

Technical quality of root fillings performed by dental students at the dental teaching centre in Reims, France

S. Moussa-Badran^{2,3}, B. Roy^{1,3}, A. S. Bessart du Parc³, M. Bruyant³, B. Lefevre³ & J. C. Maurin^{1,3}

¹Department of Restorative Dentistry and Endodontics, Champagne-Ardennes University; ²Department of Epidemiology, Faculty of Dentistry, Champagne-Ardennes University; and ³Dental service of the teaching Hospital, Reims, France

Abstract

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. *International Endodontic Journal*, **41**, 679–684, 2008.

Aim To evaluate the technical quality of root fillings performed by undergraduate students at a dental teaching centre in France.

Methodology A random sample of 419 records of patients who received dental treatment at the dental service of the teaching Hospital, in Reims, France between 2005 and 2006 was investigated. Evaluation of root filled was based on radiographical criteria defined by the French National Health Service. The length of root fillings, the radiodensity and the presence of voids in the root filling or between root filling and root canal walls were recorded and scored. Chi-square analysis was used to determine statistically significant differences between the technical quality of root fillings and tooth type.

Results Of the 304 teeth included in the study, 69% had an adequate length of root filling and 42.7% had a dense root filling without voids; only 30.3% of teeth fulfilled these criteria at the same time. The relationship between the technical quality of root fillings and tooth type was statistically significant ($P < 0.001$), the highest percentage of adequate root fillings occurred in single-rooted teeth (36.1%). The highest percentage of inadequate root fillings according to the criteria of root filling length and lateral adaptation was found in molar teeth (71.9%).

Conclusion Overall, the technical quality of root fillings performed by undergraduate students was poor.

Keywords: dental students, endodontics, epidemiology, radiographs, root canal treatment.

Received 21 November 2007; accepted 14 February 2008

Introduction

The prime objective of the root filling is to prevent reinfection of the root canal system and allow healing of the periapical tissues (Ng *et al.* 2008). The technical quality of the root filling in part determines the outcome of root canal treatment (RCT) as demonstrated by epidemiological studies reporting a

high prevalence of apical pathosis associated with root filled teeth, particularly when the root filling was inadequate (Helminen *et al.* 2000, Kirkevang *et al.* 2000, Lupi-Pegurier *et al.* 2002, Dugas *et al.* 2003). Thus, a systematic evaluation of the quality of root fillings is essential for clinicians to estimate prognosis.

The methods used to determine the technical outcome of RCTs are based mainly on radiographical evaluation (Eleftheriadis & Lambrianidis 2005, Tsuneshi *et al.* 2005, Er *et al.* 2006). According to the consensus report of the European Society of Endodontology (2006), appropriate RCT includes a radiographical control showing a prepared root canal filled

Correspondence: Dr Jean-Christophe Maurin, U.F.R d'Odontologie 2, rue du Général Koenig, 51100 Reims, France (Tel.: +33 03 26 91 34 61; fax: +33 03 26 91 34 56; e-mail: jean-christophe.maurin@univ-reims.fr).

completely without space between canal filling and canal walls. Furthermore, the root canal filling should be placed within 0.5–2 mm of the radiographical apex to prevent post-treatment disease (European Society of Endodontology 2006).

Recent epidemiological endodontic studies carried out in different population groups have reported a percentage of adequate root fillings ranging from 26.5% to 55.3% (Kirkevang *et al.* 2000, Chueh *et al.* 2003, Dugas *et al.* 2003, Barrieshi-Nusair *et al.* 2004, Eleftheriadis & Lambrianidis 2005, Er *et al.* 2006). In France, epidemiological studies on endodontic treatments have investigated mainly the quality of root fillings undertaken by general practitioners (Boucher *et al.* 2002, Lupi-Pegurier *et al.* 2002, Basmadjian-Charles *et al.* 2004). Their results showed high percentages of technically inadequate treatments (only 20.8–31.2% of adequate fillings). To date, no data reporting the quality of root fillings performed by French undergraduate students are available. Thus, the aim of this study was to evaluate the technical quality of root fillings using radiographs of teeth treated by undergraduate students at the dental teaching centre of Reims (Reims Champagne-Ardenne University and teaching Hospital), France, during 2005 and 2006.

Materials and methods

The first 419 records of patients who had received RCT at the Dental care centre of the teaching Hospital of Reims, France (Faculty of Dentistry, University of Reims-Champagne-Ardenne) between the years 2005 and 2006 were scrutinized. Records of patients younger than 19-year-old were excluded. Records that did not include preoperative and postoperative periapical radiographs with at least 2 mm of periapical region were excluded. The final sample consisted of 304 root filled teeth. All RCTs were carried out by fourth-, fifth- and sixth-year undergraduate students using a crown-down preparation technique with nickel-titanium rotary instruments (ProTaper[®] system, Denstply Maillefer, or Heroshaper[®] system; Micromega, Besançon, France) and a lateral compaction filling technique. For each root filled tooth, preoperative, working length determination and postoperative radiographs were examined. The radiographs were independently examined under even illumination in a dark room at $\times 2$ magnification by two investigators. The results were compared and a final consensus was agreed. In case of disagreement, a third investigator was asked to read the radiograph and a final agreement was reached.

Parameters used to assess radiographical quality of root fillings are listed as follows:

1. Presence or absence of a low density of root canal filling.
2. Presence or absence of voids in the root filling or between root filling and root canal walls.
3. Presence or absence of an 'underfilling': the root canal filling material is >2 mm short of the radiographical apex.
4. Presence or absence of an 'overfilling': the root canal filling material is extruded beyond the radiographical apex.

Each parameter was scored as previously described (Matysiak *et al.* 2003). Briefly, each parameter cited above was scored with 0 = absence (criterion not observed on the radiographs) or 1 = presence (criterion observed on the radiographs). For a multi-rooted tooth, each root canal was independently evaluated, scored, and then an overall score was attributed (e.g. when the same parameter was observed on several root canals, the score '1' was attributed only once for the entire tooth). The scores of each parameter were added up to obtain a final score allowing the assessment of the technical quality of the root filling. The final score 0 corresponded to a root filling deemed adequate, whereas a final score of 4 corresponded to an under- or over-filled canal. Chi-square analysis was performed to determine statistically significant differences between the technical quality of RCTs according to the tooth type. The significant level was $P < 0.05$.

Results

The final scores for the 304 root filled teeth were summarized in Table 1. The score 0 corresponding to an 'acceptable' filling was rated in 91 (30.3%) teeth. The score 4 corresponding to the combination of an inadequate length and density of the root filling was rated in 10 (3.3%) teeth. Table 2 shows the distribution

Table 1 Distribution of the final scores according to the evaluated radiographical parameters

Final scores	<i>n</i>	%
0	92	30.3
1	80	26.3
2	79	26
3	43	14.1
4	10	3.3
Total	304	100

Table 2 Percentages of the evaluated teeth according to the radiographical criteria

Radiographical criteria	Number of evaluated radiographs	Percentages of evaluated radiographs
Low density of root canal filling	100	33
Voids in the root filling or between root filling and root canal walls	164	54
Low density of root canal filling with voids in the root filling or between root filling and root canal walls	92	30.3
Voids in the root filling or between root filling and root canal walls with an adequate radiodensity	73	24
Low density of root canal filling without voids in the root filling or between root filling and root canal walls	9	3
Adequate radiodensity without voids in the root filling or between root filling and root canal walls	130	42.7
Underfilling	36	12
Overfilling	58	19

of the teeth according to the parameters evaluated by the investigators. The length of the root fillings was adequate in 209 (69%) teeth, 57 (19%) teeth were classified as being 'over-filled' and 36 (12%) teeth were evaluated as being 'under-filled'. A poor density of root filling was observed in 100 (33%) teeth and the presence of voids in the root filling was present in 163 (54%) teeth. A root filling could present both an inadequate density and voids. To evaluate the overall quality of the root filling, the density of the root filling was related with the presence of voids. In this way, 92 root fillings (30.3%) were not dense and contained voids; 73 root canal fillings (24%) were evaluated as being dense with voids; 9 root canal fillings (3%) were not dense without voids and 130 root fillings (42.7%) were dense without voids.

Table 3 shows the final score according to the tooth-type. The teeth examined were divided into three groups: anterior teeth, premolars and molars. The distribution of these groups was similar amongst the fourth, fifth and sixth year students (data not shown). The percentage of adequate root fillings (score 0) was 36% in anterior teeth, 28% in premolars and 28.9% in molars. The difference between anterior teeth and premolars or molars was statistically significant

Table 3 Distribution of the final score according to tooth types

Final score	Tooth types			
	Incisors/canines	Pre-molars	Molars	Total
0	26 (36.1) ^a	33 (28)	33 (28.9)	92 (30.3)
1	25 (34.7)	38 (32.2)	18 (15.8)	81 (26.6)
2	14 (19.4)	34 (28.8)	31 (27.2)	79 (26)
3	7 (9.7)	12 (10.2)	23 (20.2) ^b	42 (13.8)
4	0 (0)	1 (0.8)	9 (7.9) ^c	10 (3.3)
Total	72 (23.7)	118 (38.8)	114 (37.5)	304 (100)

Values in parentheses are in percentage.

^aStatistically significant differences ($P < 0.001$) between the group of anterior teeth and pre-molars/molars.

^bStatistically significant differences ($P < 0.001$) between group of anterior teeth and pre-molars/molars.

^cStatistically significant differences ($P < 0.001$) between group of anterior teeth and pre-molars/molars.

($P < 0.001$). There was no significant difference between premolars and molars. The scores 3 and 4 corresponding to the worst radiographical evaluation were more frequently attributed to the molars (28.1%), with a significant difference between the group of molars and the two groups of anterior teeth and premolars ($P < 0.001$). There was no significant difference between anterior teeth and premolars.

Finally, the density of root canal filling and the presence of voids were related to tooth type (Table 4). The best density of root filling was observed in anterior teeth and progressively decreased in premolars and molars with a significant difference amongst the three groups of teeth ($P = 0.0012$). The incidence of voids in root fillings increased in premolar and molars. There was a significant difference in the frequency of voids observed in root fillings amongst the three groups of teeth ($P < 0.001$).

Table 4 Distribution of defects in the lateral adaptation of root fillings according to tooth types

Radiographical criteria	Tooth types		
	Incisors/canines	Pre-molars	Molars
Low density of root canal filling	13 (18.1) ^a	36 (30.5) ^a	51 (44.7) ^a
Voids in the root filling or between root filling and root canal walls	27 (37.5) ^b	63 (53.4) ^b	76 (64.9) ^b

Values in parentheses are in percentage.

(The second criteria could be observed for a same tooth)

^aStatistically significant differences ($P = 0.0012$) amongst three groups: anterior teeth, pre-molars and molars.

^bStatistically significant differences ($P = 0.0012$) amongst three groups: anterior teeth, pre-molars and molars.

Discussion

In this study, a radiographical evaluation of the quality of root fillings amongst an adult population attending the dental care centre of the teaching Hospital of Reims, France in 2005 and 2006 is presented. The data used, consisted of a sample of periapical radiographs of patients who received RCTs carried out by fourth, fifth and sixth year undergraduate students. All periapical radiographs used in this study were taken during routine RCTs procedures within a dental student practice and were not taken especially for this study.

The radiographical criteria used to assess the quality of RCTs were based on those developed by the French National Health Service (Matysiak *et al.* 2003) and were the same as those used previously (Lupi-Pegurier *et al.* 2002). They were derived from the consensus report of the European Society of Endodontology (1994) and have been estimated to have good sensitivity and specificity (Matysiak *et al.* 2003). Commonly used by French clinicians, this system allowed an evaluation of the radiographical quality of root fillings. Many studies have considered the apical extent of the root filling ≤ 2 mm from the radiographical apex as adequate (Hayes *et al.* 2001, Lupi-Pegurier *et al.* 2002, Barrieshi-Nusair *et al.* 2004, Er *et al.* 2006). In this study, root fillings of adequate length were found in 69% of teeth. Although it is difficult to compare this result with other studies, this percentage was superior compared with those reported by Lupi-Pegurier *et al.* (2002) (38.7%) and Boltacz-Rzepkowska & Pawlicka (2003) (48.9%). This difference could be explained by the fact that dental students take several radiographs during RCTs until the working lengths are correct. Indeed, when RCTs were performed by students, the percentage of root fillings with adequate lengths has been reported to range from 61.3% to 69.6% (Barrieshi-Nusair *et al.* 2004, Eleftheriadis & Lambrianidis 2005, Er *et al.* 2006).

The quality of root filling was also assessed by its radiodensity and by the presence of voids within the root filling or between the filling and canal walls. Radiodensity is one of the criteria used to estimate a potential defect of the root canal sealing (Chugal *et al.* 2003). However, its assessment could be influenced by the radio-opacity of the material used to fill the root canal. Thus, this parameter was related to the presence of voids in the root filling. The result showed that only 42.7% of the teeth had a RCT which was adequately dense without voids. When the root filling length was

related to its adaptation, the percentage of teeth with adequate filling (score 0) was 30.1%. This result is consistent with previous studies showing that the percentage of adequate root fillings performed by undergraduate students ranged from 13% to 33% (Hayes *et al.* 2001, Er *et al.* 2006). However, the results from this study are lower than those obtained in previous studies with a frequency of acceptable fillings reaching 55.3% (Barrieshi-Nusair *et al.* 2004, Eleftheriadis & Lambrianidis 2005). Although it is difficult to compare the studies because of the different criteria used, the low percentage in this study could be explained by the greater proportion of posterior teeth evaluated (76.3%). This hypothesis is strengthened by the poorer results obtained with premolars and molars compared with the single rooted anterior teeth (incisors and canines). RCTs of multirooted teeth were performed by students from the first year of their clinical undergraduate education (fourth year undergraduate students). Thus, the quality of canal filling may be improved by allocating the treatment of premolars and molars to more experienced students (e.g. fifth or sixth year undergraduate students). Finally, the poorer result may be explained by the analysis considering each tooth in its entirety. The root filling was judged as 'acceptable' (score 0) only when all the roots of the tooth had an acceptable filling as described previously (Matysiak *et al.* 2003). The technical quality of root fillings as illustrated by radiographs is important for the outcome of the treatment but does not reflect the quality of the treatment in general. Indeed, the antiseptic and aseptic procedures during treatment, the method used for canal preparation and the materials used are prognostic factors that remain unknown from epidemiological studies (Wong 2004). All RCTs were performed under rubber dam, working length was determined with radiographs, all teeth were instrumented with the crown-down technique using Nickel-Titanium rotary instruments known for their ability to produce smooth tapered canal preparations and their cleaning effectiveness (Schafer & Schlingemann 2003, Peters 2004). Root canals were irrigated with 2.5% NaOCl and filled with a cold lateral compaction technique. During the pre-clinical training of students, this procedure was incorporated in the teaching during the third year and each student had to prepare a minimum of 20 root canals in extracted human teeth. The preclinical endodontic course took place over 8 months with an allocation of 3 h per week. The staff ratio for the preclinical teaching in

Reims is 1 : 10 which is comparable with other European universities (Qualtrough *et al.* 1999). This relatively limited time would restrict preclinical training in endodontics with consequent concerns over competence during clinical practice. Clinical practice takes place at Reim's Hospital during the fourth, fifth and sixth year students. Students participate in clinical training for 12 h per week for 1 year. During the fourth and the fifth clinical year, students are required to treat a minimum of 10 teeth including two single-rooted teeth, three premolars and five molars. On an average, 140 canals are treated by students during the 3 years of clinical practice. However, the actual time devoted to endodontic training is difficult to evaluate because the endodontic procedures are combined with conservative dentistry and are carried out in a multi-disciplinary clinic with prosthodontics. Thus, clinical time dedicated only to endodontic practice would allow a more precise evaluation of the time necessary for the improvement of the quality of the RCTs. Clinical supervision of undergraduate students was undertaken by restorative specialists and not totally by endodontists. The ratio of clinical staff to students is 1 : 11, which is lower than other universities (Barrieshi-Nusair *et al.* 2004, Lynch & Burke 2006). Thus, all procedures performed during RCTs may not have been directly supervised by the staff. This may explain the lower frequency of acceptable RCTs found in this study compared with others (47.4%: Barrieshi-Nusair *et al.* 2004; 70, %: Lynch & Burke 2006).

Conclusion

The technical quality of root fillings performed by undergraduate dental students using cold lateral compaction was found to be poor with only 30.1% having adequate quality. This low percentage suggests that the training course in endodontics has to be improved at both preclinical and clinical levels.

Acknowledgement

We are deeply grateful to Dr T. Dufour for the statistical analysis.

References

Barrieshi-Nusair KM, Al-Omari MA, Al-Hiyasat AS (2004) Radiographic technical quality of root canal treatment performed by dental students at the Dental Teaching Center in Jordan. *Journal of Dentistry* **32**, 301–7.

- Basmadjian-Charles C, Bourgeois D, Coudeville L, Lebrun T (2004) National survey of endodontics in general dental practice in France. *The European Journal of Prosthodontics and Restorative Dentistry* **12**, 144–53.
- Boltacz-Rzepkowska E, Pawlicka H (2003) Radiographic features and outcome of root canal treatment carried out in the Lodz region of Poland. *International Endodontic Journal* **36**, 27–32.
- Boucher Y, Matossian L, Rilliard F, Machtou P (2002) Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopulation. *International Endodontic Journal* **35**, 229–38.
- Chueh LH, Chen SC, Lee CM *et al.* (2003) Technical quality of root canal treatment in Taiwan. *International Endodontic Journal* **36**, 416–22.
- Chugal NM, Clive JM, Spangberg LS (2003) Endodontic infection: some biologic and treatment factors associated with outcome. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **96**, 81–90.
- Dugas NN, Lawrence HP, Teplitsky PE, Pharos MJ, Friedman S (2003) Periapical health and treatment quality assessment of root-filled teeth in two Canadian populations. *International Endodontic Journal* **36**, 181–92.
- Eleftheriadis GI, Lambrianidis TP (2005) Technical quality of root canal treatment and detection of iatrogenic errors in an undergraduate dental clinic. *International Endodontic Journal* **38**, 725–34.
- Er O, Sagsen B, Maden M, Cinar S, Kahraman Y (2006) Radiographic technical quality of root fillings performed by dental students in Turkey. *International Endodontic Journal* **39**, 867–72.
- European Society of Endodontology (1994) Consensus report of the European Society of Endodontology on quality guidelines for endodontic treatment. *International Endodontic Journal* **27**, 115–24.
- European Society of Endodontology (2006) Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. *International Endodontic Journal* **39**, 921–30.
- Hayes SJ, Gibson M, Hammond M, Bryant ST, Dummer PM (2001) An audit of root canal treatment performed by undergraduate students. *International Endodontic Journal* **34**, 501–5.
- Helminen SE, Vehkalahti M, Kerosuo E, Murtomaa H (2000) Quality evaluation of process of root canal treatments performed on young adults in Finnish public oral health service. *Journal of Dentistry* **28**, 227–32.
- Kirkevang LL, Orstavik D, Horsted-Bindslev P, Wenzel A (2000) Periapical status and quality of root fillings and coronal restorations in a Danish population. *International Endodontic Journal* **33**, 509–15.
- Lupi-Pegurier L, Bertrand MF, Muller-Bolla M, Rocca JP, Bolla M (2002) Periapical status, prevalence and quality of endodontic treatment in an adult French population. *International Endodontic Journal* **35**, 690–7.

- Lynch CD, Burke FM (2006) Quality of root canal fillings performed by undergraduate dental students on single-rooted teeth. *European Journal of Dental Education* **10**, 67–72.
- Matysiak M, Tardieu-Fabre F, Galliot M (2003) Establishing qualitative X-ray criteria to significantly contribute to the radiological results of an endodontic treatment. *Revue Medicale de l'Assurance Maladie* **34**, 111–20.
- Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K (2008) Outcome of primary root canal treatment: systematic review of the literature. Part 2. Influence of clinical factors. *International Endodontic Journal* **41**, 6–31.
- Peters OA (2004) Current challenges and concepts in the preparation of root canal systems: a review. *Journal of Endodontics* **30**, 559–67.
- Qualtrough AJ, Whitworth JM, Dummer PM (1999) Preclinical endodontology: an international comparison. *International Endodontic Journal* **32**, 406–14.
- Schafer E, Schlingemann R (2003) Efficiency of rotary nickel-titanium K3 instruments compared with stainless steel hand K-Flexofile. Part 2. Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. *International Endodontic Journal* **36**, 208–17.
- Tsuneishi M, Yamamoto T, Yamanaka R et al. (2005) Radiographic evaluation of periapical status and prevalence of endodontic treatment in an adult Japanese population. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **100**, 631–5.
- Wong R (2004) Conventional endodontic failure and retreatment. *Dental Clinics of North America* **48**, 265–89.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.