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Radiographic technical quality of root fillings performed by dental students in Turkey

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Abstract

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Aim To evaluate the radiographic technical quality of root fillings performed by undergraduate students at a dentistry faculty in Turkey.

Methodology A random sample of 2000 records of patients who received dental treatment at the Faculty of Dentistry, University of Gazi between 2000 and 2003 was investigated. The final sample consisted of 1893 root-filled teeth with 3692 root canals in 1654 dental patients. For each root-filled tooth, at least three periapical radiographs were examined: preoperative, working length determination and postoperative. The length, density and taper of root fillings were recorded. The length of root fillings was recorded as adequate, short or overfilled. Density of root fillings was recorded as adequate or inadequate. Taper of root fillings was recorded as adequate or inadequate. Results were evaluated statistically using one-way analysis of variance (ANOVA) and chi-square analysis.

Results Sixty-nine per cent, 53.2% and 68.3% of root fillings had adequate length, density and taper, respectively; only 33% of teeth fulfilled these three criteria at the same time. The relationship between the length, density and taper of the root filling and the presence of canal curvature was statistically significant ($P < 0.001$). There was no significant difference between maxillary and mandibular teeth according to the adequacy of the root fillings. The highest percentage of adequate root fillings was found in maxillary canines (51.5%).

Conclusions The percentage of adequate root fillings performed by undergraduate students was only 33%.

Keywords: dental students, endodontics, periapical radiographs, root canal treatment, technical quality.

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Introduction

Root canal treatment (RCT) is an essential part of comprehensive quality dental care (Chueh *et al.* 2003). Epidemiological surveys indicate technically satisfactory root fillings in 42–90% of cases (Sjögren *et al.* 1990, Eriksen 1991, Buckley & Spangberg 1995). However, the methods used to determine the technical outcome of endodontic treatment have been mostly based on radiographic evaluation (Buckley & Spangberg 1995, Saunders *et al.* 1997). Helminen *et al.* (2000) showed that success or prognosis of RCT depended on the technical quality of the root filling.

According to the European Society of Endodontology (1994), appropriate treatment includes, in addition to root canal preparation and filling, the exposure of preoperative radiographs, determination of the working length, and radiological control of the quality of the filling. Several studies indicate that root fillings placed within 0–2 mm of the radiographic apex were associated with less post-treatment disease than those that were filled greater than 2 mm from the radiographic apex or those that were overfilled (Saunders *et al.* 1997, Peak *et al.* 2001, Boltacz-Rzepkowska & Pawlicka 2003).

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Table 1 The criteria used to assess radiographic quality for root fillings

Parameters	Criteria	Definition
Length of root canal filling	Adequate	Root filling ending ≤2 mm from the radiographic apex
	Over-filling	Root filling beyond the radiographic apex
	Short-filling	Root filling ≥2 mm from the radiographic apex
Density of root canal filling	Inadequate	Voids present in the root filling or between root filling and root canal walls
	Adequate	No voids present in the root filling or between root filling and root canal walls
Taper of root canal filling	Adequate	Consistent taper from the orifice to the apex
	Inadequate	No consistent taper from the orifice to the apex

The prepared root canal should be tapered from crown to apex and no voids should be seen between the root filling and canal walls. The quality of filling should be assessed with a radiograph that shows the root apex with preferably at least 2 mm of periapical region clearly identifiable (European Society of Endodontology 1994).

Epidemiologic studies have been performed on the root canal morphology in Turkish populations (Haznedaroğlu *et al.* 2003, Sert & Bayirli 2004). However, only a few studies have evaluated the quality of the root fillings (Haznedaroğlu *et al.* 1995, Yoldaş *et al.* 2004).

The aim of this study was to evaluate the technical quality of root fillings using radiographs of teeth treated by undergraduate students at a dental teaching centre in Turkey.

Materials and methods

A random sample of 2000 records of patients who had received dental treatment at the Faculty of Dentistry, University of Gazi between the years 2000 and 2003 was investigated. Records of patients younger than 19 years of age were excluded. Records that did not include preoperative and postoperative periapical radiographs, those where the RCT was not completed or those whose the radiographic quality was poor were also excluded. The final sample consisted of 1893 root-filled teeth with 3692 root canals in 1654 dental patients. All RCTs were carried out by fourth- and fifth-year undergraduate students using a standard root canal preparation technique and a lateral compaction filling technique. If complications such as lateral or furcal perforations, fractured instruments, etc. were determined, the root filling was considered inadequate.

For each root-filled tooth, at least three periapical radiographs were examined: preoperative, working length determination and postoperative. Two investigators utilizing a magnifying lens (×2) and an X-ray viewer examined the radiographs independently. 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. The length, density and taper of root fillings were recorded according to the criteria used by Barrieshi-Nusair *et al.* (2004) (Table 1).

Canal curvature was assessed according to Schneider (1971) and if canal curvature was ≤30°, it was recorded as straight and if canal curvature was ≥30°, it was recorded as curved. Statistical analysis of the data was performed using SPSS 10.0 for Windows (Chicago, IL, USA). One-way analysis of variance (ANOVA) was used to determine statistically significant differences between the technical quality of RCTs according to the location and curvature of the teeth, and chi-square analysis to determine statistically significant differences between the technical quality of RCTs according to the tooth type. The significance level was $P < 0.05$.

Results

In all, 822 female and 832 male patients were included with a mean age of 34.5 years. Although the percentage of adequate root fillings was 34.76% in maxillary teeth and 30.36% in mandibular teeth, the difference between the jaws was not statistically significant ($P > 0.05$).

Table 2 shows the length, taper and the density of the root fillings for both straight and curved canals. The majority of inadequate fillings were observed in curved canals, where 46.3% were short, 48.6% were inadequately dense and 40.2% were inadequately tapered. The relationship between the length, density, and taper of the root filling and the presence of curvature was statistically significant ($P < 0.001$).

Table 3 shows the lengths of the root fillings according to tooth type. The highest percentage of

Table 2 The length, taper and the density of root fillings in straight and curved root canals

		Length			Density		Taper	
	Root canal	Adequate	Over-filling	Short-filling	Adequate	Inadequate	Adequate	Inadequate
Straight	3347 (72.4)	2418 (72.4)	448 (13.3)	481 (14.3)	1822 (54.4)	1525 (45.6)	2318 (69.2)	1029 (30.8)
Curved	345 (9.4)	155 (45)	30 (8.7)	160 (46.3)	143 (41.4)	202 (48.6)	203 (58.8)	142 (40.2)
Total	3692 (100)	2573 (69.6)	478 (13)	641 (17.4)	1965 (53.2)	727 (46.8)	2521 (68.3)	1171 (31.7)

Values in parentheses are in percentage.

Table 3 The length of root fillings by tooth type

Tooth group	Number of root fillings	Length		
		Adequate	Over-filling	Short-filling
Maxilla				
Incisors	218 (5.9)	163 (74.8)	46 (21.1)	9 (4.1)
Canines	103 (2.8)	73 (70.9)	11 (10.7)	19 (18.4)
Premolars	600 (16.3)	440 (73.3)	97 (16.2)	63 (10.5)
Molars	1107 (29.9)	802 (72.4)	128 (11.6)	177 (16)
Mandible				
Incisors	59 (1.6)	40 (67.8)	13 (22)	6 (10.2)
Canines	50 (1.4)	38 (76)	8 (16)	4 (8)
Premolars	212 (5.7)	171 (80.7)	18 (8.5)	23 (10.8)
Molars	1343 (36.4)	846 (63)	157 (11.7)	340 (25.3)
Total	3692 (100)	2573 (69.6)	478 (13)	641 (17.4)

Values in parentheses are in percentage.

adequate length was seen in mandibular premolars (80.7%). There was a significant difference between the percentage of root fillings of adequate length in mandibular premolars and mandibular molars ($P < 0.001$). No significant difference was found between mandibular premolars and the other tooth groups. There was a statistically significant difference between the prevalence of adequate length between maxillary incisors and mandibular molars ($P < 0.01$); between maxillary premolars and both maxillary and mandibular molars ($P < 0.001$); between maxillary molars and mandibular molars ($P < 0.001$) and between mandibular premolars and mandibular molars ($P < 0.001$).

Table 4 shows the densities of the root fillings according to tooth type. The highest percentage of root fillings with adequate density was seen in maxillary canines (68.9%). There was a significant difference between the percentage of root fillings of adequate density in maxillary canines and both mandibular and maxillary molars ($P < 0.01$). No significant difference was found between maxillary canines and other tooth groups. There was a significant difference between the prevalence of root fillings of adequate density in maxillary premolars and both maxillary and mandibular molars ($P < 0.001$); between maxillary molars and mandibular premolars ($P < 0.05$), and between mandibular premolars and mandibular molars ($P < 0.05$).

Table 4 The density of root fillings by tooth type

Tooth group	Number of root fillings	Density	
		Adequate	Inadequate
Maxilla			
Incisors	218 (5.9)	122 (56)	96 (44)
Canines	103 (2.8)	71 (68.9)	32 (31.1)
Premolars	600 (16.3)	395 (65.8)	205 (34.2)
Molars	1107 (29.9)	530 (47.9)	577 (52.1)
Mandible			
Incisors	59 (1.6)	30 (50.8)	29 (49.25)
Canines	50 (1.4)	26 (52)	24 (48)
Premolars	212 (5.7)	130 (61.3)	82 (28.7)
Molars	1343 (36.4)	660 (49.1)	683 (50.9)
Total	3692 (100)	1964 (53.2)	1719 (46.8)

Values in parentheses are in percentage.

Table 5 shows the tapers of the root fillings according to tooth type. The highest percentage of root fillings having adequate taper was seen in maxillary incisors (89.9%). There was a significant difference between the percentage of root fillings with adequate taper in

Table 5 Taper of root fillings by tooth type

Tooth group	Number of root fillings	Taper	
		Adequate	Inadequate
Maxilla			
Incisors	218 (5.9)	196 (89.9)	22 (10.1)
Canines	103 (2.8)	90 (87.4)	13 (12.6)
Premolars	600 (16.3)	490 (81.7)	110 (18.3)
Molars	1107 (29.9)	625 (56.5)	482 (43.5)
Mandible			
Incisors	59 (1.6)	46 (78)	13 (22)
Canines	50 (1.4)	40 (80)	10 (20)
Premolars	212 (5.7)	182 (85.8)	30 (14.2)
Molars	1343 (36.4)	851 (63.4)	492 (36.6)
Total	3692 (100)	2520 (68.3)	1172 (31.7)

Values in parentheses are in percentage.

maxillary incisors and mandibular and maxillary molars ($P < 0.001$). No significant difference was found between maxillary incisors and other tooth groups.

Adequacy of the filling

Table 6 shows the adequacy of the root fillings by tooth group. There was no significant difference between maxillary and mandibular teeth according to the adequacy of the root fillings. The highest percentage of adequate root fillings was found in maxillary canines (51.5%). There was a significant difference in the adequacy of the root filling between the maxillary canines and maxillary molars and mandibular molars ($P < 0.001$); between the maxillary incisors and both maxillary and mandibular molars ($P < 0.001$); between maxillary premolars and both maxillary and mandibular molars ($P < 0.001$); between maxillary molars and all mandibular incisors, canines and premolars ($P < 0.001$); between mandibular incisors and mandibular molars ($P < 0.001$), mandibular premolars and mandibular molars ($P < 0.001$).

Discussion

The data used in this study consisted of a sample of periapical radiographs of patients who received RCT at the Faculty of Dentistry, University of Gazi, in Ankara, Turkey. Ankara is the capital of Turkey and the majority of patients prefer University hospitals for dental problems. All periapical radiographs used in this study were taken during routine RCT procedures within a dental student practice and were not taken especially for this study. As panoramic radiographs do not reveal details and inter-observer variability is greater with panoramic radiographs (Flint *et al.* 1998), periapical radiographs were used instead of panoramic radiographs.

The radiographic criteria used to asses the quality of RCT were the same as those used previously (Lupi-Pegurier *et al.* 2002, Boltacz-Rzepkowska & Pawlicka 2003, Barrieshi-Nusair *et al.* 2004). In many studies, an improved outcome of RCT has been reported if the length of the filling was 0–2 mm from the radiographic apex (Saunders *et al.* 1997, Peak *et al.* 2001, Boltacz-Rzepkowska & Pawlicka 2003).

The percentage of root fillings with adequate length was 69.6% in the present study. Although it is difficult to compare these results with other studies, the percentage of root fillings that had adequate length were superior when compared with those reported by Lupi-Pegurier *et al.* (2002) (38.7%), Boltacz-Rzepkowska & Pawlicka (2003) (48.9%), Chueh *et al.* (2003) (61.7%) and by Barrieshi-Nusair *et al.* (2004) (61.3%). These differences may be the result of the fact that dental students take several radiographs during RCT in order to obtain correct working lengths.

Although there was a high percentage of short root fillings in maxillary premolars in the studies of Weiger *et al.* (1997) and Lupi-Pegurier *et al.* (2002), in the present study, the highest percentage of short fillings was found in mandibular molars (25.3%) (Barrieshi-

Table 6 Overall qualities of root fillings by tooth group

Quality		Tooth groups							
		Maxillary				Mandibular			
		Incisors	Canines	Premolars	Molars	Incisors	Canines	Premolars	Molars
Adequate	624 (33)	99 (45.4)	53 (51.5)	185 (44.2)	52 (13.7)	23 (39)	23 (46.9)	105 (49.8)	84 (18.5)
Inadequate	1269 (67)	119 (54.6)	50 (48.5)	234 (55.8)	327 (86.3)	36 (61)	26 (53.1)	106 (50.2)	371 (81.5)
Total	1893 (100)	218 (11.5)	103 (5.4)	419 (22.1)	379 (20)	59 (3.1)	49 (2.7)	211 (11.2)	455 (24)

Values in parentheses are in percentage.

Nusair *et al.* 2004). In curved canals the prevalence of short fillings (46.3%) was higher than straight canals (14.3%). This may be due to problems such as ledge formation or the blockage of canals by dentine plugs during instrumentation.

Adequate length and taper occurred in approximately 69% of cases whilst the percentage of adequate densities was 53.2%. Kirkevang *et al.* (2000) reported that inadequate density may lead to failure of RCT because of microleakage along the root filling. Similarly, Eriksen & Bjertness (1991) stated that, the prevalence of apical periodontitis was higher in root-filled teeth with poor densities.

Studies evaluating the radiographic quality of RCT were mostly based on the evaluation of the length and the density of the root filling (De Moor *et al.* 2000, Helminen *et al.* 2000, Kirkevang *et al.* 2001, Lupi-Pegurier *et al.* 2002, Dugas *et al.* 2003). However, according to the European Society of Endodontology (1994), the prepared root canal should be tapered from crown to apex. The taper of root canals is a more subjective criterion that may explain why only a few reports have been published on this matter (Barrieshi-Nusair *et al.* 2004).

In another Turkish study, Yoldaş *et al.* (2004) compared the technical quality of RCTs of 512 teeth performed by fourth- and fifth-year dental students and reported no significant difference between the two groups. Yoldaş *et al.* (2004) reported that adequate length and the density of root filling occurred in 70% and 64%, of teeth, respectively, whilst adequate length and density was 69.6% and 53.2% in the present study.

Root canal procedures at the dental school are combined with Conservative Dentistry and are carried out in a multidisciplinary clinic. The preclinical endodontic practical laboratory course continues for 7 months with an allocation of 2 h per week. Extracted human teeth are used for practise. Students in the first and second year of their clinical undergraduate education, participate in endodontic training for 4 h per week for 1 month in the first year and 4 h per week for 2 months in the second year. Students are expected to treat a minimum of 10 root canals in their first clinical year and 60 root canals during their second clinical year. The necessity to treat such a high number of teeth in a limited time interval might be an important factor related to the generally poor quality of the root fillings.

The stepback canal preparation technique used at the School is performed by determining the working length using radiographs. Instrumentation with three or four more files greater than the first file that fits to the apical foramen is then performed with stainless steel files. Appointments per patient last approximately 30–40 min and treatment takes between two and five appointments. Working length determination and root canal preparation procedures take approximately 60–80% of treatment time.

Conclusion

According to the results of the study, 33% of the root fillings had adequate technical quality.

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