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ORIGINAL ARTICLE

Odontogenic keratocyst and ameloblastoma: radiographic evaluation

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Abstract

Objectives To describe the radiographic features of odontogenic keratocysts (OKCs) and ameloblastomas and to compare the radiographic findings between these 2 lesions.

Methods Radiographs of OKCs and ameloblastomas were retrospectively reviewed. Location, border, shape, association with impacted tooth, tooth displacement, root resorption, and bone expansion were evaluated. Chi-squared or Fisher's exact tests were used for statistical analysis. A p value < 0.05 was considered to indicate statistical significance.

Results One hundred OKCs and 101 ameloblastomas were reviewed. The ratios of maxilla to mandible were 1:1.4 and 1:9.1 in OKCs and ameloblastomas, respectively. All evaluated features significantly differed between OKCs and ameloblastomas ($p \leq 0.001$). Most OKCs showed smooth border (60%) and unilocular shape (82%), while most ameloblastomas showed scalloped border (77.2%) and multilocular shape (68.3%). Association with impacted tooth was found in 47% of OKCs and 18.8% of ameloblastomas. Adjacent tooth displacement was found in 33.7% of OKCs and 55.8% of ameloblastomas. Root resorption was more common in ameloblastomas (66.7%) than in OKCs (7%). Bone expansion was also more common in ameloblastomas (96.3%) than in OKCs (63.6%).

Conclusion A unilocular radiolucent lesion with smooth border, no adjacent tooth displacement, no root resorption and causing mild or no bone expansion is suggestive of an OKC rather than an ameloblastoma.

Keywords Ameloblastoma · Differential diagnosis · Odontogenic keratocyst

Introduction

Odontogenic keratocyst (OKC) and ameloblastoma are common odontogenic lesions. OKC was classified as a tumor (keratocystic odontogenic tumor) by the World Health Organization (WHO) in 2005 due to its aggressive behavior, high recurrence and mutations in PTCH gene [1]. However, WHO reclassified it again as OKC in 2017 because of insufficient evidence to support the neoplastic origin [2]. OKC accounts for 7–20% of cystic lesions of the jaws [2–4] and ameloblastoma accounts for 13–54% of jaw tumors [5–7]. OKC is the third most common cyst of the jaws [2], while ameloblastoma is the most common odontogenic tumor [8].

Clinically, OKC and ameloblastoma may occur among patients at the same age distribution. The posterior region of the mandible is the common location for both lesions [5, 9]. Radiographically, OKC and ameloblastoma may show some similar radiographic features such as a well-defined unilocular or multilocular radiolucency associated or not associated with an unerupted tooth [9]. Various pathologies showing multilocular radiolucency may mimic OKC or ameloblastoma including glandular odontogenic cyst, traumatic bone cyst, central giant cell granuloma, odontogenic myxoma, and fibro-osseous lesion [10–12]. However, in some instances, radiographic features of OKC or ameloblastoma showing unilocular radiolucency associated with unerupted tooth may similar to those of dentigerous cyst.

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OKC and ameloblastoma have different biological behaviors; therefore, management of these lesions differs. However, differential diagnosis of these two lesions is difficult because they share many clinical and radiographic features. Therefore, it is difficult to differentiate these lesions radiographically, and definitive diagnosis is based only on histopathologic examination. However, in many instances incisional biopsy could not reveal a definitive diagnosis especially from large lesions or lesions with inflammation. Thus, to diagnose such lesions, differences in radiographic findings of these two lesions may play an important role in making the differential diagnosis.

Advanced imaging techniques such as computed tomography and magnetic resonance imaging have been used to differentiate these lesions [13–18]. However, accessibility to these modalities is occasionally limited, and conventional radiography is still the common imaging technique used by most dentists to investigate these lesions. Therefore, information from conventional images may benefit in making differential diagnosis when evaluated meticulously.

It has been suggested that some radiographic findings could be used to differentiate OKC from ameloblastoma [9, 19, 20]. OKC has a propensity to grow along the internal aspect of the mandible causing minimal expansion [9], and is less likely to cause root resorption compared with ameloblastoma [19–21]. Although studies about radiographic features of OKCs and ameloblastomas have been reported [17, 19, 21–34], details of the radiographic features are still limited. Many aspects including displacement of adjacent teeth, root resorption and bone expansion observed on radiographs are available, but these information were derived from different small series. There are only three studies that investigated all these radiographic findings [27, 30, 31]. Gumusok et al. [27] investigated 28 OKCs, MacDonald-jankowski and Li [30] investigated 33 OKCs, and MacDonald-jankowski et al. [31] investigated 61 ameloblastomas. Thus, the aim of the present study was to describe the details of the radiographic features of OKCs and ameloblastomas in a large number of cases. In addition, we aimed to compare the radiographic findings between these lesions. To our knowledge, the radiographic features between OKCs and ameloblastomas have never been compared. We believe that this information may help in making differential diagnosis of these lesions.

Materials and methods

Between the years 2003 and 2016, we performed a retrospective review of cases histopathologically diagnosed as OKCs or keratocystic odontogenic tumors and ameloblastomas. One investigator (S.P.) re-evaluated the hematoxylin and eosin–stained sections and recurred cases were excluded. Conventional radiographs and/or cone beam computed tomography (CBCT) images of these patients were retrieved. All images were evaluated by two observers who are specialists in oral and maxillofacial radiology (J.K. and N.H.R). A consensus was reached after discussion when the observers disagreed. The following features were evaluated: location, border, shape, relationship of the lesion with the impacted tooth, displacement of adjacent teeth, root resorption and bone expansion.

The location was determined by the radiographic margin of the lesion. The maxilla was divided in two anatomic regions on each side: (1) the anterior region, extending from the midline to the distal surface of the canine and (2) the posterior region, extending from the mesial aspect of the first premolar to the distal surface of maxillary tuberosity. The mandible was divided in two anatomic regions on each side: (1) the anterior region, extending from the midline to the distal surface of the canine, (2) the posterior region, which was subdivided in three regions: (2.1) the body region, extending from the mesial aspect of the first premolar to the angle of the mandible; (2.2) the ramus region, extending from the angle of the mandible to the sigmoid notch and (2.3) the condyle region, extending from the sigmoid notch to the condylar region. The border was defined as either (1) smooth, a border showing an even surface free from indentation or (2) scalloped, a border showing a series of contiguous arcs or semicircles (Fig. 1). The shape was defined as unilocular or multilocular (Fig. 2). The impacted tooth associated with the lesion was recorded. The relationship between the lesion and the impacted tooth was classified in three groups: (1) cementoenamel junction (CEJ): lesion surrounds the tooth and is attached to the tooth at the CEJ; (2) root: lesion surrounds the tooth and extends apically along the root beyond the CEJ and (3) entire tooth: lesion surrounds entire tooth. Tooth displacement and root resorption were recorded as yes or none. Bone expansion was recorded as (1) distinct: when at least one cortical bone expands more than 5 mm from the normal contour of the bone or maxillary sinus wall; (2) mild: when at least one cortical bone expands less than or equal to 5 mm from the normal contour of the bone or maxillary sinus wall; and (3) none: when no bone expansion occurred (Fig. 3).

For image acquisition, different imaging systems were used. From 2003 to 2011, Ultraspeed or Insight (Eastman Kodak, Rochester, NY) periapical radiographic films were exposed with a GX1000 (Gendex, IL, USA) or Searcher Dx-068 (Takara, Belmont, Osaka, Japan). Since 2012, intra-oral radiographs were taken with Planmeca ProX (Planmeca, Finland) using a phosphor plate system (VistaScan®, Dürr Dental, Bietigheim-Bissingen, Germany). Panoramic and other conventional extra-oral radiographs when available, i.e., postero-anterior skull and postero-anterior mandibular radiographs, were obtained

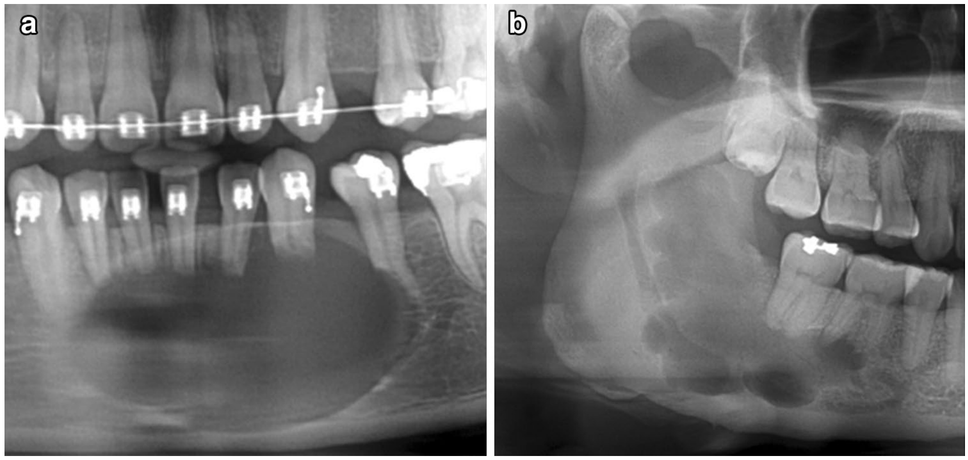

Fig. 1 Cropped panoramic images illustrating border of the lesions. **a** A lesion with smooth border. **b** A lesion with scalloped border

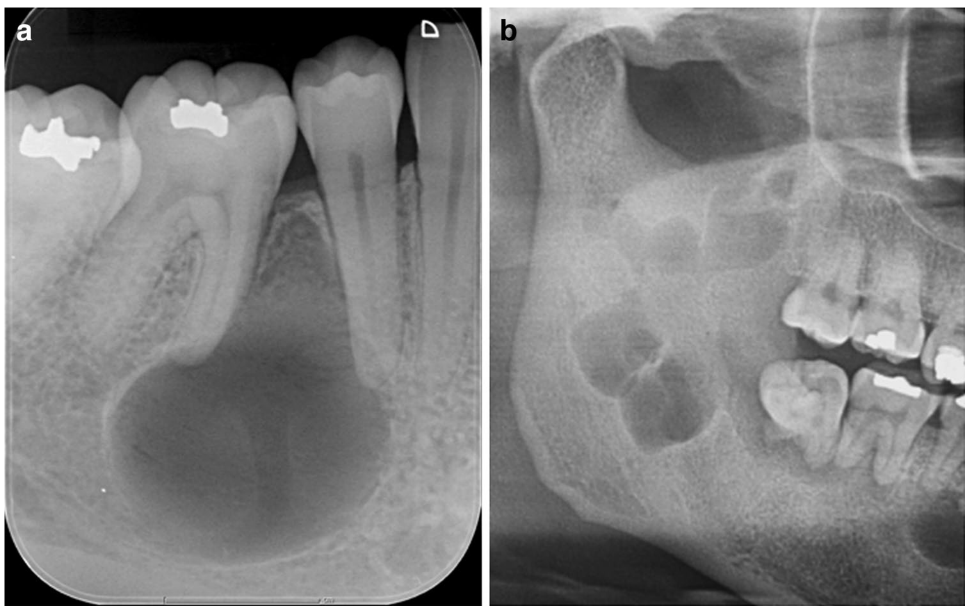

Fig. 2 Images illustrating shape of the lesions. **a** A lesion with unilocular shape. **b** A lesion with multilocular shape

with Orthopan Tomograph OP 100 (Trophy, France), PM 2002 EC Proline (Planmeca, Finland) or CS 9000 machine (Carestream Health, Inc., Rochester, NY, USA). All images which were not taken with a digital system were digitized using a Microtek ScanMaker 9800XL (Microtek Inc. Santa Fe Spring, CA, USA) with a resolution of 300 dpi. Conventional images were assessed using ImageJ Software (NIH, Bethesda, MD, USA, https://rsb.info.nih.gov/ij). CBCT images were captured using a 3D Accuitomo 170 (J Morita, Kyoto, Japan) or CS 9500 machine (Carestream Health, Inc., Rochester, NY, USA), and images were assessed using the software equipped with the machines. An 18.0-in., light-emitting diode, high-definition screen (resolution 1366 × 768 pixels) was used for image assessment. The examiners were allowed to use the zoom tool and to adjust the brightness and contrast of the images.

Data were analyzed using SPSS, Version 19 (IBM Corp., Armonk, NY, USA). The Chi-squared or Fisher's exact tests was used to determine evaluated features between OKCs and ameloblastomas. A p value less than 0.05 was considered to be statistically significant.

Results

A total of 89 cases comprised 100 lesions diagnosed as OKC and 101 cases diagnosed as ameloblastoma. All patients were Thai. Patients' age ranged from 10 to 87 years (mean 31.4 years) and from 3 to 87 years (mean 34.9 years) in OKCs and ameloblastomas, respectively. OKC patients comprised 46 females and 43 males. Among all OKC cases, 6 patients (2 females, 4 males) were associated with nevoid basal cell carcinoma syndrome confirmed by means of

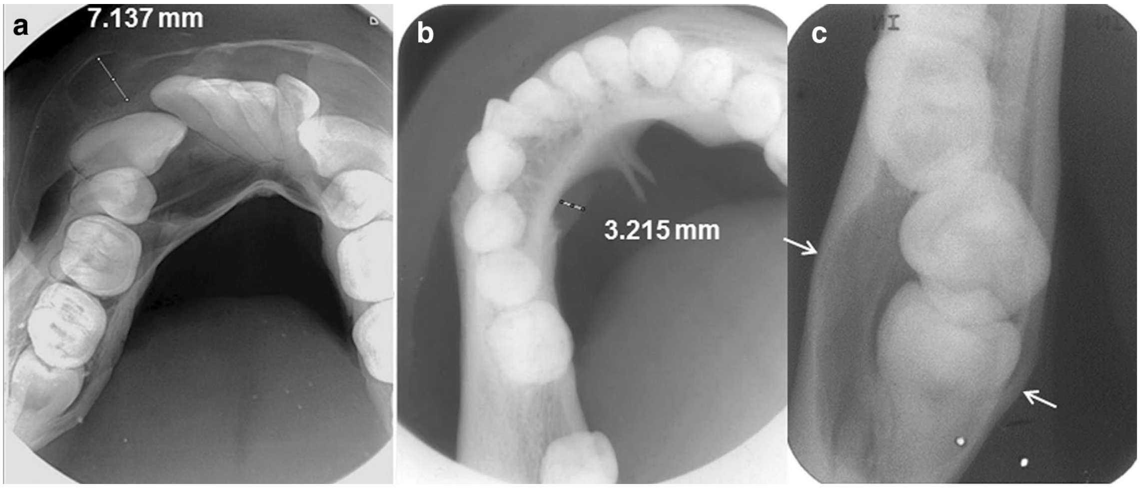

Fig. 3 Occlusal cross-sectional images. The distance of expansion was measured from the most expanded point to the point of previous normal contour perpendicular to bone surface. **a** A lesion with distinct bone expansion. **b** A lesion with mild bone expansion. **c** A lesion at the third molar area without bone expansion (arrows)

diagnostic criteria [35] and multiple OKCs had developed in all these patients with a total of 17 OKCs. A total of 53 females and 48 males presented ameloblastoma. Each case had at least one conventional radiograph. CBCT images were available in 30 OKCs (16 lesions in the maxilla, 14 lesions in the mandible), 40 ameloblastomas (4 cases in the maxilla, 36 cases in the mandible). All radiographic features were evaluated based on all available radiographs.

The lesion locations are summarized in Table 1. Regarding OKCs, 41 lesions were located in the maxilla and 59 lesions were in the mandible. The posterior region was the most common location for OKCs in both maxilla and mandible (27 OKCs and 51 OKCs, respectively). Regarding ameloblastoma, 10 lesions were located in the maxilla and 91 lesions were located in the mandible. Most ameloblastomas in the maxilla extended from anterior to posterior regions (8 cases), whereas most ameloblastomas in the mandible were found in the posterior region (52 cases). Lesions crossed midline in 14 cases of OKCs (7 cases in the maxilla and 7 cases in the mandible) and 29 cases of ameloblastomas (all in the mandible).

Radiographic findings of all cases are summarized in Table 2. Statistical analysis revealed significant differences in all evaluated features between OKCs and ameloblastomas ($p \leq 0.001$). In OKCs, 60 of 100 OKCs showed smooth border. Eighty-two OKCs (82%) showed unilocular shape. There were 47 OKCs associated with impacted teeth. Among these cases, 28 OKCs were located in the maxilla and 19 OKCs were located in the mandible. The relationship between lesion and the associated teeth could be evaluated in 42 OKCs. The cysts attached to the CEJ of the impacted teeth in 17 of 42 lesions (40.5%), extended apically along the root of the impacted teeth in 10 of 42 lesions (23.8%),

Table 1 Distribution of lesions by location in the jaws

Location	Number of lesions	
	OKC	Ameloblastoma
Maxilla	41	10
Anterior	4	1
Anterior	3	1
Anterior-op anterior	1	0
Posterior	27	1
Anterior–posterior	10	8
Anterior–posterior	4	8
Anterior–op posterior	6	0
Mandible	59	91
Anterior	0	3
Anterior	0	1
Anterior-op anterior	0	2
Posterior	51	52
Body	17	10
Ramus	6	1
Body-ramus	18	23
Ramus-condyle	1	0
Body-ramus-condyle	5	9
Body-op body	3	9
Body-op ramus	1	0
Anterior–posterior	8	36
Anterior-body	4	15
Anterior-body-ramus	0	2
Anterior-body-ramus-condyle	1	1
Anterior-op body	3	17
Anterior-op ramus	0	1
Total lesions	100	101

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Table 2 Comparison of the radiographic characteristics between OKC and ameloblastoma

Radiographic characteristic	Number of lesions						*p* value
	OKC			Ameloblastoma			
	Maxilla ($n=41$)	Mandible ($n=59$)	Total ($n=100$)	Maxilla ($n=10$)	Mandible ($n=91$)	Total ($n=101$)	
Border							
Smooth	33	27	60	5	18	23	< 0.001*
Scallop	8	32	40	5	73	78	
Shape							
Unilocular	36	46	82	5	27	32	< 0.001*
Multilocular	5	13	18	5	64	69	
Relation between radiolucent lesion and impacted tooth							
None	13	40	53	9	73	82	< 0.001*
Yes	28	19	47	1	18	19	
CEJ	8	9	17	0	8	8	
Root	4	6	10	0	5	5	
Entire tooth	13	2	15	1	5	6	
NA	3	2	5	0	0	0	
Adjacent tooth displacement[a]							
Yes	15	14	29	7	46	53	0.001*
None	25	32	57	3	39	42	
Root resorption[b]							
Yes	1	5	6	4	58	62	< 0.001*
None	39	40	79	6	25	31	
Bone expansion							
Distinct	10	12	22	4	68	72	0.001*
Mild	8	12	20	0	7	7	
None	4	20	24	0	3	3	
NA	19	15	34	6	13	19	

NA data not available

*Significant at $p < 0.05$

and enclosed the entire teeth in 15 of 42 lesions (35.7%). An example of OKC was illustrated in Fig. 4.

Among the ameloblastomas, 78 cases (77%) showed scalloped border and 69 cases (68%) showed multilocular shape. Association with impacted tooth was found in 19 of 101 cases (18.8%). Of these cases, only 1 lesion was located in the maxilla and 18 cases were located in the mandible. Lesions were attached to the tooth at the CEJ of the impacted teeth in 8 lesions (42.1%) and extended apically along the root of the impacted teeth in 5 lesions (26.3%), and enclosed the entire teeth in 6 lesions (31.6%). An example of ameloblastoma was illustrated in Fig. 5.

Adjacent tooth displacement and root resorption were not evaluated in all lesions because some lesions occurred in edentulous areas or areas that were not tooth-bearing. Hence, adjacent tooth displacement could be evaluated in 86 OKCs and 95 ameloblastomas. Adjacent tooth displacement was found in 33.7% of OKCs and 55.8% of ameloblastomas. Root resorption could be investigated in 85 OKCs and 93 ameloblastomas. It was found in only 7% of OKCs compared to 66.7% of ameloblastomas. Bone expansion was evaluated in 66 OKCs and 82 ameloblastomas. Of these cases, 30 OKCs and 39 ameloblastomas were studied from CBCT images. The remaining cases were examined with plain radiographs taken by various techniques showing information in three different planes. Among OKCs, 22 lesions (33.3%) revealed distinct bone expansion, 20 OKCs (30.3%) showed mild bone expansion, and 24 OKCs (36.4%) showed no bone expansion. While among ameloblastomas, 72 cases (87.8%) showed distinct bone expansion, 7 cases (8.5%) showed mild bone expansion, and only 3 cases (3.7%) showed no bone expansion.

Radiographic findings of different types of ameloblastoma are summarized in Table 3. In this study, the types of ameloblastoma were classified according to WHO 2017 [2]. Seventy-four lesions were conventional type consisting of 62 solid ameloblastomas and 12 desmoplastic ameloblastomas. Twenty-seven lesions were unicystic type and all of them were located in the mandible.

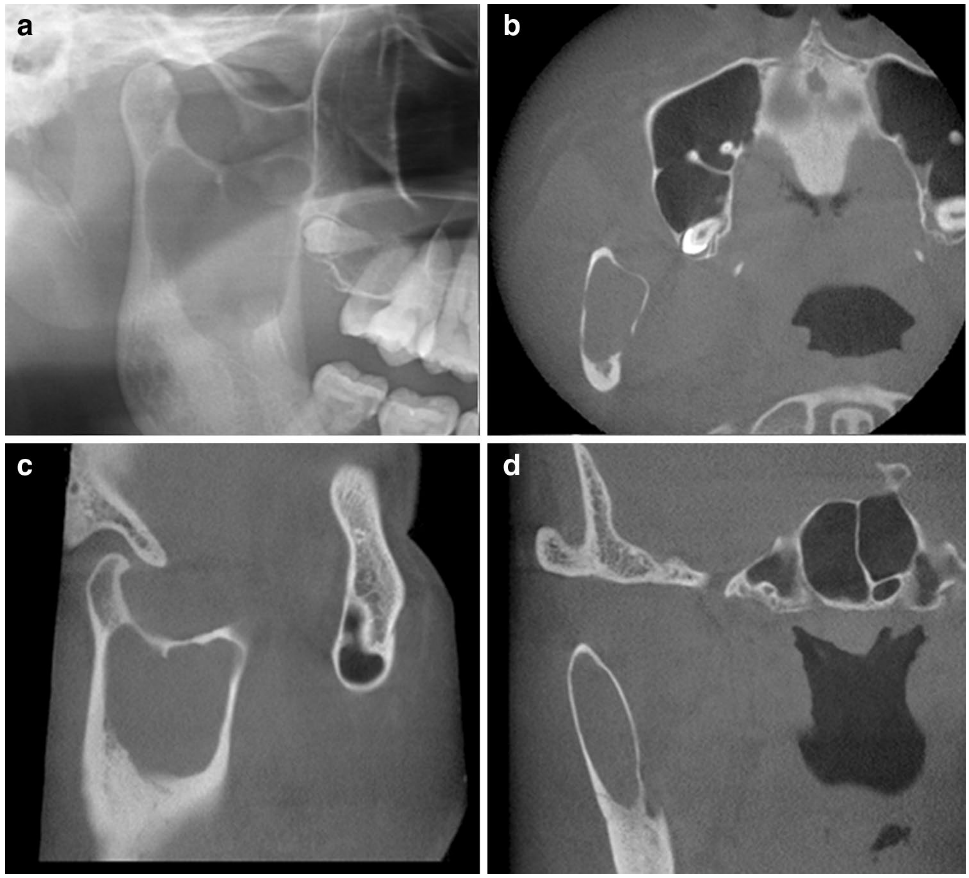

Fig. 4 An OKC in a 29-year-old woman—**a** cropped panoramic image shows a lesion at the right ramus-condyle region with smooth border, unilocular shape. **b** axial, **c** sagittal, and **d** coronal CBCT images clearly depict the lesion with mild bone expansion (white arrows)

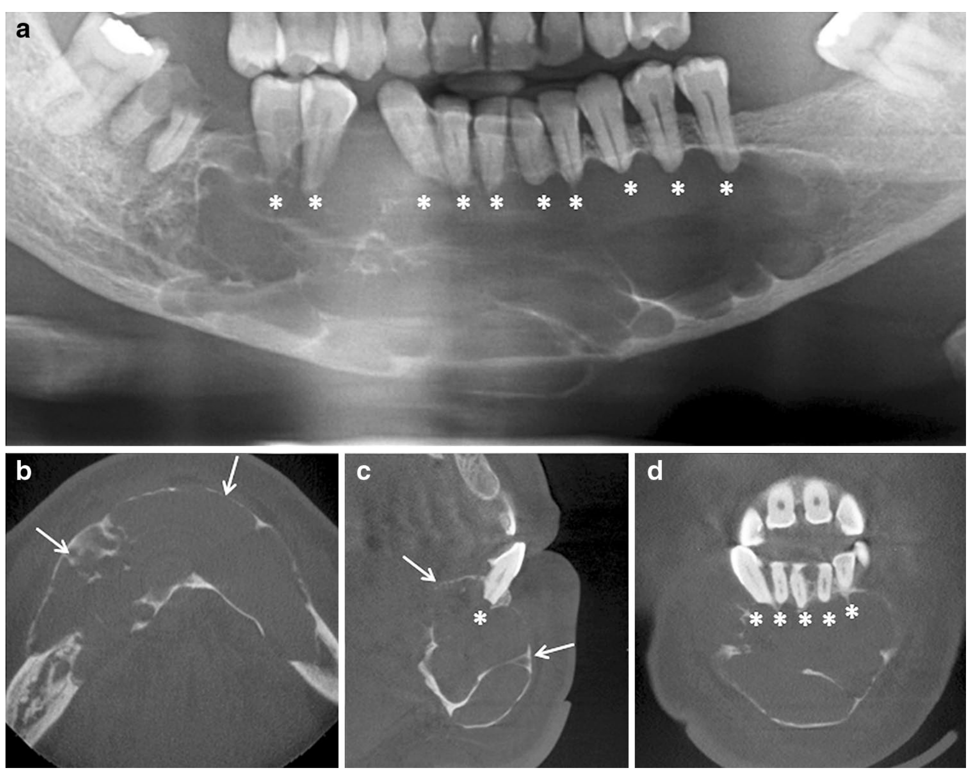

Fig. 5 Large ameloblastoma in a 55-year-old woman at the mandible—**a** cropped panoramic image, **b** axial, **c** sagittal and **d** coronal CBCT images display a lesion with scalloped border and multilocular shape. There is tooth displacement of the right canine and root resorption of the related teeth (asterisks). Distinct bone expansion is observed (white arrows)

Table 3 Comparison of the radiographic characteristics among different types of ameloblastomas

Radiographic characteristic	Conventional ameloblastoma						Unicystic ameloblastoma
	Solid type			Desmoplastic type			
	Maxilla ($n=4$)	Mandible ($n=58$)	Total ($n=62$)	Maxilla ($n=5$)	Mandible ($n=7$)	Total ($n=12$)	Mandible ($n=27$)
Border							
Smooth	2	10	12	2	0	2	9
Scallop	2	48	50	3	7	10	18
Shape							
Unilocular	2	15	17	2	0	2	13
Multilocular	2	43	45	3	7	10	14
Relation between radiolucent lesion and associated tooth							
None	4	47	51	5	7	12	19
Yes	0	11	11	0	0	0	8
CEJ	0	5	5	0	0	0	3
Root	0	2	2	0	0	0	3
Entire tooth	0	4	4	0	0	0	2
Adjacent tooth displacement[a]							
Yes	2	34	36	4	5	9	8
None	2	22	24	1	2	3	15
Root resorption[b]							
Yes	2	39	41	1	2	3	18
None	2	15	17	4	5	9	5
Bone expansion							
Distinct	1	42	43	2	6	8	21
Mild	0	5	5	0	0	0	2
None	0	1	1	0	1	1	1
NA	3	10	13	3	0	3	3

NA data not available

[a] $n=60$ solid type, 12 desmoplastic type and 23 unicystic type

[b] $n=58$ solid type, 12 desmoplastic type and 23 unicystic type

Discussion

OKC and ameloblastoma might show similar radiographic findings, leading to difficulty in providing differential diagnosis. Many studies have investigated these lesions regarding treatment and recurrence rate. However, details of the radiographic findings of these lesions, including association with impacted tooth, displacement of adjacent teeth, root resorption and bone expansion remain limited as summarized in Tables 4 and 5. Therefore, we aimed to study the image features of OKCs and ameloblastomas to help differentiate between them. The mean age of patients in OKCs and ameloblastomas in this study was in agreement with related reports [30, 32, 33, 36]. It has been reported that a slight male predominance exists regarding both OKC and ameloblastoma [9, 17, 22–25, 28–30, 33, 34, 36–38]. However, no sex predilection of OKCs and ameloblastomas was found in the present study.

In this study, the posterior region of the mandible was the predominant site in both OKCs and ameloblastomas. These results were similar to many reports [26, 27, 34, 38]. Interestingly, many OKCs in the present study were also found at the posterior region of the maxilla. Our results were in accordance with Neville et al. [12] and Regezi et al. [39] who suggested that the OKCs in the maxilla were frequently located in the posterior region. A study in Singapore showed slightly different results. Of 19 OKCs in the maxilla, 9 lesions were in the anterior region, 8 lesions were in the posterior region, and 2 lesions were in anterior to posterior region [25]. Among the ameloblastomas, the ratio of the maxilla to the mandible in our study was 1:9.1. This was similar to earlier studies evaluating a large series of ameloblastomas [26, 34].

Our results showed that OKCs and ameloblastomas showed significant differences of all evaluated imaging features. With respect to the shape of the lesions, 82% of OKCs in the present study showed unilocular shape. This result

Table 4 Comparison of clinical and radiographic findings of OKCs with previous reports

Author	Number of OKCs	Mean age (year)	Male: female	Maxilla: mandible	Most common site	Unilocular: multilocular	Association with impacted tooth	Most commonly associated impacted tooth	Displacement of adjacent teeth	Root resorption	Bone expansion
Alves et al. [17]	9	34.4	1:0.8	NA	Mand post	1:0.3	44%	Mand third M and C	NA	13%	77%
Chirapathom-sakul et al. [21]	67	36.9	1:1.2	1:2.2	Mand post	1:0.4	31.3%	Third M	NA	1.5%	NA
Apajalahti et al. [22]	46	46	1:0.5	1:1.4	Mand molar, ramus and angle	NA	28%	Third M	17%	13%	NA
Boffano et al. [23]	261	43.3	1:0.5	1: 2.7	Mand ramus and angle	1:0.2	NA	NA	NA	NA	NA
Buckley et al. [24]	83	NA	1:0.7	NA	Mand post	1:0.9	NA	NA	39%	15%	NA
Chow HT [25]	76	32.8	1:0.6	1:2.5	Mand post	NA	52.8%	Mand third M	NA	NA	NA
Gumusok et al. [27]	28	34.5	1:1	1:3.7	Mand molar, retromolar and ramus	1:1	39%	Mand third M	100%	30%	26%
Habibi et al. [28]	83	27.1	1:0.7	1:2.1	Mand post	NA	33.7	NA	NA	NA	NA
MacDonald-Jankowski and Li [30]	33	30.6	1:0.8	1:1.5	Mand post	1:1.1	56%	Max third M	69%	41%	82%
Sansare et al. [33]	72	30.7	1:0.3	1:2.6	Mand post	1:0.6	NA	NA	NA	NA	NA
Myoung et al. [36]	256	30.8	1:0.7	1:2.1	Mand molar	NA	NA	NA	NA	NA	NA
Simiyu et al. [37]	22	27.5	1:0.7	1:2.5	Mand post	1:1.4	9.1%	Mand third M and max C	NA	NA	NA
Titinchi and Nortje [38]	145	34.5	1:0.6	1:3	Mand post	1:0.4	52.4%	Mand third M	NA	0.7%	NA
This study	100	31.4	1:1.1	1:1.4	Mand post and ramus	1:0.3	42%	Max third M	33.7%	7%	64%

Mand mandibular, *NA* data not available, *Post* posterior region, *M* molar, *Max* maxillary, *C* canine

[a]All studied lesions are in the mandible

Table 5 Comparison of clinical and radiographic findings of ameloblastomas with previous reports

Author	Number of ameloblastomas	Mean age (y)	Male: female	Maxilla: mandible	Most common site	Unilocular: multilocular	Association with impacted tooth	Most commonly associated impacted tooth	Displacement of adjacent teeth	Root resorption		Bone expansion
Reichart et al. [5]	3677	36	1:1	1:5	Mand Post	1:1	NA	NA	NA	NA		NA
Alves et al. [17]	9	31.8	1:0.8	NA	Mand Post	1:0.3	44%	Mand third M	NA	75%		89%
Dhanuthai et al. [26]	1289	38.3	1:1	1:9.8	Mand Post	1:1	10.4%	NA	NA	NA		NA
Kim et al. [29]	71	30.4	1:0.8	1:6.8	Mand Post	1:0.4	NA	NA	NA	NA		NA
MacDonald-Jankowski et al. [31]	61	30.5	1:1	1:5.1	Mand Post	1:0.6	39%	Mand third M	73%	59%		100%
Philipsen and Reichart [32]	193											
Initially diagnosed as DC	90	16.5	1:0.7	1:3–13	Mand Post	1:0.2	NA	Mand third M	NA	NA	NA	
Initially diagnosed as non-DC	103	35.2	1:1.8	1:3–13	Mand Post	1:0.9	–	–	NA	NA	NA	
Siar et al. [34]	340	30.3	1:0.7	1:10.7	Mand Post	1:1.8	3.4%	NA	NA	6.7%		NA
This study	101	34.9	1:1.1	1:9.1	Mand Post	1:2.2	19%	Mand third M	55.8%	66.7%		96.3%

NA data not available, *Mand* mandibular, *Post* posterior region, *M* molar, *DC* dentigerous cyst

[a]All studied lesions are in the mandible

[b]All cases are unicystic ameloblastoma

is in agreement with many previous studies showing that most OKCs showed unilocular shape [17, 21, 23, 33, 38]. In ameloblastomas, the results of shape according to previous studies were still controversial. Some studies reported that the ratio of unilocular to multilocular shape was 1:1 [5, 26], while other studies documented that most ameloblastomas showed unilocular shape [17, 29, 31, 32]. Another study reported that multilocular shape was more prominent in ameloblastomas [34]. The present study found that more cases of ameloblastomas showed multilocular shape (68.3%) than unilocular shape (31.7%).

Regarding the association with impacted tooth, OKCs showed a greater frequency than ameloblastomas in both maxilla and mandible. Notably, almost all ameloblastomas in the maxilla were unassociated with impacted teeth. Only 1 ameloblastoma in the posterior maxilla entirely enclosed an impacted third molar. Therefore, we speculated that a lesion in the maxilla, associated with an impacted tooth was likely to be an OKC rather than an ameloblastoma. Related studies reported that 17–100% of OKCs showed displacement of adjacent teeth [22, 24, 27, 30]. Most studies of ameloblastomas did not evaluate this effect. Only 1 study reported that this effect was found in 73% of ameloblastomas [31]. In the present study, displacement of adjacent teeth was found in more cases of ameloblastomas (55.8%) than in OKCs (33.7%).

Our results showed that 66.7% of ameloblastomas caused root resorption, whereas only 7% of OKCs showed this effect. This was similar to the literature showing that root resorption was more frequently seen among ameloblastomas than among OKCs [17, 19]. With respect to bone expansion in OKCs, the results vary among studies. In our study, 64% of OKCs caused bone expansion. Three studies reported that bone expansion was found in 26%, 77%, and 82% of OKCs [17, 27, 30]. Among ameloblastomas, a high percentage of bone expansion as 89% and 100% of cases has been documented [17, 31]. Our study also found that 96.3% of ameloblastomas caused bone expansion. Among these cases, distinct bone expansion was found in most ameloblastomas (87.8%), whereas this was found in only 33.3% OKCs. The difference of this effect might be used as one of the radiographic findings to differentiate between 2 lesions as suggested by Ariji et al. [19], who revealed that buccolingual bone expansion was a significant feature to differentiate ameloblastomas from OKCs.

There were some limitations to the present study. To evaluate some radiographic features, i.e., relationship between lesion and the impacted tooth as well as bone expansion, conventional radiographs taken with various techniques are required. In this study, some cases had only one available radiograph. Therefore, these radiographic features could not be evaluated in these cases due to inadequacy of radiographs. In addition, although CBCT reveals the details of the lesion in 3 dimensions, it was not prescribed for all cases due to additional cost and radiation dose to the patients. In cases without CBCT images, all studied radiographic features were investigated from 2 dimensional radiographs with inferior image quality compared to CBCT images.

Conclusion

No gender predilection was observed for OKCs and ameloblastomas. The most common location of both lesions was at the posterior region of the jaws. Almost one half of OKCs were found in the maxilla, while ameloblastomas were predominantly found in the mandible. All evaluated radiographic features showed significant differences between OKCs and ameloblastomas. Most OKCs showed smooth border and unilocular shape, while most ameloblastomas showed scalloped border and multilocular shape. Compared with ameloblastomas, OKCs showed greater frequency to be associated with impacted tooth, and were unlikely to cause tooth displacement and root resorption. We suggest that a radiolucent lesion showing smooth border, unilocular shape, no adjacent tooth displacement, no root resorption, with mild or no bone expansion is likely to be an OKC rather than an ameloblastoma. These radiographic findings might be helpful for differential diagnosis between them.

Compliance with ethical standards

Conflict of interest Jira Kitisubkanchana, Nor Hidayah Reduwan, Sopee Poomsawat, Suchaya Pornprasertsuk-Damrongsri, and Chanchai Wongchuensoontorn declare that they have no conflict of interest.

Ethical approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (the Institutional Review Board of the Faculty of Dentistry/Faculty of Pharmacy, Mahidol University, COA No. MU-DT/PY-IRB 2017/007.0902) and with the Helsinki Declaration of 1975, as revised in 2008. According to the Institutional Review Board of our university, for this retrospective study, formal consent is not required.

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