



Radiographic Evaluation of Root Canal Fillings Accomplished by Undergraduate Dental Students

Hamidreza Yavari^a, Mohammad Samiei^a, Shahriar Shahi^a, Zahra Borna^b, Amir Ardalan Abdollahi^{a*},
Negar Ghiasvand^c, Gholamreza Shariati^a

^a Department of Endodontics, Dental and Periodontal Research Center, Dental School, Tabriz University of Medical Sciences, Tabriz, Iran; ^b Department of Endodontics, Dental School, Urmia University of Medical Sciences, Urmia, Iran; ^c Department of Operative Dentistry, Dental School, Tabriz University of Medical Sciences, Tabriz, Iran; ^d Private practice, Tabriz, Iran

ARTICLE INFO

Article Type:
Original Article

Received: 13 Nov 2014
Revised: 01 Feb 2015
Accepted: 17 Feb 2015

*Corresponding author: Amir Ardalan Abdollahi, Student's Research Committee, Dental School, Tabriz University of Medical Sciences, Tabriz, Iran.

Phone: +98-914 4091317
E-mail: ardalan_2000a@yahoo.com

ABSTRACT

Introduction: The purpose of this study was to evaluate the radiographic quality of root canal fillings by fourth-, fifth-, and sixth-year undergraduate students at Tabriz Faculty of Dentistry between 2006 and 2012. **Methods and Materials:** A total of 1183 root canal fillings in 620 teeth were evaluated by two investigators (and in case of disagreement by a third investigator) regarding the presence or absence of under-fillings, over-fillings and perforations. For each tooth, preoperative, working and postoperative radiographs were checked. The Pearson's chi-square test was used for statistical evaluation of the data. Inter-examiner agreement was measured by Cohen's kappa (k) values. The level of significance was set at 0.05. **Results:** Total frequencies of over-filling, under-filling and perforation were 5.6%, 20.4% and 1.9%, respectively. There were significant differences between frequencies of over- and under-fillings ($P < 0.05$). Unacceptable quality, under- and over-fillings were detected in 27.9% of 1183 evaluated canals. **Conclusion:** The technical quality of root canal therapies performed by undergraduate dental students using step-back preparation and lateral compaction techniques was unacceptable in almost one-fourth of the cases.

Keywords: Dental Student; Radiographic Evaluation; Root Canal Fillings; Root Canal Treatment; Technical Quality

Introduction

The main aim of canal obturation is to prevent re-infection of the root canal system and allow healing of periapical pathosis [1]. The quality of root canal filling (RCF) has been commonly reported as the main factor in the success of root canal treatment [2, 3]. A number of studies have assessed the quality of RCF in treatments carried out by undergraduate dental students (UDS). Epidemiological surveys have reported 10.9-91% technically acceptable RCFs performed by dental students [4-15]. This wide range is attributed to different factors considered in these studies.

Helminen *et al.* [16] showed that success or prognosis of root canal treatment depends on the technical quality of root canal filling. However, the methods used to determine the technical outcome of endodontic treatment have been generally based on radiographic evaluation [7, 9, 17-19].

Smith *et al.* [2] and Sjogren *et al.* [20] reported that the distance between obturation terminus and the radiographic apex, significantly affects the outcome of root canal treatment, with 87-94% of healing rates related to root fillings ending within 0-2 mm from the radiographic apex. Lower healing rates were associated with short root fillings ending more than 2 mm from the radiographic apex (68-77.6%) and with fillings extruding outside the root apex (75-76%) [21].

In addition, iatrogenic complications or procedural mishaps during root canal treatment result in imperfect RCF, and thus put the long-term consequence of treatment in jeopardy [9]. For instance, perforations are followed by infection of the periodontal ligament and the alveolar bone and subsequently compromised healing [22, 23]. Different types of root perforation (including furcation perforation, strip perforation and apical perforation) and extrusion of the root filling materials can be detected in any area along the root [24].

Furthermore, it is well known that the quality of RCF is a key factor for the prognosis of root canal therapies [17, 18, 25, 26].

Evaluation of unfavorable treatment outcomes, shows high percentages of technically unacceptable RCFs. Being aware of this inadequacy and procedural mistakes can help in providing high quality treatments and decreasing the incidence of undesirable outcomes by elevating the level of educational curriculum. As a consequence, studying the prevalence and etiology of different procedural accidents by UDSs can help the practitioner achieve an improved ending. In addition, such studies are necessary in order to assess the effectiveness of dental academic curriculum by highlighting the weak points.

Thus, the aim of this study was to evaluate the technical quality of root canal fillings using periapical radiographs of teeth treated by UDSs in Tabriz Faculty of Dentistry, Tabriz, Iran, between 2006 and 2012.

Materials and Methods

This study was approved by the Research and Ethics Committee of Tabriz University of Medical Sciences. Records of 700 patients who had received dental treatment in the Faculty of Dentistry, Tabriz University of Medical Sciences, between 2006 and 2012 were randomly selected and investigated. Records of patients younger than 19 years of age and also the records that did not include preoperative and postoperative periapical radiographs or with clichés showing less than 2 mm of periapical region, were excluded. The cases with missing radiographs or radiographies that did not allow proper evaluation due to poor imaging or processing technique and superimposition of anatomical structures, were excluded.

Finally, documents of 620 treated cases were found eligible for evaluation. All of the endodontic treatments had been carried out by fourth, fifth, and sixth-year UDSs using K-files (Mani, Tochigi, Japan) with 0.02 taper and standard step-back technique. Canal obturation was carried out by lateral compaction technique using gutta-percha and a ZOE-based sealer. For each root-filled tooth, three clichés including preoperative, working length determination, and postoperative radiographs were inspected.

The radiographs were mounted in a cardboard slit and interpreted in a dark room, using an illuminated Viewer box (Dentsply Rinn Corp. Elgin, IL, USA). Measurements were recorded using a transparent ruler of 0.5-mm accuracy by two Endodontists. In case of disagreement, a third investigator was asked to interpret the radiograph and a final agreement was reached.

Table 1. Distribution [N (%)] of inadequate fillings and iatrogenic errors in each quadrant (UR: upper right, UL: upper left, LR: lower right, LL: lower left)

	UR	UL	LR	LL
Over-filling	12 (1.92)	9 (1.44)	6 (0.96)	8 (1.28)
Under-filling	32 (5.18)	45 (7.28)	28 (4.58)	19 (3.07)
Perforation	3 (0.47)	1 (0.13)	4 (0.63)	3 (0.47)

Parameters used to assess radiographic quality of root fillings are listed as follows: *i*) under-filling: the root canal filling material >2 mm short of the radiographic apex; *ii*) over-filling: extrusion of the root filling material through the radiographic apex; *iii*) perforation (furcation perforation, strip perforation and apical perforation): extrusion of RCF anywhere along the root or root trunk. Radiographs were evaluated, classified and recorded. Data were revealed as percentages.

SPSS software (SPSS version 17.0, SPS SPSS, Chicago, IL, USA) was used for data processing and statistical analysis. The Pearson's chi-square test was used for statistical evaluation of the findings. Inter-examiner agreement was measured by Cohen's kappa (k) values among 20 of cases. The k-value was calculated as 0.64 and relatively good agreement was observed between examiners. The level of significance was set at 0.05.

Results

Generally, the records of 350 female (56.3%) and 270 male (43.7%) patients (a total of 620 treated teeth and 1183 canals) were assessed. Of 620 observed teeth in this study, 52.9%, 14.5%, 21.6% and 11% had one, two, three and four canals, respectively.

Total rates of over-fillings, under-fillings and perforations were 5.6%, 20.4% and 1.9%, respectively. Unacceptable under- and over-filling was detected in 27.9% of canals. There were significant differences between frequencies of over- and under-fillings ($P < 0.05$) with most of the failures in length control being under-filling. The distribution of inadequate fillings and iatrogenic errors in each quadrant are shown in Table 1.

The distribution of root canals with unacceptable filling according to tooth type is illustrated in Table 2. Over-filling was the most common error in first molars (3.4%). Lateral incisors and second molars (0.16%) showed the least frequency of over-filling. Under-filling was observed most frequently in first molars (8.9%) and least frequently in canines (0.64%). Perforation was reported only in first premolars and first and second molars. The first molar was the most involved tooth (Table 2).

Discussion

In this study a radiographic evaluation of the quality of root canal fillings was carried out among adult population referring to the Department of Endodontics, Faculty of Dentistry, Tabriz, Iran, from 2006 to 2012.

Table 2. Distribution [N (%)] of root canals with unacceptable fillings in different dentition groups

	Over-filling	Under-filling	Perforation
Central incisor	3 (0.48)	7 (1.13)	0 (0)
Lateral incisor	1 (0.16)	9 (1.45)	0 (0)
Canine	2 (0.32)	4 (0.64)	1 (0.15)
First premolar	4 (0.64)	22 (3.56)	0 (0)
Second premolar	1 (0.08)	21 (3.4)	7 (1.1)
First molar	21 (3.4)	55 (8.9)	4 (0.63)
Second molar	1 (0.16)	8 (1.29)	0 (0)

Many studies have considered the acceptable apical extent of the RCF within 2 mm from the radiographic apex [7, 10-13, 27]. In this study RCF with adequate length were found in 75% of teeth. Although it is difficult to compare this finding with those of other studies (because of different evaluation criteria), this percentage was noticeable compared with those in other studies with adequate length being reported to range from 54.2% to 90% [5-7, 10-14, 28, 29]. Different studies about the quality of root fillings by UDSs evaluated acceptable root filling considering several factors such as void, length, iatrogenic errors, *etc.* [6-15]. In the present study only length inadequacy and perforation were recorded.

In the present study, inadequate filling was observed in posterior teeth more than anterior teeth, with the highest percentage (4.85%) belonging to mandibular molars, similar to the study by Barrieshi-Nusair *et al.* [10].

Furthermore, in several studies on nation-wide population, it is shown that molars have the highest frequency of apical periodontitis compared with other teeth [30-33]. It is apparent that in dental schools and dental practice, successful treatment of molars is difficult. Accordingly, modification of educational programs is necessary with more emphasis on the different treatment requirements for molars compared to anterior teeth.

The ratio of single-canal teeth to multiple-canal teeth in the current study was approximately 2:1. The high percentage of adequate filling in this study could be related to this relatively high proportion of single canal treatment trend. In addition, the tendency not to report problems may have been accompanied by the limitation of two-dimensional endodontic radiographic interpretation and unknown number of cases referred to the postgraduate clinic as a result of difficulties or because of technical impairment by the UDSs, which is particularly highlighted in the cases of perforation. Perforation rate in this study was very low (1.9%) in comparison with other studies, ranging from 2.7% to 11.8% [5, 9, 34, 35].

In this study the condition of periapical area was not considered, but in two recent studies by Moreno *et al.* [36] and Mukhaimer *et al.* [37], the periradicular status was evaluated in addition to the quality of root canal treatment; they reported that high prevalence of apical periodontitis was associated with treatments with substandard technical quality.

One of the aims of academic courses is to improve knowledge and training through improvement of educational programs. The quality of education is the result of many factors such as time devoted to theoretical and practical teaching and training, the ratio of supervisors to students, the clinical and scientific level of teachers, whether they are specialists or not, the training aids and the assessment methods. In Tabriz Faculty of Dentistry, the ratio of supervisors to students between 2006-2012 was approximately 1:5, which is high compared to other studies. For example in Reims (France), UK and North America this ratio was 1:11, 1:12 and 1:9, respectively [6, 38].

In the Tabriz Faculty of Dentistry, students use K-files with step-back technique. Clinical research has revealed that there is

a higher incidence of procedural errors and a lower success rate of primary root canal therapies of molars with stainless steel files compared to the use of NiTi hand instruments in a continuous reaming action [12, 39]. Also, it has been shown that step-back technique, used by inexperienced students, may result in procedural mishaps which may lead to inadequate cleaning and under-filling [40-42]. Thus, teaching the crown-down technique and the use of NiTi files is recommended to improve obturation quality.

Despite the higher percentage of acceptable fillings in the present study in comparison to other studies, there should be plans to revise both preclinical and clinical curriculum of endodontics in the future to fulfill accepted standards. Moreover, further studies on factors such as homogeneity, taper of filling and other iatrogenic errors (such as ledge formation and file separation), is suggested.

Conclusions

The radiographic quality of root canal treatments accomplished by fourth, fifth and sixth-year undergraduate students of Tabriz Faculty of Dentistry was unacceptable almost in one-fourth of cases. Thus, there is a need to improve the quality of root canal therapies performed by undergraduate students, through revision of preclinical and clinical training curriculum in Endodontic field.

Acknowledgment

The authors thank the Research Vice Chancellor and Dental and Periodontal Research Center of Tabriz University of Medical Sciences.

Conflict of Interest: 'None declared'.

References

1. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature-Part 2. Influence of clinical factors. *Int Endod J.* 2008;41(1):6-31.
2. 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.
3. Peak JD, Hayes SJ, Bryant ST, Dummer PM. The outcome of root canal treatment. A retrospective study within the armed forces (Royal Air Force). *Br Dent J.* 2001;190(3):140-4.
4. Bierenkrant DE, Parashos P, Messer HH. The technical quality of nonsurgical root canal treatment performed by a selected cohort of Australian endodontists. *Int Endod J.* 2008;41(7):561-70.
5. Khabbaz MG, Protogerou E, Douka E. Radiographic quality of root fillings performed by undergraduate students. *Int Endod J.* 2010;43(6):499-508.
6. Moussa-Badran S, Roy B, Bessart du Parc AS, Bruyant M, Lefevre B, Maurin JC. Technical quality of root fillings performed by dental students at the dental teaching centre in Reims, France. *Int Endod J.* 2008;41(8):679-84.

7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. Roman-Richon S, Faus-Matoses V, Alegre-Domingo T, Faus-Llacer VJ. Radiographic technical quality of root canal treatment performed ex vivo by dental students at Valencia University Medical and Dental School, Spain. *Med Oral Patol Oral Cir Bucal*. 2014;19(1):e93-7.
13. Unal GC, Kececi AD, Kaya BU, Tac AG. Quality of root canal fillings performed by undergraduate dental students. *Eur J Dent*. 2011;5(3):324-30.
14. Rafeek RN, Smith WA, Mankee MS, Coldero LG. Radiographic evaluation of the technical quality of root canal fillings performed by dental students. *Aust Endod J*. 2012;38(2):64-9.
15. Ilguy D, Ilguy M, Fisekcioglu E, Ersan N, Tanalp J, Dolekoglu S. Assessment of root canal treatment outcomes performed by Turkish dental students: results after two years. *J Dent Educ*. 2013;77(4):502-9.
16. 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.
17. Saunders WP, Saunders EM, Sadiq J, Cruickshank E. Technical standard of root canal treatment in an adult Scottish sub-population. *Br Dent J*. 1997;182(10):382-6.
18. 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.
19. Tsuneishi M, Yamamoto T, Yamanaka R, Tamaki N, Sakamoto T, Tsuji K, Watanabe T. Radiographic evaluation of periapical status and prevalence of endodontic treatment in an adult Japanese population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2005;100(5):631-5.
20. Sjogren U, Haggglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. *J Endod*. 1990;16(10):498-504.
21. Chugal NM, Clive JM, Spangberg LS. Endodontic infection: some biologic and treatment factors associated with outcome. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2003;96(1):81-90.
22. Seltzer S, Sinai I, August D. Periodontal effects of root perforations before and during endodontic procedures. *J Dent Res*. 1970;49(2):332-9.
23. Tsesis I, Rosenberg E, Faivishevsky V, Kfir A, Katz M, Rosen E. Prevalence and associated periodontal status of teeth with root perforation: a retrospective study of 2,002 patients' medical records. *J Endod*. 2010;36(5):797-800.
24. Fuss Z, Trope M. Root perforations: classification and treatment choices based on prognostic factors. *Endod Dent Traumatol*. 1996;12(6):255-64.
25. 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.
26. Hommez GM, Coppens CR, De Moor RJ. Periapical health related to the quality of coronal restorations and root fillings. *Int Endod J*. 2002;35(8):680-9.
27. 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.
28. Burke FM, Lynch CD, Ni Riordain R, Hannigan A. Technical quality of root canal fillings performed in a dental school and the associated retention of root-filled teeth: a clinical follow-up study over a 5-year period. *J Oral Rehabil*. 2009;36(7):508-15.
29. Adebayo ET, Ahaji LE, Nnachetta RN, Nwankwo O, Akabogu-Okpeseyi N, Yaya MO, Hussain NA. Technical quality of root canal fillings done in a Nigerian general dental clinic. *BMC Oral Health*. 2012;12:42.
30. Jimenez-Pinzon A, Segura-Egea JJ, Poyato-Ferrera M, Velasco-Ortega E, Rios-Santos JV. Prevalence of apical periodontitis and frequency of root-filled teeth in an adult Spanish population. *Int Endod J*. 2004;37(3):167-73.
31. Kirkevang LL, Orstavik D, Horsted-Bindslev P, Wenzel A. Periapical status and quality of root fillings and coronal restorations in a Danish population. *Int Endod J*. 2000;33(6):509-15.
32. Georgopoulou MK, Spanaki-Voreadi AP, Pantazis N, Kontakiotis EG. Frequency and distribution of root filled teeth and apical periodontitis in a Greek population. *Int Endod J*. 2005;38(2):105-11.
33. Ridell K, Petersson A, Matsson L, Mejare I. Periapical status and technical quality of root-filled teeth in Swedish adolescents and young adults. A retrospective study. *Acta Odontol Scand*. 2006;64(2):104-10.
34. Dadresanfar B, Mohammadzadeh Akhlaghi N, Vatanpour M, Atef Yekta H, Baradaran Mohajeri L. Technical quality of root canal treatment performed by undergraduate dental students. *Iran Endod J*. 2008;3(3):73-8.
35. 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.
36. Moreno JO, Alves FR, Goncalves LS, Martinez AM, Rocas IN, Siqueira JF, Jr. Periradicular status and quality of root canal fillings and coronal restorations in an urban Colombian population. *J Endod*. 2013;39(5):600-4.
37. Mukhaimer R, Hussein E, Orafi I. Prevalence of apical periodontitis and quality of root canal treatment in an adult Palestinian sub-population. *Saudi Dent J*. 2012;24(3-4):149-55.
38. Qualtrough AJ, Whitworth JM, Dummer PM. Preclinical endodontology: an international comparison. *Int Endod J*. 1999;32(5):406-14.
39. Cheung GS, Liu CS. A retrospective study of endodontic treatment outcome between nickel-titanium rotary and stainless steel hand filing techniques. *J Endod*. 2009;35(7):938-43.
40. Gambarini G. Shaping and cleaning the root canal system: a scanning electron microscopic evaluation of a new instrumentation and irrigation technique. *J Endod*. 1999;25(12):800-3.
41. Greene KJ, Krell KV. Clinical factors associated with ledged canals in maxillary and mandibular molars. *Oral Surg Oral Med Oral Pathol*. 1990;70(4):490-7.
42. Kfir A, Rosenberg E, Zuckerman O, Tamse A, Fuss Z. Comparison of procedural errors resulting during root canal preparations completed by senior dental students in patients using an '8-step method' versus 'serial step-back technique'. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2004;97(6):745-8.

Please cite this paper as: Yavari HR, Samiei M, Shahi S, Borna Z, Abdollahi A, Ghiasvand N, Shariati GR. Radiographic Evaluation of Root Canal Fillings Accomplished by Undergraduate Dental Students. *Iran Endod J*. 2015;10(2): 127-30.