

Convergence Angle Of Prepared Teeth For Crowns: A comparison at College of Dentistry, Qassim University Saudi Arabia

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ABSTRACT

Objective: To compare clinically practiced convergence angle values of tooth preparation with recommended values, and also the effect of tooth position and operator experience on convergence angle.

Study Design: Cross Sectional analytical study

Place and Duration of Study: The study was carried out at the Dental clinics, Qassim University dental clinic, from August 2016 to February 2017.

Methodology: A minimum of 53 crown preparation dies were collected which were prepared by students and interns of operative dentistry. AutoCAD 2017 software was used for measurement of convergence angle. One sample t-test was applied to compare the mean practiced convergence angle values with its recommended values. One way ANOVA was applied to measure difference in convergence angle values with respect to operator experience and tooth type with the level of significance being $\alpha=0.050$.

Results: Mean reported convergence angle value was 27.62, which was significantly greater ($p < 0.001$) than the recommended values. Statistically significant difference in convergence angle was found between anterior vs. molar teeth and between premolars vs. molar teeth ($p=0.0001$ and $p=0.002$, respectively).

Conclusion: There was a considerable disparity between the convergent angles values recorded in this study and the recommended guidelines. Measured convergence angle values were greater for posterior teeth as compared to the anterior teeth.

Key words: *Convergence angle. Taper. Metal ceramic crowns. Anterior teeth. Posterior teeth.*

Introduction:

In prior studies, retention has been the primary concentration of interest for crown preparation standards. Although, resistance form is maybe more important in light of the fact that occlusal forces are coordinated in a lateral or an apical direction. (1) Retention of crown is influenced by convergence angle of preparation, height of preparation, height to base proportion of position and sort of luting cements. (2) Books rules for axial wall inclination while tooth preparation can change from 4-60 regularly referred to as perfect and 6-140 are acceptable. (2-3) These suggestions are hypothetical and hard to accomplish in clinical practice.

Functional decline criteria must characterize as pragmatic, quantifiable objective that the student can imagine and accomplish. However, a 120 degrees rule is more sensible than a 60 basis for full coverage crown preparations. (1) However, these guidelines are difficult to follow clinically, and divergence from parallel might have to be as much as 12° to be observed clinically as diverging surfaces. Mack observed that a minimal taper of 12° was necessary to ensure the absence of undercuts. (4) Goodacre et al. (7) proposed that the total CA should range between 10° and 20°. Other investigators have recommended 10° and 16° CA based on laboratory studies. Several techniques have so far been described for evaluating CA of tooth preparations. Devices such as photocopy machines, (8) overhead projectors, (10) goniometric microscopes, (11) 3-D laser scanners, (12) and diamond rotary cutting instruments (13) have been used to measure the CA of working dies; however, none of these devices have widespread acceptance.

Petal et al. administer a review in which dental medical students were instructed to get ready teeth for full crowns with a CA of 4-100. (5) Only 12.7% (8 out of 63 abutments) of the prepared teeth fell within the ideal range of 4-100, and the average CA value was 190. (6)

Annerstedt et al. assessed convergence angle values of full crown preparations for anterior, premolars and molars and the average convergence angle value reported was 210. (7) Several clinical studies reported convergence angle means for tooth preparation that ranged from 12.20 to 20.10 for dentists with no apparent correlation to their level of education and experience. (6-7)

Although the opinions of dentists vary considerably regarding the optimal CA, there is sparse data concerning the extent to which recommended values are used in dental practice.(8,9,10)

Materials and Methods:

It was cross sectional analytical study, conducted at Qassim University dental clinic, from August 2016 to February 2017. Consent was obtained from Dental Students' Research Facilitation Committee At college of dentistry Qassim university prior to initiation of the study. A minimum sample of 53 crown preparation models, (anterior, premolar and molar) were collected in order to achieve the objective of the study. Data was collected retrospectively using random sampling technique from die trimmed stone models after delivering crown to the patients. Crown preparation models of anterior, premolars and molars prepared by students and interns under normal clinical condition were included. The dies of the prepared teeth were removed from stone model base and mounted on square shaped hard wax block to stabilize in a fixed vertical position on horizontal table with white background. The camera was placed on tripod stand perpendicular to long axis of tooth and at a distance of 20 cm. Then photograph of prepared teeth stone dies were taken from mesiodistal direction using canon 600D and transferred to AutoCAD 2017 software (Sony Corporation, Tokyo, Japan) for measurement of convergence angle and axial wall tapers (mesial and distal). Data was collected form each specimen including convergence angle, axial wall taper, clinical operator level (students or interns) and tooth type (anterior, premolar and molar). Single trained investigator took photographs of prepared teeth stone models under standardized condition and to measure convergence angles with the help of software AutoCAD 2017.

A minimum sample of 53 crown preparation models were collected, 5% level of significance. Data was evaluated and analyzed using descriptive statistics to show the general behavior of data. One sample t-test was applied to compare the difference in mean clinically practiced convergence angle values with its recommended values (6-degree axial wall taper and 12-degree convergence angle). Difference in the convergence angle and axial wall taper between three groups of teeth (anterior, premolars and molars) and operator experience (students and interns) were tested for significance by one way ANOVA (Bonferroni test). A p-value below 0.05 was considered statistically significant. Statistical Package for Social Sciences (version 21.0) was employed for data entry and analysis.

RESULTS:

The (Table I) indicates that, out of 53 crown preparations 10 were prepared by 4th year students, 31 by 5th year students and 12 by interns. The mean value of convergence angle was 27.62. Meanwhile, mean value revealed convergence angle values for anterior, premolars and molars were 25.2, 24.86 and 31.36.

Finally, distal wall taper was comparatively greater than the mesial wall taper among three gatherings of teeth. Mean convergence angle and axial wall taper values among three groups of teeth are representing one-way ANOVA, which is comparing the difference in the convergence angle and axial wall taper values between three groups of teeth and indicated statistically significant difference in convergence angle values between anterior vs. molar teeth and between premolars vs. molar teeth ($p=0.0001$ and $p=0.002$, respectively).

(Table I) mean convergence angle and axial wall taper values among three groups of teeth

Variable	Tooth type	Tooth number (n=53)	Mean	std	df		P value
Buccolingual convergence angle	Anterior Premolar Molar	10	39.70	13.458	Between groups	2	0.000
		21	23.71	9.106	Within groups	50	
		22	38.41	13.458	total	52	
Mesio distal convergence angle	Anterior Premolar Molar	10	25.2	9.175	Between groups	2	.079
		21	24.86	9.334	Within groups	50	
		22	31.36	10.777	total	52	
mesial wall taper	Anterior Premolar Molar	10	12.00	7.630	Between groups	2	.952
		21	12.86	5.624	Within groups	50	
		22	12.77	8.696	total	52	
Distal wall taper	Anterior Premolar Molar	10	11.10	5.446	Between groups	2	.002
		21	10.86	4.910	Within groups	50	
		22	19.50	10.914	total	52	
Buccall taper	Anterior Premolar Molar	10	5.20	6.563	Between groups	2	.000
		21	9.62	7.003	Within groups	50	
		22	21.32	10.453	total	52	
Lingual wall taper	Anterior Premolar Molar	10	34.70	15.151	Between groups	2	.000
		21	14.86	9.769	Within groups	50	
		22	17.14	9.731	total	52	

The (Table II) is indicating one sample t-test that is found significant ($p < 0.001$) between hypothesized mean and clinically practiced mean convergence angle and taper values.

Variable	Hypothesized mean	Clinically practiced Values (mean \pm std)	P value
Convergence angle	12	27.62	.000
Axial wall taper	6	15.08	.000

DISCUSSION:

The findings of the present study led the acceptance of study hypothesis that there is a distinction in the average clinically practiced convergence angle values as for its suggested values. In the present review, the convergence angle values were observed to be significantly higher than its prescribed values. Comparative outcomes were reported for by Nordlander et al. (9)

Noonan et al. and Sato et al. analyzed convergence angle and taper estimations of dental students under normal clinical condition and special testing condition. They found more higher values under normal clinical condition compare to proficient testing condition. (8,11) Similarly, the current review also discovered higher convergence angle values under normal clinical condition. It also has been argued that clinical training helps in enhancing the clinical practices and accomplishing the values.

Weed additional findings are suggesting that dental students could create tooth preparation for complete crowns with a taper of 12.70 on typodonts, yet their clinical preparations had a mean taper of 22.80. (12) However, it is difficult to accomplish prescribed taper intraorally when contrasted with typodonts because of limited access and visibility.

Furthermore, mean value described convergence angle as a full coverage crown preparation in the present review under normal clinical condition with 27.62° , hence, that is somewhat not as much as that described by Leempoel et al., (14) Al-Omari (13) and Weed (12) and more prominent than that measured in Nordlander et al., (9) Rafeek et al. (15) and Mack. (4) This dissimilarity in the convergence angle (merging point) values were likely because of sample size distinction and random selection of crown preparation models from clinics in our review.

Furthermore, axial wall taper and convergence angle values were altogether less for premolars when contrasted with anterior and molars teeth and distal wall taper was essentially more greater than mesial wall taper, presumably, this is happening because of trouble in positioning handpiece and limited access to on distal aspect of tooth. However, the convergence angle values contrast acquired in this examination amongst anterior, premolars and molars concurred with the findings of Ayad et al.,¹⁶ Leempoel et al.,¹⁴ Smith CT et al.¹ and Al-Omari.¹³ Parker et al. concluded that correct positioning of hand piece or precious stone cutting instrument while crown preparation is quite difficult on the distal part of tooth, particularly on the molar teeth when contrasted with premolar teeth. (17)

Moreover, impact of students clinical experience did not demonstrate huge difference in convergence angle and taper values inside a similar group and between the three groups of teeth including (anterior, premolar, molars), Moreover, the findings indicates that there could be improvement in convergence angle and taper value with the support of years of clinical experiences. These findings got theoretical support by Petal et al. and Nordlander et al. (5,9)

However, hypothetical rules for wall taper and convergence angle during tooth preparation are discretionary standards and are not reliable with the reality. Given the complicated interrelationships of clinical, hypothetical, and mechanical factors that decide the retention and resistance qualities of preparation in vivo, it is advisable to design preparations that mix retentive attributes with useful demands.

Finally, the limitations of the contemporary review are, this is cross-sectional research and convenience sample used more than randomization while the collection of data. Somehow, long-term clinical studies are essential to fully assess the effect of convergence angle on the longevity of individual crown.

CONCLUSION:

In the light of current limitations, it might have concluded that there was a significant difference between the convergent angles and taper values which recorded in this review and the designs recommended in settled prosthodontic course readings and the dental literature review. Moreover, convergence angle and axial taper values were essentially greater for molar teeth when compared with premolar and anterior.

Finally, distal taper was greater than mesial wall taper.

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