Examination of the prevalence of periapical lesions and technical quality of endodontic treatment in a Turkish subpopulation

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Objective. The objective of this study was to investigate the prevalence of periapical lesions by evaluating the periapical status and to evaluate the relationship between the technical quality of endodontic treatments and presence of periapical lesions in a Turkish subpopulation.

Study design. A total of 11,542 teeth of 438 patients were radiographically evaluated. Presence of endodontic treatment and obturation levels, coronal restorations, and degree of root canal curvature angles were noted. Apical status was assessed by the Periapical Index Scores (PAI). The χ² test was used for statistical analysis.

Results. Among all teeth, 179 (1.55%) had endodontic treatment and 189 (1.63%) had periapical lesions. Of 179 endodontically treated teeth, 68 (37.99%) had periapical lesions. The prevalence of periapical lesions was found to be significantly high among underfilled teeth (P < .001). In most underfilled teeth, the presence of severe curvatures was particularly of interest. Prevalence of inadequate coronal restorations was significantly high among the teeth with periapical lesions, whether endodontically treated or not (P < .001).

Conclusions. The findings of the present study indicate that considerable effort should be spent by dental practitioners to improve the technical quality of root canal fillings. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:136-142)

Success of endodontic treatment has been the topic of more than 60 investigations in the past 80 years. Thousands of teeth have been included and evaluated in these investigations.1 However, conflicting results have been obtained in these studies in terms of success rate, owing to the differences in treatment modalities, as well as selection of materials and methodologies.1 The success rate of endodontic treatment is a public health issue that has economic and ethical consequences, and an increase in success rate is anticipated in conjunction with the developments in technology.2 The success rate of endodontic treatment is dependent upon a variety of factors. In addition to pulpal and periapical status, root canal anatomy and quality of root canal shaping and filling procedures significantly influence the final result of the therapy.3 Using periapical radiographs before, during, and after the endodontic treatment, anatomical details, canal dimensions, quality of obturation, and presence of periapical lesions can readily be detected and radiographed.3 These radiographs play a significant role in epidemiologic studies as well as the determination of endodontic treatment necessity and evaluation of treatment outcomes. Meanwhile, it has been noted that most of the unsuccessful cases are associated with insufficient root canal treatment.4-11 A well-recognized methodology used in the evaluation of periapical lesions is the scoring system developed by Ørstavik et al.12 in 1986. This system classifies periapical lesions within an index and expressed as the Periapical Index Scoring system (PAI). Nowadays, this system is used as a means of evaluating the results of endodontic treatment in epidemiologic studies as well as clinical trials.12,13

Many studies have been conducted to determine the etiology and distribution of oral health problems.1-14-22 The purpose of the present study was to investigate the prevalence of periapical lesions by evaluating the periapical status in the first 438 consecutive Turkish patients who presented to the Endodontics Department during a certain period. Another aim of the study was to evaluate the relationship between the technical quality of endodontic treatments and the presence of periapical lesions.

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MATERIAL AND METHODS

The study sample comprised 11,542 teeth belonging to 438 patients. The patients whose teeth were included were individuals who first presented to the Oral Diagnosis and Radiology Department for a general dental check-up and then were referred to the Endodontics Department. Two hundred thirty-four of the patients were females, whereas 204 were males. The ages of the participants ranged from 10 to 79 years.

Before the investigation, the patients were asked to sign a consent form that confirmed their participation and approval. Later, clinical examination results and dental histories were recorded. Information regarding previous traumatic injuries was obtained from the clinical examination of the patients as well as dental anamnesis. To provide a standardization and prevent problems that may result from the use of different devices, all the radiographs were taken by the same x-ray device in the Oral Diagnosis and Radiology Department (Trophy, ETX model, Vincennes, France). The periapical radiographs were taken using Kodak film (Kodak, Rochester, NY; T-MAT G, NY) by the bisecting angle technique with an exposure time of 63 kVp, 8 mA, 0.25 to 0.32 seconds. The films were processed using an automatic processing device (Velopex Extra-X, London, England) according to the instructions of the manufacturer. The evaluation of the periapical status of the patients was conducted by 2 separate endodontists with more than 20 years of clinical experience on a negatoscope (Dentsply, RINN67-0442, Tulsa, OK, USA). Kappa statistics was performed for the assessment of interobserver agreement by using 20 radiographs not included in the study. A kappa score of 0.92 was obtained, which indicated a high level of agreement between the observers. The evaluation was repeated at different time intervals and in case a disagreement occurred between the results, a consensus was reached between the observers by consultation.

The periapical lesions were recorded using the PAI in which an evaluation of periapical lesions is made by using a scale ranging from 1 to 5 depending on the radiographic images.\textsuperscript{12,13} PAI 1, normal width of periodontal ligament space and normal appearance of surrounding bone, was defined as healthy periapex. All other PAI scores were evaluated as apical periodontitis.

In addition to the evaluation of the ratio of periapical lesions among teeth included in our study, the following criteria were also noted:

- the degree of root curvature angles
- the presence of previous traumatic incidents

The following criteria were used in the evaluation of obturation level and coronal restorations in endodontically treated teeth.\textsuperscript{23}

**Obturation levels:**

- Underfill: Root filling 3 to 5 mm. Short of the radiographic apex.
- Flushfill: Root filling 0-3 mm. Short of the radiographic apex.
- Overfilling: Root filling that ends in the radiographic apex or overfilling.

The status of coronal restorations was analyzed as follows:

- Acceptable: Acceptable restoration (with intact margins).
- Unacceptable: Unacceptable restoration (presence of caries and/or disrupted margins).
- Missing: Loss of restoration (broken or lost).

The following classification was used in the evaluation of root canal curvature angles:\textsuperscript{24}

- Straight roots: 0 to 10°
- Roots with moderate curvatures: 10 to 15°
- Roots with severe curvatures: >25°

Teeth with moderate and severe curvatures were included in the curved-rooted teeth category during the evaluation. Data obtained were statistically analyzed. The evaluation of the differences between groups was made using the $\chi^2$ (Pearson $\chi^2$, Likelihood Ratio) test. Statistical significance level was established at $P < .05$.

RESULTS

Periapical lesions were detected in 189 (1.63%) of the 11,542 teeth evaluated. The distribution of periapical lesions is shown in Table I. Periapical lesions were encountered most frequently in the 40- to 49-years age group. Among all teeth, the number of endodontically treated teeth was determined as 179 (1.55%) (Table I). It was determined that 68 (35.97%) of the 189 teeth with periapical lesions had endodontic treatment, whereas 121 (64.03%) had none (Table II). In other words, the ratio of teeth with periapical lesions was 37.99% (68 teeth) among the endodontically treated teeth. When statistically evaluated, the frequency of periapical lesions was determined as highly significant among the endodontically treated teeth ($\chi^2$: 1468.8, $P < .001$; odds ratio [OR]: 56.91; 95% confidence interval [CI]: 40.06-80.85). When the obturation levels of 68 teeth with
endodontic treatment were evaluated, it was determined that 47 (69.11%) were underfilled, 15 (22.05%) adequately filled, and 6 (8.84%) were overfilled (Table II). When the relationship between obturation levels and frequency of periapical lesions was statistically analyzed, the prevalence of periapical lesions was found to be highly significant specifically among underfilled teeth ($P < .001$). Fifty-six (82.35%) of the 68 endodontically treated teeth with periapical lesions had severe curvatures, whereas 12 (17.65%) had straight roots.

When the obturation levels of 56 severely curved teeth with periapical lesions were evaluated, it was determined that 37 (66.07%) had incomplete fillings, 14 (25%) had adequate fillings, and 5 (8.93%) had overfillings. When the statistical data regarding the relationship between endodontically treated teeth with periapical lesions and root curvature angles were evaluated, the frequency of inadequate obturation levels was determined as statistically nonsignificant in both curved and straight roots ($P = .27$). In addition, 37 (66.07%) of 56 teeth with curved root canals had severe angles and 19 (33.93%) had moderate angles. It was particularly of interest that 37 incompletely filled teeth with periapical lesions and curved root canals had severe curvatures.

Findings related to trauma history and periapical lesions were as follows: 22 (11.64%) of 189 teeth with periapical lesions had traumatic histories; 5 (22.73%) of the 22 teeth exposed to trauma had undergone an acute traumatic incident; 17 (77.27%) of the 22 teeth were associated with chronic trauma, such as a filling or coronal prosthetic restoration with premature contacts. It was observed that 7 of the 22 teeth with periapical lesions and with a traumatic history had root canal treatments.

Table I. The distribution of periapical lesions according to PAI belonging to different age groups

<table>
<thead>
<tr>
<th>Age, y</th>
<th>10-19</th>
<th>20-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
<th>70-79</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAI 1</td>
<td>1585</td>
<td>3155</td>
<td>2056</td>
<td>2468</td>
<td>1498</td>
<td>452</td>
<td>139</td>
<td>11,353</td>
</tr>
<tr>
<td>PAI 2-5</td>
<td>17</td>
<td>30</td>
<td>38</td>
<td>49</td>
<td>46</td>
<td>4</td>
<td>5</td>
<td>189</td>
</tr>
<tr>
<td>Total no. of teeth</td>
<td>1602</td>
<td>3185</td>
<td>2094</td>
<td>2512</td>
<td>1544</td>
<td>456</td>
<td>142</td>
<td>11,542</td>
</tr>
<tr>
<td>Not treated</td>
<td>1585</td>
<td>3145</td>
<td>2040</td>
<td>2483</td>
<td>1524</td>
<td>444</td>
<td>142</td>
<td>11,363</td>
</tr>
<tr>
<td>Treated</td>
<td>17</td>
<td>40</td>
<td>54</td>
<td>34</td>
<td>20</td>
<td>12</td>
<td>2</td>
<td>179</td>
</tr>
<tr>
<td>Total subject no.</td>
<td>56</td>
<td>107</td>
<td>76</td>
<td>98</td>
<td>72</td>
<td>22</td>
<td>7</td>
<td>438</td>
</tr>
</tbody>
</table>

PAI, Periapical Index.

Table II. The distribution of periapical lesions according to PAI in the endodontically treated or not treated teeth

<table>
<thead>
<tr>
<th>Presence of endodontic treatment</th>
<th>Obturation level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not treated</td>
<td>Treated</td>
</tr>
<tr>
<td>PAI 2-5</td>
<td>Maxilla</td>
</tr>
<tr>
<td></td>
<td>Mandible</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

The prevalence of periapical lesions was found to be highly significant specifically among underfilled teeth ($P < .001$).

PAI, Periapical Index.
DISCUSSION

The patient material in the present study consisted of individuals who were referred from the Oral Diagnosis and Radiology Department to the Department of Endodontics, as stated previously. Although the selection of patients was randomized within our department by selecting the first 438 patients who presented starting from January 2009, the patient material may be somehow unsatisfactory to reflect the overall population. This may be considered as one of the drawbacks and limitations of the present study.

The Periapical Scoring System was used in the evaluation of periapical status and the detection of periapical pathology. Although the PAI system is used in many studies aiming to investigate the periapical health of teeth, it has been indicated that the validity of using PAI for all tooth positions might be questionable. It has been further stated that the PAI system may not be suitable for all tooth positions because thickness of cortical bone and the position of the root tip in relation with the cortex may vary depending on tooth position. Although these points may raise some concern regarding the reliability of the PAI system, it was preferred as the method of assessment in the present study because it provides a categorized description of periapical pathologies confirmed by histologic evaluation. Another methodology that could have been selected is Strindberg’s criteria or the modifications. Also, considering that apical periodontitis lesions limited to the cancellous bone might pass unnoticed in radiographic examination, more sensitive techniques can be used in further studies. One of these methodologies is cone-beam computed tomography. Although more precise and sensitive, these systems carry the disadvantage of exposing patients to overradiation.

One of the methodologies used in these types of research is panoramic radiography. Panoramic radiographs offer some advantages, such as the chance of visualizing all teeth in a single radiograph and the relatively lower dosage of radiation compared with full-mouth sets of periapical radiographs. In spite of these benefits, poor image quality particularly in the upper and lower anterior regions poses a major disadvantage in panoramic radiographs. Thus, periapical serial radiographs were preferred in the present study for obtaining more qualified images. Kaffe and Gratt reported that the most reliable and significant radiographic finding in distinguishing healthy teeth from those with periapical pathology is the disruption in the continuity of the lamina dura and widening of the periodontal ligament space. Huumonen and Ørstavik suggested that a widening of at least 1 mm in the periodontal ligament space in the apical one third of the root is a clear indication of periapical pathology. To clarify this issue and for the provision of standardization in the scoring of periapical pathology, Ørstavik et al. developed the PAI. In the following years the accuracy of this system was confirmed by another study of Ørstavik. PAI was used as a means of assessment of apical periodontitis in many epidemiologic studies; however, a radiograph provides only static information of a dynamic process and a periapical lesion may be either increasing in size or healing. To partially eliminate such a possibility, the patients who declared that they received endodontic treatment within the past 1-year period were excluded. Nevertheless, patients’ declarations and their memories of past interventions may be misleading. This may be considered as a minor drawback regarding the present study. Also, research limited to radiographic evaluation without other diagnostic criteria does not always give reliable information.

Many studies exist in the literature that discuss the factors affecting the success of root canal treat-
A common result of these studies is the close relationship between inadequate root canal filling and periapical pathology. Our study, which aims to investigate the frequency of periapical lesions and quality of endodontic treatment, is supportive of this relationship. Of 68 endodontically treated teeth, 47 (69.11%) were determined as having inadequate endodontic fillings; 6 of these (8.84%) had overfillings. In our study, the acceptable level of obturation was found as 22.05% (15 of 68 teeth). These results indicate that there is a highly significant relationship between the obturation level and periapical pathology \( (P < .001) \).

An interesting finding concerning the 68 endodontically treated teeth with periapical lesions was that 56 (82.35%) had curved roots (Table IV). It was determined that 37 of the 56 teeth with curved roots (66.07%) had incomplete fillings and severe curvatures.

Bergström et al. reported that it is the level of obturation rather than the homogeneity of root canal filling that has a relationship with periapical lesions. Meanwhile, Petersson et al. determined that periapical lesions develop more frequently in teeth with unfiled roots compared with those with complete obturation. In a study by Buckley and Spangberg, it was concluded that 5.5% of the 5272 investigated teeth had undergone endodontic treatment and a periapical lesion existed in 4.1% of the overall teeth and 31.3% of endodontically treated teeth. It was also concluded that a periapical pathology develops in teeth with incomplete and unsatisfactory root canal fillings, rather than those with successful and qualified root canal treatments. We also detected that, among 11,542 evaluated teeth, 179 (1.55%) had endodontic treatment, 189 (1.63%) were associated with periapical lesions (Table I) and 68 (37.99%) of 179 endodontically treated teeth had periapical lesions (Table II). The prevalence of endodontic treatment was found to be relatively low compared with other studies. It is appropriate to mention that the general patient profile of our hospital consists of individuals with rather insufficient and limited socioeconomic status. So, it is unfortunately more common among this population to prefer extraction rather than endodontic treatment. The concept of endodontically preserving natural teeth is just beginning to emerge in this community. This concept is not new in other countries or communities. We are sure that endodontic treatment incidence will definitely increase in the upcoming years as public awareness on this issue will increase. Therefore, for the time being, it is natural and rather expected to achieve a low result, such as 1.55% in the present study.

In a study that evaluates the technical quality and prevalence of root canal treatment, Boucher et al. determined that the endodontic treatment had generally poor quality and those with acceptable filling levels had a relatively lower prevalence of periapical pathology. They also noted that a significant relationship exists between the obturation level of root canal treatment and periapical pathology.

In an epidemiologic study conducted by DeMoor et al., 40.7% of root canal treatments were determined as satisfactory and apical lesions are generally not observed in teeth with root canal fillings that terminate 2 mm short of the radiographic apex. In the present study, the most unsuccessful results were observed in teeth with over- or underfillings. The quality of root canal fillings was reported as 41.4% by Weiger et al., 42.0% by Buckley and Spangberg, 36% by Imfeld, 49.4% by DeCleen et al., 46.0% by Marques et al., and 40.0% by Odesjo et al. Although different parameters were used in the evaluation of endodontic quality in all these studies, a general conclusion can be made as to the low quality of endodontic treatments performed in dental clinics.

A factor that influences the long-term success of endodontic treatment is the prevention of coronal leakage. The quality and acceptability of the coronal restoration was reported to be as effective a factor as the quality of root canal filling. Torabinejad et al., in an ex vivo study, determined that bacterial products can enter the root canal in a period of 3 weeks in endodontically treated teeth without any coronal restorations. Ray and Trope also drew attention to the significance of a well-sealing restoration in a study performed in 1995. They concluded that periapical lesions existed less frequently in teeth with good coronal restorations. The results of the present study support their findings. Twenty of the 68 endodontically treated teeth (29.41%) with periapical lesions had acceptable restorations, whereas unacceptable or lost restorations were determined in 48 teeth (70.59%). Although only 14 (11.57%) of the 121 untreated teeth with periapical lesions had acceptable restorations, 107 (88.43%) had unacceptable or lost restorations. When statistically analyzed, a highly significant relationship was determined between periapical pathology and coronal restoration \( (P < .001) \).

In some studies, it was also reported that the periapical status of endodontically treated teeth depends on the quality of both the endodontic treatment and the coronal restoration. According to Kirkevang et al., a combination of inadequate root canal and coronal restorations led to an increased incidence of apical periodontitis. Hommez et al. supported this finding by demonstrating that a successfully sealing coronal restoration and a well-performed root canal treatment were both important factors in the overall success of endodontic treatment. These researchers made an intraoral
evaluation, whereas both intraoral and radiographic criteria were combined in the present study. Considering that restoration quality and carries cannot be validated on radiographs, it was preferred to assess the overall success of restorations using both clinical examination and radiographs.

When an overall evaluation is made concerning the results of the present study, it can be concluded that the frequency of root canal treatment is low and a relationship exists between periapical pathology and the quality of root canal treatment. On the other hand, this is a cross-sectional study that may have some drawbacks. As stated previously, in cross-sectional studies, it is impossible to determine whether a periapical lesion is healing or not. Another disadvantage is the lack of information about when the endodontic treatments or restorations were performed. Boucher et al. stated that rate of success is determined to be high in studies in which endodontic treatments are performed by well-trained practitioners. They further indicated that this may not reflect the situation within the average dental clinic. It is obvious that operator skill and the conditions under which the treatment was delivered should not be underestimated. Nevertheless, the rate of periapical pathology in endodontically treated teeth was determined as 37.99% in the present study.

In an era when the success rates of endodontic treatment has reached up to 95% to 96%, the results of the present study indicate that considerable effort should be spent by dental practitioners to improve the technical quality of root canal fillings as well as restorative procedures.

REFERENCES


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