ORIGINAL ARTICLE

Effects of taper in vital and non-vital teeth for fixed partial denture

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Abstract

The degree of taper created during tooth preparation has a direct bearing on the retention of a fixed restoration. In particular, the convergence angle influences the extent to which a prepared tooth can withstand axial and lateral forces without compromising the stability of the crown. This study evaluated the taper of preparations made on vital and non-vital teeth in relation to the age and sex of the patients. Information regarding age, sex, and the clinical status of the teeth was obtained through a patient questionnaire. The convergence angle was assessed by projecting the buccolingual and mesiodistal aspects of the dies produced from impressions using an overhead projector. Fifty patients were recruited from the Department of Prosthodontics, Military Dental Centre, Dhaka, irrespective of sex and age, according to predefined inclusion and exclusion criteria. Among vital teeth in males, the mean cone angle ranged from 18.20° ± 0.88° to 22.00° ± 1.00°, while the corresponding bevel angles ranged from 23.2° ± 1.06° to 26.1° ± 1.06°. In females with vital teeth, cone angles ranged from 19.2° ± 0.78° to 21.0° ± 1.10°, and bevel angles from 22.2° ± 1.00° to 25.1° ± 1.00°. For non-vital teeth, male participants showed cone angles of 11.8° ± 0.72° to 21.5° ± 1.05° and bevel angles of 34.8° ± 1.46° to 36.1° ± 1.10°, whereas female participants demonstrated cone angles of 10.8° ± 0.82° to 22.5° ± 1.07° and bevel angles of 32.8° ± 1.26° to 35.1° ± 1.00°. Appropriate taper of the abutment is essential for maintaining the stability and clinical performance of a fixed dental prosthesis. Excessive or inadequate taper may compromise the abutment and increase the risk of fracture or eventual tooth loss.

Keywords: *Taper; Retention; Convergence angle; Axial walls*

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Introduction

The retention of a fixed restoration is governed by several factors, including the diameter and height of the prepared tooth, the properties of the luting cement, and, importantly, the convergence angle, which is largely under the clinician's control. Convergence angle refers to the angle formed by two opposing axial walls and corresponds to the combined taper of those walls relative to the long axis of the preparation. The anatomical characteristics of the tooth frequently place practical limits on the achievable height and diameter of a preparation. The contribution of luting cement to retention is related to factors such as mechanical interlocking, the area available for cement coverage, cement durability, and its resistance to mechanical deterioration and dissolution.[1]

Because of this relationship, preparation taper is regarded as an important determinant of restoration retention. Conventional teaching in fixed prosthodontics commonly recommends a wall taper of approximately 2° to 5° on each side. This range has also been incorporated into laboratory investigations using standardized tooth preparations or dies for assessment of restorative materials and clinical techniques. Experimental evidence has demonstrated a relationship between the force required to dislodge cemented cast restorations and the convergence angle of the prepared dies. Since the total convergence angle represents the combined taper of the two opposing walls, a taper of 2° to 5° on each wall produces an overall convergence angle of approximately 4° to 10°.[2]

Previous investigations have generally indicated that preparations with a smaller degree of taper or convergence provide greater resistance to dislodgement of complete-coverage restorations. Various studies have therefore proposed taper values between 2° and 7°, corresponding to convergence angles of approximately 4° to 14°, as favorable ranges for achieving adequate retention.

During preparation of teeth intended to receive single crowns or serve as abutments for fixed dental prostheses, an important objective is to establish a definite and unobstructed path of insertion for the restoration. At the same time, the preparation should maintain a clinically appropriate convergence angle. A convergence angle in the range of approximately 2.5° to 6.5° has been proposed to help limit stress concentration within the restoration and supporting tooth structure.[3,4] The present study was therefore undertaken to assess taper and convergence characteristics with the objective of optimizing retention and contributing to the long-term clinical performance of fixed partial dentures.

Method

A cross-sectional study was conducted in the Department of Prosthodontics, Military Dental Centre, Dhaka. Fifty patients were included regardless of age and sex, with both vital and non-vital teeth represented. Participants were selected according to predetermined inclusion and exclusion criteria.

Patients aged 18 to 57 years of either sex who had vital or non-vital teeth, carious lesions of varying duration, an adequate clinical crown, and an acceptable crown-to-root ratio were eligible for inclusion. Teeth with fractures, extensive structural destruction, inadequate clinical crown height, or periodontal weakness were excluded. Patients presenting with poor oral hygiene were also excluded. The instruments and materials used during the study included a dental mirror, handpiece, diamond burs, finishing and polishing burs, periodontal probe, vector scale, dental periscope, and projector.

Taper measurements were obtained from vital and non-vital teeth and evaluated according to sex and age. Participants provided information concerning their age, sex, and the clinical condition of the tooth through a questionnaire. Not all teeth included in the assessment were constructed at the study site.

For measurement of the convergence angle, impressions were used to produce dies, and the buccolingual and mesiodistal aspects of each die were projected with an overhead projector. The die was securely positioned over the projector lens using clay so that the outline of the selected surface could be reproduced accurately. After obtaining a sharply focused projection on paper, the image was traced. Reference lines were subsequently drawn parallel to the traced axial walls in the cervical or gingival third of the preparation. These lines were extended until they intersected, and the resulting angle was used to determine the convergence angle.[2]

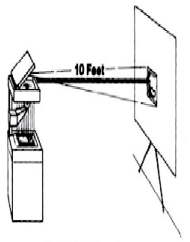

Fig. 1. Projection of preparation taper.

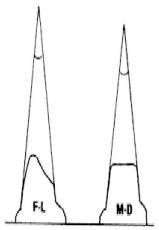

Fig. 2. Example of convergence angle worksheet. F-L = facioli ngual; M-D = mesiodistal.

Result

Table I: Distribution of patients according to age. (n=50)

Age (Years)	Number of patients	Percentage (%)
18-27	10	20%
28-37	11	22%
38-47	18	36%
48-57	11	22%

Table-I showed that among 50 patients, majority 18 (36%) patients were in age group of 38-47 & 10 (20%) patients were in the age group of 18-27.

Table II: Distribution of patients according to sex (n=50)

Gender	Vital teeth (n=25)		Non-vital teeth (n=25)	
	n	%	n	%
Male	13	52.0%	12	48.0%
Female	12	48.0%	13	52.0%

Table-II showed that among 50 patients, equal 25 (50%) patients were in male with vital and non-vital teeth and 25 (50%) patients were female with vital and non-vital teeth group.

Table III: Mean cone angle for vital and non-vital teeth according to sex (n=50)

Gender	Vital teeth (bucco-lingually) (n=25)		Non-Vital teeth (bucco-lingually) (n=25)		Vital teeth (mesio-distally) (n=25)		Non-Vital teeth (mesio-distally) (n=25)	
	Mean	SD	SD	Mean	SD	Mean	SD	Mean
Male	22.0º	1.00º	21.5º	1.05º	18.2º	0.88º	11.8º	0.72º
Female	21.0º	1.10º	22.5º	1.07º	19.2º	0.78º	10.8º	0.82º

Table-III showed that, in vital teeth group, cone angle bucco-lingually 22.0°±1.00° for male and 21.0°±1.10° for female, cone angle mesio-distally 18.2°±0.88° for male and 19.2°±0.78° for female. In non-vital teeth group, cone angle bucco-lingually 21.5°±1.05° for male and 22.5°±1.07° for female, cone angle mesio-distally 11.8°±0.72° for male and 10.8°±0.82° for female.

Table IV: Mean bevel angle for vital and non-vital teeth according to sex (n=50)

Gender	Vital teeth (bucco-lingually) (n=25)		Non-Vital teeth (bucco-lingually) (n=25)		Vital teeth (mesio-distally) (n=25)		Non-Vital teeth (mesio-distally) (n=25)	
	Mean	SD	SD	Mean	SD	Mean	SD	Mean
Male	26.1º	1.06º	36.1º	1.10º	23.2º	1.06º	34.8º	1.46º
Female	25.1º	1.00º	35.1º	1.00º	22.2º	1.00º	32.8º	1.26º

Table-IV showed that, in vital teeth group, bevel angle bucco-lingually 26.1°±1.06° for male and 25.1°±1.00° for female, bevel angle mesio-distally 23.2°±1.06° for male and 22.2°±1.00° for female. In non-vital teeth group, bevel angle bucco-lingually 36.1°±1.10° for male and 35.1°±1.00° for

female, bevel angle mesio-distally 34.8°±1.46° for male and 32.8°±1.26° for female.

Discussion

When a tooth is prepared to receive an artificial crown, the opposing axial surfaces do not remain completely parallel and consequently form an angle known as the convergence angle. This angle has clinical importance because it influences the ability of the prepared tooth and restoration to resist both axial and lateral forces without loss of retention. It also affects the relationship between the cervical margin of the restoration and the finishing line of the preparation, including the amount of exposed luting cement that may remain between the restoration and the prepared tooth after seating.[5]

A cast metal or ceramic restoration must be accurately seated onto the prepared tooth after fabrication. For this reason, the axial walls require a small degree of convergence to facilitate insertion of the restoration along its intended path. From a purely mechanical perspective, retention tends to increase as opposing preparation walls become more closely parallel.

Although a preparation with parallel walls would theoretically provide the highest degree of retention, achieving true parallelism intraorally is impractical because it increases the possibility of creating undercuts. Such undercuts can interfere with complete seating of the restoration. A controlled degree of taper is therefore introduced to improve visualization of the preparation, eliminate undesirable undercuts, accommodate minor inaccuracies arising during laboratory fabrication, and facilitate more complete seating of the restoration during cementation.[6]

A previous investigation reported a mean buccolingual cone angle of 23.0° ± 1.01° and a mesiodistal cone angle of 19.2° ± 1.07° for vital teeth. In non-vital teeth, the corresponding mean values were 22.5° ± 1.06° buccolingually and 12.8° ± 0.73° mesiodistally.[5]

In the present study, the vital-tooth group showed a mean buccolingual cone angle of 22.0° ± 1.00° in males and 21.0° ± 1.10° in females. The corresponding mesiodistal measurements were 18.2° ± 0.88° for males and 19.2° ± 0.78° for females. Among non-vital teeth, the mean buccolingual cone angle was 21.5° ± 1.05° in males and 22.5° ± 1.07° in females, while the mesiodistal cone angle measured 11.8° ± 0.72° and 10.8° ± 0.82°, respectively.

With respect to bevel angle, an earlier study found mean buccolingual and mesiodistal values of 27.1° ± 1.07° and 24.2° ± 1.07°, respectively, in vital teeth. For non-vital teeth, the reported mean buccolingual bevel angle was 37.1° ± 1.11°, while the mesiodistal value was 35.8° ± 1.47°.[5]

The present findings showed that the mean buccolingual bevel angle among vital teeth was 26.1° ± 1.06° in males and 25.1° ± 1.00° in females. The mesiodistal bevel angle measured 23.2° ± 1.06° in males and 22.2° ± 1.00° in females. For non-vital teeth, the corresponding buccolingual measurements were 36.1° ± 1.10° in males and 35.1° ± 1.00° in females. The mesiodistal bevel angle was 34.8° ± 1.46° in males and 32.8° ± 1.26° in females.

Clinical observations indicate that tooth preparations are often made with a greater degree of taper than intended. Excessive taper should be avoided because increasing the convergence angle is associated with a reduction in the retentive capacity of the preparation. Accordingly, preparation should be as conservative as clinically feasible while still eliminating undercuts and allowing proper seating of the restoration. Previous work has suggested that a minimum taper of approximately 12° may be required to avoid undercuts under certain clinical conditions.[7]

Conclusion

Accurate assessment of preparation taper and the resulting convergence angle is an important component of fixed partial denture treatment. Appropriate control of these parameters can help the clinician balance the need for adequate retention with the requirements for proper visualization, restoration seating, and conservation of tooth structure. The findings of this study provide comparative information on taper and bevel angles in vital and non-vital teeth and may assist prosthodontists in planning abutment preparations according to accepted clinical principles. Maintaining an appropriate degree of taper may contribute to the stability and long-term serviceability of fixed dental prostheses.

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