Clinical and Experimental Health Sciences

Digital Evaluation of the Depth and Width of Upper and Lower Molar Cavity Preparations of Dental Students

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ABSTRACT

Objective: The aim of this study was to evaluate the mesial and distal seat widths and the buccal, lingual, and axial wall height values of cavity preparations by measuring them with the help of a digital scanner.

Methods: In this study, 70 randomly selected students of 140 tooth preparations (mandibular molar and a maxillary molar cavities) of phantom jaw models were evaluated. The prepared teeth were scanned with an intraoral scanner. The parameters used in the analysis were the depth values of the buccal and lingual (or palatal) wall depth, the mesial and distal axial wall height, and the mesial and distal seat width values. For main effects and interactions, two-way analysis of variance was used, and for multiple comparisons, Tukey's test was used ($p < .05$).

Results: No significant difference was found in the teeth according to cavity depth. However, a significant difference was found in the cavity regions' depths or widths. There was no difference between the total buccal (1.93 ± 0.01 mm) and lingual (1.91 ± 0.32 mm) depth values. There was no difference between the total mesial (1.51 ± 0.27 mm) and distal (1.41 ± 0.26 mm) seat width values. There was no difference between the total mesial (1.11 ± 0.35 mm) and distal (1.21 ± 0.27 mm) axial wall height values.

Conclusion: It was observed that the students had more difficulty in the distal region of the tooth than in the mesial region. Digital methods in preclinical education can provide objective results in the evaluation of cavity preparations.

Keywords: Digital dentistry, tooth preparation, cavity depth, operative dentistry

1. INTRODUCTION

In dental education, students are provided with preclinical practical applications to achieve and develop their basic dental skills (1). This process includes a series of progressive stages, starting with the theoretical course and then progressing to preclinical simulation through to the clinical phase process (2). Phantom jaw models used in preclinical applications provide the opportunity to learn appropriate ergonomic working conditions and to practice the appropriate use of hand tools, such as mirrors and probes (3). Before treating the real patient in the clinic, the student is taught in preclinical practical lessons, using artificial or extracted natural teeth. For this reason, it is desired that the preclinical education of dental students who will treat patients the clinics should already include individual patient care (1). One of the important components of preclinical dental education is restorative dentistry. The practice of restorative dentistry enables students to acquire and develop manual dexterity and learn about the clinical aspects of restoration of carious or defective teeth (4).

One of the most important skills for dentists is replacing the diseased tooth structure. This skill is the main focus of undergraduate operative dentistry courses. For this reason, among the main objectives of undergraduate operative dentistry education, the education of students on making cavity preparations in teeth is important (5). The restoration should protect the remaining tooth structure, as well as create the lost tooth structure. This varies depending on the type of restoration and the material. It is important to protect the existing tooth structure, not to remove the healthy tooth structure unnecessarily, to preserve the vitality of the pulp, and to ensure retention form (6). Before going to the clinic, preclinical practice laboratories offer dental students the opportunity to learn the basic skills of operative dentistry (2). Depth perception is an important requirement in dental practice, and it is necessary not only to perceive that surfaces are at different depths but also to accurately estimate the depth within a three-dimensional object (7).

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Digitization in dentistry is a popular and expanding field, especially for the computer-aided design or computer-aided manufacture of dental restorations and devices (8). In particular, the general trend in this regard has affected laboratory practices and clinical approaches, both in computer technology and developments in industrial fields. New digital techniques will require the development of new training methods and the implementation of existing treatment protocols. The high reliability of the evaluation process regarding the performance of dental students in terms of feedback on their mistakes is essential (9). Computer-based technologies offer an opportunity to increase quality management, not only related to standardized restoration production, but also to the optimization of clinical procedures. Computer-based software ensures high processing quality and efficiency. It analyzes the examined profile (region) by scanning the full 360-degree inspection area, thus providing a comprehensive evaluation. As the parameters examined are adjustable, the intended restoration design and restorative materials can be taken into account (10).

As a result of the evaluations, the examination of the cavity depth values prepared by the dental students and measurement with the help of digital software can provide more reliable results. Therefore, the aim of this study was to evaluate the cavity depth values and mesial and distal seat width values, as well as the buccal, lingual, and axial wall height values measured with the help of a digital scanner. The null hypotheses of this study were as follows: (1) There is no significant difference between the mesial and distal seat width values and the buccal, lingual, and axial wall height values of the different tooth regions. (2) There was no significant difference between the depth values examined for different teeth.

2. METHODS

In this study, cavity preparations prepared by second-year dental students in phantom jaw models under practical exam conditions were used. Ethical approval for the study was obtained from the Necmettin Erbakan University, Faculty of Dentistry, Non-Pharmaceutical and Medical Device Ethics Committee (24.11.2022/221). Attention was paid to ensuring that the phantom jaw models used by the dental students were standard and of the same brand (Fuji, Piramit Dental, Türkiye). Cavity preparations made in phantom jaw models of 70 dental students participating in the study were examined. A total of 140 phantom teeth with MOD cavities were examined (right mandibular first molar and left mandibular first molar). Then, the teeth were scanned with an intraoral scanner 3Shape TRIOS (Copenhagen K, Denmark). The digitized models were transferred to the 3Shape 3D Viewer (Copenhagen K, Denmark) program in Standard Tessellation Language (STL) format, and three-dimensional measurements were made (Figure 1). The parameters used in the analysis are the depth values of the buccal, lingual, or palatal walls, axial wall height, and mesial and distal gingival seat width values (Figure 2 and Figure 3). In line with these parameters, it was determined that the occlusal depth was 2 mm, the axial wall height was 1 mm, and the gingival seat widths were 1.5 mm (11). In addition, according to the prepared teeth, regions were classified as upper and lower molar teeth. Digital measurements of the cavity preparations were made by two observers independently of each other.

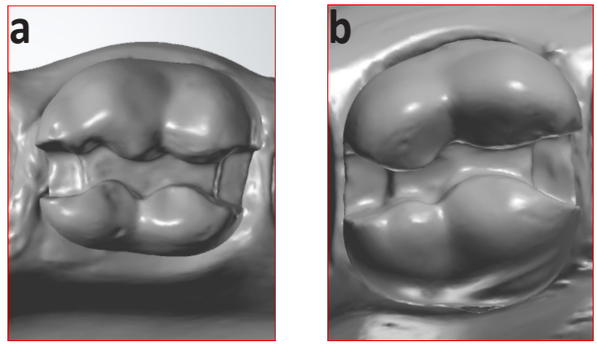

Figure 1. *a: Scanned sample lower molar tooth b: Scanned sample upper molar tooth*

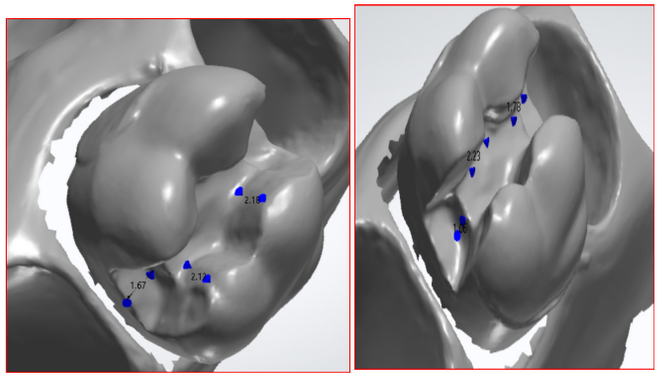

Figure 2. *Digital measurements of the sample upper molar teeth from different directions*

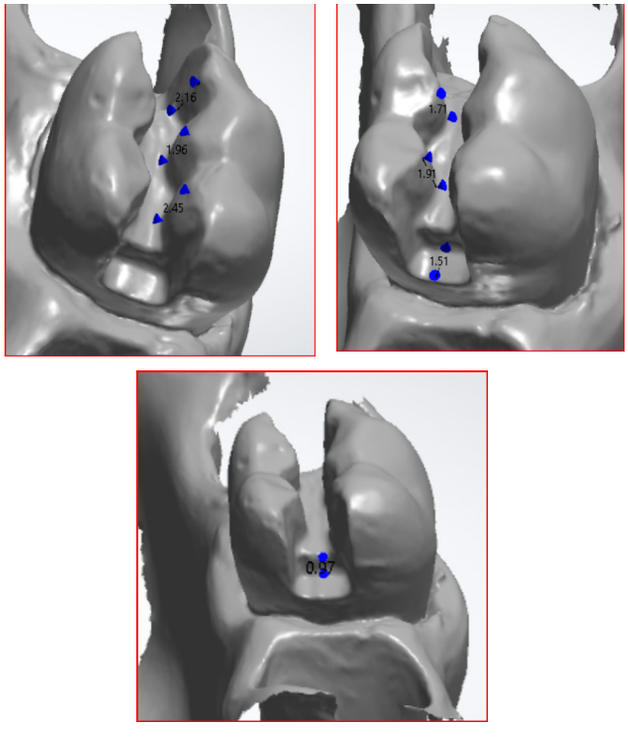

Figure 3. *Digital measurements of the sample lower molar teeth from different directions*

Statistical Analysis

The IBM SPSS Statistics for Windows (Version 23.0. Armonk, NY: USA) package program was used to perform the statistical analysis. Upon examination of the compliance of the data with the normal distribution, the decision was made by considering the Kolmogorov-Smirnov test, as well as the skewness and kurtosis values. The two-way analysis of variance was used for the depth or width of the interaction between the factors (region×tooth). If the interaction between region and tooth was not significant, the depth or width values of the analyzed variables on the main effects were evaluated by examining the total values (if the main effect was significant). The Bonferroni test was used to compare the main effects. Tukey's test was used for multiple comparisons. Partial eta squared (η^2) values are a statistical measure used to rank the effect of independent variables on dependent variables. The effect of region, tooth, and interactions on the dependent variable was also shown with partial eta squared. It was used to show the level of the main effect or the effect of the interaction on the dependent variable. The significance level of difference was set at $p < .05$.

3. RESULTS

The main effects and interactions of the investigated parameters are shown in Table 1. Descriptive values (mean ± standard deviation) are shown in Table 2. According to the two-way ANOVA results, no significant differences were found between the teeth according to the examined cavity depth or width ($p = .466$), although there was no difference between the lower and upper teeth (Table 2). However, it was determined that there were significant differences in the cavity regions according to the cavity depth or width ($p < .001$). There was no difference between the total buccal (1.93 ± 0.01 mm) and lingual (1.91 ± 0.32 mm) depth values ($p = .069$). There was also no difference between the total mesial (1.51 ± 0.27 mm) and distal (1.41 ± 0.26 mm) seat width values ($p = .069$). In addition, there were no differences between the total mesial (1.11 ± 0.35 mm) and distal (1.21 ± 0.27 mm) axial wall height values ($p = .086$).

When the agreement between the observers was examined without any discrimination, the ICC value was found to be 0.995 ($p < .001$). The correlation values obtained ranged between 0.991 and 0.998 when tooth separation was made, and the obtained values were statistically significant ($p < .001$). The correlation value was high and statistically significant, the analysis was performed by taking the average values of the observers' measurements (Table 3).

Table 1. *Two-way ANOVA results for parameters (main effects and interaction)*

Source	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
region	0.048	1	0.048	0.533	.466	.001
tooth	81.947	5	16.389	183.345	< .001	.525
region × tooth	0.345	5	0.069	0.772	.570	.005

R Squared = .527 (Adjusted R Squared = .520)

Table 2. *Means and standard deviations for region and teeth. The total data in the column indicates the teeth, and the total data in the row indicates the region*

Region	36	16	Total
B	1.95 ± 0.25	1.90 ± 0.36	1.93 ± 0.31[a]
L	1.88 ± 0.23	1.93 ± 0.39	1.91 ± 0.32[a]
MB	1.49 ± 0.28	1.53 ± 0.26	1.51 ± 0.27[b]
MA	1.10 ± 0.36	1.13 ± 0.35	1.11 ± 0.35[c]
DB	1.42 ± 0.26	1.40 ± 0.25	1.41 ± 0.26[b]
DA	1.19 ± 0.24	1.23 ± 0.29	1.21 ± 0.27[c]
Total	1.50 ± 0.42[A]	1.52 ± 0.44[A]	1.51 ± 0.43

B:Buccal, L:Lingual, MB: Mesial gingival seat width, MA: Mesial axial wall height DB: Distal gingival seat width DA: Distal axial wall height
Different lower letters represent statistically significant differences in column. Different capital letters represent statistically significant differences in colum in row. There is no difference between the same letter.

Table 3. *ICC results*

	ICC (%95 CI)	p
36-B	0.992 (0.987 – 0.995)	<.001
36-L	0.991 (0.986 – 0.994)	<.001
36-MB	0.991 (0.985 – 0.994)	<.001
36-MA	0.997 (0.995 – 0.998)	<.001
36-DB	0.995 (0.991 – 0.997)	<.001
36-DA	0.995 (0.993 – 0.997)	<.001
16-B	0.944 (0.911 – 0.965)	<.001
16-L	0.998 (0.996 – 0.999)	<.001
16-MB	0.994 (0.991 – 0.997)	<.001
16-MA	0.995 (0.992 – 0.997)	<.001
16-DB	0.996 (0.993 – 0.997)	<.001
16-DA	0.998 (0.997 – 0.999)	<.001
Total	0.995 (0.994 – 0.995)	<.001

B:Buccal. L:Lingual. MB: Mesial gingival seat width. MA: Mesial axial wall height
DB: Distal gingival seat width DA: Distal axial wall height

4. DISCUSSION

In this study, the mesial and distal seat width, buccal and lingual depth, and mesial and distal axial wall heights of the lower and upper molar cavity preparations were prepared in a preclinical laboratory. The prepared teeth were measured and evaluated with the help of digital software. In this study, the evaluation of Class II cavity preparations was based on the parameters used in the previous study (11). The reasons for using these criteria for evaluation are based on their clinical significance.

Previous study should be stated that the use of amalgam in dental restorations is decreasing over the years amalgam's cost, durability and ease of manipulation have persuaded many dentists to continue to use it as their first choice for restoring posterior teeth (12). Amalgam restorations require mechanical retention, and therefore cavity design is essential for retention and resistance forms (11). Cavity forms prepared in the teeth include the preservation of the remaining tooth structure. However, with increasing cavity depth, the remaining dentin thickness may decrease,

resulting in approaching the pulp of the tooth (13). Therefore, accurate measurement of cavity depth is an important factor for evaluation. Preclinical dental education contributes greatly to the clinical practice of dental students. Preclinical laboratories in operative dentistry play an important role in the early development of psychomotor skills in dental students (11). With the increasing innovations in dentistry, it is necessary to train dental students to be fully equipped. Using approaches that help the students plan, analyze, and evaluate their work is an important part of learning (14). However, the performance results of preclinical applications cannot be directly correlated with clinical practice (15). The teeth used in this study consisted of plastic teeth used in phantom jaw models. Since this is not similar to the natural tooth structure, it cannot be attributed to the cavity depth to be created in the natural tooth, but it can provide an idea during the cavity preparation stage.

The null hypothesis of our study was that there is no significant difference between the buccal, lingual, and axial walls of the different tooth regions, the cavity depth values, and the mesial and distal seat width values, and it was rejected. Differences were detected in cavity preparations according to region. The buccal depth of the cavity was found to be closer when compared with the lingual depth of the cavity, which was measured at values closer to the cavity depth values. The fact that the students had a more comfortable viewing angle in the buccal region of the cavity in the phantom jaw model may have played a role in this situation. However, no feedback was received from the students in this study, which constitutes a limitation to the research. The fact that the mesial seat width and mesial axial height of the lower molar tooth were closer to the desired values than the distal seat width and distal axial height indicates that the students experience difficulty in the distal region (axial and gingival). This may be because they cannot fully apply indirect working principles yet. When the cavity depth or width of the lower and upper molars were evaluated (main effects), they were found to be similar. Based on these findings, our study's null hypothesis (2) was accepted. The prepared teeth were not found to be cavity depth or width significantly different, independent of the jaw.

Cavity preparation is an important skill for all dental students to acquire. Students may not understand the instructors' judgments and may think that bias exists (16). In dental education, cavity preparations are evaluated subjectively using the visual method. However, visual assessment cannot objectively inform students or evaluate the precise parameters of tooth structure removal to achieve optimal preparation (17). Evaluation of cavity preparation with digital devices may help students to be more objective in their feedback. In this study, as a result of the observers' evaluation of the values measured in the cavity, it was found that the interobserver agreement was high. With digital measurements, evaluation is possible and reliable under certain conditions (18). It has been suggested that digital working models offer advantages, such as storage feasibility, ease of retrieval of information, ease of transfer as needed, potentially equal or better diagnostic capabilities, and sending virtual images for reference or immediate consultation (19). Previous research has shown that digital measurements gave more accurate results than manual measurements because digital measurement shows a three-dimensional view, allowing for better positioning of reference points and involves measuring diameters and distances along selected planes (20). Therefore, three-dimensional digital scanning and measurement have been found to be reliable (6). In our study, three-dimensional digital scanning and measurement methods were used to achieve more reliable results and standardization. However, these systems may also have disadvantages, such as scanner-related design issues and the inability to measure certain regions exactly (16). In addition, a cavity preparation evaluation software system for dentistry was reported to be in development (21).

This study has some limitations. For example, clinical situations could not be simulated because students prepared artificial teeth in a preclinical laboratory. Clinical dentistry study is significantly more difficult than preclinical study due to changes in tongue and cheek factors, saliva, and patient-related factors. These factors that make clinical work difficult for dental students are absent from preclinical education. In addition, the shape of caries is most likely to determine the shape of the cavity in clinical conditions. Therefore, different teeth and different cavity preparations may also be investigated in future studies. If the same scanner model and certain standardizations are provided, a multicenter study can be done to express the importance of preclinical practice well. According to the findings from this study, although the results seem promising, several dental faculties in different cities can be included. In this study, student preparations were randomly selected while obtaining data, and it is not known how many points the included models received as a result of the evaluation. In addition, the students' scores and the digital assessments of the preparations can be compared in future studies.

5. CONCLUSION

As a result of the findings of this study, the cavity depth and seat width values of the teeth in cavity preparations were within acceptable limits. However, it was observed that the students had more difficulty in the distal region of the tooth than in the mesial region. More practical training is required with indirect working and working positions in dentistry education. The preparation of students with different teeth should be investigated in future studies. Digital methods in preclinical education can provide objective results in the evaluation of cavity preparations.

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Author Contributions:

Research idea: M.F., H.Y.G.
Design of the study: M.F., H.Y.G.
Acquisition of data for the study: M.F., H.Y.G.
Analysis of data for the study: M.F., H.Y.G.
Interpretation of data for the study: M.F., H.Y.G.
Drafting the manuscript: M.F., H.Y.G.
Revising it critically for important intellectual content: M.F., H.Y.G.
Final approval of the version to be published: M.F., H.Y.G.

REFERENCES

[1] Malau-Aduli BS, Lee A, Alele F, Adu M, Drovandi A, Jones K. Preclinical to clinical transition experiences of dental students at an Australian Regional University. Eur J Dent Educ 2022;26:182-196. DOI: 10.1111/eje.12687.

[2] Khattak O, Ganji KK, Iqbal A, Alonazi M, Algarni H, Alsharari T. Educational videos as an adjunct learning tool in pre-clinical operative dentistry-A randomized control trial. Healthcare (Basel) 2022;10:178. DOI: 10.3390/healthcare10020178.

[3] Ozveren N, Baltacı E, Sevinc B. Evaluation of dental students' knowledge and opinion about learning with virtual reality. Eur Ann Dent Sci 2021;48:14–16. DOI: 10.52037/eads.2021.0026.

[4] Kerim Ayar M. Relationship between students' performance on weekly task assessments and final practical exam at the preclinical restorative dentistry course. Eur Res J 2019;5:607–612. DOI: 10.18621/eurj.400696.

[5] Nassar HM, Tekian A. Computer simulation and virtual reality in undergraduate operative and restorative dental education: A critical review. J Dent Educ 2020;84:812-829. DOI: 10.1002/jdd.12138.

[6] Guven ME, Inal H. Digital evaluation of total occlusal convergence and margin widths of tooth preparations for metal ceramic crowns by dental students. Neu Dent J 2022;4: 67-72. DOI: 10.51122/neudentj.2022.44

[7] Dimitrijevic T, Kahler B, Evans G, Collins M, Moule A. Depth and distance perception of dentists and dental students. Oper Dent 2011;36:467-477. DOI: 10.2341/10-290-L.

[8] Schlenz MA, Michel K, Wegner K, Schmidt A, Rehmann P, Wöstmann B. Undergraduate dental students' perspective on the ımplementation of digital dentistry in the preclinical curriculum: A questionnaire survey. BMC Oral Health 2020;20:78. DOI: 10.1186/s12903.020.01071-0.

[9] Zitzmann NU, Kovaltschuk I, Lenherr P, Dedem P, Joda T. Dental students' perceptions of digital and conventional ımpression techniques: A randomized controlled trial. J Dent Educ 2017;81:1227-1232. DOI: 10.21815/JDE.017.081.

[10] Schubert O, Erdelt KJ, Tittenhofer R, Hajtó J, Bergmann A, Güth JF. Influence of ıntraoral scanning on the quality of preparations for all-ceramic single crowns. Clin Oral Investig 2020;24(12):4511. DOI:10.1007/s00784.020.03316-2

[11] Satwik A, Neelakantan P. Quality of class ıı cavity preparations performed by preclinical students with and without magnifying loupes – Oral Health Group. 2016. https://www.oralhealthgroup.com/features/quality-class-ii-cavity-preparations-performed-preclinical-students-without-magnifying-loupes/(Accessed: 27th November 2022)

[12] Bharti R, Wadhwani KK, Tikku AP, Chandra A. Dental amalgam: An update. J Conserv Dent 2010;13(4):204. DOI: 10.4103/0972-0707.73380

[13] Wisithphrom K, Murray PE, About I, Windsor LJ. Interactions between cavity preparation and restoration events and their effects on pulp vitality. Int J Periodontics Restorative Dent 2006;26:596-605. PMID: 17243333.

[14] Giuliani M, Lajolo C, Clemente L, Querqui A, Viotti R, Boari A, Miani CM. Is manual dexterity essential in the selection of dental students? Br Dent J 2007;203:149-155. DOI: 10.1038/bdj.2007.688.

[15] Alrahabi M, Zafar MS, Ahmed N. Effects of handpiece speed on the performance of undergraduate dental students in preclinical training. J Taibah Univ Med Sci 2015;10: 50–55. DOI: 10.1016/j.jtumed.2014.12.005.

[16] Zou H, Jin S, Sun J, Dai Y. A cavity preparation evaluation system in the skill assessment of dental students. J Dent Educ 2016;80:930–937. DOI: 10.1002/j.0022-0337.2016.80.8.tb06173.x

[17] Kim YK, Kim JH, Jeong Y, Yun MJ, Lee H. Comparison of digital and conventional assessment methods for a single tooth preparation and educational satisfaction. Eur J Dent Educ. 2023;27(2):262-270. doi:10.1111/eje.12799.

[18] Okurama S, Tanimoto H, Yasuo K, Iwata N, Yoshikawa K, Yamamoto K. Study on evaluation of cavity preparation using non-contact high-speed 3-D shape measuring device. ODEP 2021;1:77–187. DOI: 10.11471/odep.2021-011.

[19] Jiménez-Gayosso SI, Lara-Carrillo E, López-González S, Medina-Solís CE, Scougall-Vilchis RJ, Hernández-Martínez CT, Colomé-Ruiz GE, Escoffié-Ramirez M. Difference between manual and digital measurements of dental arches of orthodontic patients. Medicine (Baltimore) 2018;97:e10887. DOI: 10.1097/MD.000.000.0000010887.

[20] Kiviahde H, Bukovac L, Jussila P, Pesonen P, Sipilä K, Raustia A, Pirttiniemi P. Inter-arch digital model vs. manual cast measurements: Accuracy and reliability. Cranio. 2018;36(4):222–227. DOI: 10.1080/08869.634.2017.1344811.

[21] Wang D, Zhao S, Li T, Zhang Y, Wang X. Preliminary evaluation of a virtual reality dental simulation system on drilling operation. Biomed Mater Eng. 2015;26 Suppl 1:747–756. DOI: 10.3233/BME-151366.

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