Frequency and Quality of Root Canal Fillings in an Adult Serbian Population

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SUMMARY

Introduction Estimation of frequency and quality of root canal fillings is the way to evaluate endodontic treatment needs and success/failure rates of performed endodontic procedures.

Objective The aim of this study was to determine the frequency and quality of root canal fillings and the frequency of apical periodontitis on endodontically treated teeth in a group of adult patients from Serbia.

Methods In order to analyze the presence and quality of root canal fillings and the frequency of periapical radiolucencies on endodontically treated teeth, 3526 teeth were examined on orthopantomograms of 153 adult patients.

Results Overall, 12.5% of examined teeth were root filled, and 51.8% of them had radiographic signs of apical periodontitis. The analysis of root fillings quality revealed the presence of more inadequate ones (55.9%). The frequency of apical periodontitis was significantly higher in teeth with inadequate than in those having adequate root canal obturation (72.2% and 25.9%, respectively).

Conclusion The frequency of apical periodontitis on root-filled teeth in this group of patients was high, indicating a low success rate of performed endodotic procedures and high endodontic retreatment needs.

Keywords: apical periodontitis; orthopantomography; root canal filling quality

INTRODUCTION

The success rate of root canal treatment is a public health problem that has significant medical and economic repercussions. Various studies revealed that the prevalence of endodontic treatment ranged from 22% to 72% and the majority of apical periodontal lesions seem to be located in previously root-filled teeth [1]. The goal of endodontic treatment is either to prevent apical periodontitis (AP) or to create conditions for its resolution [2]. Accordingly, the persistence of AP in endodontically treated tooth after a certain period may be considered as the sign of root canal treatment failure. Therefore, the estimation of AP frequency can be the way to evaluate endodontic treatment needs and success/failure rates of performed procedures. Detection of disease frequency is the objective of descriptive epidemiological investigations that are most commonly designed as cross-sectional studies [1]. Descriptive approach with a cross-sectional study design is also widely used in the studies of the quality and success of endodontic treatment. Findings of these studies may be very useful in dental care planning as well as in evaluation and planning of dental education [3].

The results of numerous controlled clinical studies have shown that the success rates of endododontic procedures can be very high, even more than 90% [1]. On the other hand, epidemiological studies have documented a substantially lower success rate in the general population which is in range of 35% to 80% [4-12]. Strong correlation has been found in all of these trials between the root canal filling quality and prevalence of AP in endodontically treated teeth. All of epidemiologically based investigations reported considerable percentage of poor root fillings in examined populations [13].

OBJECTIVE

Data on the frequency and quality of performed root canal treatments are rare in Serbia. Considering the fact that these findings may be useful for the evaluation of performed endodontic treatments as well as for dental care planning and the lack of such information, the aim of this study was to investigate the frequency and quality of root canal obturations and their association with periapical radiolucencies in a group of adult patients from Serbia.

METHODS

Study population

The sample in this cross-sectional study was formed of adult patients (older than 18 years), who attended the Clinic for Restorative Odontology and Endodontics of the School of Dental Medicine, University of Belgrade for routine dental care. All patients included in this sample were with an indication for panoramic radiography as a part of the routine examination and treatment planning. Individuals with less than

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seven remaining teeth as well as those who had undergone root canal treatment in less than one year from the beginning of the study were excluded. The Ethical Board of the School of Dental Medicine, University of Belgrade approved the study and the patients gave written informed consent. Radiographs were taken by experienced radiology assistants using a Siemens Palomex Ortoceph 10 (Siemens, Germany). Films were processed in a Kodak M-35 X-OMAT (Kodak dental, Stuttgart, Germany). Only radiographs with readable quality were included for analysis. This resulted in 153 orthopantomograms (OPGs) to be examined.

Data collection

The patients' details were collected in an individually structured form specially designed for this investigation. The form consisted of a part with general and a part considering teeth information. The general information referred to the patients' gender and age. Five age groups were formed (a: 18-29, b: 30-39, c: 40-49, d: 50-59 and e: over 60 years). The distribution of the sample according to the patients' age and gender is shown in Table 1. Teeth information were gathered by radiographic analysis and referred to the total number of remaining teeth as well as the quality of root canal fillings and evaluation of periapical region on endodontically treated teeth.

Table 1. Distribution of patients according to age and gender

Age group (years)	Number of patients (%)		
	Female	Male	Total
18–29	20 (13.1)	11 (7.2)	31 (20.3)
30–39	20 (13.1)	9 (5.9)	29 (19.0)
40–49	21 (13.7)	21 (13.7)	42 (27.4)
50–59	16 (10.5)	12 (7.8)	28 (18.3)
≥60	12 (7.8)	11 (7.2)	23 (15.0)
Total	89 (58.2)	64 (41.8)	153 (100.0)

Table 2. Average number of remained teeth according to patients' age and gender

Age group (years)	Mean±SD (%)		
	Female	Male	Total
18–29	29.6±3.1	28.4±1.8	29.2±2.8
30–39	27.5±3.4	26.7±3.6	27.2±3.5
40–49	23.1±3.5	23.4±4.9	23.3±4.2
50–59	19.9±4.8	22.6±5.8	21.1±5.4
≥60	17.4±4.3	20.6±4.5	19.1±4.7
Total	25.1±5.5	24.5±5.1	24.8±5.4

Table 3. Distribution of observed parameters by tooth group

Teeth group	Number of teeth (%)		
	Teeth examined	Root-filled teeth	Root-filled teeth with AP
Upper frontals	835 (23.7)	137 (31.3)	61 (26.9)
Lower frontals	874 (24.8)	17 (3.9)	11 (4.8)
Upper premolars	406 (11.5)	91 (20.8)	51 (22.5)
Lower premolars	486 (13.8)	68 (15.5)	38 (16.7)
Upper molars	479 (13.6)	62 (14.2)	31 (13.7)
Lower molars	446 (12.6)	63 (14.4)	35 (15.4)
Total	3526 (100.0)	438 (100.0)	227 (100.0)

Radiographic evaluation

Teeth were categorized as endodontically treated if a radiopaque material was detected in the pulp chamber and/or root canal(s). Root fillings were either classified as adequate or inadequate on the basis of guidelines published by the European Society of Endodontology (ESE) [14]. Canal fillings ending within 2 mm from the radiographic apex and with no visible voids were classified as adequate. Underfilled, overfilled or poorly condensed root fillings, as well as those limited to the pulp chamber (pulpotomy), were classified as inadequate. The periapical health was assessed using the periapical (PAI) index [15]. Scores 1 and 2 were considered as healthy periapical structures, whilst PAI scores 3, 4 and 5 as signs of present AP. Multirooted teeth were classified according to the root with the most severe score.

The radiographs were analyzed by a calibrated examiner in a dark room using an illuminated viewer box and magnification (2×). The kit of 100 reference radiographs and "gold standard" observations [15] were used to calibrate the examiner for the use of the index PAI. Intraobserver reproducibility was evaluated by the PAI scoring of periapical radiolucencies in 20 OPGs, not included in the study, at the beginning and at the end of the survey. Calculated Cohen's Kappa value (0.83) expressed a high value of intraobserver agreement.

Statistical analysis

The methods of descriptive statistics used were frequencies, percentages, mean value, standard deviation (SD) and range. The significance of revealed differences between observed parameters was analyzed using the t test. The distribution of endodontically treated teeth between genders was compared by the Chi-square and Kolmogorov-Smirnov tests. P values of less than 0.05 were considered statistically significant.

RESULTS

A total of 3526 teeth were examined. The average number of teeth per patient in this sample was 24.8 with the range from 7 to 33 (in one female patient a retromolar was identified). The mean values of remained teeth were significantly higher in age groups 18-29 and 30-39 years, both in female and male patients ($p<0.05$) (Table 2). The upper and lower frontals were most commonly retained teeth (23.7% and 24.8%, respectively; $p<0.05$) (Table 3).

Endodontic treatment was detected in 438 teeth (12.5% of sample). There were 130 patients with at least one endodontically treated tooth (range 1-21), meaning that the prevalence of subjects with root canal treatment was 85%. No significant difference was detected in the age distribution of endodontically treated teeth between males and females ($p>0.05$), with the highest frequency in the age group 40-49 years for both genders ($p<0.05$) (Table 4). In

Table 4. Distribution of root canal treatment frequency according to patients' age and gender

Age group (years)	Root canal treatment frequency (%)		
	Female	Male	Total
18–29	33 (7.5)	29 (6.6)	52 (14.2)
30–39	60 (13.7)	21 (4.8)	81 (18.5)
40–49	83 (18.9)	69 (15.8)	152 (34.7)
50–59	58 (13.2)	32 (7.3)	90 (20.5)
≥60	29 (6.6)	24 (5.5)	53 (12.1)
Total	263 (60.0)	175 (40.0)	438 (100.0)

Table 5. Distribution of inadequate fillings in the sample

Inadequate root filling type	Number (%)
Short, homogeneous	127 (51.8)
Short, inhomogeneous	54 (22.1)
Correct length, inhomogeneous	15 (6.1)
Overfilling, homogeneous	26 (10.6)
Overfilling, inhomogeneous	3 (1.2)
Pulpotomy	20 (8.2)
Total	245 (100.0)

Table 6. Distribution of periapical index (PAI) scores in apical periodontitis affected endodontically treated teeth

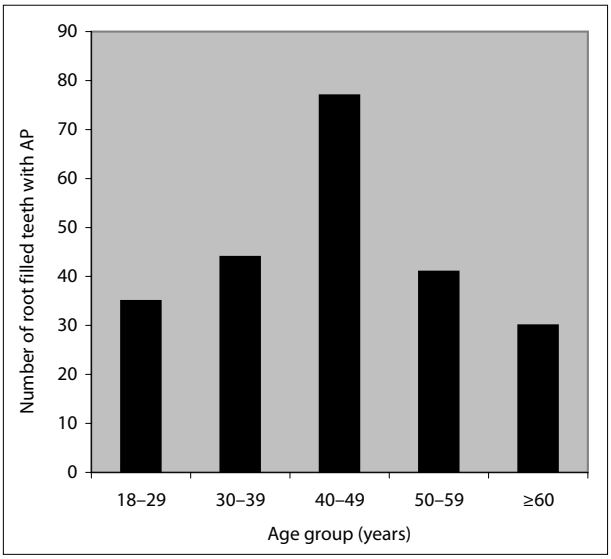
PAI score of radiolucency	Number (%)
PAI 3	152 (67.0)
PAI 4	53 (23.3)
PAI 5	22 (9.7)
Total	227 (100.0)

the group of endodontically treated teeth the upper frontals were most frequent (31.3%). Analysis of root fillings quality revealed a high level of inadequate ones (55.9%). The distribution of different types of inadequate root fillings is shown in Table 5.

AP was detected in 227 endodontically treated teeth (51.8% of treated teeth). Considering the subjects with root-filled teeth, it was found that 122 (93.8%) had AP affecting at least one treated tooth. The frequency of AP was significantly higher ($p<0.05$) in teeth with inadequate (72.2%) than in those having adequate root canal obturation (25.9%). The highest frequency of root-filled teeth with AP was in the age group 40-49 years ($p<0.05$) (Graph 1). The upper frontals were the most frequent AP affected root-filled teeth ($p<0.05$) (Table 3).The analysis of the distribution of PAI scores in endodontically treated teeth with AP (Table 6) revealed that a PAI score of 3 was statistically most frequent (67%, $p<0.05$).

DISCUSSION

This research was designed as cross-sectional, using and modifying the protocols of similar investigations [4, 5, 8, 16]. It is well known that this type of studies provide a static view of observed processes [1] and therefore it is not possible to determine whether the periapical lesion is healing or expanding. It has been shown that such a study design can be used in endodontic studies despite limitations. Namely, Peterson et al. [17] found in their ten-year



Graph 1. Distribution of apical periodontitis (AP) affected root-filled teeth according to patients' age and gender

longitudinal study on endodontic treatment success that the number of newly formed periapical lesions was comparable to the number of healed ones and concluded that cross-sectional studies gave valid results on the frequency of AP within given populations.

Panoramic radiographs were used to analyze observed parameters. OPGs are often used in the studies of quality and success of endodontic treatment for their convenience: all teeth can be seen on single radiography; radiation dose is reduced compared to the full mouth periapical radiograph survey and the speed at which OPGs can be exposed and processed is high [4, 5, 8, 18]. The accuracy of OPGs in the detection of AP was investigated by Ahlqwist et al. [19] and they reported agreement of 76% and 90% for single and multirooted teeth, respectively, when comparing panoramic with full mouth periapical radiographs. Muhammed and Manson-Hing [20] found no statistically significant difference between OPGs and periapical radiographs in the detection of AP. Therefore, the panoramic radiograph could be considered as acceptable diagnostic tool for the detection of periapical lesions. It is noteworthy that a study of Grondahl et al. [21] showed that interobserver variability was greater when analyzing OPGs than periapical radiographs. This kind of variability was avoided in our study by involvement of one investigator in the analysis of all radiographs. Moreover, intraobserver agreement at the beginning and at the end of the survey was very high.

The sample consisted of more female than male patients. This may be the reflection of some of population's sociologic aspects, such as females being more healthcare conscious than males. Other studies in this field found a similar gender proportion [5, 12, 22-25].

Criteria for AP evaluation vary among studies [4-12, 16, 18, 22-29]. Similarly to a vast number of other researches in this field [4, 12, 16, 23, 29], including very recent studies of López-López et al. [30] and Castellanos-Cosano et al. [31], the PAI system was used in our study as well, and scores 3-5 were considered as evidence of AP. The PAI system has been introduced by Ørstavik et al. [15] to

provide criteria that are measurable, mutually exclusive, meaningful and reproducible. This also allows for a more appropriate results comparison among different studies.

The mean number of teeth per patient in this study is the closest to the findings of cross-sectional studies performed on adults from South European countries: Portugal, Marques et al. [4] –24.8; Spain, Jiménez-Pinzón et al. [12] – 24.7 and López-López et al. [30] – 23.6; and Greece, Georgopoulou et al. [22] – 25. This may be the result of similar social and cultural aspects in the Southern European countries. Our findings of the distribution of remaining teeth with the most frequent remain of frontals are also in agreement with other studies [12, 26]. This result may be explained by patients' stronger motivation to preserve frontal teeth for esthetic reasons.

The total percentage of root-filled teeth in our study is in range of other studies – from 1.5% reported by Marques et al. [4] to 21% in the study of Tsuneishi et al. [23]. However, the prevalence of subjects with root-filled teeth in our study is higher than reported in almost all other studies where this parameter was in range from 22% to 87% [1, 23]. This wide range in different surveys may be the consequence of variations in the sample formation, but also the effect of different healthcare services and insurance systems in various countries. Gender had no influence on the frequency and distribution of endodontic treatment in our study, and this is in agreement with other studies. We found that endodontic treatment was most frequent in the age group 40-49 years. This can be explained with fact that endodontic treatment needs in younger patients are low, and in elderly there are fewer teeth remained with a consecutively lower frequency of root-filled teeth. The upper frontals are most frequently treated teeth in our survey, and that is in correlation with the fact that they were with the highest tendency to be preserved. The distribution of endodontic treatment according to the tooth type was not analyzed in many similar studies. Where available, these findings are very diverse. In the study of de Moor et al. [8], same as in our survey, the upper frontals were found to be most frequently treated teeth.

Quality of root canal fillings are claimed to be one of the most important factors for the endodontic treatment success. In our study, same as in almost all other comparable studies, fillings were scored as adequate if they were homogenous and ended between 0 and 2 mm from the radiological apex. These criteria are based on the Consensus report of the European Society of Endodontology on quality guidelines for endodontic treatment [14]. The quality of root canal fillings with more than half of inadequate was a disappointing finding in our survey, but within the range of most other published studies [8, 9, 11, 18]. Our findings are closest to those obtained by de Moor et al. (59.3%.) [8] The majority of inadequate root canal fillings were short obturations, either homogenous or inhomogeneous, and this is in agreement with most similar studies [8, 23, 28, 29].

The frequency of AP in root-filled teeth (51.8%) is consistent with the results reported in previous methodologically comparable studies conducted on university patients and using the PAI index, where the frequency of AP was in range from 21.4%, reported by Da Silva et al. [29] to 65% detected by Jiménez-Pinzón et al. [12]. Moreover, we found that 93.8% of subjects with root-filled teeth had AP affecting at least one treated tooth. Thus, the present study supported the well-documented conclusion that the realistic outcome of endodontic treatment in the population was considerably poorer than the potential outcome demonstrated in controlled clinical studies [1]. These findings indicated that AP was very prevalent in this group of patients and that conducted endodontic treatment did not control the disease. The results also indicated relatively large retreatment needs in the examined group.

Root filling quality significantly influenced AP commencing considering that the frequency of AP in teeth with inadequate root filling was 72.2%. High frequency of AP in teeth with inadequate root canal fillings has been reported in a very recent study of Sang et al. [32]. These findings are also in agreement with observations in several previous studies [4, 7, 16]. Almost 26% of teeth having adequate root fillings were associated with AP in our study indicating that periapical health of endodontically treated teeth was influenced by factors other than just the quality of root fillings.

We found that the most frequent PAI score of root-filled teeth associated with AP was 3. The same as in our study, Kirkevang et al. [3] and Da Silva et al. [29] also found that the score of 3 was most frequently given in connection with endodontically treated teeth. These results are also in agreement with histological findings of Brynolf [33] in a classic study on teeth periapical region which gave fundamentals for introducing of PAI index.

CONCLUSION

The frequency of AP in endodotically treated teeth of this patient group was high and inadequate root fillings had a significant influence on it. These findings demonstrated a low standard of performed endodontic procedures and the consequent low success rate. The study indicated that the endodontic retreatment needs of this group of patients were great.

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Учесталост и квалитет пуњења канала корена зуба код одраслих особа у Србији

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КРАТАК САДРЖАЈ

Увод Утврђивање учесталости и квалитета пуњења канала зуба јесте начин да се процене потребе за ендодонтским лечењем и степен успеха примењених ендодонтских процедура.

Циљ рада Циљ овог рада је био да се одреде учесталост и квалитет пуњења канала корена зуба, као и учесталост апексних пародонтитиса ендодонтски лечених зуба код одраслих пацијената у Србији.

Методе рада Ради утврђивања постојања и квалитета пуњења канала корена и учесталости расветљења у периапексу ендодонтски лечених зуба, анализирано је 3.526 зуба на ортопантомограмима 153 одрасле особе.

Резултати Укупно је ендодонтски лечено 12,5% прегледаних зуба, од којих је 51,8% имало радиографске знаке апексних пародонтитиса. Анализа квалитета пуњења канала показала је да је било више неадекватних пуњења (55,9%). Учесталост апексних пародонтитиса је била значајно већа код зуба с неодговарајућим каналним оптурацијама (72,2%) у односу на оне с одговарајућим пуњењем канала корена (25,9%).

Закључак Код испитаних пацијената утврђена је висока учесталост апексних пародонтитиса зуба с пуњеним каналима корена, што указује на слабу успешност примењених ендодонтских захвата, као и на потребу за поновљеним ендодонтским лечењем.

Кључне речи: апексни пародонтитис; ортопантомографија; квалитет пуњења канала корена

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