Evaluation of Tooth Preparation by Dental Students in Jazan University during Pre-Clinical Training

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Abstract

Purpose: Accurate preclinical prosthodontic training is an integral part of the curriculum and the students should be regularly monitored for the retention and resistance form, structural durability and the planar reduction when crown preparations are done. The objectives of this study were to evaluate cast metal preparations carried out by 4th year dental students at College of Dentistry, Jazan University and to compare the degree of taper, presences of planner occlusal reduction, functional cusp bevel and round line angles between male and female groups.

Materials and methods: A total of 89 preparations for cast metal crown (43 male, 46 female) on ivory teeth were collected from the 4th year dental students as a final requirement of the preclinical course. All the teeth were mounted on the typodont with the occlusal plane of the prepared teeth parallel to the floor. Photographs of axial, buccal, and lingual aspects were taken for each tooth. The photographs were transferred into a personal computer, an AutoCAD software program was used to measure the mesio-distal and bucco-lingual degree of taper for each preparation. Analysis of Variance (ANOVA) was used to test the level of significance difference which was set at 5%.

Results: The mean MD and BL degrees of taper were 19.52 and 23.25 (Male) 19.77 and 22.38 (Female) degrees respectively. Significant difference was found between males and females. The male/female ratios were 100/76 and 88/80 and 86/96 % for planar occlusal reduction, functional cusp bevel and rounded angles respectively.

Conclusions: The degrees of taper were slightly higher than that mentioned by literature, but considered clinically acceptable. However, planar occlusal reduction and functional cusp bevels carried by female group were more comparing with the male groups which were clinically inadequate to provide enough structural durability. Rounded angles were present more in male group.

Key Words: Taper, Metal Crown Preparation, Pre-clinical training

Introduction

Complete cast metal crowns are commonly recommended for restoration of extensively damaged posterior teeth. The ability of dentist to adequately prepare teeth is fundamental to the success of these restorations [1-4]. The British Society for Restorative Dentistry (1999) has outlined the principal considerations in tooth preparation as follows: Conservation of tooth tissue, Control of the path of insertion, Optimum retention and resistance form, Appropriate clearance in occlusion and articulation, and the removal of adequate tooth tissue to allow the manufacture of restorations with appropriate cosmetic results without the over-contouring of the finished restoration [5].

One of the fundamental principles of tooth preparation is the retention and resistance form. Retention features prevent the dislodgment of the prosthesis along the path of insertion whereas resistance features prevent prosthesis dislodgment when oblique, non-axial forces act on the tooth [1].

Taper is defined in ISO 1119: 1998(E) Geometrical Product Specifications (GPS)- Series of conical tapers and taper angles; as ratio of the difference between the diameters of two sections to the distance between these sections [6]. The angle formed between opposing walls of the tooth preparation is called taper angle [7]. Retention of castings decreases with increasing taper and has been shown to be inversely proportional to taper angle [8]. The ideal taper recommended by fixed Prosthodontics textbooks and different dental schools is 2◦ to 7◦ per axial wall or 4◦ to 14◦ total convergence angle [1-4].

A new technological method is using the Auto-CAD software to measure the taper angle, which is reliable and with a high degree of accuracy that can be used as educational tool for clinical assessment [9].

One of the problems most frequently encountered with preparation of teeth for cast metal crown is lack of improper occlusal reduction [10]. The structural durability of the restoration is improved by creating planar occlusal reduction, functional cusp bevel and rounded angles. This way bulk of the restorative material is adequately fortified to withstand forces of occlusion [1,2].

The preparation of cast metal crowns is a common procedure in general dental practice. Therefore, it is essential that dental students develop optimum skills and expertise during the training period [11]. The assessment of skills developed by students is important to educators as it is worth noting the effectiveness of their teaching strategies [12]. It is necessary to investigate the outcomes of teaching not only as part of curriculum development and ongoing quality audit, but also to examine the competency of graduates [13]. Such an indicator can show whether the students are at par with their peers. There is a low correlation between preclinical laboratory performance on typodont and clinical performance by dental students involving the preparation of full metal crowns [14].

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The objective of this study was to evaluate the quality of tooth preparation carried out by 4th year dental students at College of Dentistry, Jazan University. The study mainly focused on auditing the following aspects of tooth preparation:

1. Measure and compare the achieved mesio-distally, bucco-lingual degrees of taper between male and female group with respect to its theoretical guidelines and other schools all around the world.

2. Evaluate and compare the quality of occlusal preparation by evaluating the presence of planar occlusal reduction, the functional cusp bevel and rounded line angles.

Materials and Methods

This cross-sectional study was conducted at Department of Prosthodontics, College of Dentistry, Jazan University. A total of 89 ivory teeth were prepared for complete cast metal crown by the 4th year preclinical dental students under examination condition (43 samples from male and 46 samples from female students). The preparations on ivory teeth (Frasaco teaching and demonstrations teeth AnA-4 ZE100, Verkaufs partner/agent, GMBH, Post fach 1244, 88061 Teltnag/ Germany) were done for complete cast metal crown in tooth # 47. All the models were mounted on the phantom heads during the tooth preparations. In our college of dentistry, the first pre-clinical course consists of preparations for cast metal, porcelain fused to metal and all ceramic crowns.

No special instructions were given to the students or instructors that we are going to use these preparations for subjective evaluations (degree of taper and structural durability). All the prepared ivory teeth were mounted in the Frasaco typodont model (Frasaco An-4 Puk, Pok) (*Figure 1*) on a table. Each prepared tooth was placed at 25 cm distance away from the camera and with position of the occlusal surface parallel to the top of the table. All the adjacent teeth were removed from the typodont to facilitate the photographs from different surfaces. A digital camera (Cyber-shot® S750 Digital Camera DSCS750, Sony, Japan) with 12.1 mega pixel 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.

For each tooth in the typodont two different photographs from buccal and axial or proximal views were taken (*Figure 2*). Single trained investigator took photographs of the typodont models with prepared ivory tooth. The photographs were transferred into a personal computer and AutoCAD 2007 software program (Sony Corporation, Tokyo, Japan) was used to measure the mesio-distal and bucco-lingual degrees of tapers for each prepared tooth. The method of measurement used for this study was used in the study conducted by Dorriz et al. 2008 [15] and Al Ali et al. 2009 [16]

For each photograph, lines were drawn over the right and left contours of the axial walls of the die, mid-mesial and mid-distal for the buccal view or mid-buccal and mid-lingual of the proximal view. The lines were 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 angle created by the two lines (the line parallel to the long axis of the tooth and the line parallel to the axial walls) was measured to determine the taper or axial angle of this side mesio-distally and bucco-lingually respectively (*Figure 2*).

The data consisting of the degree of taper was recorded. The findings were statistically analyzed by comparing the means using a paired *t*-test. Finally one way analysis of variance was conducted. All the analyses were done using SPSS software package version 20 (SPSS, Chicago, IL, USA) and a p-value of 0.05 was considered to be statistically significant.

The presence or absence of planar occlusal reduction, functional cusp bevel and rounded line angles were recorded also. The measurements in this cross sectional study were evaluated as mentioned in the recommended textbook [1-4] (*Figure 3a and 3b*). Single investigator carried out the two measurements for each tooth and the mean was recorded for each, respectively.

Results

From *Table 1*, it is clear that the difference in mean was statistically significant with Mesio - Distal degrees of taper angles (P<0.05) and also with Bucco-Lingual degrees of taper angle (P<0.05).The values obtained for mesial and distal degree of taper by the males and females were almost identical, though the males achieved better results. A Paired *t* - test was conducted and it showed a significant gender association (P<0.05) with Mesio-distal, Bucco-Lingual degree of taper angle values.

Table 2 shows the percentage difference which suggested that males had 46.5% and 18.6% of them falling in normal range [4-14] and females had 23.9% and 13.04% falling in the normal range for the mesio-distal and bucco-lingual degree of taper respectively.
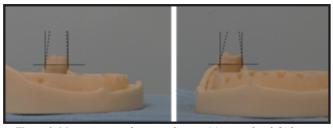

Figure 2. Measurements of taper in degrees (a) mesio distal (b) bucco-lingual.

Figure 3a. Occlusal view after preparation; 3b: Maximum inter-cuspation showed inter-occlusal clearance.

Figure 1. Occlusal view of the typodont with ivory teeth.

Table 1. Means ± Standard Deviations for Mesio-Distal and Bucco-lingual angles.

	Mesial	**Distal**	***M-D**	**Buccal**	**Lingual**	***B-L**
Male	11.44 ± 6.44	7.54 ± 3.81	18.98 ± 1.9	19.46 ± 4.84	3.32± 2.67	22.78 ± 5.41
Female	10.80 ± 4.34	9.59 ± 20.43	20.43 ± 6.23	20.35 ± 3.21	2.63 ± 0.90	22.88 ± 4.31
Total	11.12 ± 5.44	8.60 ± 4.01	19.73 ± 7.84	19.87 ± 4.07	2.96 ± 1.98	22.83 ± 4.31

Table 2. Percentage value of taper falling in the recommended range*

	Mesio Distal %	**Bucco Lingual %**
Male	46.5%	18.60 %
Female	23.9%	13.04 %
Total	35.1%	15.70 %

Table 3.Means and standard deviations for mesio – distal and bucco - lingual tapers created by dental students of different universities in comparison to the jazan university.

Students and University	Year of Study	* (M-D) Mean ± standard deviation	* (B–L) Mean ± standard deviation
King Abdul Aziz University dental students (KSA)	2004	14.1 ± 3.80	15.6 ± 4.80
Tanta University dental students (Egypt)	2004	19.4 ± 9.10	19.8 ± 10.00
The Ohio State University dental students (USA)	2004	15.2 ± 4.6 0	17.3 ± 5.90
University of Science and technology, Irbid (Jordan)	2004	25.3	22.4
Tohoku University Graduate School of Dentistry (Japan)	2005	10.4 ± 6.5	17.1 ± 9.6
Tehran University of Medical Science (Iran)	2008	28.81 ± 11.18	17.20 ± 8.37
West Indies University (USA)	2010	14.2◦ - 5.0◦	18.2◦ - 7.1◦
Cork University Dental School and Hospital (Ireland)	2013	19.89 ± 10.48	17.73 ± 2.84
Governmental and Private School (Sudan)	2014	38.96 (11.7)	42.3 (10.8)
Jazan University, Dental Students (KSA)	2014	19.73 ± 7.84	22.83 ± 4.30

The graph or *Figure 4*, comparing the values of males and females suggested that the planar reduction was 100% for males and it was 76% for females. The functional cusp bevel between the males and females values did not show much difference with males obtaining 88% and females obtaining 80% respectively. While the females had a higher percentage in the round angle value when compared to the males, the value obtained was 96% for females when compared to 86% of males.

Discussion

Current literature is available on preparing teeth for crowns which identifies desirable or ideal parameters with respect to tooth reduction. This often differs with what is actually achieved in preclinical practice. This could be related to multiple factors including stress during graduation requirements, instructor's evaluation methods or student experience. Objective evaluation should be inclusive including quantitive evaluation of parameter-volume of occlusal reduction, margin shape and surface smoothness [17].

Several techniques have been described for evaluating CAs of preparations. Devices such as photocopy machines [18], overhead projectors [19], goniometric microscopes [20], three-dimensional laser scanners [17], diamond rotary cutting instruments [21] and metrology equipment [11] have been used to measure the CA of working dies. In our study we used the Auto-CAD software for the evaluation of the photographs which have been previously used by Dorriz et al. 2008 [15] and Al Ali et al. 2009 [16].

Results from *Table 2* have shown that the percentage of the preparations which is in the ideal range of 4-14º taper were 35.1% and 15.7% for MD and BL respectively. These results are in agreement with OW et al. [22], who has also registered 38% of his students preparing taper greater than 20º. Our finding is in contrast with Rafeek et al. [11] who have achieved 62% (MD) and 36% (BL) taper. Also El-Mubarak et al. [23] found 100% of his samples out of the ideal range

(they prepared their first clinical case), this could be due to minimal preclinical experience of the students either because of lack of proper teaching aids or supporting staff which had negative impact on the performance of the students. With the increase in taper of the preparation, retention decreases and will lead to the failure of restoration. Prosthodontics being a very practical subject, training on phantom head is of great importance.

When comparing values of taper angle in degrees between male and female (*Table 1*), it was seen that male registered lower values which is close to recommended values. Whereas values recorded by females were considered in the clinically acceptable range, as they are in the process of gaining experience and will continue in the following upcoming semesters. When compared buccolingually, lowest taper values were recorded on the lingual side in both males and females, 3.32 ± 2.67 and 2.63 ± 0.90 degrees respectively, whereas buccally it was found to be highest in males and female 19.46 ± 4.84 and 20.3.5 ± 3.21 respectively. This could be explained on the basis of anatomy of the typhodont and slight buccal inclination which is seen in *Figure 1*. This is in accordance with Wo et al. [22] and Ayad et al. [20] when comparing mesiodistal values and Rafeek et al. [11] al-Omari and Al-Wahdani, [24] Wo et al. [22] Okuyama et al. [25] when compared buccolingually.

Mean values of taper when recorded mesiodistally and buccolingually were 19.73 ± 7.84 and 22.38 ± 4.31 respectively. These values were coinciding with the finding of Dorriz et al. [15] Wo et al. [22] Ayad et al. [20] and Al-Omari and Al-Wahdani, [24] as showed in *Table 3*.

When compared our results with Al-Mubarak et al. [23], taper values were in accordance buccolingually but not mesiodistally and it can be attributed to the lingual inclination of the lingual cusps, as well as the convexity of the buccal surfaces of the typhodont used in our study.

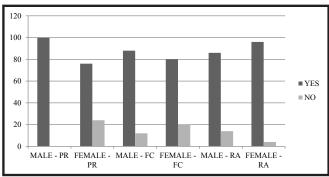However, values deferred in BL and MD taper when compared to Rafeek et al. [11] and Poon and Smales [26]

Figure 4. Planar Reduction (PR), Functional Cusp bevel (FC) and Round line Angle (RA) - A comparison between the male and female students.

who registered much higher values then recommended. Taper values registered in our institution were considered clinically acceptable as compared to the values of other schools and colleges of Jordan, USA, Saudi Arabia, Egypt, Ireland and Iran (*Table 3*).

One of the major factors of fixed partial denture failures is the lack of structural durability. According to *Figure 4*, males were slightly better as compared to female regarding planar reduction, presence of functional cusp bevel and rounded angles. Even though the concepts of tooth preparation in preclinical prosthodontics is fresh in the students mind but still they performed better and the overall preparation was adequate to gain sufficient or ideal amount of structural durability for metal crown. When compared for functional cusp bevels and rounded angles, males and females were having almost equal percentages, however males showed higher percentage for the occlusal planner reduction. Our

findings were similar with Poon and Smales [26] when considered for the presence of insufficient planar occlusal reduction and functional cusp bevel however it was not in accordance with Wo et al. [22], El-Mubarak et al. [23] and Al-Omari and Al-Wahdani [24] who found adequate amount of structural durability in their preparations and this can be attributed to the use of different types of typhodont used in each school. For rounded line angles in the preparations for full metal crown, our results coincided with the findings of Esser et al. [17] and Al-Mubarak et al. [23]. Overall we agreed with Al Ali et al. [16] in that the visual evaluation of the occlusal reduction is insufficient for adequate structural durability.

Conclusion

Within the limitations of this study, the following conclusions were drawn:

- The taper achieved by dental students of the college of dentistry, University of Jazan when preparing teeth for cast metal crowns was outside the ideal range of 4to 14 degrees but considered as clinically acceptable.
- When compared in both males and females the taper on the buccal side was more as compared to the lingual side which was within the normal range.
- Taper was more on the mesial side as compared to the distal side in both the males and the females group.
- It showed that students understood the principles of crown preparation but still require more practical sessions in order to master the art of tooth preparation.

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