Radiographic technical quality of root canal treatment performed by a new rotary single-file system

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Summary

Aim. The aim of the present study was to evaluate radiographically the technical quality of root canal filling performed by postgraduate students with a new single-file Nickel-Titanium System (F6 Skytaper Komet) in clinical practice.

Methods. Records of 74 patients who had received endodontic treatment by postgraduate students at the School of Dentistry, Faculty of Medicine, University of Pavia in the period between September 2015 and April 2016 were collected and examined: the final sample consisted 114 teeth and 204 root canals. The quality of endodontic treatment was evaluated by examining the length of the filling in relation to the radiographic apex, the density of the obturation according to the presence of voids and the taper of root canal filling. Chi-squared analysis was used to determine statistically significant differences between the technical quality of root fillings according to tooth's type, position and curvature.

Results. The results showed that 75,49%, 82,84% and 90,69% of root filled canals had adequate length, density and taper respectively.

Conclusions. Overall, the technical quality of root canal fillings performed by postgraduates stu-

dents was acceptable in 60,78% of the cases.

Key words: apical periodontitis, nickel-titanium files, quality of root canal treatment, root filling.

Introduction

The aim of root canal treatment is to prevent and treat apical periodontitis (1), with the objective of eliminating microorganisms and necrotic pulp through chemomechanical debridement, and providing an adequate root filling (2) in order to seal the canals and prevent reinfection (3).

Several Authors reported a lower incidence of periapical periodontitis in teeth with adequate root fillings, so this variable should be taken into consideration when evaluating root canal treatment success (4). In the study performed by Azim et al. (1), they reported that poor root filling density, short root filling length (> 2mm short from the radiographic apex) are associated with unfavorable outcome, and in teeth with overextended filling a delayed healing could be expected.

The quality of root canal treatment undertaken in different populations by students (5) and general practitioners (6, 7) has been extensively investigated, and it was observed that the technical quality of root fillings was poor and unsatisfactory in most cases. Treatment success can be related to lots of reasons such as patient age or immune conditions, but probably also to poor canal cleansing and shaping, use of inadequate aseptic techniques and lack of rubber dam, which could contribute to the persistence or introduction of microbes into the canal system (8).

Shaping of the root canal was achieved by using stainless steel hand files, but the introduction of nickel-titanium instruments in the last decades has led to a significant improvement of quality of root canal shaping and less iatrogenic damage, even in severely curved canals (9, 10). Over the years, several generations of file systems have been introduced, instrument design has changed considerably intending to improve on previous generations.

The fifth generation of shaping files is the last that has been introduced, with instruments characterized by having the centre of mass and/or rotation offset, with a design, which should minimize the engagement between the file and the dentin (11). F6 SkyTaper system (Komet, Brasseler GmbH & Co., Lemgo, Germany) belongs to fifth generation, is a single-file endodontic systems, which are used in continuous rotation, with two sharp cutting edges in a double-S

cross-section design, and it is made up of 5 different instruments (12).

The purpose of this study is to evaluate, analyzing periapical radiographs, the technical quality of root canal treatment performed by postgraduate students at the School of Dentistry, Faculty of Medicine, University of Pavia.

Materials and methods

Patient selection

Records of 74 patients who had received endodontic treatment by postgraduate students at the School of Dentistry, Faculty of Medicine, University of Pavia in the period between September 2015 and April 2016 were collected and examined. The final sample consisted of periapical radiographs of 204 root canals, for a total of 114 teeth. All endodontic treatment was performed by postgraduate students, with the supervision of teaching assistants. First, every patient was required to give informed consent together with medical and dental history, then the teeth and soft tissues were clinically examined for tenderness, swelling, crown fracture, and finally, if necessary, they have been treated and information about root canal fillings was acquired.

Preoperative and postoperative periapical radiographs were taken for every tooth and, when necessary, also the intraoperative radiograph was taken. Radiographs with over-projection of anatomical structures, poor quality and not visible apex were excluded from the study to eliminate the possibility of radiographic misinterpretation.

Canal preparation

All patients were treated with the following protocol: local anesthesia was administered (if needed) and then an aseptic isolation with rubber dam technique was applied in all the cases. After the access preparation, to eliminate coronal interferences and for a quick enlargement of the canal entrance, an Opener OP10 (Komet Brasseler GmbH & Co., Lemgo, Germany) was used, then working length was acquired using 0,10 K-file with an apex locator (Endopilot, Komet Brasseler GmbH & Co., Lemgo, Germany). In every root canal a glide path was created first using a K-file and then with the PathGlider PG03 of 0.03 taper (Komet Brasseler GmbH & Co., Lemgo, Germany), whose rotational speed was set on 300 rpm and torque of 0,5 Ncm. A mechanical preflaring helps to create a safe and easy glide path and maintain the original canal anatomy even when used by inexperienced clinician (13).

Then, a suitable F6 SkyTaper file was chosen according to the size of the previously used manual file, and finally the root canal was instrumented with a crown down technique in continuous clockwise rotation with gentle in- and out-motion for quick and safe root canal preparation. The F6 SkyTaper System is composed of highly flexible nickel-titanium files in five

different sizes and three lengths with 6% taper; the rotational speed advised for these instruments, which is 300 rpm, and a torque of 2,2 Ncm for 020-030 files and 2,8 Ncm for 035-040 files, are controlled by an endodontic motor (EndoPilot, Komet Brasseler GmbH & Co., Lemgo, Germany) (14). For each tooth, a new F6 was used and canal preparation was accomplished with continuous irrigation with 5,25% sodium hypochlorite and 17% EDTA solution; afterwards teeth were filled with a carrier-based filling system (F360 Fill Obturators, Komet Brasseler GmbH & Co., Lemgo, Germany) with a root filling material based on epoxy resin (EasySeal, Komet Brasseler GmbH & Co., Lemgo, Germany).

Radiographic examination

Digital periapical radiographs were taken using a paralleling device (XCP, Dentsply Rinn, Elgin, IL, USA) with an intraoral X-ray equipment set on 7mA, 70kVp, 50/60 Hz (BlueX IntraOs 70, BIOTEX S.A., Athens, Greece) and examined using the equipment own software (Digora Soredex-Finndent Medical Systems, Helsinki, Finland), which provides the options for measuring root lengths and also the distance between the end of the filling and the root apex. The radiographs were evaluated independently by two different operators and the results were compared, then a final evaluation was agreed.

The quality of endodontic treatment was determined by the length of the root filling in relation to the radiographic apex, the density of the obturation according to presence of voids and the taper of root canal fillings (consistent taper from coronal to apical aspect of the root), according to the criteria of Barrieshi-Nusair et al. (15). The root canal obturation ending more than 2 mm from the radiographic apex was considered under filling while extending beyond the radiographic apex was considered over filling. Presence of voids, no homogenous root canal fillings were considered as poor filling, moreover not consistent taper from the coronal to the apical part of the filling was considered as poor taper (Tab. 1).

The relation of root canal length, density and taper adequacy to canal curvature, arch and tooth position (mandibular/maxillar) was assessed. The teeth were classified according to their location in the arch. Canal curvature was recorded as straight or curved. A straight line parallel to the long axis of the canal was drawn using an endodontic ruler along the coronal straight portion of the root canal space. If this line passed through and intersected the apical foramen, the canal was considered straight. If the line deviated and did not pass through the apical foramen, the canal was considered curved, according to Barrieshi-Nusair (15).

Statistical analysis

The analysis of the data was performed using SPSS 14.0 for Windows (SPSS Inc., Chicago, IL, USA). Sample means and their standard errors were used to describe every item listed on the evaluation form.

Table 1. Criteria for the standard of the examined root canal treatment.

Variable	Criteria	Definition
Length of root canal filling	Acceptable	Root filling end 0-2 of radiographic apex
	Overfilled	Root filling ending beyond the apex
	Underfilled	Root filling ending > 2 mm short of radiographic apex
Density of root filling	Acceptable	Uniform density of root filling without voids
	Poor	No uniform density of root filling with clear space is visible
Taper of root filling	Acceptable	Consistent taper from the coronal to the apical part
	Poor	No consistence taper from coronal to apical part

The chi-square test of independence was used to compare obturation quality of root filling in term of length, density and taper in relation to canal preparation technique. Because of the low relative frequencies Fisher's exact test was alternatively used. A P-value <0,05 was considered statistically significant.

Results

A sample of 74 patients, 20 females and 54 males, aged 56,5 on average, was included in the study, for a total number of 114 teeth and 204 canals, with the predominance of maxillary teeth (56,86%). According

to the tooth type, more than half of the canals (56,86%) belonged to molars teeth, while canals of anteriors and premolars were respectively 42 (20,59%) and 46 (22,55%). Only 18,6% of the canals treated were considered curved.

Tables 2 and 3 show relative and percentage frequencies for length, density and taper according to canal curvature and position (anterior, premolars, molars). No relation was established between tooth position (anterior/posterior) and the involved parameters ($P > 0,05$). Similarly, the shape of the canals did not show any relation with the adequacy of length, density and taper of the root fillings ($P > 0,05$).

Table 4 shows the length, density and tapering of the

Table 2. Length, density and taper of canal filling in relation to canal curvature.

Root canal	Total	Length			Density		Taper	
		acceptable	overfilled	underfilled	acceptable	poor	acceptable	poor
Straight	166 (81,37%)	125 (75,30%)	19 (11,45%)	22 (13,25%)	138 (83,13%)	28 (16,87%)	152 (91,57%)	14 (8,43%)
Curved	38 (18,63%)	29 (76,32%)	5 (13,16%)	4 (10,53%)	31 (81,58%)	7 (18,42%)	33 (86,84%)	5 (13,16%)
Total	204 (100%)	154 (75,49%)	24 (11,76%)	26 (12,75%)	169 (82,84%)	35 (17,16%)	185 (90,69%)	19 (9,31%)

Table 3. Length, density and taper of canal filling in relation to teeth position.

Root canal	Total	Length			Density		Taper	
		acceptable	overfilled	underfilled	acceptable	poor	acceptable	poor
Anterior	42 (20,59%)	27 (64,29%)	10 (23,81%)	5 (11,90%)	38 (90,48%)	4 (9,52%)	39 (92,86%)	3 (7,14%)
Premolar	46 (22,55%)	35 (76,09%)	4 (8,70%)	7 (15,22%)	38 (82,61%)	8 (17,39%)	44 (95,65%)	2 (4,35%)
Molar	116 (56,86%)	92 (79,31%)	10 (8,62%)	14 (12,07%)	93 (80,17%)	23 (19,83%)	102 (87,93%)	14 (12,07%)
Total	204 (100%)	154 (75,49%)	24 (11,76%)	26 (2,75%)	169 (82,84%)	35 (17,16%)	185 (90,69%)	19 (9,31%)

Table 4. Length, density and taper of canal filling in relation to the teeth location.

Root canal	Total	Length			Density		Taper	
		acceptable	overfilled	underfilled	acceptable	poor	acceptable	poor
Maxillary	116 (56,86%)	96 (82,76%)	14 (12,07%)	6 (5,17%)	94 (81,03%)	22 (18,97%)	105 (90,52%)	11 (9,48%)
Mandibular	88 (43,14%)	58 (65,91%)	12 (13,64%)	18 (20,45%)	75 (85,23%)	13 (14,77%)	80 (90,91%)	8 (9,09%)
Total	204 (100%)	154 (75,49%)	24 (11,76%)	26 (12,75%)	169 (82,84%)	35 (17,16%)	185 (90,69%)	19 (9,31%)

Figure 1. Length of the root canal filling in relation to the arch.

root canal filling in the maxilla or mandible; tests of independence between the root canal location and adequacy of the canal filling length showed that tooth location is related to length adequacy. There were significantly more mandibular canals (20,45%) with short fillings compared to maxillary canals (5,17%) ($P < 0,05$) (Fig. 1).

Considering the overall adequacy, adequate density was found in 82,84% of the cases, and adequate taper in 90,69% of the cases.

A good quality root canal filling (defined as adequate length, density and taper) was found in 60,8% (124 canals) of all evaluated teeth (Fig. 2).

Discussion

This study aimed to evaluate the quality of root canal treatment carried out by postgraduate students with a new rotary single-file system (F6 SkyTaper Komet) at the School of Dentistry, Faculty of Medicine, University of Pavia. Periapical radiographs were used for assessment. The quality of root canal obturation was evaluat-

Figure 2. Overall quality of root canal treatment.

ed according to the criteria of Barrieshi-Nusai et al. (15). To increase the objectivity of the study, two different examiners evaluated the periapical radiographs. Quality of root canal treatment has been investigated in many countries and often resulted to be inadequate. In this study the density resulted to be adequate in 82,84% of the cases, more than the study of Khabbaz (33,5%) (5) and Moradi (34,1%) (16) and also the taper, acceptable in 90,69%, of the cases, is better than other studies such as Rafeek (72,2%) (17) and Barrieshi (85,3%) (15), showing that the Ni-Ti files and the new system perform well even when used by recently graduated students without great experience.

It was observed that the mandibular molars had a higher percentage of short fillings, similar to the results of the studies of Khabbaz (5), Vukadinov (4) and Barrieshi (15). This may be explained partly by the anatomy of such teeth, especially the presence of more than one canal in a root, and curvature of such roots, which makes root canal treatment more challenging (15), or because of difficulty in isolation (18). The results of the present study demonstrated adequate quality of root fillings in 60,78% of root canals, more than the study of Barrieshi (47,4%) (15), Khabbaz (33,5%) (5) and Elsayed (24%) (18) but lower than the frequency reported by Benenati (91,05%) (19) and Al-Yahya (20), even if it's difficult to make comparison between different studies.

Within the limitations of the presented study, it can be concluded that 60,78% of root canal fillings performed by postgraduate students resulted radiographically adequate, which is quite satisfactory and the new endodontic system F6 SkyTaper Komet is really effective.

Conflict of interest statement

The Authors of this study have no conflict of interest to disclose.

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