THE INFLUENCE OF TOBACCO SMOKING ON DENTAL PERiapICAL CONDITION IN A SAMPLE OF AN ADULT POPULATION OF THE ŁÓDŹ REGION, POLAND

KATARZYNA SOPIŃSKA and ELŻBIETA BOŁTACZ-RZEPKOWSKA

Medical University of Lodz, Łódź, Poland
Department of Conservative Dentistry

Abstract

Objectives: Epidemiological studies show that apical periodontitis (AP), alongside tooth decay, is the most common oral disease. The aim of the study was to evaluate the influence of smoking on the prevalence of AP in the population of the Łódź region, Poland. Material and Methods: The study involved 815 first-time, randomly selected patients reporting to the Central Teaching Hospital of the Medical University of Lodz. The studied group was a systematic sample of the population admitted for treatment in 2016. The study consisted of a questionnaire and a radiological part. Each patient filled out a questionnaire containing demographic data, and an interview regarding smoking and diabetes. The radiological part of the study included the analysis of panoramic radiographs which showed the periapical status, and the presence and quality of root canal treatment. Results: Teeth with AP were observed more frequently in patients addicted to tobacco either at the time of the study or in the past (group 1) – 7.2% than in people who had never smoked (group 2) – 5.2% (p < 0.0005). In the teeth without root canal treatment, AP was observed more frequently in group 1 – 3.5% than in group 2 – 1.9% (p < 0.0005). A statistically significant difference was found in the percentage of endodontically treated teeth between group 1 and group 2 (10.7% vs. 9.6%) (p = 0.017). However, no difference was observed in the frequency of AP in the endodontically treated teeth in both groups (37.6% vs. 35.8%) (p = 0.451). Conclusions: Smokers are a group facing an increased risk of AP and, therefore, there is a need for an early detection and treatment of caries and its complications in this group of patients. The multifactorial etiology of AP indicates the necessity to undertake further studies on the effect of smoking on the periapical status.

Key words: risk factor, smoking, oral health, apical periodontitis, dental care, panoramic radiograph

INTRODUCTION

Epidemiological studies show that apical periodontitis (AP), alongside with tooth decay, is the most common oral disease. The frequency of inflammatory lesions in the periapical region varies in different populations from 26% to 80% [1–4]. Apical periodontitis is associated with the complications of caries and its treatment. The complex mechanism of chronic AP and the accompanying response of the body’s immune system cause that not only tooth specific factors predisposing to AP but also non-tooth specific factors, such as general diseases, should be considered. Diabetes is the most frequently mentioned disease affecting the periapical periodontium. The impairment of healing processes is one of its consequences, which may influence the health of periapical tissues. At the molecular level, hyperglyce-
The aim of the study was to evaluate the influence of smoking on the prevalence of apical periodontitis in the population of the Łódź region.

MATERIAL AND METHODS

The study involved 815 first-time, randomly selected patients reporting to the Central Teaching Hospital of the Medical University (Centralny Szpital Kliniczny Uniwersytetu Medycznego – CSK UM) in Łódź. The study group was a systematic sample of the population admitted to the hospital in 2016. All the patients read the information about the study and gave their written consent to participate in the experiment. The study received a positive opinion of the Bioethics Committee of the Medical University of Lodz, No. RNN/24/14/EC. The patients who did not answer all the questions included in the questionnaire, had <8 teeth or suffered from diabetes [5] were excluded from the project. The experiment also excluded persons whose radiographs could not be properly assessed due to the overlapping of anatomical structures (Figure 1).

The study consisted of a questionnaire and a radiological part. Each participant in the experiment was asked to complete the questionnaire. The questionnaire was divided into 2 thematic parts:
- the first one included demographic data, i.e., gender and age,
- the second concerned an interview regarding smoking and diabetes.

Tobacco addicts included patients who smoked at the time of the study or had been smoking at least 10 cigarettes a day in the past for 5 years without interruption [10]. The radiological part of the study included the analysis of panoramic radiographs which were taken at the Imaging Diagnostics Laboratory at the Medical University of Lodz, using a Gendex Orthoralix 9200 digital camera (Dentsply Gendex, Italy).

In the X-rays, the periapical status and the presence and quality of root canal treatment were evaluated, based on...
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Table 1. Criteria for assessing the parameters under examination for both groups in the study on the influence of smoking on the prevalence of apical periodontitis in the population of the Łódź region (N = 815)

| Variable                          | Reference  | Assessment criteria                                                                                                                                 |
|-----------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Apical periodontitis              | 3,11–14    | a periapical radiolucent area whose diameter is twice the width of the periodontal ligament space on the lateral aspect of a tooth, or the presence of a radiolucent area connected with the apical part of the root demarcated from the surrounding tissues with an osteosclerotic border |
| Root canal treatment              | 3,12,14,15,17 | a tooth containing a radiopaque material in the root canal and/or the pulp chamber                                                                   |
| Quality of root canal treatment   | 3,12,14,15,18 | 1 – correct: filling material in the canals 0–2 mm from the radiographic apex  
2 – incorrect: filling material in the canals >2 mm from the radiographic apex, non-homogeneous filling material in the canals |

Statistics

The collected data were analyzed using basic statistical measures. The χ² independence test was used to compare the groups. In the case of non-homogeneity of the groups according to independent variables, the Mantel-Haenszel (MH) test was used. In the study, a statistically significant level p < 0.05 was adopted, and the decision was made based on the p-value calculated using the statistical package (Statistica 12PL). In order to assess the impact of the quality of treatment on the prevalence of periapical lesions, odds ratios (ORs) were calculated and 95% confidence intervals (CIs) were given.

RESULTS

A total of 703 patients were submitted to statistical analysis. The study group (group 1) comprised 386 smokers whereas the control group (group 2) included 317 subjects without tobacco addiction. Among the patients classified to group 1, 188 people (48.7%) reported that they were current smokers while 198 (51.3%) had been smoking in the past for 5 years without interruption, at least 10 cigarettes a day [11].

The structure of the studied population, depending on gender and age, is presented in Table 2. As can be seen from the data in Table 2, the majority of patients in both groups were women – 60.6% (459), while 39.4% were men (301). The participants’ age ranged 18–91 years. The average age in group 1 was 46.1±15.3 years, compared to 45.1±19.6 years in group 2. Group 1 was mostly represented by persons of 31–45 years of age (30.6%), while group 2 by persons >30 years of age (32.8%).

In the pantomographs, 16 213 teeth were assessed. There were no statistically significant differences in the group of smokers and non-smokers regarding the total number of teeth examined, the number of teeth in anatomical groups, and in the maxilla and mandible (Table 3). The basic descriptive statistics for the assessed and missing teeth are presented in Table 4.

The presence of at least one periapical lesion was found in 66.6% of the patients in group 1 and 55.5% in group 2 (Table 5). In accordance with the MH test that indicates statistical non-significance of the calculated common OR (p = 0.094) for the prevalence of AP along age classes, the
observed more frequently in patients addicted to tobacco either at the time of the experiment or in the past (7.2%) than in the control group (5.2%). The difference was statistically significant (p < 0.0005).

In both groups, the periapical lesions were significantly more common in the premolars and molars as compared to the anterior teeth (p < 0.0005). The percentage of the results of the χ² independences tests for each age class are shown in Table 6. For the second age class (31–45 years old), a statistically significant dependence between the analyzed variables can be observed (among smokers, the prevalence odds of AP are higher than among non-smokers).

As can be seen from the data in Table 7, AP was found in 1010 teeth assessed. Teeth with periapical lesions were observed more frequently in patients addicted to tobacco either at the time of the experiment or in the past (7.2%) than in the control group (5.2%). The difference was statistically significant (p < 0.0005). In both groups, the periapical lesions were significantly more common in the premolars and molars as compared to the anterior teeth (p < 0.0005). The percentage of the
Table 4. Descriptive statistics for the assessed and missing teeth in the study on the influence of smoking on the prevalence of apical periodontitis in the population of the Łódź region (N = 815)

| Parameter       | Teeth (N = 19,684) |               |       |               |       |
|-----------------|-------------------|---------------|-------|---------------|-------|
|                 | total (N = 16,213)| group 1 (N = 8,726) | group 2 (N = 7,487) | total (N = 34,71) | group 1 (N = 20,82) | group 2 (N = 13,89) |
| Min.–max        | 8–28              | 8–28          | 8–28  | 0–20          | 0–20  | 0–20         |
| Lower quartile  | 20                | 20            | 21    | 0             | 1     | 0            |
| M               | 23.1              | 22.6          | 23.6  | 4.9           | 5.4   | 4.4          |
| Me              | 25                | 24            | 26    | 3             | 4     | 2            |
| Upper quartile  | 28                | 27            | 28    | 8             | 8     | 7            |
| SD              | 5.5               | 5.4           | 5.5   | 5.5           | 5.4   | 5.5          |

Explanations as in Table 2.

Table 5. Prevalence of apical periodontitis (AP) in the study on the influence of smoking on the prevalence of apical periodontitis in the population of the Łódź region (N = 815)

| Group     | Participants (N = 703) |       |       |
|-----------|------------------------|-------|-------|
|           | without AP | % | AP ≥1 | % |
| Group 1   | 129 | 33.4 | 257 | 66.6 |
| Group 2   | 141 | 44.5 | 176 | 55.5 |

χ² test p = 0.003; MH test (age) p = 0.094; MH test (gender) p = 0.004.

Table 6. Chi² independences tests for each age class and the prevalence of apical periodontitis (AP) in the study on the influence of smoking on the prevalence of apical periodontitis in the population of the Łódź region (N = 815)

| Age         | Participants (N = 703) | p     |
|-------------|------------------------|-------|
|             | without AP | % | AP ≥1 | % |
| ≤30 years   |           |   |       |   |
| group 1     | 47 | 66.2 | 24 | 33.8 |
| group 2     | 77 | 74.0 | 27 | 26.0 |
| 31–45 years |           |   |       |   |
| group 1     | 43 | 36.4 | 75 | 63.6 |
| group 2     | 38 | 55.1 | 31 | 44.9 |

χ² test p = 0.262

Chi² test p = 0.013
only among tobacco addicts. The above data are presented in Table 8.

In the teeth without root canal treatment, the pathologies of the periapical region were significantly more frequently (p < 0.0005) observed among the patients in group 1 – 3.5% than in group 2 – 1.9%.

There was also a statistically significant difference between group 1 and group 2 in the percentage of endodontically treated teeth (10.7% vs. 9.6%) (p = 0.017).

incisors and canines with periapical pathologies was at a similar level (3.1% and 3.0% in group 1, and 2.3% in group 2). In both groups, an approximately 2-fold higher percentage of lesions was observed in the premolars than in the anterior teeth. Also, the percentage of teeth with AP was about twice as high in the molars as in the premolars in both groups. In the study and control groups, AP occurred more often in the maxilla than in the mandible although a statistically significant difference was found only among tobacco addicts. The above data are presented in Table 8.

In the teeth without root canal treatment, the pathologies of the periapical region were significantly more frequently (p < 0.0005) observed among the patients in group 1 – 3.5% than in group 2 – 1.9%.

There was also a statistically significant difference between group 1 and group 2 in the percentage of endodontically treated teeth (10.7% vs. 9.6%) (p = 0.017).

Table 6. Chi² independences tests for each age class and the prevalence of apical periodontitis (AP) in the study on the influence of smoking on the prevalence of apical periodontis in the population of the Łódź region (N = 815) – cont.

| Age           | Participants | P       |
|---------------|--------------|---------|
|               | (N = 703)    |         |
|               | without AP   |         |
|               | n            | %       |
|               | AP ≥1        | n       | %   |

46–60 years
- group 1: 21 (19.1%), 89 (80.9%)
- group 2: 10 (18.9%), 43 (81.1%)

<60 years
- group 1: 18 (20.7%), 69 (79.3%)
- group 2: 16 (17.6%), 75 (82.4%)

Table 7. Comparison of the prevalence of apical periodontitis (AP) in endodontically treated teeth and non-endodontically treated teeth (the table refers to the teeth) in the study on the influence of smoking on the prevalence of apical periodontis in the population of the Łódź region (N = 815).

| Group | Teeth evaluated | with AP | without root canal treatment | without root canal treatment with AP | with root canal treatment | with root canal treatment and AP |
|-------|----------------|--------|-----------------------------|-------------------------------------|--------------------------|----------------------------------|
|       | n              | n      | n                           | n                                   | n                        | n                                |
| group 1 | 8726         | 624    | 7.2                         | 7 791                               | 272                      | 3.5                              |
| group 2 | 7487         | 386    | 5.2                         | 6 770                               | 129                      | 1.9                              |
|        |               |        |                             |                                      |                          | 935                              |
|        |               |        |                             |                                      |                          | 10.7                             |
|        |               |        |                             |                                      |                          | 352                              |
|        |               |        |                             |                                      |                          | 37.6                             |

* Chi² test p* < 0.0005, MH test 0.005, common OR estimate 0.779, 95% CI: 0.681–0.891.
* Chi² test p* < 0.0005, MH test 0.005, common OR estimate 0.585, 95% CI: 0.472–0.726.
* Chi² test p* = 0.017, MH test 0.561, common OR estimate 0.968, 95% CI: 0.871–1.076.
* Chi² test p* = 0.451, MH test 0.760, common OR estimate 0.963, 95% CI: 0.783–1.184.
* Chi² test is conducted to compare the analyzed groups according to the indicated variables.
However, no significant difference in the percentage of endodontically treated teeth with AP was found (37.6% vs. 35.8%) (p = 0.451). The above data are presented in Table 7.
In both groups, the analysis showed a statistically significant difference in the frequency of AP depending on the quality of root canal treatment. In Group 1, among the teeth with an improperly filled canal, 81.4% had apical periodontitis, and in group 2 – 80.0%. However, only 15.7% of the teeth with correct root canal treatment showed periapical lesions in both groups. The prevalence of AP was higher among patients addicted to tobacco (OR = 23.46) in comparison with those without addiction (OR = 21.56) (Table 9).

**DISCUSSION**

The study was conducted at the Central Teaching Hospital of the Medical University of Lodz, which provides access to primary and specialized dental care. Patients presenting to the facility form a diverse population in terms of age, education, the place of residence and treatment needs. The hospital enables people from various social groups to be comprehensively treated; therefore, it was considered a suitable place to conduct this analysis.

Diabetic patients were excluded from the experiment because, according to current research, diabetes is one of the risk factors for the prevalence of AP and this could affect the results reliability [5].

The experiment was a cross-sectional study that describes the state of health of the apical periodontium at the time of carrying out the research; therefore, it does not provide information on the dynamics of the disease process [19]. Epidemiological and clinical studies show that inflammatory lesions after endodontic treatment are, in most cases, healed after 2 years from the end of therapy.

In many teeth, as a result of complications of caries or improper root canal treatment, new pathologies develop. This is confirmed by the studies by Petersson et al. [20] regarding the effectiveness of root canal treatment. The authors assessed the state of teeth of the same population after ten years and found that the number of teeth in which inflammatory lesions in the periapical region were healed was comparable to the number of teeth in which new lesions were formed at the same time. Therefore, the statement that cross-sectional studies provide reliable data on the incidence of AP, despite some limitations resulting from the methodology of the experiment, is justified [4,19,21].

In this study, panoramic radiographs were used to assess the periapical status, which are commonly used by dentists for diagnostic purposes and for planning multi-specialist dental treatment. They are also widely applied in epidemiological reviews because commissioning radiological research for scientific purposes only is not accepted in many countries [13,18,22,23]. Their advantage is a relatively low dose of radiation, the speed and ease of use, and the fact that all teeth are visible on one X-ray [14,24,25]. Panoramic radiographs also provide information on hard dental tissues, the presence of caries and fillings, root canal treatment and the periapical status [19,26,27]. Taşköker and Akgünül [23] underline the high sensitivity (96%) and specificity (86%) of this diagnostic method.

According to epidemiological reviews, smoking is one of the factors predisposing to the occurrence of AP [2,6]. Tobacco smoke components have a negative effect on the alveolar bone. Bone regeneration processes are slower and, in the presence of inflammation, they impede the healing process and accelerate the destruction of periodontal structures [5,28].

Most of the data concern the assessment of the impact of smoking on the marginal periodontium, but there is little information about the AP itself. In 2003, Kirkevang and Wenzel [29] examined 613 residents of Denmark and were the first researchers to report that smoking contributes to the increased occurrence of periapical diseases. However, there is no data on this topic in the Polish population.

According to the research conducted by the authors of this paper, apical periodontitis in at least 1 tooth was found more often in smokers (66.6%) than in patients without this ad-
diction (55.5%). Similar results were obtained in the Spanish population, where at least 1 inflammatory lesion in the periapical region was found in 74% of smokers and in 41% of non-addicted people [30]. Peršić et al. [5], studying the Croatian population, also found a higher incidence of AP in smokers (86.1%) than in the control group (78.1%), but this relationship was not statistically significant.

A further detailed analysis was performed with regard to the number of teeth, and not the number of people, because the population similar in numbers may have a different number of teeth. The statistical analysis showed that the examined groups did not differ significantly in terms of the total number of teeth and the number of teeth assessed in anatomic groups.

The prevalence of AP was found to depend on the tooth type. Both among patients addicted to tobacco and those without addiction, AP was more frequently found in the molars (14.7% and 10.0%, respectively) and premolars (7.7% and 5.6%) than in the incisors (3.1% and 2.3%) and canines (3.1% and 2.3%). Literature data also show that AP has been most frequently reported in the molars [12,31,32]. Caries can quickly develop on the occlusal surfaces of the posterior teeth, frequently leading to pulp diseases. The complicated anatomy of the canal system often makes it difficult to carry out the correct endodontic treatment, which results in the development of AP [29]. Epidemiological reviews have also revealed some differences in the prevalence of apical pathologies in the maxilla and mandible [31,33], which was also confirmed by this research. In both groups, the inflammatory lesions occurred more often in the maxilla than in the mandible although the difference was statistically significant only among people addicted to tobacco. According to Murto-maa et al. [34], the anterior teeth of the upper arch are more prone to injuries, which may result in the pulp necrosis and consequent AP.

In the population of the Łódź region, the percentage of teeth with apical periodontitis in the group of smoking patients was significantly higher than among those without addiction (7.2% vs. 5.2%). Analyses carried out by Segura-Ege et al. [30] in Spain, and by Correia-Sousa et al. [35] in Portugal, also revealed this correlation, although in both countries the values of this parameter were lower: in Spain – 5% and 3%, and in Portugal – 3% and 1.9%, respectively. Definitely more frequent periapical lesions occurred in Croatia, where 13% of teeth with changes were observed among smokers and 10% among non-smokers [5].

Rodriguez et al. [36] investigated this problem in the Swiss population and revealed certain differences in the prevalence of AP, associated with the time of exposure to the components of tobacco smoke. In the group of men who smoked >1 packet of cigarettes/day for 10 years, the percentage of teeth with changes was 12%, among those who smoked for a shorter time, it was 5.5%, while in those who had never smoked, the percentage was the lowest and equaled 3.8%.

The present study revealed that in patients addicted to tobacco there was a statistically higher percentage of teeth with apical periodontitis without root canal treatment (3.5%) than in the control group (1.9%). These findings may be explained by the results of studies by Palmer et al. [37] on oral hygiene, which revealed a more frequent occurrence of dental plaque in people with addiction. Smoking reduces pH and saliva buffering capacity, which leads to an increase in the number of cariogenic bacteria Streptococcus mutans and Lactobacillus acidophilus. A thicker biofilm layer increases the susceptibility of tooth tissues to caries, which is one of the main risk factors for AP [5,38,39].

Bergström et al. [9] conducted a questionnaire survey, as well as a clinical and radiological examination in 257 musicians and found a higher prevalence of periodontal diseases in people with addiction. The analysis also showed a greater atrophy of the alveolar bone in those who smoked for at least 15 years. Rudziński and Banach [10] are also of the opinion that the components of tobacco smoke negatively affect the periodontium and cause a more frequent
occurrence of marginal periodontitis. Due to the closeness of anatomical structures, untreated marginal periodontal diseases may contribute to the formation of pathologies in the apical periodontium, especially those which are caused by the same anaerobic gram negative flora [40,41].

The literature also points out that a larger number of endodontically treated teeth is observed in people exposed to tobacco smoke. Studies of the Portuguese population revealed that the percentage of such teeth in smokers was higher (4.9%) in comparison with non-smokers (3.9%) [10]. According to Segura-Ege et al. [30], the number of teeth undergoing treatment increased with the years of addiction, and decreased over the years since quitting. This is in line with the results of the study of the Łódź population. In smokers, the percentage of teeth with filled root canals was 10.7%, and in non-smokers 9.6%. However, the data on this issue are not unequivocal, as the studies of the Croatian and Swedish populations did not confirm the existence of similar correlations [5,7].

Among the inhabitants of the Łódź region, the effect of smoking on the periodontal status of endodontically treated teeth was also assessed. There were no differences in the prevalence of periapical lesions in smokers compared to non-smokers (37.6% vs. 35.8%). Definitely higher values, but not statistically different, were obtained in Spain – 67% and 58%, respectively [30]. Similar results were reported by Peršić et al. [5] who studied the Croatian population, and by Marending et al. [42] who assessed the teeth of Swiss citizens.

The main aim of the endodontic therapy is to maintain the health of the apical periodontium. Despite this fact, root canal treatment is one of the most frequently reported tooth specific risk factors for AP [2,3,33]. Epidemiological reviews carried out in different countries indicate a correlation between the quality of root canal treatment and the presence of apical pathologies [19,22,43,44]. This was also confirmed by the results of this research. Periapical lesions were found in 80.8% of the teeth with improperly filled root canals, whereas in the properly treated teeth, the percentage was 15.7%.

In the teeth with incorrect endodontic treatment, the prevalence of AP was similar, equaling 81.4% among smokers and 80.0% among non-addicts. Only 15.7% of the correctly endodontically treated teeth had AP in both groups. Chances of the occurrence of apical pathologies in the teeth with improperly filled canals were higher among patients addicted to tobacco compared to non-smokers (23.46 and 21.56 times higher, respectively).

The literature also emphasizes the influence of non-tooth specific factors that may contribute to an increased risk of AP in smokers. According to the authors, tobacco addiction is correlated with a lower level of education and a poorer socio-economic status. Representatives of these social groups often have lower pro-health awareness and poorer hygiene, and they rarely visit a dentist [5,45].

CONCLUSIONS

1. Smokers are a group facing an increased risk of apical periodontitis and, therefore, there is a need for an early detection and treatment of caries and its complications in this group of patients.

2. The multifactorial etiology of apical periodontitis indicates the necessity to undertake further studies regarding the effect of smoking on the periapical status.

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