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Unilocular Radiolucent Lesions of the Jaws: a Retrospective Panoramic and Cone Beam Computed Tomography Evaluation

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SUMMARY

Background/Aim: *The aim of this study was to evaluate and compare the imaging characteristics of common, radiolucent, unilocular, intraosseous lesions of the jaws using both panoramic radiography and cone beam computed tomography (CBCT); also, to evaluate sufficiency of panoramic radiography in determining characteristic features of jaw lesions.* ***Material and Methods:*** *Retrospectively selected images of 57 patients with histopathology results were evaluated by two oral radiologists. The lesions were assessed based on shape, location, borders, relationship with the mandibular canal, presence of destruction of cortical bone, and expansion of cortical bone, and presence of an unerupted tooth related to the lesion. In addition, the widest areas of the lesions were measured. A total of 9 (15.8%) odontogenic keratocysts, 9 (15.8%) apical granulomas, 24 (42.1%) radicular cysts, 12 (21.0%) dentigerous cysts and 3 (5.2%) central giant cell granulomas in 57 patients (20 women, 37 men) with a mean age of 36.93 ± 17.96 years were included. Fifty-seven CBCT and 56 panoramic images of these patients were evaluated.* ***Results:*** *Twenty-nine (50.8%) lesions were in the mandible and 28 (49.2%) in the maxilla. A statistically significant difference was determined for the areas in CBCT images (p=0.007).* ***Conclusions:*** *Panoramic radiography is not as successful as CBCT in demonstrating some characteristics of the lesions, such as expansion and destruction. The area measurements may be beneficial in establishing the differential diagnosis of the lesion.*

Key Words: Cone Beam CT, Intraosseous Lesions, Odontogenic Cysts

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Introduction

Many intraosseous pathological lesions occur in the maxillofacial region. These lesions appear as odontogenic or non-odontogenic, neoplastic or non-neoplastic, benign or malignant, and of developmental or inflammatory origin[1-3]. These lesions have a wide range of histopathological features but have similar radiographic presentation, which sometimes makes differential diagnosis challenging[4]. The various features of the lesion are the location, the characteristics of the margins, its relationship with the surrounding tissues or the teeth and the age of the patient, all of which are relatively useful for the differential diagnosis[4,5]. Thus, radiological examination is of great importance after making a clinical examination[1,6].

Two-dimensional (2D) conventional images, including periapical, occlusal and panoramic radiographs, are basic and necessary for detecting most jaw and dental abnormalities[7]. These radiographic techniques are essential for identification and follow-up of the lesions[1]. Among these imaging methods, panoramic radiography is the most commonly used. There are some disadvantages, however, such as magnification, distortion and superposition of anatomic structures on the image; therefore, 3-dimensional (3D) imaging such as cone beam computed tomography (CBCT) may be required to obtain an accurate description of the lesions[1,6]. CBCT has a high

diagnostic quality and good resolution and can show the borders, contents and adjacent structures of intraosseous lesions close to their actual size without superposition[8,9].

The use of a variety of imaging methods may make it easier to obtain a differential diagnosis of intraosseous lesions; nevertheless, the differential diagnosis of unilocular, radiolucent lesions can be especially challenging. To make a differential diagnosis of such lesions, the image characteristics of the lesion should be identified[10]. Hence, in the present study, we aimed to compare and determine the detailed features of the five frequently found benign, radiolucent, unilocular, intraosseous jaw lesions using digital panoramic and CBCT images. And also aimed to evaluate, comparing panoramic radiography and CBCT results, the sufficiency of the panoramic radiography in determining characteristic features of lesions.

Material and Methods

This study was reviewed and approved by the ethics board of the Dentistry Faculty with decision number: 2019/2. In this retrospective study, the apprised images were chosen from patients who had CBCT images made between 2016 and 2018 because of the presence of a pathological jaw lesion, as well as from patients with panoramic radiographs and histopathological results recorded on the patient information system of Dentistry Faculty Department of Oral and Maxillofacial Radiology. A total of 57 participants (20 women and 37 men) with unilocular, radiolucent, benign intraosseous lesions including *Odontogenic Keratocysts, Apical Granulomas, Radicular Cysts, Dentigerous Cysts and Giant Cell Granulomas* were selected. Multilocular, multifocal, radiopaque and mixed lesions and images with artifacts and distortions were excluded from the study.

All CBCT images were obtained with the same device (Instrumentarium Dental, Palo DEx Group Oy Nahkelantie 160FI04300 Tuusula, Finland) and by using parameters in the following range: 80 Kvp, 4-12 mA, 6.09-8.15 sec. exposure time. The images were assessed with the 5-mm slice thickness and 2× filter on a monitor (BenQ GL2460) with the resolution of 1920 × 1080 pixels. Likewise, all the digital panoramic images were made with a single device, the Kodak 8000 Digital Panoramic Dental X-ray System (Carestream Health Inc. Rochester NY, USA), and all panoramic images were evaluated and measured using the Image *J* (version 1.4) image processing and analysis program on the same monitor. Two experienced oral radiologists who were blind to the pathology results evaluated the panoramic and CBCT images. In case of conflict, the two observers collaborated to reach a final decision.

In the first part of the study, lesions were assessed based on the shape, location, borders, relationship with the mandibular canal, presence of destruction of cortical bone, presence of expansion of cortical bone and presence of an unerupted tooth in the lesion (Figures 1 and 2). One of the evaluated parameters was ‘shape’, categorized as oval, round or amorphous. The parameter ‘location’ was designated as the anterior mandible or maxilla and the posterior mandible or maxilla, or also extended from the anterior to the posterior of the mandible or maxilla. However, two regions of the mandible are important for some lesions; therefore, the ramus and angle of the mandible were used as separate location categories. The ‘borders’ of the lesion were described as sclerotic, well-defined or ill-defined. In order to define the ‘relationship of lesions with the mandibular canal’, categories that identified destruction of the canal walls, migration of the canal, adjacency to the canal but not affecting and finally no-relationship were used.

Figure 1. Digital panoramic radiography of a huge odontogenic keratocyst with migration of the mandibular canal (white arrows) and expansion (red arrows)

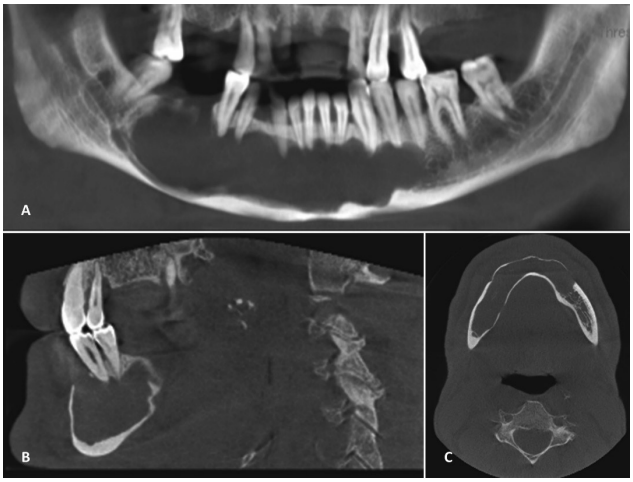

Figure 2. A-C. CBCT images of a huge odontogenic keratocyst. A. Sagittal CBCT section of the lesion with expansion and buccal destruction. B. Axial CBCT section of the lesion with some lingual and buccal destruction areas and expansion. C. Panoramic CBCT section of the lesion demonstrating thinned cortical bone and destruction of the alveolar crest

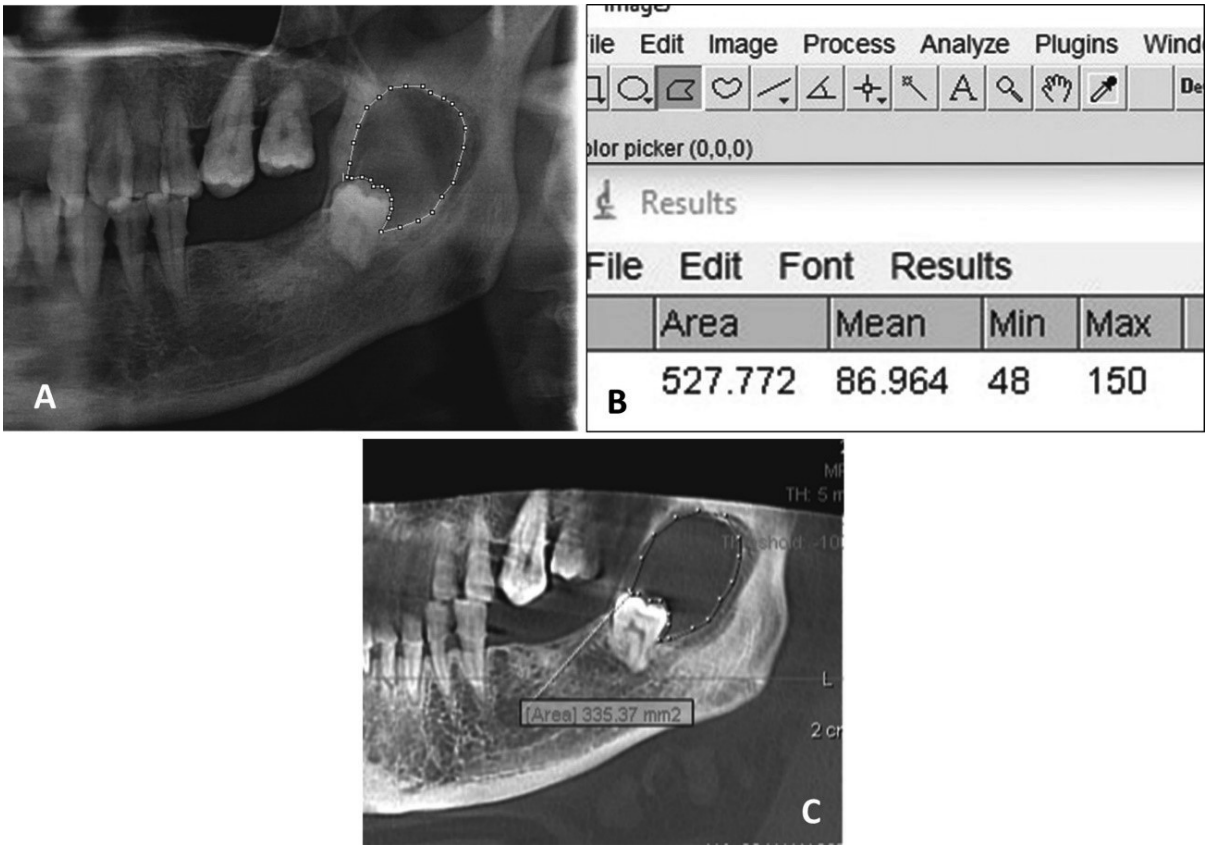

Figure 3. A-C. Measurements of the lesions in the panoramic sections of CBCT and digital panoramic radiography. A. Measurements of the area of lesions in widest borders in panoramic radiography. B. Measurement area value of panoramic radiography obtained by using image J program. C. Measurements of area of lesions in panoramic section of the CBCT

Secondly, the areas of the lesions were measured at the widest possible borders and recorded (Figure 3). These measurements were carried out separately using the same monitor and programs for the panoramic and CBCT. Panoramic sections were used for the measurements of the CBCT images to accurately compare with the panoramic radiographs.

Descriptive statistical analysis was performed using the IBM SPSS Software (version 21) statistical program. Because parametric test assumptions were not provided, the Kruskal Wallis test was used for the area measurements to analyze the difference between the lesion types. According to the results obtained, post hoc binary comparison tests were performed to evaluate the difference between the groups. '$P<0.05$' considered as statistically significant.

Results

According to the pathology results, there were 9 (15.8%) odontogenic keratocysts, 9 (15.8%) apical granulomas, 24 (42.1%) radicular cysts, 12 (21.0%) dentigerous cysts and 3 (5.2%) central giant cell granulomas in 57 patients (20 women, 37 men) with a mean age of 36.93 ± 17.96 (range 7- 74 years). Fifty-seven CBCT and 56 panoramic images of these patients (a panoramic image was excluded from the study as it was inadequate) were evaluated. Twenty-nine (50.8%) lesions occurred in the mandible and 28 (49.2%) in the maxilla. Findings and descriptive statistics for the characteristics of the evaluated intraosseous lesions are given in Tables 1 and 2. Since the findings of the panoramic and CBCT images were identical in the presence of an impacted tooth, the shape of lesions and their locations, the results of these categories are shown in a single table (Table 1). However, because of differences in other categories, the results are presented separately for the CBCT and panoramic images (Tables 2 and 3).

A statistically significant difference was found in the area size of lesions only in CBCT images (p= 0.007). According to this result, the mean area size at the time of imaging of odontogenic keratocysts (651.90 mm^2 ± 557.07) was not only significantly different from the mean area of the dentigerous cyst (225.67 mm^2 ± 116.61) but also significantly different from that of apical granulomas (146.98 mm^2 ± 67.51). The average area information measured from the panoramic section of the CBCT for all lesions is shown in Table 4.

Table 1. Distribution and percentage values of some features of the lesions in both panoramic and CBCT images

Lesion Type	Impacted Tooth		Shape				Location						
	(+)	(-)	Oval	Circular	Amorphous	Ramus	Mand. ant	Mand. post	Mand. body	Mand. ang.	Max. ant.	Max. post.	Max. body
Odontogenic Keratocyst	4 44.4%	5 55.6%	4 44.4%	1 11.1%	4 44.4%	2 22.2%	1 11.1%	2 22.2%	2 22.2%	0 0.0%	0 0.0%	1 11.1%	1 11.1%
Apical Granuloma	3 33.3%	6 66.7%	0 0.0%	3 33.3%	6 66.7%	0 0.0%	2 22.2%	4 44.4%	0 0.0%	0 0.0%	3 33.3%	0 0.0%	0 0.0%
Radicular Cyst	2 8.3%	22 91.7%	10 41.7%	5 20.8%	9 37.5%	0 0.0%	1 4.2%	6 25.0%	1 4.2%	0 0.0%	10 41.7%	5 20.8%	1 4.2%
Dentigerous Cyst	11 91.7%	1 8.4%	2 16.7%	2 16.7%	8 66.7%	0 0.0%	0 0.0%	7 58.3%	0 0.0%	1 8.3%	3 25.0%	1 8.3%	0 0.0%
Central Giant Cell Gronuloma	0 0.0%	3 100%	0 0.0%	1 33.3%	2 66.7%	0 0.0%	1 33.3%	0 0.0%	0 0.0%	1 33.3%	0 0.0%	1 33.3%	0 0.0%

Table 2. Distribution and percentage values of some features of the lesions in CBCT image

Lesion Type	Relationship with the Mandibular Canal				Destruction		Expansion		Margins of Lesion		
	Destruction	Migration	Ineffective	No relationship	(+)	(-)	(+)	(-)	Sclerotic	Well-defined	Ill-defined
Odontogenic Keratocyst	4 44.4%	1 11.1%	0 0.0%	4 44.4%	9 100%	0 0.0%	6 66.7%	3 33.3%	4 44.4%	4 44.4%	1 11.1%
Apical Granuloma	1 11.1%	1 11.1%	2 22.2%	5 55.6%	5 55.6%	4 44.4%	4 44.4%	5 55.6%	0 0.0%	9 100%	0 0.0%
Radicular Cyst	4 16.7%	0 0.0%	1 4.2%	19 79.2%	19 79.2%	5 20.8%	13 54.2%	11 45.8%	1 4.2%	22 91.7%	1 4.2%
Dentigerous Cyst	6 50.0%	2 16.7%	0 0.0%	4 33.3%	7 58.3%	5 41.7%	9 75.0%	3 25.0%	7 58.3%	4 33.3%	1 8.3%
Central Giant Cell Granuloma	1 33.3%	0 0.0%	0 0.0%	2 66.7%	2 66.7%	1 33.3%	2 66.7%	1 33.3%	0 0.0%	3 100%	0 0.0%

Table 3. Distribution and percentage values of some features of the lesions in panoramic images

Lesion Type	Relationship with the Mandibular Canal				Destruction		Expansion		Margins of Lesion		
	Destruction	Migration	Ineffective	No relationship	(+)	(-)	(+)	(-)	Sclerotic	Well-defined	Ill-defined
Odontogenic Keratocyst	4 50.0%	0 0.0%	2 25.0%	2 25.0%	5 62.5%	3 37.5%	2 25.0%	6 75.0%	2 25.0%	4 50.0%	2 25.0%
Apical Granuloma	1 11.1%	1 11.1%	2 22.2%	5 55.6%	1 11.1%	8 88.9%	1 11.1%	8 88.9%	0 0.0%	7 77.8%	2 22.2%
Radicular Cyst	3 12.5%	2 8.3%	2 8.3%	17 70.8%	11 45.8%	13 54.2%	6 25.0%	18 75.0%	7 29.2%	10 41.7%	7 29.2%
Dentigerous Cyst	4 33.3%	4 33.3%	0 0.0%	4 33.3%	1 8.3%	11 91.7%	3 25.0%	9 75.0%	8 66.7%	2 16.7%	2 16.7%
Central Giant Cell Gronuloma	1 33.3%	0 0.0%	0 0.0%	2 66.7%	2 66.7%	1 33.3%	2 66.7%	1 33.3%	2 66.7%	1 33.7%	0 0.0%

Table 4. Mean areas of the lesions at CBCT images and standard deviation (Std.), minimum (Min.), maximum (Max.) and P values

Lesion type	Number	Mean (mm^2)	Std, Deviation	Min. (mm^2)	Max. (mm^2)	P value
Odontogenic Keratocyst	9	651.89	557.07	196.55	1865.86	0.007
Apical Granuloma	9	146.98	67.513	70.45	268.45	0.007
Radicular Cyst	24	502.93	102.66	68.06	2517.16	0.007
Dentigerous Cyst	12	225.67	116.61	69.11	455.63	0.007
Central Giant Cell Gronuloma	3	614.04	512.08	185.66	1181.21	0.007
Total	57	361.39	435.03	68.06	2517.16	0.007

Discussion

Although the development of advanced imaging methods has enabled the early detection of many jaw lesions, it is still not possible to make a differential diagnosis with existing imaging methods and to reach a definitive diagnosis. Nevertheless, information from patients such as age and sex and the characteristic features of lesions obtained by imaging methods can narrow the differential diagnosis[11]. Several studies have compared the radiographic features of such lesions using imaging techniques including panoramic images, CBCT images or ultrasonography[1,2,6,12]. Lesions were categorized according to location, border features, contents, relations with adjacent tissues, presence of unerupted teeth, and shape characteristics. In addition, in these studies, either two types of lesions or a wide variety of lesion (cysts, tumors or tumor-like lesions) were compared. However, making a differential diagnosis of unilocular, radiolucent lesions is more challenging as they have more similar features. Furthermore, these lesions are frequently encountered in the jaws[10]. For this reason, in our study, the characteristics of a unilocular radiolucent lesion were evaluated on CBCT and panoramic images, regardless of the pathology reports.

CBCT, frequently used in dentistry, can accurately identify and reliably reflect the characteristics of intraosseous lesions[13]. However, studies have also evaluated lesions using panoramic radiography[2,6,14]. In the present study, the same lesions were evaluated with panoramic images and CBCT images. Nevertheless, when the results were assessed, the panoramic and CBCT findings were inconsistent in terms of the presence of cortical expansion, cortical destruction, relationship with the mandibular canal and borders of the lesion and also measurements of lesion area. Likewise, according to the study of Langaroodi *et al.*[2], which assessed intraosseous lesions with panoramic radiography, the presence of bone expansion could not be evaluated from radiographs so they used clinical examination. Apajalahti and Hagström[5] reported that scallop margins of the odontogenic keratocysts in the maxilla and the association of the cysts with the maxillary sinus were not clearly observed in panoramic radiographs. However, accurate results could be obtained by evaluating lesions in the mandible, particularly in the posterior region[15].

In line with some other studies[14,16,17], the most common odontogenic cysts of the jaws of the present study were radicular cysts, dentigerous cysts and odontogenic odontogenic keratocysts respectively. However, Jamshidi *et al.*[3] and Su *et al.*[18] found the second most common cyst to be the odontogenic keratocyst. Even, Langaroodi *et al.*[2] found the most common odontogenic cyst to be odontogenic keratocysts with a rate of 29% instead of radicular cyst. This may be the result of geographical differences or habits (e.g. brushing teeth regularly).

Intraosseous lesions have been reported predominantly in the mandibular posterior region and secondly in the maxillary anterior region[2,3]. In the present study too, the lesions were most frequently observed in the posterior region of the mandible (31.6%) and secondly in the maxillary anterior region (28%). The odontogenic keratocyst, dentigerous cyst and apical granuloma were encountered more commonly in the posterior mandible and the radicular cyst in the maxillary anterior region. Central giant cell granulomas occurred mostly in the anterior region of the mandible[7,11], yet in this study, only one of the three lesions was observed in the anterior region of the mandible. This might be because of the inadequate number of the lesions. Images of central giant cell granulomas may vary. These lesions can be seen unilocular or multilocular and may cause jaw expansion, tooth displacement or resorption[19,20]. Gupta *et al.*[20] reported that central giant cell granulomas were equal in both jaws, most commonly in the posterior region and most of them performed bone expansion. Although the number of data in the present study is limited due to the selected unilocular ones, it is consistent with the results of the study.

The incidence of odontogenic cysts has been reported to be higher in men than women, with 83.9% of cysts having well-defined but non-sclerotic borders[2]. These results are consistent with the present results (35.1%- 20 females and 64.9%- 37 males). Gümüşok *et al.*[9] reported that 90% of odontogenic keratocysts caused cortical destruction and 60% caused displacement of the mandibular canal. Additionally, Abdi *et al.*[12] reported that

most odontogenic keratocysts caused buccal or lingual displacement in the mandibular canal. In our study, dentigerous cysts (50%) and odontogenic keratocysts (44.4%) were the most common causes of destruction in the mandibular canal in intraosseous lesions, and odontogenic keratocysts caused only displacement of the mandibular canal in one case.

The most common intraosseous lesion associated with an impacted tooth is the dentigerous cyst. In almost all dentigerous cysts, an impacted tooth was observed[13]. Between 28% and 30% of odontogenic keratocysts were also found to be associated with an impacted tooth[5,8]. In our study, 44.8% of odontogenic keratocysts and 91.7% of dentigerous cysts were associated with impacted teeth. While the characteristics of the dentigerous cyst and odontogenic keratocysts are similar[11], the cysts surrounding the crown from the enamel-cement junction of the impacted tooth are generally dentigerous cysts, but the odontogenic keratocyst tends to adhere to the apex of the tooth[21]. Besides the most important differential characteristic of the odontogenic keratocyst is anteroposterior extension in the jaws[11,13]. Therefore, although minimal expansion of the cortical bone was seen in the buccolingual direction, it was more destructive in these bones[5]. In the present study, all odontogenic keratocysts caused cortical destruction and 75% of dentigerous cysts caused expansion.

Due to the anteroposterior growth tendency of odontogenic keratocysts with minimal expansion, they can be diagnosed when they reach large sizes, especially in asymptomatic patients[21]. In our study, odontogenic keratocysts had the largest area size (651.89 mm^2) as measured in panoramic sections of the CBCT.

Periapical granulomas are chronic inflammatory lesions with no true cystic epithelium. When they reach large dimensions, they cannot be distinguished radiologically from radicular cysts[22]. On the other hand, distinguishing granuloma and cyst formation is important in terms of the form of treatment because granuloma can resolute with modern root canal filling materials, whereas radicular cysts often require apical resection[23]. Area measurements of the lesion may point out nature of a lesion; if the area of the apical lesion is over 200 mm^2, the lesion is probably a cyst[22]. Compatible with this result, in the current study, the mean area of apical granulomas was 146.98 mm^2 and that of the radicular cysts was 502.93 mm^2. In addition, most of periapical granulomas (44.4%) were found in the posterior mandible, while the majority of radicular cysts (41.7%) were found in the maxillary anterior region.

Conclusions

In conclusion, to differentiate among unilocular, radiolucent and benign lesions of the jaws, information about the characteristic images of each lesion is needed. Panoramic radiography is not as successful as CBCT in demonstrating characteristic images such as expansion and destruction, even though it can identify some characteristics leading to an initial diagnosis. The area measurements are highly beneficial in differential diagnosis between radicular cysts and apical granulomas and distinguishing among the odontogenic keratocysts or dentigerous cysts and the apical granulomas.

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