

Radiographic quality of root canal treatments



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Title: Radiographic quality of root canal treatments performed by undergraduate dental students

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Summary:

The aim of the present study was to evaluate the quality of root canal treatments performed by students of Isfahan University School of Dentistry between 2013 and 2015. Periapical radiographs from 784 root treated teeth including 1674 root canals were randomly selected and evaluated in terms of quality of root fillings (length and density of root fillings) and procedural errors (ledge, foramen perforation, root perforation, and fractured instrument). Descriptive statistics and chi square test were used for evaluation of the data ($P < 0.05$). The results showed that frequency of root canals with acceptable filling was 54.1%. Over filling was found in 11% of root canals, under filling in 8.3% and inadequate density in 34.6%. No significant difference was found between Frequency of acceptable root fillings in maxilla and mandible ($P = 0.072$). More acceptable fillings was found in canals of premolars (61.3%) than molars (51.3%) ($P = 0.001$). Frequency of procedural errors was 18.6%, which included 12.5% ledge, 2%

foramen perforation, 2. 4% root perforation and 2% fractured instrument.

Procedural errors were more frequent in canals of molars (22. 5%) than anterior teeth (12. 3%) ($P= 0. 003$) and premolars (9. 5%) ($P <0. 001$).

According to the study's findings it can be concluded that educational programs in Endodontics needs to be revised in order to improve quality of root canal treatments.

Key words: dentistry, procedural errors, radiography, root canal treatment, undergraduate student

Introduction

Root canal treatment (RCT) is an important part of comprehensive dental care (1). High prevalence of apical periodontitis in endodontically treated teeth, as reported by epidemiological studies (2-4), reveals that outcome of RCT in many populations is poor, which as a health care problem can elicit medical, economical and ethical consequences (1).

Outcome of primary endodontic treatment is reported to be associated with many factors (5). One of these factors is technical quality of RCT that is usually evaluated using radiographic method (3, 6). It's shown that the length of the root filling, relative to the radiographic apex, significantly affects the treatment outcomes (7). In addition, root fillings with an adequate density are strongly associated with a lower risk of periapical disease (8).

Also, procedural errors such as ledges, zip and elbow formations, fractured instruments and perforations may accrue during the RCT. These errors may result in compromised cleaning and shaping, leakage through root filling or

infection of the periradicular tissues and can jeopardize the endodontic outcomes (9).

Recent studies accomplished in various population groups, show that undesirable quality is a common finding in RCTs performed by dentists and undergraduate dental students (Table 1).

Therefore a worldwide enhancement in the quality of RCT is required (2) that could be achieved by means of education. Studies concerning quality of RCT are needed in order to appraise the efficiency of dental training, highlight the weaknesses and help with the planning for dental education. Thus, the aim of the present study was to evaluate quality of root canal treatments (quality of root fillings and incidence of procedural errors) performed by students of Isfahan University School of Dentistry between 2013 and 2015.

Materials and methods

In this cross-sectional study, a random sample of 1200 cases were selected from the records of patients who had received RCT by undergraduate students at School of Dentistry, Isfahan University of Medical Sciences, Iran, during 2013-2015. Records with missing or unreadable radiographs due to improper imaging or processing technique, or those with radiographs that didn't show the entire length of the root canals and 2mm of periapical area, were excluded. Finally, 784 treated teeth including 1674 canals were evaluated.

The RCTs were accomplished by fourth, fifth and sixth year undergraduate dental students according to the following protocol: after taking medical and

dental history and diagnosis of pulp and periapical disease, local anesthesia was injected and the access cavity was prepared. An aseptic technique with rubber dam isolation was applied and working length was determined using periapical radiographs. Canals were prepared using step back technique by means of stainless steel k-files of 0.02 taper (Dentsply, Tulsa, USA or Mani, Tochigi, Japan). In some cases Gates-Glidden drills (Mani, Tochigi, Japan) were used for preparation of coronal third of the canals. Canals were irrigated by 2.5% sodium hypochlorite. Obturations were carried out using lateral compaction technique with gutta-percha cones (Ariadent, Tehran, Iran) and a ZOE based sealer. Teeth were temporarily restored and referred for permanent restorations. For root canal treatment of each tooth, 4 periapical radiographs (preoperative, working length determination, master cone and postoperative) were taken by the bisecting-angle method using De Gotzen dental radiography machine (De Gotzen, Roma, Italy) and E speed size 2 intraoral films (Primax, Berlin, Germany). Developing solutions (Champion, Tehran, Iran) were used to process the radiographs in a time-temperature technique. Endodontist academic staff supervised all the treatment steps. Average academic staff: student ratio has been 1:6 at the time of the study.

In order to evaluate the quality of each RCT, at least 3 radiographs including preoperative, working length determination and postoperative, were examined. Evaluations were made in a dark room under even illumination and 3x magnification. Radiographs were mounted in a cardboard slit to exclude the extraneous lights. Measurements were done using a transparent ruler of 0.5 mm accuracy. In cases that the radiographic images were taken

with an alternation in horizontal angulation, it was supposed that they were exposed with a mesial angulation.

Two individual investigators (GM and AV) securitized the radiographs of each record. The results were compared and in case of disagreement a third investigator (MS) was asked to examine the records, and a final agreement was achieved.

Before the study, investigators were calibrated and Inter-examination agreement was determined by evaluating 30 radiographic records that weren't included in the study. For establishing intra-examiner agreement, each investigator re-evaluated the same radiographs after 2 weeks.

Evaluation of quality of RCTs was accomplished by examining radiographic quality of root fillings and detection of the procedural errors. Root canal was considered as the unit of evaluation.

Quality of root filling in each canal was categorized as acceptable and unacceptable based on the following criteria:

1. Acceptable root filling: root filling ending 0-2 mm from radiographic apex without any visible voids in the filling mass or between the filling mass and root canal walls.
2. Unacceptable root filling:
 1. Overfilling: root filling that extends beyond radiographic apex.
 2. Undrefilling: root filling ending shorter than 2 mm from the radiographic apex.

3. Inadequate density: root fillings with visible voids in the filling mass or between the filling mass and root canal walls.

The criteria for the detection of procedural errors in this study, were as follows:

1. A ledge was identified if the root filling in the final radiograph did not follow the curvature of the main canal path in working-length radiograph.
2. Root perforations (including furcation perforation, strip perforation and lateral perforations of the root) were detected when extrusion of the filling materials was identified in any area of the root except the apical foramen.
3. Foramen perforation was diagnosed when the apical termination of the filled canal appeared as an elliptical shape transported to the outer wall.
4. Fractured instruments: was detected by observing a part of instrument in the root canal or in periarticular area in the final radiograph.

Statistical analysis

Data were analyzed using SPSS software version 21 (SPSS Inc., Chicago, USA). Descriptive analyzes were used for expressing frequency of radiographic criteria of quality of RCTs. Pearson's chi square test was used to compare the results among tooth types and locations and also academic year of students. P-values < 0. 05 were considered statistically significant. Inter-examiner and intra-examiner agreement was evaluated using Cohen's kappa (k) values.

Results

From 1200 collected records of endodontically treated teeth, 416 cases (34.7%) were excluded and 734 teeth including 1674 root canals were evaluated. 52% of treated root canals were in maxilla and 48% were in mandible. Canals of molar teeth comprised the most frequent treated root canals (68%), followed by canals of premolars (22%) and anterior teeth (10%). 6th year students performed RCTs on 49% of root canals. 5th and 4th year students treated 32% and 19% of root canals, respectively. Anterior teeth and premolars constituted the teeth treated by 4th year students while 5th and 6th year students treated premolars and molars (Table 2).

Technical quality of root fillings

According to length and density, acceptable fillings were found in 54.1% of root canals. From treated maxillary root canals, 56.2% and from treated mandibular root canals, 51.9% were acceptable. Rate of acceptable root fillings wasn't significantly different between the two arches ($P=0.072$). Among tooth types, canals of molar teeth exhibited lower ratio of acceptable root fillings (51.3%) compared to premolars (61.3%) ($P=0.001$). Rate of acceptable fillings in anterior teeth (57.7%) wasn't significantly different from molars ($P=0.430$) and premolars ($P=0.128$). Inadequate density, overfilling and underfilling were found in 34.6%, 11% and 8.3% of root canals, respectively. In both arches inadequate density consisted the most common cause for unacceptable fillings. In maxilla overfilling consisted the second frequent cause for unacceptable fillings, followed by underfilling,

However, underfilling was the second common cause of unacceptable fillings in mandible and overfilling was the least frequent cause (Table 3).

From the root canals treated by 5th year students 46.1% had acceptable fillings which is significantly lower than canals treated by 4th year students (55.6%) ($P= 0.007$) and 6th year students (58.8%) ($P <0.001$). No significant difference was found between frequency of acceptable fillings performed by 4th and 6th year students ($P= 0.339$) (Table 4).

Procedural errors:

Procedural errors were found in 18.6% of root treated canals. Incidence of procedural errors between 5th year students (22.2%) and 6th year students (19%) wasn't significantly different ($P= 0.149$). Students of 4th year had created less procedural errors (11.6%) than students of 5th year ($P <0.001$) and students of 6th year ($P= 0.003$).

Ledge was the most frequent procedural error and was identified in 12.5% of root treated canals. Foramen perforation, root perforation and fractured instrument were detected in 2%, 2.4% and 2% of canals, respectively (Table 5).

Incidence of procedural errors wasn't significantly different in canals of anterior teeth (12.3%) and premolars (9.5%) ($P= 0.341$). These errors were significantly more frequent in canals of molars (22.5%) than anterior teeth ($P= 0.003$) and premolars ($P <0.001$).

The k-value for inter-examiner agreement was 0.87 for detection of acceptable root fillings and 0.81 for identification of RCTs without procedural errors. For intra-examiner agreement k-values for detection of acceptable root fillings and identification of RCTs without procedural errors were 0.93 and 0.87 for first and 0.84 and 0.81 for second investigator, respectively.

Discussion

This study was designed to evaluate the quality of root canal treatments accomplished by undergraduate dental students at School of Dentistry, Isfahan University of Medical Sciences. Periapical radiographs taken during the RCT procedures were used for this investigation. Root fillings were considered acceptable if terminated 0-2 mm from radiographic apex and had no voids. This criteria is extensively documented to be associated with improved periapical health (4, 5, 8).

In order to limit inter-examiner and intra-examiner erraticism, the radiographic criteria were strictly defined and two investigators were calibrated before the study. It's reported that great variations could exist between investigators regarding assessment of technical quality of RCT (22). In the present study, the k-value of 0.87 for detection of acceptable root fillings and 0.81 for identification of RCTs without procedural errors, exhibit good agreement between the investigators. Also values for intra-examiner agreement were found to be greater than 0.81, which shows reliability of each investigator.

Acceptable root fillings according to length and density was found in 54.1% of investigated canals. Comparing this result to the findings of others is <https://assignbuster.com/radiographic-quality-of-root-canal-treatments/>

rather difficult due to differences in level of practitioners (undergraduate students, general practitioners, and endodontists), techniques and materials used for preparation and obturation of the canal and also evaluation criteria used to assess the quality of RCT. For example, in the study of Bierenkrant et al. (18) who investigated root canals treated by endodontists, 91% of root fillings had adequate quality which is greater than the present study and other studies investigating quality of RCT performed by undergraduate students and general practitioners (Table 2). Among the studies concerning quality of RCT performed by undergraduate students, frequency of acceptable fillings in the current study is comparable to the findings of Eleftheriadis & Lambrianidis (14) (55.3%) and Khabbaz et al. (19) (54.8%). In the study of Er et al. (15), 33% of root fillings were acceptable which is less than the present study; thought, they used different evaluation criteria. Lynch and Burke (16) reported adequate fillings in 63% of RCTs, which is higher than the present study, however they only evaluated single rooted teeth.

In the present study, inadequate density was the most common cause for unqualified root fillings. This is consistent with the findings of Balto et al. (20). It's believed that lateral condensation technique with gutta percha, could create voids in canals with insufficient flaring (14).

No significant difference was found between quality of maxillary and mandibular root fillings. Also adequate root fillings in molars were less than premolars. This result was consistent with findings of Er et al. (15) and Khabbaz et al. (19) who report a lower quality of root fillings in molar teeth.

This could be explained by posterior position and complex anatomy of these teeth.

Students of 5th year had performed more unacceptable root fillings than 4th and 6th year students. This could be explained considering the fact that at Isfahan University School of Dentistry, first clinical encounter of undergraduate students with molar teeth, is at their 5th year of study.

Iatrogenic errors were detected in 18.6% of root canals. These errors are more frequent in molar teeth. Balto et al. (20) and Khabbaz et al. (19) also reported a high prevalence procedural errors in molar teeth. The reason for this, could be explained by curved and narrow canals of molar teeth, which makes them challenging for undergraduate students. Furthermore, 5th and 6th year students had created more procedural errors than 4th year students. This is because 4th year students only perform RCTs on anterior teeth and premolars which are less challenging than molar teeth.

In this study, ledge was found to be the most frequent procedural error and was detected in 12.5% of root canals. This finding is similar to incidence of ledged root canals in the study of Khabbaz et al. (19) and is less than study of Eleftheriadis & Lambrianidis (14). It's shown that stainless steel hand files used by unexperienced undergraduate students could increase the incidence of ledge and other procedural errors (14).

Radiographic images cannot illustrate all iatrogenic errors. For instance, over instrumentation which drives pulpal fragments and microorganisms beyond

the apex into the periapical tissues, can only be radiographically diagnosed when it is followed by extrusion of filling material from the apex.

The use of bisecting-angle technique for taking periapical radiographs, results in less accuracy in recognition of canal length, comparing to the parallel technique (23). It has also been shown that using only one orthoradial radiographic image for assessing the adaptation of the filling material to the root canal walls, isn't reliable. This adaptation has to be further investigated with at least one extra radiography of distal or mesial angulation in order to obtain more realistic estimate of density of root filling (24).

Although radiographic quality of RCT is a significant determinant in predicting outcomes of primary endodontic treatment, the radiographic images can not reflect the general quality of treatment. Application of the antiseptic and aseptic techniques, material used and microbial circumstance of the canal are the predicting factors which are not investigated in radiographic studies.

At Isfahan University School of Dentistry, Step-back preparation and cold lateral condensation techniques are being taught to the undergraduate dental student. Most universities teach these standard techniques to their students. It's shown that using rotary Ni-Ti instruments provide better canal shaping, reduce the procedural errors and are being taught in undergraduate curriculum in some dental schools (17).

In many studied insufficient time allocated to clinical and preclinical training, the academic stuff: student ratio and evaluation methods are stated as <https://assignbuster.com/radiographic-quality-of-root-canal-treatments/>

reasons for low quality of RCTs in university clinics (14, 19, 20). Isfahan University School of Dentistry uses endodontic specialists and 3rd year post graduate students as training staff. Also academic curriculum have been recently revised to increase preclinical training. Nevertheless, enhancing the time allocated to clinical training and increasing staff: student ratio could lead to improvements in quality of RCTs performed by undergraduate students.

In conclusion, findings of this study shows that 54. 1% of root fillings performed by undergraduate students of Isfahan University School of Dentistry were acceptable. Thus, there a necessity to revise the educational programs in Endodontics in order to improve quality of root canal treatments.

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