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Clinical dental students' perceptions of difficulties in fixed prosthodontics bridgework denture preparation: a pilot study

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ABSTRACT

Preparing abutment teeth for fixed bridgework presents varying challenges to dental students, impacting their training effectiveness and clinical outcomes. Understanding the most difficult stages can help improve educational strategies. This study aims to rank the difficulty of each stage in abutment tooth preparation using student evaluations, identifying the greatest challenges. A quantitative approach was used, analyzing perceptions of 155 clinical dental students from 2021-2023 cohorts at Faculty of Dentistry, Universitas Trisakti, through the non-parametric Friedman's ANOVA Test. Student evaluations covered seven stages of abutment tooth preparation, identifying variability in perceived difficulty from most difficult to easiest. Results indicate the most difficult stage is proximal reduction (mean rank: 3.01), followed by cervical preparation (mean rank: 3.28), and lingual reduction (mean rank: 3.35). The stages with the lowest difficulty are finishing (mean rank: 5.35), followed by alignment of preparation between 2 abutment teeth (mean rank: 4.85), buccal reduction (mean rank: 4.13), and occlusal reduction (mean rank: 4.03). Proximal reduction is particularly difficult due to the need for high technical skills and precision, requiring accurate space estimation and careful reduction without damaging adjacent teeth. This difficulty is compounded by natural variations in tooth shapes and positions among patients. Findings highlight the importance of refining educational strategies to tackle these challenges, enhancing student learning and clinical skills. This research provides crucial data on which stages need greater emphasis in the curriculum, aiding the creation of more efficient and focused training methods.

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1. INTRODUCTION

The objectives of fixed prosthodontic treatment can range from restoring individual teeth to rehabilitating the entire occlusion [1], [2]. A single tooth can be restored to achieve both functional and aesthetic improvements [3]. Additionally, replacing a missing tooth with a fixed prosthesis can enhance a patient's ability to chew, preserve or enhance dental arch function, and positively impact their self-esteem [4].

In the journey of dental professional education, the prosthodontics course opens wide opportunities for students to understand the complexity of fixed prosthodontic treatment [5]. It doesn't rely solely on theory but involves practical skills at various stages, such as guiding groove, occlusal, proximal, buccal, lingual,

cervical, and finishing. Furthermore, effective tooth preparation should possess precise geometric features to ensure adequate retention and resistance against both vertical and lateral forces exerted on the restoration [6]. Success in mastering each of these stages is the key to providing high-quality fixed partial denture [7], [8].

Bridgework dentures, a complex form of fixed partial denture treatment, demand advanced clinical skills and precision from dental practitioners. This procedure involves intricate coordination between hand and eye movements, as well as strong sequential and spatial reasoning to execute each step accurately and safely [9], [10]. Among the various stages, tooth preparation is often cited as the most technically challenging, requiring detailed knowledge of dental anatomy, appropriate angulation, and careful reduction to ensure proper fit and function. Consequently, many dental students struggle with this stage due to the high level of manual dexterity, concentration, and procedural accuracy required [11]. These challenges highlight the need for enhanced training methods, such as simulation-based learning or digital guidance systems, to improve student competence and confidence in performing bridgework denture procedures.

In this context, the competency standards for Indonesian dentists stipulate that students must be able to master and perform bridge denture treatment as an integral part of the required competencies [12]. Nevertheless, field practices indicate that there are still difficulties in implementing this practice [13], [14]. A number of dentists, especially co-assistant students, still encounter challenges ranging from a lack of clinical experience to ambiguity regarding correct techniques and the complexity of dental anatomy [15].

The novelty of this research lies in several aspects that contribute to a new understanding of the challenges faced by dental students, particularly co-assistant students, in the context of tooth preparation for the fabrication of fixed dental bridges in Indonesia. The study focuses on the difficulties encountered by dental students, especially co-assistant students, in tooth preparation for the fabrication of fixed dental bridges. While literature on prosthodontics is available globally, this research explores the specific context in Indonesia, enriching the understanding of the challenges faced by dental students in this country. This research is conducted with the aim of obtaining the sequence of difficulties in tooth preparation from the most difficult to the easiest. The identification of difficulties in tooth preparation in the field of dental prosthodontics holds significant importance, as it allows dental faculties to focus on and modify training in stages considered challenging by students. Thus, this can enhance learning effectiveness by providing special attention to areas needing more focus, improve the professional quality of students by aiding them in overcoming clinical practice obstacles, minimize clinical error risks by enhancing students' clinical preparedness, and enhance student satisfaction by providing tailored training to their needs, ultimately aiding them in achieving success in their dental careers. Furthermore, this research is described as a pilot study, indicating that it may be a preliminary step in further investigation on this topic. Consequently, the study paves the way for further research that can explore more in-depth aspects or additional variables that may influence the perceptions and difficulties of dental students.

2. METHOD

The research design applied in this study is descriptive observational using a cross-sectional method. The aim of this research is to detail the perceptions of clinical students at the Faculty of Dentistry, Universitas Trisakti, regarding the difficulties they experience in carrying out bridgework denture tooth procedures. The population in this study consists of clinical students from the Faculty of Dentistry, Universitas Trisakti. A questionnaire was used as the data collection tool and distributed in September-October 2023. Respondents included clinical students from the cohorts of 2021-2023 based on their entry year into clinical internship, totaling 155 respondents. Sampling was conducted using purposive consecutive sampling (total population sampling), with inclusion criteria involving active clinical students who have met the requirements of fixed dental prosthodontics and are willing to provide informed consent and complete the questionnaire. Meanwhile, exclusion criteria limited participation to clinical students who have not met the requirements of fixed dental prosthodontics or are on leave, as well as those who have graduated from dental education [16].

In this study, we conducted validity and reliability calculations to ensure the reliability and validity of the questionnaire used to measure the preparation of dental bridges. To measure the questionnaire's reliability, we opted for the Rasch model analysis method. After analyzing the results from 50 respondents who completed the questionnaire, we obtained a Cronbach's alpha value of 0.75 (>0.70), indicating acceptable internal consistency reliability. This suggests that the items in our questionnaire are reliably measuring the intended constructs. Therefore, we can have confidence in the consistency of responses obtained from participants. To ensure content validity of the research instrument, the questionnaire was reviewed by three faculty members who specialize in prosthodontics. This approach allowed us to refine and validate the questionnaire, ensuring its appropriateness and effectiveness for measuring the intended constructs.

To analyze the complexity involved in abutment tooth preparation for fixed bridgework, this study utilized a rigorous data analysis approach. We employed the non-parametric Friedman's ANOVA test to rank the difficulty across seven distinct stages of preparation, as experienced by clinical dental students. Each stage

was analyzed to determine both the mean rank and the variation in perception among students regarding the most and least challenging stages. The rankings, delineated from the most to the least difficult, provided a quantifiable measure of each stage's complexity based on student evaluations.

The main instrument used in this research is a questionnaire utilizing Google Forms. Then, the Google Form link was sent to a WhatsApp group consisting of students who are undergoing prosthodontics modules. The questionnaire contains 7 statement items representing the stages of bridgework denture tooth preparation work, which consist of: i) occlusal reduction, ii) proximal reduction, iii) lingual reduction, iv) buccal reduction, v) cervical finish preparation, vi) alignment of preparation between 2 teeth, and vii) finishing [17]. After signing the informed consent, students were asked to rank the stages of work with a score of 1 for the most difficult stage and a score of 7 for the easiest stage. The score of hardest to easiest rank is presented in Table 1. Then the scores of each item from all participants were summed so that the overall ranking of the difficulty level of the stages of bridgework denture tooth preparation work was obtained. The total score of each item with the smallest number was interpreted as the most difficult stage of work, and the largest total score was interpreted as the easiest stage of work. This methodology not only ensured a comprehensive understanding of the procedural challenges but also highlighted areas potentially needing enhanced instructional focus.

Table 1. Score of hardest to easiest ranks

Hardest-easiest stages	Score
Rank 1 (hardest)	1
Rank 2	2
Rank 3	3
Rank 4	4
Rank 5	5
Rank 6	6
Rank 7 (easiest)	7

3. RESULTS

Based on the collection of ranking results using the Friedman test and descriptive statistics on the seven stages of abutment tooth preparation for fixed bridgework, the mean rank results for each stage were obtained. It is undeniable that each clinical student has a different perception in determining which stage is the most difficult and which is the easiest when performing abutment tooth preparation for fixed bridgework. As reviewed from Table 2, the mean rank obtained from Friedman's test has the same value as the mean generated from descriptive statistics. Based on the overall ranking of abutment tooth preparation stages, starting from the most difficult stage with the lowest mean rank (1 = hardest), namely "proximal reduction preparation" (mean rank: 3.01), followed by the second stage "cervical finish preparation" (mean rank: 3.28), the third stage "lingual reduction preparation" (mean rank: 3.35), the fourth stage "Incisal/occlusal reduction preparation" (mean rank: 4.03), the fifth stage "buccal reduction preparation" (mean rank: 4.13), the sixth stage "alignment of preparation between two abutment teeth" (mean rank: 4.85), and the seventh stage with the highest mean rank considered the easiest (7 = easiest) is "finishing of abutment teeth" (mean rank: 5.37).

Table 2. Ranking of difficulty levels from hardest to easiest for all respondents based on mean rank

Preparation stages	N	(Friedman's test) mean rank	Mean	95% Confidence interval for mean		Median	Standard deviation
				Lower bound	Upper bound		
Proximal reduction	155	3.01 (1)	3.01	2.72	3.30	3.00	1.820
Cervical preparation	155	3.28 (2)	3.28	2.98	3.59	3.00	1.940
Lingual reduction	155	3.35 (3)	3.35	3.11	3.58	3.00	1.475
Occlusal reduction	155	4.03 (4)	4.03	3.71	4.35	5.00	2.014
Buccal reduction	155	4.13 (5)	4.13	3.95	4.32	4.00	1.179
Alignment of preparation between 2 abutment teeth	155	4.85 (6)	4.85	4.51	5.18	6.00	2.096
Finishing	155	5.35 (7)	5.35	5.01	5.69	7.00	2.146

The Friedman's ANOVA test does not require a normality test because it is a non-parametric test that does not rely on specific distribution assumptions, such as the normal distribution. Non-parametric methods like the Friedman test are based on ranks of data rather than their original values, making them more robust to violations of normality assumptions. This test is often employed when data is measured on an ordinal scale

[18]. The results of the Friedman statistical test indicated a test statistic Chi-square value is 148.385. This value depicts how much difference exists between the ranks of the compared groups. The larger the Chi-square value, the more significant the difference between the stages of the preparation groups. The obtained degrees of freedom (df) are 6, corresponding to the number of stages (k) assessed in this study minus one (k-1). The significance value, represented by Asymp. Sig. is 0.000 (<0.05), indicating that the p-value of this statistical test is zero, below 0.05. This p-value indicates that there is consistency in how dental students assess the difficulty of various stages in the evaluation process. Although each student may have different opinions, the Friedman test results indicate that there is a general similarity in their perceptions of the difficulty levels of certain stages.

4. DISCUSSION

This study aims to gain a deeper understanding of how dental clinic students at the Faculty of Dentistry, Universitas Trisakti, perceive the difficulties in the process of preparing bridgework dentures. The focus of this research is not only on assessing difficulties but also on determining the order of stages considered most difficult to easiest by all respondents, involving a total of 155 respondents. This is to provide a more comprehensive overview of the dynamics of difficulty perception in the stages of bridgework denture tooth preparation for all cohorts from 2021 to 2023.

From the results of ranking the seven stages of bridgework denture tooth preparation for all co-ass cohorts, starting from the stage considered the most difficult in the first rank, namely "proximal reduction," followed by "cervical preparation" in the second rank, "lingual reduction" in the third rank, "incisal/occlusal reduction" in the fourth rank, "buccal reduction" in the fifth rank, "alignment of preparation between two abutment teeth" in the sixth rank, and finally, the stage considered the easiest is "finishing."

The most difficult stage, namely proximal reduction, presents a major challenge because it requires highly technical skills. Students need extraordinary precision because they must estimate the amount of space required to be adequate and have free contact with the proximal walls of adjacent teeth, considering the limited space in the proximal area, and ensure precise reduction without damaging adjacent teeth. This difficulty can be influenced by natural variations among patients, such as different tooth shapes and positions, creating dynamic challenges at this stage [19], [20].

The next stage, cervical finish preparation in the form of a chamfer, adds complexity by requiring careful cutting of the tooth's cervical edge to achieve precise results. Difficulty arises because students must carefully consider the extent of cervical finish formed without excess or deficiency of preparation [21]. This requires a deep understanding of cervical finish shapes, such as supragingival, equigingival, and subgingival, that match the planned bridgework denture design, mature technical operator skills, and proper bur selection for chamfer creation [22]. Furthermore, the preparation of the cervical finish line is also a significant requirement to obtain a good impression using polyvinyl siloxane, thereby facilitating dental laboratory technicians in creating a precise finish line and well-fitted dental bridges [23].

Lingual reduction becomes the next challenging stage. Difficulty arises from limited access and visibility in the lingual area, creating additional challenges in maintaining structural integrity and tooth alignment. Moreover, the difficulty in this stage is further exacerbated by the tongue's proximity to the lingual wall, so the operator must ensure that the bur does not injure the tongue, especially if the patient's tongue is large and hyperactive [24].

Meanwhile, occlusal reduction requires a careful approach to achieve the right balance between adequate reduction for the denture and preservation of the existing tooth tissue's health. Difficulty at this stage can be influenced by the uneven cervico-occlusal level between teeth and varying occlusal plane among patients; therefore, the operator needs to be careful for unnecessary removal or excess of tooth structure and to prevent pulp damage [25]. The occlusal plane is a plane parallel to the line connecting the occlusal peaks between teeth, so it is crucial for chewing function and aesthetics in bridgework, denture restoration planning [26].

Buccal reduction, while not too difficult, has its own challenges. Students are faced with the challenge of ensuring precise buccal preparation without sacrificing structural integrity. This difficulty may be related to limited access to the buccal area because it is a direct area facing the cheek mucosa, and if the operator is not careful, it may potentially injure the cheek mucosa, especially if the patient has thick and chubby cheeks [27]. Additionally, students still find it difficult to prepare the buccal due to the two reduced buccal areas, occlusal two-thirds and cervical one-third areas, and students often make mistakes in determining these two areas, resulting in short cervico-occlusal teeth and becoming non-retentive [17].

Determining the alignment between two abutment teeth is a stage that requires high precision and a deep understanding of tooth alignment. Difficulty arises from variations in the width of abutment teeth and differences in tooth anatomy among patients [28]. Students need to ensure that the denture can be accurately positioned, which can be challenging, especially when facing cases with unusual alignments, because students

are expected to identify abutment tooth alignment to facilitate the insertion direction of the bridgework denture [29]. Finally, the easy stage, "finishing," involves final detailing to achieve smooth and aesthetic results. Difficulty arises in achieving the desired smoothness and maintaining structural integrity, especially when faced with limited access in certain areas and the ability to ensure consistency in finishing results [30].

The difficulties faced by dental clinic students at the Faculty of Dentistry, Universitas Trisakti, in each stage of bridgework denture tooth preparation reflect the complexity of tooth anatomy, patient variations, and high technical skill demands. These challenges provide a deep understanding of critical aspects in prosthodontics education, highlighting the need for the development of teaching strategies that focus more on complex clinical and technical aspects [31], [32].

Difficulties that arise in each stage also need to be considered alongside several influencing factors. Intrinsic factors, originating from the students themselves, such as hand-eye coordination, sequential and spatial reasoning, including their precision technical skills, and level of experience in performing bridgework, denture tooth preparation stages [33]. They need to understand that these skills are not just technical but also the core of high-quality dental practice. Through good clinical experience and continuous practice, co-assistant students can improve their hand-eye coordination and sequential and spatial reasoning skills, which in turn will contribute to their success in providing high-quality bridgework denture dental care to patients.

Hand-eye coordination skills allow operators to coordinate their hand movements with a three-dimensional visualization of the work area. In the context of tooth preparation, hand-eye coordination allows operators to manipulate instruments with high precision, cutting and reducing tooth substance accurately according to the treatment plan. Without good hand-eye coordination, the risk of errors in tooth preparation increases, which can result in unsatisfactory outcomes and even damage to healthy tooth structure. Dental students need to continuously train and develop these hand-eye coordination skills during their education, both through clinical practice and simulation, to improve their ability to carry out tooth preparation procedures accurately [34], [35].

Sequential reasoning is also an important aspect in bridgework denture tooth preparation. Sequential reasoning abilities enable dentists to plan and execute a series of tooth preparation steps logically and sequentially. In this context, dental students need to be able to understand the stages required in the tooth preparation process, determine the correct sequence to carry out these steps, and adjust the treatment plan based on specific patient conditions. Without good sequential reasoning, dentists may have difficulty organizing the tooth preparation process efficiently, which can result in delays in treatment completion and even errors in the tooth preparation process [36].

Spatial reasoning plays a critical role in tooth preparation for bridgework and dentures, enabling dentists to visualize the three-dimensional anatomy of teeth and accurately assess the space required for the pontic and connectors. Dentists rely on spatial reasoning to align and fit the prepared teeth, manage undercuts, predict interferences, and create a clear path of insertion for optimal seating of the bridgework denture. By visualizing tooth structure and estimating space, spatial reasoning enhances the precision and accuracy of tooth preparation, ensuring proper fit, alignment, and retention of the bridgework dentures. Additionally, spatial reasoning aids in the anticipation of potential interferences and facilitates the creation of parallel walls to optimize retention and stability, ultimately contributing to the successful fabrication and placement of bridgework dentures [34], [37].

Difficulties can also arise from extrinsic factors, namely the complexity of work influenced by the location and position of teeth that may not be advantageous, or the conditions around the teeth to be prepared, such as a tongue that is too large and the inner part of the cheek that is too thick. These extrinsic factors create variations in the level of difficulty among dental clinic students, as each student has different experiences in preparing various areas of teeth, such as upper regions, lower regions, right side, left side, posterior teeth, or anterior teeth. This provides an overview that each stage of tooth preparation for bridge denture fabrication may have varying levels of difficulty depending on the experience and position of the dental work area faced by dental clinic students, so line of vision on posture, muscle activity, and sitting balance is very helpful in carrying out tooth preparation [38].

However, it is important to note that the weakness of this study may lie in the lack of more detailed inclusion regarding intrinsic and extrinsic factors that affect the difficulty at each stage of bridgework denture tooth preparation. The researchers may not deeply include certain variables, such as more specific technical skills, detailed clinical experience levels, or other intrinsic factors that may affect the research results. The lack of detail in including these variables could be a limitation, as there may be specific factors that are not fully identified. Therefore, future research can explore intrinsic and extrinsic factors in more detail to provide a more comprehensive and in-depth understanding of the difficulties faced by dental clinic students during the stages of bridgework denture tooth preparation. By including more detailed variables, future research can provide deeper insights into the complexity of factors affecting dental clinic students' difficulties. Thus, future research

is expected to refine methodologies to include more variables and provide a richer understanding of specific aspects of the bridgework denture tooth preparation process.

5. CONCLUSION

This research aims to rank the difficulty of each stage in abutment tooth preparation using student evaluations, identifying which stages pose the greatest challenges. It focuses on understanding the challenges faced by dental students in Indonesia during the tooth preparation process for fixed dental bridges. The study provides a comprehensive analysis of the most difficult stages, from occlusal reduction to final finishing. The study highlights that from 2021 to 2023, i) proximal reduction was the most challenging stage for all students, followed by ii) cervical preparation, iii) lingual reduction, iv) occlusal reduction, v) buccal reduction, vi) alignment of preparation between two abutment teeth, and vii) finishing. Proximal reduction is particularly difficult due to the need for high technical skills and precision, requiring accurate space estimation and careful reduction without damaging adjacent teeth. This difficulty is compounded by natural variations in tooth shapes and positions among patients. The findings offer deeper insights into clinical challenges and promise significant impacts on dental curriculum development and teaching methods. With a better understanding of the difficulties in each stage of tooth preparation, more effective solutions can be provided for dental education and training in Indonesia.

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Aditya Pratama	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

ETHICAL APPROVAL

This research has obtained ethical clearance from the ethics commission of the Faculty of Dentistry, Universitas Trisakti, with number 729/S1/KEPK/FKG/8/2023.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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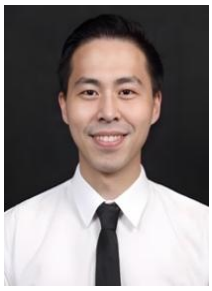

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