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Decoding odontogenic keratocysts: A retrospective radiographic study

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Abstract:

Odontogenic keratocysts display aggressive growth and variable CBCT appearances that can overlap with other jaw cysts and tumors, complicating radiographic characterization and surgical planning. Therefore, it is of interest to evaluate the demographic distribution, anatomical location, internal architecture, radiographic variants, lesion borders, dimensional profile and effects on adjacent structures in 39 histopathologically confirmed odontogenic keratocysts using archival CBCT examinations. Categorical features were summarized descriptively, a standardized smaller-to-larger dimension ratio was calculated from the largest documented lesion pair and associations between internal structure and adjacent-structure effects were tested using Fisher's exact test. The cohort included 23 males and 16 females (mean age 30.0 ± 15.6 years); 28 cases involved the mandible alone, 7 the maxilla alone and 4 both jaws, while multilocular architecture, cortical expansion, inferior alveolar canal involvement and tooth displacement were observed in 66.7%, 94.9%, 69.2% and 53.8%, respectively, with no significant adjacent-structure difference by locularity (all $p > 0.05$). Thus, CBCT provided clinically important three-dimensional information, but no single imaging sign, including locularity or dimensional ratio, was sufficiently specific to replace histopathological confirmation.

Keywords: Odontogenic keratocyst (OKC), cone-beam computed tomography (CBCT), radiographic variants, inferior alveolar canal, cortical expansion, multilocular lesion

Background:

Odontogenic keratocyst (OKC) is a developmental odontogenic cyst derived from dental lamina remnants and is recognized for its infiltrative growth, tendency to extend along cancellous bone and clinically important recurrence potential. Although its terminology and classification have changed over time, current understanding places it among odontogenic cysts while retaining emphasis on its aggressive biological behavior [1]. The lesion can occur across a broad age range but commonly affects younger adults and shows a preference for the posterior mandible and ramus. Its presentation may be solitary or multiple and multiple lesions warrant clinical evaluation for nevoid basal cell carcinoma syndrome. Radiographically, OKCs may appear unilocular or multilocular, may surround impacted teeth and may mimic dentigerous cysts, radicular cysts, lateral periodontal cysts, or ameloblastoma [2, 3]. Panoramic radiography remains useful for initial detection and overall jaw assessment, but two-dimensional imaging may underestimate cortical perforation, expansion, canal displacement and the true three-dimensional relationship of the lesion to teeth and adjacent spaces. CBCT provides multi-planar visualization with high spatial resolution and has become valuable for defining lesion boundaries and surgical risk [4]. A proposed imaging discriminator is the buccolingual width-to-mesiodistal length ratio. A relatively low ratio may reflect the characteristic anteroposterior growth of OKCs with limited buccolingual expansion; however, published evidence indicates that this parameter is supportive rather than diagnostic because values overlap with other odontogenic lesions [5]. Therefore, it is of interest to evaluate the demographic and CBCT radiographic characteristics of histopathologically confirmed odontogenic keratocysts and their effects on adjacent structures.

Materials and Methods:**Study design and setting:**

A retrospective radiographic study was conducted using archival CBCT examinations from the Department of Oral Medicine and Radiology, SVS Institute of Dental Sciences, Mahabubnagar, and Telangana, India. The supplied dataset contained 39 histopathologically confirmed OKC cases. The precise archival period and institutional ethics approval number were not present in the supplied records and should be inserted by the authors before journal submission.

Eligibility criteria:

Cases were included when a histopathological diagnosis of OKC was available and the CBCT volume permitted assessment of lesion location, borders, internal architecture and adjacent structures. Cases were excluded when histopathological confirmation was absent, image quality was degraded by motion or metal artifact, or surgery or another intervention had been performed before imaging.

Variables recorded:

Age and sex were recorded for each patient. Anatomical distribution was classified as mandible only, maxilla only, or both jaws. Mandibular involvement was further described as body only, ramus only, or combined body-ramus involvement. Multiple-lesion status was retained from the source records.

Radiographic assessment:

The evaluated CBCT characteristics included unilocular or multilocular internal structure; well-defined corticated borders with or without scalloping; collateral, envelopmental, extraneous, replacement, or mixed radiographic variant; inferior alveolar nerve canal involvement and displacement; tooth displacement; association with missing or impacted teeth; root resorption; and cortical expansion.

Dimensional analysis:

The source dataset contained paired lesion dimensions rather than a consistently oriented numerical ratio. To provide a reproducible summary, all dimension pairs were extracted from each record, the pair with the largest calculated area was selected when multiple lesions were documented and the smaller dimension was divided by the larger dimension. This standardized ratio therefore represents a morphology proxy and should not be interpreted as a formally oriented buccolingual-to-mesiodistal measurement when the original plane labelling was incomplete.

Statistical analysis:

Continuous variables were summarized as mean ± standard deviation, median and range and categorical variables as frequency and percentage. Male and female ages were compared using Welch’s independent-samples t-test. Associations between internal structure and categorical imaging effects were evaluated with Fisher’s exact test because of small cell counts. Statistical calculations were reproduced using Python 3.11 with pandas and SciPy. A two-sided p value <0.05 was considered statistically significant.

Results:

Thirty-nine CBCT examinations were analyzed. The age range was 6–64 years, with a mean of 30.0 ± 15.6 years and a median of 27 years. The cohort included 23 males (59.0%) and 16 females (41.0%). Mean age was 27.1 ± 14.2 years in males and 34.1 ± 17.0 years in females, without a statistically significant difference (p=0.187). The 21–40-year group was the largest age stratum (56.4%). Mandibular-only involvement was present in 28 cases (71.8%), maxillary-only involvement in 7 (17.9%) and involvement of both jaws in 4 (10.3%). Thirty-two cases had mandibular disease; among these, combined body-ramus involvement was recorded in 16, body-only involvement in 15 and isolated ramus involvement in 1. Eleven records (28.2%) were marked as multiple lesions. Multilocular internal architecture predominated, occurring in 26 cases (66.7%), while 13 lesions (33.3%) were unilocular. All lesions were described as corticated; scalloping was documented in 33 cases (84.6%). Collateral and envelopmental variants together accounted for 33 of 39 cases. Cortical expansion was the most frequent effect on surrounding structures, followed by inferior alveolar canal involvement, canal displacement and tooth displacement. The standardized smaller-to-larger dimension ratio averaged 0.55 ± 0.18 (median 0.50; range 0.26–1.00). Fourteen cases (35.9%) had a ratio <0.50, 20 (51.3%) had a ratio of 0.50–0.69 and 5 (12.8%) had

a ratio ≥0.70. Multilocular lesions showed numerically higher frequencies of tooth displacement, root resorption and cortical expansion than unilocular lesions. Nevertheless, Fisher’s exact testing did not identify a statistically significant association between internal structure and any assessed adjacent-structure effect. This suggests that locularity alone did not reliably predict anatomical aggressiveness within this sample. Demographic/anatomical distribution, CBCT imaging characteristics and associations with adjacent structures are presented in **Tables 1, 2 and 3** respectively.

Table 1: Demographic and anatomical distribution of the study cohort (n=39)

Variable	Category	n/value	%
Age, mean ± SD		30.0 ± 15.6	—
Age, median (range)		27 (6–64)	—
Age group	≤20 years	10	25.6
	21–40 years	22	56.4
	41–60 years	4	10.3
	>60 years	3	7.7
Sex	Male	23	59.0
	Female	16	41.0
Jaw distribution	Mandible only	28	71.8
	Maxilla only	7	17.9
	Both jaws	4	10.3
Multiple lesions	Present	11	28.2
Mandibular region (n=32)	Body only	15	46.9
	Body + ramus	16	50.0
	Ramus only	1	3.1

Table 2: CBCT imaging characteristics and effects on surrounding structures

Domain	Finding	n/value	%
Internal structure	Unilocular	13	33.3
	Multilocular	26	66.7
Border	Corticated with scalloping	33	84.6
	Corticated without scalloping	6	15.4
Radiographic variant	Collateral	17	43.6
	Envelopmental	16	41.0
	Extraneous	4	10.3
	Replacement	1	2.6
Adjacent effect	Mixed	1	2.6
	IANC involvement	27	69.2
	IANC displacement	22	56.4
	Tooth displacement	21	53.8
	Associated missing tooth	18	46.2
	Root resorption	7	17.9
	Associated impacted tooth	15	38.5
Standardized ratio	Cortical expansion	37	94.9
	Mean ± SD	0.55 ± 0.18	—
	<0.50	14	35.9
	0.50–0.69	20	51.3
	≥0.70	5	12.8

*Fisher’s exact test. IANC: inferior alveolar nerve canal.

Table 3: Association between internal structure and effects on adjacent structures

Radiographic effect	Unilocular (n=13)	Multilocular (n=26)	P value*
Inferior alveolar nerve canal involvement	9/13 (69.2%)	18/26 (69.2%)	1.000
Inferior alveolar nerve canal displacement	8/13 (61.5%)	14/26 (53.8%)	0.740
Tooth displacement	5/13 (38.5%)	16/26 (61.5%)	0.196
Associated missing tooth	7/13 (53.8%)	11/26 (42.3%)	0.520
Root resorption	1/13 (7.7%)	6/26 (23.1%)	0.388
Associated impacted tooth	6/13 (46.2%)	9/26 (34.6%)	0.508
Cortical expansion	11/13 (84.6%)	26/26 (100.0%)	0.105

Discussion:

The present study provides a detailed CBCT-based description of 39 histopathologically confirmed OKCs and shows the broad imaging spectrum of this lesion. The cohort showed a male predominance and a concentration of cases in the second to fourth decades, broadly consistent with previous institutional series. The mean age of 30.0 years was close to the third-decade peak reported in the master study and other clinical cohorts [6]. The mandible was the principal site, with 28 mandibular-only cases and an additional 4 cases involving both jaws. This

distribution agrees with systematic evidence showing that OKCs preferentially involve the mandible, especially posterior regions and the ramus. The predominance of mandibular disease is clinically important because lesions may extend considerably before producing obvious expansion or symptoms [7, 8]. Eleven records were marked as multiple lesions and four involved both jaws. Multiple OKCs raise the possibility of syndromic disease, but the supplied dataset did not include clinical or genetic details sufficient to classify nevoid basal cell carcinoma syndrome. Previous radiological work emphasizes that multiple lesions require broader patient evaluation even when discovered incidentally [9]. A notable finding was the predominance of multilocular architecture, observed in two-thirds of cases. This contrasts with several published series in which unilocular lesions were more frequent. The difference may reflect referral bias toward large or complex lesions, the relatively high number of multiple cases, or the use of CBCT, which can reveal internal septation not apparent on panoramic images. Earlier work has suggested that locularity may evolve with lesion size and duration rather than represent a distinct biological subtype [10, 11]. All lesions were described as corticated and 84.6% had scalloped margins. Scalloping is compatible with extension along cancellous bone and may help distinguish OKC from smoothly expansile lesions, but it is not pathognomonic. The collateral and envelopmental patterns were the most common radiographic variants, emphasizing the diverse relationships OKCs can establish with roots and unerupted teeth [12]. Cortical expansion occurred in 94.9% of cases, which is higher than the traditionally described pattern of limited buccolingual expansion. This may again indicate a referral population enriched with larger lesions. Inferior alveolar canal involvement and displacement were also common, supporting the value of CBCT for surgical planning, risk communication and selection of an approach that minimizes neurovascular injury [13]. Root resorption was comparatively uncommon, occurring in 17.9% of cases, whereas tooth displacement was present in more than half. The relative rarity of resorption is consistent with the view that OKCs can spread through medullary spaces without the prolonged pressure remodeling characteristic of some ameloblastomas. Nevertheless, the presence of resorption does not exclude OKC and should be interpreted with the entire imaging pattern [14]. The standardized dimension ratio averaged 0.55 and only 35.9% of cases were below 0.50. This finding is less supportive of a universal low width-to-length ratio than the master article, which reported a greater proportion below the proposed threshold. The discrepancy may result from lesion multiplicity, incomplete orientation labels in the source dataset, selection of the largest recorded lesion pair and genuine population variation. Logistic-regression imaging studies similarly show that dimension ratios can contribute to diagnosis but should be combined with location, border, internal architecture and effects on adjacent anatomy [15]. Multilocular lesions showed higher numerical frequencies of tooth displacement, root resorption and cortical expansion, but no association reached statistical significance. The absence of significance may reflect limited power and the high baseline frequency of anatomical effects across both groups.

Clinically, these results caution against using locularity alone as a surrogate for aggressive behavior. The study has limitations. It was retrospective, the exact archival interval and ethical approval number were not supplied and the records did not consistently label the orientation of paired dimensions. The dataset was case-based rather than lesion-based in patients with multiple OKCs and clinical symptoms, histological subtype, treatment and recurrence were not available. Future studies should use standardized lesion-level measurements, blinded examiner calibration, interobserver reliability assessment and longitudinal follow-up. Despite these limitations, the study demonstrates that CBCT can reveal clinically important extension, cortical change, canal relationship, tooth effects and lesion multiplicity. A structured radiographic checklist may improve consistency in reporting and help surgeons anticipate anatomical risks while preserving histopathology as the definitive diagnostic standard. A 2024 retrospective histopathological study similarly emphasized the heterogeneous clinicopathological presentation of odontogenic keratocysts and the continuing need for histopathological confirmation [16]. Recent 2025 evidence also supports diffusion-weighted MRI as an adjunct for differentiating odontogenic keratocysts from other cystic jaw lesions, underscoring the value of multimodal imaging when CBCT features overlap [17].

Conclusion:

Odontogenic keratocysts in this 39-case series' most often involved the mandible and frequently showed multilocular architecture, scalloped corticated borders, cortical expansion and interaction with the inferior alveolar canal or adjacent teeth. CBCT was valuable for defining lesion extent and surgical relationships, but internal locularity and dimensional ratio did not independently identify anatomical aggressiveness. Radiographic findings should therefore be integrated with clinical assessment and confirmed histopathologically.

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