



## Quality of Root Canal Obturation Performed by Senior Undergraduate Dental Students

Saeed Moradi<sup>a</sup>, Maryam Gharechahi<sup>b\*</sup>

<sup>a</sup> Dental Material Research Center, Department of Endodontics, Dental School, Mashhad University of Medical Sciences, Mashhad, Iran; <sup>b</sup> Dental Research Center, Department of Endodontics, Dental School, Mashhad University of Medical Sciences, Mashhad, Iran

ARTICLE INFO	ABSTRACT
<p>Article Type: <b>Original Article</b></p>	<p><b>Introduction:</b> There is a direct relationship between the quality of root canal obturation and success of endodontic therapy. The aim of the present study was to assess the quality of canal obturation performed by undergraduate dental students at the Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran. <b>Materials and Methods:</b> Records of 200 endodontically treated teeth from patients who were visited by undergraduate students between 2009 and 2010, at the Endodontic department, Faculty of Dentistry, Mashhad University of Medical Sciences, were randomly selected for evaluation. Periapical radiographs of all treated teeth were assessed in terms of canal obturation quality (<i>i.e.</i> adequate density and length). Statistical analysis of data was carried out using SPSS software and chi-square test. The Statistical significance level was set at <math>P=0.05</math>. <b>Results:</b> Forty-five percent of teeth fulfilled the criteria of an acceptable root canal obturation. Adequate length and density of root filling was found in 89% and 34% of teeth, respectively. There was a significant difference between maxillary and mandibular teeth regarding the length of root canal obturation (<math>P=0.004</math>). A significant difference was observed between molars and other tooth types. The frequency of root canals with an acceptable filling was significantly greater in the anterior teeth compared to premolars or molars. <b>Conclusion:</b> The technical quality of root canal treatment performed by undergraduate dental students was found to be less than ideal.</p> <p><b>Keywords:</b> Dental Radiography; Endodontics; Root Canal Obturation; Root Canal Therapy; Undergraduate Medical Education</p>
<p>Received: 02 May 2013 Revised: 01 Nov 2013 Accepted: 21 Nov 2013</p>	
<p>*Corresponding author: Maryam Gharechahi; Department of Endodontics, Dental Research Center, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: +98-915 5140340 Email: gharechahim@mums.ac.ir</p>	

### Introduction

Preservation of the natural dentition has become more popular in contemporary society [1]. Therefore, endodontic therapy is becoming an increasingly routine part of general dental practice [2]. Success of root canal treatment has been reported to be 53-94% [3, 4].

The methods for assessment of endodontic treatment outcome are mostly based on radiographic evaluation only [5-7], combination of radiographic and clinical evaluation [8-10] or histological examination, in case of treatment failures [11, 12]. The quality of root canal treatment performed by general practitioners in different populations has also been extensively investigated in many studies, the results of which have shown high percentage of inadequate root canal treatment [7, 13-15]. The reasons are complex and may be related to the different endodontic teaching methods at dental schools [16].

Some of the problems in endodontic teaching may be attributed to limited time allocated to endodontics, poor staff-to-student ratios and the fact that many endodontists have not taken the teaching skills [17].

Students are taught endodontics within five levels, at the Faculty of Dentistry, Mashhad University of Medical Sciences, Iran. A preclinical course is presented in the third year within two semesters, during which students are trained to perform root canal treatment on human extracted teeth. They are expected to complete the root canal treatment (RCT) of at least 5 anterior teeth, 2 bicuspid and 4 molars. The other three courses are clinical practice, where senior students of 4th, 5th and 6th years, are expected to perform endodontic treatment on a variety of teeth belonging to the patients diagnosed to require RCT. During the 4th year, the students perform the RCT of 6 anterior teeth and 2 bicanal premolars. In 5th year, they have to complete the RCT of 8

**Table 1.** The criteria for the assessment of radiographic quality of root canal filling

Parameter	Criteria	Definition
Length of root canal filling	Adequate	Root filling ending $\leq 2$ mm from radiographic apex
	Over-filling	Root filling beyond the radiographic apex
	Short-filling	Root filling $> 2$ mm from radiographic apex
Density of root canal filling	Adequate	No voids present in the root filling or between root filling and root canal walls
	Inadequate	Voids present in the root filling or between root filling and root canal walls
quality	Acceptable	Adequate length and density

**Table 2.** Distribution of teeth in maxillary and mandibular arches

Tooth type	N	%
Maxillary	112	56
Maxillary anterior teeth	60	30
Maxillary premolars	27	13.5
Maxillary molars	25	12.5
Mandibular	88	44
Mandibular anterior teeth	1	0.5
Mandibular premolars	20	10
Mandibular molars	67	33.5
Total	200	100

molars, one premolar, and carry out one retreatment within the two terms. And finally, in 6th year, during one endodontic course root canal treatment of 3 molars should be carried out. So, the fifth year seems to be the appropriate time for evaluating the technical quality of root canal therapy by undergraduate students.

Eleftherioudis *et al.* evaluated root canal obturation by 4th and 5th year undergraduate students [18]. Balto *et al.* [19] and K-fir *et al.* [20] in separate studies assessed the quality of root canal therapy carried out by fifth-year undergraduate students. Such studies are necessary in order to assess the effectiveness of medical education and dental care and also help with planning of future dental training strategies.

The aim of this observational study was to evaluate the technical quality of root canal obturation using radiographs of teeth treated by fifth-year undergraduate dental students at Endodontic department, Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran.

## Material and Methods

Records of 245 patients who had received endodontic treatment by fifth-year undergraduate students at Faculty of Dentistry, Mashhad University of Medical Sciences, from 2009 to 2010, were selected and evaluated. Records that did not include pre- and post-operative periapical radiographs or those with poor radiographic quality besides the records of patients with incomplete endodontic treatment, were excluded. The final sample consisted of 200 documents of endodontically treated teeth. Among these, 61 were anterior teeth while 47 and 92 teeth were premolars and molars, respectively. All the RCTs had been performed by fifth-year undergraduate students. An aseptic

technique with rubber dam isolation had been applied in all the cases and working lengths was determined by means of radiographs. All the teeth had been instrumented with passive step-back technique using stainless steel K-files (Dentsply, Tulsa, Ok, USA) with 0.02 taper and irrigated with 2.5% sodium hypochlorite solution. Root fillings had been carried out with lateral compaction technique using gutta-percha (Ariadent, Tehran, Iran) and AH-26 sealer (Dentsply Maillefer, Tulsa, OK, USA). All the teeth had been temporarily filled and referred for permanent restoration.

All the treatment steps were conducted under the supervision of teaching staff and postgraduate students of the department with an average staff-to-student ratio of 1:5. Evaluation of the technical quality of RCT was based on the immediate postoperative radiograph of each case.

For the present assessment, the quality of root canal obturation was evaluated according to the criteria of Barrieshi-Nusair *et al.*, and the final radiographs were examined by two independent investigators using a with a few selected cases which were not included in the study[16].

An evaluation form was designed to record the information gathered from the immediate postoperative radiographs. The method of viewing the radiographs was standardized; they were interpreted in a dark room using an illuminated viewer box (Dentsply Rinn Corp. Elgin, IL, USA) with magnification (2 $\times$ ) whilst mounted in a cardboard slit to block off ambient light emanating from the viewer. Measurements were recorded using a transparent ruler of 0.5 mm accuracy. The results were compared and a final consensus was agreed upon. In case of disagreement, a third investigator was asked to evaluate the radiograph and a final agreement was reached. Each root was scored individually and the tooth was considered as a unit. In multi-rooted teeth, the highest score of all the roots was attributed to the tooth and ultimately, failure of one root was considered the failure of the tooth as a whole. The quality of endodontic treatment was determined by the length of root canal obturation in relation to the radiographic apex and also the density of the obturation based on the presence of voids (Table 1). Acceptable obturation quality was defined as adequate length and density with the absence of any procedural error.

Statistical analysis of data was carried out using SPSS software, version 7.5 (SPSS Inc., Chicago, IL, USA) and the chi-square test. Statistical significance was set at  $P < 0.05$ .

**Table 3.** Overall quality, length, and density of root canal filling

n	Quality		Length			Density	
	Acceptable	Unacceptable	Adequate	Short-filling	Over-filling	Acceptable	Unacceptable
200	90 (45%)	110 (55%)	178(89%)	15(7.5%)	7(3.5%)	69(34.5%)	131(65.5%)

**Table 4.** Quality, length, and density of root canal filling in relation to teeth position

Arch	n	Quality		Length			Density	
		Acceptable	Unacceptable	Adequate	Short-filling	Over-filling	Acceptable	Unacceptable
Maxillary	112	51(45.5%)	61(54.5)	106(94.6)	3(2.7%)	3(2.7%)	39(34.8%)	73(65.2%)
Mandibular	88	39 (44.3%)	49 (55.7%)	72(81.8%)	12(13.6%)	4(4.5%)	30(34.1%)	58(65.9%)

**Table 5.** Quality, length, and density of root canal filling according to teeth type

Tooth type	n	Quality		Length			Density	
		Acceptable	Unacceptable	Adequate	Short-filling	Over-filling	Acceptable	Unacceptable
Anterior	61	40(65.6%)	21(34.4%)	60(98.4%)	0(0%)	1(1.6%)	21(34.4%)	40(65.6%)
Premolar	47	29(61.7%)	18 (38.3%)	44(93.6%)	2(4.3%)	1(2.1%)	15(31.9%)	32(68.1%)
Molar	92	21 (22.8%)	71 (77.2%)	74(80.4%)	13(14.1%)	5(5.4%)	33(35.9%)	59(64.1%)

## Results

The teeth were classified according to their location in the arches. The frequencies of teeth examined in this study are shown in Table 2. There were 112 maxillary and 88 mandibular teeth. Quality of root canal filling (*i.e.* length, and density) is shown in Table 3. Ninety teeth (45%) fulfilled the criteria of an acceptable root canal filling. Adequate length of the root filling was found in 89% of teeth, while 7.5% were underfilled and 3.5% were overfilled. Adequate density was found in 34% of teeth.

There was no statistically significant difference between maxillary and mandibular teeth in terms of the quality of root fillings ( $P=0.864$ ). However, there was a significant difference between maxillary and mandibular teeth in relation to the length of root canal obturations ( $P=0.004$ ). Adequate length of root filling was found in 94.6% of maxillary and 81.8% of mandibular teeth. A total of 13.6% of mandibular and 2.7% of maxillary teeth were underfilled, while 2.7% and 4.5% of the teeth were overfilled in maxilla and mandible, respectively. Adequate density was found in 34.8% of maxillary and 34.1% of mandibular teeth (Table 4).

There was a relationship between tooth type and the quality of root filling. A significant difference was observed between molars and other tooth types ( $P=0.000$ ). The frequency of root canals with an acceptable obturation was significantly higher in anterior teeth (40%) compared to premolars (29%) or molars (21%) (Table 5).

## Discussion

This study aimed to evaluate the quality of root canal treatment carried out by senior undergraduate students at Faculty of Dentistry, Mashhad University of Medical Sciences. Postoperative periapical radiographs were used for assessment. The quality of root canal obturation was evaluated according to the criteria of Barrieshi-Nusair *et al.* [16].

Studies evaluating the radiographic quality of root canal treatment have mostly been based on the evaluation of the length and the density of root canal obturation [21-24]. The results of the present study demonstrated adequate quality of root fillings in 45% of teeth, similar to the results of a study performed by Barrieshi-Nusair *et al.* [16]. Such frequency was lower than the frequency reported by Benenati *et al.* (91.05%) [25], Al-Yahya *et al.* (76%) [26], Lynch (63%) [27], and Eleftheriadis and Lambrianidis (55%) [18]. Also, the results were higher than those reported by Hayes *et al.* which was 13% [28].

The results of this study showed that quality of root canal obturation was less than ideal. The reasons for this fact are complex and may be related to the endodontic teaching strategy undertaken at dental schools [16].

The quality of maxillary and mandibular root fillings was the same in this study. The frequency of teeth with an acceptable root canal obturation was significantly higher in anterior teeth (40%) compared to premolars (29%) and molars (21%) ( $P=0.000$ ). Such results are consistent with the findings of Boucher *et al.* [29] and Eleftheriadis and Lambrianidis [18], who reported that the technical quality was acceptable more often in anterior teeth. This may be explained partly by the anatomy of these teeth.

The percentage of root canal fillings with adequate length was 89% in the present study. Although it is difficult to compare these results with those of other studies, the percentage of root fillings with adequate length was higher when compared with those reported by Er *et al.* (69.6%) [30], Chueh *et al.* (61.7%) [31] and Barrieshi-Nusair *et al.* (76.7%) [16]. However, estimation of the root filling length was probably not reproduced correctly in all the radiographs because the undergraduate students use the bisecting-angle technique to take the postoperative radiographs. Forsberg demonstrated that root canal fillings are projected shorter (*i.e.* more coronally), on the radiographs exposed with the bisecting-angle technique than with the paralleling technique [32].

In the present study, underfillings were found in 7.5% of the teeth. The highest percentage of underfilling was found in mandibular molars. This finding concurs with those of studies by Barrieshi-Nusair *et al.* [16] and Er *et al.* [30] and may be explained by the anatomy of these teeth, *i.e.* multi-canal roots and their curvature and also difficult access to posterior teeth that make their root canal treatment more challenging for students.

In this study overfilling was found in 3.5% of the teeth. The higher percentage of overfillings reported in other studies may be attributed to the higher incidence of teeth with preexisting periapical radiolucency in these studies [10, 19, 30]. These lesions can result in resorption and destruction of the apical constriction and this loss may have influenced working length control by undergraduate students.

Inadequate density of root canal obturation may lead to failure of root canal treatment because of microleakage along the root filling [23]. Eriksen and Bjertness reported the incidence of apical periodontitis to be higher in root-filled teeth with inadequate densities [33]. The results of the present study indicated that adequate density occurred in 34.5% of cases. Such frequency was consistent with the study of Balto *et al.*, who reported adequate density in 35% of teeth [19]. On the contrary, it was lower than the values reported by Yoldas *et al.* (64%) [34] and Er *et al.* (53%) [30]. However, it is difficult to compare these studies as a result of differences in their sample size.

In Mashhad Faculty of Dentistry, passive step-back instrumentation using conventional stainless steel files and cold lateral condensation are taught to undergraduate dental student. These techniques are the most widely taught and used techniques in dental schools [35]. A number of schools have incorporated the use of rotary nickel-titanium (NiTi) instruments in their undergraduate curricula [36]. Some studies have shown that when dental students use either hand or rotary NiTi instruments, canals are prepared with less procedural errors and more successful treatment results are achieved compared to the use of conventional stainless steel instruments [37-40].

In our school, preclinical endodontics is taught in two academic terms. Each term lasts 4 months with an allocation of 3 h per week at the phantom-head laboratory. This short time tends to limit students' preclinical training in endodontics with consequent problems during clinical practice. Some investigators, who have evaluated the undergraduate endodontic teaching, have reported similar teaching problems [17, 36, 41].

To sum up, in order to improve the technical quality of root canal treatment performed by undergraduate dental students, the endodontics curricula have to be revised. Thus, the time of training of the students at the pre-clinic and clinic has to be extended, and subsequently the clinical requirements for endodontics have to be increased, so that the student will be given more time to treat more cases. The clinical training courses have to be arranged to provide the students with proper skills in endodontics, starting with the basic principles in clinical practice.

## Conclusion

According to the results of this observational study, the technical quality of root canal treatment performed by undergraduate dental students was found to be less than 50%. Thus, revision of training courses for the students at the pre-clinic and clinic is suggested.

## Acknowledgment

The authors would like to thank the Vice Chancellor of Research of Mashhad University of Medical Sciences for financial support.

Conflict of Interest: 'None declared'.

## References

- [1] Daly RM, Elsner RJF, Allen PF, Burke FM. Associations between self-reported dental status and diet. *J Oral Rehabil.* 2003;30(10):964-70.
- [2] Legan JJ, Brown CE, Jr. Instrumentation enhances today's endodontic care. *J Indiana Dent Assoc.* 1998;77(4):30-4, 7-8, 40-1.
- [3] Jokinen MA, Kotilainen R, Poikkeus P, Poikkeus R, Sarkki L. Clinical and radiographic study of pulpectomy and root canal therapy. *Scand J Dent Res.* 1978;86(5):366-73.
- [4] Lazarski MP, Walker WA, 3rd, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. *J Endod.* 2001;27(12):791-6.
- [5] Kerekes K, Tronstad L. Long-term results of endodontic treatment performed with a standardized technique. *J Endod.* 1979;5(3):83-90.
- [6] Buckley M, Spangberg LS. The prevalence and technical quality of endodontic treatment in an American subpopulation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1995;79(1):92-100.
- [7] Saunders WP, Saunders EM, Sadiq J, Cruickshank E. Technical standard of root canal treatment in an adult Scottish subpopulation. *Br Dent J.* 1997;182(10):382-6.
- [8] Swartz DB, Skidmore AE, Griffin JA, Jr. Twenty years of endodontic success and failure. *J Endod.* 1983;9(5):198-202.
- [9] Smith CS, Setchell DJ, Harty FJ. Factors influencing the success of conventional root canal therapy-a five-year retrospective study. *Int Endod J.* 1993;26(6):321-33.
- [10] Peak JD, Hayes SJ, Bryant ST, Dummer PMH. Endodontics: The outcome of root canal treatment. A retrospective study within the armed forces (Royal Air Force). *Br Dent J.* 2001;190(3):140-4.
- [11] Lin LM, Pascon EA, Skribner J, Gangler P, Langeland K. Clinical, radiographic, and histologic study of endodontic treatment failures. *Oral Surg Oral Med Oral Pathol.* 1991;71(5):603-11.

- [12] Lin LM, Skribner JE, Gaengler P. Factors associated with endodontic treatment failures. *J Endod.* 1992;18(12):625-7.
- [13] Eckerbom M, Andersson JE, Magnusson T. Frequency and technical standard of endodontic treatment in a Swedish population. *Endod Dent Traumatol.* 1987;3(5):245-8.
- [14] De Cleen MJ, Schuur AH, Wesselink PR, Wu MK. Periapical status and prevalence of endodontic treatment in an adult Dutch population. *Int Endod J.* 1993;26(2):112-9.
- [15] De Moor RJ, Hommez GM, De Boever JG, Delme KI, Martens GE. Periapical health related to the quality of root canal treatment in a Belgian population. *Int Endod J.* 2000;33(2):113-20.
- [16] Barrieshi-Nusair KM, Al-Omari MA, Al-Hiyasat AS. Radiographic technical quality of root canal treatment performed by dental students at the Dental Teaching Center in Jordan. *J Dent.* 2004;32(4):301-7.
- [17] Dummer PM. Comparison of undergraduate endodontic teaching programs in the United Kingdom and in some dental schools in Europe and the United States. *Int Endod J.* 1991;24(4):169-77.
- [18] Eleftheriadis GI, Lambrianidis TP. Technical quality of root canal treatment and detection of iatrogenic errors in an undergraduate dental clinic. *Int Endod J.* 2005;38(10):725-34.
- [19] Balto H, Al Khalifah S, Al Mugairin S, Al Deeb M, Al-Madi E. Technical quality of root fillings performed by undergraduate students in Saudi Arabia. *Int Endod J.* 2010;43(4):292-300.
- [20] Kfir A, Rosenberg E, Zuckerman O, Tamse A, Fuss Z. Comparison of procedural errors resulting during root canal preparations completed by junior dental students in patients using an '8-step method' versus 'serial step-back technique'. *Int Endod J.* 2003;36(1):49-53.
- [21] Dugas NN, Lawrence HP, Teplitsky PE, Pharoah MJ, Friedman S. Periapical health and treatment quality assessment of root-filled teeth in two Canadian populations. *Int Endod J.* 2003;36(3):181-92.
- [22] Helminen SE, Vehkalahti M, Kerosuo E, Murtomaa H. Quality evaluation of process of root canal treatments performed on young adults in Finnish public oral health service. *J Dent.* 2000;28(4):227-32.
- [23] Kirkevang LL, Horsted-Bindslev P, Orstavik D, Wenzel A. A comparison of the quality of root canal treatment in two Danish subpopulations examined 1974-75 and 1997-98. *Int Endod J.* 2001;34(8):607-12.
- [24] Lupi-Pegurier L, Bertrand MF, Muller-Bolla M, Rocca JP, Bolla M. Periapical status, prevalence and quality of endodontic treatment in an adult French population. *Int Endod J.* 2002;35(8):690-7.
- [25] Benenati FW, Khajotia SS. A radiographic recall evaluation of 894 endodontic cases treated in a dental school setting. *J Endod.* 2002;28(5):391-5.
- [26] Al-Yahya A. Analysis of student's performance in an undergraduate endodontic's program. *Saudi Dent J.* 1990;2:58-61.
- [27] Lynch CD, Burke FM. Quality of root canal fillings performed by undergraduate dental students on single-rooted teeth. *Eur J dent Educ.* 2006;10(2):67-72.
- [28] Hayes SJ, Gibson M, Hammond M, Bryant ST, Dummer PM. An audit of root canal treatment performed by undergraduate students. *Int Endod J.* 2001;34(7):501-5.
- [29] Boucher Y, Matossian L, Rilliard F, Machtou P. Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopulation. *Int Endod J.* 2002;35(3):229-38.
- [30] Er O, Sagsen B, Maden M, Cinar S, Kahraman Y. Radiographic technical quality of root fillings performed by dental students in Turkey. *Int Endod J.* 2006;39(11):867-72.
- [31] Chueh LH, Chen SC, Lee CM, Hsu YY, Pai SF, Kuo ML, et al. Technical quality of root canal treatment in Taiwan. *Int Endod J.* 2003;36(6):416-22.
- [32] Forsberg J. Estimation of the root filling length with the paralleling and bisecting-angle techniques performed by undergraduate students. *Int Endod J.* 1987;20(6):282-6.
- [33] Eriksen HM, Bjertness E. Prevalence of apical periodontitis and results of endodontic treatment in middle-aged adults in Norway. *Endod Dent Traumatol.* 1991;7(1):1-4.
- [34] Yoldas O, Topuz A, Isci AS, Oztunc H. Postoperative pain after endodontic retreatment: single- versus two-visit treatment. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2004;98(4):483-7.
- [35] Cailleateau JG, Mullaney TP. Prevalence of teaching apical patency and various instrumentation and obturation techniques in United States dental schools. *J Endod.* 1997;23(6):394-6.
- [36] Qualtrough AJ, Whitworth JM, Dummer PM. Preclinical endodontology: an international comparison. *Int Endod J.* 1999;32(5):406-14.
- [37] Park H. A comparison of Greater Taper files, ProFiles, and stainless steel files to shape curved root canals. *Oral Surg Oral Pathol Oral Radiol Endod.* 2001;91(6):715-8.
- [38] Pettiette MT, Metzger Z, Phillips C, Trope M. Endodontic complications of root canal therapy performed by dental students with stainless-steel K-files and nickel-titanium hand files. *J Endod.* 1999;25(4):230-4.
- [39] Pettiette MT, Olutayo Delano E, Trope M. Evaluation of success rate of endodontic treatment performed by students with stainless-steel K-files and Nickel-titanium hand files. *J Endod.* 2001;27(2):124-7.
- [40] Gluskin AH, Brown DC, Buchanan LS. A reconstructed computerized tomographic comparison of Ni-Ti rotary GT™ files versus traditional instruments in canals shaped by novice operators. *Int Endod J.* 2001;34(6):476-84.
- [41] Qualtrough AJ, Dummer PM. Undergraduate endodontic teaching in the United Kingdom: an update. *Int Endod J.* 1997;30(4):234-9.

Please cite this paper as: Moradi S, Gharechahi M. Quality of Root Canal Obturation Performed by Senior Undergraduate Dental Students. *Iran Endod J.* 2014;9(1):66-70.