

# Evaluation of the Quality of Endodontic Treatment among A sample of Jordanian Population. A Radiographic Study

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## ABSTRACT

**Objectives:** To evaluate the quality of root canal treatment using radiographic examination in a sample of Jordanian population

**Methods:** The study sample consisted of randomly selected patients referred to endodontic clinics, at Al-Hussien hospital. Clinical and radiographical (Orthopantomographs) examinations were performed to evaluate 139 patients. The periapical status of all teeth was examined. The quality of the root canal filling was rated as 'adequate' or 'inadequate'. Endodontically treated (with or without periapical radiolucency), existed, filled teeth (with or without root canal treatment) were recorded. The quality of endodontic treatment was correlated to age and gender, and its association with periapical radiolucency and tooth restoration was determined. Data were analyzed statistically using the Chi-square test and t-test. The quality of endodontic treatment was assessed using odd ratios in the chi square test in terms of adequacy in association with existed or absence of periapical radiolucency. Level of significance was set at 0.05.

**Results:** Out of 3433 examined teeth, 8.3% were endodontically treated. Periapical radiolucency was associated with 11.9% of teeth, of these 4.7% were related to endodontically treated teeth and 36.2% of filled teeth were endodontically treated. Females had significant more existed teeth ( $p < 0.05$ ) and more periapical radiolucency associated with non-endodontically treated teeth ( $p < 0.01$ ), however, males significantly had more periapical radiolucency with root canal treatment ( $p < 0.05$ ). The prevalence of endodontically treated teeth increased with age, and it is significant in patients aged 40 years or more. The prevalence of periapical radiolucency increased with age. However, it was only significant in non-endodontically treated teeth ( $p < 0.05$ ), in patients aged 50 years and above. Significantly more endodontically treated teeth and periapical radiolucency in the maxilla than in the mandible ( $P < 0.05$ ). Adequate endodontic treatment with periapical radiolucency was 30.1%, whereas inadequate root filling and periapical radiolucency was 69.9%. Approximately, 62% of endodontic treatment was significantly unsatisfactory ( $p = 0.001$ ).

**Conclusions:** 8.3% of examined teeth were endodontically-treated, of these, 40% were associated with periapical radiolucency. Only 48.8% of endodontic treatments were adequate and not associated with periapical radiolucency, however, 62% were unsatisfactory.

**Key words:** Endodontic treatment, Jordan, orthopantomogram, periapical radiolucency, prevalence, root canal filling.

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### Introduction

The success rate of root canal treatment is a

economic, and ethical repercussions.<sup>(1)</sup> The biological and therapeutic aim of endodontic

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public health problem that has medical,

treatment is either to prevent apical

periodontitis or to create optimal conditions for healing,<sup>(2)</sup> based on the removal of infection and elimination of bacteria from the root canal system and prevention of re-infection.<sup>(3)</sup>

Therefore, in order to evaluate the endodontic status, numerous studies have focused on the prevalence and quality of root canal treatment.<sup>(4-14)</sup> Several reports indicated that the prevalence of root canal treatment varies from 2.1% to 23.4%<sup>(15-21)</sup> and increases with age<sup>(22-23)</sup> and the prevalence of apical periodontitis varies from 1.6% to 27.0%<sup>(1,4,5,7-10,15-18,20,22-26)</sup>

Radiology is especially important for diagnosis in the detection of periapical lesions, and to assess treatment success including post-treatment healing.<sup>(1,4,5,7,9)</sup> The interpretation of radiographs is the only method that can be used to evaluate periapical health in an epidemiologic study.<sup>(10,17,20,27-28)</sup>

Several epidemiological studies have evaluated the periapical status of teeth in various population groups through the evaluation of intraoral or panoramic radiographs.<sup>(6,15,29)</sup>

They also show that when these root canal treatments are evaluated radiographically, they are judged to be insufficient, in a large proportion of cases<sup>(4-6,11,13,15,20,23,30)</sup> that the frequency of teeth containing poor quality endodontic treatments is high.<sup>(7,9,10,17,19, 31)</sup> In addition, 25 to 87% of the cases were associated with radiographic signs of periapical lesions.<sup>(5-9, 16-17, 19-20)</sup>

In some epidemiological studies, it has been concluded that poor quality of endodontic treatment was found to be associated with apical periodontitis,<sup>(2,4)</sup> which is commonly observed in root-filled teeth. Studies which attempt to evaluate the quality of root canal treatment in Jordan are rare and to the authors' knowledge there is only one study investigated the prevalence and distribution of apical periodontitis and endodontic treatment in a Jordanian subpopulation.<sup>(20)</sup> They indicated a high prevalence of periapical lesions associated with very poor root canal treatment.

The null hypothesis of the study was that the quality and adequacy of endodontic treatment is not related to apical radiolucency. Therefore this study was conducted to

evaluate and assess the quality of root canal treatment using radiographic examination in a sample of Jordanian population.

## Methods

**Participants:** The present research project was approved by The Human Research Ethics Committee, the Royal Medical Services (No 2/216).

A total of 139 (60 male and 79 female) patients were included in this cross-sectional study. All participants were selected from patients who attended and/or referred to two endodontic clinics at the Department of Dentistry, King Hussien Medical Center, Royal Medical Services, Amman, Jordan; over one month period (January 2016) for endodontic/restorative dental procedures. Root canal treatments evaluated in this study were performed by general dental practitioners and specialists in both private clinics and public health centers in Jordan.

The data were obtained by filling a form to provide information concerning their demographic data (including age, gender, and insurance number). Informed verbal consent was obtained from all patients who were included in the study. They were also required to accept the clinical and undergo radiographical examinations.

### **Clinical and radiographic examination:**

Intra-oral clinical dental examination was performed on the dental chair; existing, missing and filled teeth were recorded (with the exception of third molars) and cross-marked on the examination sheet.

For each participant, a digital orthopantomogram (OPG) was taken using Orthophos XG Plus (Model: 5884999d3352, SN: 03024, Sirona, Siemens, Germany). All OPGs were performed by one trained dental radiographic technician in the department. The exposure parameters 64 kV and 8 mA were selected and the mean resolution of the original OPGs was 1744x3158 pixels. All digital OPGs were viewed digitally using Sidexis next Generation software (Version 1.52; Sirona, Siemens, Germany), on Dell Inspiron (N 5010, China) personal computer. Endodontically treated teeth were recorded and the root canal treatment (RCT) evaluated,

those with periapical radiolucency whether they were root canal treated or not and those with extra coronal restoration were also recorded.

#### ***Inclusion/exclusion criteria:***

Patients less than 18 years of age and/or with less than 8 standing teeth (including third molars) were excluded. Also excluded were any OPGs that were damaged in any way or were of poor quality (i.e. poor coverage of the periapical region, radiolucent artifacts in the anterior region, marked changes in radiographic density and images suggestive of unrelated periodontal/ endodontic disease and/or post-endodontic surgical lesions). After applying the exclusion criteria, 139 OPGs were included in the study. Following sample collection, radiographs were distributed by gender and age group.

#### ***Assessment of apical periodontitis***

Teeth were categorized as endodontically treated if they had been obturated with a radio-opaque material in the pulp chamber and/or in one or more of the root canals. Radiographs were assessed for the presence or absence of periapical radiolucency using the method of De Moor *et al.*<sup>(15)</sup>

Periapical radiolucency was judged present in teeth in which the apical part of the periodontal space appeared radiolucent and/or was associated with the apical portion of the root. Apical status was assessed using the peri-apical index (PAI) score, in which 2 scores were attributed to the apical area of the radiographic images, as follows: 1) normal periapical structures; 2) periodontitis with well-defined radiolucent area. For multirooted teeth, any root with periapical radiolucency was recorded as a tooth with inadequate root canal treatment.

#### ***Assessment of endodontic treatment of teeth***

The criteria used for evaluation of the quality of the root filling were modified slightly from those described by Tavares *et al.*<sup>(19)</sup>, as follows:

1. Adequate: all canals obturated, no voids present, root canal fillings terminate 0-2 mm short of the radiographic apex.
2. Inadequate: root canal fillings end > 2mm short of the radiographic apex or are grossly overfilled (i.e. extrusion of filling material through apex), root canal fillings with voids,

inadequate density, unfilled canals, and/or poor compaction.

#### ***Methods error:***

Reliability of examiners was assessed by examining internal consistency and reproducibility. Clinical examinations and radiographic evaluation were performed by two independent endodontists' examiners (72 subjects from one endodontist and 67 from another endodontist) who used the same evaluation criteria. Inter-examiner variability and bias in evaluation were assessed by re-examining 14 (10.1%) randomly selected subjects by each examiner. Cronbach's test and Student's t-test were performed for inter-examiner reliability evaluation.

#### ***Statistical analysis***

Statistical analysis of data was performed using the statistical package for social science (SPSS, version 17.0) software, (SPSS Corporation, Chicago, IL, USA). Descriptive statistics were used to calculate the mean, standard deviation, total number and percentages of the variants (patients' age, existed, quality of endodontically treated teeth, periapical radiolucency and filled teeth). Paired samples t-test analyses performed to record gender differences in the mean number of existed teeth and age. The Chi square test was used to determine the significance of percentage differences by sex, age, dental arch (maxillary/mandibular). The quality of endodontic treatment was assessed using odd ratios in the chi square test in terms of adequacy in association with existed or absence of periapical radiolucency. Level of significance was set at 0.05.

## **Results**

Cronbach's internal consistency coefficient was 0.768. Paired t-test revealed no statistically significant deviation between the examiners' evaluation at a 5% significance level (mean difference 2.24±0.67; p = 0.726). As there was strong Cronbach's coefficient and small mean difference between the two examiners, it was assumed that the other data collected from clinical examinations and radiographical evaluations would be reliable. A total of 139 (60 males and 79 females) patients were included, the mean age was

40.0±13.5 years (ranged between 18 and 79 years). The distribution of female and male subjects in relation to different age group is shown in Table I.

The total number of existed teeth in the whole sample was 3433 (mean=24.7±4.2, ranged between 8 and 28) tooth. The total number of endodontically treated teeth was 286 (8.3 %), with the mean of 3.04±2.21. Of these, only 109 (38.1%) were found with adequate root canal filling (mean±SD was 2.10±1.32), which represent 3.1% of endodontically treated teeth. On the other hand, there were 177 (61.9%) with inadequate root canal (mean±SD was 2.13±1.69). There were 408 (11.9%) tooth with periapical radiolucency, of these 163 (40.0%) were associated with teeth with RCT (mean±SD was 1.94±1.14). In addition, the total number of filled teeth was 795 (23.2%) with mean±SD value of 6.46±4.27; of these, 288 (36.2%) were endodontically treated (mean±SD was 3.10±2.23).

Paired samples t-test analyses performed to record any statistical gender differences in the mean number of existed teeth and age revealed no significant difference (p=0.537; t-test) in the mean number of teeth present between males (24.8±4.41) and females (24.6±4.13). Although male patients were slightly younger (39.9±12.1 years) compared with females (40.0±14.5 years), but the difference was not significant (p=0.951; t-test).

Table II shows differences between gender and among age group in number (%) of endodontically-treated teeth, those with periapical radiolucency and those with coronal restoration. Chi square analysis recorded statistically significant gender differences in the total number of existed teeth. Females had significant (p<0.05) more existed teeth compared with males (1945 (56.7%) and 1488 (43.3%); respectively. Insignificantly, the prevalences of endodontically treated and filled teeth were higher in males than in females (p>0.05). The

overall prevalence of periapical radiolucency in the examined teeth (408) was 11.9%, of these, 40% were endodontically treated. Statistically significant gender differences were recorded for teeth with periapical radiolucency. Males significantly recorded more periapical radiolucency with their root canal filled teeth compared with females, however, females had more non-endodontically treated teeth with periapical radiolucency (p<0.01). The prevalence of endodontically treated teeth increased with age, and it is significant in patients aged 40 years or more. The prevalence of periapical radiolucency increased with age. However, it was only significant in non-endodontically treated teeth (p<0.05), in patients aged 50 years and above.

The difference in the prevalence of endodontic treatment and periapical radiolucency was significantly different between maxillary and mandibular teeth. There were significantly more endodontically treated teeth and more teeth with periapical radiolucency in the maxilla than in the mandible (P < 0.05). However, the differences between those endodontically treated with “adequate” and “inadequate” RCT were not significant. In addition, periapical radiolucency was significantly more frequently associated with endodontically treated teeth in the mandible than in the maxilla and with untreated teeth in the maxilla than in the mandible (P<0.05) (Table III).

The relationship between the quality of endodontic treatment and periapical radiolucency is presented in Table IV. The percentage of adequately-filled teeth with periapical radiolucency was 30.1%, whereas the percentage of teeth with inadequate root filling and periapical radiolucency was 69.9%. Successful endodontic treatment is indicated by root canal filling adequacy. Approximately, 62% of root canal treatment was significantly failure (p=0.001; Odds ratio: 16.40; CI: 2.06-12.38).

**Table I:** Distribution of patients according to gender and age group.

Age group	Male	Female	Total (%)
< 20	1	4	5 (3.6)
20-29	12	20	32 (23.0)
30-39	18	14	32 (23.0)
40-49	20	22	42 (30.2)
50-59	4	11	15 (10.8)
60-69	4	5	9 (6.5)
70-79	1	3	4 (2.9)
Total (%)	60 (43.2%)	79 (56.8%)	139 (100)

**Table II:** Gender and age group differences in number (%) of endodontically-treated teeth, those with periapical radiolucency and those with coronal restoration (chi square test).

Gender	All teeth n ‡ (%)	RCT **teeth (%)	Non-RCT/ PAR † (%)	RCT/PAR (%)	Teeth with restoration	RCT / restoration
Male	1488 (43.3)	140 (9.4)	99 (6.7)	78 (5.2)	354 (23.8)	140 (39.5)
Female	1945 (56.7)	146 (7.5)	146 (7.5)	85 (4.4)	441 (22.7)	146 (33.1)
Total	3433	286 (8.3)	245 (7.1)	163 (4.7)	795 (23.2)	286 (36.0)
Chi square	0.037 (*)	0.055 (NS)	0.0025 (**)	0.0064 (**)	0.087 (NS)	0.094 (NS)
Age group						
< 20	107 (3.1)	1 (0.93)	4 (3.7)	1 (0.93)	7 (6.5)	1 (0.93)
20-29	850 (24.8)	25 (2.9)	41 (4.8)	10 (1.8)	101 (11.9)	20 (2.4)
30-39	772 (22.5)	55 (7.1)	38 (4.9)	31 (4.0)	162 (21.0)	63 (8.2)
40-49	1007 (29.3)	116 (11.5) <sup>a</sup>	75 (7.4)	73 (7.2)	280 (27.8)	120 (11.9)
50-59	311 (9.1)	37 (11.9) <sup>a</sup>	37 (11.9) <sup>a</sup>	26 (8.4)	93(29.9)	41 (13.2)
60-69	178 (5.2)	22 (12.4) <sup>a</sup>	23 (12.9) <sup>a</sup>	10 (5.6)	68 (38.2) <sup>b</sup>	18 (10.1)
70-79	208 (6.0)	30 (14.2) <sup>a</sup>	27 (13.0) <sup>a</sup>	12 (5.8)	84(40.4) <sup>b</sup>	25 (12.0)
Total	3433	286 (8.3)	245 (7.1)	163 (4.7)	795 (23.2)	288 (8.4)
Chi square		0.037 (*)	0.048 (*)	0.53 (NS)	0.0072 (NS)	0.062 (NS)

‡n: number; \*\*RCT: root canal treatment, † PAR: periapical radiolucency.

NS: not significant; \* p<0.05 ; \*\* p<0.01, <sup>a</sup> and <sup>b</sup> denotes sig. category.

**Table III:** Distribution of number of endodontically-treated teeth according to root-canal filling quality and teeth with periapical radiolucency in root-canal treated and untreated.

Jaw	No. * (%) endodontically treated teeth			No. (%) of teeth with PAR †		
	All	Adequate RCT **	Inadequate RCT	All	RCT	No RCT
Maxilla	162 (56.6%)	62 (38.3%)	100 (61.7%)	239 (58.6%)	79 (33.1%)	160 (66.9%)
Mandible	124 (43.4%)	47 (37.9%)	77 (62.1%)	169 (41.4%)	84 (49.7%)	85 (50.3%)
Total	286 (100%)	109 (38.1%)	177 (61.9%)	408 (100%)	163 (40%)	245 (60%)
Chi square	0.027	0.758	0.974	0.016	0.047	0.046
Sig.	P < 0.05	NS ‡	NS	P < 0.05	P < 0.05	P < 0.05

\*No.: number; \*\*RCT: root canal treatment, †PAR: periapical radiolucency; ‡NS: not significant.

**Table IV:** Association of endodontic treatment quality with periapical radiolucency. (percentage for adequate RCT without periapical radiolucency / inadequate RCT with periapical radiolucency).

Root filled teeth	Periapical radiolucency *		Total (%)		P **
	Existed	Abscent	Successful	Failure	
Adequate	49 (30.1%)	60 (48.8%)	109 (38.1%)	177 (61.9%)	0.001
Inadequate	114 (69.9%)	63 (51.2%)			
Total	163 (57.0%)	123 (43.0%)	286 (100.0%)		

\*Confidential intervals (CI) refer to existed periapical radiolucency as reference category.

\*\*The P value denotes the significance level of chi-square test. (Odd ratios=16.40; CI: 2.06-12.38; p=0.001).

## Discussion

This study aimed to evaluate the quality of root canal treatment and to assess their association with periapical radiolucency detected in orthopantomographic examination

in a sample of Jordanian population, as it is impossible to evaluate the success of any endodontic treatment without considering the independent interpretation of diagnostic radiographical findings.

In order to evaluate the quality of root canal treatment, the subjects were stratified according to association of radiolucency, number of existed teeth, those with coronal restoration and those with endodontic treatment. The incorporation of these multi-variables against the clinical and radiographical findings used to evaluate their endodontic/periapical health status, with inclusion of age and gender factors, renders it more comprehensive and of valuable outcome.

The findings of this study demonstrate that 8.3% of teeth were endodontically treated, which is higher than reported in previous studies.<sup>(9,17,20,22)</sup> This finding could be explained by that the oral status of adults is unsatisfactory, due to insufficient oral hygiene leading to a large numbers of carious teeth, and/or inadequate quality of fixed dentures, and, the absence of programs for integrated prevention and control of dental caries could exacerbate these problems and lead to more advanced dental and periodontal problems. However, it is lower than other prevalences reported in some other studies.<sup>(4,7-8,16,21)</sup> This could be a consequence of the survey population being unrepresentative of the whole country and/or to differences in the socio-economic factors and the provision of dental care services in these various other countries. In contrast, our data are in agreement with a number of previous studies that found the prevalence of endodontically treated teeth to range between 6.8 and 10.0%.<sup>(11-12,15)</sup>

The results of this study showed that 40% of endodontically treated teeth were associated with periapical radiolucency, which is lower than that reported in Belarus (45%)<sup>(7)</sup> and Spain (64.5%)<sup>(6)</sup> but remain considerably higher than that reported in Portugal (22%),<sup>(4)</sup> Ireland (25%),<sup>(17)</sup> the United States (37.5%)<sup>(9)</sup> and France (31.5%).<sup>(5)</sup> The high rate of periapical radiolucency in endodontically treated teeth may be the result of inadequate endodontic treatment provided.

The results of this study showed that the frequency of endodontically treated teeth and periapical radiolucency increased with age, in addition, in non-endodontically treated teeth; the frequency of periapical radiolucency was

highest in the older groups above the age of 50 years. Other studies have also demonstrated that the periapical radiolucency increases with age.<sup>(22-23)</sup> Younger people tend to visit the dentist more often compared with the elderly, and thus have a lower incidence of caries and periodontal diseases.

This study demonstrated significant female dominance in the total number of existed teeth. These findings are in accordance with a previous study.<sup>(1)</sup> However, there was no significant association of gender with the frequency of either endodontically treated or filled teeth, these findings are in agreement with the findings of previous studies.<sup>(8,20,22,32-34)</sup> When stratified by whether the teeth are mandibular or maxillary, the study data regarding the frequency of periapical radiolucency and endodontically treated teeth are comparable with those of other studies.<sup>(1,8)</sup> These studies reported significantly more percentage of endodontically treated teeth and periapical radiolucency in the maxilla than the mandible. These findings are supported in previous studies.<sup>(7-8,22)</sup> However, periapical radiolucency associated with endodontically treated teeth was significantly more frequently in the mandible than in the maxilla.<sup>(5)</sup>

The existence of periapical radiolucency was influenced by the quality of the root filling. The measurement and categorization of the quality of the root filling differs among studies. Several studies used the periapical index (PAI) scoring system to evaluate root filling quality.<sup>(6,11,16,18,21)</sup> In this study, the criteria used for the evaluation of the quality of root filling were modified slightly from those described by Tavares *et al.*<sup>(19)</sup>

The results regarding the quality of endodontic treatment showed that only 38.1% of root fillings were found adequate. In the literature the prevalence of adequate endodontic treatments ranges between 18% and 87%.<sup>(2,4,6,8-9,11,13,16-19,23,26,31,35)</sup> Successful endodontic treatment is indicated by root canal filling adequacy. Approximately, 62% of root canal treatment was significantly unsatisfactory.

The quality of the root filling was frequently unsatisfactory. periapical radiolucency was present in 40% of endodontically treated teeth. Only 48.8% of these root filled teeth

fulfilled the criteria for an acceptable root canal filling with absence of any associated periapical radiolucency, which is low compared with other studies.<sup>(1,10,15,31)</sup>

Although the methods and parameters used to evaluate the quality of root canal filling were not the same as other studies, it can be postulated that the poor quality of root canal filling observed in this study are the result of low standards and/or poor technique in root canal procedures.

The present study provides information concerning the prevalence of endodontic treatment and its association with periapical radiolucency among a wide age range in both genders demonstrates a baseline knowledge of the success rate of root canal treatment in Jordan in this dimension and refutes the null hypothesis. Although the dental literature contains many researches were carried out in this field, but it was difficult to compare their results with those in this study due to variations in the variables incorporated.

One of the limitations of this study was the use of OPG in the assessment of periapical status especially in the anterior region. Another limitation was that risk factors have not been evaluated. Further research is still needed to overcome the limitations of this study which includes lack of information of socio-economic status and educational level of participants, distribution of remaining teeth, oral hygiene status and the relation of oral status with general health, and endodontic treatment quality of teeth performed in royal medical services. In addition, the use of periapical radiographs should be considered in the future studied to eliminate the drawbacks of the OPG especially where anterior teeth are evaluated.

## Conclusion

Within the limitations of this study, the following conclusions can be withdrawn:

1. It was observed that 8.3% of examined teeth were endodontically-treated, of these, 40% were associated with periapical radiolucency.
2. Periapical radiolucency were recorded in 11.9% of examined teeth, of these 4.7% were associated with teeth with RCT and 36.2% of filled teeth were endodontically

treated. However, only 38% of endodontic treatment were adequate, approximately half of these were not associated with periapical radiolucency.

3. Males significantly recorded more periapical radiolucency with their root canal filled teeth compared with females; however, females had more non-endodontically treated teeth with periapical radiolucency ( $p<0.01$ ).

4. Periapical radiolucency increased with age. Significantly associated with endodontically treated teeth in patients aged 40 years or more and with non-endodontically treated teeth in those aged 50 years and above ( $p<0.05$ ).

5. There were significantly more endodontically treated teeth and more teeth with periapical radiolucency in the maxilla than in the mandible ( $P<0.05$ ). Periapical radiolucency was more frequently associated with endodontically treated teeth in the mandible and with untreated teeth in the maxilla ( $P<0.05$ ).

6. Approximately 70% of teeth were either with inadequate root filling or with periapical radiolucency. Hence, successful endodontic treatment is indicated by root canal filling adequacy, it can be concluded that approximately 62% of root canal treatment was significantly of poor quality ( $p=0.001$ ).

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