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Frequency of Periapical Radiolucency in CBCTs of Iranian Patients

Farzad Esmaeili[1], Masoomeh Johari[1], Mahdi Rahbar[2], Sona Molaei[1]*, Parisa Entezari[3]

[1]Department of Oral And Maxillofacial Radiology, Dental and Periodontal Research Center, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Department of Operative and Esthetic Dentistry, Dental and Periodontal Research Center, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[3]Department of Operative and Esthetic Dentistry, Dental Branch, Islamic Azad University, Tehran Iran

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ABSTRACT

The present study is aimed to determine the frequency of periapical periodontitis lesions in CBCT images, taken from patients referred to the Radiology Department of Dentistry Faculty of Tabriz University of Medical Sciences during 2014-2017. In this descriptive cross-sectional study, CBCT images were selected from 151 patients (84 women and 67 men, with mean age of 43 years), who were referred to this center. The recorded data included patients' age and sex, lesion's site, type, and condition of the teeth involved. The frequency of the lesions was determined based on these variables with the help of the chi-square test. P-value of ≤ 0.05 was considered statistically significant. Periapical lesions were observed in 123 patients (81.5%). There was a significant difference in the frequency of lesions among different age groups (p < 0.011). Out of 428 lesions, 73 cases (17.1%) were in the age group of < 30 years, 132 cases (30.8%) were in the age group of 31-40 years, 111 cases (25.9%) were in the age group of 41-51 years, and 112 cases (26.2%) were in the age group of > 51 years. The frequency of periapical lesions was not significantly different between male and female patients. Most lesions were seen on the right mandible (28.3%) and the 6th tooth (19.39 %). Frequency of lesions was higher in maxilla than mandible. In 23.36% of the cases, the involved teeth had proper root canal treatment and 39.33% had inappropriate root canal treatment. This work concluded that the prevalence of periapical radiolucency was very high in the studied patients and its prevalence increased in older patients and in teeth with complex anatomy.

Key words: Dental Digital Radiography, Diagnostic Imaging, Periapical Diseases

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***Corresponding author**: Sona Molaei
e-mail: sonamolaei@yahoo.com
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INTRODUCTION

Periapical lesions consist of inflammatory lesions (with pulpal and non-pulpal origin) and non-inflammatory lesions, such as cysts and tumors. Apical Periodontitis (AP) includes granuloma cysts and periapical abscesses. In some cases, the frequency of each of these lesions has been investigated among the periapical lesions [1]. Periapical inflammatory lesions cause the most common pathologic changes of mandibles. Unlike other bones, teeth act as a direct pathway, facilitating the entry of infections and inflammatory factors through decay and periodontal disease. When the primary source of the lesion is a necrotic pulp and bone lesion is limited to the dental area, it is called a periapical inflammatory lesion. Apical periodontitis is the result of a necrotic pulp, caused by microorganisms present in the root canal [2, 3]. Chronic inflammation in periapical tissues usually develops without any specific symptoms. Therefore radiographic images are still essential in identifying these lesions [4].

Panoramic and periapical radiographs have many applications in diagnosis, treatment, and follow up of treatment outcomes in patients with apical periodontitis. However, the two-dimensional nature of these images [4-6], the lack of information on the buccolingual plane, and the superimposition of structures on these

radiographs reduced their importance and effectiveness in detecting apical periodontitis lesions. According to some observations, apical periodontitis is detected only in these radiographies when cortical bone had mineral defects. However, these lesions can no longer be detected when apical periodontitis lesions are present in spongy bones [7]. In panoramic radiography, the anatomical details of periapical periodontitis lesions are not recognizable. Moreover, in periapical images, diagnosis is difficult for the observer due to the interference of other parts of the bone with periapical structures. Furthermore, the apical periodontitis is usually given less importance than what it deserves, or is not detected at all (in some cases of 2D radiographs) [8, 9].

Cone-beam Computed Tomography (CBCT) is a relatively new technology. It is designed following the development of digital radiography systems, which allows the preparation of 3D images of jaw and facial structures without the superimposition of anatomy. Common uses of CBCT in dentistry includes the following: evaluating the jaw for insertion of implants, examining teeth and facial structures in the orthodontic treatment plans, evaluating temporomandibular joints to determine degenerative changes of bone, assessing the proximity of mandibular third molar to mandibular canal prior to tooth extraction, and evaluating teeth and bone for signs of infection, cysts, and tumor [10].

Some researchers have shown that CBCT images, contrary to 2D radiographs, have a high accuracy to detect apical periodontitis lesions [4, 8, 9]. This is because this technique makes it possible to observe periapical areas in the sagittal, coronal, and axial sections. Moreover, CBCT technique is capable of examining the size and extent of the lesions as well as the condition and spatial relationship of lesions with the adjacent structures [8, 11].

Results of the prevalence of apical periodontitis in CBCT images in a Brazilian population showed the highest frequency of periapical lesions (71.3%) in the age group of 60-69 and in the molars [12]. In a recent study, apicalperiodontitis lesions were observed in most CBCTs that had a significant relationship with the patient's age and tooth type. However, no research has been done to investigate the prevalence of periapical periodontitis in the Iranian population. Therefore, the purpose of this study was to determine the rate of occurrence of periapical periodontitis in CBCTs, by studying patients who were referred to the Radiology Department of Tabriz Dentistry Faculty in 2017. The reason behind this investigation was the importance of identifying these lesions in different population groups within the country. Moreover, the availability of CBCT images and the potential superiority of this technique compared with conventional methods for the diagnosis of apical periodontitis lesions were grounds on which the study was conducted.

MATERIALS AND METHODS

This descriptive-cross sectional study collected the research data by the observation method and recorded them in a checklist. In this study, 151 patients, who were referred to the Oromaxillofacial Radiology Department of Tabriz Dentistry Faculty were evaluated during the study period of 2014-2017. Sampling was performed by multistage and census method. A list of patients with medical records in this department was prepared and all eligible patients were included in the sampling.

All CBCTs in patients' files were taken for therapeutic purposes and not for the sake of this study. Due to the retrospective nature of the research, patients were not contacted and the information related to their records was used for research purposes only (without disclosing their information).

The inclusion criteria consisted of having CBCT radiography with appropriate quality and having at least one tooth in CBCT. Patients under 12 years, toothless patients, and radiolucent images associated with known systemic diseases were excluded from the study [12]. None of the patients underwent CBCT radiography examinations for research purposes. CBCT scans in patients were performed for the following purposes: endodontic, periodontal, stomatology, dental implantation or surgical and orthodontic treatment.

The diagnostic criteria included the presence of radiolucency in periapical area of the involved tooth. These were categorized into: healthy groups, remained roots (treated root without corona), restored tooth, tooth with decay, tooth with proper root treatment (the root area was completely filled without empty space or bubble and the filling ends are 1-2mm apart from the

apex), and tooth with inappropriate treatment. Teeth with inappropriate treatment were further divided into 3 groups: overfilled, underfilled, and voided. Insufficient root filling or inappropriate treatment was considered as root canal space with bubble, poorly filled root, and filling by > 2mm of apex (underfilled) or outside the apex area (overfilled). In multiroot teeth, the root with the worst filling conditions was considered. The condition of apical radiolucency was determined in patients according to dental groups, including maxillary incisors and canines, maxillary premolars and molars, mandibular incisors and canines, maxillary molars, mandibularpremolars, and molars.

For preparation of images, CBCT Newtom VGI device (Verona, Italy) was used with a Field of View (FOV) of 3-25cm and each cut thickness of 0.01mm (m.A 3.5 and kV 110). All CBCT images were examined by a mandibulofacial radiologist with 5 years of clinical experience. The number of patients' teeth was recorded using panoramic-like images. Furthermore, periapical periodontitis was investigated in multiplanar and cross-sectional images.

The AP was examined in a 3-dimensional mode based on the checklist, and its association was studied in each patient, along with age, sex, number, and site of the teeth. Results were categorized and analyzed according to age, sex, lesion's site, and teeth condition. Differential diagnosis included periapical malignancies, such as osteosarcoma. This was due to the lack of other radiographic symptoms, including destruction of adjacent structures. Risk of periapical malignancy was very low (the incidence of periapical malignancies is rare and, therefore, it does not significantly interfere with the frequency of periapical inflammatory lesions). Two samples of periapical radiolucency CBCT images in this study are presented in Figures 1 and 2.

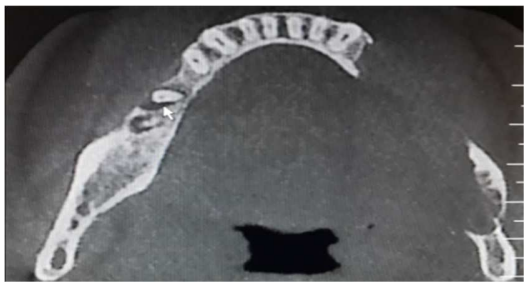

Figure 1: CBCT scan of periapical radiolucency in the left second molar

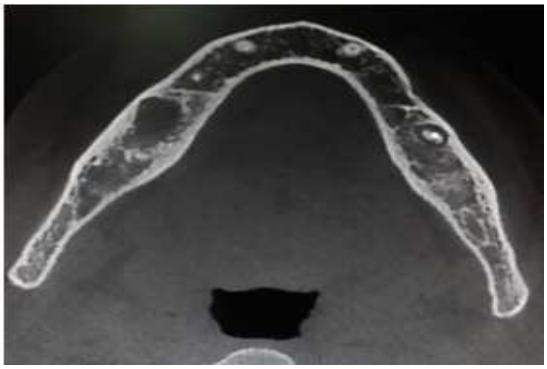

Figure 2: CBCT scan of periapical radiolucency in a 47-year old woman (right fisrt molar of mandible)

Data was analyzed using SPSS software version 18. For this purpose, frequency of periapical radiolucency was determined based on patients' age, lesion's sites, and the type and condition of tooth involved. For comparing the age difference between men and women, the student-t test was used. The difference in the frequency of lesions—based on the sex, age, lesion's site, and the condition of the involved teeth in the two sexes and different age groups—was statistically analyzed by the chi-square test. P-values ≤ 0.05 was considered statistically significant.

RESULTS

In this study, out of 151 subjects, 84 (55.6%) were women and 67 (44.4%) were men. The mean age of women was 41.2 ± 12.4 years and that of the men was 44.7 ± 12.0 years. According to the student-t test, the difference between the ages of male and female patients was not statistically significant (P = 0.09).

Out of the total 151 patients, 123 (81.5%) had a periapical radiolucency and 28 patients (18.5%) had no lesions. Among 123 patients with periapical radiolucency, a total of 428 lesions was observed. On investigation, 245 (57.2%) instances in women and 183 cases (42.8%) in men were identified (Chart 1). Furthermore, out of 428case, 123 patients were diagnosed with periapical radiolucency, 211 patients (49.3%) with lesions on the left side, 217 patients (50.7%) with lesions on the right side of the mouth, 199 cases (46.5%) with lesion in the maxilla, and 299 cases with lesion (53.5%) in the mandible (Chart 2). The frequency of periapical radiolucency site was reported in terms of sex in chart 3.

According to chi-square test results:
•There was no significant difference in the frequency of periapical radiolucency in terms of sex (P = 0.86).
•There was no significant difference in the frequency of periapical radiolucency according to lesion's site (P = 0.37).
•There was no significant difference in the periapical radiolucency site in terms of sex (P = 0.16).

The frequency of periapical radiolucency was investigated based on the number of teeth. The study showed that in women, (of the total 245 teeth affected) the highest frequency was in the 6th tooth with 49 cases (20%) and the lowest frequency was in the 8th tooth with 11 cases (4.49%). Among men, out of the 183 teeth involved in periapical lesions, the highest frequency was in the 5th tooth with 40 cases (21.86%) and the lowest frequency was in the 8th tooth with 4 cases (2.19%) (Chart4).

Investigation of the condition of the tooth involved in periapical radiolucency of the patients showed the following: healthy teeth in 10 cases (2.34%), teeth with residual root in 54 cases (12.62%), decayed teeth in 39 cases (9.11%), restored teeth in 55 cases (12.85%), teeth with appropriate root canal treatment in100 cases (23.36%), underfilled root canal treatment in 73 cases (17.06%), voided root canal treatment in 87 cases (20.33%), and overfilled in 10 teeth (34.2%). The frequency of each of the above, according to sex, is shown in Chart 5. The chi-square test showed a significant difference in teeth condition of periapical radiolucency in terms of sex (P = 0.008).

Investigation of periapical radiolucency in terms of age groups of the studied patients showed 22 patients with periapical radiolucency with ages < 30, 39 lesions in the age group of 31-40 years, 28 lesions in the age group of 41-50 years, and 34 lesions in the age group of >51 years (Table 1). The chi-square test showed a significant difference in the frequency of periapical radiolucency in terms of age groups (P = 0.011).

Out of 428, periapical radiolucency was detected in 123 subjects; 73 patients (17.1%) were in the age group of < 30 years, 132 patients (30.8%) in the age group of 31-40 years, 111 patients (25.9%) in the age group of 41-51 years, and 112 cases (26.2%) in the patients in the age group of > 51 years.

The results of investigating the condition of periapical radiolucency based on the involved type and side in different age groups of patients is shown in Chart 6. The chi-square test showed no significant difference in the condition of periapical radiolucency lesions in different age groups (P = 0.7).

The results of the frequency of the type of involved tooth in terms of periapical radiolucency—based on age group—showed that in the age group of <30 years, the highest frequency was found in the 6th tooth (19 cases; 26.03%) and the lowest frequency in the 3rd tooth (2 cases; 2.74%); in the age group of 31-40 years, the highest frequency was found in the 5th and 6th teeth (each with 27 cases; 20.45%) and the least frequency in the 8th tooth (4 cases; 3.03%); in the age group of 41-51 years, the highest frequency was related to the 5th tooth (22 cases; 19.22%) and the least frequency to the 8th tooth (3 cases; 7.2%); in the age group >51 years, the highest frequency was related to the 5th tooth (19 cases, 16.96%) and the least frequency was related to the 8thtooth (1 case; 0.89%). The frequency of other teeth involved in terms of periapical radiolucency in different age groups is provided in chart 7.

The condition of the involved teeth in terms of periapical radiolucency in different age groups of patients is shown in Chart 8. The results of chi-square test showed a statistically significant difference in the condition of the involved tooth in periapical radiolucency in different age groups (P = 0.02).

Table 1: Frequency of patients with periapical radiolucency lesions according to age groups

age / category Periapical lesions	<30 years	31-40 years	41-50 years	>51 years	Total
No lesion	7 (24.1%)	2 (4.9%)	4 (12.5%)	15 (30.6%)	28 (18.5%)
With lesion	22 (75.9%)	39 (95.1%)	28 (87.5%)	34 (69.4%)	123 (81.5%)
Total	29 (100 %)	41 (100 %)	32 (100 %)	49 (100 %)	151 (100 %)

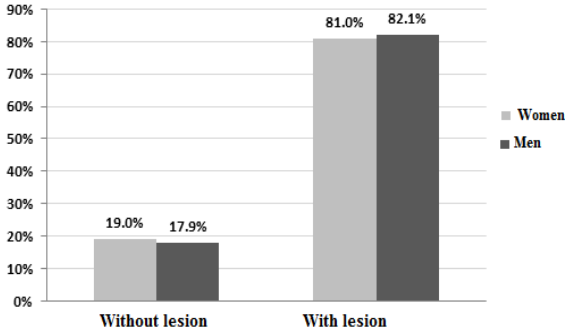

Chart 1: The frequency of periapical radiolucency lesions according to sex

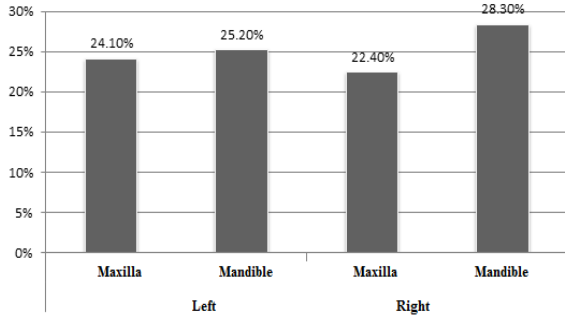

Chart 2: Comparison of the frequency of periapical radiolucency according to lesion's site

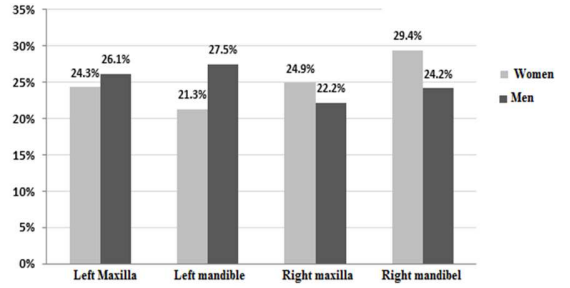

Chart 3: The frequency of periapical radiolucency lesions according to sex

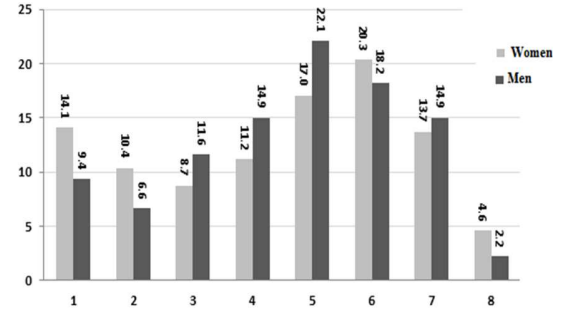

Chart 4: Frequency of the type of the teeth involved with periapical radiolucency lesions according to sex

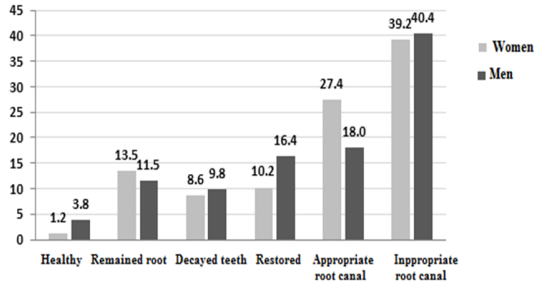

Chart 5: The frequency of the condition of the teeth involved with periapical radiolucency lesions according to sex

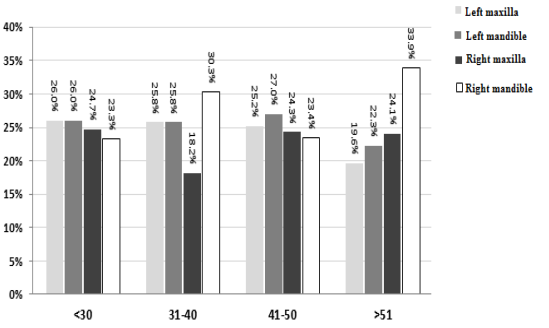

Chart 6: Frequency of the position of periapical radiolucency lesions according to age groups

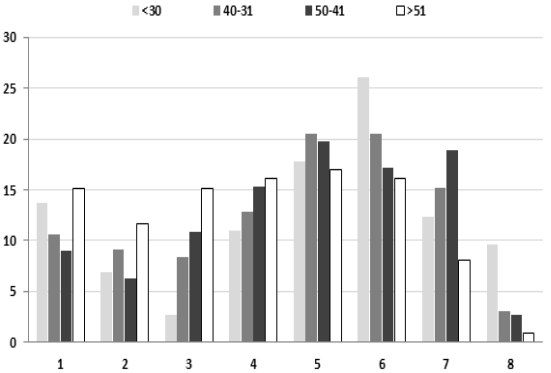

Chart 7: Frequency of the type of involved teeth with periapical radiolucency lesions according to age groups

DISCUSSION

The prevalence of periapical radiolucency has been reported from 20% to 52% in different societies, using different imaging methods [13, 14]. Considering the use of CBCT images as a new technology in the present study, it seems that the prevalence of AP lesions is different and possibly higher than found in studies using panoramic or periapical radiographs in different societies (due to its high diagnostic ability). The prevalence of AP lesions could be associated with various factors, such as patients' age, studied population, and the

results of assessment methods. In a study conducted by Paes da Silva Ramos Fernandes et al., (2013) on Brazilian population using the CBCT technique, AP lesions were reported in 51.4% of patients. This was significantly less, as compared with 81.5% in the present study [12]. Moreover, Estrela et al. (2008) reported the prevalence of apical periodontitis lesions in 17.6% and 63.3% of endo-treated teeth by conducting panoramic radiography and CBCT technique, respectively [8]. However, this too is less than that found in the current study. The high prevalence of AP lesions in this study can be explained by inappropriate oral hygiene and different characteristics of the studied population. On the other hand, the difference in the prevalence of AP lesions may be due to factors—such as differences in the studied population, absence of standards for preparation of various radiographic methods, difference in the methods of endodontic treatment between general dentists and endodontists, difference in the experience of the dentist who performs the endodontic treatment, and the differences in infection control rates in different societies. Moreover, several factors affect the radiographic evaluation of bone lesions, including the variable thickness of the cortical layer, the structure of the mineralized tissues, the lesion's condition, and the method used for evaluating radiographic images [7]. On the other hand, the greater difference in the frequency of apical lesions in CBCT technique than the panoramic technique can be due to high rates of false negative diagnosis in the panoramic radiograph.

The minimum age for inclusion of patients into the study was 12, and the mean age of patients was approximately 43 years. In the Brazilian research, the minimum age for participation was also 12 [12]. In other studies on AP lesions, the minimum age of the studied patients was 15 years [15], 16 [16, 17], 18 [18-20] or > 20 [21, 22]. Inclusion of adolescents in the present study was due to the importance of knowing about their dental status. According to the results of this study, there was a significant difference in the prevalence of periapical lesions among patients in different age groups. The prevalence of AP lesions was less in the age group of < 30 years than in other age groups. Out of 428 detected lesions, 73 cases (17.1%) were in the age group of < 30 years, 132 cases (30.8%) were in the age group of 31-40 years, 111 cases (25.9%) were in the age group of 41-50 years, and 112 (26.2%) in the age group of > 51 years. In the research by Paes da Silva Ramos Fernandes et al., (2013), it was concluded that the prevalence of AP lesions increased with age [12]. This finding was also documented in a number of other studies [18, 21].

The conditions and characteristics of the studied patients were important factors as to the results of the study. In most studies, patients who were referred for the first time to a dentistry faculty or clinic were evaluated [15, 18, 20-23]. Periapical and panoramic radiographs are the correct choices for initial examinations of patients who were referred to a medical center and need basic treatment. Nevertheless, the use of CBCT scans is not a simple and routine method due to high radiation dose. None of the CBCTs used in this study were for research purposes, and studied patients were receiving treatment at different departments of the Dentistry Faculty of Tabriz University of Medical Sciences. Hence, their oral hygiene may be better than those who were first referred to the Dentistry Faculty or clinic for panoramic or periapical radiographs (although there is no guarantee of this). According to the results of this study, the prevalence of AP was 81.8% and 82.1% in men and women, respectively, and there was no significant difference between them. Therefore, the incidence of AP lesions was not related to sex, as documented in several studies [16, 19, 22, 23].

In examining the condition of AP lesions, most of them were found on the right side of the mandible (121 of 428 lesions; 28.3%) and the first molar (83 of 428 lesions; 19.39%). The frequency of lesions was higher in maxilla than that in mandible (46.5% vs. 53.5%). The complex anatomy of the posterior teeth seems to increase the risk of developing dental caries. This can be due to increased levels of plaque accumulation, difficulty in maintaining oral hygiene, and difficulty in shaping and filling during root canal treatments. Furthermore, oral hygiene is more difficult in maxilla as compared to mandible.

In examining the condition of the teeth affected by periapical lesions, 36.23% of the cases had proper root treatment and 20.33% voided. While in 34.2% of cases, the involved tooth was healthy and a same percentage of them had overfilled teeth. Since the root canal treatment involves performing actions such as proper cleansing, forming, and/ or restorative processes, the quality of these treatments cannot be assessed on images. This is one of the limitations of cross-sectional

research when using images. Similarly in these studies, there is no information available on the biological factors and the clinical conditions [5, 16]. Due to the high frequency of inappropriate root canal treatment, perhaps these incomplete treatments are one of the factors associated with the incidence of AP lesions in patients. Moreover, in these cases, the bacteria remain within the root canal system and the restored tooth [3].

According to Tsuneishi et al., (2005), the prevalence of AP lesions varies depending on patients' age, type of tooth, and the quality of root canal treatments. This was investigated in the present study, like the Brazilian study [12, 21]. In the present study, the studied patients included those who were referred to one department in one city. Considering the vast geography of Iran, undoubtedly the results cannot be generalized to the whole community living in the country. However, it resulted in generating useful information on the prevalence of apical periodontitis lesions. Using its findings, new therapeutic strategies can be designed to prevent periapical area diseases. In addition, according to the results, CBCT images can be useful for epidemiological evaluations in further studies.

According to researchers, the present cross-sectional study evaluated the prevalence of periapical radiolucency lesions in an Iranian population using CBCT technology. According to previous reports, CBCT technique is superior to the conventional radiographic methods for diagnosis of periapical lesions [4, 8, 24, 25]. The reliability of observers is confirmed with high kappa values in CBCT and, therefore, CBCT technique is a useful tool in cross-sectional studies. They are useful in detecting and diagnosing periapical lesions. Farman (2007) reported that CBCT could determine more accurate periapical lesions, and the value of periapical radiography was limited due to the absence of apical periodontitis [26]. Furthermore, Christensen et al. (2009) showed higher periapical lesions detected by CBCT images, as compared with periapical radiography [27].

In the present study, only CBCT images of patients were used to determine the prevalence of periapical lesions. While in previous epidemiological studies, panoramic images [15, 18, 28, 29] or complete oral periapical radiographs were also used [16, 19, 21, 23].

In the present study, CBCTs with only maxilla or mandible detected with specific scanning protocols, such as lower FOV were excluded from the study. In these cases, no information could be obtained about the opposite jaw. Since the periapical lesions could exist in the opposite jaw as well, the validity of the results would have been limited. Therefore, it is suggested to investigate the prevalence of periapical lesions using radiographic images and include both jaws. However, if the goal is to determine the frequency of apical lesions in the tooth, the radiographs of the jaws can also be examined separately (since the total number of teeth is determined in these cases).

The emergence of CBCT technique in dentistry has brought about tremendous changes. With a slight increase in patient's dose, this technique helps in obtaining useful and proper information on quality and quantity, as compared with other radiographic images. In most cases, this increased dose is justified in comparison with the information obtained. However, it should be noted that various studies were conducted on whether it is necessary to use this technology to increase the diagnostic accuracy of dental structures and treatments based on these diagnosis or not. In fact, if this imaging modality does not lead to an obvious increase in the diagnostic accuracy, there would be no reason to increase the dose in dental clinics. The patients' dose in CBCT images is about 3 to 7 times higher than the usual radiography technique and its use is time-consuming. However, the patients' dose in CBCT technique in dentistry is much less than CT scan images [30].

Despite considerable benefits of the CBCT technique, artifacts in the dental root canal and its effect on the apical area can cause problems in diagnosis and assessment of the apical area in dental root canal treatment [4]. Of course, in designing a treatment plan especially apical surgery the presence of CBCT images is important. Endodontic patients especially without specific pathology in their apical region, but with suggestive clinical findings or in surgeries for multiroot teeth three-dimensional CBCT technique should be used. Moreover, it should not be limited to radiographic routines.

Overall, the prevalence of periapical lesions was remarkable in patients referred to the Radiology Department of the Dentistry Faculty of Tabriz University of Medical Sciences. It was associated

with factors such as age and condition of the tooth involved in AP lesions. Therefore, older patients with complex anatomy and inadequate endodontic treatments were more likely to develop these lesions.

The limitations of this study included the fact that the results of the study were limited to patients referring to one department in one city. Furthermore, the clinical conditions of root canal treatment could not be evaluated for patients due to the cross-sectional and retrospective nature of the study.

For further studies, it is suggested that the prevalence of periapical radiolucency be examined in patients who were referred to other dentistry faculties or private clinics. It is suggested to use different imaging modalities for the diagnosis of periapical periodontitis lesions and the frequency of periapical radiolucency lesions on the first visits of the patients to dental and private clinics.

CONCLUSION

The results of studying the prevalence of periapical radiolucency in CBCTs of patients, referred to Oromaxillofacial Radiology Department of Dentistry Faculty of Tabriz University of Medical Sciences, Tabriz, Iran, during 2014-2017, showed:

- The prevalence of periapical radiolucency lesions was 81.0% and 82.1% in men and women, respectively, without significant difference between them.
- Most lesions were on the right mandible (28.3%) and the 6th tooth (19.39%). The frequency of lesions was higher in maxilla than mandible (53.5% vs. 46.5%).
- In 23.36% of the cases, the involved tooth had appropriate root canal treatment and 39.73% had inappropriate root canal treatment. While 2.34% of the cases had healthy teeth.
- In general, the prevalence of periapical radiolucency was higher in the studied patients and its frequency increased in older patients with complicated teeth anatomy. CBCT is a useful imaging tool for estimating the prevalence of periapical lesions in cross-sectional studies.

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Conflict of interest
The authors hereby report no conflicts of interest with regards to this work.

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