ORIGINAL RESEARCH

Comparison of the Convergence Angle in Full-crown Abutment Teeth prepared by the Preclinical and Senior Students in Faculty of Dentistry, Tabriz University of Medical Sciences, Islamic Republic of Iran

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ABSTRACT

Introduction: One of the main factors in the successful treatment of fixed prosthodontics is preparation of the teeth such that proper retention of the crown is provided. The aim of the study was to compare the convergence angle in full-crown abutment teeth prepared by the preclinic and senior students in the Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Islamic Republic of Iran.

Materials and methods: A cross-sectional/analytical study was conducted on dental students in the Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Islamic Republic of Iran in 2016. The sample size was determined randomly at n = 30 for each group. Preparation angle for each specimen was measured and recorded by digital photographs and Autocad software. The results were analyzed with appropriate statistical tests.

Results: The results showed that preclinic and senior students prepared the anterior teeth with average values of 22.13 ± 9.59 to 18.53 ± 8.87° and 18.46 ± 11.08 to 14.6 ± 6.32° respectively, from the buccolingual and mesiodistal aspects. Concerning posterior teeth, preclinic and senior students prepared them with average values of 21.4 ± 10.24 to 22.46 ± 8.99° and 19.46 ± 8.09 to 21.13 ± 8.83° respectively. Although the average value of convergence angle in both aspects was higher for preclinic students than for the senior students, t-test for independent groups revealed no significant differences (p > 0.05).

Conclusion: Either preclinic or senior students prepared the teeth with a convergence angle, i.e., higher than ideal. However, all the recorded angles were within the range of previous studies.

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INTRODUCTION

Retention of the crown depends on several factors, including the convergence angle of preparation, height of the prepared tooth, and type of the dental cement.[1,2] Convergence angle is defined as the angle between the two opposing walls of the prepared tooth. In theory, retention increases as parallelism of the prepared walls is increased. However, walls are prepared with a minor degree of convergence to expose the prepared surface, avoid undercuts, and have an accurate and thorough construction processes and compensate inaccuracies.[1-5]

Ward[6] was the first to recommend a convergence angle of 3 to 12°. In subsequent years, the so-called convergence angle has varied between 3 to 5° and 10 to 14°.[2,7-9] Wilson Jr and Chan[10] proposed a 6 to 12° range for the convergence angle since it is practically viable and facilitates laboratory work in association with a better retention between the crown and tooth. Goodacre et al[11] reviewed the papers of the last 50 years and concluded that the convergence angles of 10 to 20° yield the best clinical results.

Studies show that an increase in taper reduces the retention of the crown significantly. In a study conducted by Ayad et al,[12] maximum and minimum retention of restorations was observed in a convergence angle of 5 to 25°. In another study, Shekar et al[5] evaluated 80 crowns of the upper premolar teeth bonded with glassionomer and zinc phosphate cements. They reported that by increasing the angle of convergence from 0 to 6 or 12°, no major change was observed in crown retention. They also concluded that decreasing this angle from 18 to 24° reduced retention significantly. It should also be noted that from 24° upward, retention drops by 50% compared with the parallel case.

In a research carried out by Ghafoor et al[1] on 75 teeth, convergence angle was considerably higher than the recommended value. The average value of 27° was reported in this study. Furthermore, the convergence angle in the posterior teeth was higher than that in the interior teeth.

Given the primary role of convergence angle in the retention of prostheses and its undeniable role in the longevity of prostheses, choosing a proper angle for it is one of utmost importance in tooth preparation for fabricating fixed prostheses in the clinic. If this principle is not met, serious emphasis should be placed on fundamental training to solve the problems involved. A preliminary research showed that this issue has not been dealt with in the Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Islamic Republic of Iran and the available studies are few and sometimes contradictory.

MATERIALS AND METHODS

A cross-sectional/analytical study was conducted on dental students in the Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Islamic Republic of Iran and general practitioners in Tabriz, Islamic Republic of Iran in 2016. The sample size was estimated at n = 30 for each group, using Patel et al's[2] data at $\alpha = 0.05$ and power = 80%. In this regard, 15 central incisors of the upper jaw and 15 molar teeth of the upper jaw were examined in each group.

In this study, 30 models consisting of 15 models with central incisors of the upper jaw and 15 models with first molars of the upper jaw were prepared by preclinic students and classified as group one. The same procedure was applied to the senior students and classified as group two. To match the preparation conditions between the groups, the models were fixed on the head phantom before the preparation started. A maximum of 30 minutes was given to each student.

To measure the convergence angle of the teeth with white background, digital photographs were taken perpendicular to the longitudinal axis of teeth from a distance of 20 cm (Canon EOS 450D, 12.2 MP; Canon Inc., Tokyo, Japan) with a 100 mm macrolens in RAW format under the same photography conditions with mesiodistal and faciolingual aspect considerations. Afterward, the convergence angle was measured and recorded separately for each specimen by two prosthodontists using AutocadAutodesk (Sony Corporation, Tokyo, Japan 2012).[1-4] To ensure the unanimity of observers, Kappa coefficient was used (Kappa coefficient = 98%). To perform statistical analyses, descriptive statistics (means and standard deviation) and t-test were used with Statistical Package for the Social Sciences version 21. Statistical significance was set at p < 0.05.

Table 1: Convergence angles of preparation in the two study groups

Group	Mean ± Standard deviation
Anterior teeth	
Buccolingual	
Preclinic	22.1333 ± 9.59067
Senior	18.4667 ± 11.08968
Mesiodistal	
Preclinic	18.5333 ± 8.87103
Senior	14.6000 ± 6.32230
Posterior teeth	
Buccolingual	
Preclinic	21.4000 ± 10.24556
Senior	19.4667 ± 8.09644
Mesiodistal	
Preclinic	22.4667 ± 8.99894
Senior	21.1333 ± 8.83877

RESULTS

Table 1 presents the mean convergence angles in posterior and anterior teeth separately.

The results showed that preclinic and senior students prepared the anterior teeth with mean values of 22.13 ± 9.59 to 18.53 ± 8.87° and 18.46 ± 11.08 to 14.6 ± 6.32° from buccolingual and mesiodistal aspects respectively. Concerning posterior teeth, preclinic and senior students prepared them with mean 21.4 ± 10.24 to 22.46 ± 8.99° and 19.46 ± 8.09 to 21.13 ± 8.83°. Despite the fact that the mean value of convergence angle in both aspects was higher for preclinic students than for senior students, t-test for independent groups revealed no significant differences between them (p > 0.05).

DISCUSSION

In theory, the retention increases as parallelism of the prepared walls increases. However, the walls are prepared with a minor degree of convergence to expose the prepared surface, avoid undercut, and bring about an accurate and thorough construction processes and compensate inaccuracies.[1-5] Mack[13] estimated that a minimum of 12° is required to ensure that undercuts will be avoided.

Moreover, studies showed that in preparation angle of 2.5 to 6.5°, stress in the cement between the prepared tooth and the restoration is minimized. As the taper increases up to 15°, a slight increase in stress value is observed; continuing this trend up to 20° results in a highly concentrated stress.[14,15] Therefore, a little preparation angle in the abutment tooth is necessary, the ideal reported range being 3 to 5°.[1,5,12,16]

In numerous studies, preparation angle of 16° is practically viable in clinical terms and provides adequate retention for restorations (the angle can vary up to 10°

in anterior teeth compared with the 22°, i.e., observed in molar teeth).[17]

In this study, the results showed that preclinic and senior students prepared the anterior teeth with average values of 22.13 to 18.53° and 18.46 to 14.6° respectively, from the buccolingual and mesiodistal aspects. Concerning posterior teeth, preclinic and senior students prepared them with average values of 21.4 to 22.46° and 19.46 to 21.13° respectively. Either preclinic or senior students prepared the teeth with a convergence angle, i.e., higher than ideal. However, all the recorded angles were within the range of the previous studies.

In a research carried out by Ghafoor et al[1] on 75 teeth, convergence angle was considerably higher than the recommended value. The average value of 27° was reported in this study.

In a study, Annerstedt et al[18] examined the preparation angle of anterior, premolar, and molar teethand reported an average value of 21°.

Patel et al[2] asked 63 dental students to create convergence angles of 4 to 10°. Only eight students (12%) were able to do so. Regardless of any educational categorization, on average, the convergence angle was 19°.

Kent et al[7] reported a convergence angle of 12 to 20° based on the work experience of dentists. In this study, experience had no effect on convergence angle.

In another study conducted by Makker et al,[8] on 300 specimens, prosthodontists prepared the teeth with a slight difference from the ideal angle. In contrast, teeth prepared by general dental practitioners had a higher convergence angle.

Taking all the above-mentioned discussions into consideration, it seems that achieving an ideal convergence angle in central walls of the tooth is difficult. Nevertheless, it is compulsory in terms of undercut elimination and facilitation of restoration. Consequently, convergence angle should be made with the full knowledge about restoration retention effects. In cases where retention of the restoration is not ensured, slit, and/or resin cements should be considered to increase retention. Besides, tools are recommended that can help create a desired convergence angle. In this study, the preparations were made on models installed on head phantoms. However, it seems that unlike laboratory conditions, tooth preparation faces some difficulties associated with sight, etc. In a study conducted by Rafeek et al,[4] tooth preparation angles in anterior teeth prepared by students under laboratory and clinical conditions were 26.7 to 14.9 and 31.6 to 16.8° from buccolingual and mesiodistal aspects respectively. Thus, comprehensive studies are required under clinical conditions. It should also be noted that despite the fact that convergence angle was slightly higher in teeth prepared by preclinic students it was not significant statistically.

Despite expectations, it can be concluded that there was no difference between convergence angles created by preclinic and senior students. However, it was not feasible to evaluate the efficacy of the training received during the university courses since comparisons were made in two different groups. Therefore, it is recommended that longitudinal assessments be carried out to examine the efficiency of trainings received.

CONCLUSION

Both the preclinic and senior students prepared the teeth with a convergence angle higher than the ideal. However, all the recorded angles were within the ranges of previous studies.

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