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Evaluation of the effects of differences in preclinical education on endodontic clinical practice

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Purpose: This survey study aims to evaluate the effects of differences in preclinical education on endodontic clinical practice.

Methods: Students who are currently studying in the fifth year of dentistry faculty have practiced on extracted teeth in their endodontics preclinical training. Students studying in the fourth year have practiced on extracted teeth and phantom jaws and taken exams in the OSCE/OSPE laboratory. The survey was applied to a total of 199 students, 104 of whom were fourth year students and 95 of whom were fifth year students, who were actively continuing their education on a voluntary basis. The survey consisted of a total of 12 questions, the first two of which addressed gender and academic year. The remaining 10 questions evaluated the impact of differences in preclinical education on clinical education. Data were analyzed using Pearson's Chi-Square test and Fisher's Exact test.

Results: The relationship between academic year and gender distribution was examined. The analysis revealed no statistically significant relationship between these variables ($p > 0.05$). The relationship between academic year and survey responses was examined. The analysis revealed a statistically significant relationship ($p < 0.05$) between academic year and the survey question, "Did you experience difficulty applying the rubber dam during endodontic treatment?".

Conclusion: The group of students who received training in OSCE/OSPE and phantom laboratory practices found their preclinical applications to be similar to clinical applications and reported feeling more successful and prepared in treating patients.

Keywords: OSCE/OSPE; phantom laboratory; preclinical education.

Introduction

For dental students, traditional sources of fundamental knowledge have been textbooks and lectures, while technical and communication skills are acquired through simulation laboratories and clinical training (1). Laboratory and clinical settings are essential components of dental education. The integration of these two environments is crucial for applying and incorporating different learning domains, including cognitive (thinking), affective (emotion/feeling), and psychomotor (physical/kinesthetic) skills. Traditionally, before practicing on patients, students receive preclinical theoretical courses in which procedures and concepts are introduced, followed by laboratory-based practical training. Practicing on dental simulators

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helps students master their skills in a controlled and safe environment while preventing harm to patients (2).

Simulation is an experiential learning tool designed to replicate "real-life" situations, and dental simulations can be defined as practices that recreate or imitate clinical conditions in dentistry. Traditionally, simulation-based education has involved performing clinical procedures using extracted or artificial teeth placed in phantom heads. More recently, the scope of simulation has expanded to include commercially available jaw models that replicate primary, mixed, or permanent dentition, as well as dental hard tissues (enamel, dentin, and pulp), carious lesions, and periodontal, endodontic, or surgical conditions. To better mimic clinical scenarios, simulator equipment such as phantom heads with jaws and torso-mounted dental operation units, as well as specially designed dental units replicating the clinical environment, have been developed (3). These types of model-based applications and simulated clinical environments are incorporated into Objective Structured Clinical Examination (OSCE) and Objective Structured Practical Examination (OSPE) laboratories. Through these simulated scenarios, students can enhance their diagnostic skills, treatment planning abilities, and patient communication competencies.

In Turkey, dental education consists of a five-year program, including both preclinical and clinical training. The first three years comprise basic science courses, professional theoretical courses, and preclinical practical training. During the preclinical education phase, students develop their clinical skills by performing treatment procedures on extracted teeth, phantom jaws, and within OSCE/OSPE laboratories. The fourth and fifth years place a greater emphasis on clinical training. During these years, students gain hands-on experience by treating patients in various clinical settings (4). By the end of this process, they acquire the ability to perform uncomplicated clinical dental procedures independently. Dentists who have successfully completed both the theoretical and practical components of their education are awarded the title of dentist (5).

Dental faculties structure their curricula in alignment with the National Core Education Program to ensure that graduates attain the fundamental competencies and skills required for the profession (6). As a result, dental education in Turkey is designed as an integrated system in which theoretical knowledge and practical skills are developed in a complementary manner through preclinical and clinical training.

OSCE and OSPE are educational methods that have started to be implemented in our country in recent years, and there are limited studies on them. To improve this educational system, more research is needed. At our faculty, current fifth year students performed their endodontic preclinical training on extracted teeth. In contrast, fourth year students conducted their preclinical training on both extracted teeth and phantom jaws and were evaluated in OSPE and OSCE laboratory exams. This study, which includes a 12-question survey, aims to evaluate the effects of differences in preclinical education on endodontic clinical practice. The null hypothesis (H0) of the study is formulated as: "Differences in preclinical education do not affect endodontic clinical practice."

Materials and Methods

Ethical approval was obtained from Non-Interventional Clinical Research Ethics Committee of Bolu Abant Izzet Baysal University. (No: 2025/48, Date: 04/02/2025). The study was conducted under the principles of the Declaration of Helsinki

Sample Size Calculation

In this study, using the "G. Power-3.1.9.2" program, the standardized effect size was taken as 0.30, as suggested by Cohen (7), with the originality of the study (8) at a 95% confidence level ($\alpha = 0.05$), and the minimum sample size was calculated as 172 with a theoretical power of 0.90.

This survey study was conducted with students registered at Bolu Abant Izzet Baysal University Faculty of Dentistry. The survey was applied to a total of 199 students, 104 of whom were fourth year students and 95 of whom were fifth year students, who were actively continuing their education on a voluntary basis. The groups of students included in our study had the same groups of teeth treated in the fourth year Endodontics clinic. In order to evaluate fourth and fifth year students objectively, fifth year students were asked to answer the questions by taking into account their treatment during fourth year.

The study used survey and data collection methods. The survey consisted of a total of 12 questions, the first two of which addressed gender and academic year. The remaining 10 questions evaluated the impact of differences in preclinical education on clinical education. The survey was conducted online through a created link.

Statistical Analysis

In this study, descriptive statistics of the data (frequency and percentage) were provided. To test the relationship between categorical variables, the Pearson Chi-Square test was applied when the sample size assumption (expected value > 5) was met. When the sample size assumption was not met, Fisher's Exact test was used. All analyses were conducted using IBM SPSS 27 software.

Results

When examining the gender distribution by academic year, the proportion of female students in the fourth year was determined to be 54.7%, while the proportion of male students was 47.9%. In the fifth year, the proportion of female students was 45.3%, and the proportion of male students was 52.1%. Among the female students, 67.3% were in the fourth year, while 61.1% were in the fifth year. Among the male students, 32.7% were in the fourth year, whereas 38.9% were in the fifth year. (Table 1).

The Pearson Chi-Square test was applied to examine the relationship between academic year and gender distribution. The analysis revealed no statistically significant relationship between these variables ($p > 0.05$). The gender distribution across academic years was found to be homogeneous. (Table 1).

The distribution of survey responses by academic year is presented in the Table 2. The proportion of students who reported experiencing high levels of stress when they first started treating patients in the clinic was 46.2% in the fourth year and 45.3% in the fifth year. The proportion of students who believed that their preclinical training was similar to clinical applications was 53.8% in the fourth year and 37.9% in the fifth year. (Table 2).

Among students who felt prepared to treat patients as a result of their preclinical training, 37.5% were in the fourth year, while 28.4% were in the fifth year. The proportion of students who believed that their preclinical success and grades aligned with their clinical performance was 39.4% in the fourth year and 38.9% in the fifth year. Students who stated that the challenges they faced in preclinical training were similar to those they encountered with patients in the clinic accounted for 37.5% in the fourth year and 31.6% in the fifth year. (Table 2).

Regarding diagnostic skills, 45.2% of fourth year students and 44.2% of fifth year students reported not having difficulty diagnosing patients and identifying the painful tooth. The proportion of students who had difficulty positioning the patient and achieving an adequate field of view was 41.3% in the fourth year and 47.4% in the fifth year. (Table 2).

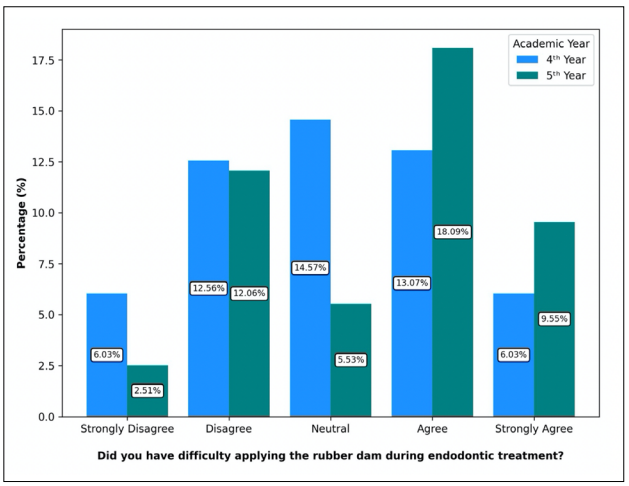

Fig. 1. The survey question.

Among students who did not experience difficulty during the access cavity preparation stage of endodontic treatment, 32.7% were in the fourth year, while 40.0% were in the fifth year. The proportion of students who reported struggling with rubber dam application during endodontic treatment was 25.0% in the fourth year and 37.9% in the fifth year. The proportion of students who found the preparation stage of endodontic treatment challenging was 26.9% in the fourth year and 36.8% in the fifth year. (Table 2).

To examine the relationship between academic year and survey responses, Pearson's Chi-Square and Fisher's Exact tests were performed. The analysis revealed a statistically significant relationship ($p < 0.05$) between academic year and the survey question, "Did you experience difficulty applying the rubber dam during endodontic treatment?". It was determined that students who responded "Agree" were predominantly from the fifth year, while those who responded "Neutral" were mostly from the fourth year. (Fig. 1).

Table 1. Distribution of students' genders according to their periods and their relationships

	4th year			5th year				
	n	%	P%	n	%	P%	Test Statistics	p
Gender								
Female	70	54.7	67.3	58	45.3	61.1	0.846	0.358
Male	34	47.9	32.7	37	52.1	38.9		

%: Row percentage and %P: Column percentage for periods.

Table 2. Distribution of survey questions according to students' periods and their relationships

	4th year			5th year				
	n	%	P%	n	%	P%	Test Statistics	p
When I started treating patients in the clinic, my stress level was high.								
Strongly Disagree	0	0.0	0.0	2	100.0	2.1	3.688	0.453
Disagree	9	69.2	8.7	4	30.8	4.2		
Neutral	8	57.1	7.7	6	42.9	6.3		
Agree	39	49.4	37.5	40	50.6	42.1		
Strongly Agree	48	52.7	46.2	43	47.3	45.3		
Do you think your preclinical training is similar to clinical practice?								
Strongly Disagree	3	37.5	2.9	5	62.5	5.3	5.619	0.222
Disagree	19	48.7	18.3	20	51.3	21.1		
Neutral	22	44.0	21.2	28	56.0	29.5		
Agree	56	60.9	53.8	36	39.1	37.9		
Strongly Agree	4	40.0	3.8	6	60.0	6.3		
Do you feel ready to treat patients as a result of the training you received in the preclinical clinic?								
Strongly Disagree	1	11.1	1.0	8	88.9	8.4	9.233	0.051
Disagree	23	56.1	22.1	18	43.9	18.9		
Neutral	37	52.1	35.6	34	47.9	35.8		
Agree	39	59.1	37.5	27	40.9	28.4		
Strongly Agree	4	33.3	3.8	8	66.7	8.4		
Do you think your preclinical success and scores are parallel to your success in the clinic?								
Strongly Disagree	5	41.7	4.8	7	58.3	7.4	1.476	0.844
Disagree	30	54.5	28.8	25	45.5	26.3		
Neutral	25	54.3	24.0	21	45.7	22.1		
Agree	41	52.6	39.4	37	47.4	38.9		
Strongly Agree	3	37.5	2.9	5	62.5	5.3		
Are the difficulties and problems you experience in preclinical practice similar to the difficulties you experience while treating patients?								
Strongly Disagree	9	37.5	8.7	15	62.5	15.8	3.241**	0.518
Disagree	36	52.9	34.6	32	47.1	33.7		
Neutral	12	48.0	11.5	13	52.0	13.7		
Agree	39	56.5	37.5	30	43.5	31.6		
Strongly Agree	8	61.5	7.7	5	38.5	5.3		
Have you had difficulty diagnosing the patient or the aching tooth?								
Strongly Disagree	12	75.0	11.5	4	25.0	4.2	4.840	0.300
Disagree	47	52.8	45.2	42	47.2	44.2		
Neutral	21	48.8	20.2	22	51.2	23.2		
Agree	21	50.0	20.2	21	50.0	22.1		
Strongly Agree	3	33.3	2.9	6	66.7	6.3		
Did you have difficulty positioning the patient to provide adequate viewing angle?								
Strongly Disagree	3	42.9	2.9	4	57.1	4.2	1.613	0.836
Disagree	17	51.5	16.3	16	48.5	16.8		
Neutral	20	58.8	19.2	14	41.2	14.7		
Agree	43	48.9	41.3	45	51.1	47.4		
Strongly Agree	21	56.8	20.2	16	43.2	16.8		
Did you have any difficulties in the access cavity phase while performing endodontic treatment on a patient?								
Strongly Disagree	11	64.7	10.6	6	35.3	6.3	3.175**	0.529
Disagree	34	47.2	32.7	38	52.8	40.0		
Neutral	21	61.8	20.2	13	38.2	13.7		
Agree	30	50.0	28.8	30	50.0	31.6		
Strongly Agree	8	50.0	7.7	8	50.0	8.4		
Did you have difficulty applying the rubber dam during endodontic treatment?								
Strongly Disagree	12a	70.6	11.5	5a	29.4	5.3	13.818**	0.008*
Disagree	25a	51.0	24.0	24a	49.0	25.3		
Neutral	29a	72.5	27.9	11b	27.5	11.6		
Agree	26a	41.9	25.0	36b	58.1	37.9		
Strongly Agree	12a	38.7	11.5	19a	61.3	20.0		
Did you have any difficulties in the preparation phase when performing endodontic treatment on a patient?								
Strongly Disagree	4	66.7	3.8	2	33.3	2.1	7.143	0.120
Disagree	26	45.6	25.0	31	54.4	32.6		
Neutral	35	66.0	33.7	18	34.0	18.9		
Agree	28	44.4	26.9	35	55.6	36.8		
Strongly Agree	11	55.0	10.6	9	45.0	9.5		

Discussion

Before performing treatments on real patients in dental faculties, students attend preclinical theoretical courses and then practically work on extracted teeth and simulated head models in the phantom laboratory, as well as participate in OSCE/OSPE applications (9). Before treating patients in the clinic, faculty's fifth year students received clinical observation training in addition to theoretical and extracted tooth-based endodontic treatment training in the preclinical phase. On the other hand, fourth year students, before treating patients in the clinic, underwent theoretical and extracted tooth-based training in the preclinical phase, performed root canal treatment on phantom jaw models, applied rubber dam, and after clinical observation, participated in OSCE/OSPE applications. This study aims to evaluate the effects of different educational methods applied in preclinical education on endodontic clinical practice at faculty. Practicing on extracted teeth to simulate clinical conditions is a common approach in endodontic preclinical practical education (10,11). In traditional simulation applications, extracted human teeth or artificial teeth are placed in jaw models for use. Some of these teeth and models are designed to mimic not only enamel, dentin, pulp, and caries but also periodontal, endodontic, and surgical conditions (3).

Students in the phantom laboratory environment perform repeatable procedures on a simulation head mounted on the simulator, thereby enhancing their psychomotor and manual skills while refining their abilities through practice (2). During OSCE applications, in addition to simulation models in phantom laboratories, sample patient profiles are also used to create an environment where students can explain a patient's symptoms by linking them to pathophysiological mechanisms. In OSCE stations, students may be required to analyze case scenarios and then answer multiple-choice questions regarding diagnostic tests, assessments, and treatment planning. This can be carried out through verbal questions posed by a station examiner or in written format, where students answer short-answer classic questions or multiple-choice questions (12).

In an OSCE, a student must demonstrate clinical competence rather than merely possessing theoretical knowledge of the subject (13). OSCE was later expanded into OSPE and was described in 1975 and in more detail in 1979 (14). Both are student assessment approaches where competencies are evaluated comprehensively, consistently, and in a structured manner. OSCE and OSPE terms are often used interchangeably without distinction (15). It is stated that OSPE is an exam format that allows for the identification of both the strengths and weaknesses of students' practical skills (16). Both students and educators consider this examination format to be positive and useful (17).

OSPE is now considered the gold standard for evaluating practical laboratory skills worldwide (18). OSCE, on the other hand, is still undergoing continuous improvement in terms of reliability, validity, objectivity, and applicability. However, OSCE has gained global acceptance as an established method for student evaluation (15). It has been reported that students believe OSCE is a fairer and less stressful test format compared to traditional written and oral exams (19). OSCE also promotes learning by enhancing communication skills and contributes to students making more accurate self-assessments (20). In a study by Radke et al. (21) comparing traditional exam methods and OSPE, they noted that students performed better in OSPE but found no statistical difference between the two methods. OSPE has been found to be applicable and acceptable to students for evaluating practical skills in undergraduate dental education.

In dental faculties, many students experience high levels of stress in the dental clinic learning environment, which leads to challenges for both the instructors and students (22). The morphological complexity and diversity of the root canal system, the complexity of endodontic procedures, and the lack of confidence among students lead many dental students to describe endodontics as a stressful, challenging, and complex field to learn (23). In the survey study, both student groups similarly reported high stress levels.

Students should not treat patients until they demonstrate the necessary skills in a preclinical environment. However, it may not always be possible to sufficiently simulate all procedures in a preclinical setting, and in such cases, learning through practice in the clinical environment should be facilitated. Similarly, sometimes students may not be exposed to all procedures in the clinical environment during their undergraduate education, and simulation may be the only way to practice relevant skills (24). This situation demonstrates the connection and importance of OSCE/OSPE and phantom laboratory applications in preclinical and clinical education in dental education.

Considering the role of OSCE/OSPE and phantom laboratory training in preparing students for clinical practice, the fact that fourth year students who received this training feel more ready and successful in performing treatments compared to the student group who did not receive this training, and the similarity of the challenges they face with those experienced in the preclinical setting, supports this training model.

In dental education, after completing their theoretical and practical training through traditional methods, students may encounter difficulties in the diagnostic and treat-

ment stages when they begin clinical internships to treat patients. It is believed that realistic preclinical applications have a significant impact on helping students adapt to and succeed in clinical internships, especially in patient examination, diagnosis, and treatment (15,25). The survey results in this study show that the student group who did not receive OSCE/OSPE training similar to clinical practice struggled with diagnosing and identifying the painful tooth.

Seijo et al. (22) similarly showed that the biggest challenges faced by preclinical and clinical students were related to radiographic techniques, the treatment of curved and narrow canals, root canal orifice identification, rubber dam application, access cavity preparation, and root canal filling. Mirza et al. (26) also reported that the majority of students faced difficulties with rubber dam application in their studies. In line with these studies, the group of students who did not receive training in OSCE/OSPE and phantom laboratories reported greater difficulties in patient positioning, access cavity preparation, rubber dam application, and preparation stages in the survey results.

When comparing the similarity between preclinical and clinical applications, the student group trained in OSCE/OSPE and phantom laboratory practices found the applications to be more similar to each other. It is thought that preclinical training models that resemble clinical procedures may yield beneficial results for clinical performance. Similarly, Brand et al. (27) found that students who practiced on training models were significantly more confident and calm while performing anesthesia, leading to reduced patient pain and an increased trust in the dentist by the patient. Based on the literature review, it is suggested that the quantity and quality of endodontic education could affect treatment outcomes (28).

To identify the challenges faced by students and reduce these challenges, more extensive research should be conducted on a larger scale. Feedback from students is crucial for educational reforms and should be periodically collected to improve learning. The limitations of this study are that the findings are based on a specific participant group, which limits the generalizability of the results. Additionally, the study is based on subjective data that may be subject to participant bias. Furthermore, external factors such as differences in curricula and teaching methods between dental schools may influence the applicability of the findings on a broader scale. Future research should consider a more diverse sample and use objective measurements.

Conclusion

Undergraduate students' perceptions of their dental school experience should be taken into account in all discussions and decisions regarding dental education. Students can provide valuable feedback and suggestions for curriculum revision and improving the learning environment (29). According to the feedback received from the students in the survey, the group of students who received training in OSCE/OSPE and phantom laboratory practices found their preclinical applications to be similar to clinical applications and reported feeling more successful and prepared in treating patients. On the other hand, the student groups who did not receive this training experienced higher stress levels and reported greater difficulties with diagnosis and treatment procedures. Considering the results, it is believed that the applications in OSCE/OSPE and phantom laboratories positively contribute to the practical education of students.

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