The quality assessment of teeth prepared by fresh graduates for ceramo-metal full coverage crowns

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Received 28 December 2014; revised 28 January 2015; accepted 29 January 2015

1. Introduction

It is essential that dental graduates develop optimum skills and expertise while undergoing training under supervision. Assessing the level of skills imparted to graduates is important to educators as it is worth noting the effectiveness of their teaching strategies. 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. Likewise, the identification of areas of curricular concern from trainees’ perspective provides curriculum managers with indicators for program improvement. The American Dental Education Association obtains opinions about curricular content from graduating dentists regularly. The preparation of ceramo-metal crowns (CMC) is a common procedure in general dental practice. At King Khalid University–College of Dentistry (KKU/COD), as part of graduation competency students are required to complete pre-clinical preparation of ceramo-metal, full metal and all ceramic crowns for anterior and posterior teeth. In addition, clinical teeth preparation for ceramo-metal and all ceramic crowns for anterior and posterior teeth are routine procedures. Post and core is also part of the graduate requirements. The ability to adequately prepare teeth is considered fundamental to the prognosis of extensively damaged and restored teeth. Ample reduction allows fabrication of restoration with appropriate cosmetic results without over-contouring. Emphasis is laid on buccal and occlusal reductions, sufficient to enhance the function and appearance of the finished restoration. One of the problems most frequently encountered with preparation of teeth for ceramo-metal crown is lack of improper occlusal reduction. 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.

This study was aimed at assessing the quality of tooth preparation carried out by graduating dentists (Interns) and their opinion regarding the difficulties encountered while preparing teeth for CMC. It mainly focused on auditing the following important areas of teeth preparation carried out by graduating dentists.

1. Amount of buccolingual (BL) and mesiodistal (MD) reductions of posterior teeth that received CMC.
2. The quality of occlusal preparation by evaluating the presence of planar occlusal reduction, rounded angles and the functional cusp bevel.
3. Opinion regarding the difficulties encountered while preparing natural posterior teeth for CMC.

2. Material and methods

This retrospective study included the audit of ceramo-metal work and questionnaire survey of graduating dentists at KKU/COD. KKU/COD Internship Program Committee approval was taken for conducting the study. A self-administered questionnaire was prepared to explore key areas of CMC training and difficulties for tooth preparation. Seventy eight out of eighty four (93% response rate) graduating dentists responded to the questionnaire. The obtained dichotomous data were analyzed in percentage and frequency values using Microsoft Excel 2013 software (USA).

Two hundred dental casts with dies that received CMC between August 2012 and April 2013 were randomly collected from the Prosthodontics Production Laboratory at KKU/COD. From among these, 112 maxillary and mandibular casts were included in the study that had sound natural antimere teeth without any restoration or damage to the crown. An antimere was defined as the bilateral tooth on the other half of the same arch of the prepared tooth. Anterior teeth were excluded from the study because of a significant deficiency in the numbers of mandibular anterior teeth prepared during the study period. Each trimmed die and the antimere tooth was evaluated for BL and MD diameters in millimeters. The BL and MD diameters of the antimere (BLA and MDA) were considered as the greatest distance between the buccal–lingual and mesial–distal surfaces of the crown respectively (Figs. 1a and b). The BL and MD diameters of the die (BLD and MDD) were considered as the maximum distance between the buccal–lingual and mesial–distal surfaces of the prepared crown respectively (Figs. 2a and b). The measurements were made with digital calipers (Derby, France) held perpendicular to the occlusal plane and in line with the long axis of the tooth. Single investigator carried out each measurement thrice and the mean was recorded to minimize human error. Calibration for zero was checked after each reading. The amount of BL and MD reductions in the measured dies was calculated as follows:

Amount of BL reduction (BLR) = BLA – BLD (Figs. 1a and 2a)
Amount of MD reduction (MDR) = MDA – MDD (Figs. 1b and 2b)

The mean BLR and MDR values were statistically compared with hypothetically calculated ideal reduction (HCIR) values for this audit. HCIR was formulated by combining the desired, ideal buccal and lingual reduction values. Similarly, HCIR from MD perspective was formulated by combining the ideal mesial and distal reduction values. The data obtained were analyzed by unpaired t-test using SPSS Version 21 statistical software. The level of significance was set at 5%.

Figure 1 (a) Bucco–lingual diameter of antimere tooth (BLA) and (b) Mesio–distal diameter of antimere tooth (MDA).
HCIR from BL perspective = 1.9–2.4 mm, Mean = 2.15 mm (±0.25)
HCIR from MD perspective = 2.0–2.4 mm, Mean = 2.2 mm (±0.2)

In addition, the presence of planar occlusal reduction, rounded angles and the functional cusp bevel were also recorded.

3. Results

The average BLR and MDR of all the prepared crowns evaluated in this study were 2.05 mm (±0.84, Table 1) and 2.33 mm (±0.79, Table 2) respectively. These values were within the hypothetically calculated ideal range and the statistical comparison was insignificant (p > 0.05, Tables 1 and 2). However, the average BLR of maxillary posterior teeth was less than the HCIR (Table 1). This resulted in a statistically significant difference (p < 0.05, Table 1) of BLR between maxillary and mandibular prepared crowns. Contrary to this, an insignificant difference of MDR between maxillary and mandibular teeth was observed (Table 2). Comparison of BLR and MDR between premolar and molar dies was also insignificant (p > 0.05, Tables 1 and 2). Fig. 5 illustrates, only one third (33.93%) of the studied dies had adequate planar occlusal reduction. Six out of ten (60.71%) dies showed proper functional cusp bevel. 63.39% of the dies had rounded cusp preparation.

Responses to the questionnaire survey are illustrated in Figs. 3 and 4. Majority of the graduating dentists considered facial and lingual reductions of teeth to be easy. However, they reported difficulty in preparing the occlusal surface for CMC. Compared to mandibular teeth reduction, the respondents felt maxillary teeth reduction to be difficult.
Fresh graduates’ perspectives about their clinical training can be a major influence on the continuous improvement of the dental curriculum. Many investigators have evaluated the areas of strengths and weaknesses of the curriculum, as perceived by graduating dentists.17-19 Majority of the KKU/COD graduates (Interns) considered facial (93.59%) and lingual (88.46%) tooth reductions for CMC work to be easy (Fig. 3). However, 40% deemed occlusion reduction to be difficult. This was reflected in their work, where 66% were unable to perform planar occlusal reduction (Fig. 5). A contrasting difference of opinion was observed between maxillary and mandibular teeth reductions. 41.03% of the respondents considered the reduction of maxillary teeth difficult while only 10.26% reported difficulty in reducing mandibular teeth. This was evident in the BLR values of their work (Table 1) in maxillary and mandibular teeth, where the mean BLR reduction was less than desired. Almost two thirds of the fresh graduates reported difficulty in preparing natural teeth after being trained on phantom teeth in the students’ laboratory.

The best time to inculcate good-practice in students is when they are working under supervision. Visual and tactile perceptions are essential skills that should be honed during training period. While preparing teeth, the operator does not always have the luxury of pre and post measurement values of the teeth and it is believed that clinicians overestimate tooth reduction.20 Dunne21 reported interesting observations regarding the visual perception of size and distance of teeth by students. In his study, majority of the students overestimated size. The HCIR values used in this study were a novel criterion unknown in previous literature. Calculation of amount of ideal tooth reduction can get complex relative to the tooth and the site at which it is estimated, hence, considering a range of values can minimize any error. BL and MD reductions performed by the graduates in the study sample were well within the hypothetically calculated range and valid statistically. The average reduction was however, closer to the upper limit of the range (Tables 1 and 2). BL reductions of maxillary teeth were less than HCIR (Table 1). This was in complete contrast with the findings of Alhouri13 where BL reduction exceeded the normal limit.

The general principles of tooth preparation must be frequently reminded during pre-clinical and clinical training sessions.22 Results of this study coincide with the findings of Tarib and Ahmed2 regarding fulfilling the principles of tooth preparation. Acceptable tooth preparation involves conservative reduction, smooth surfaces without sharp angles. Unnecessary tooth removal is equally undesirable as under preparation. Training experience gathered over the years tells that majority of students master tooth reduction relatively faster than creating the intricacies of tooth morphology. Structural durability of a restoration is achieved, at least in part, by creating planar occlusal reduction, functional cusp bevels and rounded preparation angles. Deficiency in duplicating the basic inclined plane pattern of the occlusal surface was observed in our study. Poon and Smale23 reported similar results where cuspal and central fossa reduction was insufficient for CMC preparations. This can decrease the retention capacity while rendering the restoration weak. Inappropriate functional morphology results in perforation during finishing or wear in the patients’ mouth.

The absence of functional cusp bevel results in a thin crown, a defective occlusal contact, and overall reduction in the retention of the final restoration.11,12 The fresh graduates did well in this area of tooth preparation – 60.71% adequately prepared beveled functional cusps. This was in agreement with the findings of Tarib and Ahmed.7 Rounded edges of the preparation avoid generation of stress in the final restoration, which could otherwise lead to fracture of the porcelain portion.24,25 Satisfactory result was displayed in this area of tooth preparation which was in agreement with the results of Al-Omari and Al-Wahadni26 and Esser et al.21 Most of the preparations involved in this study were by-and-large acceptable. This expounds the importance of correct understanding of the principles of tooth preparation and its application for structural durability of the ceramo-metal restorations.

5. Conclusion

From this retrospective study, the following conclusions and suggestions are made:

- The overall quality of tooth preparation evaluated for ceramo-metal crown in this study was satisfactory.
- Teaching strategies for tooth reduction in maxillary posterior teeth may be reviewed and amended to achieve better buccolingual results.
- Greater emphasis warranted for occlusal reduction during training.
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- The process of auditing students/graduates work should be made continuous to assess the effectiveness of the teaching strategies.
- Use of intra-oral 3D scanners to assist in evaluating occlusal reductions before finalizing preparations should be evaluated.

Conflict of interest

No potential conflict of interest relevant to this article is reported.

Acknowledgements

We would like to thank the Department of Dental Education and Internship Program Committee of King Khalid University College of Dentistry as much as the Intern dentists who took part in the study.

References