

Assessment of Posterior Teeth Preparations for Metal-Ceramic Crowns

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ABSTRACT

Objectives: To evaluate teeth preparation designs for metal-ceramic crowns in private dental practice in Jordan. *Materials and methods:* One-hundred and seventy two dies were included. Different aspects of tooth preparations were quantified, analyzed and compared with the recommended guidelines. *Results:* Almost 64% of preparations finish lines were positioned subgingivally. Shoulder finish lines were observed in 74.4% whereas 22.7% showed chamfer finish lines. Total occlusal convergence angles were 29.8° in BL plane, 24.7° in MD plane. *Conclusions:* Dental practitioners in private practice in Jordan did not fully adhere to the recommended guidelines for tooth preparations for MCRs.

INTRODUCTION

Metal-ceramic restorations (MCRs) have been considered the “gold standard” in modern prosthetic dentistry because of their excellent mechanical properties, acceptable degree of esthetic outcomes, satisfactory marginal fit and internal adaptation, in addition to long-term scientific evidence of clinical success.¹⁻⁶

Several studies showed that MCRs are more resistant to fracture than all-ceramic ones.⁷⁻⁹ A 5-year survival rate of 94.4% was reported for all metal-ceramic bridges compared to a 5-year survival rate of 88.6% for all-ceramic bridges.⁵ A success rate of 71% was reported for metal-ceramic fixed partial dentures after 18 years of use,¹⁰ and a 5-year survival rate of 95.6% for metal-ceramic crowns.⁴

As the MCR is a combination of metal and ceramic, it is mandatory that adequate, anatomical reduction is essential to create enough space for both materials. Without this space for a sufficient thickness of the materials, the restoration would be poorly contoured with unacceptable esthetic results and could adversely affect the periodontium. However, over reduction can endanger the pulp and may lead to loss of pulp vitality.¹⁰

Recommendations and guidelines of the desirable values of different aspects of tooth preparations for different types of indirect restorations have been proposed aiming to develop restorations that are functionally durable, provide acceptable esthetic results, and to support a healthy periodontium.¹¹⁻¹³

For MCRs with porcelain veneered margins and occlusal surfaces, the recommended reduction of the axial surface is from 1.0-1.7 mm and is 2.0 - 2.5 mm for the incisal/occlusal surface. A number of different types of finish lines have been advocated; these include: chamfer, beveled chamfer, shoulder and beveled shoulder. The recommended finish line depth is from 1.0 - 1.5 mm. Supragingival finish lines on sound dental tissue should

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always be adopted for MCRs if the preparation requirements, esthetic and retention needs permit. Unfortunately subgingival margins are needed in some clinical cases such as with short clinical crowns, discolored teeth, and for removal of subgingival caries or restorations.¹¹

Recommended total occlusal convergence (TOC) angle for MCRs ranged from 4-14 degrees. These recommendations are theoretical and appear difficult to achieve in clinical practice.¹¹ Realistic published recommended TOC tapers are 16 degrees,¹² 10-22 degrees¹¹ and 10-20 degrees.¹³

Auxiliary retentive features such as grooves, boxes, occlusal cavities and pin holes are included in teeth preparations for metal and MCRs. They are used mainly to improve the retention and resistance to dislodgement of preparations for teeth that are short or have inadequate resistance form.¹⁴

Occlusal reduction for posterior teeth should have a functional cusp bevel by placing a wide bevel on the functional cusps. This aims to provide enough space to ensure extra thickness of the restorative material in an area with high occlusal loads.^{11,14}

Several studies investigated the performance of General Dental Practitioners (GDPs) regarding their adherence to the standards of teeth preparations. Fifty-six percent of teeth were found to have been prepared with regard to tooth morphology and 42% were prepared with only one plane of preparation on the buccal/labial aspect.¹⁵ In addition, the average values of all preparation aspects of all-ceramic crowns studied were within the recommendations as defined in the preparation guidelines of the manufacturer. However, on an individual tooth level nearly all preparations showed one or more locations with imperfections.¹⁶

In Jordan, only two studies were performed. One study evaluated the adherence of GDPs in private dental clinics to the standards of tooth preparations for all-ceramic restorations.¹⁷ The other study evaluated only three aspects of tooth preparations (convergence angle, occlusal reduction and finish line depth) prepared by final year dental students for the fabrication of metal-ceramic restorations.¹⁸

This study is based on analyses of samples of dies, which were prepared to receive metal ceramic crowns (MCCs) obtained from commercial dental laboratories in Jordan featuring work by General Dental Practitioners (GDPs) and Prosthodontics specialists (ProSs) to investigate the most common clinical variations between the two groups of practitioners regarding different aspects of teeth preparations to receive and to assess if they follow the relevant guidelines.

MATERIAL AND METHODS

One-hundred and fifty of laboratory models (n=150) featuring posterior teeth (premolars and molars in maxillary and mandibular arches) preparations for metal ceramic restorations (MCRs) by GDPs and ProSs in private dental practice in Jordan were chosen from 17 private dental laboratories. All 172 dies (42 mandibular premolars, 49 mandibular molars, 39 maxillary premolars and 42 maxillary molars) were examined visually and were found to be sound without defects or cracks. For all dies, laboratory prescriptions from dental practitioners requested porcelain to cover all the metal substructure surfaces.

All samples included master casts obtained from dental laboratories containing sound contralateral teeth without any defects or restorations. The master casts were used first for measurement of the tooth margin positions in relation to the gingival margin positions on the buccal and lingual aspects before die trimming and then all master casts were trimmed to record the rest of the measurements as mentioned below. A specially designed wax cylinder (23 mm length and 20 mm width) was fabricated to hold the prepared die in position. (Figure 1). The preparation criteria investigated in this study included:

1. The positions of tooth preparation margin in relation to the gingival margin on the buccal and lingual aspects. This was measured before die trimming using a Williams periodontal probe (Ash, UK)¹⁹ according to the following criteria:

- 1.1) >2mm supragingival margin
- 1.2) ≤ 2mm supragingival margin
- 1.3) Subgingival margin
- 1.4) Level with gingival margin
- 1.5) No clear margin



Figure 1: Anterior view of the die fixed in the center of wax cylinder.

2. The total amount of tooth reduction in the buccolingual and mesiodistal planes. The measurements were carried out using a digital vernier caliper (Mitutoyo, Japan) and calculated by deducting the width of the prepared teeth from the unprepared contralateral tooth width in the two planes.²⁰ (Figures 2 & 3). It was assessed according to the following criteria:

- 2.1) >3mm
- 2.2) $\leq 3 \text{ mm} >2\text{mm}$
- 2.3) $\leq 2 \text{ m m} >1\text{mm}$
- 2.4) $\leq 1\text{mm}$ and 0mm



Figure 2: Measuring the buccolingual width of the prepared tooth.



Figure 3: Measuring the mesiodistal width of the prepared tooth.

3. The amount of occlusal reduction. This was measured using the digital caliper (Mitutoyo, Japan) by comparison to contralateral crown height²⁰ according to the following groups:

- 3.1) >3 mm
- 3.2) $\leq 3 \text{ mm} >2\text{mm}$
- 3.3) $\leq 2 \text{ mm} >1\text{mm}$

3.4) $\leq 1\text{mm}$ and 0 mm

4. The buccal and lingual margin design of tooth preparations (Shoulder, Beveled shoulder, Chamfer, Beveled Chamfer, No clear margin). This was examined using a x2.5 magnification (Dental Loupes, Orasoptic, USA).¹⁵

5. Functional cusp bevel. This was assessed visually on the maxillary palatal cusps and mandibular buccal cusps with the aid of a x2.5 magnification (Dental Loupes, Orasoptic, USA).²⁰

6. Axial convergence angle between two opposing walls.²¹ This was measured using a Tool maker microscope (Figure 4). The prepared die was held in a vertical position over a graded rotary table, and viewed under the microscope. The vertical line of the lens should overlap one of the axial walls. The graded rotary table that held the die was then adjusted and turned around until the line overlapped the opposing axial wall. The angle formed between the two positions of the line represents the convergence angle. The variables were assessed as if axial convergence was:

- 6.1) ≤ 6
- 6.2) $>6^\circ - \leq 10^\circ$
- 6.3) $> 10^\circ - \leq 19^\circ$
- 6.4) $> 19^\circ - \leq 29^\circ$
- 6.5) $> 29^\circ - \leq 39^\circ$
- 6.6) $> 39^\circ - \leq 49^\circ$
- 6.7) $> 49^\circ - \leq 59^\circ$



Figure 4: The tool maker microscope.

7. Finish line depth. This was assessed using the Toolmaker Microscope. The die was held in a horizontal position over the graded table and viewed under the microscope. The graded rotary table was moved until the vertical line of the microscope lens was overlapping the internal line angle of the finish line of the prepared die, at this time the measurement knob pointer reading was registered as the reference point. While keeping the line at the same position and direction, the table moved laterally or medially so that the line became close to the outer surface of the prepared die. The difference between the new reading of the knob and the reference point indicated the depth of the finish line. Finish line depth was assessed as if:

- 7.1) < 0.5 mm
- 7.2) 0.5 - 1.5 mm
- 7.3) > 1.5 mm

8. The facial planes of tooth preparation. The facial planes of tooth preparation were assessed using the Toolmaker Microscope. The die was held horizontally over the graded table and viewed under the microscope. The M-D axis of the prepared tooth was held perpendicular to the graded table. The exter-

nal x-y axis of the microscopic lens was adjusted to across the labial surface of the die. If the x-axis kept in close contact from the cervical third to the incisal/occlusal third of the prepared die this indicated non-anatomical (1 plane) labial tooth reduction and if the x-axis kept in close contact till middle third only and then deviated from the labial surface, this indicated anatomical labial (2 planes). This was categorized as:

- 8.1) Anatomic \geq 2 planes tooth preparation.
- 8.2) Non anatomic 1-plane tooth preparation.

9. Retentive preparation features. These features were assessed visually with the aid of a magnifier lens as the prepared tooth has any of the retentive features or not. This criterion was assessed according to the form of the retentive feature as: Grooves, Boxes, Occlusal cavity, Pin hole, Not applied.

STATISTICAL ANALYSES

Frequency tables were used to describe criteria of aspects of preparations examined on dies and numbers of preparations which followed the identified criteria. Data were analyzed using Statistical Package for Social Sciences, v 20; SPSS Inc) and described using percentages, means and standard deviations wherever appropriate. Differences between two means were analyzed using independent sample t-test and the differences between more than two means using One -way ANOVA test. Chi square test was used to analyze differences between percentages. A P- value of less than 0.05 was considered statistically significant. To investigate the inter-examiner reproducibility of the scoring systems, a random subsample of dies (n = 30) was selected and re-scored after 7 days and the results compared.

RESULTS

Of the total 150 casts examined, 96 (55.8%) dies were prepared by GDPs and 76 (44.2%) dies were prepared by ProSs. The total number of dies examined was 172.

A supragingival finish line margin was recorded on 26 dies (15.1%). Thirty five dies (20.3%) demonstrated a finish line margin level with the gingival margin. The majority of finish line margins were prepared subgingivally on 110 dies (64%). No significant difference was found between GDPs and ProSs in preparing finish lines in any of the positions in relation to the gingival margin. (p = 0.124).

A shoulder finish line on the buccal and lingual aspects was observed on 128 dies (74.4%), whilst 39 dies (22.7%) showed a chamfer finish line. Five dies (2.9%) showed no clear type of finish line. Neither GDP nor ProS in this study used a beveled shoulder or beveled chamfer finish line. No significant difference was found between GDPs and ProSs in preparing any of the 2 finish lines on the examined dies. (p = 0.071).

The results showed that the average axial tooth reduction in the buccolingual (BL) plane was 1.03 mm. A significant difference was found between GDPs and ProSs in this aspect of tooth preparation ($p = 0.016$). The average reduction in the BL plane by GDPs was 0.92 mm and by ProSs was 1.16 mm. One hundred and nine dies (63.4%) had 1 mm or less tooth reduction, whereas 61 dies (35.5%) had $\geq 1 - 2$ mm. (Table 1). Regarding tooth reduction in the mesiodistal (MD) plane, the results showed that the average reduction in this plane was 1.33 mm (1.23 mm by GDPs and 1.46 mm by ProSs). Around 26% of dies had a MD reduction of 1 mm or less compared to 68.6% of dies which exhibited a reduction of more than 1 mm up to 2 mm. A significant difference was found between GDPs and ProSs regarding the amount of tooth reduction in the MD plane ($p = 0.01$). (Table 2).

The average occlusal reduction was 2.17 mm with no significant difference ($p = 0.77$) between GDPs and ProSs in this regard (2.19 mm by GDPs and 2.16 mm by ProSs Cs). Of the 172 dies only 6 dies (3.5%) had an occlusal reduction of 1 mm or less. The majority of dies (82%) had an occlusal reduction of more than 1 mm and up to 3 mm. Fourteen point five percent

of dies exhibited over reduction in excess of 3 mm. Only 6 dies (3.9%) from the 155 posterior teeth preparations showed a functional cusp bevel. All were found in preparations by ProSs. ($p = 0.005$).

About 35% of dies exhibited an anatomical tooth preparation in the facial plane (21 dies by ProSs and 39 dies by GDPs) with no significant difference between GDPs and ProSs. ($p = 0.076$). The average depth of the finish line was found to be 0.69 mm with no significant difference ($p = 0.053$) between GDPs and ProSs (0.688 mm and 0.695 mm respectively). In the majority of dies (84.9%), finish line depths were between 0.5 mm-1.5 mm. In 15% of dies, finish line depths were found to be less than 0.5 mm. The greatest finish line depth registered in the study was 1.4 mm.

The results showed that 95.3% of dies were prepared without any retentive features. Those features included grooves found in 2.9%, boxes used only in 1 die and an occlusal cavity prepared in 2 dies (1.2%). Significantly more ProSs included retentive features compared to GDPs ($p = 0.048$).

Table 1. Total amount of tooth reduction in the BL plane. (The average reduction in the BL plane by GDPs was 0.92 mm and by ProSs was 1.16 mm)*

Plane of reduction	Amount of tooth reduction	GDPs N(%)	ProSs N(%)	Total N(%)
Axial BL plane	0-1 mm	69(71.9)	40(52.6)	109 (63.4)
	>1-2 mm	27(28.1)	34(44.7)	61 (35.5)
	>2-3 mm	0(0)	2(2.6)	2 (1.2)
	>3 mm	0(0)	0(0)	0 (0)
Total N(%)		96(100)	76(100)	172(100)

*p- value= 0.016

Table 2. Total amount of tooth reduction in the MD plane. (The average reduction in the MD plane was 1.23 mm by GDPs and 1.46 mm by ProSs)*.

Plane of reduction	Amount of tooth reduction	GDPs N(%)	ProSs N(%)	Total N(%)
Axial MD Plane	0 - 1mm	33(34.4)	11(14.5)	44(25.6)
	>1 - 2mm	59(61.5)	59(77.6)	118(68.6)
	> 2 - 3 mm	4(4.2)	6(7.9)	10(5.8)
	>3 mm	0(0)	0(0)	0(0)
Total N(%)		96(100)	76(100)	172(100)

*p- value= 0.01

The average axial convergence angle of teeth preparations was 29.8 and 24.7 degrees in the BL and MD planes respectively. The majority of dies (93%) exhibited a convergence angle greater than 10 degrees while only 7% of dies had an angle less than 10 degrees in the BL plane. GDPs created an average convergence angle of 29.1 and 25 degrees in the BL and MD planes respectively, whilst ProSs preparations had angles of 30.6 degrees in the BL plane and 24.2 degrees in the MD plane. In the MD planes, 94.8% of prepared dies had convergence angles greater than 10 degrees and only 5.2% had convergence angles of 10 degrees or less. (Tables 3 & 4).

KAPPA STATISTICS

There were strong to perfect agreements in all categorical measurements: finish line position, type of finish line, facial planes of reduction and functional cusp bevel between the two duplicate readings. Kappa ranged from 0.84 to 1 with a p-value of less than 0.005 for all measurements. For all continuous variables: finish line depths, convergence angles and axial /occlusal reduction depth, the paired t test did not show statistical significance between the duplicate readings.

Table 3. Axial convergence angle in the BL plane. (The average TOC was 29.1 degrees by GDPs and 30.6 degrees by ProSs)*

	GDPs N(%)	ProSs N(%)	TotalN(%)
Axial convergence angle in BL plane			
≤ 6 °	3(3.1)	1(1.3)	4(2.3)
>6° - ≤ 10°	5(5.2)	3(3.9)	8(4.7)
> 10°- ≤ 19°	18 (18.8)	11(14.5)	29(16.9)
> 19°- ≤ 29°	25(26)	18(23.7)	43(25)
> 29°- ≤ 39°	20(20.8)	26(34.2)	46(26.7)
> 39° - ≤ 49°	19(19.8)	15(19.7)	34(19.8)
> 49°- ≤ 59°	6(6.3)	2(2.6)	8(4.7)
Total	96(100)	76(100)	172(100)

*p-value = 0.675

Table 4. Axial convergence angle in the MD plane. The average TOC was 25 degrees by GDPs and 24.2 degrees by ProSs)*

	GDPs N(%)	ProSs N(%)	Total N(%)
Axial convergence angle in the MD plane			
≤ 6 degrees	1(1.0)	0(0)	1(.6)
>6- ≤10 degrees	5(5.20)	3(3.9)	8(4.7)
> 10°- ≤ 19°	28(29.1)	13(17.2)	41(23.9)
> 19°- ≤ 29°	34(35.4)	40(52.6)	74(43)
> 29°- ≤ 39°	17(17.8)	14(18.4)	31(18)
> 39° - ≤ 49°	9(9.4)	5(6.6)	14(8.1)
> 49°- ≤ 59°	2(2.1)	1(1.3)	3(1.7)
\ Total	96(100)	76(100)	172(100)

*p-value = 0.619

DISCUSSION

Proper tooth preparation plays a major role in determining the success of any extra-coronal restoration. Adequate and anatomical tooth reductions in all surfaces create the space required to develop restorations with normal contours, good esthetic results and high strength. Thus preserving dental tissues and ensuring a healthy periodontium, especially if the finish line is accurately designed and positioned.¹¹

Supragingival finish lines on sound dental tissue should always be adopted if tooth status, esthetic and retention permit, as this preserves more dental tissue during preparation. In addition, impressions making, the fabrication of provisional restorations and excess cement removal are much easier. In this way, the periodontal tissues maintain their health without any irritation caused by the restoration margins.^{5,11,22} Unfortunately, a supragingival finish line in many clinical situations is often not possible. So, the choice of subgingival margins sometimes is mandatory as in cases with short clinical crowns to enhance the resistance and retention of the restoration, and in cases where caries and restorations extend subgingivally. Esthetic reasons sometimes dictate subgingival margins to cover discolored or stained teeth. In these cases the margin can be placed at the gingival crest or, at most, 0.25 mm to 0.5 mm subgingivally to avoid compromising the epithelial attachment.²²

In the present study, 64% of tooth preparations had subgingival margins. This is in contrast to previous investigations which reported subgingival margins in 29% of tooth preparations,¹⁵ 20% for porcelain laminate veneers,¹⁷ 32% for resin-bonded ceramic veneers¹⁸ and 36% for resin bonded all ceramic crowns.¹⁷

Although a minimal TOC of 4-6 degrees is considered as ideal and 4-14 degrees as acceptable,¹² several studies have shown that these minimal taper angles are only theoretical because they are difficult to achieve in clinical daily practice. Dental students achieved preparations with 12.7 degrees average taper on typodonts whereas they created much greater average taper clinically (22.8 degrees).²³ The mean taper achieved by dentists (22.1 degrees) was higher than that by dental students (19.4 degrees) with an overall mean taper of 21 degrees.²⁴ Furthermore, It has been reported that the mean TOC created on preparations to receive MCRs by fifth year dental students in the BL and MD planes were 22.4° and 25.3° respectively.¹⁸ Recently, higher values of TOC (44.1° faciolingually and 35.8° mesiodistally) created by final year dental students were reported with an average of 39.98 degrees.²⁵ The results of the present study showed that teeth preparations were found to have a mean angle of 29.8 and 24.7 degrees in the buccolingual and mesiodistal planes respectively, with an average of 27.25 degrees that is relatively greater than that reported in the aforementioned studies.

The results of the present study also demonstrated that buccolingual surfaces had greater total convergence angles than mesiodistal surfaces. These results are consistent with the recommendations proposed.^{13,24}

The selection of one type of finish line for MCRs in order to improve the marginal fit of the restoration has not yet been validated by research. It has been recommended that the choice of finish line type shouldn't be based on the marginal fit but on dentist preference and experience, esthetic considerations, type of metal ceramic crown (metal collar margin or porcelain margin) and ease of formation.¹³ In the present study, shoulder finish line was observed in about 74% of dies, whilst 39 dies (22.7%) showed chamfer finish lines. Five dies (2.9%) showed no clear type of finish line. Neither GDPs nor the ProSs in this study reported to use the beveled shoulder or beveled chamfer finish lines.

Recommended finish line depths for metal-ceramic restorations ranged from 1.0 to 1.5 mm.^{11,13,25} This depth is the minimum thickness required to ensure satisfactory strength and esthetics in addition to the minimum space enough for the development of a physiologic emergence profile. Previous studies reported that finish line depths of more than 1 mm are required as they found the minimum thickness for porcelain to match the shade guide was 1.0 mm.^{26,27} Finish line depths were mostly recorded less than that recommended. Previous studies reported average finish line depths of 0.75 mm,²⁸ 0.74mm¹⁸ and 0.9mm¹³. The average depth of the finish line in this study was found to be 0.69 mm. The maximum depth achieved in this study was 1.4 mm.

Auxiliary retentive features such as grooves, boxes, occlusal cavities and pin holes can be used for metal and metal-ceramic restorations. They are used mainly to improve the retention and resistance to dislodgement of restorations for teeth that are short or have inadequate resistance form. A previous study recorded that from 107 molar dies, only 8 had grooves and 54% of the molar castings did not have sufficient resistance form, so they recommended to consider axial retentive features with molars to improve their resistance form.²⁹ Another study reported that only two dies (1.7%) from the whole sample were prepared with grooves despite the fact that most of these preparations had large occlusal convergence angles.²⁵ The results of this study demonstrated that 95% were prepared without any retentive features and only 8 dies (4.7%) were prepared with one of the additional retentive features.

Axial reductions of 1.0 to 1.7 mm and 2.0 to 2.5 mm of incisal/occlusal reductions have been recommended for MCRs when these surfaces are planned to be covered with ceramic. These depths ensure enough space for development of restorations with satisfactory strength, normal contours and acceptable esthetic results.^{11,12} Insufficient axial reduction will develop restorations with poor contours leading to esthetics and periodontal problems. Over preparation means loss of dental tissues without need or benefit. On the contrary, this will endanger the pulp and may end up with a need for en-

dodontic treatment.¹¹ It has been reported that the average occlusal reduction created by final year dental students for metal-ceramic crowns was 2 mm with a range between 1.5 and 2.2 mm.¹⁸ AL-Dwairi *et al*, indicated that 18% of dies prepared to receive all-ceramic crowns were underprepared incisally (less than 1 mm).¹⁷

The results of the study demonstrated that the average total axial tooth reduction was 1.18 mm. This is nearly within the recommended range for axial reduction (recommendation 1.0 to 1.7 mm).¹¹⁻¹³ The average reduction in the buccolingual (BL) plane was 1.03 mm and 1.33 mm in the MD. These depths can provide the space required to create restorations with desirable strength, esthetics and normal contour. Over preparation can be a danger to the pulp and may lead to loss of pulp vitality. The most common complication with single crowns was the need for root canal treatment (RCT), whereas the most common complications with bridges were caries by followed by the need for RCT.³⁰

Occlusal reduction measurements showed an average of 2.17 mm, which is an acceptable reduction and within the recommended range¹¹⁻¹³ as the majority of dies (82%) had an occlusal reduction of more than 1 mm and up to 3 mm.

Occlusal reduction for posterior teeth should be accompanied with the creation of a functional cusp bevel with a wide bevel placed on the functional cusps most often at about 45° to the long axis of the tooth. This step is recommended to provide enough space to ensure extra thickness of the restorative material in an area with high occlusal loads. In the present study, only 4% of the examined dies prepared by ProSs were found to have a functional cusp bevel. This might be due to the lack of knowledge and under estimation of the importance of this step to the strength of the restoration.

Anatomical tooth preparation necessitates tooth reduction based on its anatomy; this will be more conservative to the dental tissues and provide better esthetic results besides enhancing retention and resistance form of the preparation. Facial surface reduction should be prepared in two planes, the occlusal/incisal and cervical (gingival) planes. Reduction in the cervical plane only means that the occlusal/incisal edge will protrude and the result can be an over contoured restoration with poor esthetics and shade match. Preparations can be too close to the pulp if reduction was only prepared in the occlusal/incisal plane.^{11,12} it has been found that 83% of preparations for all-ceramic crowns in private dental practice in Jordan had non-anatomical preparations while only 17% had the recommended anatomical labial preparations.¹⁷ In this study, the results showed that 34.9% of dies exhibited anatomical tooth preparation in the facial plane. Results from these two studies demonstrated that the majority of dentists in private dental practice in Jordan created non-anatomical facial preparations.

There are two principal reasons for the acceptance of metal-ceramic restorations. First, they are more resistant to fracture than the traditional all-ceramic crown, because the combination of ceramic and metal bonded together is stronger than the ceramic alone.

Second, the MCR is the only dependable means of fabricating an esthetic fixed partial denture when full coverage is required on one or both retainers.^{11,12} However, routinely placing metal-ceramic crowns on all premolars and molars is overtreatment because of the additional tooth structure that must be destroyed to accommodate the combined thickness of metal and ceramic. The routine use of all-ceramic surfaces has been criticized. This restoration design offers maximum cosmetic effect when required by location in a highly visible area or by patient preference. Patients who demand ceramic occlusal and lingual surfaces should know of the potential problems. The use of all-ceramic occlusal surfaces requires the removal of more tooth structure, and the completed restorations pose a threat to the structural integrity of opposing occlusal surfaces.^{11,12}

As for dental practitioners, preparations for metal-ceramic restorations should be done with a plan for the extent of ceramic coverage in mind, since the areas to be veneered with ceramic require deeper reduction than those portions of the tooth that will be overlaid with metal alone.

CONCLUSIONS

The study demonstrated variations in teeth preparations for metal-ceramic restorations between GDPs and prosthodontics specialists in Jordan. Within the limitations of the study, it can be concluded:

1. Most of GDPs and specialists tend to place finish line margins of their MCRs preparations subgingivally.
2. Although GDPs and ProSs followed the guidelines to the finish line types by creating shoulder finish lines to their preparations, many preparations had depths less than that recommended.
3. The majority of preparations had the recommended reduction in the MD plane, but not in the BL plane.
4. The majority of preparations were underprepared. Non-anatomical facial tooth preparations were observed in most of cases.
5. Despite the fact that the most of preparations had the recommended occlusal reduction, the majority of specialists and all GDPs didn't prepare a functional cusp bevel. Retentive preparation features are rarely adopted by GDP and specialists in Jordan for MCRs posterior teeth preparations.
6. The majority of GDPs and specialists tend to produce total occlusal convergence angles greater than the recommended angles.

RECOMMENDATIONS

- Continuous dental education programs are necessary to improve the quality of dental treatment procedures and adherence to the recommended guidelines for tooth preparations.
- Dental school undergraduate courses should be modified and directed to provide more practical tuition regarding recommended guidelines for teeth preparations,
- The internship program for newly graduated GDPs should be thoroughly reviewed to include a log book of certain fixed prosthodontic cases under close supervision.

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