Advances in Medical Education and Practice

Dovepress
Taylor & Francis Group

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ORIGINAL RESEARCH

The Technical Quality of Preclinical Tooth Preparation by Undergraduate Dental Students

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Background: Tooth preparation is a fundamental technical skill in dentistry, demanding accuracy, careful attention to detail, and a comprehensive knowledge of dental anatomy. Pre-clinical training allows dental students to cultivate and enhance these abilities prior to conducting procedures on real patients. This research seeks to assess the quality of tooth preparation carried out by dental students in their pre-clinical training.

Methods: A total of 221 artificial typodont teeth were used for simulated tooth preparations for a full contour ceramic crown by fourth-year pre-clinical dental students in a simulated dental environment (n=111 males and 110 females). Jaw models were mounted on phantom heads during the tooth preparation procedure. The tooth preparations were evaluated using standardized criteria, including 1.5–2 mm lingual, facial, axial and occlusal reductions, 6–10 degrees of axial wall taper, marginal integrity and surface smoothness. Descriptive statistics were used to summarize the results as either acceptable or unacceptable.

Results: The majority of the students showed unacceptable occlusal reduction (89.6%). For axial reduction, the majority of students showed unacceptable results, recorded in 99.5% and 98.6% on the mesial and distal sides, respectively. Unacceptable facial and lingual reductions were noted in 93.7% and 77.4%, respectively. The taper angle on the mesial and distal sides was acceptable in 53.8% and 57.5%, respectively. About 56.6% of the dental students demonstrated acceptable marginal placement during preparation. Moreover, satisfactory finishing and rounded angles of the preparation were done by 68.3% and 58.4% of the students, respectively.

Conclusion: The results revealed that most students achieved unsatisfactory results. This study underscores the importance of continuous assessment and tailored teaching strategies to enhance the quality of tooth preparation during pre-clinical training.

Keywords: preclinical education, prosthodontic, tooth preparation, education, dental students, Saudi Arabia

Introduction

In dental education, clinical skills are typically developed within a simulated environment.[1,2] Preclinical programs are integral to the curriculum, providing students with the foundational knowledge and dexterity needed for effective clinical practice. These programs combine theoretical learning with hands-on experience in laboratory settings, where students practice on artificial patient models. This approach helps bridge the gap between classroom instruction and real-world clinical scenarios.[3–5] The primary goal of general dentistry programs is to prepare students to deliver high-quality care in their future professional practice.[6]

Educational institutions focus on the development of competencies that enable future dentists to address the challenges of modern dental practice.[7,8] With dentistry becoming increasingly interdisciplinary, the need for advanced knowledge and collaborative skills is critical.[9] To equip dental undergraduates for these demands, preclinical training focuses not only on imparting theoretical knowledge but also on refining practical skills in procedures and techniques.[10,11]

Received: 5 March 2025
Accepted: 16 May 2025
Published: 23 May 2025

Fixed prosthodontics, a key area of dentistry, demands particular attention.[1] Effective tooth preparation for fixed prosthodontic restorations requires both comprehensive theoretical understanding and hands-on proficiency. The practical component of this skill depends heavily on manual dexterity, which is developed through repeated practice under supervision. Theoretical concepts are conveyed through various teaching methods, including lectures, seminars, and guided instructor demonstrations on tooth models; each offering unique benefits to the learning process.[12] Ultimately, proper tooth preparation is critical to the success of any fixed prosthesis; as inadequate tooth preparation can lead to premature failure of prosthetic restorations, often due to biological factors such as caries or complications arising from endodontic or periodontal diseases.[13] As such, mastering this skill is a cornerstone of dental education. Despite the development of various training techniques—such as manikin exercises and computer-based simulations—achieving the necessary manual dexterity for intraoral tooth preparation remains one of the most significant challenges in preclinical training.[14]

Tooth preparation forms the basis for many prosthetic procedures, highlighting its importance in dental training. Preclinical training offers a controlled setting where students can improve these skills before transitioning to clinical practice. By practicing on typodonts or artificial teeth, students can replicate real-life situations and gain valuable experience without the risks associated with patient care. Research has shown that effective preclinical training enhances students' manual dexterity, spatial awareness, and understanding of anatomical factors, all of which are essential for performing precise tooth preparations.[15] Furthermore, the ability to execute accurate tooth preparations is directly linked to the success and longevity of restorative treatments, highlighting its critical role in dental education.[16]

The preclinical curriculum typically includes a variety of hands-on activities designed to teach students the "how-to" aspects of dental procedures.[17] Instructors demonstrate techniques on manikin heads, providing students with the opportunity to observe and practice under expert guidance. Adequate instructor availability is essential for students to benefit from timely feedback and guidance during their practice sessions.[18] Assessing tooth preparation at this preclinical stage is crucial to ensure that students are developing the necessary skills and attention to detail.

Preparing dental students for independent clinical practice can be challenging. New graduates are typically regarded as possessing strong theoretical knowledge and being well-informed on critical thinking skills. However, when it comes to more complex procedures, they often report feeling less confident.[19] Although preclinical education is vital to skill development, research indicates that students often struggle with specific aspects of tooth preparation, such as achieving proper marginal integrity and ensuring smooth, even surfaces.[12–18] Therefore, this study aimed to evaluate the tooth preparation abilities of dental students during their preclinical training.

Methods

This study took place at the College of Dentistry at the University of Hail, in Hail, Saudi Arabia. The present work was granted approval by the Research Ethics Committee (REC) at the University of Hail, with the reference number H-2024-219. All information obtained was kept private and only used for the purposes of this research.

This cross-sectional study was conducted at the Department of Prosthodontics at the College of Dentistry. A total of 221 ivory-colored artificial plastic typodont teeth were used for simulated tooth preparations for a full contour all ceramic crown by fourth-year preclinical dental students in a simulated dental environment (n=111 males and 110 females). The students were divided into 3 groups, each performing the full contour preparation on one of the following tooth types: anteriors (n=119), premolars (n=61) or molars (n=41). The students were divided into their assigned groups based on their needed preclinical requirements.

Jaw models were mounted on phantom heads during the tooth preparation procedure. The tooth preparations were evaluated based on the following criteria:

1. Marginal integrity: The finish line should be smooth, continuous, and free of irregularities. It should also be placed in an acceptable position.
2. Occlusal, axial, facial and lingual reductions: Adequate reduction (1.5–2 mm) should be achieved to accommodate the restorative material.

3. Axial wall taper: The walls should have a convergence angle of 6–10 degrees. The facial walls of anterior teeth and the axial wall bearing the functional cusps of posterior teeth should also demonstrate two-plane reduction, following the original tooth contour.
4. Surface smoothness: The prepared surface should be free of grooves, pits, or uneven areas, with no sharp angles.

After that, each prepared tooth was positioned with its occlusal surface parallel to the top of the table and 25 cm from the camera lens. The camera used was the iPhone 14 dual-lens setup comprising a 12-megapixel (MP) main wide-angle camera with an $f/1.5$ aperture and sensor-shift optical image stabilization, and a 12MP ultra-wide-angle camera with an $f/2.4$ aperture and a 120-degree field of view. This setup allowed for 2x optical zoom out and up to 5x digital zoom. To make it easier to take pictures from various perspectives, the typodont model's neighboring teeth were all removed. To take the pictures, the camera was positioned perpendicular to the prepared artificial tooth's long axis. Photographs were taken from the buccal, axial, and proximal aspects of each prepared tooth in the typodont model. Photographs were taken by a single, qualified investigator. After transferring the photos to a computer, lines were drawn along the right and left axial wall contours of each image, as well as the mid-mesial and mid-distal of the buccal aspect and the mid-buccal and mid-lingual of the proximal aspects. The lines were drawn coronally, starting at the finish line. To measure the taper or axial angle of the corresponding side of the preparation, mesio-distally and bucco-lingually, the angle formed by the line (perpendicular to the axial walls) was measured (Figure 1). The photographs were also used to evaluate marginal integrity and surface smoothness of the preparations. Manual measurements with a protractor were also used to measure the occlusal, axial, facial and lingual reductions for each prepared tooth.

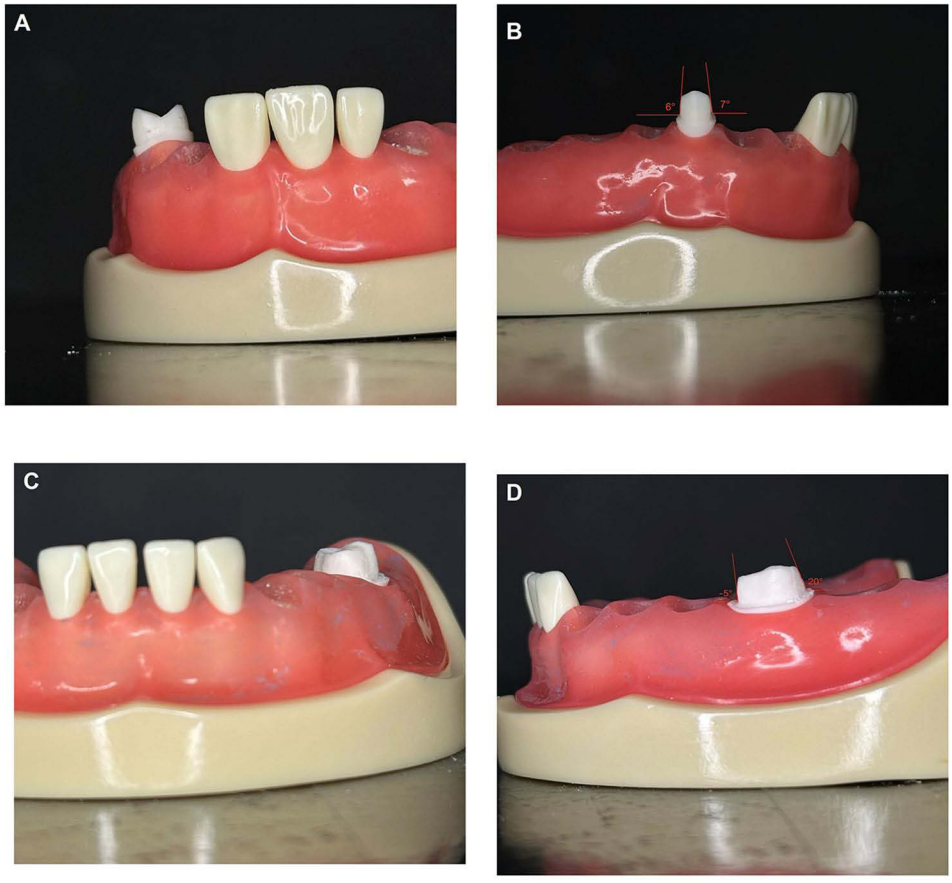

Figure 1 Sample preparations performed by the students. (**A**) Mesial aspect of a maxillary first premolar showing two-plane facial reduction and supragingival margins. (**B**) Facial view of the maxillary first premolar used to measure the axial taper. (**C**) Mesial aspect of a mandibular first molar with no two-plane facial reduction. (**D**) Facial view of the mandibular first molar used to measure the axial taper. The lines represent the axial taper; when the angle is above 90 degrees it is calculated as a "positive number", while when the angle is below 90 degrees it is calculated as a 'negative number. The ideal range is set at 6–10 degrees per axial wall. Note the acceptable axial taper in (**B**), while in (**D**), the mesial wall shows a negative taper indicating an undercut and the distal wall is over-tapered, showing an overall unacceptable axial taper.

https://doi.org/10.2147/AMEP.S522300

Prior to the evaluation, the examiners took part in calibration training. Marginal integrity was deemed unacceptable if the margins were ≥2 mm subgingival or ≥1 mm supragingival in the facial aspect of anterior teeth. Occlusal reduction was deemed unacceptable if it was <1.5 mm or >2.5 mm. Axial, facial and lingual reductions were deemed unacceptable if they were <1.2 mm or >2 mm. Axial wall taper was deemed unacceptable if it was <4 degrees or >16 degrees or if no two-plane reduction was observed. Surface smoothness was deemed unacceptable if the preparation had poor surface finish and/or sharp angles in over 50% of the preparation surface.

Twenty percent of the sample was evaluated and examined for calibration by the examiners (G.D.A., F.F.A. and L.H. A). and the supervisors (S.A.A., R.K.A. and A.A.M., who have over 14 years of experience). The kappa coefficient was computed to assess the level of agreement among observers, yielding a result of 0.88. Instances of disagreement were assessed and debated by the observers, ultimately arriving at a distinct consensus.

Data were examined with the Statistical Package for the Social Sciences (IBM Co., New York, NY, USA), which included frequency distribution and cross-tabulation analysis. The examination established the overall count of the results as either acceptable or unacceptable The chi-square test was utilized to determine if there was any relationship between the gender or dental arch and technical quality of tooth preparations by dental students. The significance level was established at $\alpha = 5\%$.

Results

Of the 221 students who participated in the study, 111 (50.2%) were male students, while the other 110 (49.8%) were females. A total of 148 preparations were done on maxillary teeth (67%) and 73 on mandibular teeth (33%). Table 1 displays the distribution of the technical quality of the principal tooth preparation criteria by the dental students. Overall, occlusal reduction was acceptable in only 23 preparations (10.4%), with the majority of the students showing unacceptable occlusal reduction (89.6%). For axial reduction, the majority of students showed unacceptable results, recorded in 99.5% and 98.6% on the mesial and distal sides, respectively. The findings of this study also indicate that dental students performed unacceptable facial reduction during tooth preparation in 93.7%, and 77.4% performed unacceptable lingual reduction.

Table 1 Descriptive Statistics of the Technical Quality of Tooth Preparation by Dental Students

Variables		Frequency n (%)
Gender	Male	111 (50.2%)
	Female	110 (49.8%)
Arch	Upper	148 (67%)
	Lower	73 (33%)
Margin	Subgingival	31 (14%)
	Supragingival	91 (41.2%)
	Equigingival	99 (44.8%)
Tooth type	Anterior	119 (53.8%)
	Premolar	61 (27.6%)
	Molar	41 (18.6%)
Occlusal reduction	Acceptable	23 (10.4%)
	Unacceptable	198 (89.6%)
Axial reduction (mesial)	Acceptable	1 (0.5%)
	Unacceptable	220 (99.5%)

(*Continued*)

Table 1 (Continued).

Variables		Frequency n (%)
Axial reduction (distal)	Acceptable	3 (1.4%)
	Unacceptable	218 (98.6%)
Facial reduction	Acceptable	14 (6.3%)
	Unacceptable	207 (93.7%)
Lingual reduction	Acceptable	50 (22.6%)
	Unacceptable	171 (77.4%)
Taper (mesial)	Acceptable	119 (53.8)
	Unacceptable	102 (46.2%)
Taper (distal)	Acceptable	127 (57.5%)
	Unacceptable	94 (42.5%)
Marginal placement	Acceptable	125 (56.6%)
	Unacceptable	96 (43.4%)
Two-plane reduction	Acceptable	142 (64.3%)
	Unacceptable	78 (35.3%)
Finishing	Acceptable	151 (68.3%)
	Unacceptable	70 (31.7%)
Rounded angles	Acceptable	129 (58.4%)
	Unacceptable	92 (41.6%)

Another important element of tooth preparation is the axial taper angle. The taper angle on the mesial side of tooth preparations performed by dental students was adequate in 53.8% of the study sample as shown in Table 1. Similarly, 57.5% of the dental students performed the taper angle on the distal side of the preparation with acceptable range. About 56.6% of dental students demonstrated satisfactory marginal placement during preparation. Moreover, satisfactory finishing and rounded angles of the preparation were done by 68.3% and 58.4% of dental students, respectively.

The technical quality of tooth preparations was categorized by gender and arch in Tables 2 and 3, respectively. The technical quality of the tooth preparation did not change significantly between males and females ($p > 0.05$), with the

Table 2 Comparison of the Technical Quality of Crown Preparations Between Genders

Variables			Frequency n (%)	p-value
Margin	Male	Subgingival	31 (14%)	0.008
		Supragingival	1 (0.5%)	
		Equigingival	79 (35.7%)	
	Female	Subgingival	0 (0%)	
		Supragingival	90 (40.7%)	
		Equigingival	20 (9%)	

(*Continued*)

https://doi.org/10.2147/AMEP.S522300

Table 2 (Continued).

Variables			Frequency n (%)	p-value
Tooth type	Male	Anterior	60 (27.1%)	0.886
		Premolar	31 (14%)	
		Molar	20 (9%)	
	Female	Anterior	59 (26.7%)	
		Premolar	30 (13.6%)	
		Molar	21 (9.5%)	
Occlusal reduction	Male	Acceptable	9 (4.1%)	0.275
		Unacceptable	102 (46.3%)	
	Female	Acceptable	14 (6.4%)	
		Unacceptable	96 (43.4%)	
Axial reduction (mesial)	Male	Acceptable	0 (0%)	0.315
		Unacceptable	111 (50.2%)	
	Female	Acceptable	1 (0.5)	
		Unacceptable	109 (49.3%)	
Axial reduction (distal)	Male	Acceptable	2 (0.9%)	0.994
		Unacceptable	109 (49.3%)	
	Female	Acceptable	1 (0.5%)	
		Unacceptable	109 (49.3%)	
Facial reduction	Male	Acceptable	4 (1.9%)	0.078
		Unacceptable	107 (48.4%)	
	Female	Acceptable	10 (4.6%)	
		Unacceptable	100 (45.2%)	
Lingual reduction	Male	Acceptable	18 (8.2%)	0.029
		Unacceptable	93 (42.1%)	
	Female	Acceptable	32 (14.5%)	
		Unacceptable	78 (35.3%)	
Taper (mesial)	Male	Acceptable	60 (27.1%)	0.692
		Unacceptable	51 (23%)	
	Female	Acceptable	59 (26.7%)	
		Unacceptable	51 (23.1%)	

(*Continued*)

Table 2 (Continued).

Variables			Frequency n (%)	p-value
Taper (distal)	Male	Acceptable	57 (25.8%)	0.829
		Unacceptable	54 (24.4%)	
	Female	Acceptable	70 (31.7%)	
		Unacceptable	40 (18.1%)	
Marginal placement	Male	Acceptable	63 (28.5%)	0.953
		Unacceptable	48 (21.7%)	
	Female	Acceptable	62 (28.1%)	
		Unacceptable	48 (21.7%)	
Two-plane reduction	Male	Acceptable	72 (32.6%)	0.556
		Unacceptable	39 (17.6%)	
	Female	Acceptable	71 (32.3%)	
		Unacceptable	39 (17.6%)	
Finishing	Male	Acceptable	72 (32.6%)	0.268
		Unacceptable	39 (17.6%)	
	Female	Acceptable	79 (35.7%)	
		Unacceptable	31 (14%)	
Rounded angles	Male	Acceptable	63 (28.5%)	0.626
		Unacceptable	48 (21.7%)	
	Female	Acceptable	66 (29.9%)	
		Unacceptable	44 (19.9%)	

Table 3 Comparison of the Technical Quality of Crown Preparations Between Arches

Variables			Frequency n (%)	p-value
Tooth type	Upper	Anterior	119 (53.8%)	0.000
		Premolar	29 (13.1%)	
		Molar	0 (0%)	
	Lower	Anterior	0 (0%)	
		Premolar	32 (14.5%)	
		Molar	41 (18.6%)	

(*Continued*)

https://doi.org/10.2147/AMEP.S522300

Table 3 (Continued).

Variables			Frequency n (%)	p-value
Margin	Upper	Subgingival	0 (0%)	0.003
		Supragingival	88 (39.8%)	
		Equigingival	60 (27.1%)	
	Lower	Subgingival	31 (14%)	
		Supragingival	3 (1.4%)	
		Equigingival	39 (17.6%)	
Occlusal reduction	Upper	Acceptable	22 (10%)	0.007
		Unacceptable	126 (57%)	
	Lower	Acceptable	1 (0.5%)	
		Unacceptable	72 (32.6%)	
Axial reduction (mesial)	Upper	Acceptable	1 (0.5%)	0.482
		Unacceptable	147 (66.5%)	
	Lower	Acceptable	0 (0%)	
		Unacceptable	73 (33%)	
Axial reduction (distal)	Upper	Acceptable	1 (0.5%)	0.144
		Unacceptable	147 (66.5%	
	Lower	Acceptable	2 (1%)	
		Unacceptable	71 (32.1%)	
Facial reduction	Upper	Acceptable	3 (1.4%)	0.000
		Unacceptable	145 (65.6%)	
	Lower	Acceptable	11 (5%)	
		Unacceptable	62 (28.1%)	
Lingual reduction	Upper	Acceptable	23 (10.4%)	0.000
		Unacceptable	125 (56.6%)	
	Lower	Acceptable	27 (12.2%)	
		Unacceptable	46 (20.8%)	
Taper (mesial)	Upper	Acceptable	100 (45.2%)	0.000
		Unacceptable	48 (21.8%)	
	Lower	Acceptable	36 (16.3%)	
		Unacceptable	37 (16.7%)	

(*Continued*)

Table 3 (Continued).

Variables			Frequency n (%)	p-value
Taper (distal)	Upper	Acceptable	80 (36.2%)	0.668
		Unacceptable	68 (30.8%)	
	Lower	Acceptable	47 (21.3%)	
		Unacceptable	26 (11.8%)	
Marginal placement	Upper	Acceptable	91 (41.2%)	0.036
		Unacceptable	57 (25.8%)	
	Lower	Acceptable	34 (15.4%)	
		Unacceptable	39 (17.6%)	
Two-plane reduction	Upper	Acceptable	99 (44.8%)	0.352
		Unacceptable	49 (22.2%)	
	Lower	Acceptable	44 (19.9%)	
		Unacceptable	29 (13.1%)	
Finishing	Upper	Acceptable	105 (47.5%)	0.234
		Unacceptable	43 (19.5%)	
	Lower	Acceptable	46 (20.8%)	
		Unacceptable	27 (12.2%)	
Rounded angles	Upper	Acceptable Unacceptable	83 (37.6%) 65 (29.4%)	0.327
	Lower	Acceptable Unacceptable	46 (20.8%) 27 (12.2%)	

exception of margin placement, which displayed significant differences between genders ($p < 0.05$) as indicated in Table 2. The technical quality of the tooth preparations between the maxillary and mandibular arches is presented in Table 3. There were no significant differences between preparations done on maxillary and mandibular teeth in many criteria, except for marginal placement, occlusal reduction, facial reduction, lingual reduction and mesial taper, where a statistically significant difference ($p < 0.05$) was noted between the dental arches.

Discussion

The foundation of preclinical dental education relies on effective teaching techniques designed to enhance the technical abilities of students, particularly in tooth preparation. This procedure is not only a fundamental aspect of clinical practice, but it also acts as an indicator of the quality of patient care provided in later stages of education and the professional journey of a dental student. The creation of clinically acceptable tooth preparations is crucial, as it establishes the foundation for effective restoration methods, which directly affect the durability and performance of the final restoration. Proper preparation of the teeth can lower the risk of complications, enhance patient satisfaction, and lead to better long-term treatment outcomes, highlighting the critical requirement for effective teaching methods in preclinical settings.[20]

Teaching methods in dental education encompass a range of approaches, such as conventional lecture-based instruction, hands-on simulations, peer-supported learning, and thorough feedback systems. The effectiveness of these different methods

can vary, as the outcomes of learning are influenced not only by the instructional strategy employed but also by the individual learning styles and preferences of the students.[21] Conventional, though standardized, approaches might not consistently engage students or promote a greater comprehension.[22] Conversely, evidence indicates that the most engaging models, like simulation-based learning, enhance psychomotor abilities and critical thinking in dental students.[23] These methods facilitate iterative practice and prompt feedback, which are essential for encouraging the required skill in tooth preparation.

During tooth preparation procedures, it is essential to create sufficient space for the restorative material. Our research indicates that the occlusal reduction, axial reduction, facial reduction, and lingual reduction were typically insufficient. Additionally, students have more difficulty with axial taper than occlusal reduction. As they prepared axial surfaces, the students demonstrated their need for additional skill development instruction and were motivated to enhance their tactile skills. These findings align with those of Poon and Smales.[24] They assessed 63 single complete gold crown preparations and 151 single ceramo-metal crown preparations carried out by dental students. They discovered a generally insufficient reduction along with larger axial convergence angles than suggested. The study by Al-Moaleem et al[25] highlights the differences that may occur between students' self-assessments and faculty evaluations. Their research revealed a tendency among students to overrate their technical skills, indicating a lack of self-awareness about their actual performance levels. The evaluations conducted by the faculties, grounded in their extensive experience and calibration, frequently uncovered a more discerning viewpoint on the abilities of the students. The differences between self-assessment and faculty judgment emphasize the necessity for ongoing feedback systems in the educational system, as they can help pinpoint particular learning deficiencies and foster a culture of reflective practice among learners.

The angle formed by the opposing walls of a tooth preparation is known as the taper or convergence angle. Studies indicate that as the taper increases, the retention of indirect restorations decreases, with retention being inversely related to the taper or convergence angle.[26] The ideal taper is generally recommended to be between 2° and 7° per axial wall, or a total convergence angle of 4° to 14°.[27] Okuyama et al[28] conducted a quantitative assessment of axial wall taper in artificial teeth performed by preclinical students. Following a fixed prosthodontics course, they were instructed to prepare artificial teeth for full cast restorations. A statistically significant greater reduction in tooth structure than necessary was observed. The largest variations occurred in the vestibular area with an average taper value of 21.7° instead of the 2–7° needed. In a similar manner, Aleisa et al[29] assessed 355 tooth preparations for fixed prosthetics performed by dental students in their final year of study. Only 32.7% of the preparations fell within the total occlusal convergence range suggested in the study, indicating that dental students typically struggle with taper control. The findings documented in the present study showed that the taper, both mesially and distally, was deemed acceptable in merely 44 (19.9%) and 56 (25.3%) of preparations, respectively. Ow et al[30] noted that 38% of their students were preparing for a taper greater than 20°. Rafeek et al[31] similarly reported a mean taper greater than 18° in the buccolingual plane and 14° in the mesiodistal plane in teeth prepared for full-veneer crowns by dental students on typodonts in the laboratory or on patients in a clinical setting. El-Mubarak et al[1] reported that all of the preparations included in their study were outside the optimal range.

In the current study, there were no significant differences between genders with the exception of marginal placement. Female students recorded a higher frequency of supragingival margins, while male students were more likely to perform subgingival margins (Table 2). One explanation for these findings could be that female students were more careful during tooth preparation, and it is possible that they were worried about damaging the gingiva if their margins were placed subgingivally.

Regarding differences in tooth preparation between arches, variations in the preparations were noted between maxillary and mandibular teeth. This aligns with the findings of Wo et al[30] and Ayad et al[32] regarding mesiodistal measurements, and Rafeek et al,[31] al-Omari and Al-Wahdani,[33] Okuyama et al[28] in terms of buccolingual comparisons. These differences can be attributed to differences in visibility, ergonomic constraints and tooth morphology. As a result, students may become more comfortable with certain preparations over other. Munshi[34] reported that students are more likely to produce a wider finish line on teeth that are in more inaccessible areas. Syed et al[35] also found statistical differences in the bucco-lingual reduction between maxillary and mandibular teeth performed by fresh dental graduates. Hence, teaching strategies regarding maxillary and mandibular teeth may require reassessment to focus on areas where students face challenges associated with each arch in preclinical and clinical settings.

According to the results of this investigation, 220 (99.5%) and 218 (98.6%) of the preparations had axial reduction (mesial and distal) that was considered unacceptable This could be because students frequently find it difficult to

maintain consistent depth and clearly defined borders, which causes them to prepare too much or too little. Research suggests that a number of instructional and performance gaps frequently make it difficult for first-time dental students to meet the best preparation criteria.[1,25,36–39] Several performance and instructional aspects impact undergraduate dental students' technical proficiency in preclinical tooth preparation. Student competency can be greatly increased by filling in the gaps found through better teaching strategies, better feedback systems, and cutting-edge simulation tools. Higher-quality patient care can be achieved by improving dental education methods, which will better prepare students for clinical practice.[36–39] The current study is consistent with El-Mubarak et al,[1] who reported that 100% of the preparations included in their study were outside of the optimal range. This could be because the students had little preclinical experience or because there were insufficient teaching resources or support personnel, both of which had a detrimental effect on the students' performance.

The incorporation of organized evaluations, cutting-edge simulation tools, and enhanced training for instructors in the dental program can present a significant chance to elevate the technical proficiency of teeth preparation by dental students throughout their preclinical training. These strategies not only aim to enhance students' outcomes but also ensure a more consistent transfer of skills and knowledge as they progress in clinical practice. A review of the current literature shows a diverse strategy marked by the blending of conventional teaching methods and contemporary technological innovations.[40,41] Conventional approaches, such as instructional lectures and hands-on workshops, remain essential elements of the foundation of preclinical education. Nonetheless, their efficacy can be enhanced by integrating modern educational tools.[42] Furthermore, the role of faculty tutoring has emerged as a key factor that affects student outcomes. Students who got direct tutoring and feedback from expert faculty generally displayed better technical skills than those who relied solely on peer education or self-study.[43] This finding emphasizes the significance of the current faculty's participation in assessing skills and providing constructive feedback during the preclinical education process. Improved tutoring can create a more customized learning experience, address the specific needs of individual students, and boost confidence in their technical abilities.

Theoretical and Practical Implications

Tooth preparation is a crucial skill in restorative and prosthetic dentistry. The accuracy and quality of preparations directly affect the success of restorations including crowns, bridges, and veneers. The quality of preparations completed by students during preclinical training can reflect poorly on their subsequent clinical performance. Properly prepared teeth result in restorations that have improved retention, fit, and function, minimizing complications such as secondary caries and restoration failure. For dental students, achieving proficiency in this skill is a fundamental milestone that necessitates both theoretical understanding and hands-on practice. The effects of technical quality in tooth preparation go beyond scholarly evaluation and affect clinical results, operational efficiency, and the advancement of dental education. It also emphasizes the necessity for thorough training initiatives that combine theoretical education with practical experience. Recognizing frequent mistakes and their effects will then enable enhancements to the curriculum and the development of more effective teaching methods.

Limitations of the Study

The current investigation exhibited certain limitations. First, it is essential to acknowledge that this research has a narrow scope as it focuses on just one institution, which may restrict the extent to which the findings can be generalized to dental students from other universities. To enhance the availability of comprehensive knowledge and skills in prosthodontics, multicenter studies are crucial for pinpointing weaknesses and developing effective solutions. Additionally, a subjective assessment of the abutment teeth prepared by dental students was performed. As with other studies, the measuring approach employed in this investigation involved manual measurements using a protractor.[28,44] In the future, a standardized measurement system for three-dimensional shapes such as those based on a digital software should be considered.

Conclusions

Within the limitations of this study, it can be concluded that tooth preparations performed by dental students was not optimal. The ability to perform precise and effective tooth preparations is foundational to the success of restorative and prosthetic

treatments. While students are often equipped with strong theoretical knowledge and basic skills, there are still significant challenges in achieving the required precision in tooth preparations, as evidenced by the findings of this study. Inadequate occlusal, axial, facial, and lingual reductions, as well as taper control, were commonly observed. Preclinical dental education plays a vital role in developing the necessary technical skills for dental students, particularly in regards to tooth preparation. These findings underscore the need for continued refinement of teaching methods and assessment strategies, as well as more hands-on practice for students to become proficient in the technique. The ultimate goal is to graduate dental students with proficient clinical experience, practical insights, and skills as they progress through their clinical career.

Data Sharing Statement

The datasets are available and accessible from the corresponding author upon reasonable request.

Informed Consent

The participants provided their informed consent to partake in the study.

Funding

This research was funded by Scientific Research Deanship at University of Ha'il, Saudi Arabia through project number <<BA-23 017>>.

Disclosure

The authors state that they have no conflicting interests in this work.

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