

Evaluation of Quality of Root Canal Fillings Performed by Undergraduate Students of a Brazilian University

Avaliação da qualidade da obturação do canal radicular realizada por estudantes de graduação de uma Universidade brasileira

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ABSTRACT

The aim of this study was to evaluate the quality of root canal filling performed by undergraduate students at the Federal University of Espírito Santo (UFES). A total of 368 periapical radiographs of endodontic treatment performed by undergraduate students between 2012 and 2014 was assessment. The quality of root canal filling was based on two criteria: length of root canal filling and adequate density of the obturation. Root canal fillings were considered adequate if had no voids and were located at 0-2 mm below the radiographic apex. Statistical analysis was conducted using chi-square tests, with a 5% significance level. In 93.8% of the cases the root canal filling was considered adequate. The density of the obturation was considered inadequate in 3% of the cases. When the length of root canal filling was observed, 1.2% of cases were considered as over-filled and 2.2% were considered under-filled. Non-significant differences were observed among the tooth type (incisive, canines and pre-molars) and the quality of root canal filling. Most of root canal filling performed by undergraduate students at the UFES were considered adequate, regardless of tooth type.

Key-words: Dental students, Endodontics, Radiography, Root Canal Obturation, Root Canal Therapy.

RESUMO

O objetivo deste estudo era avaliar a qualidade do enchimento de canais radiculares realizado por estudantes de graduação da Universidade Federal do Espírito Santo (UFES). Foi avaliado um total de 368 radiografias periapicais de tratamento endodôntico realizadas por estudantes de graduação entre 2012 e 2014. A qualidade do enchimento do canal radicular foi baseada em dois critérios: comprimento do enchimento do canal radicular e densidade adequada da obturação. O enchimento do canal radicular foi considerado adequado se não houvesse vazios e estava localizado 0-2 mm abaixo do ápice radiográfico. A análise estatística foi conduzida utilizando testes qui-quadrados, com um nível de significância de 5%. Em 93,8% dos casos, o enchimento do canal radicular foi considerado adequado. A densidade da obturação foi considerada inadequada em 3% dos casos. Quando o comprimento do enchimento do canal radicular foi observado, 1,2% dos casos foram considerados preenchidos em excesso e 2,2% foram considerados preenchidos em falta. Foram observadas diferenças não significativas entre o tipo de dente (incisivo, canino e pré-molar) e a qualidade de obturação do canal radicular. A maioria do preenchimento do canal radicular realizado por estudantes de graduação da UFES foi considerada adequada, independentemente do tipo de dente.

Palavras-chave: Estudantes de medicina dentária, Endodontia, Radiografia, Enchimento do canal radicular, Terapia do canal radicular.

1 INTRODUCTION

The technical quality of the root canal filling is considered by some authors as a factor that can affect the outcome of the root canal treatment (RCT)¹⁻⁴. According to the American Association of Endodontists⁵, three criteria radiographically evaluated are used for judging the technical success of the obturation: length, shape, and density of root canal filling. The root canal completely filled, with no space or voids between filling and canal wall and located at 0.5-2 mm below the radiographic apex are characteristics reported by the guidelines of the European Society of Endodontology (ESE) for radiographic evaluation of root canal fillings⁶. Thus, the length and the density of the root canal filling are variables that may affect the quality of RCT⁷.

Endodontic education is an important requirement for the training of dental students⁶. Stress and anxiety can affect the academic performance among dental students^{8,9}. Studies previous evaluated the quality of RCT performed by dental students and the importance of pre-clinical experience^{7,10-13}. The authors found rates of 13% to 79.47% of adequate length and density of root canal filling performed by undergraduate students. However, few studies have evaluated the quality of RCT performed by undergraduate students at Brazilian universities¹⁴. The evaluation of dental students' outcomes in endodontics can help to improve dental education^{3,8}.

The aim of this study was to assess the radiographic technical quality of root canal fillings performed by clinical undergraduate students in the endodontics clinic at the Dental School, Federal University of Espirito Santo (UFES). The correlation between the quality of the root canal fillings and the tooth type was also investigated.

2 MATERIALS AND METHODS

2.1 SELECTION OF CASES

This study was approved by the Research Ethics Committee of the UFES (protocol number 28244914.3.0000.5060). Records of 511 patients who had received RCT, between 2012 and 2014, by undergraduate students of the third year were randomly selected to evaluate the radiographic quality of the root canal fillings. One hundred and forty-three were excluded and the final sample involved 368 periapical radiographs of endodontically treated teeth.

Inclusion and exclusion criteria

Endodontically treated incisors, canines, and premolars with preoperative, working length measurement, and postoperative. periapical radiographs, with proper

processing and technical quality, were included in the present study. Exclusion criteria consisted of unreadable radiographs, with processing errors or incorrectly positioned images, teeth with external or internal resorption, calcified canals, perforations, deviations, fractured instrument, and retreatment.

The RCT were performed by undergraduate students following the same treatment protocol. Rubber dam isolation was applied in all the teeth. After the endodontic access, the working length was established 1 mm from the radiographic apex. The root canal were prepared by stainless steel K-files (Dentsply Maillefer, Ballaigues, Switzerland), using the modified Oregon technique. A 2,5% sodium hypochlorite was used as an irrigation solution. The root canal filling was performed according to Tagger's hybrid technique with gutta-percha cones (Dentsply Maillefer, Ballaigues, Switzerland) and AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland). For RCT of each tooth, 4 periapical radiographs were taken using the bisecting-angle technique: preoperative, working length confirmation, master cone and postoperative. Endodontic Department's academic staff supervised all the treatment steps.

2.2 RADIOGRAPHIC ASSESSMENT OF THE QUALITY OF ROOT CANAL FILLINGS

With a previous calibration¹³, three examiners assessed the quality of the root canal filling. Cohen's Kappa test was used to assess the agreement between examiners and intra-examiners, and Kappa values were >0.9 for both. The periapical radiographs were identified by an alphabetical and numerical code, with the purpose of keeping confidentiality of undergraduate students' and patients' identities. The examiners evaluated the radiographs independently using an X-ray viewer.

The root canal filling of each root was radiographically assessed in terms of the length and density of the filling materials using the criteria suggested in previous studies^{15,16}. The root canal filling was classified as adequate if the root filling ended 0–2mm of the radiographic apex and there were no space/voids between root filling and root canal wall (Table 1). The failure in one parameter means failure of the RCT and the failure of one root in biradicular teeth results in failure of the whole treatment. Thus, if the length or density was classified as inadequate, the quality of the whole root canal filling was inadequate.

Table 1. Evaluation criteria used for radiographic assessment of the quality of root canal fillings

Assessment criteria	Parameters	Definition
Adequate	Length of root canal filling	Root filling ending 0–2mm of the radiographic apex
	Density of root canal filling	No space/voids between root filling and root canal wall
Inadequate	Length of root canal filling	Over-filling: Root filling ending beyond the radiographic apex Short-filling: Root filling ending > 2mm short of the radiographic apex
	Density of root canal filling	Voids present in the root filling or between root filling and root canal walls

Data were analyzed with SPSS software for Windows, version 17.0 (SPSS version 17.0, SPSS Inc., Chicago, IL, USA), and Chi-square test was used to analysed the association between the study variables. The significance level adopted was 5%.

3 RESULTS

From a total of 511 records selected to radiographic assessment of the quality of root canal fillings, 143 were excluded (16 presented radiographic errors, 61 incomplete radiographs, 31 retreatments, 4 teeth presented incomplete rhizogenesis, 2 teeth with radicular resorption, 28 teeth with deviated, and 1 with fractured instrument), resulting in a final sample of 368 records of 442 root canals.

The most investigated teeth were premolars, representing 54.1% of the sample, with 199 teeth and 273 root canals, followed by incisors with 126 teeth, representing 34.2% of the total sample, and canines with 43 teeth, representing 11.7% of the total sample.

Of the 368 records of root canal treatments evaluated, adequate root canal fillings were detected in 345 (93.8%), whereas inadequate root canal fillings were detected in 23 (6.2%) records. According to the tooth type, the number of adequate root canal fillings was distributed as follows: 186 (93.6%) in premolars, 122 (96.8%) in incisors and 37 (86%) in canines (Table 2). Comparison between quality of root canal filling and tooth type showed non-significant differences ($P > 0.05$).

Table 2. Evaluation of root canal fillings as adequate or inadequate according to the tooth type

Type of tooth	Sample	Root canal filling				p-value
		Inadequate		Adequate		
		n	%	N	%	
Incisive	126	4	3,2	122	96,8	0.056
Canine	43	6	14,0	37	86,0	
Pre-molar	199	13	6,5	186	93,5	
Total	368	23	6.2	345	93.8	

The assessment of root canal filling length is in Table 3. No short-filling was found among incisors, but it was found in 3 (7%) canines and 5 (2.5%) premolars. Over-filling was observed in 2 premolars (1%), 2 incisors (1.6%) and 1 (2.3%) canine. Comparison between type of tooth showed non-significant differences in the length of root canal filling. The quality of the filled canals revealed that 96.6% were adequate in length.

Table 3. Quality of root canal fillings based on length

Type of tooth	Sample	Length						P-value
		Short-filling		Over-filling		Adequate		
		N	%	N	%	N	%	
Incisive	126	-	-	2	1,6	124	98,4	0.058
Canine	43	3	7,0	1	2,3	39	90,7	
Pre-molar	199	5	2,5	2	1,0	192	96,5	
Total	368	8	2.2	5	1.2	355	96.6	

The assessment of root canal filling density is in Table 4. The quality of density was the highest in incisors (98.4%) followed by premolars (96.5) and canines (95.3). Inadequate density was found in 2 (1.6%) incisors, 2 (4.7%) canines, and 7 (3.5%) premolars. Comparison between type of tooth showed non-significant differences in the density of root canal filling. The quality of the root canal filling revealed that 97% were adequate in density.

Table 4. Quality of root canal fillings based on density

Type of tooth	Number of teeth	Density				p-value
		Inadequate		Adequate		
		N	%	N	%	
Incisive	126	2	1,6	124	98,4	0.459
Canine	43	2	4,7	41	95,3	
Pre-molar	199	7	3,5	192	96,5	
Total	368	11	3.0	357	97.0	

4 Discussion

This study assessed the technical quality of root canal filling performed by undergraduate students at the Dental School, XXXX. According to the periapical radiographs taken immediately after the RCT, root fillings were considered acceptable if had no voids and terminated 0–2 mm short of the radiographic apex.

The overall quality of the root canal filling was 93.8%. This result is similar to Unal et al.¹² (2011), Lynch et al.¹⁷ (2006), and Vukadinov et al.¹⁸ (2014). However, the result of the present study is not in agreement with others that found success rates between 10-54%^{2,7,15,16,19,20}. These studies include molars in the evaluation. This may have influenced the overall quality of the root canal filling, because represent more complex cases. The available patients and the types of treatments can influence the gain of the student's clinical experience and, to increase self-efficacy in endodontic clinic^{8,21}. Thus, it is preferable to start with root canal therapy cases with lower levels of difficulty cases.

The length of root canal fillings was the best criteria performed by the undergraduate students; similar to others studies^{2,3,7,16}. The length was adequate in 335 teeth (96.6%), which corroborates with other results^{7,13,18-20,22-25}. Such results differ from the ones from Kabak and Abbot²⁶ (2005), who found 47.7% of adequate length, and Al-Anesi et al.³ (2019) who found 56.4% of root canals with adequate length. In these studies, the adequate length of single-rooted teeth was higher than multi-rooted teeth, with highly significant difference.

According to Santos et al.¹⁴ (2010), the maintenance of an adequate apical extension and the adaptation of the master gutta-percha cone in the critical apical zone are challenges of root canal filling. The high percentage of adequate length found in this study may be attributed to the fact that the students perform periapical radiographs to

determine the correct working length, and to confirm the proper adaptation of the master cone.

The adequate density was found in 97% of evaluated teeth, in agreement with others findings^{13,17,18,22,23,25, 7}, which do not corroborate with the results found by Rafeek et al.²⁰ (2012) of 27.6%, Balto et al.⁷ (2010) of 35%, and Al-Anesi et al.³ (2019), who found adequate density in 13.1%.

Santos et al¹⁴ (2010) found 90.94% of adequate root canal filling density. Similar to this study, a possible fact that may explain the results is the choice of the thermomechanical technique for filling, which allows greater flow of the filling material through the interior of the root canal, reducing the possibility of empty spaces formation²⁸.

The evaluation of the technical quality of the root canal therapy performed by undergraduate students of teaching institutions is based mainly on radiographic methods^{7,13,17,18,20,23,27-30}. The levels of inter-examiner variability may affect the radiographic examination and interpretation²¹. In our study, the high inter-examiner reproducibility values (Kappa values >0.9) supported a high level of reliability of the evaluation. However, this method implies limitations by promoting bi-dimensional images and the radiographs were not taken in a strictly standardized and reproducible manner.

According to the ESE⁶, dental students must receive preclinical and clinical training to be able to successfully treat uncomplicated teeth and gain clinical confidence^{3,9}. Therefore, RCT is an important educational requirement in a dental course. The students' self-efficacy is influenced mostly by their clinical experience⁸. So, treating difficult cases (molars and retreatments) might reduce their self-efficacy^{23,30}. The curriculum of Endodontology in our dental school is given in one academic year, in the 3th year of course. The first semester is a preclinical training where the dental students trained how to perform RCT on human extracted teeth (single- and multi-rooted teeth). The second semester is at the clinic. Most complex cases are treated in posterior disciplines, in 4th and 5th years of courses.

Although it is difficult to compare studies that evaluate the quality of endodontic treatments performed by undergraduate students due to the difference in evaluation methods and quality parameters, the high percentage of adequate root canal filling in the present study may be related to some factors such as the exclusion of the group of molars^{17,20}. In this manner, this work opens perspectives for the comparison of treatments

performed by the students of advanced classes performing more complex treatments, and in this context, permitting a possible confirmation of success in the teaching-learning relationship.

It is important to emphasize that before performing the RCT, the students, as an obligatory routine, develop a detailed and illustrated treatment plan for each case to be performed. This plan is discussed and corrected by the professors of the discipline. At the end of each case, the students receive a feedback from the professors, in relation to the quality of the concluded treatment, which could have contributed to the low percentages of inadequate root canal filling. Baaij et al.⁸ (2020) showed that student feedback can increase their self-efficacy at graduation.

Other possible explanations for the low frequency of inadequate root canal filling is related to the supervision of the students by professors specialized in Endodontics. The student-professor ratio was 7:1, which allowed for better student supervision. This value was similar to that presented by Vukadinov et al.¹⁸ (2014), which was 8:1, and lower than the ones in the studies by Khabbaz et al.²⁸ (2010) and Balto et al.⁷ (2010) where the applied proportions were 15:1 and 12:1, respectively.

With effective theoretical, preclinical, and clinical training of undergraduate students, the technical quality of root canal fillings can be improved. An appropriate teacher-to-student ratio, the development of a detailed and illustrated treatment plan for each case, and the student feedback, are strongly recommended.

In conclusion, the technical quality of root canal filling performed by undergraduate dental students of a Brazilian university was adequate in 93.75%. The length of root canal fillings was the best criteria performed by the undergraduate students. The tooth type did not influence the quality of root canal filling.

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