

## Radiological evaluation of endodontic treatment

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**Abstract:** Objectives: The main purpose of the study was to evaluate the quality of root canal treatments and coronal restorations and to associate them with periapical status. Materials and method: 79 panoramic radiographs were analyzed, with 234 teeth identified with endodontic treatment, thus constituting the study group. The radiographs monitored the status of the teeth treated endodontically by means of the periapical index scoring system (PAI). The data were statistically analyzed with the SPSS Statistics IBM-trial version. Results: Of the 234 teeth evaluated, 69.6% had radiographic signs of periapical lesions (PAI>2). Only 9.82% of endodontically treated teeth (n = 234) showed the criteria of a properly performed root canal obturation and showed no signs of periapical lesions. 28.12% of correctly treated endodontic teeth (n = 32) have periapical lesions (PAI = 3/4/5). No tooth with severe periodontitis with exacerbating features (PAI = 5) had the characteristics of a correctly performed endodontic treatment. Conclusions: The results of this study showed that improper root canal treatment is often associated with an increase in frequency of chronic apical periodontitis. Many endodontic treatments have been incorrectly from a technical point of view and substantial efforts are needed to improve the standard of endodontic treatment.

**Keywords:** apical periodontitis, coronal restoration, endodontics, radiology, root fillings .

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Date of Submission: 05-02-2018

Date of acceptance: 20-02-2018

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### I. Introduction

The success of endodontic therapy relies on three principles: cleaning, shaping and obturation of the root canal system. The obturation is the only one we can see on radiographs so we cannot obtain accurate information about the quality of the whole root canal treatment. A proper root canal filling is expected to provide a 3-dimensional seal against bacteria [1].

Apical periodontitis is an inflammatory disorder of periradicular tissues caused by bacterial invasion and colonization of the root canal [2,3]. Bacteria and their toxins can reach the pulpal space via dental caries, trauma or operative procedures and then they can advance into the periapical tissues, where they meet various factors of the host defense systems [4]. This inflammatory disorder is frequently asymptomatic and detected primarily on routine radiographic examination. Early-stage apical pathology may be indicated by radiographically visible changes in the lamina dura [5]. Radiology is especially important for diagnosis in the detection of periapical lesions, and to assess treatment success including post-treatment healing [6].

Clinical signs, such as pain, swelling, tenderness and sinus tract formation occur to varying degrees and are only moderately specific. Radiographic interpretation is therefore the prime criterion for the diagnosis of apical periodontitis [7].

The goal of endodontic treatment is either to prevent or to treat apical periodontitis (AP), most often by performing root canal treatment [8]. While the success of a root canal treatment may depend on several factors, it has repeatedly been demonstrated that the preoperative presence or absence of AP is one of the most important prognostic factors for a root-canal-treated tooth [9-12].

Radiologic evaluation of the root canal treatment may help assess the treatment outcome, the frequency of apical periodontitis and the factors may lead to periapical bone lesions (poor temporary or permanent coronal restorations, improper root canal filling). Periapical bone lesions may lead to tooth loss when not treated. Periodically obtaining radiographic images is important in determining the presence, progression or resolution of the periapical bone lesion [13, 14].

Regarding the radiologic evaluation of the root canal filling, the European Society of Endodontology established that “the prepared root canal should be filled completely unless space is needed for a post. The

prepared and filled canal should contain the original canal. No space between canal filling and canal wall should be seen. There should be no canal space visible beyond the end-point of the root canal filling.”[15].

The periapical index (PAI) is a system that provides an ordinal scale of scores ranging from ‘healthy’ to ‘severe periodontitis with exacerbating features’. Each of the roots was categorized as: (1) Normal periapical structure; (2) small changes in bone structure; (3) changes in bone structure with some mineral loss; (4) periodontitis with well-defined radiolucent area; and (5) severe periodontitis with exacerbating features. The root with the worst score of all was taken to represent the PAI score for multirooted teeth.

The periapical index was introduced by Ørstavik et al. and is used in clinical trials and epidemiological studies [16-19]. It was described for periapical radiographs [20]. Later on, was used for panoramic radiographs [21 – 23], or a combination of panoramic radiographs and periapical radiographs [24, 25].

The objective of the present study was to determine the technical quality of root filling and coronal restoration in root filled teeth and their association with apical periodontitis in a Romanian population.

## **II. Materials and Methods**

### **2.1 Patient selection**

The sample used for this study consisted of randomly selected orthopantomographs (OPGs) from database of a private dental clinic in Craiova. Radiographs of patients less than 18 years of age and/or with less than 8 standing were excluded. Also excluded were any OPGs that were damaged in any way or were of poor quality. After applying the exclusion criteria, 79 OPGs are included in the study. These OPGs were examined by two independent observers. Patient-related information was limited only to age and gender, therefore maintaining patient confidentiality.

### **2.2 Radiographic evaluation**

Teeth were categorized as endodontically treated if they had been obturated with radio-opaque material in one or more of the root canals. In the root filled teeth the parameters listed in Tabel 1 were assessed. The periapical status was assessed using the “Periapical Index” (PAI) score. The worst score of all roots was taken to represent PAI score for multirooted teeth. A score greater than 2 (PAI>2) was considered to be a sign of periapical pathology [20].

### **2.3 Data treatment**

Diagnostic parameters for the present study were (Table 1):

1. Lateral seal of the endodontic treatment: adequate if no voids were present in the root filling; score 1= adequate, and scores 2, 3 and 4 = inadequate.
2. Length of root filling: adequate if ending  $\leq 2$ mm from, or flush with, the radiographic apex; score 1 and 3 = adequate, and score 2 and 4 =inadequate.
3. Periapical bone: score 1 and 2 = sound, and score 3, 4 and 5 = diseased (AP).

The data were statistically analyzed with the SPSS Statistics IBM-trial version. All values were compared using a chi-squared test for statistical significance. Significance was determined at the 0.001 level of confidence.

## **III. Results**

The total number of root filled teeth was 234 and 163 of them (69,9%) had apical periodontitis (PAI scores 3-5). Only 55 teeth (23,5%) were with complete root canal fillings, a homogeneous filling finishing 0-2 mm from radiographic apex.

The relationship between the length of root filling and periapical status is shown in Table 2. Apical periodontitis was found in 18.37% of teeth with adequate length of root filling, whereas if the filling was too short or long, periapical lesions were present in 51.28% of teeth ( $p < 0.001$ ).

Tabel 3 shows the relationship between the adaptation of root filling to canal walls and periapical status. Root filled teeth without voids had AP in 20.94% of cases, whereas if voids were detected, disease was present in 48.71% of the teeth ( $p < 0.001$ ).

The relationship between the quality of the coronal restoration and periapical status is presented in Tabel 4.

Finally, all tree-quality parameters were combined. Coronal restoration, filling adaptation and length were found to be adequate only in 32 teeth (13,67%) and 9 (3,84%) of them had AP.

**Table 1** Parameters recorded on root filled teeth

Parameters	Registrations and codes
Coronal restoration (filling and crown)	1 = Adequate (radiographically sealed) 2 = Inadequate (signs of overhangs or with open margins) 3 = Without restoration
Adaptation of root filling	1 = Adequate: no voids were present in the root filling 2 = Adequate in the coronal 2/3 of the root filling + inadequate in the apical 1/3 of the root filling 3 = Inadequate in the coronal 2/3 of the root filling + adequate in the apical 1/3 of root filling
Length of root filling	1 = Root filling ending $\leq$ 2mm from radiographic apex 2 = Root filling ending $>$ 2 mm from radiographic apex 3 = Flush, root filling ending at the radiographic apex 4 = Over-filling root filling material seen in the periapical area
Periapical index (20)	1 = Normal periapical structures 2 = Small changes in the bone structure 3 = Changes in bone structure with some mineral loss 4 = Periodontitis with well defined radiolucent area 5 = Severe periodontitis with exacerbating features

**Table 2** Relation between length of fillings and apical periodontitis

Treatment	With apical periodontitis (%)	Without apical periodontitis (%)	Total no. of teeth
Adequate length	43 (18.37)	38 (16.23)	81
Inadequate length	120 (51.28)	33 (14.1)	153
Total	163 (69.65)	71 (30.34)	234

p &lt; 0.001

**Table 3** Relation between adaptation of fillings and apical periodontitis

Treatment	With apical periodontitis (%)	Without apical periodontitis (%)	Total no. of teeth
Adequate adaptation	49 (20.94)	38 (16.23)	87
Inadequate adaptation	114 (48.71)	33 (14.1)	147
Total	163 (69.65)	71 (30.34)	234

p &lt; 0.001

**Table 4** Relation between quality restoration and apical periodontitis

Treatment	With apical periodontitis (%)	Without apical periodontitis (%)	Total no. of teeth
Without coronal restoration	23 (9.82)	3 (1.28)	26
Adequate coronal restoration	56 (23.93)	51 (21.79)	107
Inadequate coronal restoration	85 (36.32)	16 (6.83)	101
Total	164 (70.08)	70 (29.91)	234

p &lt; 0.001

#### IV. Discussion

The most usual method for assessing the results of a root canal treatment is radiographic examination [1]. Panoramic radiographies were used as a survey tool for this study because of their availability; an intraoral full mouth survey is seldom taken. Ahlqwist et al. (1986) stated that the use of panoramic radiography in epidemiological studies of dental health is a useful diagnostic tool for the evaluation of apical lesions [2]. In a comparison of panoramic and periapical radiography survey, Muhammed and Manson-Hing discovered that there is no statistically significant difference in the detection of AP [3]. Evaluating periapical lesions on a panoramic radiography is a reliable method, fact that is confirmed by different studies made on this subject [4,5].

The field of endodontics focuses on the prevention and/or elimination of apical periodontitis. Apical periodontitis is caused mainly by bacterial contaminations of the root canals [26,27]. It should be taken into account that the presence of AP in association with a root-filled tooth does not necessarily indicate a treatment failure. The apical radiolucency scored as treatment failure may be a apical lesion that is healing [6]. Also, the apical periodontitis has different stages of development. Nair et al. analyzed 256 periapical lesions and discovered that 35% were periapical abscess, 50% granulomas and 15% cysts (9% apical true cysts, 6% apical pocket cysts). True apical cysts have fewer chances to heal with conventional endodontic treatment [7].

Eriksen et al. determined from the review of epidemiological studies that the technical quality of the root fillings should be considered the most important determinant for endodontic success [8]. In this study, like in other studies, the quality of the root canal filling is estimated by the length and the homogeneity of the root canal filling. The evaluation of the technical quality of root canal treatment, on the basis of root canal filling length, revealed that 34,61% of root fillings were executed properly. Only 23,5% of endodontic treatments

were adequate regarding the length and homogeneity, which confirmed the results of other surveys that showed that a large percentage of root canal fillings were not acceptable [9,10,11].

In this study, 69,6% endodontic treated teeth had apical periodontitis. This prevalence is similar to than that found by Georgopoulou et al. (60%) [12] and Segura-Egea et al., (64,5%) [10]. The prevalence found in this study is higher than that found by Touré et al. (56,1%)[13], Sunay et al. (53,5%)[14], Kirkevang et al. (52%)[15], De Moor et al. (40,4%)[9]. This difference in the prevalence of apical periodontitis observed between our study and other studies could be explained by the difference in methodology and difference in oral health policies between countries. Also, the lack of standardization of the methods of radiographic assessment and the different levels of endodontic practice may contribute to the final results of the studies.

Healthy periapical structures depend on the quality of the root canal treatment and of the coronal restoration, but there is still some controversy when it comes to the level of impact of the coronal restoration on the success rate of the endodontic treatment[16]. Coronal restoration quality was investigated as a contributing factor to the presence or development of AP.

Torabinejad et al. discovered that in 3 weeks, bacteria ingresses into the root canals of endodontic treated teeth without coronal restorations [17]. Allen et al. observed that permanently restored teeth after orthograde endodontic or surgical retreatment had a better outcome compared to the teeth that were not restored[18]. Another study found a strong association between a good coronal restoration and the periradicular status of the tooth and suggested that the quality of the coronal restoration is the main factor in the development of AP and is even more important than the quality of the root canal treatment.[19] Other studies found that the quality of root canal filling is more significant than coronal restoration for periapical health[20, 21].

Estrela et al. assessed the prevalence and risk factors of apical periodontitis in a selected population of Brazilian adults. AP prevalence with adequate endodontic treatment was 16,5% and it dropped to 12,1% in cases with good endodontic treatment and adequate coronal restoration. The result showed that inadequate coronal restoration increases the risk of apical periodontitis [22].

In this study, only 21,79% of the teeth treated endodontically had a good periapical status and a good restorations and 7,67% had a good periapical status and inadequate restoration. That difference suggests that the coronal restoration is clearly a contributor factor to AP.

This study contained a similar number of females (50,64%) and males (49,46%). The gender proportion was like in other studies in this field [10, 12, 23]. This difference is not significant but may reflect a small difference in the interest in obtaining dental care.

The root canal treatment of the anterior single-canal teeth was better than that of the posterior multi-canal teeth. Such result was similar with other studies that discovered that the quality of the endodontic treatment was acceptable more often in anterior teeth. [24-29]. The result it is explained by the more complex anatomy of posterior teeth and the position of the tooth that the endodontic treatment more difficult.

The findings of the present study showed that the prevalence of apical periodontitis was high when associated with inadequate root canal treatment and that the coronal restorations is a contributor factor to developing AP.

## V. Conclusion

The diagnosis of apical periodontitis and the assessment of the endodontic treatment are important in dentistry. A tooth with adequate root canal treatment and adequate restorative treatment has an increased chance for healing apical periodontitis. Many root canal treatments were technically unsatisfactory so it is important to improve the endodontic treatment.

Contribution Note: All authors made equal contributions to the study and the publication.

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Mihaela-Jana Țuculina "Radiological evaluation of endodontic treatment. "IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), Volume 17, Issue 2 (2018), PP 07-11.