

Challenges faced by undergraduate dental students during root canal treatment: a survey study

Desafios enfrentados por estudantes de graduação em odontologia durante o tratamento de canal radicular: um estudo de pesquisa

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Resumo

Introdução: o tratamento endodôntico é um procedimento desafiador, frequentemente encontrado pela primeira vez por estudantes de odontologia, levando a diversas dificuldades e erros. **Objetivo:** este estudo teve como objetivo identificar as dificuldades específicas encontradas por estudantes de graduação em Odontologia durante o tratamento endodôntico e a frequência de erros cometidos por eles em relação a essas dificuldades. **Material e método:** este estudo empregou um desenho de pesquisa transversal. Um grupo de 60 estudantes do terceiro ano respondeu a um questionário autoaplicável composto por 27 perguntas abordando vários aspectos do tratamento endodôntico e 11 áreas-chave dos procedimentos de canal radicular. As opções de resposta para cada questão foram baseadas em uma escala Likert de 4 pontos. A análise dos dados foi realizada utilizando a linguagem de programação Python e mapas de calor foram criados utilizando a biblioteca seaborn para melhor compreender a distribuição dos dados. **Resultado:** os alunos encontram desafios no desenvolvimento da sensação tátil, na colocação do cone acessório e no alcance preciso do ápice durante a localização do canal. As escolas de odontologia devem se concentrar em melhorar as habilidades táteis e os métodos dos alunos para alcançar o ápice e aumentar a eficácia do ensino sobre tratamento de canal radicular. Em contrapartida, os estudantes relataram menos erros na aplicação do dique de borracha e nas medidas de segurança durante o tratamento. Os educadores odontológicos devem enfatizar o uso adequado dos instrumentos e as precauções de segurança durante o tratamento do canal radicular. Curiosamente, os alunos não consideraram estas áreas problemáticas, apesar de cometerem erros. **Conclusão:** este estudo fornece informações valiosas sobre os desafios e erros encontrados por estudantes de odontologia durante o tratamento endodôntico. Os educadores odontológicos devem abordar essas questões para melhorar as habilidades e técnicas dos alunos e fornecer o melhor atendimento ao paciente.

Descritores: Educação odontológica; estudantes de odontologia; preparo de canal radicular; percepção tátil.

Abstract

Introduction: root canal treatment is a challenging procedure often first encountered by undergraduate dental students, leading to various difficulties and mistakes. **Objective:** this study aimed to identify the specific difficulties encountered by undergraduate dental students during root canal treatment and the frequency of mistakes they committed in relation to these difficulties. **Material and method:** this study employed a cross-sectional survey design. A cohort of 60 third-year students completed a self-administered questionnaire consisting of 27 questions addressing various aspects of endodontic treatment and 11 key areas of root canal procedures. The response options for each question were based on a 4-point Likert scale. Data analysis was performed using Python programming language and heatmaps were created using the seaborn library to better understand the distribution of the data. **Result:** students encounter challenges in developing tactile sensation, accessory cone placement, and accurately reaching the apex during canal location. Dental schools should focus on improving students' tactile skills and methods to reach the apex to enhance the effectiveness of root canal treatment education. In contrast, students reported fewer mistakes



in rubber dam application and safety measures during treatment. Dental educators should emphasize proper instrument use and safety precautions during root canal treatment. Interestingly, students did not perceive these areas as problematic despite committing mistakes. **Conclusion:** this study provides valuable insights into the challenges and mistakes encountered by undergraduate dental students during root canal treatment. Dental educators should address these issues to improve students' skills and techniques and provide optimal patient care.

Descriptors: Dental education; dental students; root canal preparation; tactile perception.

INTRODUCTION

Root canal treatment is a complex and technically demanding procedure that requires a combination of theoretical knowledge and technical skills. The procedure can be challenging even for experienced dental professionals, and mistakes made during the procedure can result in a variety of complications^{1,2}. Undergraduate dental students need to be equipped with the necessary knowledge and skills to perform root canal treatments effectively. However, the process of learning endodontic procedures can be a challenging experience for many students. Root canal treatment requires a high level of precision, and even minor errors can lead to significant problems.

Several studies have examined the difficulties encountered by undergraduate dental students during root canal treatment³⁻⁶. The challenges identified in these studies include difficulties in diagnosing endodontic conditions accurately, pain management during the procedure, placement of rubber dam, locating canal orifices, and working length determination, among others. These challenges highlight the importance of providing students with adequate training and education in root canal treatment to prepare them for their future professional careers.

Moreover, mistakes made by undergraduate dental students during root canal treatment can have significant implications for the patient's oral health^{3,6}. The consequences of these mistakes can range from mild discomfort to severe pain and infection, and may require further interventions to correct⁷. Therefore, it is essential to identify the specific areas where students encounter difficulties and mistakes during root canal treatment to develop effective training programs and improve the quality of dental care.

The purpose of this study is to identify the specific difficulties encountered by undergraduate dental students during root canal treatment and to determine the frequency of mistakes made by students in various aspects of the procedure. The results of this study can provide valuable insights into the challenges faced by students during endodontic procedures, which can help educators develop more effective training programs and improve the quality of care provided to patients.

MATERIAL AND METHOD

This study employed a cross-sectional survey design to explore the difficulties encountered by undergraduate dental students during root canal treatment. The entire cohort of 60 third-year students, all at the same level of their dental education, was actively recruited to participate in this study. Data were collected using a self-administered questionnaire consisting of two parts. Part 1 contained 27 questions addressing various aspects of endodontic treatment, while Part 2 assessed the frequency of mistakes made by students in 11 key areas of root canal procedures. The questionnaire was designed based on a review of the literature and was pretested among a group of dental students to ensure its validity and reliability.

The response options for each question were based on a 4-point Likert scale: Never (0), Rare (1), Sometimes (2), and Frequent (3). This scale allowed the students to rate the frequency of their difficulties in each area, providing a nuanced understanding of their experiences (Appendix 1). The survey was administered either online or on paper, depending on the participants' preferences, and was completed anonymously to ensure the confidentiality of the responses.

Data analysis was performed using Python programming language (Python 3.11) and the pandas, seaborn, and matplotlib libraries. The data was first prepared and cleaned to ensure accurate and consistent results. Data visualization by means of heatmaps was also used to better understand the distribution of the data. Heatmaps were created using the seaborn library (Appendix 2). Each heatmap was customized to highlight the mean values of each difficulty faced by dental students in root canal treatment, with the highest mean values shown in red and the lowest mean values shown in blue. The code used to create the heatmap and the customization options applied are provided in the Supplementary Material.

Ethical approval for the study was obtained from the institutional review board of Oman Dental College where the study was conducted, and all participants provided informed consent before participating in the study.

RESULT

Among the 60 participants in this study, 90% (54) were local students and 10% (6) were international students. All participants were female, with ages ranging from 21 to 24 years. The average age was 21.5 years, and the median age was 21 years. Heatmaps provided a clear and concise visual representation of the data, allowing for a better understanding of the challenges faced by dental students during root canal treatment.

The results indicate that the students encountered the most challenges in feeling the apical constriction/developing tactile sensation (mean: 2.40, median: 3), followed by difficulty with accessory cone placement (mean: 2.50, median: 3) and reaching the apex following canal location (mean: 2.16, median: 2). These findings suggest that students may struggle with fine motor skills and spatial awareness, which are essential for successful root canal treatments. Emphasizing the importance of a steady hand, spatial perception, and providing ample opportunities for practice with feedback could enhance students' skills in these areas.

On the other hand, students experienced the least difficulty with separation of instruments (mean: 0.944, median: 1) and sodium hypochlorite spills/accidents (mean: 1.13, median: 1). These results indicate that students may have a better understanding of instrument handling and safety precautions during root canal treatment. Dental educators should continue to emphasize the importance of proper instrument use and safety measures.

Overall, the variability in responses was moderate, with standard deviations ranging from 0.468 to 0.952. This variability may reflect individual differences in students' learning experiences, aptitude, or comfort with various aspects of root canal treatment. To ensure comprehensive and effective education, dental schools should consider incorporating a variety of teaching methods and resources, including hands-on practice, demonstrations, and theoretical coursework. Additionally, providing targeted support and resources for struggling students can help address individual difficulties and foster skill development.

These findings suggest that dental educators may need to focus on improving students' tactile skills, accessory cone placement techniques, and methods to accurately reach the apex during canal location to enhance the effectiveness of root canal treatment education. By addressing these specific challenges, dental schools can better prepare students for successful careers in dentistry (Figure 1).

Figure 2 presents the frequency of mistakes in key aspects of root canal procedures reported by undergraduate dental students. The mean values range from 1.87 to 2.37 with a median of 2 for all questions except for question 8 which had a median of 2. The standard deviation values ranged from 0.456 to 0.675, indicating that the responses were relatively consistent for most questions. Students reported the highest frequency of mistakes in difficulty in reaching the apex (question 7) with a mean of 2.37 and locating canal orifices (question 5) with a mean of 2.26. The lowest frequency of mistakes was reported in rubber dam application (question 2 and 3) with a mean of 1.87 and 1.97 respectively, indicating that students had relatively good skills in this aspect of root canal treatment.

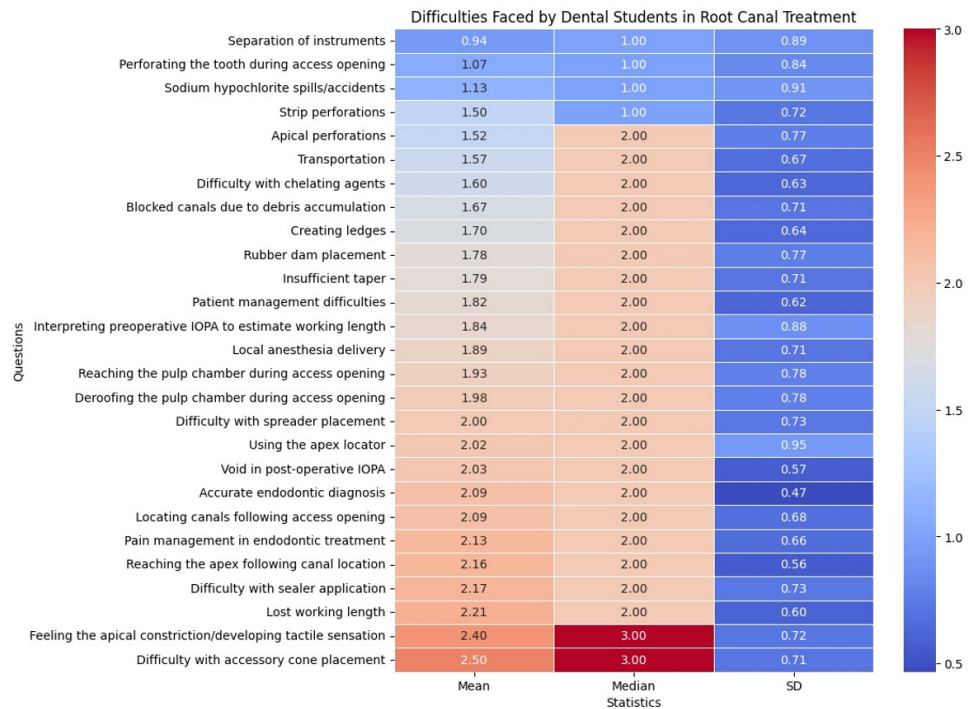


Figure 1. Difficulties faced by dental students in root canal treatment: a heatmap analysis of mean, median, and standard deviation. IOPA: Intraoral periapical radiograph.

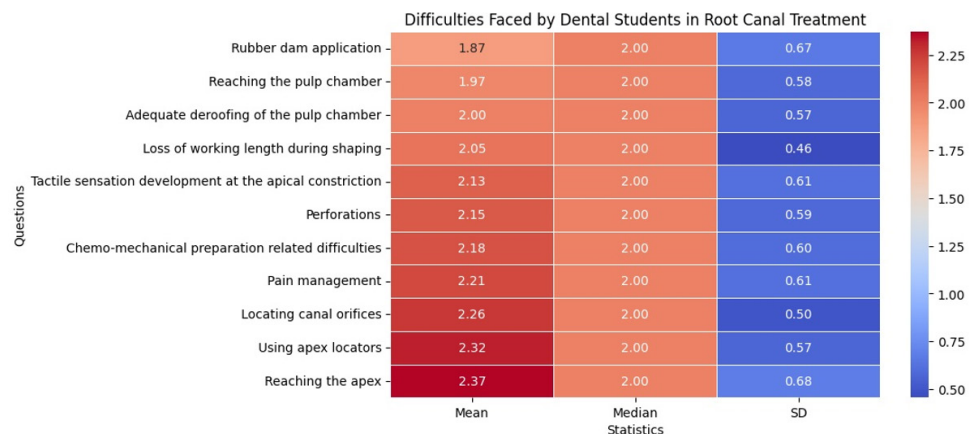


Figure 2. Frequency of mistakes in key aspects of root canal procedures: a heatmap analysis of mean, median, and standard deviation.

DISCUSSION

This study aimed to identify the specific difficulties undergraduate dental students encounter during root canal treatment. The results provide valuable insights into the areas where students face the most challenges, as well as those in which they demonstrate a better understanding. In this discussion section, we will elaborate on the implications of these findings and provide recommendations for dental education to address the identified difficulties.

The most significant challenges reported by students were related to feeling the apical constriction/developing tactile sensation, accessory cone placement, and reaching the apex following canal location. These difficulties highlight the importance of fine motor skills and spatial awareness in performing successful root canal treatments⁸. To address these challenges, dental educators should consider incorporating teaching methods that specifically target the development

of these skills⁹. For example, incorporating simulation-based training with haptic feedback could help students develop a better sense of touch and improve their spatial perception^{10,11}. Additionally, providing ample opportunities for hands-on practice with real patients, under the supervision of experienced clinicians, may also enhance students' skills and confidence in these areas¹².

The study also identified challenges in other areas, such as diagnosis, pain management, canal location, and working length determination, indicating a need for comprehensive training in diagnostic and procedural skills, as well as patient management strategies¹³. Dental educators could consider incorporating more interactive and problem-based learning approaches to help students develop the critical thinking and decision-making skills necessary for successful root canal treatment¹⁴.

In contrast, students reported the least difficulty with dealing with manual and/or rotary instruments and sodium hypochlorite solution. These findings suggest that students have a relatively better understanding of instrument handling and safety precautions during root canal treatment. It is essential for dental educators to continue emphasizing the importance of proper instrument use and safety measures to maintain and further improve these skills. This can be achieved through regular reinforcement of safety protocols during lectures, demonstrations, and practical sessions^{15,16}.

When comparing the mean scores of related questions and aspects from both heatmaps (Figures 1 and 2), it is evident that the difficulties faced by undergraduate dental students remain relatively consistent. Pain management, rubber dam application, reaching the pulp chamber, and locating canal orifices appear to be common challenges across both sets of data. Most students experience these difficulties at least "sometimes" during their root canal treatments. It is interesting to note that while students reported committing mistakes in certain areas of root canal treatment, they did not perceive these areas as problematic. This could be due to the fact that the mistakes were made during their learning process, and the students may have already learned from these mistakes¹⁷. Additionally, it is possible that the students did not fully recognize the potential consequences of their mistakes, such as the negative impact on patient outcomes and the need for additional treatment or corrections¹⁸. Dental educators should help students understand the significance of these mistakes and how they can be prevented, emphasizing the importance of continuous learning and improvement.

The moderate variability in responses observed in this study may be attributed to individual differences in learning experiences, aptitude, or comfort with various aspects of root canal treatment. Dental educators should be aware of these individual differences and consider adopting a personalized approach to teaching, where possible. This may involve offering additional support or resources to struggling students, as well as using a variety of teaching methods to cater to different learning styles¹⁹. Moreover, it is crucial for dental schools to foster a supportive learning environment where students feel comfortable seeking help and discussing their difficulties. Encouraging peer-assisted learning, mentorship programs, and open communication between students and faculty can help create a positive atmosphere that promotes skill development and continuous improvement²⁰.

This study has several limitations that should be considered when interpreting the findings. First, the sample was comprised solely of female students, which may restrict the applicability of the results to male students or mixed-gender cohorts. Second, the majority of participants were local students, potentially underrepresenting the experiences of international students who may encounter unique challenges and provide distinct perspectives. Third, the study was conducted at a single institution, which might limit the generalizability of the findings to other institutions with varying teaching methods, resources, or student populations. Future research could expand on this work by exploring the challenges faced by dental students in different settings, using more objective measures of performance, and investigating the effectiveness of specific educational interventions in improving their root canal treatment skills. Longitudinal studies can contribute to understanding the persistence and development of these challenges throughout students' dental education and professional growth.

The results of this study underscore the importance of addressing the identified challenges through targeted training and support, ultimately enhancing the competence of dental students in endodontics and contributing to better patient outcomes. Dental educators, program administrators, and professional organizations should consider these findings when designing and implementing curricula and training programs to ensure the continued development of skilled and confident dental practitioners. To better address the challenges faced by students during root canal treatment, dental education institutions and instructors could revise and adapt their curricula and teaching methodologies. Emphasizing hands-on training, offering additional resources, and incorporating problem-based learning approaches can help students develop the necessary skills to overcome these difficulties. Regular evaluation and feedback can identify areas of improvement and ensure the development of competent practitioners.

By addressing these identified challenges and implementing targeted interventions, dental education institutions can better equip their students with the skills and knowledge required to provide high-quality root canal treatment, ultimately improving patient outcomes and satisfaction. As the demand for quality dental care continues to grow, it is important to ensure that dental students are adequately prepared to meet the needs of their patients.

CONCLUSION

The findings of this study provide valuable insights into the specific challenges faced by undergraduate dental students during root canal treatment. Dental educators should use this information to refine their teaching methods and develop targeted interventions to address the identified difficulties. By focusing on improving students' tactile skills, spatial awareness, and fine motor skills, dental schools can better prepare their students for successful careers in dentistry and ultimately contribute to improved patient outcomes.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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Supplementary Material

Supplementary material accompanies this paper.

Appendix 1. Questionnaire.

Appendix 2. Python code for generating heatmap 1.

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