

Assessment and Comparison of Convergence Angle of Tooth Preparations for Full-Veneer Crowns among Practitioners with Different Levels of Experience

Abstract

Aim: The proposed values of axial inclination of preparations vary dramatically. A range of 4 to 10 degrees is recommended as optimal, but is difficult to achieve in clinical practice. This study aims to assess and compare the convergence angle of abutment teeth prepared for full-veneer crowns by practitioners with different levels of experience i.e. general dental practitioners, prosthodontists and other specialists.

Materials and Methods: Samples consisted of 300 prepared teeth for full-veneer crowns by general dental practitioners, prosthodontists and other specialists. The obtained dies were scanned and convergence angle was determined both buccolingually and mesiodistally. All the results were recorded and the data were analysed by means of z-test.

Results: It was found that the dies obtained from prosthodontists had the least Convergence Angle among the three groups. **Conclusion:** It was concluded that the recommended Convergence Angle was difficult to achieve in clinical practice.

Key Words

Convergence angle; tooth preparation; veneer crown

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INTRODUCTION

Successful tooth preparation and success of subsequent restoration depends on important factors like retention and resistance. Factors for good retention in fixed prosthesis include: a) size of teeth; b) magnitude of dislodging forces; c) geometry of tooth preparation; d) roughness of fitting surface; e) cement to be used, and f) film thickness of luting agent. Convergence angle is one of the several factors that influence the adequacy of tooth preparation. It is the calculated taper of two opposite axial walls. Parallel opposing walls enhance retention and resistance; however, preparing them in the oral cavity with no undercuts is not an easy task to fulfill. Some degree of convergence is necessary in order to minimize tooth reduction, yet allow assessment of preparation walls, prevent undercuts, compensate for inaccuracies of fabrication process and permit more favorable seating of restorations during

cementation.^[1] Theoretically, the more nearly parallel the opposing walls of a preparation, the greater would be the retention.^[2] However, parallel walls are impossible to create in the mouth without producing preparation undercuts. The proposed values of axial inclination of preparations vary dramatically. A range of 4 to 10 degrees is recommended as optimal, but is difficult to achieve in clinical practice.^[3] Modern Prosthodontics is more evidence-based rather than theoretical. In Indian context, not many studies have been conducted to check the convergence angle of prepared teeth. Hence, this study has taken the axial convergence angle into consideration. The aim of this study was to assess and compare the convergence angle of teeth prepared for full-veneer crowns by practitioners with different levels of experience.

The objectives of this study were:

- To assess and compare the convergence angle of

- teeth prepared for full-veneer crowns between General dental practitioners and prosthodontists.
- To assess and compare the convergence angle of teeth prepared for full-veneer crowns between General dental practitioners and other specialists.
 - To assess and compare the convergence angle of teeth prepared for full-veneer crowns between prosthodontists and other specialists.
 - To compare the convergence angle of teeth prepared for full-veneer crowns among the three groups.

MATERIALS AND METHODS

300 master working casts of fixed dental prostheses with removable dies were randomly collected from private practitioners in the city of Indore. These included the general dental practitioners, prosthodontists and other specialists. Post-graduate students in Prosthodontics who were still in their training period and other specialists who were not engaged in prosthodontic work themselves were excluded from the study. To evaluate the convergence angle of the prepared tooth, the die was placed in a vice grip and scanned by specialized metrology equipment - 3-Dimensional Coordinate Measuring Machine (Model 8106 CNC, Axes Metrology, Indore, MP) with a measuring range of 800×1000×600 mm, a measuring error of 3.0+L/250 µm, a probing error of 3.5 µm and a maximum load of 1000 kg. It consists of a touch trigger probe (TT20), a rotatable probe head (PH10M) (Reinshaw, UK), and a PC as a controller. This machine uses the application software CAPP5 6, which is an ultimate part programming solution to develop inspection programs for dimensional measurement and analysis. This gave the convergence angle of the preparation in a mesio-distal (MD) and bucco-lingual (BL) plane (Fig. 1).



Fig. 1: Measurement using a 3-dimensional Coordinate Measuring Machine

3-D coordinate metrology is an advanced measurement technology for free form surface measurements.^[4] Such measurement consists of

three separate processes: the 'extraction' of 3-D coordinates relating to the surface of the sample; interpolation of these coordinate data into mathematical formulae in order for them to be transformed into a computer image; and thirdly image analysis - where linear, angular or volumetric measurements are produced as required. The collected data were analyzed by means of Z-test.

RESULTS

The observations of the study were in the following manner for each group i.e. general dental practitioners, prosthodontists and other specialists. 100 observations were made for each group of 50, making a total of 300 observations.

Group	M-D Convergence Angle	B-L Convergence Angle
General Dental Practitioners		
GP1	18.64	23.1
GP2	19.09	20.75
Prosthodontists		
PR1	15.74	19.63
PR2	13.62	16.52
Other Specialists		
OS1	18.28	19.20
OS2	19.59	21.6

The mean convergence angles of general dental practitioners, prosthodontists and other specialists are shown in Table 1. There were statistically significant differences among the three groups in the mesio-distal ($p=0.0$) as well as bucco-lingual convergence angles ($p=0.04$). Moreover, there was also statistically significant difference in the mean mesio-distal and bucco-lingual convergence angles for general dental practitioners ($p=0.004$) and prosthodontists ($p=0.001$). However, the difference in the mean mesio-distal and bucco-lingual convergence angle for other specialists was not statistically significant ($p=0.168$).

DISCUSSION

Convergence angle is one of the many factors that affect the overall acceptability of a crown preparation. Ward was one of the first to recommend taper between 5% to 20% per inch (3 to 12 degrees).^[5] Jorgensen^[6] and Kaufmann *et al.*,^[7] have demonstrated that retention decreases as taper is increased. In recent years, recommendations for optimum axial wall taper of tooth preparations for cast restorations have ranged from 3 to 5 degrees,^[8] 6 degrees^[9] and 10 to 14 degrees.^[10] To minimize stress in the cement interface between the preparation and the restoration, a taper of 2.5 to 6.5 degrees has been suggested as optimum, but there is only a slight increase in stress as taper increases

Table 1: Mean, minimum, maximum and SD values of Mesiodistal Convergence Angle and Buccolingual Convergence Angle

Groups	Mesiodistal Convergence Angle				Buccolingual Convergence Angle			
	Mean	Min.	Max.	SD	Mean	Min.	Max.	SD
General practitioners	20.16	1.36	36.17	7.92	23.13	9.58	37.05	6.80
Prosthodontists	14.82	1.28	30.25	6.28	17.58	5.60	29.18	5.04
Other specialists	17.20	2.95	35.61	6.43	18.43	8.03	44.57	6.23

from 0 to 15 degrees. However, stress concentration increases sharply at 20 degrees. Studies of actual crown preparations have shown average tapers between 13 and 29 degrees.^[11-16] The results of the present study showed that the mean M-D as well as mean B-L Convergence Angle of tooth preparations was highest for the general practitioners (20.16° and 23.13° respectively), followed by other specialists (17.20° and 18.43° respectively) and was the least for Prosthodontists (14.82° and 17.58° respectively). These results were in correlation with the results of Annerstedt *et al.*,^[17] (21°) and Al Ali *et al.*,^[18] (25.7°). This may be due to the limited time set for each patient in general practice or because of different clinical experiences. The findings of this study showed the mean B-L Convergence Angle was greater than the mean M-D Convergence Angle in the three groups. This was in correlation with the previous studies conducted by Ohm and Silness^[10] and Al Ali *et al.*^[18] This could be due to the difficulty to inspect the buccal and lingual aspects of tooth for undercuts, especially the mandibular molars and misleading of bur direction due to the presence of cheek and tongue. Presence of short cingula on incisors is the major reason for overtapering in the bucco-lingual aspect. Although the mean convergence angle found among the three groups was higher than the recommended value, it was still within the acceptable limits.

CONCLUSION

Within the limitations of this study, it can be concluded that:

- i. The recommended Convergence Angle is difficult to achieve clinically.
- ii. The least mean Convergence Angle was achieved by the Prosthodontists while the general dental practitioners produced the highest Convergence Angle.
- iii. The mean B-L Convergence Angle of the tooth preparations was more than the mean MD Convergence Angle.

Further studies are needed to compare the convergence angle between maxillary and mandibular teeth, anterior and posterior teeth, single crown and FPD abutments and between vital and non-vital teeth. Use of sophisticated equipment's such as laser scanners and use of CAD-CAM may give a totally different dimension to these studies.

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