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CONE BEAM COMPUTED TOMOGRAPHY IMAGING CHARACTERISTICS OF MANDIBULAR DENTIGEROUS CYSTS AND POSSIBLE IMAGING FEATURES ASSOCIATED WITH BONE EXPANSION

MANDİBULAR DENTİJERÖZ KİSTLERİN KONİK IŞINLI BİLGİSAYARLI TOMOGRAFİ GÖRÜNTÜLEME ÖZELLİKLERİ VE KEMİK EKSPANSİYONU İLE İLİŞKİLİ OLABİLECEK GÖRÜNTÜLEME ÖZELLİKLERİ

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ABSTRACT

Objective: Dentigerous cysts (DC) are one of the most common cysts in the jaw, and radiographic features are important for diagnosis. This study aims to evaluate the radiographic features of mandibular DCs on cone beam computed tomography (CBCT) images and investigate the possible associations between the imaging features and bone expansion.

Material and Methods: Patients who had CBCT images with pathologically proven DC within the mandible were included the study. On CBCT images, besides lesion radiographic features, the position of the impacted tooth and cyst-to-crown relationship were also recorded.

Results: Among 36 DCs, 69.4% affected the impacted tooth (61.1% were displaced, 5.6% were resorbed and 2.8% were both displaced and resorbed), 80.6% expanded, 100% had cortical involvement (perforation and thinning), 80.6% affected the inferior alveolar canal (%13.9 resorption, %11.1 displacement, 55.6% resorption and displacement), 65.7% affected the adjacent teeth (27.8% resorption, 30.6% lamina dura loss, 5.6% displacement and lamina dura loss), 25% of impacted tooth position were in buccal/lingual obliquity, and 55.5% had a lateral type cyst-to-crown relationship. There was a statistically significant relationship between the expansion rate and effect on the impacted tooth (p=0.023), between the expansion rate and effect on the adjacent tooth (p=0.011), and between the cyst-to-crown relationship and impacted tooth buccolingual position (p=0.031).

Conclusion: Resorption and displacement of the impacted tooth and resorption, displacement and lamina dura loss of the adjacent tooth were common and statistically related with DCs expansion rates. These imaging features could be a sign of expansion and should be carefully examined.

Keywords: Cone beam computed tomography, dentigerous cyst, mandible

ÖZ

Amaç: Dentijeröz kist (DK), çenelerde sık görülen kistlerden biri olup teşhis edilmesinde radyografik özellikleri önem taşımaktadır. Bu çalışmanın amacı mandibular DK'lerin konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleme özelliklerini incelemek ve kemik ekspansiyonu ile görüntüleme özellikleri arasındaki olası ilişkileri değerlendirmektir.

Gereç ve Yöntem: Çalışmaya KIBT görüntüsü olan ve patoloji raporu ile tanısı doğrulanan hastalar dahil edilmiştir. KIBT görüntülerinde lezyonun radyografik özelliklerinin yanı sıra, gömülü dişin pozisyonu ve kist-kron ilişkisi de değerlendirilmiştir.

Bulgular: 36 DK'nin %69,4'ünün gömülü dişi etkilediği (%61,1 yer değişikliği, %5,6 rezorpsiyon ve %2,8 yer değişikliği ve rezorpsiyon), %80,6'sının ekspansiyona neden olduğu, %100'ünün kortikal tabakalarda tutuluma neden olduğu (perforasyon ve incelme), %80,6'sının inferior alveolar kanalı etkilediği (%13,9 rezorpsiyon, %11,1 yer değişikliği, %55,6 rezorpsiyon ve yer değişikliği), %65,7'sinin komşu dişi etkilediği (%27,8 rezorpsiyon, %30,6 lamina dura kaybı, %5,6 yer değişikliği ve lamina dura kaybı), gömülü dişlerin %25'inin bukkal/lingual oblik pozisyonda olduğu ve %55,5'inde lateral tip kist-kron ilişkisi olduğu tespit edildi. Ekspansiyon oranı ile gömülü dişe etki (p=0,023) ve komşu dişe etki (p=0,011) arasında istatistiksel olarak anlamlı ilişki saptandı. Ayrıca kist-kron ilişkisi ile gömülü dişin bukkolingual konumu arasında da istatistiksel olarak anlamlı ilişki gözlendi (p=0,031).

Sonuç: Bu çalışmada gömülü dişte rezorpsiyon ve yer değişikliği ile komşu dişte yer değişikliği ve lamina dura kaybının sık olduğu ve bunların DK'lerin ekspansiyon oranı ile istatistiksel olarak ilişkili olduğu bulundu. Bu bulgular ekspansiyonun belirtisi olabileceğinden dikkatlice değerlendirilmelidir.

Anahtar Kelimeler: Konik ışınlı bilgisayarlı tomografi, dentijeröz kist, mandibula

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INTRODUCTION

Dentigerous cysts (DC) are one of the most common cysts in the jaw and represent 17.1-30% of jaw cysts (1-3). Although in previous studies an inflammatory etiology was suggested, in 2022 World Health Organization Classification DC was classified as an odontogenic developmental cyst (1). In clinical features there is usually no pain or discomfort, but hard swelling and facial asymmetry are possible (4). Typically, DC presents as an asymptomatic unilocular radiolucency enclosing the crown of an unerupted or impacted tooth, mostly mandibular third molar (2,4). Radiographic features of DCs on panoramic radiographs have been well defined by various studies (5,6). However, there were limited studies about the radiographic features of DCs on cone beam computed tomography (CBCT) images. Although the recent studies demonstrated different imaging characteristics of intraosseous jaw lesions, including DCs, between the panoramic and CBCT images, the possible associations between the imaging features have not been evaluated (7-9).

CBCT is widely accepted and used in different fields of dentistry (10-13). However, the radiation dose and cost are important factors that should be considered when making a CBCT imaging decision (14). Also, CBCT has some disadvantages, including susceptibility to various artefacts from metallic restorations, patient motion, inadequate scanner calibration and undersampling (4,10). Thereby CBCT images are not always used for surgical treatment planning of DCs and, in some cases, treatment planning could be made only on panoramic images. However, the ability to enable three-dimensional imaging promotes CBCT preference in the evaluation of intraosseous pathologies in the oral and maxillofacial region (15). CBCT provides unobstructed views of both anatomic structures and intraosseous lesions in their precise locations (7). Also, it plays an important role in the delineation of maxillofacial cystic lesions and their impact on the adjacent tissues (15). Because of its three-dimensional nature, CBCT demonstrates lesion expansion, cortical involvement and the effect on surrounding structures of intraosseous jaw lesions better than panoramic imaging (7,8).

As DC is a common developmental cyst and bone expansion is usually the only clinical sign, its imaging features and possible associations between the imaging features, especially lesion expansion, is critical. Therefore, this study aims to evaluate the imaging characteristics of mandibular DCs on CBCT images and investigate the possible associations between the imaging features, especially lesion expansion, which is difficult to evaluate on panoramic images.

MATERIAL and METHODS

This retrospective study was reviewed and approved by the Non-Interventional Non-Invasive Clinical Studies Ethics Board of Hacettepe University (Date:06.11.2018, No: GO 18/1051) and all procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. For this type of study, formal consent is not required. CBCT images were obtained from the CBCT image archives in the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Hacettepe University. The CBCT scans were acquired with an i-CAT Next Generation (Imaging Sciences International, Hatfield, PA, USA) unit. A tube voltage of 120 kVp was used for all acquisitions, with variation in the field of view, acquisition voxel size (0.200-0.250 mm), tube current (3-7 mA), and exposure time.

A total of 5974 CBCT scans obtained for various reasons between January 2016 and October 2018 were evaluated and 502 images that showed cyst-like lesions were detected. Among these images, patients with inconclusive pathology results and CBCT images of poor diagnostic quality were excluded from the study. Patients who had CBCT images with pathologically proven DC within the mandible were included in the study. The final sample consisted of 34 patients. The images were viewed with i-CAT Vision software (version 1.9.3.14, Imaging Science International, Hatfield, PA, USA). All images were evaluated by two oral and maxillofacial radiologists (28 and 17 years of experience, respectively). In the event of disagreement, a final diagnosis was reached by consensus reading.

Evaluation of CBCT images

The following imaging features of DCs were analyzed:

Location and Size: Locations of the lesions were classified as inter-canine region, posterior (premolar-molar) region, and ramus region. Lesion size was measured at its maximum length on axial, sagittal and coronal planes. The measurements were recorded and repeated by the same observer at an interval of 2 weeks and the mean value was used for analysis.

Shape: The outline of an entire lesion was classified as circular (Figure 1), oval (Figure 2), and scalloped.

Internal structure: DCs were classified as radiolucent, mixed density (radiolucent lesion with radiopaque foci) (Figure 2), or multilocular.

Borders: Lesion borders were divided between corticated and non-corticated.

Effects on surrounding structures: Lesion expansion, cortical involvement and its effect on the impacted tooth, inferior alveolar canal and adjacent teeth were evaluated.

Figure 1: Sagittal CBCT image showing a circular-shaped, central-type dentigerous cyst. Note the root resorption at the distal root of the adjacent second molar

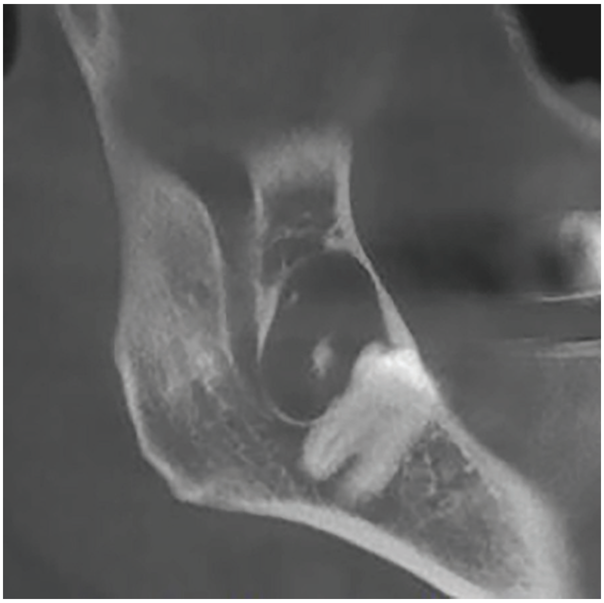

Figure 2: Sagittal CBCT image showing an oval-shaped, lateral-type dentigerous cyst. Note the radiopaque foci inside the radiolucent lesion

Expansion: Expansion rate was categorized as absent, mild and severe. Lesions with expansion were noted and the maximum length of expansion was measured. In the same image section, the healthy opposite side was measured and the ratio of expanded lesion side/healthy opposite side was calculated. Ratios ≤ 1.5 were recorded as mild and ratios > 1.5 were recorded as severe expansion. Also, expansion direction (buccal, lingual, alveolar crest, etc.) was recorded.

Cortical involvement: Cortical plates were evaluated for existence of perforation and thinning.

Effect on impacted tooth: DC's effect on the impacted tooth was recorded as resorption and/or displacement.

Effect on the inferior alveolar canal: DC's effect on the inferior alveolar canal was recorded as absent, resorption, displacement, and resorption and displacement.

Effect on the adjacent teeth: Adjacent teeth were evaluated for resorption (Figure 1), displacement, and loss of lamina dura.

Position of impacted tooth: Impacted tooth position was recorded using Winter Classification as mesioangular, distoangular, horizontal, vertical, buccal/lingual obliquity, transverse or inverse. Also the impacted tooth's buccolingual position in bone was recorded using the modified Khojastepour method as lingual position (epicenter of the crown located in the lingual one third of the buccolingual distance), buccal position (epicenter of the crown located in the buccal one third of the buccolingual distance) and central position (epicenter of the crown located in the center of the buccolingual distance) (16).

Cyst-to-crown relationship: Tooth-DC relationship was classified as central (Figure 1), lateral (Figure 2) and circumferential (Figure 3). In the central type the cyst surrounds the crown of the tooth and the enveloped tooth is positioned at the center of the cyst. In this type the cyst is attached to tooth at the region of cementoenamel junction. In the lateral type the radiographic appearance results from dilatation of the follicle on one aspect of the crown and cyst grows laterally along the root surface and attaches to the middle or apical region of the root. Lateral type DC is commonly seen with a partially erupted tooth that its superior aspect is exposed. In the circumferential type, the entire tooth appears to be enveloped by the cyst (3,17).

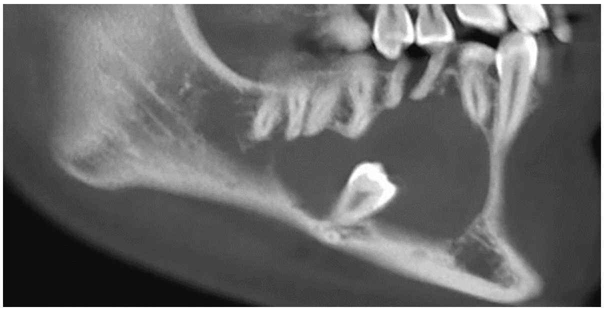

Figure 3: Sagittal CBCT image showing a circumferential type dentigerous cyst. The entire tooth is enveloped by the cyst

Statistics

Mean±Standard Deviation was used as descriptive statistics for normally distributed numerical variables such as age. Otherwise, median, minimum and maximum values were used. The normality of the numerical variables was assessed by using Shapiro-Wilk Normality test. Independent groups were compared using the Independent samples t-test where the parametric test assumptions were satisfied and there are two independent groups. In addition to the evaluating normality assumption, the Levene test was used for assessing homogeneity of group variances. When the parametric test assumptions were violated, the Mann-Whitney U test was used to compare two independent groups. One-way Analysis of Variance test was used where the parametric test assumptions were satisfied and there are more than two independent groups. Otherwise, the Kruskal-Wallis test was used.

Categorical data were presented by frequencies and percentages as n (%). Depending on the dimension of the contingency table, Fisher's Exact test or the Fisher-Freeman-Halton Exact test were used for evaluating dependency between categorical variables.

Significance level was set at 0.05. All analysis was carried out using IBM SPSS Statistics v23.0 for Windows OS.

RESULTS

This study included 34 patients with a mean age of 38.12±19.01 years who had both CBCT images and pathology reports. Among 34 patients, 11 (32.4%) were females with a mean age of 26.64±19.55 years and 23 (67.6%) were males with a mean age of 43.61±16.47 years. The age distribution of males was significantly different from females (p=0.013). Two patients

Table 1: CBCT imaging characteristics of 36 dentigerous cysts

Imaging Feature		Frequency (%)
Localization		
	Posterior region	32 (88.9)
	Ramus region	3 (8.3)
	Inter-canine region	1 (2.8)
Impacted tooth		
	Right third molar	16 (44.4)
	Left third molar	11 (30.6)
	Right second molar	1 (2.8)
	Right second premolar	3 (8.3)
	Left second premolar	3 (8.3)
	Right canine	1 (2.8)
	Left second deciduous molar	1 (2.8)
Shape		
	Oval	26 (72.2)
	Circular	9 (25)
	Scalloped	1 (2.8)
Internal structure		
	Lucent	33 (91.6)
	Mixed	2 (5.6)
	Multilocular	1 (2.8)
Borders		
	Corticated	32 (88.9)
	Non-corticated	4 (11.1)
Effect on surrounding structures		
	Effect on the impacted tooth	25 (69.4)
	Displaced	22 (61.1)
	Resorbed	2 (5.6)
	Displaced and resorbed	1 (2.8)
	Expansion	29 (80.6)
	Buccal	2 (5.6)
	Lingual	14 (38.9)
	Buccal and lingual	10 (27.8)
	Coronal	3 (8.3)
	Cortical involvement	36 (100)
	Effect on the inferior alveolar canal	29 (80.6)
	Resorption	5 (13.9)
	Displacement	4 (11.1)
	Resorption and displacement	20 (55.6)
	Effect on adjacent teeth	23 (65.7)
	Resorption	10 (27.8)
	LLD	11 (30.6)
	Displacement and LLD	2 (5.6)
Cyst-to-crown relationship		
	Lateral	20 (55.5)
	Central	15 (41.7)
	Circumferential	1 (2.8)
Impacted tooth position		
Winter Classification	Vertical	8 (22.2)
	Horizontal	8 (22.2)
	Buccal/lingual obliquity	9 (25)
	Inverse	6 (16.7)
	Mesioangular	2 (5.6)
	Distoangular	2 (5.6)
	Transverse	1 (2.8)
Impacted tooth position		
Modified Khojastepour Classification	Central	23 (63.9)
	Lingual	10 (27.8)
	Buccal	3 (8.3)
Lesions dimensions		Mean Values
	Mesio-distal direction	23.08±9.80 mm
	Bucco-lingual direction	13.50±2.71 mm
	Apico-incisal direction	20.42±7.33 mm

LLD: Loss of lamina dura

Table 2: Detailed distribution of the relation between the expansion and effect on impacted tooth and adjacent tooth

Expansion	Effect on impacted tooth				
	Absent	**Present**		**Total**	
Absent	5 (71.4%)	2 (28.6%)	0 (0%) Resorption 2 (28.6%) Displacement 0 (0%) Resorption and displacement	7 (100%)	
Mild	1 (9.1%)	10 (90.9%)	0 (0%) Resorption 10 (90.9%) Displacement 0 (0%) Resorption and displacement	11 (100%)	p=0.023*
Severe	5 (27.8%)	13 (72.2%)	2 (11.1%) Resorption 10 (55.6%) Displacement 1 (5.6%) Resorption and displacement	18 (100%)	
	Effect on adjacent tooth				
	Absent	**Present**		**Total**	
Absent	4 (57.1%)	3 (42.9%)	2 (28.6%) Resorption 1 (14.3%) LLD 0 (0%) Displacement and LLD*	7 (100%)	
Mild	6 (60%)	4 (40%)	0 (0%) Resorption 2 (20%) LLD 2 (20%) Displacement and LLD	10 (100%)	p=0.011*
Severe	2 (11.1%)	16 (88.9%)	8 (44.4%) Resorption 8 (44.4%) LLD 0 (0%) Displacement and LLD	18 (100%)	

One dentigerous cyst was excluded from this evaluation because although the adjacent tooth had resorption it also had periapical lesion, which could be the reason of the root resorption, *p<0.005 statistically significant relation, LLD: Loss of lamina dura

(15-year-old female and 67-year-old male) had bilateral DCs, thus 36 DCs were evaluated. Table 1 shows CBCT imaging features of 36 DCs.

The median age of patients whose DCs associated with primary teeth, permanent canine and premolars (12 years (6-75)) were younger than patients whose DCs associated with permanent molars (42.50 years (15-67)) (p=0.017). Although the median age of the lateral type DC (42.45 years) was higher than the central type (34.20 years) this wasn't statistically significant.

There were 7 (19.4%) no expansion, 11 (30.6%) mild, and 18 (50%) severe expansion rates. The expansion rate and the other imaging features relations were examined and there was a statistically significant relationship between the expansion rate and its effect on the impacted tooth (p=0.023). The relationship was statistically significant between the expansion rate and the effect on the adjacent tooth (p=0.011). DCs with expansion showed significantly more impacted teeth with displacement and/or resorption and more adjacent tooth with lamina dura loss than the DCs without expansion (Table 2). Also, there were significant relationships between the expansion rate and mesio-distal and apico-incisal dimensions of the lesion (p=0.017 and p=0.001 respectively), however, there was no relationship between expansion and the bucco-lingual dimension (p=0.07) of the lesion. There was no relation between age and expansion rate and mean ages were statistically similar among expansion groups (no expansion 40.86±21.043 years, mild expansion 33.55±17.688 years, severe expansion 40.17±20.523 years) (p=0.638). Similarly, there was no relationship between age and lesion dimensions. Table 3 shows the detailed characteristics of expansion.

Among 15 central type DCs, the most common bucco-lingual position was central (13 (86.7%)), while 1 (6.7%) was in the buccal, and 1 was (6.7%) in the lingual position. Twenty lateral type DCs' bucco-lingual positions were 10 (50%) central, 2 (10%) buccal and 8 (40%) lingual. There was only 1 circumferential type DC and it was in the lingual position. There was a statistically significant relationship between the cyst-to-crown relationship, the impacted tooth's bucco-lingual position, and central type DCs were commonly central in the bucco-lingual position (p=0.031).

DISCUSSION

Dental professionals must be knowledgeable about jaw cysts as they are common, and DCs are one of the most common cysts of the jaw. Many jaw cysts have no clinical symptoms or have similar symptoms like jaw expansion and missing teeth. Radiographs provide useful diagnostic information about cysts that influence the treatment plan (3, 4, 18). Usually, panoramic imaging is the first imaging choice in the surgical treatment planning of DC as it is easy to access and has low radiation dose (19, 20). However, differential diagnosis of DC and odontogenic keratocyst (OKC) on panoramic images is difficult as their radiographic features are similar. Expansion is a common radiographic finding of DC and is widely used for differential diagnosis of DC with OKC (4, 21). However, because of pano-

Table 3: Detailed characteristics of expansion

		Expansion			p-value
		Absent	Mild	Severe	
Gender					
	Female	2 (28.6%)	3 (27.3%)	7 (38.9%)	p=0.897
	Male	5 (71.4%)	8 (72.7%)	11 (61.1%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Localization					
	Ramus	3 (42.9%)	0 (0%)	0 (0%)	p=0.005*
	Posterior	4 (57.1%)	11 (100%)	17 (94.4%)	
	Inter-canine	0 (0%)	0 (0%)	1 (5.6%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Shape					
	Circular	3 (42.9%)	4 (36.4%)	2 (11.1%)	p=0.270
	Oval	4 (57.1%)	7 (63.6%)	15 (83.3%)	
	Scalloped	0 (0%)	0 (0%)	1 (5.6%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Perforation					
	Absent	2 (28.6%)	1 (9.1%)	4 (22.2%)	p=0.633
	Present	5 (71.4%)	10 (90.9%)	14 (77.8%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Thinning					
	Absent	2 (28.6%)	0 (0%)	1 (5.6%)	p=0.113
	Present	5 (71.4%)	11 (100%)	17 (94.4%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Effect on inferior alveolar canal					
	Absent	3 (42.9%)	2 (18.2%)	2 (11.1%)	p=0.209
	Present	4 (57.1%)	9 (81.8%)	16 (88.9%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Bucco-lingual position					
	Central	7 (100%)	5 (45.5%)	11 (61.1%)	p=0.051
	Buccal	0 (0%)	0 (0%)	3 (16.7%)	
	Lingual	0 (0%)	6 (54.5%)	4 (22.2%)	
	Total	7 (100%)	11 (100%)	18 (100%)	
Cyst-to-crown relationship					
	Central	4 (57.1%)	3 (27.3%)	8 (44.4%)	p=0.620
	Lateral	3 (42.9%)	8 (72.7%)	9 (50%)	
	Circumferential	0 (0%)	0 (0%)	1 (5.6%)	
	Total	7 (100%)	11 (100%)	18 (100%)	

*p=0.005 statistically significant relation

ramic imaging, two-dimensional nature lesion expansion and cortical involvement, its effect on surrounding structures could not be properly evaluated. These radiographic features could be more accurately evaluated with CBCT images (7, 8, 10). In this study, besides DCs radiographic features on CBCT images, relations among these features, especially lesion expansion, were investigated. As jaw expansion could be the only clinical symptom of DC and is critical for differential diagnosis of DC, this study aims to evaluate the relation between lesion expansion and other radiographic features.

In this study, 34 patients with 36 DCs (2 patients had bilateral DCs) were evaluated and their mean age (38.12±19.01 years) and gender distribution (female 32.4%, male 67.6%) was similar with the literature (2, 5, 20, 22). Females (26.64±19,556) were at a younger age compared to males (43,61±16,470 (p=0.013). Also, the localization of legions, (88.9% posterior region), involved tooth (75% third molar), and shape (97.2% oval or circular) were compatible with the literature (2, 15, 18). Previous studies reported that DC is associated with permanent teeth (2, 23). However, in this study, one DC was associated with a deciduous tooth (Figure 4). The median age of patients whose DCs were

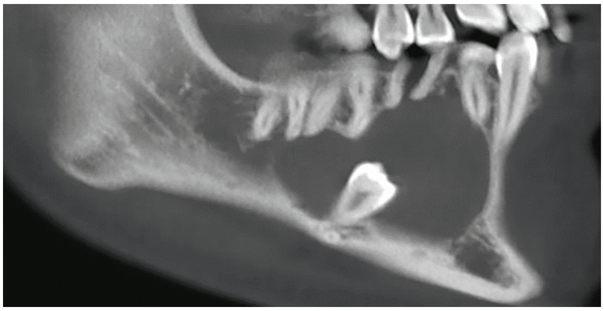

Figure 4: Cropped reconstructed panoramic image demonstrating a DC with deciduous tooth

associated with primary tooth, permanent canine and premolars (12 years) were younger than patients whose DCs were associated with permanent molars (42.50 years) (p=0.017). As permanent third molars are the last teeth that develop in the oral cavity, DCs associated with these teeth were seen in older age groups. When age and cyst-to-crown relationships were evaluated, it was seen that the median age of the lateral type DC (42.45 years) was higher than the central type (34.20 years). However, this wasn't statistically significant.

Terauchi et al. and Main analyzed DCs around the mandibular third molar and reported that there was no relationship between the lesion size and age (5, 24). Similarly, Akçiçek et al. analyzed 25 DCs, 5 in the maxilla and 20 in the mandible and found no relation between lesion size and age (25). The present study found similar results suggesting that lesion enlargement is independent from age.

DCs are usually defined as unilocular radiolucent lesions around the crown of an impacted or unerupted tooth with no septa or loculation within the cyst (4, 21). In this study, most of the DCs fit this definition. However, the internal structure of 2 (5.6%) DCs were radiolucent with radiopaque foci and 1 (2.8%) was multilocular. Although mixed internal structure is unexpected in DCs, there are reports of DCs containing radiopaque foci (calcifications) in radiolucent lesions, as in this study (21, 23, 26, 27). Another unexpected radiographic feature is septa formation within the cyst and in this study, this feature was observed in 1 (2.8%) patient. There have been some studies that reported multilocular appearance of DCs (5, 28, 29). Terauchi et al. investigated panoramic images of 257 DCs and there were 229 (89.1%) unilocular and 28 (10.9%) multilocular cysts (5). Occasionally, trabeculations may be seen in DCs and this may cause multilocular internal structure with an erroneous impression (3, 28). In this study, DCs were evaluated with CBCT images, while Terauchi et al. used panoramic images (5). Therefore, it is possible that they classified trabeculations in DCs as multilocularity on panoramic images. Similarly, Martinelli-Klay et al. reported a DC that showed multilocular radiographic features on a panoramic image. However, multi-slice computed tomography revealed a unilocular lesion without septations (28).

As previously mentioned, expansion is a common radiographic finding of DCs and is widely used for differential diagnosis of DC with OKC (4, 21). A unilocular radiolucent OKC with an impacted tooth has similar radiographic findings with DC except for cortical expansion (4, 15). However cortical expansion could not be adequately evaluated with panoramic images, the most widely used dental imaging method, and could be properly determined with CBCT images (7, 10). Meng et al. investigated DCs in the maxilla and found 78.5% buccal expansion and 36.7% lingual expansion (15). The present study investigated 36 DCs in the mandible and found 33.3% buccal expansion and 69.4% lingual expansion. The different results between Meng et al. and the present study are because of different jawbones (15). As the external oblique ridge is located on the buccal surface, the buccal side of the mandible is denser than the lingual side and this may restrict the expansion.

Expansion and the other radiographic features' relations were examined and there was a statistically significant relationship between the expansion and its effect on the adjacent tooth (resorption and loss of lamina dura) (p=0.011). The effect on the adjacent tooth was seen on 23 (64%) DCs and this was higher than the other studies (Meng et al. 10.1%, Açıkgöz et al. 13.1%) (15,18). Among these studies, different imaging methods used and different effects were evaluated and these could cause differences in the results too.

Also, there was a statistically significant relationship between the expansion and the effect on the impacted tooth (p=0.023). Among 25 (69.4%) impacted teeth the most seen alteration was tooth displacement (22, 61.1%). Displaced teeth can affect surrounding structures, can perforate the cortical plates or inferior alveolar canal, as in this study, and consequently complicate treatment. In this study, resorption of the impacted tooth was only seen in DCs with severe expansion. However, it is not possible to conclude that resorption of the impacted tooth occurs only in DCs with severe expansion because of our limited study sample. Further studies with larger samples are needed. Nevertheless, in the cases with a displacement of the impacted tooth, resorption and/or loss of lamina dura at the adjacent tooth in panoramic images the thought that there may be expansion should be considered.

DC expands the cortical boundary of the involved jaw as it grows (4, 17). This property was obviously observed in the present study; cortical expansion was seen in 29 (80.6%) cases. There was a statistically significant relationship between the expansion and lesion dimensions, especially the mesio-distal and apico-insical dimensions (p=0.017 and p=0.001 respectively). This feature is important for differential diagnosis of DC and OKC, as growing along the internal aspect of the jaws and causing minimal expansion is characteristic of OKC (4, 17).

Impacted tooth displacement was 61.1% (22/36) in this study and this was higher than in other studies (Açıkgöz et al. 9.9%, Lee et al. 19.15%) (18, 30). Similarly, expansion (80.6%) and cortical perforation (80.6%) rates were higher than in other studies (Lee et al. 67.3% expansion, 36.7% cortical perforation) (30). Lee et al. used computed tomography imaging to identify expansion and cortical perforation while in the present study, CBCT imaging is used (30). Different imaging methods have different resolutions and interval sections that could influence the results, especially cortical perforation.

Many lesions in the mandible can affect the inferior alveolar canal and DC is one of them (3, 4, 31). In the present study, this effect was found in 29 (80.6%) of DCs and was higher from Kauke et al. results (31). This may be due to our study only included mandibular DCs and also most of them localized at the posterior region.

Some lesions with unerupted teeth can have similar radiographic images to DC (22). In some studies, the cyst-to-crown relationship is used for differential diagnosis and it was stated that DC attaches to the tooth at the cementoenamel junction and this feature is important for differential diagnosis (4, 31). Ikeshima and Tamura investigated the attachment point of lesions to the impacted tooth and reported that DCs' attachment points to the root were closer to the cementoenamel junction than benign tumors (22). However, it was also reported that, as in our former study, the cyst-to-crown relationship of DCs shows several radiographic variations (15, 25). In this study only 15 (41.7%) DCs were central type, 20 (55.5%) were lateral and 1 (2.8%) was circumferential type. This was similar to our previous study that DCs cyst-to-crown relationship was categorized as an attachment at the cementoenamel junction (40%) and attachment the at root surface (60%) (25). Meng et al. reported similar central type DC (44.3%), however, their lateral (38%) and circumferential (11.4%) types were different (15).

In this study, Khojastepour classification is modified and the epicenter of the crown is used for the impacted tooth buccolingual position (16). There was a statistically significant relationship between impacted tooth buccolingual position and cyst-to-crown relationship (p=0.031) and centrally positioned DCs' cyst-to-crown relationship was the most common central type. This finding has critical importance while surgical treatment is planned with panoramic images.

The biggest limitation of this study is the small sample size. Although a total of 5974 CBCT scans were evaluated, only 34 patients were included in the study. Despite this limited sample size DCs displayed varying imaging characteristics than expected. For a better understanding of these variations, future studies with larger sample groups are needed.

CONCLUSIONS

In this study, resorption and displacement of impacted tooth and resorption, displacement, and lamina dura loss of adjacent tooth are related to DCs expansion rates. Therefore, these radiographic features could be a sign of expansion and should be carefully examined.

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