



Radiographic Evaluation of Root Canal Fillings Performed by Dental Students

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ABSTRACT

Objectives: To evaluate radiographically the technical quality of root canal fillings performed by dental students at the School of Dentistry, University of the West Indies.

Methods: The dental school’s database of student clinical activity between the period 2000-2004 was investigated for patients who completed root canal treatment. For each root filled tooth, at least four periapical radiographs were examined: preoperative, working length determination, try in GP point and postoperative. The final sample consisted of 198 patients with 288 root filled teeth and 460 canals. The length, presence of voids, taper, curvature of canal and fractured instruments were recorded and scored. Chi-squared analysis was used to determine statistically significant differences between the technical quality of root fillings and tooth type.

Results: Sixty-three percent, 27.6% and 72.2% of root filled canals had adequate length, density and taper respectively. Fractured instruments were found in only 7 of the root canals (1.5%).The acceptability for both length and taper was found in 31.5% of canals. A significantly greater proportion of root fillings of adequate length and taper were observed in straight canals compared to curved canals (P<0.05). However no significant difference was observed for the presence of voids in straight or curved canals. The percentage of root fillings with adequate length was significantly greater in maxillary teeth than in mandibular teeth (P <0.05) and in anterior teeth compared to posterior teeth (P< 0.001).The overall acceptability of root fillings having adequate length and taper, absence of voids and no fractured instruments was found in 10.9% of canals. The mandibular incisors had the greatest level of acceptability for all observed parameters (27.3%).

Conclusion: The overall acceptability of root fillings performed by dental undergraduate students was only 10.9%. Changes in teaching methods may be required to improve the quality of root canal treatment among dental students.

INTRODUCTION:

- Non-surgical root canal treatment includes procedures that aim to maintain the health of normal periradicular tissues or to restore health when these tissues become diseased (1).
- The root canal system should be shaped, cleaned and obturated (filled) to reliably achieve the above goals. Obturation helps to prevent re-infection of the root canal space (2).
- The quality of the root filling including length of filling relative to radiographic apex, presence or absence of voids and the shape of the filled canal all appear to have an influence on the success of treatment (1, 3, 4-9).
- The quality of these fillings placed by dental undergraduates in various populations has been reported with varying results (2, 10-15).
- The objective of this study was to evaluate radiographically the technical quality of root canal fillings performed by dental students at the School of Dentistry, University of the West Indies, Trinidad.
- The study also examined how the quality of the root canal filling length, taper and density is related to tooth type, jaw and curvature of the root canal.

MATERIALS AND METHODS:

- All root canal treatments were carried out under rubber dam isolation using the modified crown-down technique using the balanced force technique for the coronal third of the root canal system and the step back technique for the middle and apical thirds. Stainless steel K-Flex handfiles (SybronEndo Corporation, CA, USA) were used to prepare the canals. RCPrep® (Premier Dental Products, PA, USA) was used as the lubricant and sodium hypochlorite as the irrigant. In multi- visit root canal treatment, non-setting calcium hydroxide was applied as the intracanal medicament of choice. Canals were obturated using cold lateral condensation with gutta percha and a Ca(OH)2 based sealer i.e. Sealapex® (SybronEndo Corporation, CA, USA).
- The inclusion criterion for this selection was that each case had to include root canal treatments completed on either a single rooted or multi-rooted permanent tooth. A post-obturation periapical radiograph taken using the long cone paralleling technique, had to be present and of adequate quality, i.e. contrast and clarity, and should show the entire length of the root and the periapical area to be included. The sample size was 198 case notes with 288 root filled teeth and 460 root filled canals.

- All types of teeth were included in the study and for molars and premolars each canal was evaluated separately. The criteria examined were length of the root canal filling, presence or absence of voids, taper of the root fillings, curvature of the root canals and presence or absence of fractured instruments. Table 1 gives details on the parameters applied.

- The post-operative radiograph was viewed on an illuminated viewer box, in a card board frame blocking off the extraneous light from the box, in a darkened room using a magnifying lens 3.5x. A transparent ruler of 0.5mm accuracy was used to measure the distance from the radiographic apex. One examiner (MM) was calibrated and assessed the radiographs and recorded the necessary information.

- The acceptable length of the root canal was defined by criteria proposed by Barrieshi-Nusair et al (10). The presence or absence of voids was noted and taper of the root fillings was defined as being either continuous with the root canal or irregular. Criteria used for curvature of the canals were the same as that used by Barrieshi-Nusair et al (10), i.e. straight or curved. This was determined by drawing a straight line parallel to the long axis of the canal using an endodontic ruler along the coronal straight portion of the root canal space. Intersection of this line with the radiographic apex indicated that the canal was straight whilst any deviation indicated a curved canal. Fractured instruments were determined as being either present or absent.

- SPSS 13.0 for Windows software Package program (SPSS Inc., Chicago, IL, USA) was used for data processing and statistical analysis. The chi-squared statistic was used for statistical evaluation of the results and a P-value < 0.05 was considered statistically significant. Chi-square analysis was used to determine statistically significant differences between adequate root canal fillings in each group of teeth (incisors, canines, premolars and molars) according to its location (maxillary or mandibular), position (anterior or posterior) and curvature.

RESULTS:

The total number of root filled teeth was 288. Total number of root filled canals was 460. Nearly three-quarters (72.9%) of the sample were maxillary teeth and overall the sample consisted of 130 (45.1%) incisors and canines, 89 (30.9%) premolars and 69 (24%) molars. The most commonly filled teeth were the upper incisors (33.3%) followed by the upper premolars (22.9%).

Table 2 shows the length, presence of voids and taper of the root fillings for both straight and curved canals.

- A significantly greater proportion of root fillings of adequate length and taper were observed in straight canals compared to curved canals (P<0.05). However no significant difference was observed for the presence of voids in straight or curved canals.

Table 3 shows the length, presence of voids and taper of the root fillings according to tooth type.

- The percentage of root fillings with adequate length was 63.0% in this study. The highest percentage of adequate length root fillings was seen in maxillary canines (83.3%).
- The percentage of root fillings with adequate length was significantly greater in maxillary teeth than in mandibular teeth P <0.05 and in anterior teeth (incisors and canines) when compared to posterior teeth (premolars and molars) (P< 0.001).
- Maxillary anterior teeth had a significantly greater proportion of acceptable root fillings in terms of length compared to maxillary posterior teeth (P< 0.001) and mandibular posterior teeth (P< 0.001) but no significant difference was observed when compared to mandibular anterior teeth (P> 0.05). There was a significantly greater percentage of adequate length root fillings in mandibular anterior teeth compared to mandibular posterior teeth (P<0.05).
- 27.6% of root fillings had no voids while the highest percentage of root fillings with no voids was seen in mandibular incisors (54.5%).
- There were significantly more root fillings with voids in maxillary teeth than mandibular teeth (P< 0.05) but no significant difference was found for the absence of voids between anterior or posterior teeth (P>0.05).
- Maxillary anterior teeth had the most root fillings with voids at 86.8% and this was significantly greater than in mandibular anterior teeth (P<0.05) and in maxillary posterior teeth (P<0.05). However in the mandible there was no significant difference for the prevalence of root fillings with voids between anterior and posterior teeth.
- There was adequate taper in 72.2% of all root fillings and the highest percentage of root fillings with adequate taper was seen in mandibular incisors (81.8%).
- There was no significant difference for canals with adequate taper between the maxilla and mandible (P>0.05) but there were significantly more anterior teeth with adequate taper when compared to posterior teeth (P <0.05). It was found that both maxillary and mandibular anterior teeth had significantly greater proportion of teeth with adequate taper than mandibular posterior teeth.
- Fractured instruments were found in only 7 of the root canals (1.5%) and 5 of these were in molar teeth.

The acceptability for length and taper was found to be 31.5% of root filled canals or 40.6% of root filled teeth. The overall acceptability or adequacy of root fillings can be defined by those having adequate length and taper, absence of voids and no fractured instruments. This was found in 10.9% of root filled canals or 10.1% of root filled teeth. Table 4 shows the overall acceptability of root fillings by tooth group.

Table 1 - Criteria used to record information from post-operative radiograph

Variable	Criteria	Definition
Length	Acceptable	Root filling ending ≤2mm short of radiographic apex
	Overfilled	Root filling ending beyond radiographic apex
	Underfilled	Root filling ending >2mm short of radiographic apex
	No voids	No radiolucent areas associated with root filling
Voids		
Taper	Voids	Radiolucent areas associated with root filling
	Continuous	Continuous taper from the coronal to the apical part of the filling, with good reflection of the canal shape
	Irregular	Not continuous taper from the coronal to the apical part of the filling
Curvature	Straight	Coronal portion of canal in line with apical portion
	Curved	Apex of canal deviates from coronal portion

Table 2 - Length, voids and taper of root canal fillings in straight curved canals.

Root Canal	Total	Length			Voids		Taper	
		Adequate	Overfilled	Underfilled	No voids	Voids present	Adequate	Inadequate
Straight	355 (77.2%)	227 (63.9%)	45 (12.7%)	83 (23.4%)	96 (27.0%)	259 (73.0%)	260 (73.2%)	95 (26.8%)
Curved	105 (22.8)	63 (60.0%)	13 (12.4%)	29 (27.6%)	31 (29.5%)	74 (70.5%)	72 (68.6%)	33 (31.4%)
Total	460 (100%)	290 (63.1%)	58 (12.6%)	112 (24.3%)	127 (27.6%)	333 (72.4%)	332 (72.2%)	128 (27.8%)

Table 3 - Length, voids and taper of root canal fillings by tooth type

Tooth group	Total	Length			Voids		Taper	
		Adequate	Overfilled	Underfilled	No voids	Voids present	Adequate	Inadequate
Maxilla								
Incisors	96 (20.9%)	74 (77.1%)	13 (13.5%)	9 (9.4%)	14 (14.6%)	82 (85.4%)	67 (69.8%)	29 (30.2%)
Canines	18 (3.9%)	15 (83.3%)	1 (5.6%)	2 (11.1%)	1 (5.6%)	17 (94.4%)	12 (66.7%)	6 (33.3%)
Premolars	107 (23.3%)	68 (63.6%)	14 (13.1%)	25 (23.3%)	40 (37.4%)	67 (62.6%)	84 (78.5%)	23 (21.5%)
Molars	90 (19.6%)	42 (46.7%)	16 (17.8%)	32 (35.5%)	27 (30%)	63 (70%)	69 (76.7%)	21 (23.3%)
Mandible								
Incisors	11 (2.4%)	8 (72.7%)	3 (27.7%)	0 (0%)	6 (54.5%)	5 (45.5%)	9 (81.8%)	2 (18.2%)
Canines	5 (1.0%)	4 (80%)	0 (0%)	1 (20%)	0 (0%)	4 (100%)	4 (80%)	1 (20%)
Premolars	23 (5.0%)	15 (65.2%)	1 (4.4%)	7 (30.4%)	8 (34.8%)	15 (65.2%)	17 (73.9%)	6 (26.1%)
Molars	110 (23.9%)	64 (58.2%)	10 (9.1%)	36 (32.7%)	30 (28.2%)	80 (71.8%)	70 (63.6%)	40 (36.4%)
Total	460 (100%)	290 (63.1%)	58 (12.6%)	112 (24.3%)	127 (27.6%)	333 (72.4%)	332 (72.2%)	128 (27.8%)

Table 4 - Overall acceptability of root fillings by tooth group

Tooth Group	Total	Acceptable	Unacceptable
Maxilla			
Incisors	96 (33.3%)	9 (9.4%)	87 (90.6%)
Canines	18 (6.3%)	1 (5.6%)	17 (94.4%)
Premolars	66 (22.9%)	10 (15.2%)	56 (84.8%)
Molars	30 (10.4%)	0 (0%)	30 (100%)
Mandible			
Incisors	11 (3.8%)	3 (27.3%)	8 (72.7%)
Canines	5 (1.8%)	0 (0%)	5 (100%)
Premolars	23 (8.0%)	4 (17.4%)	19 (82.6%)
Molars	39 (13.5%)	2 (5.1%)	37 (94.9%)
TOTAL	288 (100%)	29 (10.1%)	259 (89.9%)

DISCUSSION:

- Radiographical parameters used to assess the radiographs were the same as those used by Barrieshi-Nusair et al 2004 (10), and in part by Er et al 2006 (11) in order to ensure valid comparisons.

- Root fillings of adequate length in this study were found in 63.0% of teeth. Although it is difficult to compare results with other studies due to sample size, and type of teeth sampled; the result for acceptable length is still comparable to other studies Eleftheriadis and Lambrinidis 2005 (12) with 62.7%, Moussa-Badran et al 2008 (13) with 69%, Lynch and Burke 2006 (14) with 70%, Barrieshi-Nusair et al 2004 (10) with 61% and Er et al 2006 (11) with 69% acceptable length. Only the first two studies cited had a similar sample size.

- Underfilled and overfilled teeth were 24.4% and 12.6% respectively. In this study most of the underfilled teeth occurred in upper molars (35.5%) and lower molars (32.7%).

- In this study 72.2% of teeth had adequate taper and this is comparable to other studies by Barrieshi-Nusair et al 2004 (10) with 85.3% and Er et al 2006 (11) with 68.3%. The highest percentage of inadequately tapered teeth occurred in mandibular molars (36.4%).

- The data collected for the presence or absence of voids in the root filling however seems to be at variance with other reported studies. Absence of voids was reported in 27.6% of root fillings which was lower than that reported by Eleftheriadis and Lambrinidis 2005 (12), Barrieshi-Nusair et al 2004 (10), Er et al 2006 (11) and Moussa-Badran et al 2008 (13) each reporting 82.6%, 72.6 %, 53.2% and 42.7% respectively.

- A surprisingly high percentage of voids were found in maxillary anterior teeth (86.8%). This could in part be due to the inexperience of the students using insufficient force and accessory gutta percha points during lateral compaction in the relatively larger volumes in the coronal aspect of this tooth type.

- The overall acceptability or adequacy was found in only 10.9% of root fillings but when voids were excluded the overall acceptability of root fillings increased to 31.5%.

- The low percentage for overall acceptability in this study could also be due to other reasons including the design of the study, the inclusion and exclusion criteria employed, the technique used for root canal treatment, the degree of clinical supervision and the accuracy of post-obturation radiographic interpretation.

CONCLUSION:

The percentage acceptability of root fillings for length and taper was 31.5%. The overall adequacy of root canal fillings performed by undergraduate dental students was found in only 10.9% of the root canals examined. Improvements are obviously required to increase the number of radiographically acceptable root canal treatment outcomes. Changes will have to be made to the pre-clinical and clinical teaching to achieve this goal and future audits performed to assess the clinical survival of these root treated teeth.

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