

Outcomes of Root Canal Treatments Performed by Pre-Graduated Dental Students in Clinical Practice

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Abstract: This study aims to determine radiographically the quality and the periapical status of root canal treatments performed by undergraduate students from an adult population following 6 to 36 months after treatments. The records of 674 clinical cases corresponding to 1097 canals of patients, performed by dental students in a dental faculty, between the years 2007 and 2009 were followed. Among the patients that returned, 596 charts of cases were randomly selected corresponding to 963 root canals and a follow-up of 6 to 36 months. Pré and pós-operative periapical radiographs were collected and in the follow-up radiographs were performed and examined, to classify the quality of the endodontic treatment and periapical status investigated. The treatment is more in the maxillary teeth (62.6%), than in the mandibular teeth (37.4%). The quality of length filling is significantly associate to the dental arch ($\chi^2(1) = 9.646; p = 0.002$); it was adequate in 90.09% in maxillary teeth whereas in mandibular teeth was 81.17%. The periapical bone was considered healthy in 86.9%. In the radiographs analyzed there was no evidence of separated instruments or root canal perforations. The quality of root canal treatment performed by undergraduate dental students was acceptable, without fractures of instruments and perforations and with a success of 86.9%.

Keywords: Apical periodontitis; Dental students; Endodontic outcome; Root filling quality.

INTRODUCTION

Root canal treatment aims to preserve the teeth in function with healthy periradicular tissues. The curriculum of dental education is expected to deliver programs that should ensure the graduated students to provide dental knowledge to be competent to perform adequate root canal treatment [1]. So it is expected that newly graduated dentists possess the skills and knowledge to treat most circumstances that they may encounter in clinical environment. Thus according the European Society of Endodontology (ESE), dental students should be competent to be able to perform diagnosis of the pulp and periradicular disease and to manage root canal treatment of single or multiradicular uncomplicated teeth [1]. Despite the ESE guidelines, several papers refer that root canal treatment performed by dental students is often inadequately performed [2, 3]. Although the amphitheater lectures is the more frequent and traditional method of teaching, a variety of pedagogic educational model as problem-based learning (PBL) and active group discussions should be implemented to reach their educational goals and student self-confidence [4]. This methodology used has shown to increase student confidence and stimulate

them to active learning and best endodontic practice. Dental undergraduate students should be prepared to perform the total oral care of their patients including root canal treatment without supervision [1]. At the Faculty of Medicine, University of Coimbra, Portugal (Dentistry Course), undergraduate students in Endodontics must complete a pre-clinical course, which includes both theoretical and practical training in extracted teeth. To obtain clinical skills, teaching on clinical environment of endodontics begins in the 4th year. During two semesters (32 hours), the students perform in patient root canal treatment on anterior and premolar teeth supervised by experienced tutor in endodontics fields in the ratio 1:8 students. In the 5th year, during 32 hours, the students performed in patient root canal treatment on anterior, premolar and molar teeth supervised by experienced tutor in endodontics fields in the ratio 1:8 students. The primary purpose of the outcomes of endodontic treatment is to monitor healing or development of apical periodontitis. This is associated of clinical and radiographic follow-ups at regular intervals for a minimum observation period of 1 year [5, 6]. In the literature, several papers refer the outcomes of endodontic treatment performed by

undergraduate dental students [2,7,8]. Therefore this paper aims to assess the outcomes of root canal treatment and the competence of undergraduate dental students of the Faculty of Medicine, University of Coimbra, Portugal (Dentistry Course), to perform root canal treatment.

METHODOLOGY

A total of 674 clinical treatments were performed by dental students of the 4th and 5th year of the pre-graduated course between the years of 2007 and 2009. After informed consent all patients were treated under the same protocol and rubber dam isolation. Cleaning and shaping of the root canals were performed using K-flex files (Dentsply Maillefer, Ballaigues, Switzerland). The canals were irrigated with sodium hypochlorite 2,5% used between each file, using Luer lock syringe with needle 27G (Monoject TM, Covident 15 Hampshire St, MA 02048, USA). The treatment was completed in 2 or more sessions, using calcium hydroxide placed inside of the canals between appointments. Root canals filling were performed using gutta-percha and an epoxy resin sealer with lateral compaction technique. The intraoperative information recorded for each tooth was: pulpal and periapical diagnosis; tooth number, number of roots and root canals; length of the canal; master apical file; number of sessions; procedural errors. In the follow-up of postoperative treated teeth the patient was requested about symptoms and a careful inspection of the mucosa was accomplished to investigate the presence of sinus tract. The lateral and vertical percussion test was done to investigate the provoked symptoms. In the chart the time that occurred between final endodontic treatment and coronal restoration and the status of periapical tissues was assessed.

Periapical radiographs were performed by orthoradial angulation, using Gendex Oralix AC (Gendex Corporation, Cusano Milanino, Milano, Italy) machine operating at 65 kVp and 7.5 mA, acquired with Vixwin software system and shown on a 17-inch flat screens. In the follow-up all the anonymized

radiographs of the root canal treated teeth, were analyzed by two designated examiners with clinical experience, previously calibrated against a set of reference teeth. In cases with disagreement, a highly experienced endodontist served as the third observer. The quality of root canal filling was classified according to the distance between the end of root filling and radiographic apex, grouped as follows: root filling 0–2 mm short of the radiographic apex=adequate; root filling >2 mm short of the radiographic apex is under filled=inadequate; root filling extruded beyond the radiographic apex is overfilled=inadequate. Instrument separation was defined when an instrument fracture occurred and was not removed. The quality of root canal filling was scored as adequate if no voids were present and inadequate if poor density and voids were present. The periapical status of the controlled teeth was assessed according the periapical index (PAI). Outcomes were recorded and classified as success in the absence of symptoms, absence of apical periodontitis (PAI ≤ 2) and tooth survival. If the tooth had been extracted for endodontic problem, persistent of periapical disease (PAI ≥ 3) with persistent pain, the treatment was considered failed.

STATISTICAL ANALYSIS

Absolute and relative frequencies were compute in the groups under study to describe the gathered data. These results were also used to test for association using the chi-square test. Statistical analysis was performed using the SPSS software 20 (Statistical Package for the Social Sciences, IBM, Chicago IL), and it was assumed 5% (α = 0.05) as the significance level.

RESULTS

A total of 674 clinical cases treated, 596 were followed in this prospective study. The frequency of dental arch treatment was larger in maxillary (62.6%) than in mandibular teeth (37.4%) with more incisors (193/54) and premolars (134/94) involved however with more mandibular molars (75) than maxillary molars (46) teeth treated (Table 1).

Table-1: Distribution of teeth examined

Teeth	Maxillary (n/ %)	Mandibular (n/ %)	Total (n/ %)
Incisor/ Canine	193 (32.4%)	54 (9%)	274 (41.4%)
Premolar	134 (22.5%)	94 (15.8%)	228 (38.3%)
Molar	46 (7.7%)	75 (12.6%)	121 (20.3%)
Total	373 (62.6%)	223 (37.4%)	596 (100 %)

Among the 596 controlled teeth, 289 (48,5%) had necrosis of the pulp, 274 (48,5%) vital, 11 (1,9%) retreatment case and 22 (3,7%) with diagnosis unknown (Table 2).

In the length filling obturation it can be observed that is an error that occurred more in mandibular teeth (18.8%) than in maxillary teeth (9.9%) (Table 2).

Table-2: Diagnosis of maxillary and mandibular treated teeth

Diagnosis	n	%
Vital	274	45,9
Necrose	289	48,6
Retreatment	11	1,8
Unknown	22	3,7
Total	596	100

This type of error is meaningfully associated ($\chi^2(2) = 8.572; p = 0.014$) to the type of maxillary teeth being mostly prevalent in pre-molar teeth. The same kind of association ($\chi^2(2) = 15.622; p < 0.001$) is also presented in the mandibular arch, but in this case molar are the type of teeth more prone to this error.

In the maxillary teeth, the overfilling obturation occurred in 7.8% of the analyzed teeth, under filled in 2.2% and acceptable filled teeth in 90.0% (Table 3).

In the mandibular teeth, the overfilling occurred in 10.3% of the analyzed teeth, the under filled in 8.5% and acceptable filled teeth in 81.2% (Table 4).

Table-3: Distribution of the quality of root canal filling by dental arch.

Work Length	Maxillary teeth n (%)	Mandibular teeth n (%)	Total n (%)
Over and Underfilled	37 (9.9%)	42 (18.8%)	79 (13,3%)
Acceptable	336 (90.1%)	181(81.2%)	517 (86,7%)
Total	373 (100%)	223 (100%)	596 (100%)

Table-4: Periapical status per teeth group in the maxillary teeth.

Periapical status	Maxillary teeth		
	Inc/ Can n (%)	Pré-Molars n (%)	Molars n (%)
Healed	161 (83.4%)	121 (90.3%)	44 (95.7 %)
Disease	32 (16.6%)	13 (9.7%)	2 (4.3%)
Total n (%)	193 (100%)	134(100%)	46 (100%)

We could observe a significant association ($\chi^2(1) = 9.646; p = 0.002$) between the errors in the obturation length and dental arch (upper and lower).

Most of the errors occur in the mandible with an odds-ratio of 2.107 (IC95% [1.307; 3.397]) (Table 5).

Table-5: Periapical status per teeth group in the mandibular teeth

Periapical status	Mandibular teeth		
	Inc/ Can n (%)	Pré-Molars n (%)	Molars (%)
Healed	38 (70.4%)	89 (94.6%)	65 (86.7%)
Disease	16 (29.6%)	5 (5.4%)	10 (13.3%)
Total n (%)	54(100%)	94(100%)	75 (100%)

Concerning periapical status (Table 6 and 7), we could observe in the maxilla and in the mandible a

significant association between the periapical healing and the group of the teeth

($\chi^2(2) = 6.643; p = 0.036$ and $\chi^2(2) = 16.966; p < 0.001$, respectively).

The success in the maxilla and in the mandible was of 87.4% (IC95% [83.6%, 90.6%]) and 86.1%

(IC95% [80.8%, 90.3%]), respectively, without statistical meaning.

($\chi^2(1) = 0.208; p = 0.646$) (Table 8).

Table-6: Periapical status in the maxillary and mandibular teeth

Periapical status	Maxilla n (%)	Mandíbule n (%)	Total n (%)
Healed	192 (86.1%)	326 (87.4%)	518 (86,9%)
Disease	31 (13.9%)	47 (12.6%)	78 (13,1%)
Total n (%)	223 (100%)	373(100%)	596 (100%)

The success of the treatment was of 86.9% IC95% [83.9%, 89.5%], and no fractured instrument

was observed in the treatments that were performed by dental students.

DISCUSSION

Dental students should be trained to perform root canal treatment to a high standard quality [1]. Studies published in the literature have shown that the technical quality of root canal treatment performed by dental students is often of low level [2, 3]. In this retrospective study, we attempted to analyze the technical quality of root canal filling and the periapical status of the teeth treated by undergraduate dental students in a Dental Faculty. To improve the endodontic teaching we emphasize the importance of preclinical practice. Our students must perform a pre-clinical course in endodontic during two semesters of the third year of the course, comprising two hours per week during 32 weeks (64 pre-clinical hours) and attend to 32 hours of lectures. Comparing the preclinical exercise training with other countries it is similar in Scandinavian and greater than in North of America [9].

The clinical endodontic practice program at our school is delivered over the two last years of the pre-graduated course. Students have one session weekly, with the duration of two hours. For this purpose, during procedures the students have access to magnification with microscope and all the root canal treatment was performed under rubber dam isolation and supervised by academic endodontic staff in the ratio of 1:8. The patients included in this study are treated by students of both fourth and fifth year. Although the inclusion of the fourth-year students in this study owing low level of experience the results are very satisfactory. The root canal preparation were performed with conventional stainless steel hand k-files, using crown-down or step-back technique and root canal filling performed by cold lateral compaction with gutta-percha and a resin sealer. To check the quality of endodontic treatment, periapical radiographs of the patients treated by dental students at the School of Medicine in study program of endodontics, were used. This method of analysis has some limitations compared with Cone Beam Computerized Tomography (CBCT) Scans that has high sensitivity for detection of bone changes of apical periodontitis but periapical radiographs remain as the most common method used for routine diagnosis and to evaluate the outcomes of endodontic treatment [10, 11]. The prevalence of inadequate quality of endodontic treatment is considered the main factor responsible for the prevalence of post-treatment of apical periodontitis [10, 12-14]. Several systemic diseases were found to affect the outcome of endodontic treatment [15, 16]. In this study this criteria was not used and all the patients were included. The criteria used to analyze the quality of root canal treatment are the homogeneity and the length of the canal filling which is the most common of iatrogenic errors. In this study, 13.3% of the treated teeth had root canals ranked with inadequate in quality that developed periapical periodontitis in 4.3 %. On the other hand, root canal treatment was acceptable in 86.7% with adequate

quality in which the teeth without lesion was of 95.7 %. In this study, root canal treatments were more frequently undertaken in maxillary than in mandibular teeth and inadequate length filling occurred more frequently in the mandible than in the maxillary teeth. This may be, because the technique of lateral compaction was more difficult to perform in the maxillary teeth. In relation to the status of the periapical tissues, using the PAI score of Ørstavik, successful cases were considered with normal periapical tissue and absence of symptoms and was more frequent in the maxilla than those in the mandible. The number of patients who can be followed systematically over long periods of time is usually extremely small. In this study we followed 674 clinical cases corresponding to a total number of 1097 canals of adult patients, performed by dental students between the years of 2007 and 2009, amongst of them 596 returned for evaluation.

Although the results of success of root canal treatment achieved by dental students of the FMUC, new paradigm are a challenging in the curriculum of pre-graduate students of dental medicine. A critical thinking and evidence based dentistry is an important step to promote dental education [4]. In an effort to improve teaching at the dental area of the FMUC changes are currently introduced in the curriculum, focused to address the demands for dentist education to meet the challenges of this new millennium.

CONCLUSIONS

The frequency of root canals performed was significantly greater in the maxilla than in the mandible. The technical quality of RCT performed by undergraduate dental students was classified as 'acceptable' in 86, 7% of cases.

The success rate of root canal treatment in a Dentistry Course is (86,9%), similar to rates reported previously. To increase the quality of root canal treatment performed by dental students some possible solutions may include revision of the curriculum structure and introduction new techniques of root canal preparation and filling.

Ethical approval

This study used dental clinic radiographs data of anonymous patients and all procedures performed were in accordance with the ethical standards of the Institutional Review Board (FMUC-Ethics Committee, Of. Ref^o 063-CE-2017).

Informed consent

For this type of study, formal consent is not required

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