique from trimmedcasts. All maxillary molars were prepared under normal conditions by general practitioner dentists.

A digital camera (Cyber-shot® S750 Digital Camera DSCS750, Sony, Japan) with 12.1 mega pixels was mounted on a tripod stand (Benro Tripod T-600 Ex, Copyright Beniro Industrial Inc, China) perpendicular to the long axis of the axial line of the prepared tooth to take the photographs. Each die was placed at 20 cm distance away from the camera and with the position of the occlusal surface parallel to the top of the table.

For each die two different photographs from buccal and axial views were taken. The photographs were transferred into a personal computer. AutoCAD 2007 software program (Sony Corporation, Tokyo, Japan), was used to measure the mesial, distal, buccal and lingual degrees of tapers for each prepared die. Single trained investigator took photographs of the dies, models under standardized condition. The measurement method used in this study was used in the study conducted by [1,14-19].

On each photograph, two lines were drawn over the right and left contours of the axial walls of each die, mid-mesial and mid-distal for the buccal view or mid-buccal and mid-lingual of the proximal view. A line was drawn from the finish line extended coronally, another line was drawn parallel to the long axis of the tooth contingent with the internal finish line. The angles formed by the line parallel to the long axis of the tooth and the line parallel to the axial walls were measured to determine the degree of taper or axial angle of each side separately. The total of both sides was calculated as converge angles.

The presence or absence of occlusal planar reductions, functional cusp bevels and rounded line angles for each die were recorded. The measurements in this cross sectional study were evaluated as mentioned in the recommended textbook [2,3]. Single investigator carried out the two measurements for each tooth and the mean was recorded for each respectively.

The recorded data were entered into the computer and analyzed using SPSS software package version 20 (SPSS, Chicago, IL, USA). The tests used for comparison of mean values between the groups were: One Way Analysis Of Variance (ANOVA) and Tukey's Honestly Significant test for pairwise comparison. The level of significance was set at 5%.

3. RESULTS

Table 1 shows descriptive statistics for different taper degrees among the tooth preparation samples of general practitioners from different regions. It can also be observed that the mean values for the taper degrees were higher and above the ideal range (4º-14º) in all the regions (Table 2). The data, when subjected to statistical analysis for comparison showed no statistically significant difference with buccal, lingual taper and buccolingual convergence between the regions ($p<0.05$) (Table 3). However, significant differences were observed between the tooth preparation samples from four regions with distal taper and mesiodistal convergence angles ($p<0.05$) (Table 4). Furthermore, Tukey's Honestly Significant test revealed that the mesiodistal convergence angles for tooth preparations for Dammam were significantly lower than tooth preparations from Jeddah, Abha and Jizan ($p<0.05$) (Table 5 & Fig. 1).

Fig. 2 shows the other characteristics of tooth preparation, evaluation related to structural durability i.e. Presence of rounded angles, adequate occlusal plane reduction and functional cusp bevels. It can be observed that the preparations from all regions were evaluated to be adequate and satisfactory in all the locations.

4. DISCUSSION

Factors for good retention and resistance in PFM restorations includes, size of the tooth, the magnitude of dislodging force, geometry of the tooth preparation and roughness of the preparation [2]. In this study, we selected the preparation of molar teeth because of, it is the first tooth erupted in the oral cavity and exposed to dental caries. Alesia & Khalil [19] founded that the molar teeth were the most caries teeth among the Saudi population. Also the PFMs are still the most widely used restorations.

Table 1. The mean and standard deviation values for axial taper according to the regions

Location	Mesial taper		Distal taper		Buccal taper		Palatal taper	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Jeddah	12.8100	3.5414	17.5613	4.4079	12.8167	3.3799	13.6267	3.6949
Abha	11.9707	4.4253	17.6620	6.0064	14.7800	4.1620	12.5767	0.9137
Jizan	11.9413	5.2816	13.1153	3.2184	14.2527	3.2468	12.2480	0.8001
Dammam	13.5626	3.6258	13.5487	3.2300	14.4400	3.7971	11.2613	3.7541
Total Average	12.0692	4.1923	15.0247	5.0145	14.0723	3.6489	12.4282	2.7674

Table 2. Percentage of tooth preparation within ideal range

	Mesio-distal taper (within 4-14 degrees)
Jeddah	0
Abha	12.14
Jizan	12.14
Dammam	12.14

Table 3. Comparison of mean buccal taper, lingual taper and buccolingual convergence degrees between different region samples by one-way ANOVA

		Sum of squares	df	Mean square	F	Critical value	Sig.
Buccal taper	Between groups	33.678	3	11.226	.836	2.769	.480
	Within groups	751.898	56	13.427			
	Total	785.576	59				
Lingual taper	Between groups	42.786	3	14.262	1.952	2.769	.132
	Within groups	409.094	56	7.305			
	Total	451.881	59				
Buccolingual convergence	Between groups	20.624	3	6.875	.328	2.769	.805
	Within groups	1174.093	56	20.966			
	Total	1194.717	59				

*Significance level at 5%

Table 4. Comparison of mean mesial taper, distal taper and mesio-distal convergence degrees between different region samples by one-way ANOVA

		Sum of squares	df	Mean square	F	Critical value	Sig.
Mesial taper	Between groups	12.594	3	4.198	.229	2.769	.875
	Within groups	1024.358	56	18.292			
	Total	1036.952	59				
Distal taper	Between Groups	415.407	3	138.469	7.259	2.769	.000*
	Within Groups	1068.177	56	19.075			
	Total	1483.584	59				
Mesiodistal convergence	Between groups	534.297	3	178.099	4.210	2.769	.009*
	Within groups	2369.038	56	42.304			
	Total	2903.336	59				

*Significance level at 5%

Table 5. Pair wise comparison of mesiodistal convergence degrees by location by tukey's honestly significant test

	Jeddah	Abha	Jizan	Dammam
Mean	30.3713	29.6327	25.0567	23.3147
SD	6.77415	6.83414	7.39219	4.68807
Jeddah	P=1.0000			
Abha	P=0.989	P=1.0000		
Jizan	P=0.126	P=0.229	P=1.0000	
Damman	P=0.022*	P=0.049*	P=0.883	P=1.0000

**Significant value*

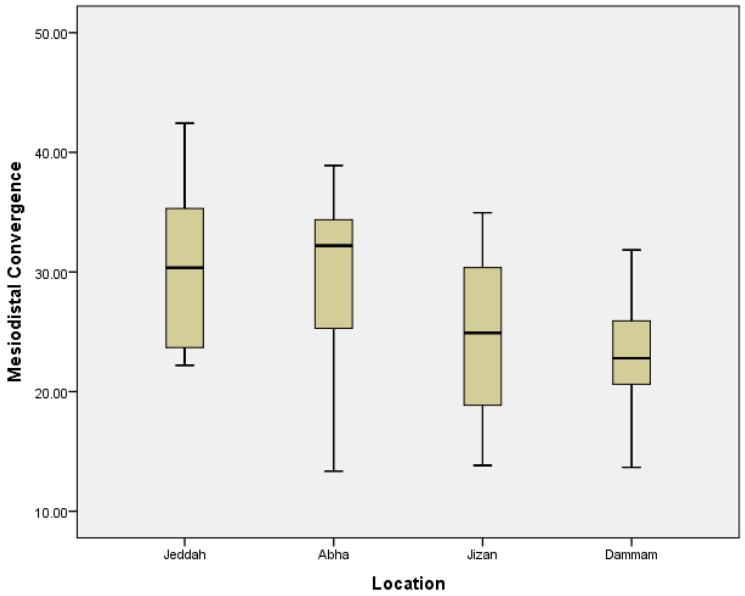

Fig. 1. Comparison of mean of mesiodistal convergence angles by location

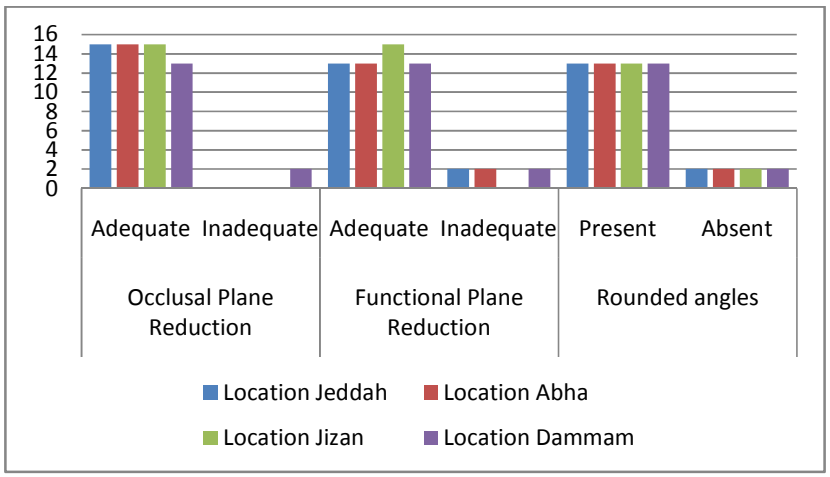

Fig. 2. Clinical evaluation outcomes of tooth preparation characteristics with respect to occlusal planar reduction, functional cusp bevel and rounded angles

According to the results obtained in this study as shown in Table 2, the percentage of convergence angles falling within the normal range were 12.14% in all of the regions, except that Jeddah region which was 0%. This is in agreement with El-Mubarak et al. [20], but disagreed with Rafeek et al. [1] and Ow et al. [21], which could be explained by lack of experience, limited access, visual error and anatomical variation which may play a role in our result.

Most of the cast and their die preparations collected from different regions registered that the mean of converges angles in both mesiodistal and buccolingual were out of the ideal range stated by the Prosthodontics manuals and textbooks. The registered values of mesial, distal, buccal and palatal tapers degrees were 12.067, 15.024, 14.072 and 12.428 respectively (Table 1). This is in agreement with Rafeek et al. [1] Al Ali et al. [14] Ghafoor et al. [15] Dorriz et al. [16] Madani et al. [17] Ghafoor et al. [18] and Makker et al. [22], Annerstedt et al. [23], Kiroval et al. [24], Kart et al. [25]. The probable reason for the same could be that the fresh graduated dentists had minimal short clinical experiences and they wish more favorable and easy seating of the restoration during try-in and cementation of the final restorations.

The mean values of buccal, lingual and buccolingual convergence angles were shown in Table– 3. Our results agree with that of Al Ali et al [14], who registered 24.9±10.2 facially and 27.2±9.2 lingually as the mean of preparation of single crown of posterior teeth for cast prepared by general practitioners in Riyadh, Saudi Arabia. Also agree with MADANI et al. [17], those founded tendency by dentists for more tapering in buccal than lingual surfaces of posterior teeth.

Table -4, showed significant differences between the distal and mesiodistal convergence angles which could be explained with difficulty in visual access and positioning of the hand-piece with burs, and the possibility of injury to the adjacent teeth. This is in agreement with Rafeek et al. [1] Al Ali et al. [14] Madani et al. [17], but disagree with Al Moaleem et al. [19] and Makker et al. [22], which could be explained by the situation, environment and the location of the prepared teeth, since they used typodont in their study.

Occlusal features and adequate clearances are important factors for sufficient occlusal preparation of teeth and sufficient structural durability for Prosthodontics crowns. From Fig.-2, it is clear that, most of the preparation in all groups (Jeddah, Abha, Jizan and Dammam) showed adequate occlusal planar reduction, functional cusp bevel in addition to that the rounded line angle were present and obvious in the majority of the casts preparations. Factors such as direct vision, accessibility of the surface, absence of adjacent soft tissue structures play an important factor in production of good proportions. These findings coincide with that obtained by El-Mubarak et al. [20], Ow et al. [21], Kart et al. [25], Poon & Smales [26], Al-Omari & Al-Wahdani [27]. For the occlusal planar reduction our finding disagrees with the finding of Poon & Smales [26], because of the sufficient direct vision of the occlusal surface of maxillary molars in our study which results in adequate occlusal reduction. While it is agreed with El-Mubarak et al. [20] and Al-Omari & Al-Wahdani [27], in the adequate presentation of functional cusp bevel in their preparations. On the other hand, our finding coincided with the finding of Esser et al. [12] and El-Mubarak et al. [20] with respect to the presence of rounded line angles in the prepared teeth.

5. RECOMMENDATIONS

Limitations of this clinical study were lack of collection of samples from all regions in Saudi Arabia and it was a cross sectional study. So long term clinical studies are necessary to fully assess the retention and resistance as well as the structural durability features for the longevity of individual restoration.

6. CONCLUSION

Within the limitation of this study, it can be concluded that:

1- Most of converge angles of the prepared teeth were out of the hypothesized range and out the recommended manual of fixed Prosthodontics but still acceptable clinically.
2- Converges angles degrees registered by general practitioners in Dammam were close to the recommended degrees.
3- The mesiodistal converge angles were less than the buccolingual converges degree.
4- The majority of the prepared casts showed adequate structural durability requirements in relation to planar occlusal reduction, functional cusp bevel and the presence of

rounded angles in most of their preparations.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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