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Evaluation of Resistance and Retention form of Molar Crown Preparation for Porcelain Fused to Metal Crown at the University of Ghana Dental School

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Abstract

Background: It is recommended that for a molar crown preparation to have adequate resistance and retention form for a porcelain fused to metal (PFM) crown, it should have a clinically acceptable taper between 6-14^0 and a total occlusal convergence (TOC) also in the range of 6-22^0. Aim: To determine whether the molar crown preparations for full-coverage PFM crowns made by Resident dentists at the University of Ghana Dental School (UGDS) meet the clinical requirement for resistance and retention form. Methods: This was a prospective study to analyse the taper and TOC which are some of the intrinsic factors of resistance and retention form. Seventy-seven molar crown preparations made by Resident dentists at UGDS were used. The Exocad software was used to measure the taper and TOC of each molar die. A descriptive summary of the taper and TOC were summarised as means and their standard deviations. Chi-square test was used to compare the acceptability levels of the variables with their respective recommended clinically acceptable values. Results: The mean buccal, lingual, mesial and distal taper recorded were 25.2^0 ± 15.3^0, 26.5^0 ± 14.3^0, 26.0^0 ± 12.5^0 and 26.9^0 ± 14.5^0 respectively. Also, the mesiobuccal, mesiolingual, distobuccal and distolingual taper recorded were 27.3^0 ± 7.7^0, 27.3^0 ± 7.7^0, 26.1^0 ± 8.9^0, and 26.2^0 ± 7.4^0. The mean buccolingual TOC, mesiodistal TOC, Mesiobuccal-distolingual TOC and mesiolingual-distobuccal TOC recorded were 51.2^0 ± 26.9^0, 52.8^0 ± 24.1^0, 53.5^0 ± 12.9^0, and 52.3^0 ± 12.4^0. Conclusion: The current study showed that it was a challenge to achieve the recommended clinically acceptable values of taper and TOC to achieve adequate resistance and retention form.

Keywords: Resistance form, retention form, molar tooth, porcelain fused to metal crown, crown preparation

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INTRODUCTION

Full-coverage PFM crowns are extracoronal restorations mostly used for restoring lost or damaged coronal tooth tissue with compromised structural integrity. They provide maximum retention with favourable restoration contours and aesthetics. PFM crowns are still considered the gold standard [1-3] of indirect restorations despite the advances in technology for the fabrication of all-ceramic crowns and their increased usage. This standard is a result of its good mechanical properties, satisfactory aesthetics, clinically acceptable margins and internal fit. [4-6]

Molar crown preparation for a full-coverage PFM crown is a surgical procedure where the crown of the tooth is clinically reduced in size both axially and occlusally to a recommended dimension.

Resistance and retention forms are the features of a prepared crown that help to retain the full-coverage PFM crown on the prepared crown (abutment) during function. These features prevent the dislodgement/removal of cemented full-coverage PFM crowns by forces acting on them during function. Lateral forces can dislodge full-coverage crowns by causing them to rotate about the gingival margin and eventually tipping them off their abutment. For a full-coverage PFM crown to last and function longer in the

mouth, its abutment should have both resistance and retention forms. A prepared crown for a fixed restoration has either resistance and retention form or it doesn't. [7] The intrinsic factors of a prepared crown that contribute to its resistance and retention form are the taper, total occlusal convergence, width and height. [8, 9]

Resistance form is the capacity of a crown preparation to prevent dislodgment of restoration by nonaxial forces as well as to prevent any movement of the restoration under occlusal forces. Resistance areas of a crown preparation are the areas that are placed under compression to prevent the rotation of the full-coverage PFM crown when lateral forces act on them. Many of these areas collectively form the resistance form of the crown preparation. [8, 9] The feature of a prepared crown that prevents a full-coverage PFM crown from being removed along its path of insertion is the retention form.

It is recommended that the clinically acceptable taper and TOC of crown preparations for indirect extracoronal full-coverage restorations should be 6-14^0 [10]and 6-22^0 [11]respectively. Hence this study seeks to evaluate the taper and TOC of molar crown preparations which affects resistance and retention form.

MATERIALS AND METHODS

Seventy-seven molar crown preparations by Residents for porcelain fused to metal crowns were selected for the study. Dies of the prepared crowns were made with pyrax gypsum type IV die stone (Dental Plaster manufacturers & OEM manufacturers, India) from their silicon impressions. The apical 2mm from the margin of each die was ditched to make the margin more prominent and distinct. Two vertical points of 1mm apart were marked on the mid-buccal, mid-lingual, mid-distal and mid-mesial. Also, two vertical points were marked on the junction of buccal and mesial, buccal and distal, lingual and mesial and lingual and distal. The dies were scanned using a 3D Cyber-Scan Art plus scanner (Pi Manufacturing Co. Ltd, Hungary) and the images were digitalised on a computer. The buccal, lingual, mesial, distal, mesiobuccal, mesiolingual, distobuccal and distolingual tapers were measured as the angle formed by a line from the axiogingival margin through the two vertical points to meet a line through the long axis of the crown of each die using the Exocad DentalDB 3.0 Galway 7754 software (Exocad GmbH, Germany) as shown in figure 1.

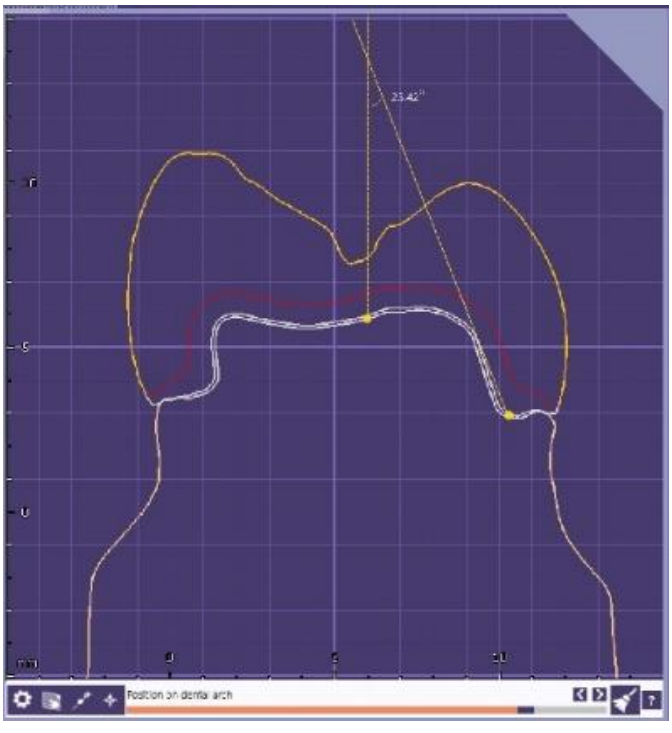

Figure 1: Taper measurement using Exocad software

Also, the buccolingual, mesiodistal, mesiobuccal-distolingual and mesiolingual-distobuccal TOC was measured as shown in Figure 2.

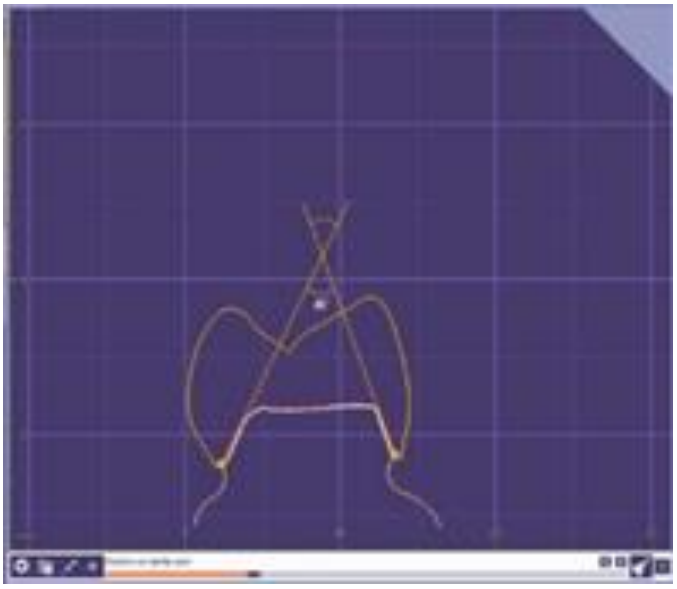

Figure 2: Measurement of TOC using Exocad software

This study was approved by the institutional review Board of the Korle-Bu Teaching Hospital (KBTH-STC/IRB/000187/2021). A written informed consent was obtained from all the participants of this study.

Data Management and Analysis

A descriptive summary of the taper and TOC were summarized as means and their standard deviations. These summaries were presented as tables. To compare the levels of acceptability of the measurements in proportions, the chi-square test was used. A significant level was set at $p< 0.05$.

RESULTS

Seventy-seven molar dies were used for the study. There were thirty-seven (37) maxillary molar dies and forty (40) mandibular molar dies. Also, 74 molar dies were made from endodontically treated teeth while the remaining 3 were made from vital teeth.

The range, mean and standard deviation of the buccal, lingual, mesial, distal, mesiobuccal, mesiolingual, distobuccal and distolingual taper recorded are shown in Table 1.

Table 1: The range, mean and standard deviation of the various tapers.

Variable	Range	Mean ± SD
Buccal taper	4.8^0 - 83.9^0	$25.2^0 \pm 15.3^0$
Lingual taper	5.8^0 – 85.8^0	$26.5^0 \pm 14.3^0$
Mesial taper	5.6^0 – 86.4^0	$26.0^0 \pm 12.5^0$
Distal taper	8.3^0 – 86.0^0	$26.9^0 \pm 14.5^0$
Mesiobuccal taper	13.3^0 - 53.3^0	$27.3^0 \pm 7.7^0$
Mesiolingual taper	7.0^0 - 48.7^0	$27.3^0 \pm 7.7^0$
Distobuccal taper	6.1^0 - 48.5^0	$26.1^0 \pm 8.9^0$
Distolingual taper	5.4^0 - 50.9^0	$26.2^0 \pm 7.4^0$

Table 2 shows the proportions of acceptability and unacceptability of the buccal, lingual, mesial, distal, mesiobuccal, mesiolingual, distobuccal and distolingual tapers of the molar dies measured as compared to the recommended taper value of 6-14^0. The table also compares the level of

acceptability between the buccal, lingual, mesial, distal, mesiobuccal, mesiolingual, distobuccal and distolingual tapers of the molar dies.

Table 2: Comparison of the acceptability and unacceptability levels of all the taper

Variable	Acceptable (%)	Unacceptable (%)	P value
Buccal taper	5(6.5)	72 (93.5)	0.144
Lingual taper	2 (2.6)	75 (97.4)	
Mesial taper	1 (1.3)	76 (98.7)	
Distal taper	0 (0.0)	77 (100)	
Mesiobuccal taper	1 (1.3)	76(98.7)	
Mesiolingual taper	1 (1.3)	76 (98.7)	
Distobuccal taper	1 (1.3)	76 (98.7)	
Distolingual taper	1 (1.3)	76 (98.7)	

The range, mean, and standard deviation (SD) of the TOC of the 77 study dies are shown in Table 3.

Table 3: The range, mean, and standard deviation of TOC recorded

Variable	Range	Means ± SD
Buccolingual TOC	12.8^0 - 160.4^0	$51.2^0 \pm 26.9^0$
Mesiodistal TOC	14.4^0 - 61.0^0	$52.8^0 \pm 24.1^0$
MBDL TOC	27.2^0 - 104.2^0	$53.5^0 \pm 12.9^0$
MLDB TOC	19.3^0 - 84.3^0	$52.3^0 \pm 12.4^0$

The proportion of acceptability and unacceptability of the buccolingual, mesiodistal, mesiobuccal-distolingual (MBDL) and mesiolingual-distobuccal (MLDB) TOC of the molar dies are shown in Table 4. The table also compares the level of acceptability of the buccolingual, mesiodistal, mesiobuccal-distolingual and mesiolingual-distobuccal TOC of the molar dies.

Table 4: Comparison of the acceptability and unacceptability levels of all the TOC

Variable	Acceptability (%)	Unacceptability (%)	P value
Buccolingual TOC	6 (7.8)	71 (92.2)	0.233
Mesiodistal TOC	2 (2.6)	75 (97.4)	
MBDL TOC	0 (0.0)	77 (100)	
MLDB TOC	1 (1.3)	76 (98.7)	

DISCUSSION

The proposed clinically acceptable taper in the literature to provide adequate resistance and retention form is $6\text{-}14^0$ [10]. This current study found that the mean taper for the buccal, lingual, mesial and distal recorded did not met the recommended clinically acceptable taper. Moreover, the mean taper of the mesiobuccal, mesiolingual, distobuccal and distolingual also did not meet the recommended taper. This may be due to the challenge with accessibility and visibility of molar teeth and the difficulty in positioning the handpiece to the molar teeth during crown preparation. Clinically molar crown preparation is a challenge in that, obstruction from the tongue and cheek makes it difficult to adequately prepare the lingual and distal sides of molar crowns. The posterior position of the molar teeth poses the challenge of easy accessibility and visibility which makes it difficult to prepare. To prevent undercut and over tapering of the crown preparation, the bur should be oriented along the long axis of the tooth which is difficult to do on the distal aspect of molar teeth. Also, the patient and dentist's position influence the taper formed because if the patient's head is not well positioned, may lead to wrong judgement of the position of the tooth which will lead to over-tapering of the crown preparation.

Also, the literature recommends that a TOC of $6^0 - 22^0$ [11-13] is clinically acceptable to provide adequate resistance and retention form for extracoronal full-coverage restorations. The mean TOC values recorded for the buccolingual, mesiodistal, mesiobuccal-distolingual and mesiolingual-distobuccal TOC did not achieve the recommended clinically acceptable value. This is a result of over-tapering the axial walls of the molar crown due to the challenge of accessing, visualizing and correctly positioning the bur to the long axis of the molar crown.

CONCLUSION

It was a challenge to achieve the recommended clinically acceptable values of taper and TOC of molar crown preparation which directly influence its resistance and retention form. Dentists should be mindful of these parameters when preparing molar crowns for full-coverage porcelain fused to metal crowns.

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Authors' contribution

Stephen Ekow Ankoh was involved in the conceptualisation, data curation, data analysis, funding, methodology, project administration, resources, validation, writing (original draft) and writing (review and editing). Patrick Caldicock Ampofo was involved in methodology, project administration, supervision, validation, writing (original draft) and writing (review and editing). Sandra Ama Hewlett was involved in methodology, data analysis, project administration, supervision, validation, writing (original draft) and writing (review and editing). Ebenezer Anno Nyako was involved in conceptualisation, supervision, and writing (review and editing). Tom Akuetteh Ndanu was involved in the data curation, data analysis, validation, visualisation, supervision and writing (review and editing). Akua Boakyewaa Konadu was involved in supervision and writing (review and editing). Ruby Yayra Goka was involved in the data analysis, resources and writing (review and editing). Nana Frimpomaa Adu-Ampomah was involved in the data analysis, resources and writing (review and editing). Gladia Toledo Mayari Yabang was involved in writing (original draft) and writing (review and editing). Neil Quartey Papafio was involved in supervision and writing (review and editing).

Conflicts of Interest

The author reports no conflicts of interest.

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