

Quality of root canal filling performed by undergraduate students of odontology at Kaunas University of Medicine in Lithuania

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SUMMARY

Introduction. High-quality filling of root canals is one of indicators of successful endodontic treatment. However, poor-quality of the filling is still a common phenomenon in the work of general practitioners. Better training of dental students of modern odontology is possible solution of the problem.

The aim of this study was to evaluate the quality of root canal filling performed by undergraduate students in single-rooted and multi-rooted teeth shaped by hand stainless-steel or rotary ProTaper instruments.

Materials and methods. We analyzed 258 post-operative radiographs under illumination and $\times 7$ magnification. 120 (46.5%) root canal were prepared using hand stainless-steel K-files, 138 (53.5%) using ProTaper rotary instruments. The filling was evaluated as adequate when it was located at 0-2 mm below the radiographic apex, under-filled >2 mm below the radiographic apex, over-filled, protruded through the radiographic apex. The filling homogeneity and condensation were also evaluated.

Results. The filling height and position in relationship to the radiographic apex showed 84.1% were filled adequately, 10.5% – under-filled, 5.42% – over-filled. Homogeneity and density in 79.5% was good, in 20.5% – poor.

Conclusions. The quality of root canal filling was acceptable, because 84.1% cases were filled adequately. The density and homogeneity were statistically reliably better in the canals prepared using ProTaper System.

Key words: undergraduate, dental education, obturation, root filling, quality, endodontic treatment.

INTRODUCTION

Endodontic treatment occupies a significant place in the work of a general dental practitioner. This treatment consists of several important stages: removal of damaged or necrotic pulp from root canals, mechanical cleaning of the canals, elimination of infection from the root canal system, high-quality filling of the canals (especially obturation of apical foramina), and hermetic restoration of the dental crown following endodontic treatment [1]. Poor qual-

ity of at least one of these stages entails high risk of unsuccessful treatment of the tooth resulting in progressing or persistent chronic apical periodontitis [2]. Unfortunately, cases of unsuccessful endodontic treatment in the work of general dental practitioners are abundant not only in Lithuania, but also abroad [3-8]. The evaluation of failures of endodontic treatment in separate stages is complicated. The radiological evaluation of the quality of root canal filling is relatively easy, since filling material in the canals provides good contrast. This facilitates the evaluation of the degree to which the filling material obturates the root canal, the evaluation of its position in relation to the radiographic apex, its density, homogeneity, and condensation, as well as the presence of voids. Although this radiological evaluation of the quality of the filling of root canals is far from reflecting the real situation. Numerous

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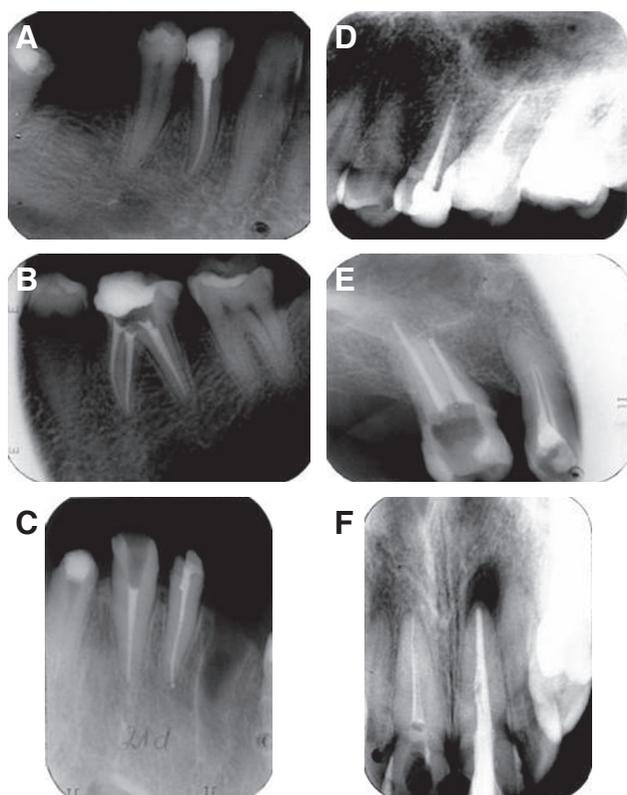


Fig. 1. Root canal fillings classification according relationship to the radiographic apex of the root and its homogeneity

researchers have proven a direct relationship between poor quality of root canal filling and radiological changes in apical periodontium characteristic of apical periodontitis [1-2,8-9]. Researchers have proven that total elimination of infection from micro and macro systems of root canals via mechanical cleaning and intra-canal medications is very complicated. For this reason, high-quality filling of root canals and obturation of apical foramina are especially important for the blockage of the remaining infection in the canal and the prevention of reinfection [3-4].

The reduction of cases of unsuccessful endodontic treatment in dental practice is highly important. Better training of odontology students in the field of modern odontology is one of possible solutions to the problem, which is recognized by many universities of various countries, seeking to improve student training in the area of root canal treatment [10-11]. Undergraduate curriculum guidelines for endodontology [12-14] prepared by the European Society of Endodontology are especially useful here [12-14]. Endodontic treatment is expensive, but retreatment of previously treated teeth is even more expensive if at all possible – especially in countries with few endodontology specialist. For this reason, the aim of our study was to evaluate the quality of root canal filling performed by undergraduate students in single-

rooted and multi-rooted teeth shaped by hand stainless-steel or rotary ProTaper instruments. The findings are of practical significance since they may indicate to which direction the training of students for practical work of an endodontic treated should be developed.

MATERIALS AND METHODS

We analyzed radiographs of over 500 root canals independently filled by students during two terms of the academic year 2006-2007, when they studied clinical endodontics. Of these radiographs of endodontically treated teeth, we randomly selected 198, where we evaluated the radiological quality of the filling of 258 root canals. Of these, 159 canals were filled in single-rooted teeth, and 99 – in multi-rooted teeth. Radiographs were selected according to the following criteria:

- The quality of the radiograph;
- Roentgenography performed using the paralleling technique;
- The radiograph showed the whole lumen of the filled canal as well as periapical tissues;
- The SLOB rule is followed in radiographs of multi-rooted teeth;
- Radiographs of teeth that were endodontically treated for the first time.

The radiographs under investigation were examined by two examiners under illumination in a darkened room at x7 magnification. The radiological quality of the filling of root canals was evaluated with respect to 2 main criteria - the relationship of the root canal filling to the root apex, and the homogeneity of the filling material. Non-uniform homogeneity (density) of the filling material throughout the lumen of the root canal may be a result of, insufficient condensation of gutta-percha points, and this also reflects the quality of root canal filling.

Root canal fillings were classified according to the relationship of the root canal filling to the radiographic apex of the root (Figure 1)

- “acceptable”: when the root canal filling material is within the root canal system and within 2 mm of the radiographic apex (Figure 1 A, B);
- “over-filled”: the root canal filling material is extruded beyond the radiographic apex (Figure 1 C);
- “under-filled”: when the root canal filling is >2 mm short of the radiographic apex (Figure 1 D).

The evaluation of the quality of filling with respect to the density of the filling material, i. e. its homogeneity and condensation was the following: good homogeneity (Figure 1 E) – the roentgenologic contrast of the filling material was uniform through-

out the lumen of the root canal; and poor homogeneity (Figure 1 F) – the roentgenologic contrast of the filling material throughout the lumen of the root canal was non-uniform. We also compared radiological quality of filling between root canals that were cleaned and shaped using hand stainless steel K-type files, and those that were prepared using ProTaper system rotary instruments. Of 258 root canals, 120 were cleaned and shaped using hand endodontic instruments, and 138 – using ProTaper system NiTi rotary files.

Root fillings were either classified as adequate or inadequate on the basis of guidelines published by the European Society of Endodontology (1994, 2006). The former category indicated as a well filled root without visible voids contained within the tooth and ending no less than 2 mm from the radiographic apex. An inadequate root filling was underfilled, overfilled or poorly condensed [13, 15].

The statistical analysis was performed using SPSS 13.0 for Windows, where *t* stands for ‘test’ and χ^2 – for ‘square analysis’. The significance was accepted at $p < 0.05$.

RESULTS

This study presents a generalized review of the radiological qualitative results of the filling of 198 endodontically treated teeth. Students performed endodontic treatment in 76 teeth diagnosed as “pulp vitalis” or health pulp. In the majority of these teeth, the pulp was removed as part of the preparation of the teeth for prosthetics. In 56 teeth, endodontic treatment was performed in the presence of pulpitis, in 14 teeth the diagnosis was necrotic pulp without radiological changes in the apical periodontium, and in 52 teeth – apical periodontitis.

The analysis of the students’ work showed that in total, the treatment of 198 teeth involved filling of

258 root canals. Of these, 159 canals were filled in single-rooted teeth, and 99 – in multi-rooted teeth. The majority of the single-rooted teeth were upper left central incisors, and the majority of the multi-rooted ones were lower left first molars.

The evaluation of the quality of root canal filling with respect to the height of the filling material in the canal and the relationship of the filling material with the radiographic root apex showed that the majority of root canals (217 out of 258) were filled adequately.

However, the evaluation of the radiological quality of root canal filling with respect to the homogeneity of the filling material showed that even if the filling of the root canal was acceptable, sometimes the density of the filling material in the canal was insufficient (poor), or even voids were detected. Such root canals may manifest micro-leakage, which worsens the quality of filling and potentially entails poorer outcomes of endodontic treatment. Table 1 presents the results of root canal filling concerning not only the height of the filling material in the canal, but also its homogeneity.

The results of the study showed that there was no statistically reliable difference in the quality of root canal filling between single-rooted and multi-rooted teeth. This study also evaluated the quality of root canal filling with respect to the tools applied for the cleaning and shaping of root canals, i. e. either NiTi rotary ProTaper system files or hand stainless steel K-files. The obtained results showed that, concerning the relationship of the filling material with the radiographic root apex, there was no statistically reliable difference in the quality of filling between canals prepared by hand instruments or those prepared by the ProTaper system instruments (Table 2).

Meanwhile, the homogeneity of the filling material in root canals was statistically reliably better in the canals that were cleaned using the ProTaper sys-

Table 1. Results of the quality of filling in root canals concerning the relationship of the material level with radiographic apex and homogeneity

Acceptable		Under-filled		Over-filled	
Good	Poor	Good	Poor	Good	Poor
70.1%	13.9%	5.4%	5.1%	3.9%	1.6%

$\chi^2=15.2$; $df=2$; $p<0.001$

Table 2. Evaluation of the quality of filling in root canals cleaned using different instruments concerning the relationship of the filling material with the radiographic root apex

	Acceptable	Under-filled	Over-filled
Stainless steel K-file (n=120)	81.7%	12.5%	5.8%
ProTaper n=138	86.2%	8.7%	5.1%

$\chi^2=1.1$, 2; $df=2$; $p=0.573$

Table 3. Evaluation of the quality of filling in root canals cleaned using different instruments concerning the homogeneity of the filling material

Quality of filling	Instruments	
	Stainless steel K-file (n=98)	ProTaper (n=119)
Good homogeneity and acceptable	71.4% $p<0.001$	93.3%
Good homogeneity and under-filled	Stainless steel K-file (n=15) 46.7% $p=0.239$	ProTaper (n=12) 75.0%
Good homogeneity and over-filled	Stainless steel K-file (n=7) 57.1% $p=0.559$	ProTaper (n=7) 85.7%

tem rotary NiTi files compared to those that were cleaned using hand stainless steel K-files (Tables 3).

DISCUSSION

In the analysis of the results of root canal filling performed by students, attention was focused on quality criteria set by the European Society of Endodontology. Root fillings were classified either as adequate or inadequate. The former category indicated a well-filled root canal without visible voids contained within the tooth and ending no less than two millimeters from the radiographic apex. An inadequate root treatment was under-filled, over-filled, or poorly condensed [15]. A number of clinical trials clearly substantiated these quality criteria and showed that an optimal treatment outcome in infected teeth with periradicular lesions was achieved when the apical terminus was 0-2 mm short of the radiographic apex [1-2].

Naturally, we agree with the authors who state that the disinfection of the root canal system cannot be determined from the radiographs and as a consequence, even apparently well-filled canals can remain infected [2]. We equally agree that the radiographic quality of the root fillings is in no way indicative that the root canal was well sealed [16]. Numerous studies from European countries have shown a high percentage of inadequately root filled teeth to be resulting in apical periodontitis [3,6-8,17].

Loftus J. J. et al. found that root-filled teeth classified as adequately treated had apical periodontitis in 23.9 percent cases compared with 35 percent in teeth classified as inadequately root filled. Teeth with poorly condensed fillings had a high incidence of apical periodontitis, compared to teeth that had well condensed but over-filled or under-filled root fillings. The findings of these studies from different countries indicate that the standards for root canal treatment performed by general dental practitioners are often less than ideal. This again confirms the importance of student training in the field of endodontology. It is clear that dental students should be educated to provide endodontic treatment corresponding to high standards. For this reason we are highly satisfied with the obtained findings on the quality of root canal filling performed by the students of Kaunas University of Medicine. The results of our study showed that in as much as 84 percent of root canals filled by students, the height of the filling material was 0-2 mm from the radiographic root apex. However, the results of our evaluation showed that the homogeneity of the filling material was good only in 70.1 percent of root canals whose quality of filling was evaluated

as acceptable. We tend to think that this percentage is sufficiently good compared to the results seen in general dental practice. Similar results were obtained at the University Dental School and Hospital, Cork, although in this case students were filling the canals of single-rooted teeth only [11]. Meanwhile, a similar study performed in Jordan found that over two-fifths of root canal filling performed by undergraduate students were inadequate [18]. When analyzing the quality of root canal filling performed by students, we evaluated the difference in the filling quality between single-rooted and multi-rooted teeth, since at some universities students primarily fill the canals of single-rooted teeth. General dental practitioners also tend to avoid endodontic treatment of multi-rooted teeth [19]. We did not detect any significant difference in the quality of filling between root canals of single-rooted and multi-rooted teeth. However, we did find a reliable difference in the homogeneity of the filling material between root canals cleaned and shaped using different instruments. Our study showed that the homogeneity of the filling material was significantly reliably more frequently superior in root canals cleaned and shaped using ProTaper system NiTi rotary instruments and filled with special points adapted for filling of root canals shaped using such instruments.

Although manual instrumentation is still the most popular way of preparing the root canals, many specialists and an increasing number of general practitioners in Lithuania are using rotary NiTi instruments. For this reason, students at Kaunas University of Medicine are trained to work with this instruments, although teachers of many foreign universities hold the opinion that students must first become competent with hand files before using rotary files [20]. The results of the quality of root canal filling performed by our students support the authors who maintain that NiTi rotary instruments can be safely introduced into undergraduate dental curriculum with a substantial improvement in the quality of root canal treatment [21-25].

CONCLUSION

The quality of root canal fillings placed in single and multi-rooted teeth by undergraduate dental students at University of Medicine in Kaunas was acceptable: 84.1 percent of root fillings were within 2 mm of the radiographic apex, in 70.1 percent on cases, not only the quality of root canal filling was acceptable, but the homogeneity of the filling material was good as well. The density and homogeneity of the filling material were statistically reliably better in root

canals prepared using ProTaper system rotary instruments. These results might have been influenced by the fact that at Kaunas University of Medicine, the pre-clinical and clinical curriculum of endodontology meets the requirements set by the Undergraduate

Curriculum Guidelines for Endodontology proposed by the European Society of Endodontology, as well as by the fact that teaching and training in undergraduate endodontics is carried out by specialists-endodontists.

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