IEJ Iranian Endodontic Journal

Pattern of Endodontic Periapical Lesion Extension in Anterior Teeth: A CBCT Study in an Iranian Population

Maryam Kazemipoor [a,b], Farinaz Sabaghzadegan [a*], Fatemeh Ezoddini Ardakani [c]

a Department of Endodontics, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran; b Social Determinants of Oral Health Research Center, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran; c Department of Oral & Maxillofacial Radiology, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

ARTICLE INFO

Article Type: **Original Article**

Received: 08 Feb 2019
Revised: 23 Jun 2019
Accepted: 02 Jul 2019
Doi: *10.22037/iej.v14i4.24188*

**Corresponding author*: Farinaz Sabaghzadegan, Department of Endodontics, School of Dentistry, Emam St. Dahe Fajr Blvd., Yazd, Iran.

Tel: +98-913 3598543
E-mail: farinazsabagh@yahoo.com

ABSTRACT

Introduction: Health of periapical tissues has been considered as an index for the evaluation of endodontic outcomes. The present study sought to assess the pattern of periapical lesion extension in anterior teeth using cone-beam computed tomography (CBCT). **Methods and Materials:** In this descriptive study, 199 CBCT images belonged to patients aging from 15 to 79 were assessed according to periapical lesion extension in the regions of maxillary and mandibular anterior teeth. Maximum periapical lesion extensions in three orthogonal planes were measured and recorded in millimeters and were assessed according to age, gender, dental arch and tooth type. Statistical analysis was performed using percentages, repeated measure ANOVA and Bonferroni tests. The significant level was set at 0.05. **Results:** The highest average of lesion extension, in both maxilla and mandible, was in vertical dimension, followed by horizontal buccolingual and horizontal mesiodistal dimensions, respectively. There were significant differences between the vertical and mesiodistal (P=0.004) and also mesiodistal and buccolingual (P=0.010) periapical lesion extension dimensions. In addition, there were significant differences in maxilla and mandible (P=0.012). In maxilla, there were no significant differences between the three tooth types (P=0.346) but in the mandibular arch, there were significant differences between central-canine (P=0.004) and lateral-canine (P=0.026). According to independent variables, only gender had a significant effect on the lesion extension in anterior regions of maxilla and mandible (P=0.001). The periapical lesion extensions were significantly higher in men compared with women. **Conclusions:** The bone destruction_as a consequence of periapical inflammatory process_ was greatest in the vertical, and lowest in the horizontal mesiodistal dimensions. That way, the extension in buccolingual dimension, which could not be detected in the 2-D imaging techniques, was rather high in the present study. Thus CBCT, as a 3-D imaging technique, could be recommended for the precise evaluation of lesion extension in the periapical area.

Keywords: Cone-beam Computed Tomography; Diagnosis; Endodontics; Periapical Disease; Periapical Lesion; Periapical Periodontitis

Introduction

Microorganisms in dental caries are the main causes for induction of pulpal and periradicular tissue . Dental pulp is infected as a result of exposure to oral cavity, bacteria and their products [1]. Usually, it cannot eliminate such harmful provocations and therefore, even in the best instances, defense mechanisms can temporarily prevent the spread of infection and tissue damage [2]. If provocations are persistent, inflammation is first observed throughout the pulpal tissue, and as a result, this process will lead to pulp necrosis [3]. Ultimately, bacteria or their byproducts, and other necrotic pulp stimulants-expanded from the canal to the apical side as well as an inflammatory lesion- will establish themselves in the periapical area [3].

Methods for detecting periapical lesions with dental origin include histological sections and imaging methods. Imaging methods include intra-oral radiography, occlusal, panoramic, and 3D imaging, such as cone-beam computed tomography (CBCT) [4].

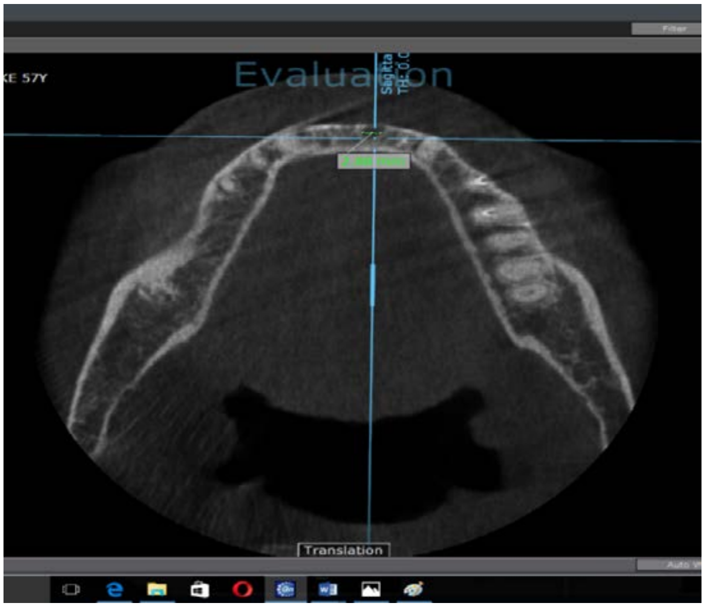

Figure 1. Periapical lesion extension in the axial view

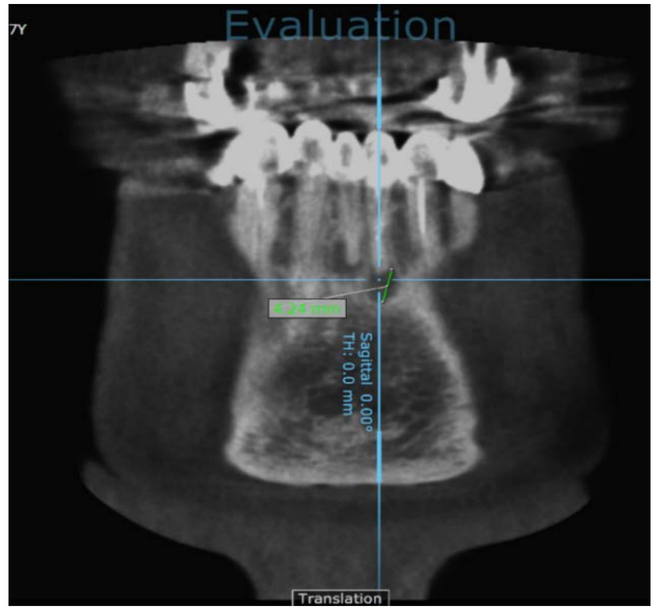

Figure 2. Periapical lesion extension in the coronal view

According to the studies conducted, a lesion -in radiographic images- is clearly observed when 30%-50% of the bone mineral content has been removed [5], or when the lesion reaches the point of contact with spongy and cortical bone [6].

Furthermore, in radiographic images, the degree of periapical lesion detection depends on various factors; such as the density of the surrounding bone [6], the contrast and angle of the x-ray beam [7], the position of the tooth [8], the size of the lesion [9] and the three-dimensional shape of the lesion (lesion extension pattern) [10].

Apical periodontitis lesions, smaller than 1-2 mm in size, cannot be detected in periapical radiography [10]. On the other hand, the size of bony lesions in periapical radiography is always smaller than that of the lesion in bone [11]. In CBCT imaging technique, there is a possibility of three-dimensional evaluation of the jaw and bone surrounding the teeth [12]. Therefore, it is possible to identify and precisely diagnose periapical lesions and the extension process in bone plates using CBCT [13]. Some studies compared the accuracy of CBCT imaging and intraoral radiography in the diagnosis of periapical lesions [14]. Based on the results of these studies, compared with two-dimensional radiographies, CBCT images can detect small radiolucency in the periapical region (0.5-1 mm) [15].

A few studies have investigated the effect of periapical lesions on the diagnostic accuracy of CBCT imaging technique compared with other two-dimensional imaging methods [9, 16]. However, using CBCT imaging -to show the pattern of periapical lesion extension in different regions of the jaws- has not yet been studied. Therefore, the objective of this study was to investigate the extension pattern of inflammatory periapical lesions in anterior teeth using CBCT imaging technique.

Materials and Methods

All the experimental periods in this study were approved by Shahid Sadoughi University of Medical Sciences Ethics Committee Yazd, Iran (IR.SSU.REC.1396.200). In this descriptive study, 199 CBCT archived images, prepared by Scanora 3D (Soredex, Tuusula, Finland) with image capture parameters set at 90 kVp, 13 mA, scan/exposure time of 16/3.75 sec, were used. The slice thickness was 0.5 mm, and the voxel size was 0.20 mm. 94 participants (47.2%) were male and 105 (52.8%) were female. The mean age was 49.64±13.87 years with an age range of 15 to 79.

Images from 199 patients were divided into 3 different age groups: *a)* 15-44, *b)* 45-54, and *c)* 55-79 years old. The studied teeth included maxillary and mandibular central incisors, lateral incisors and canine teeth with periapical lesions. The samples were excluded in case of perforation of one of the buccal or lingual-palatal plates and open apices.

CBCT images were evaluated using Toshiba computer (Satellite A200-Th1 Notebook Screen Size 15.40" Screen Resolution 1280×800) and studied in Ondemand 3D software (CyberMed, Seoul, South Korea).

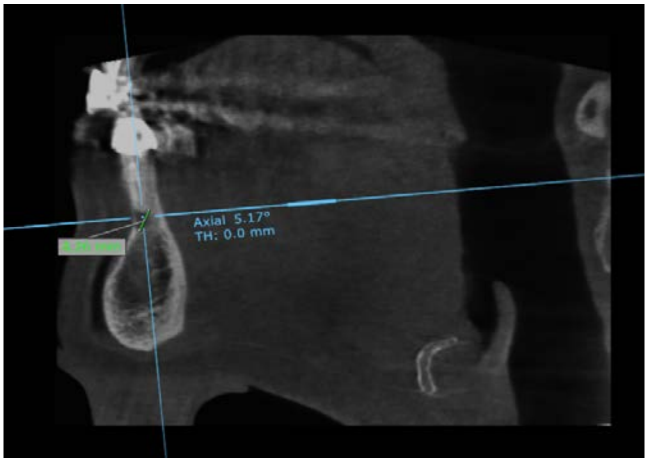

Figure 3. Periapical lesion extension in the sagittal view

The sections of the teeth were stored in all three -axial, sagittal, and coronal planes in Digital Imaging and Communications in Medicine (DICOM) format and analyzed in a semi-dark room. In OnDemand3D software, the images were evaluated for having patient-specific criteria (age, sex, dental arches, and type of tooth) using Database Manager (DBM) analysis of DICOM files. Information for each patient was recorded in the tables provided for the purpose of this study.

In all three planes axial, coronal, and sagittal, the cuttings with the lowest thicknesss (0.5 mm) were chosen to interpret and evaluate the precision of the periapical lesions. Considering the resolution of each image, "Sharpen filter" was used to evaluate and improve the sharpness of images. The filter was set on filtered off, 1× and 2×, and periapical lesions were evaluated in the three states. The internal zoom of the software and the manual magnifier with a magnification of 2.5× was used for zoom, increased accuracy, and visibility. To detect and determine the presence of desired teeth, the researchers moved the ROI (region of interest) and Range toolbar along the path of the three primary and secondary regions (including the number of images taken in the axial view of the patient's skull). Then, the lesion area from the apex region of the teeth was examined in the axial view and the maximum horizontal extensions of the periapical lesion in the buccolingual (buccopalatal) and mesiodistal dimensions were determined in mm (Figure 1).

Following that, in the mid-coronal view, the maximum vertical extension of the lesion in the occluso-apical (vertical) dimension and the maximum horizontal extension of the lesion in the mesiodistal dimension were determined (Figure 2). In the mid-sagittal view, the maximum extent of the vertical extension of the lesion in the occluso-apical dimension and the maximum horizontal extension of the lesion in the buccolingual dimension were measured and the numbers obtained were recorded in the relevant table (Figure 3). The lesion outline and the changes along the border of the lesion were determined using Hounsfield number. The highest extension values for each anterior tooth were reported in the relevant plane.

Screening of CBCT images was done by an endodontist and radiologist simultaneously. Data obtained from this study were recorded in SPSS software (SPSS version 17.0, Chicago, IL, USA). The data were analyzed using repeated measure ANOVA and Bonferroni tests. The significance level was set at $P<0.05$.

Results

In general, in the population examined, the highest average of lesion extension was reported in the vertical dimension (2.8±1.8), then in the horizontal buccolingual dimension (2.7±1.1) and finally in the horizontal mesiodistal dimension (2.5±1.3).

There was a significant statistical difference between the amount of vertical and mesiodistal lesion extensions (P=0.004), and between the two horizontal dimensions (P=0.010). No significant statistical differences were observed between the vertical and buccolingual lesion extensions (P=0.362).

Evaluation and comparison of lesion extension in three dimensions according to age

The average of lesion extensions in the three examined dimensions according to age is summarized in Table 1.

In the three age groups, the highest extension was observed in the vertical followed by buccolingual and mesiodistal dimensions. Thus, the pattern of periapical lesion extension in the three age groups was similar. Considering the effect of age, there were no significant differences in lesion extension observed in the three age groups (P=0.859).

Evaluation and comparison of lesion extension in three dimensions according to gender

The average of lesion extensions in the three examined dimensions according to gender is summarized in Table 2.

Considering the effect of gender, there were significant differences in lesion extension attributed to men and women (P=0.001). The lesion extensions were significantly higher in men compared with women. There was a significant difference between the extent of periapical lesions in all three dimensions of vertical (P=0.000), mesiodistal (P= 0.002), and buccolingual (P= 0.002) between men (n=94) and women (n=105).

Evaluation and comparison of lesion extensions in three dimensions according to dental arch and tooth type

In this study, 36.2% of the samples belonged to maxilla and 63.8% belonged to mandible.

The means and standard deviations of lesion extensions in the three dimensions are summarized in Table 3.

The samples included 52.3% central teeth, 30.2% lateral teeth, and 17.6% canine teeth. The means and standard deviations of the lesion extensions in the three dimensions examined in terms of the type of tooth are summarized in Table 4.

The highest average of lesion extensions, in both maxilla and mandible, was in the vertical dimension, followed by the horizontal buccolingual and horizontal mesiodistal dimensions, respectively. Considering the two variables of tooth type and dental arch (repeated measure ANOVA), there were significant differences in periapical extensions of the three tooth type in maxilla and mandible (*P*=0.012). In maxilla, there were no significant differences between the three tooth types (*P*=0.346), but in mandible, there were significant differences between the three tooth types (*P*=0.005). Based on Bonferroni test, in the mandibular arch, there were significant differences between central-canine (*P*=0.004) and lateral-canine (*P*=0.026).

Discussion

Health of periapical tissues has been considered as an index for the evaluation of endodontic outcomes [16, 17]. Another concern -with regard to periapical lesions- is the pattern of bone destruction and extension in the three spatial planes [18]. Adequate bone volume, which remains following the extraction of a hopeless tooth with periradicular lesion, plays an important role in osseointegration and success of implant placement [4].

Although intraoral periapical radiographs are the most commonly used treatment adjuncts -due to *a)* the compression of 3D structures (superimposition), *b)* geometric distortion and *c)* anatomical noise- limited information is available for periapical lesions [19]. The aim of the present study was to evaluating the pattern of bone destruction resulted from assess the pattern of periapical lesion extensions in anterior teeth; using CBCT imaging technique.

Studies have shown that for the detection of a periapical lesion in periapical radiography, bone demineralization should reach approximately 30%-50% [19]. Other factors like x-ray angulation, shape of the lesions , size and location (restriction in the cancellous bone) may interfere with the detection of apical periodontitis in 2D periapical radiography [20]. Pattern of periapical lesion extensions is correlated with the thickness of cortical bone and position of the root tip in relation with the cortex, which varies with tooth position [16].

The present research is, to the best of the authors' knowledge, the first study to assess the pattern of periapical lesion extensions in anterior region of maxilla and mandible. Based on the results of the present study, the highest average of lesion expansions was reported in the vertical dimension, followed by buccolingual and mesiodistal dimensions, respectively. There were significant differences between the lesion expansions in the vertical and mesiodistal, and also mesiodistal and buccolingual dimensions.

The development of periapical lesions have been investigated histologically in a number of studies [21, 22]. Yu and Stashenko [23] evaluated the histopathogenesis, dynamics and size of periapical lesions using radiographic and histologic methods in a rat model . They concluded that periapical lesions were radiographically detectable in virtually all animals on day 15. They also reported that the maximum rate of bone loss occurred approximately between day 1 and 15 (the most active phase of periapical lesion pathogenesis), followed by a relative size stability between days 15 and 30 (more chronic phase). It seems that the active phase for periapical lesion extensions mostly occurred before its detection in radiographic images. Therefore, the patterns of lesion extensions that were observed

Table 1. Means (SD) of lesion extensions in three dimensions according to age

Age (N)	Occlusoapical	Mesiodistal	Buccolingual
15-44 (68)	2.90 (2.22)	2.56 (1.45)	2.78 (1.30)
45-54 (66)	2.94 (1.72)	2.61 (1.42)	2.88 (1.34)
55-79 (65)	2.76 (1.45)	2.49 (1.02)	2.52 (0.79)
Total (199)	2.85 (1.81)	2.55 (1.28)	2.71 (1.15)

Table 2. Means (SD) of lesion extensions in three dimensions according to gender

Gender (N)	Occlusoapical	Mesiodistal	Buccolingual
Male (94)	3.50 (2.28)	2.84 (1.50)	3.02 (1.45)
Female (105)	2.38 (1.28)	2.27 (1.02)	2.50 (0.79)
Total (199)	2.91 (1.90)	2.54 (1.30)	2.75 (1.18)

Table 3. Means (SD) of lesion extensions in three dimensions according to dental arch

Dental arch (N)	Occlusoapical	Mesiodistal	Buccolingual
Maxilla (72)	3.07 (1.93)	2.83 (1.24)	3.00 (1.35)
Mandible (127)	2.81 (1.90)	2.37 (1.31)	2.60 (1.04)
Total (199)	2.91 (1.9)	2.54 (1.30)	2.75 (1.18)

Table 4. Means (SD) of the lesion extensions in three dimensions according to tooth type

Type of tooth (N)	Occlusoapical	Mesiodistal	Buccolingual
Central (104)	2.64 (1.73)	2.46 (1.22)	2.73 (1.21)
Lateral (60)	3.07 (1.94)	2.47 (1.48)	2.71 (1.01)
Canine (35)	3.45 (2.24)	2.90 (1.18)	2.90 (1.36)
Total (199)	2.91 (1.91)	2.54 (1.30)	2.75 (1.18)

in the present study had been stabilized at the time of evaluation. Yamasaki *et al.* [22] -in a histological study- concluded that at first, periapical lesions extended mesiodistally with the resorption of cortical bone and cementum, and then progressed vertically.

Considering the effect of gender on periapical lesions, there are only prevalence studies [24, 25] and no surveys are directed towards the pattern of periapical lesion extensions based on gender. The present study recorded significant differences between periapical lesion extensions in males and females. Totally, the extension of periapical lesions was significantly higher in men compared with women. In men participants, the highest mean value of extension was in vertical dimension and in women the highest value was in horizontal buccolingual dimension. Considering the age factor, in the age group of 15-44 years, there was a significant difference between the lesion extension in vertical and mesiodistal dimensions. In the age group of 45-54 years, there was a significant difference between the lesion extension in mesiodistal and buccolingual dimensions. In the age group of 55-79 years, there were no significant differences between the lesion extensions in the three dimensions. Although, in different age groups, the quality and quantity of bone structure and immunological responses altered considerably, the pattern of periapical lesion extensions was similar in the three age groups examined in the present study [26].

Based on the results of the present study, and in comparison with the mandibular region, the lesion extensions were higher in the anterior maxillary arch; nevertheless the difference was not significant. Maxillary central tooth and canine had the highest lesion extensions in the buccolingual dimension. However, and in contrast, lateral tooth showed the highest value in the vertical dimension. In the anterior mandibular region, the highest lesion extensions in the three examined teeth were recorded in the vertical dimension.

The differences in the lesion extensions in the maxillary and mandibular arches may be attributed to the thickness of the compact and cancellous (spongy) bone in the maxilla and mandible. Considering the effect of the dental arch and tooth type, there were only significant differences between the lesion extensions in the mandibular teeth but not in the maxillary ones. The lesion extensions in maxillary arch were similar in the three examined tooth types. However, in the mandibular arch, canine showed statistically significant differences with the central and lateral teeth. The highest value of lesion extension was observed in mandibular canine.

The location of the root and the quantity of the surrounding bone may be considered as contributing factors for the difference in pattern and quantity of bone destruction observed in different tooth types [9].

Another important factor in the detection of periapical lesions is the study sample [4, 9] . Artificially, creating lesions in animal models with different maxillary and mandibular bones may result in different patterns of periapical lesions compared with human samples [4]. The thickness of the surrounding cancellous bone plays an important role in the extension of periapical lesions in different areas of maxillary and mandibular bones [9].

Studies have revealed that the CBCT imaging technique is a suitable method for the evaluation of buccolingual view of a resorption area; since the addition of one more dimension to radiographic views could significantly enhance the power of precise diagnosis [27, 28]. Moreover, different CBCT image type, size and voxel play an important role in differential diagnosis. Based on a systematic review study, the cross-sectional images, which were applied in the present study, can provide more accurate assessment of periodontal bone loss [29].

Application of CBCT imaging technique should be limited to cases in which precise detection of bone destruction is needed. Since *in vivo* periapical lesions typically show no clean and distinct edges, application of image processing techniques could improve the detection of lesions borders. Future clinical studies in different populations are required to establish the pattern of periapical lesion extensions in relation to different maxillary and mandibular teeth.

Conclusion

Within the limitations of the present study, periapical lesion extensions in the anterior region of maxillary and mandibular bone structures followed a delicate and precise pattern. In the anterior region of maxilla and mandible, the highest extension occurred in the vertical followed by the horizontal buccolingual and horizontal mesiodistal dimensions. It seemed that the quality (cancellous *vs* compact bone) and quantity of surrounding bone structure determined the pattern of the lesion extension in the anterior region of maxilla and mandible. Moreover, the periapical lesion extension in the buccolingual dimension, which could not be detected in the 2-D imaging techniques, was rather high in the present study. Thus, CBCT -as a 3-D imaging technique- is a suitable option for the precise evaluation of lesion extensions in the periapical region. For better evaluation of the lesion extensions attributed to the different areas of the jaws, future studies *a)* on the posterior regions of the jaws, *b)* in different communities and *c)* on racial context are highly recommended to be designed.

Acknowledgment

The authors wish to express their special thanks to Roqayeh Hakimian for her technical assistance and Mohammad Hossein Ahmadie for his biostatistical advice.

The present study was supported by the Vice chancellor of research and technology, Shahid Sadoughi University of Medical Sciences.

Conflict of Interest: 'None declared'.

References

1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol. 1965;20:340-9.
2. Sabeti M, Valles Y, Nowzari H, Simon JH, Kermani-Arab V, Slots J. Cytomegalovirus and Epstein-Barr virus DNA transcription in endodontic symptomatic lesions. Oral Microbiol Immunol. 2003;18(2):104-8.
3. Hahn CL, Liewehr FR. Innate immune responses of the dental pulp to caries. J Endod. 2007;33(6):643-51.
4. Sakhdari S, Talaeipour AR, Talaeipour M, Pazhutan M, Tehrani SH, Kharazifard MJ. Diagnostic Accuracy of CBCT with Different Voxel Sizes and Intraoral Digital Radiography for Detection of Periapical Bone Lesions: An Ex-Vivo Study. J Dent (Tehran). 2016;13(2):77-84.
5. Bender IB, Seltzer S. Roentgenographic and direct observation of experimental lesions in bone: II. 1961. J Endod. 2003;29(11):707-12; discussion 1.
6. Ricucci D, Mannocci F, Ford TR. A study of periapical lesions correlating the presence of a radiopaque lamina with histological findings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;101(3):389-94.
7. Halse A, Molven O, Fristad I. Diagnosing periapical lesions--disagreement and borderline cases. Int Endod J. 2002;35(8):703-9.
8. Shoha RR, Dowson J, Richards AG. Radiographic interpretation of experimentally produced bony lesions. Oral Surg Oral Med Oral Pathol. 1974;38(2):294-303.
9. Tsai P, Torabinejad M, Rice D, Azevedo B. Accuracy of cone-beam computed tomography and periapical radiography in detecting small periapical lesions. J Endod. 2012;38(7):965-70.
10. Gao Y, Haapasalo M, Shen Y, Wu H, Jiang H, Zhou X. Development of virtual simulation platform for investigation of the radiographic features of periapical bone lesion. J Endod. 2010;36(8):1404-9.
11. Santos Junior O, Pinheiro LR, Umetsubo OS, Cavalcanti MG. CBCT-based evaluation of integrity of cortical sinus close to periapical lesions. Braz Oral Res. 2015;29.
12. Deman P, Atwal P, Duzenli C, Thakur Y, Ford NL. Dose measurements for dental cone-beam CT: a comparison with MSCT and panoramic imaging. Phys Med Biol. 2014;59(12):3201-22.
13. Patel S, Durack C, Abella F, Shemesh H, Roig M, Lemberg K. Cone beam computed tomography in Endodontics - a review. Int Endod J. 2015;48(1):3-15.
14. Durack C, Patel S, Davies J, Wilson R, Mannocci F. Diagnostic accuracy of small volume cone beam computed tomography and intraoral periapical radiography for the detection of simulated external inflammatory root resorption. Int Endod J. 2011;44(2):136-47.
15. Estrela C, Bueno MR, Azevedo BC, Azevedo JR, Pecora JD. A new periapical index based on cone beam computed tomography. J Endod. 2008;34(11):1325-31.
16. Esposito S, Cardaropoli M, Cotti E. A suggested technique for the application of the cone beam computed tomography periapical index. Dentomaxillofac Radiol. 2011;40(8):506-12.
17. Torabinejad M, Kutsenko D, Machnick TK, Ismail A, Newton CW. Levels of evidence for the outcome of nonsurgical endodontic treatment. J Endod. 2005;31(9):637-46.
18. Kiarudi AH, Eghbal MJ, Safi Y, Aghdasi MM, Fazlyab M. The applications of cone-beam computed tomography in endodontics: a review of literature. Iran Endod J. 2015;10(1):16-25.
19. Saidi A, Naaman A, Zogheib C. Accuracy of Cone-beam Computed Tomography and Periapical Radiography in Endodontically Treated Teeth Evaluation: A Five-Year Retrospective Study. J Int Oral Health. 2015;7(3):15-9.
20. Patel S. New dimensions in endodontic imaging: Part 2. Cone beam computed tomography. Int Endod J. 2009;42(6):463-75.
21. Yamasaki M, Kumazawa M, Kohsaka T, Nakamura H, Kameyama Y. Pulpal and periapical tissue reactions after experimental pulpal exposure in rats. J Endod. 1994;20(1):13-7.
22. Yamasaki M, Nakane A, Kumazawa M, Hashioka K, Horiba N, Nakamura H. Endotoxin and gram-negative bacteria in the rat periapical lesions. J Endod. 1992;18(10):501-4.
23. Yu SM, Stashenko P. Identification of inflammatory cells in developing rat periapical lesions. J Endod. 1987;13(11):535-40.
24. Becconsall-Ryan K, Tong D, Love RM. Radiolucent inflammatory jaw lesions: a twenty-year analysis. Int Endod J. 2010;43(10):859-65.
25. Jamshidi S, Shojaei S, Roshanaei G, Modabbernia S, Bakhtiary E. Jaw Intraosseous Lesions Biopsied Extracted From 1998 to 2010 in an Iranian Population. Iran Red Crescent Med J. 2015;17(6):e20374.
26. Florenzano P, Pan KS, Brown SM, Paul SM, Kushner H, Guthrie LC, de Castro LF, Collins MT, Boyce AM. Age-Related Changes and Effects of Bisphosphonates on Bone Turnover and Disease Progression in Fibrous Dysplasia of Bone. J Bone Miner Res. 2019.
27. Friedland B, Faiella RA, Bianchi J. Use of rotational tomography for assessing internal resorption. J Endod. 2001;27(12):797-9.
28. Madani Z, Moudi E, Bijani A, Mahmoudi E. Diagnostic Accuracy of Cone-Beam Computed Tomography and Periapical Radiography in Internal Root Resorption. Iran Endod J. 2016;11(1):51-6.
29. Anter E, Zayet MK, El-Dessouky SH. Accuracy and precision of cone beam computed tomography in periodontal defects measurement (systematic review). J Indian Soc Periodontol. 2016;20(3):235-43.

Please cite this paper as: Kazemipoor M, Sabaghzadegan F, Ezoddini Ardakani F. Pattern of Endodontic Periapical Lesion Extension in Anterior Teeth: A CBCT Study in an Iranian Population. Iran Endod J. 2019;14(4): 259-64. *Doi: 10.22037/iej.v14i4.24188.*