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The perspectives of dental clinical students about the challenges of endodontic procedures

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Purpose: To evaluate the opinions of dental clinic students regarding the challenges of endodontic therapy and compare their responses based on their academic years.

Methods: A survey was prepared to evaluate the difficulties experienced by students regarding anesthesia, taking radiographs, use of rubber dam, cavity preparation, identifying radiographic apex, instrumentation, irrigation, intracanal medicament application, root canal filling, and temporary restoration procedures. The survey, consisting of 13 main questions (with yes/no answers) and 13 sub-questions (multiple choice), was responded to by 60 fourth-year and 60 fifth-year dentistry students. The Pearson Chi-Square and Fisher's Exact tests were applied to evaluate the students' answers according to their academic years.

Results: Taking radiographs, determining the master cone, and filling the root canal were the most challenging endodontic procedures. There was a statistically significant difference between the responses of fourth- and fifth-year students to the main questions regarding root canal filling and access cavity preparation ($p<0.05$).

Conclusion: During training, more emphasis should be placed on taking radiographs, identifying the master cone, and filling the root canals. Fifth-year students performing endodontic treatment of anatomically difficult cases were found to have less self-efficacy in filling root canals and preparing the endodontic access cavity.

Keywords: Dental education; dental students; endodontics; root canal treatment.

Introduction

Dental education should enable dental students to perform endodontic procedures independently, confidently, and successfully upon graduation (1,2). Many variables, such as clinical experience, practical application of theory, student efforts, student-patient and student-teacher relationships, have a significant impact on students' academic and professional development (3,4). Clinical experiences while applying endodontic therapies affect students' self-efficacy. As the number of root canal therapies they perform on patients increases, students' self-efficacy rises. However, it has been stated that treating challenging end-

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odontic cases could negatively impact students' self-efficacy (5). Many dental students reported feeling inadequate to perform endodontic procedures, especially on molars with complex root canals (6).

On the other hand, the self-confidence of dentistry students may significantly affect the success of endodontic treatment. By identifying the difficulties students encounter while performing root canal treatment and adopting approaches to overcome them, learning can be enhanced, and patients can be provided with better care. In this regard, students' feedback is very important for educational improvements (7). The perceptions of dentistry clinical students on root canal treatment procedures are a valuable resource in developing teaching strategies (8). Therefore, the purpose of this survey was to assess the perspectives of students who finished their Endodontics clinical training at Marmara University Faculty of Dentistry regarding the challenges of endodontic therapy.

Materials and Methods

This cross-sectional survey was conducted at Marmara University Faculty of Dentistry. In this school, endodontic education starts in the second year of dentistry school and lasts until graduation. Second-year dentistry students receive pre-clinical training that includes performing endodontic procedures on extracted teeth. Third-year students observe final-year students in the endodontics clinic and complete root canal treatment of a single-rooted tooth. While fourth-year students are expected to perform root canal therapy mostly on single-root teeth (at least 2 molar teeth), fifth-year students are required to treat mainly molars. Also, theoretical lessons continue from the second to the fourth year.

A survey was prepared to evaluate the difficulties experienced by students regarding anesthesia, application of radiographic techniques, use of rubber dam, cavity preparation, canal access, determination of working length, instrumentation, irrigation, intracanal medicament application, root canal filling, and temporary restoration procedures during endodontic treatment. The survey, consisting of 13 main questions (with yes/no answers) and 13 subquestions (with multiple choices), was created by modifying the survey in the study of Tavares et al. (9). A pilot test was conducted to eliminate the risk of bias and verify that the questions were understandable by the participants.

This study was approved by the Ethics Committee of Marmara University Faculty of Health Sciences (protocol no: 110-30.11.2023). The minimum total sample size was determined as 88 using the G. Power-3.1.9.2 program (α = 0.05; power = 0.80; effect size = 0.3) (10). Fourth and fifth-year students who completed their endodontics clinical internship at Marmara University Faculty of Dentistry in the first semester of the 2023-2024 academic year were included in the research. The survey was answered by 60 fourth and 60 fifth-year dental students.

Statistical Analyses

Statistical analyses were performed in the IBM SPSS Statistics 25 program. (SPSS Inc., Chicago, IL, USA) Descriptive statistics of the research data were expressed as numbers and percentages. The Pearson Chi-Square and Fisher's Exact tests were applied to evaluate the answers given by the students according to their academic years. The significance level was determined as 0.05.

Results

The distribution of students' answers to the survey questions according to academic years is given in Table 1. Taking radiographs, determining the master cone, and filling the root canals were the most challenging endodontic procedures. On the other hand, there was a statistically significant difference between the answers provided by fourth and fifth-year students to questions Q4, Q5sq, Q7sq, Q12, Q12sq, and Q13 ($p < 0.05$).

To the question "Did you encounter any difficulties during the preparation of the endodontic access cavity? (Q4)," the majority of the fourth-grade students (71.7%) answered "no," while the majority of the fifth-grade students (56.7%) answered "yes" ($p = 0.002$).

All of the participants who responded "premolar teeth" to the question "Which option was most challenging for you when you encountered difficulties during the removal of the pulp chamber roof? (Q5sq)" were fourth-year students, while almost all of the fifth-year students (94.1%) responded "molar teeth" ($p = 0.001$).

In response to the question "Which tooth group was the most difficult for you when determining the radiographic apex? (Q7sq)," all of the participants who answered "maxillary anterior," "mandibular anterior," "maxillary canine," "maxillary premolar," and "mandibular premolar" were fourth-grade students. The majority of fifth-grade students (61.5%) answered "maxillary molar" to this question ($p = 0.011$).

The participants who answered "no" to the question "Did you encounter any difficulties during root canal filling? (Q12)" were mostly fourth-year students (65%), and those who answered "yes" were mostly fifth-year students (57.5%) ($p = 0.020$). All of the respondents who answered "accessory cone selection" to the question "Which option was the most challenging for you during root canal filling (Q12sq)" were fourth-year students; all of the respon-

Table 1. Distribution of students' answers to the questions

Question		Answers	Fourth-year (n = 60)			Fifth-year (n = 60)			Total (n = 120)		
			n	%	%Y.	n	%	%Y.	n	%	p
Q1	Did you encounter any difficulties during anesthesia?	No	35	48.6	58.3	37	51.4	61.7	72	60	0.709*
		Yes	25	52.1	41.7	23	47.9	38.3	48	40	
Q1sq	If your answer is yes, which option was the most challenging for you?	Inferior alveolar nerve block	22	52.4	88.0	20	47.6	90.9	42	89.4	1.000†
		Mental nerve block	2	66.7	8.0	1	33.3	4.5	3	6.4	
		Posterior superior alveolar nerve block	1	50.0	4.0	1	50.0	4.5	2	4.3	
		Infiltration	0	0	0	0	0	0	0	0.0	
Q2	Did you encounter any difficulties during the rubber dam application?	No	25	55.6	41.7	20	44.4	33.3	45	37.5	0.346*
		Yes	35	46.7	58.3	40	53.3	66.7	75	62.5	
Q2sq	If your answer is yes, which option was the most challenging for you?	Clamp choice	5	55.6	14.3	4	44.4	10.0	9	12.0	0.081†
		Clamp adaptation	20	37.7	57.1	33	62.3	82.5	53	70.7	
		Adaptation of rubber dam	6	75.0	17.1	2	25.0	5.0	8	10.7	
		Other	4	80.0	11.4	1	20.0	2.5	5	6.7	
Q3	Did you encounter any difficulties in taking radiographs?	No	19	51.4	31.7	18	48.6	30.0	37	30.8	0.843*
		Yes	41	49.4	68.3	42	50.6	70.0	83	69.2	
Q3sq	If your answer is yes, which option was the most challenging for you?	Positioning of the patient	0	0.0	0.0	2	100.0	4.8	2	2.4	0.663†
		Placement of periapical film in the mouth	2	40.0	4.9	3	60.0	7.1	5	6.0	
		Positioning the periapical X-ray cone	13	48.1	31.7	14	51.9	33.3	27	32.5	
		Patient-related factors (Gag reflex, the patient's inability to hold the film, etc.)	26	53.1	63.4	23	46.9	54.8	49	59.0	
Q4	Did you encounter any difficulties during the preparation of the endodontic access cavity?	No	43	62.3	71.7	26	37.7	43.3	69	57.5	0.002*
		Yes	17	33.3	28.3	34	66.7	56.7	51	42.5	
Q4sq	If your answer is yes, which option was the most challenging for you?	Direct access to canals	12	30.8	70.6	27	69.2	79.4	39	76.5	0.257†
		Contour shape	0	0.0	0.0	1	100.0	2.9	1	2.0	
		Convenience form	3	42.9	17.6	4	57.1	11.8	7	13.7	
		Cleaning the cavity	0	0.0	0.0	2	100.0	5.9	2	3.9	
		Removal of carious dentin and defective restoration	2	100.0	11.8	0	0.0	0.0	2	3.9	
Q5	Did you encounter any difficulties during the removal of the pulp chamber roof?	No	35	57.4	58.3	26	42.6	43.3	61	50.8	0.100*
		Yes	25	42.4	41.7	34	57.6	56.7	59	49.2	
Q5sq	If your answer is yes, which option was the most challenging for you?	Anterior teeth	0	0.0	0.0	2	100.0	5.9	2	3.4	0.001†
		Premolar teeth	7	100.0	28.0	0	0.0	0.0	7	11.9	
		Molar teeth	18	36.0	72.0	32	64.0	94.1	50	84.7	
Q6	Did you have difficulty distinguishing root canals on radiography?	No	20	43.5	33.3	26	56.5	43.3	46	38.3	0.260*
		Yes	40	54.1	66.7	34	45.9	56.7	74	61.7	
Q6sq	If your answer is yes, which option was the most challenging for you?	Maxillary incisors	0	0.0	0.0	0	0.0	0.0	0	0.0	0.185†
		Mandibular incisors	0	0.0	0.0	0	0.0	0.0	0	0.0	
		Maxillary canine	1	100.0	2.5	0	0.0	0.0	1	1.4	
		Mandibular canine	0	0.0	0.0	0	0.0	0.0	0	0.0	
		Maxillary premolars	6	60.0	15.0	4	40.0	11.8	10	13.5	
		Mandibular premolars	1	100.0	2.5	0	0.0	0.0	1	1.4	
		Maxillary molars	15	41.7	37.5	21	58.3	61.8	36	48.6	
		Mandibular molars	17	65.4	42.5	9	34.6	26.5	26	35.1	
Q7	Did you have difficulty determining the radiographic apex of teeth?	No	40	54.1	66.7	34	45.9	56.7	74	61.7	0.260*
		Yes	20	43.5	33.3	26	56.5	43.3	46	38.3	
Q7sq	If your answer is yes, which option was the most challenging for you?	Maxillary incisors	1	100.0	5.0	0	0.0	0.0	1	2.2	0.011†
		Mandibular incisors	1	100.0	5.0	0	0.0	0.0	1	2.2	
		Maxillary canine	1	100.0	5.0	0	0.0	0.0	1	2.2	
		Mandibular canine	0	0.0	0.0	0	0.0	0.0	0	0.0	
		Maxillary premolars	6	85.7	30.0	1	14.3	3.8	7	15.2	

		Mandibular premolars	1	100.0	5.0	0	0.0	0.0	1	2.2	
		Maxillary molars	7	30.4	35.0	16	69.6	61.5	23	50.0	
		Mandibular molars	3	25.0	15.0	9	75.0	34.6	12	26.1	
Q8	Did you encounter any difficulties during mechanical instrumentation of root canals?	No	24	48.0	40.0	26	52.0	43.3	50	41.7	0.711*
		Yes	36	51.4	60.0	34	48.6	56.7	70	58.3	
Q8sq	If your answer is yes, which option was the most challenging for you?	Determination of the initial apical file (IAF)	5	71.4	13.9	2	28.6	5.9	7	10.0	0.146†
		Removal of vital or necrotic tissues	6	66.7	16.7	3	33.3	8.8	9	12.9	
		Apical shaping	15	41.7	41.7	21	58.3	61.8	36	51.4	
		Determination of the master apical file (MAF)	7	77.8	19.4	2	22.2	5.9	9	12.9	
		Step-back technique	3	33.3	8.3	6	66.7	17.6	9	12.9	
Q9	Did you encounter any difficulties during irrigation of root canals?	No	50	51.5	83.3	47	48.5	78.3	97	80.8	0.487*
		Yes	10	43.5	16.7	13	56.5	21.7	23	19.2	
Q9sq	If your answer is yes, which option was the most challenging for you?	Positioning the irrigation needle 1-2 mm shorter than the working length	2	33.3	20.0	4	66.7	30.8	6	26.1	0.660†
		Up-and-down movemen t of the irrigation needle	8	47.1	80.0	9	52.9	69.2	17	73.9	
Q10	Did you encounter any difficulties during intracanal medicament application?	No	52	49.5	86.7	53	50.5	88.3	105	87.5	0.783*
		Yes	8	53.3	13.3	7	46.7	11.7	15	12.5	
Q10sq	If your answer is yes, which option was the most challenging for you?	Preparation	2	100.0	25.0	0	0.0	0.0	2	13.3	0.467†
		Application	6	46.2	75.0	7	53.8	100.0	13	86.7	
Q11	Did you encounter any difficulties during the determination of the master cone?	No	16	42.1	26.7	22	57.9	36.7	38	31.7	0.239*
		Yes	44	53.7	73.3	38	46.3	63.3	82	68.3	
Q11sq	If your answer is yes, which option was the most challenging for you?	Master cone selection	2	50.0	4.5	2	50.0	5.3	4	4.9	0.372†
		Radiographic verification of master point	8	40.0	18.2	12	60.0	31.6	20	24.4	
		Tactile test (tug-back)	34	58.6	77.3	24	41.4	63.2	58	70.7	
Q12	Did you encounter any difficulties during root canal filling?	No	26	65.0	43.3	14	35.0	23.3	40	33.3	0.020*
		Yes	34	42.5	56.7	46	57.5	76.7	80	66.7	
Q12	If your answer is yes, which option was sqthe most challenging for you?	Sealer manipulation	0	0.0	0.0	2	100.0	4.3	2	2.5	0.036†
		Accessory cone selection	4	100.0	11.8	0	0.0	0.0	4	5.0	
		Placement of gutta percha	4	25.0	11.8	12	75.0	26.1	16	20.0	
		Lateral condensation	19	46.3	55.9	22	53.7	47.8	41	51.3	
		Removal of excess gutta-percha	0	0.0	0.0	3	100.0	6.5	3	3.8	
		Cleaning the cavity after filling	7	50.0	20.6	7	50.0	15.2	14	17.5	
Q13	Did you encounter any difficulties during the temporary restoration application?	No	42	43.3	70.0	55	56.7	91.7	97	80.8	0.003*
		Yes	18	78.3	30.0	5	21.7	8.3	23	19.2	
Q13sq	If your answer is yes, which option	Material selection	2	100.0	11.1	0	0.0	0.0	2	8.7	0.726†
sq	was the most challenging for you?	Implementation	13	81.3	72.2	3	18.8	60.0	16	69.6	
		Other	3	60.0	16.7	2	40.0	40.0	5	21.7	

%: Percentage of rows; %Y: Column percentage for academic year; *Pearson Chi-Square; †Fisher's Exact Test. The significance level was determined to be less than 0.05.

dents who answered "sealer manipulation" and "removal of excess gutta percha" and the majority of the respondents (75%) who answered "placement of the gutta percha" were fifth-year students (p = 0.036).

The majority of students who responded "no" to the question "Did you encounter any difficulties during the temporary restoration application (Q13)" were in fifth grade (56.7%), whereas the majority of those who responded "yes" were in fourth grade (78.3%) (p = 0.003).

There was no statistically significant difference between the answers given by fourth and fifth-year students to other questions. It was determined that the answers to those questions did not change according to the academic year (p > 0.05).

Discussion

The majority of students think that endodontics is a challenging and demanding field due to the variety of root canal anatomy and the necessity of treating patients appropriately (4). Dental students' perception of difficulty regarding endodontic procedures significantly affects their self-confidence, motivation, and overall performance during treatment (11). However, undergraduate dentistry students should have gained the ability to perform uncomplicated endodontic treatments at the end of their education (1). Therefore, it is crucial to identify the areas where students have difficulties and find solutions to overcome them.

Sixty percent of the students stated that they did not experience any problems during anesthesia administration. Almutairi et al. (11) reported this rate of around 70%, while Kaplan et al. (12) observed this rate of approximately 80%. Ninety-point-nine percent of our participants who had problems with anesthesia said inferior alveolar nerve block was challenging. Previous research has shown that students who practice on local anesthesia models are more prepared, more confident, and have improved motor control when administering anesthesia to patients in the clinic (13). Using these models as pre-clinical training tools can help our students to have a smoother anesthesia experience for inferior alveolar nerve block. The pulpal status of the tooth may also contribute to students' problems with inferior alveolar nerve block anesthesia. Clinical studies have shown that the failure rate of inferior alveolar nerve block in patients diagnosed with irreversible pulpitis is 43-83% (14).

The current study revealed that 62.5% of students had problems with rubber dam application, mostly during clamp adaptation. On the contrary, previous studies have reported that approximately 66-92% of students did not perceive this stage as difficult (9,11,12). The reason for this contrast may be that our students applied the rubber dam directly on the patient for the first time in the third grade. Almutairi et al. (11) stated that students received practical training on rubber dam in their second and third years. As a result of these evaluations, it was decided to include comprehensive hands-on training on rubber dams in the pre-clinical program so that students can have a better experience with rubber dams in the clinic.

During root canal treatment, working length is determined using radiographic methods or electronic apex locators (15). In our school, periapical radiography is used for this step. When determining the working length, students need to take a radiograph with optimum characteristics, distinguish the root canals, and determine the radiographic apex. Considering the results of all survey questions, students had the most difficulty in taking radiography (almost 70%). Patient-related factors such as the gag reflex and the patient's inability to hold the film were the most challenging factors for them. In such circumstances, using a film holder for periapical radiography may be beneficial. However, a previous investigation indicated that incorrect angulation relative to anatomical locations was one of the most common faults at this step (16). On the other hand, 61.7% of students had difficulties distinguishing the root canals, whereas the same percentage of students said they had no trouble identifying the radiographic apex of teeth. In both stages, the most challenging tooth group for the students was the maxillary molars. In cases where it is difficult to take radiographs, distinguish the root canals, or identify the radiographic apex, using apex locators to determine working length can help students feel more comfortable in the endodontic clinic.

The majority of fourth-year students had no trouble preparing the endodontic access cavity, whereas the majority of fifth-year students struggled. This may be because fifth-year students often perform root canal treatment on anatomically challenging molars (17). Fourth-year students answer the questions based on their practical experience with simple endodontic treatments. Furthermore, the majority claimed that gaining direct access to the canals was the most difficult step in endodontic cavity preparation. Regarding the removal of the pulp chamber roof, more than half of the students stated that they did not experience any difficulties, similar to previous studies (11,12). Although most students, regardless of grade level, stated that removing the pulp chamber roof on molars was more difficult, seven fourth-grade students stated that they experienced the most difficulty in premolars.

For successful endodontic treatment, root canals must be properly shaped, irrigated, and subsequently filled (18). It is critical to preserve the original canal form and avoid procedural errors such as ledges and zips during root canal shaping (19). Almost 60% of the students had trouble with canal mechanical instrumentation, particularly with apical shaping, whereas previous studies reported this rate as 31-36% (11,12). The reason for this discrepancy could be that prior research did not include sub-questions with multiple choices, so their participants were unable to correlate the difficulties they encountered with the question. Allowing students to use rotary instruments in curved or narrow canals may reduce the perception of difficulty associated with the mechanical instrumentation of root canals (20). However, it has been reported that manual hand instruments are safer than rotary instruments in terms of instrument fracture in endodontic treatments performed by students (21). For this reason, it is emphasized that stu-

dents should receive intensive theoretical and pre-clinical training before using rotary file systems in the clinic (21).

A previous study reported that one of the most difficult situations for students was their inability to manage the length of the main cone (22). Similarly, about 70% of our participants had trouble determining the master cone. Many students responded that their difficulty was a sense of tug-back. This could be related to the difficulty they had with apical shaping during mechanical instrumentation.

In contrast to earlier studies (11,12), it was observed that most students described the canal filling process, especially the lateral condensation process, as difficult. This discrepancy may be attributed to differences in dental schools' curriculum types and teaching strategies. The majority of the students who had problems with the canal filling were fifth-year students. Since they perform endodontic treatment in more difficult cases, they may be less confident in this regard (5). Approximately 80% of the students reported that they had no problems with irrigation, intracanal medicament, and temporary material applications. As expected, fourth-year students were the most likely to struggle with applying temporary materials.

Considering all the main questions, there was no endodontic procedure that the students had no problems with. At some stages, it was observed that a small number of students encountered difficulties. The general education program can be reorganized to address the issues that the majority have problems with. However, the problems experienced by the minority also need to be solved. Since pre-clinical and clinical education in dentistry provides lecturers with the opportunity to deal with students one-on-one, personalized approaches can be applied after learning the needs of each student through similar surveys and practical tests.

Conclusion

This study findings suggest that greater emphasis should be placed on taking radiographs, identifying the master cone, and filling root canals during the educational process. Fifth-year students performing endodontic treatment of anatomically difficult cases were found to have less self-efficacy in filling root canals and preparing the endodontic access cavity.

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