



Evaluation of undergraduate dental students in typodont preparation for all-ceramic crowns

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Abstract:

Background: All-ceramic crown (ACC) preparations are widely used in day-to-day dental clinical practice. **Objectives:** This study aimed to evaluate all-ceramic crown preparations performed by pre-clinical dental students at the College of Dentistry, Jazan University in Saudi Arabia and to compare the quality of the preparations between male and female groups. **Materials and Methods:** A total of 95 ivory teeth were prepared by fourth-year dental students (44 males, 51 females). The students prepared a maxillary right central incisor for ACC after mounting in the Frasco typodont arches. Two silicone putty indexes for maxillary anterior were obtained that extended to cover one or two teeth on either side. The facial index was used to provide information about the facial reduction mesio-distally. Another index was prepared by cutting the silicone in half along the faciolingual midline of the prepared tooth, providing us with incisal, buccal, palatal, and axial reductions, in addition to biplane reduction. The data were encoded into a Statistical Package for Social Sciences program and analyzed accordingly using Chi-square test. **Results:** The preparations of ACC for maxillary anterior teeth were acceptable, ranging within 60%-85% in all criteria, which included structural durability, retention, and resistance. The male group was more excellent in incisal reduction (41.0%), whereas the female group was more excellent in axial taper preparations (59.1%), resulting in significant differences between genders in this preparation criteria. All gender groups showed acceptable tooth preparations in shoulder reductions and location of finish lines, ranging within 57%-89%. **Conclusion:** The preparations for ACC achieved by these dental students were considered clinically acceptable. The students clearly understood the principles of crown preparation. However, they still require more practice in order to master the art of crown preparation.

Key words: Ceramic crowns, maxillary, pre-clinical, cingulum, typodont

Introduction:

In recent decades, all-ceramic crowns (ACC) preparations are common and widely used in day-to-day dental clinical practice. Therefore, dentistry graduates should develop optimum skills and expertise during the pre-clinical training and learning period.¹ The fundamental principles of tooth preparations are the retention and resistance form, structural durability, marginal integrity, and preservation of the periodontium.²

The structural durability of the anterior ACC is improved by making two labial planar reductions, palatal concave cingulum, vertical axial reduction, sufficient incisal reduction and rounded angles. This feature makes the bulk of the restorative material to adequately withstand forces from occlusion and during mastication.²⁻⁵ In addition, axial tapers and total convergence angles are important factors influencing the retention and resistance of any restoration.²⁻⁵

The prepared finish line dictates the shape and bulk of restorative material in the

margin of the restoration. Whenever possible, the finish line preparation must be located supragingivally to be easily prepared by the dentist, duplicated by the final impression, and easily cleaned by the patient. All of these factors are responsible for the preservation of the periodontium.²⁻⁵

Problems most frequently encountered in the preparation of teeth for ACCs are the lack of biplane reduction in either labial and palatal surfaces, insufficient incisal or axial walls reduction, indistinct margins, excess gingival extension, and presence of sharp angles on the preparation.⁶

Several studies evaluated the student preparation according to the following aspects: axial taper quality, finish line location and configuration, biplane reduction and rounded line angles. The quality of the axial taper was slightly higher than that in a previous study but was still considered clinically acceptable.⁷⁻⁹

The number of rounded line angles was greater in the male group than in the female group, but the planar reduction performed by the female group was better than that performed by the male group, indicating clinical inadequacy in providing enough structural durability.⁷ Axial preparations were acceptable when compared with the ideal and with smooth and continuous finishing lines, although discontinuity was common. In general, preparations were smooth with no irregularities or sharp angles.^{8,9}

Pre-clinical laboratory performance on the typodont with ivory teeth had a strong correlation with the clinical performance by dental students in the preparation of anterior ACCs.¹ Therefore, adequate pre-clinical prosthodontic training is an integral part of the curriculum, and the teaching staff should regularly monitor the students during pre-clinical training courses. This study aimed to evaluate the quality of tooth preparation for ACC on maxillary anterior tooth performed by the pre-clinical dental undergraduate students during their pre-clinical training. In

addition, we compared the quality of preparation between male and female students.

Materials and Methods:

This study was conducted at the Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University in Saudi Arabia. It was established or started after the approval of the Ethics Committee in the college.

No special instructions were given to individual students. The students were not informed that these prepared teeth are going to be used in the future for evaluations other than the regular evaluation by the instructors supervising the students.

A total of 95 ivory teeth (Frasaco Teaching and Demonstration teeth AnA-4 ZE100, Verkaufs partner/agent, GMBH, Post fach 1244, 88061 Teltnag/Germany) were prepared by fourth-year pre-clinical dentistry students (44 males, 51 females) during their pre-clinical training course. They prepared a maxillary right central incisor for ACCs during the 2015/2016 academic year. All the prepared ivory teeth were mounted in the Frasaco typodont arches and then mounted in the Frasaco head (Frasaco An-4 Puk, Pok).

Two silicone putty indexes for unprepared maxillary typodont ivory teeth were obtained to judge the amount of tooth reduction. The silicon putty base and catalyst were mixed and adapted over the facial and lingual surfaces of intact teeth. The putty was extended to cover one or two teeth on either side of the tooth to be prepared. The facial index was prepared by sectioning the adapted putty along the incisal edges of the tooth imprints. These indexes provided information about the facial reduction mesio-distally (**Figure I**). Another mid-sagittal index was prepared by cutting the silicone in half along the faciolingual midline of the tooth to be prepared. This index provided information

Table I: Assessment criteria for all-ceramic crown preparations

Parameter/Criteria	Excellent	Satisfactory	Unacceptable
Incisal reduction	1.5 mm of clearance in maximum intercuspal position and all excursions	Underprepared, less than the recommended but can be corrected	Over-reduction, more than the recommended and cannot be corrected
Facial reduction	1.2 mm of uniform reduction is achieved	Less than 1.2 mm reduction but can be corrected	Over-reduction and non-planar reduction, which cannot be corrected
Biplane labial reduction	Apparent incisal and gingival reductions	Sufficient amount of labial reduction	One plane was either gingival or incisal
Cingulum reduction	1 mm of reduction present, following cingulum concavity	Less than 1 mm reduction, preparation not following the cingulum concavity but can be corrected	Absence of reduction or over-reduction than cannot be corrected
Axial taper reduction	Parallel axial wall with minimal taper	Slightly overtapering of walls	Presence of undercut
Rounded line angles	All line angles are rounded and smooth	Slightly rounded angles or presence of sharp angles	Overall rough preparation with apparent sharp line angles
Shoulder reduction	Rounded shoulder at least 1 mm wide	Presence of reduction but less than 1 mm deep	Absence of reduction
Location of finish line	Finish line at gingival margin, clear, smooth, and continuous.	Slightly sub- or supra-gingival, clear, smooth, and continuous finish line	Clearly supragingival or deep subgingival, unclear, irregular, not continuous finish line

Figure I: Index for evaluating the preparation mesio-distally**Figure II:** Index during evaluating the incisal, buccal, palatal, and biplane reduction

about the reduction along the midline of the prepared tooth, including the incisal, buccal, palatal and interproximal reductions, in addition to biplane reduction (**Figure II**).

The prepared typodont ivory teeth were collected and the preparations were analyzed. The qualities of the prepared teeth were compared between male and female students. Teeth that fractured or had chipped surfaces after the preparation were excluded from the samples. The prepared teeth were evaluated for structural durability, retention, and resistance, which included incisal reduction, facial reduction, labial two plane reduction, lingual concave cingulum reduction, adequate axial taper and rounded line angles. The criteria also included the preservation of the

periodontium and marginal integrity (location of finish line in relation to free gingival margin and shoulder finish line configuration (**Table I**). The prepared teeth were evaluated by a single investigator by using hand instruments along with visual examination.

The data were recorded and summarized as frequencies and percentages. Associations with gender and assessment criteria for ACC were tested with Chi-square. Statistical significance was considered at $P < 0.05$. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software (version 20.1 SPSS, Chicago, Illinois, USA).

Table II: Results of structural durability, retention, and resistance

Parameter / Gender	Excellent		Satisfactory		Unacceptable		Total		'P' value
	N	%	N	%	N	%			
Incisal reduction									0.000 *
Male	18	41.0	13	29.5	13	29.5	44	100	
Female	4	7.8	43	84.4	4	7.8	51	100	
Facial reduction									0.109
Male	10	22.7	29	65.9	5	11.4	44	100	
Female	4	7.9	38	74.5	9	17.6	51	100	
Biplane labial reduction									0.605
Male	6	13.6	29	65.9	9	20.5	44	100	
Female	6	11.8	30	58.8	15	29.4	51	100	
Cingulum reduction									0.257
Male	1	2.3	31	70.5	12	27.2	44	100	
Female	5	9.8	36	70.6	10	19.6	51	100	
Axial taper preparation									0.000 *
Male	26	59.1	3	6.8	15	34.1	44	100	
Female	4	7.8	29	56.9	18	35.3	51	100	
Rounded line angle									0.773
Male	6	13.6	31	70.5	7	15.9	44	100	
Female	7	13.7	33	64.7	11	21.6	51	100	

*Significant differences

Table III: Results of preservation of the periodontium and marginal integrity

Parameter / Gender	Excellent		Satisfactory		Unacceptable		Total		'P' value
	N	%	N	%	N	%	N	%	
Shoulder reduction									0.938
Male	2	4.6	39	88.6	3	6.8	44	100	
Female	3	5.9	44	86.3	4	7.8	51	100	
Location of finish line									0.029
Male	0	0.0	35	79.5	9	20.5	44	100	
Females	4	7.8	29	56.9	18	35.3	51	100	

Results:

The total numbers of the prepared ivory teeth were 95, with 44 males (46.3%) and 51 females (53.7%). **Table II** shows the number and percentage of structural durability, retention and resistance distribution of the prepared teeth. In the males, the rates of incisal, facial, and axial taper reductions (41.0%, 22.7%, 59.1%) were greater than those in the females (7.8%, 7.9%, 7.8%), respectively. Meanwhile, biplane labial reduction and the presence of rounded line angles were similar between the males and females (11.8%-13.7%). Cingulum reduction was more excellent in the females (9.8%) than in the males (2.3%). Satisfactory preparations for incisal and axial taper reductions were higher in the females (84.4%, 56.9%) than in the males (29%, 6.8%), respectively. Percentages in facial, biplane labial, cingulum and rounded finish line reductions were not significantly different between the two genders. The results in the incisal and axial taper preparations were significantly different $P < .000$ between the males and females.

With regard to the preservation of the periodontium and marginal integrity, as listed in **Table III**, shoulder reductions were almost the same in excellence (4.6%, 5.9%) and satisfactory (88.6%, 86.3%) for both males and females respectively. The satisfactory location of the finish line was higher for the males (79.5%) than for the females (56.9%). while in females; it was excellent in 7.8% ($P = 0.029$). The result was

not clinically significant between genders (**Table III**).

Discussion:

Cosmetic dentistry has become increasingly demanding. Therefore, dentistry undergraduates need to be well prepared to perform proper treatment because most of the patients are concerned about aesthetics.¹⁰ Tooth preparation for all-ceramic prostheses is a common procedure that all dentists should be able to execute correctly. However, predicting a desirable result is difficult to achieve^{11,12} especially for dental students or young dentists.

Pre-clinical training in Jazan University includes the preparation of ACCs. Graduate students must be competent and confident in treating patients with ACCs. However, they need to be reminded of the importance of some steps, such as preservation of cingulum, axial, and facial reductions, which contribute to the retention and resistance aspect of the extra-coronal restoration.² The students are still in the process of learning. Hence, their skills in ACC preparation are not yet perfect. Therefore, we hypothesize that the preparations would be moderately acceptable because they considerably lack sufficient experience in ACC preparation. Overall, the ACC preparations performed by dental students from both genders were considered clinically acceptable, and some gained excellence in some criteria. This finding is consistent⁷⁻⁹ with all the criteria,

which include structural durability, retention and resistance, preservation of periodontium and marginal integrity.

Structural durability, retention, and resistance

Most of the crowns prepared by the students were acceptable, which clearly illustrates that they understood the principles of crown preparation and applied it practically while preparing the typodont teeth for ACC.

Axial taper preparations were noted to be excellent in preparations of 26 samples by males and 4 samples by females, resulting in a significant difference between genders $P < 0.000$; this finding agreed with Al Moaleem et al.⁷ The axial taper reduction created by males and females was also significantly different between genders (**Table II**), which also strongly agreed with Al Moaleem et al;¹³ even their samples were prepared by a specialist.

One of the major factors of fixed partial denture failures is the lack of structural durability. According to **Table II**, males were slightly better than females in performing planar reduction. However, males showed higher percentage for the incisal reduction. The findings of the present study were within the border of the finding of Al Moaleem et al.⁷ Moreover, the criteria of rounded line angles and satisfactory preparation in the axial taper reductions were present more in the male group than in the female group.

Our results were consistent with those achieved by Sadatullah et al¹⁴, i.e., the amount of tooth reduction performed by the intern dentists for ceramo-metal crowns was within normal range. In another study conducted by Al Moaleem et al,¹⁵ majority of the prepared casts showed adequate structural durability requirements in relation to planar occlusal reduction in the presence of rounded line angles in most of their preparations. This result is also consistent with our finding.

Preservation of the periodontium and marginal integrity

The ideal location of the margin should be supragingival or at the gingival margin, which would prevent any plaque accumulation as oral hygiene is easy to maintain. This location would also contribute to the maintenance of the periodontium and preservation of biological width.^{16,17} This result is consistent with the finding among students in the Faculty of Dentistry, Universiti Kebangsaan in Malaysia, and College of Dentistry in Khartoum University.^{8,9}

One of the limitations of this study is the use of traditional equipment to evaluate their preparation. We have to use the 3D programs or new machines, such as CAD/CAM. We recommend evaluating the preparation of the same students in the coming clinical courses.

Conclusion:

Within the limitations of this cross-sectional study, many conclusions can be drawn. The performances of students in the preparation of all-ceramic maxillary anterior restoration were acceptable, ranging within 60%-85% in all criteria of structural durability, retention, and resistance. The male group was more excellent with regard to incisal reduction (41.0%), whereas the female group was more excellent in axial taper preparations (59.1%), resulting in significant differences between genders in these preparation criteria. All gender groups showed satisfactory tooth preparations in shoulder reductions and location of finish lines, ranging within 57%-89%. Overall, the ACC preparations achieved by the participating dental students were considered clinically acceptable, showing that the students clearly understood the principles of crown preparation. However, they still require practice in order to master the art of tooth preparation.

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