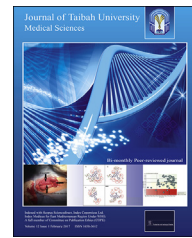




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Original Article

Technical quality assessment of root canal treatment performed by preclinical dental students at Taibah University, KSA



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المخلص

أهداف البحث: تهدف هذه الدراسة إلى تقييم الجودة التقنية لنتائج معالجة قناة الجذر التي قام بها طلاب طب الأسنان في المرحلة قبل السريرية في كلية طب الأسنان بجامعة طيبة بالمملكة العربية السعودية.

طرق البحث: تم في هذه الدراسة معالجة قناة جذور 259 سناً مخلوفاً من قبل طلبة كلية طب الأسنان بجامعة طيبة، في المملكة العربية السعودية، في مرحلتهم الدراسية قبل السريرية من عام 2013 إلى عام 2015. كانت معايير التقييم؛ طول حشوة قناة الجذر، وكثافة حشوة قناة الجذر (التجانس)، وتدبب حشوة قناة الجذر. وأعطى كل معيار درجة محددة (0 أو 1 أو 2).

النتائج: من بين 259 سناً تم علاجها، كانت الجودة التقنية لعلاج الجذور لـ 138 سناً (53.3%) غير مرضية، والجودة التقنية لعلاج الجذور لـ 42 سناً (16.2%) كانت مقبولة نوعاً ما، والجودة التقنية لعلاج الجذور لـ 50 سناً (19.3%) كانت مقبولة، والجودة التقنية لعلاج الجذور لـ 29 سناً (11.2%) كانت مقبولة تماماً. لم تكن هناك فوارق ذات قيمة في الجودة التقنية لحشو جذر القناة بين أنواع الأسنان.

الاستنتاجات: أوضحت نتائج هذه الدراسة بأن الجودة التقنية لعلاج جذور الأسنان التي قام بها طلبة الأسنان في مرحلتهم الدراسية قبل السريرية تراوحت بين غير مقبولة، ومقبولة نوعاً ما، ومقبولة ومقبولة تماماً. شكلت فئة غير المقبولة الجودة أكبر نسبة من الحالات، وتمثل أكثر من نصف الحالات، بينما شكلت الحالات مقبولة الجودة تماماً أقل نسبة. هناك حاجة ملحة لتحسين برامج تدريس علم علاج جذور الأسنان في كلية الطب بجامعة طيبة. ينبغي إعادة هذا البحث مستقبلاً لتقييم تحسين الأداء في ما يتعلق بعلاج جذور الأسنان، الذي يقوم به طلبة كلية طب الأسنان في جامعة طيبة.

الكلمات المفتاحية: طلبة الأسنان؛ التعليم؛ علم علاج جذور الأسنان؛ المملكة العربية السعودية؛ النواحي التقنية

Abstract

Objectives: The aim of this study was to evaluate the technical quality of root canal treatment (RCT) performed by preclinical undergraduate dental students at the Dental College of Taibah University KSA.

Methods: In this study, 259 extracted teeth were treated endodontically by preclinical students of the College of Dentistry, Taibah University, KSA, from 2013 to 2015. The evaluation criteria were root canal obturation length, root canal obturation density (homogeneity), and root canal obturation taper. A specific score (0, 1, or 2) was assigned to each parameter.

Results: Of 259 endodontically extracted teeth, 138 (53.3%) had RCT of unacceptable technical quality, 42 (16.2%) had treatment of slightly acceptable technical quality, 50 (19.3%) had treatment of acceptable technical quality, and 29 (11.2%) teeth had RCT of perfectly acceptable technical quality. There were no significant differences ($p > 0.05$) in the technical quality of root canal obturation among types of teeth.

Conclusion: The results of this study showed that there were varied levels of technical quality of root canal treatment performed by preclinical undergraduate dental students, and the outcome varied between unacceptable, slightly acceptable, acceptable, and perfectly acceptable. The unacceptable cases were the most common, representing more than half of all cases, and the perfectly acceptable cases were the least common. There is an urgent need to improve the endodontics teaching programmes in the College of Dentistry of Taibah University. This research should be repeated in the future to evaluate improvement in the performance of RCT by undergraduate dental students in Taibah University.

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Keywords: Dental students; Education; Endodontics; KSA; Technical aspects

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Introduction

According to the Association for Dental Education in Europe, all dental students should be qualified to perform root canal treatment efficiently after graduation.¹ The teaching of endodontics is considered a major challenge for those academics responsible for this task more than any other subject in the undergraduate curriculum.² Recent years have seen a marked increase in the demand of patients for root canal treatment due to the increased age of the population, so dental students should possess the knowledge and skills in this discipline before the need increases even more.³ The assessment of dental student performance in endodontics will help to improve dental education.³ Therefore, undergraduate training should promote the comprehension of root canal treatment outcome and related factors.⁴

Contemporary endodontic curricula focus on optimizing the technical quality of root canal procedures. An association between root-canal-specific training as an undergraduate and improved quality of root canal obturation by dental graduates has been reported.^{5–8} Evaluation of root canal treatment quality has been shown to assist in planning future endodontic educational programmes.⁹ The quality of root canal filling is an important component of endodontic treatment.¹⁰ To improve clinical performance, knowledge, training, ability, and utilization of technology are necessary.^{11–13} Studies of the quality of root canal treatments (RCTs) and prevalence of endodontic procedural accidents can improve educational programmes, leading to improvement in the oral-health-related quality of life.¹⁴ Evaluation of the technical quality of root canal obturation is based on the limit and density of the obturation material.^{11,15,16} The length of root canal obturation from the radiographic apex and its density and taper have also been used to evaluate RCT.^{17,18} Canals with a 0- to 1-mm distance between the radiographic apex and the end of the obturation material were more successful than were canals in which the obturation material ended more than 1–3 mm from the radiographic apex. However, both are preferable to obturation materials that extrude through the apex.¹⁹ Although practical exercises by preclinical undergraduates improved the technical quality of RCTs performed by dental students at the clinical stage,²⁰ few studies of the performance of preclinical undergraduate students have been performed. Dental students at Taibah University take a preclinical annual endodontic course in the third year of their 6-year Bachelor of Dental Surgery degree. The course consists of a 1-credit theoretical hour and 2 practical credit hours per week for 28 weeks, during which they perform the technical aspects of

root canal treatment on extracted teeth. A recent study revealed the importance of improving RCT in Almadinah Almunawwarah by emphasizing the training of undergraduate students.²¹ The aim of this study was to evaluate the technical quality of RCT performed by preclinical undergraduate dental students in the Dental College at Taibah University, KSA.

Materials and Methods

This study was approved by the Research Ethics Committee of the College of Dentistry, Taibah University (reference number: TUCDREC/20160308/ALRAHABI).

In this study, we evaluated the technical aspects of root canal treatment of 259 extracted teeth performed by preclinical students of the College of Dentistry at Taibah University, KSA, during 2013–2015.

Tooth instrumentation

In this study, 259 extracted teeth were treated endodontically by preclinical students of the College of Dentistry at Taibah University, KSA, during 2013–2015. Sample distribution according to tooth type is shown in Table 1. All students underwent comprehensive training on the technical aspects of RCT of all types of teeth (one single canal tooth, one premolar, and one molar), and then the samples of the study were collected. The teeth had been prepared using stainless steel K-files (Dentsply Maillefer) with the step-back technique. All root canals were obturated using the lateral compaction technique using the 0.02 taper gutta-percha points (DENTSPLY DeTrey GmbH) and AH-26 sealer (DENTSPLY DeTrey GmbH).

Radiographic procedures

The radiographic procedure was performed using a dental X-ray unit (Gendex Expert DC KaVo, Germany) at 70 kVp, 10 mA, and 0.25 s exposure time and a digital sensor (Gendex GXS-700, USA). Buccolingual radiographs of extracted teeth were obtained using the paralleling technique. A 20° horizontal mesial angulation of the X-ray tube was used for the mandibular molars and upper premolars to prevent superimposition of root canals. The images were evaluated by two endodontists with more than 7 years of experience in endodontics. In case of disagreement, a third observer from the Department of Restorative Dental Science, College of Dentistry, Taibah University, was asked to make a final

Table 1: Sample distribution according to tooth type.

Tooth type and location	No. of teeth	Percent
Upper incisor	27	10.4
Lower incisor	44	17.0
Upper premolar	57	22.0
Lower premolar	45	17.4
Upper molar	41	15.8
Lower molar	45	17.4
Total	259	100

decision. The images were evaluated using the Vixwin™ Imaging Software, USA.

Radiographic evaluation

The evaluation criteria were root canal obturation length, root canal obturation density (homogeneity), and root canal obturation taper. A specific score (0, 1, or 2) was assigned to each parameter, as shown in Table 2. After evaluation of the root canal obturation parameters, each root canal obturation was assigned a score of 0–6 points. Based on this score, the supervisor determined the quality of root canal obturation and assigned a suitable mark to the student. Table 3 shows the points of technical quality of these RCTs.

Statistical analysis

Data were analyzed using SPSS software, version 20.0 (SPSS, Inc., Chicago, IL, USA). Descriptive analysis was performed separately for each type of root canal. Wilcoxon signed-ranks and Kruskal–Wallis tests were used to compare the quality of root canal obturation between tooth types. Tables 4 and 5 show the results of the tests. The tests were performed at a 0.05 significance level.

Table 2: Parameters used to evaluate root canal obturation.

Parameter	Definition	Score
Length of root canal obturation	Root filling ending >2 mm short of the radiographic apex (under-filling)	0
	Root filling limited to the pulp chamber	0
	Root filling ending beyond the radiographic apex (over-filling)	(unacceptable)
Density of root canal obturation	Root filling ending at the radiographic apex (tip-to-tip) or 1–2 mm shorter than the radiographic apex	1 (acceptable)
	Root filling ending 0.5–1 mm short of the radiographic apex (adequate)	2 (perfect)
	Inhomogeneous root canal obturation with several visible voids	0 (unacceptable)
Taper of root canal obturation	Root canal obturation with only one visible void	1 (acceptable)
	No void present in the root canal obturation (adequate)	2 (perfect)
	Not consistently tapered from the apex to the coronal part (over- or under-shaped)	0 (unacceptable)
Taper of root canal obturation	Not enough taper	1 (acceptable)
	Consistently tapered from the apex to the coronal part (adequate)	2 (perfect)

Table 3: Quality categories of root canal treatment.

Evaluation points	Quality of case	Student mark
Cases with 0–2 points	Totally unacceptable	0%
Cases with 3 points with a length score of 0	Unacceptable	20%
Cases with 3–4 points with a length score of 1	Slightly unacceptable	40%
Cases with 3 points with a length score of 1 or 2	Neutral	50%
Cases with 4 points with a length score of 1 or 2	Slightly acceptable	60%
Cases with 5 points	Acceptable	80%
Cases with 6 points	Perfectly Acceptable	100%

Results

Technical aspects of root canal treatment

Of 259 extracted teeth treated endodontically, 138 (53.3%) had RCT of unacceptable technical quality, 42 (16.2%) had treatment of slightly acceptable technical quality, 50 (19.3%) had treatment of acceptable technical quality, and 29 (11.2%) teeth had RCT of perfectly acceptable technical quality. There were no significant differences ($p > 0.05$) in the technical quality of root canal obturation among types of teeth.

Effect of tooth type on the technical quality of root canal treatment

In this study, the highest rate of RCTs of perfectly acceptable technical quality was for the upper premolars (24.4%), and the lowest rate was for the lower incisors (4.5%). The highest rate of RCTs of acceptable technical quality was for the lower incisors (25%), and the lowest rate was for the upper premolars (12.3%). The highest rate of RCTs of slightly acceptable technical quality was for the upper incisors (33.3%), and the lowest rate was for the upper molars (7.3%). The highest rate of RCTs of unacceptable technical quality was for the upper premolars (70.2%), and the lowest rate was for the upper incisors (37%). The number of cases with slightly acceptable technical quality treatment of the lower incisors, upper premolars, lower premolars, and lower molars decreased significantly when compared with whole the sample and with upper incisors and upper molars. Figure 1 shows the technical quality of treatments of extracted teeth.

Relationships between tooth type and the length, density, and taper of root canal obturation

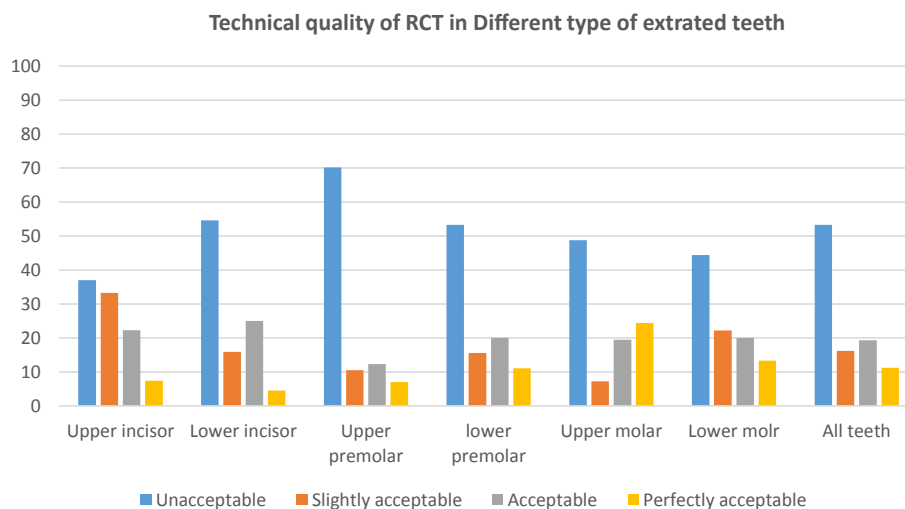
The numbers of cases of unacceptable length root canal obturation were significantly greater in the lower incisors, upper premolars, lower premolars, and lower molars compared with all teeth ($p < 0.05$). Furthermore, the number of perfect cases regarding the taper parameter was significantly greater in the upper incisors, lower incisors, upper premolars, lower premolars, and lower molars compared with all teeth ($p < 0.05$). There was no significant difference

Table 4: Wilcoxon Signed Ranks Test to compare accepted and not accepted endodontically treated teeth according to tooth type (significance level $p < 0.05$).

Type of tooth	Length of root canal filling			Taper of root canal filling			Density of root canal filling		
	Mean rank		p -Value	Mean rank		p -Value	Mean rank		p -Value
	Accepted	Not accepted		Accepted	Not accepted		Accepted	Not accepted	
Upper incisor	6.50	6.50	1.000	6.00	6.00	0.007	9.00	9.00	0.000
Lower incisor	13.50	13.50	0.019	13.50	13.50	0.000	11.50	11.50	0.000
Upper premolar	18.50	18.50	0.001	11.50	11.50	0.000	12.50	12.50	0.004
Lower premolar	15.00	15.00	0.041	16.50	16.50	0.000	13.50	13.50	0.006
Upper molar	17.00	17.00	0.223	12.00	12.00	0.061	13.50	13.50	0.019
Lower molar	14.00	14.00	0.034	18.50	18.50	0.000	16.00	16.00	0.007

Table 5: Kruskal–Wallis Test results to assess the relationship between type of tooth and quality of root canal filling parameters (significance level $p < 0.05$).

Type of tooth	Length of root canal filling				Taper of root canal filling				Density of root canal filling			
	N	Mean rank	Chi-square	p -Value	N	Mean rank	Chi-square	p -Value	N	Mean rank	Chi-square	p -Value
Upper incisor	27	148.28	12.723	0.026	27	119.26	12.966	0.024	27	150.83	5.451	0.363
Lower incisor	44	122.35			44	131.00			44	138.52		
Upper premolar	57	114.94			57	117.09			57	117.32		
Lower premolar	45	124.23			45	153.73			45	126.93		
Upper molar	41	159.20			41	112.78			41	126.49		
Lower molar	45	124.76			45	143.78			45	131.50		

**Figure 1:** The percent of technical quality of RCT in different types of extracted teeth.

in the density parameter among tooth types ($p > 0.05$). Table 6 shows the relationships between evaluation criteria and tooth type.

Discussion

This study evaluated the technical aspects of RCT performed by preclinical undergraduate dental students on extracted teeth at the College of Dentistry, Taibah University, KSA, between 2013 and 2015. Evaluations were performed using X-rays. The radiographic criteria used to evaluate the technical aspects of root canal obturation were

based on current European guidelines and previous clinical studies of RCT by dental undergraduates.^{22,23} Few studies of the technical quality of RCT by preclinical students have been performed.^{7,24} In this study, of 259 extracted teeth treated endodontically, 138 (53.3%) had unacceptable quality of root canal obturation. This is in agreement with the results of clinical studies of the technical quality of root canal obturation by undergraduate dental students, which have reported rates of 13–60.4%.^{22,25,26} In another study, the technical quality of RCT of molars extracted by undergraduate dental students was considered acceptable in 35.6% of the cases.¹⁴ However, it is difficult to compare the results of the present work with the results of other

Table 6: Relationship between evaluation criteria and tooth type.

Tooth type	Length of root canal filling			Taper of root canal filling			Density of root canal filling		
	Unacceptable	Acceptable	Perfectly acceptable	Unacceptable	Acceptable	Perfectly acceptable	Unacceptable	Acceptable	Perfectly acceptable
Upper incisor	22.2%	55.6%	22.2%	3.7%	59.3%	37.0%	3.7%	37.0%	59.3%
Lower incisor	43.2%	40.9%	15.9%	9.1%	40.9%	50.0%	2.3%	50.0%	47.7%
Upper premolar	49.1%	36.8%	14.0%	3.5%	61.4%	35.1%	8.8%	57.9%	33.3%
Lower premolar	44.4%	35.6%	20.0%	4.4%	28.9%	66.7%	13.3%	42.2%	44.4%
Upper molar	31.7%	19.5%	48.8%	17.1%	43.9%	39.0%	17.1%	36.6%	46.3%
Lower molar	42.2%	40.0%	17.8%	15.6%	20.0%	64.4%	17.8%	31.1%	51.1%
All teeth	40.5%	37.1%	22.4%	8.9%	42.1%	49.0%	10.8%	43.6%	45.6%

studies because of differences in design, evaluation criteria, sample size, and type of study (clinical or preclinical). In the present study, 42 (16.2%) teeth had root canal obturation of slightly acceptable technical quality, 50 (19.3%) were of acceptable technical quality, and 29 (11.2%) teeth had RCT of perfectly acceptable technical quality. Classification of students' work based on these categories (slightly acceptable, acceptable, perfectly acceptable) will help in making continuous assessment of students during practical training more reasonable and accurate. At a 95% confidence level, there were no significant differences in the technical quality of root canal obturation among all types of treated teeth, although clinical studies have reported a difference in quality between anterior and posterior teeth.^{25,26} This is may be because working on extracted teeth is easier than working on patients. This highlights the need to intensify training on molars at the preclinical stage. There was no significant difference in the density of root canal obturation among all tooth types, as had been reported previously.¹⁷ The step-back technique of root canal instrumentation using stainless steel K-files is used for teaching endodontics to undergraduate dental students. However, the sequential apical-to-coronal steps of this technique can cause procedural accidents (ledges, canal transportation, perforation), resulting in ineffective root canal obturation.^{27,28} The introduction of NiTi rotary instruments to endodontic practice revolutionized the cleaning and shaping of the root canal system.²⁹ Due to their flexibility, NiTi rotary systems cause less canal transportation and alteration of working length (WL) than do stainless steel instruments.^{30,31} The endodontics curriculum should thus be modified to cover advances in instruments and materials. Indeed, the dental curriculum should include teaching NiTi rotary instrumentation to undergraduate students,³² as this technique facilitates more rapid and accurate root canal preparation than is possible with stainless steel hand instruments.³³ Additionally, improving preclinical training by adding new techniques to determine WL will improve dental students' clinical performance.²⁰ Moreover, root canal filling using the vertical compaction method rather than lateral compaction and preventing extrusion of the obturation material will produce more homogeneous root canal obturation.³⁴ Furthermore, an increase in the number of specialized staff members and in preclinical and clinical endodontic training time would improve the endodontics competency of students. A re-evaluation of the technical quality of root canal treatment performed by undergraduate dental students is warranted to assess the efficiency of modifications to educational programmes.

Conclusions

The results of this study showed the low level of technical quality of root canal treatment performed by preclinical undergraduate dental students, with the technical quality varying between unacceptable, slightly acceptable, acceptable, and perfectly acceptable. The unacceptable cases were the most common and accounted for more than half of all cases, and the perfectly acceptable cases were the least common. There is an urgent need to improve the endodontics

teaching programmes in the College of Dentistry of Taibah University. This research should be repeated in the future to evaluate improvement in the performance of undergraduate dental students in root canal treatment.

Conflict of interest

The author has no conflict of interest to declare.

Author's contribution

MAR confirms that this article with title "Technical quality assessment of root canal treatment performed by preclinical dental students at Taibah University, Saudi Arabia." is original work and not plagiarize from any other work. This study was approved by the Research Ethics Committee of the College of Dentistry, Taibah University (reference number: TUCDREC/20160308/ALRAHABI). In this study, MAR and ALM evaluated the technical aspects of root canal treatment of 259 extracted teeth performed by preclinical students of the College of Dentistry at Taibah University, KSA, during 2013–2015. The evaluation criteria were root canal obturation length, root canal obturation density (homogeneity), and root canal obturation taper. MAR has been reviewed and approved the final draft and MAR is responsible for the content and similarity index of the manuscript.

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