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Quality of Root Canal Fillings Performed by Undergraduate Dental Students

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ABSTRACT

Objectives: The purpose of this study was to evaluate the radiographic quality of root canal fillings performed by first and second clinical year dental students at the Faculty of Dentistry in Süleyman Demirel University, Turkey.

Methods: The technical quality of 833 root canal fillings was evaluated by three examiners according to the density of the filling and the distance between the end of the filling and the radiographic apex. A root canal with acceptable filling length and homogeneous root filling was defined as being good quality endodontic work (GQEW). A treated tooth was defined as having good quality endodontic work tooth (GQEW-T) when all its canals had a GQEW rating.

Results: A Chi-square (χ^2) test at the 0.05 significance level was used for the statistical analysis of the data. Of a total of 833 root canals, 662 (79.47%) root fillings were classed as GQEW. Two hundred fifty canals (73.4%) (135 teeth) treated by first clinical year dental students were defined as GQEW-T while 412 canals (204 teeth) (73.9%) treated by second clinical year dental students were defined as GQEW-T (P>.05). Most of the GQEW-T were defined in anterior teeth (90.1%), whereas the fewest were in molar teeth (46.6%) for both first and second clinical year dental students (P<.001).

Conclusions: The quality of root canal fillings in anterior teeth performed by undergraduate dental students in Isparta, Turkey was satisfactory. However, to improve the success with molar teeth, education about newer techniques and instruments must be incorporated into the preclinical and clinical curriculum. (Eur J Dent 2011;5:324-330)

Key words: Radiograph; Root canal filling; Root canal treatment; Technical quality; Undergraduate dental students.

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INTRODUCTION

Follow-up studies on root canal treatment[1-5] reported that the technical quality of root canal treatment may affect the outcome of the procedure and the long-term retention of teeth. The probability of apical periodontitis was closely correlated with the quality of the root filling.[6,7] Peri-

radicular health is associated with root fillings that terminate within 2 mm of the radiographic apex and that are of adequate density.[8-10]

It is known that the standard of root canal treatment carried out by general dental practitioners in Europe is poor.[6,10,11,14] It has been reported that one of the causes of such poor quality treatment in general practice may be that students graduate with a lack of expertise and a poor understanding of the principles involved.[15]

The technical quality of root fillings is determined by its length in relation to the apex and by its homogeneity. Some studies show that the technical quality of root canal treatments performed by undergraduates demonstrates a good quality of endodontic work in a very wide range, between 13% and 70%.[16-23]

In Turkey, the first dental faculty (the Istanbul University Faculty of Dentistry) was founded in 1964. When this study was conducted, undergraduate dental education was undertaken by 21 dental faculties, consisting of 19 governments and 2 private dental schools. Suleyman Demirel University, Faculty of Dentistry was founded in 1995. Undergraduate endodontic education came under the wing of conservative dentistry during the period of this study. A few studies have been published on the incidence, quality, and success rates of root canal treatments performed by dental school students or general dental practitioners in Turkey.[18,24,25]

The aim of this study was to evaluate the radiographic quality of root canal fillings performed by first and second clinical year dental students at the Dental Faculty in Suleyman Demirel University, Turkey during 2004 and 2006.

MATERIALS AND METHODS

A random sample of 617 radiographs of patients who had received dental treatment in a year at the Faculty of Dentistry, University of Suleyman Demirel in the Conservative Dentistry Department. Records of patients younger than 18 years of age were discarded. Unreadable radiographs due to developing procedures, superimposed anatomical structures and in proper storage conditions were excluded. Records of third molars were also excluded. In total 173 radiographs had been discarded. The final sample consisted of 833 root canal fillings of 460 teeth in patients treated by first and second clinical year dental students. Undergraduate students were able to treat endodontic cases, including those with irreversible pulpitis and apical periodontitis, and to perform intentional treatment of teeth with vital pulps. More advanced cases that require specialist treatment, such as teeth with perforations, fractured instruments, posts, and teeth with extremely severe curved root canals, were referred to the postgraduate clinic. All root canal treatments were carried out by using the step-back and lateral-compaction techniques with gutta-percha. A post-obturation radiograph was taken with the long-cone paralleling technique, using a Trophy (France) X-ray unit. Kodak E-Speed films were exposed at 65 kV, 10 mA. The post-obturation radiograph showed the entire length of the root and the periapical area.

Three observers - a specialist endodontist with 12 years' clinical experience (ADK), a specialist endodontist with 7 years' clinical experience (GCU), and a doctoral student (BUK) with 4 years' clinical experience - examined the radiographs. Before evaluation, the observers participated in calibration training, which consisted of 75 randomly selected periapical radiographs of endodontically treated incisors, premolars, and molars. Strength of agreement was determined by calculation of the Kappa value (<0.20=poor, 0.21-0.40=fair, 0.41-0.60=moderate, 0.61-0.80=good, 0.81-1.00=very good).[26] Observers evaluated the samples with agreement levels of 'good' and 'very good'. A consensus was reached by negotiation of disagreements and difficult borderline cases, and a 'joint evaluation' (JE) was established. Intra-observer reproducibility was evaluated by a repeat scoring of the same 75 periapical radiographs, 2 months after the first examination. Before the second evaluation, the observers were re-calibrated by scoring 75 periapical radiographs. All Kappa values were between 0.90 and 0.84. The score of 'joint evaluation' was pooled as data for the radiographic quality of the root canal fillings.

Periapical radiographs were evaluated in a darkened room via a standard fluorescent light box and a magnifying viewer (3.5X) while mounted in a black cardboard slit to block off surrounding light from the viewer.

The technical quality of the root filling[24] was evaluated according to the density of the filling and the distance between the end of the filling and radiographic apex and scored as follows:

Length of the root filling:

1. Root filling terminating 0-2 mm from the radiographic apex (acceptable).

2. Root filling terminating >2 mm from the radiographic apex (unacceptable).

3. Root filling extending beyond the radiographic apex (unacceptable).

Homogeneity of the root filling:

1. Homogeneous root filling, good condensation, no voids visible (acceptable).

2. Inhomogeneous root filling, poor condensation, voids visible (unacceptable).

A root canal with an acceptable filling length and a homogeneous root filling was defined as being good quality endodontic work (GQEW).[27] A treated tooth was defined as having good quality endodontic work tooth (GQEW-T) when all its canals had a GQEW.

Statistical analysis

Statistical analysis of the data was performed using SPSS 10.0 for Windows (SPSS Inc., Chicago, IL, USA). The data regarding gender and location of the teeth were analyzed with a Chi-square (χ^2) analysis, and it was also used to determine statistically significant differences between the technical qualities of the root canal treatment according to the tooth type and clinical experience of dental students. A Chi-square (χ^2) test at the 0.05 significance level was used for the statistical analysis of the data.

RESULTS

Females (258) comprised 55.96% of the sample and males (203) were 44.04%. The percentage of GQEW-T was 34.76% in females and 30.36% in males; the difference between the genders was not statistically significant (P>.05).

The prevalence of tooth type and location of the teeth receiving root canal treatment are shown in Table 1. The percentage of GQEW-T was 34.76% in the maxillary teeth and 30.36% in the mandibular teeth, but the difference between the jaws was not statistically significant (P>.05). One hundred eighty-four (40.0%) teeth were treated by first clinical year undergraduates, and 276 (60.0%) were treated by second clinical year undergraduates. Of the 460 teeth, 9 (1.95%) were retreatments.

Table 2 shows the quality of root fillings in terms of homogeneity and length. Six hundred sixty-two (79.47%) root fillings were defined as GQEW.

Table 3 summarizes the GQEW-T in terms of dental students and type of tooth. There were no significant differences between the first and second clinical year dental students for all types of teeth (anterior, premolar, and molar) (P>.05). The relationship between the technical quality of root fillings and the tooth types was statistically significant (P<.001). Most of the GQEW-T were defined in anterior teeth (90.1%), whereas the fewest were in molar teeth (46.6%) for both the first and second clinical year dental students (P<.001).

DISCUSSION

The material used in this investigation consisted of the dental records and periapical radiographs of patients who had received root canal treatment at the Dental Faculty of Süleyman Demirel University. Panoramic radiographs were not used for this study as it has been shown that they provide less inter-examiner reliability and give difficulty in reading panoramic view radiographs.[28,29] Periapical radiographs have some limitations because a single radiograph provides only a two-dimensional image. Therefore, it is not possible to separate superimposed anatomical structures, such as the root canals. In addition, the length of the roots and canal fillings may not be reproduced accurately. Anatomical structures (maxillary antrum, zygomatic bone, zygomatic process of the maxilla) may contribute to difficulties in radiographic interpretation.[30,31] Radiographs with superimposed canal fillings or over-projections of anatomical structures were excluded because of the possibility of radiographic misinterpretation.

Previous epidemiological studies have used different criteria when categorizing root fillings as acceptable or unacceptable. Some studies have evaluated the quality of root fillings according to their length,[6,10,22,29] whereas most of the studies use both the length and homogeneity of the root fillings.[8,9,11,12,14,17,19,27,32-34] In addition, most of the studies assumed the apical termination of the root filling at ≤2 mm from the radiographic apex as the gold standard, while others used a broader standard of ≤3 mm from the radiographic apex as a criterion for an acceptable root filling.[12,34,37,38] In this study, the criteria used to assess the quality of root canal fillings were originally adopted from Hommez et al.[14]

Amongst the 833 root canals examined, acceptable filling length was observed in 84.3% and homogeneous root filling in 92% of the root canals. In this study, both acceptable filling length and homogeneous root filling in the whole root canal were used as the criteria for defining a GQEW. Similar criteria are advocated by ESE,[41] i.e., a radiographically dense filling with its end located between 0 and 2 mm from the apex. By this definition, 79.5% of the treated root canals fulfilled the criteria and, thus, qualified as being a GQEW. The published data relating to the quality of root filling performed by undergraduates showed an accept-

ability range between 13 and 70%.[16,23] The discrepancy in percentage of endodontically treated teeth that qualified as GQEW could be due to the use of different parameters to score the endodontic quality. Some of these studies adopted both acceptable or adequate root filling length and homogeneous filling as the criteria for a GQEW.[20,25] In addition to these criteria, the taper of the root filling was also considered in some studies.[18,19] However, a few investigations used the level of the root filling as the only criterion for judging a GQEW.[21,22]

Like the faculty in Isparta/Turkey, undergraduate students must complete a pre-clinical course in endodontics before beginning clinical endodontic treatments. This course was offered during the both autumn and spring term of the third year of the dental degree programme. During this course, students received 2 h lectures, and gained 4 h experience on 25 extracted teeth in the preclinical laboratory per week. The amount of pre-clinical laboratory teaching in Eastern Europe, the UK, Western Continental Europe, North America, Cork, and Scandinavia, was, 16, 24, 38, 41, 48, and 66 h respectively.[23,45] It was reported that the pre-clinical hour was 96 in Jordan and France.[17,19] The preclinical endodontic course took place over 32 week with an allocation of 4 h per week (128 h in total) in Isparta, Turkey. The staff/student ratio for the pre-clinical laboratory course is also important for determining the success of the undergraduates. This ratio was 1:8 in Isparta and is comparable with the other reports.[17,22,23,45]

The clinical endodontic teaching programme at the Faculty of Dentistry in Isparta, Turkey, was offered by the Department of Endodontics and took place in the department's clinic over the final 2 years of the undergraduate degree programme. The first and second clinical year students have three and a half weeks of treatment sessions that are 4 h in duration each. During this time, first clinical year students are expected to successfully obturate 17 teeth, including 8 anterior teeth, 5 molar teeth, 2 re-treatments, and 2 posts. Second clinical year students were requested to treat more than 2 teeth for each tooth group treated by first clinical year students. The treatments are performed under the clinical supervision of the department's full-time academic staff. There are specialist endodontists on the clinical teaching staff, unlike in some dental schools in France[17] and in Cork[22,23] where a senior academic consultant in restorative dentistry with a special interest in endodontics directs the clinical endodontic programme. In France, students participate in clinical training for 12 h per week for 3 years. During the fourth and the fifth clinical years, students are required to treat a minimum of 10 teeth including 2 single-rooted teeth, 3 premolars and 5 molars. On average, 140 canals are treated by students during the 3 years of clinical practice.[27] In Isparta, the ratio of clinical staff to students is 1:4, while it is 1:11 in France.[17]

Table 1. Prevalence of tooth type and position (FDI Classification).

Maxilla	Molar	Premolar	Anterior	Total
N (%)	86 (29.55)	99 (34.03)	106 (36.42)	291
Mandible	**Molar**	**Premolar**	**Anterior**	**Total**
N (%)	75 (44.37)	58 (34.32)	36 (21.31)	169

Table 2. Homogeneity and length of root filling.

	N (%)
Homogeneity acceptable, length acceptable (GQEW)	662 (79.47%)
Homogeneity acceptable, terminating >2 mm	61 (7.32%)
Homogeneity acceptable, beyond the radiographic apex	43 (5.16%)
Homogeneity unacceptable, length acceptable	40 (4.80%)
Homogeneity unacceptable, terminating >2 mm	23 (2.76%)
Homogeneity unacceptable, beyond the radiographic apex	4 (0.48%)

Table 3. Prevalence of GQEW-T according to dental students and type of tooth N (%).

	First clinical year	Second clinical year	Total
Anterior GQEW-T	53 (89.8)[a]	75 (90.4)[a]	128 (90.1)
Premolar GQEW-T	60 (85.7)[a]	76 (87.4)[a]	136 (86.6)
Molar GQEW-T	22 (40.0)[b]	53 (50.0)[ß]	75 (46.6)
Total GQEW-T	135 (73.4)	204 (73.9)	339 (73.7)

It is difficult to compare the studies because of the different criteria used. In some studies teeth were categorized as posterior and anterior or; anterior, premolar and molar. Posterior sometimes includes molar and premolar tooth, anterior includes only incisors or incisors and canines. Moussa-Badran et al[17] evaluated the premolars in the posterior teeth group. The proportion of the evaluated molar teeth (37.5%) was similar to that (35%) in the present study. Moussa-Badran et al[17] explained the poorer results obtained in the study by the evaluation of a greater proportion of posterior teeth. Whereas the quality of anterior teeth was also poor (36.1%) than the present study (90.1%). We thought that the poorer results obtained in Moussa-Badran et al's[17] study was not attributed only the quality of posterior teeth.

The percentage of the adequate root filling in a study[23] that included only single-rooted teeth was closer than the results of this study. It is significant that the students in Isparta receive more preclinical endodontic courses and training from a number of specialist endodontic academic staff than the students do in either of studies reported.[16,17,19] Another study in Turkey reported that only 33% of root fillings performed by undergraduates were technically adequate.[18] The proportion of molar teeth (44%) that was evaluated in Er et al[18] was almost two times than the anterior teeth (22.7%). The poor results of molar teeth (21.8%) could decrease the percentage of adequate root fillings. Unlike many studies[6,13,42,44] addition to the length and the density, they also evaluated the taper of the root fillings. If the taper of the root fillings was taken into consideration in the present study, the percentage of GQEW-T could be lower. Radiographic assessment of taper was excluded in the present study because it was thought to be a highly subjective criterion. The preclinical and clinical endodontic course time was quite less in the previous study[18] in Turkey than that in Isparta. It was reported that the preclinical course time was 56 hours; clinical course time was 16 hours in first and 32 hours in second clinical year. Compared to our dental school, students are expected to treat more root canals (10 root canals in the first and 60 root canals in the second clinical year) in a less time interval. The necessity to treat fewer teeth in a longer time interval could be the other factor related to the generally high (79.5%) quality of root fillings in the present study.

ESE has emphasized that the preclinical and clinical experience affects the success of undergraduates and advised gaining the requisite experience on 20 extracted teeth. There was no significant difference between the first and second clinical year dental students for all types of teeth (anterior, premolar, and molar) ($P>.05$). Preclinical teaching on 25 extracted teeth gave rise to the percentage of GQEW-T, except in molar teeth, for both clinical years. Having curved root canals can cause a low percentage of GQEW-T in molar teeth as compared to the other studies.[17,19,20,27] Step-back preparation and cold-lateral condensation are standard techniques that have been taught to our undergraduate dental students. These techniques are the most widely taught and used techniques in the world.[46] Preparation with nickel-titanium files, as well as a balanced force technique, are recommended in curved root canals.[47] The preparation of canals was reported as having fewer procedural errors and more successful treatment compared to using conventional stainless steel instruments when dental students used either hand or rotary nickel titanium instruments.[48] North American, Scandinavian, and Western European schools have incorporated usage of nickel titanium hand instruments into their routine preclinical teaching.[45] Unfortunately, neither nickel titanium hand instruments nor rotary instruments were being used in preclinical and clinical undergraduate teaching when this study was designed. All of the canals were prepared with only one technique (step-back preparation) whether the root canal showed curvature or not. This could affect the GQEW-T in molar teeth in this study.

In Isparta, the endodontic procedures are not carried out in a multi-disciplinary clinic, so clinical time dedicated only to endodontic practice allows a more precise evaluation of the time necessary for the improvement of the quality of the RCTs, and clinical supervision of undergraduate students was undertaken by specialists in endodontics. Thus the quality of root canal fillings performed by undergraduate dental students in Isparta, Turkey, was satisfactory. However, to improve success with molar teeth, education in newer techniques and instruments must be incorporated into preclinical and clinical curriculum.

Root fillings' taper was used as a criterion in a few studies evaluating radiographic technical quality of root fillings. It was reported that the taper of root canals were assessed subjectively in these studies. The assessment of the taper with objective criteria able to increase the value of this kind of studies.

CONCLUSIONS

The quality of root canal fillings in anterior teeth performed by undergraduate dental students in Isparta, Turkey was satisfactory. However, to improve the success with molar teeth, education about newer techniques and instruments must be incorporated into the preclinical and clinical curriculum.

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