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Current Classification, Radiological Features, And Treatment Approaches Of Odontogenic Cysts: A Narrative Review

Odontojenik Kistlerin Güncel Sınıflandırması, Radyolojik Bulguları Ve Tedavi Yaklaşımları: Anlatı Derlemesi

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Abstract

Odontogenic cysts are pathological lesions arising from remnants of odontogenic epithelium and may occur within the jawbones and surrounding soft tissues. These lesions may be developmental or inflammatory in etiopathogenetic origin and vary in their clinical, radiographic, histopathological, and biological characteristics. In the current World Health Organization (WHO) classification, odontogenic cysts are classified under the broader heading of "Cysts of the Jaws," without a formal subdivision into inflammatory and developmental categories. The integration of clinical and radiographic findings is important for diagnosis, while histopathological examination contributes to establishing a definitive diagnosis when indicated. This narrative review evaluates odontogenic cysts within the framework of the current literature and the 2022 WHO classification, focusing on their classification, etiopathogenesis, epidemiological characteristics, clinical and radiographic findings, histopathological features, differential diagnoses, contemporary treatment approaches, recurrence tendencies, and follow-up requirements. In addition, radiographic features relevant to the differential diagnosis of odontogenic cysts and the clinical implications of recent classification changes are discussed. This review aims to provide clinicians with an up-to-date and practical reference for the recognition and differential diagnosis of odontogenic cysts and for determining appropriate treatment and follow-up strategies.

Keywords: *Oral pathology, Jaw cysts, Odontogenic cysts, Radiography, Treatment.*

Özet

Odontojenik kistler, odontojenik epitel kalıntılarından köken alan ve çene kemikleri ile çevre yumuşak dokularda görülebilen patolojik lezyonlardır. Bu lezyonlar etiyopatogenetik olarak gelişimsel veya enflamatuvar köken gösterebilmekte; klinik, radyolojik, histopatolojik özellikleri ve biyolojik davranışları bakımından farklılık göstermektedir. Güncel Dünya Sağlık Örgütü (WHO) sınıflamasında odontojenik kistler, enflamatuvar ve gelişimsel olarak resmî alt gruplara ayrılmaksızın "çene kistleri" başlığı altında sınıflandırılmaktadır. Tanıda klinik ve radyolojik bulguların birlikte değerlendirilmesi önem taşımakta olup, gerekli olgularda histopatolojik inceleme kesin tanıya katkı sağlamaktadır. Bu anlatı derlemesinde odontojenik kistler güncel literatür ve 2022 WHO sınıflaması çerçevesinde ele alınmış; sınıflandırmaları, etiyopatogenezleri, epidemiyolojik özellikleri, klinik ve radyolojik bulguları, histopatolojik özellikleri, ayırıcı tanıları, güncel tedavi yaklaşımları, nüks eğilimleri ve takip gereksinimleri değerlendirilmiştir. Ayrıca odontojenik kistlerin ayırıcı tanısında önem taşıyan radyolojik özellikler ile güncel sınıflandırmadaki değişikliklerin klinik uygulamaya yansımaları tartışılmıştır. Bu derlemenin, odontojenik kistlerin doğru tanınması, ayırıcı tanısının

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yapılması ve uygun tedavi ve takip yaklaşımlarının belirlenmesinde klinisyenlere güncel ve pratik bir kaynak sağlaması amaçlanmıştır.

Anahtar Kelimeler: *Ağız patolojisi, Çene kistleri, Odontojenik kistler, Radyoloji, Tedavi.*

OVERVIEW / GENEL BAKIŞ

1. INTRODUCTION

Odontogenic cysts are pathological lesions originating from remnants of the odontogenic epithelium and are among the most common lesions affecting the jaws. These lesions may be developmental or inflammatory in origin and differ in their clinical characteristics and biological behavior (1, 2).

Odontogenic cysts are generally asymptomatic and are often detected incidentally during routine radiographic examinations. However, depending on their size and location, they may present with clinical manifestations such as pain, bone expansion, tooth displacement, and root resorption. Panoramic radiography, periapical radiography, and cone-beam computed tomography (CBCT) play important roles in the diagnosis and treatment planning of odontogenic cysts. Accurate diagnosis generally requires the integration of clinical and radiographic findings and, when indicated, histopathological evaluation (3, 4).

In the fourth edition of the WHO Classification of Head and Neck Tumours published in 2017, odontogenic cysts were classified into two major categories: inflammatory and developmental odontogenic cysts. Inflammatory odontogenic cysts included radicular cysts, residual cysts, and inflammatory collateral cysts, whereas developmental odontogenic cysts comprised dentigerous cysts, eruption cysts, lateral periodontal cysts, gingival cysts, odontogenic keratocysts, orthokeratinized odontogenic cysts, glandular odontogenic cysts, and calcifying odontogenic cysts (5).

In the fifth edition of the WHO Classification of Head and Neck Tumours published in 2022, odontogenic cysts are organized under the broader heading of "Cysts of the Jaws," without the previous formal subdivision into inflammatory and developmental categories. The principal odontogenic cyst entities include radicular cyst, inflammatory collateral cysts, gingival cysts, dentigerous cyst, orthokeratinized odontogenic cyst, lateral periodontal cyst and its botryoid variant, calcifying odontogenic cyst, glandular odontogenic cyst, and odontogenic keratocyst. Within this framework, residual cyst represents a residual form of radicular cyst, while eruption cyst is regarded as the superficial soft-tissue counterpart of the dentigerous cyst. Nasopalatine duct cyst and surgical ciliated cyst are included among the non-odontogenic cysts of the jaws (6).

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This narrative review summarizes the current literature on the etiopathogenesis, clinical, radiographic, and histopathological characteristics, differential diagnosis, treatment, recurrence, and follow-up of WHO-recognized odontogenic cysts, with particular emphasis on lesions of clinical and radiographic relevance.

2. REVIEW METHODOLOGY

This narrative review was conducted through a literature search of PubMed/MEDLINE, Scopus, and Web of Science. The literature search was last updated in August 2026. Search terms included combinations of "odontogenic cyst," "radicular cyst," "residual cyst," "inflammatory collateral cyst," "dentigerous cyst," "eruption cyst," "odontogenic keratocyst," "orthokeratinized odontogenic cyst," "calcifying odontogenic cyst," "glandular odontogenic cyst," "lateral periodontal cyst," "botryoid odontogenic cyst," "gingival cyst," "radiographic features," "CBCT," "treatment," "recurrence," and "follow-up." Particular emphasis was placed on the current World Health Organization classification and on recent systematic reviews, meta-analyses, and clinically relevant studies addressing radiographic characteristics, differential diagnosis, treatment, recurrence, and follow-up. Classical publications were additionally included when relevant to the historical description or classification of individual lesions. Because this study was designed as a narrative review, study selection and synthesis were performed qualitatively rather than according to a formal systematic-review protocol.

3. WHO 2022 CLASSIFICATION OF JAW CYSTS

The fifth edition of the World Health Organization (WHO) Classification of Head and Neck Tumours, published in 2022, introduced a revised framework for the classification of jaw cysts. In contrast to the 2017 edition, the formal subdivision of odontogenic cysts into inflammatory and developmental categories was removed, and the lesions were organized under the broader heading of "Cysts of the Jaws." The 2022 classification also refined the terminology and hierarchical relationships of several cystic entities and introduced essential and desirable diagnostic criteria to facilitate more standardized diagnosis. The principal differences between the 2017 and 2022 WHO classifications are summarized in Table 1 (6).

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Table 1. Comparison of the 2017 and 2022 WHO classifications of jaw cysts.

Entity / Feature	WHO 2017	WHO 2022	Major change / clarification
Classification framework	Inflammatory and developmental cysts	Cysts of the Jaws	Formal etiological subdivision removed
Radicular cyst	Inflammatory odontogenic cyst	Radicular cyst	Retained
Residual cyst	Associated with radicular cyst	Subtype/presentation of radicular cyst	Not a separate major entity
Inflammatory collateral cysts	Inflammatory odontogenic cysts	Inflammatory collateral cysts	Paradental cyst and mandibular buccal bifurcation cyst recognized as subtypes
Dentigerous cyst	Developmental odontogenic cyst	Dentigerous cyst	Retained
Eruption cyst	Associated with dentigerous cyst	Superficial soft-tissue subtype of dentigerous cyst	Presented under dentigerous cyst
Gingival cysts	Developmental cysts	Gingival cysts	Retained
Orthokeratinized odontogenic cyst	Developmental odontogenic cyst	Orthokeratinized odontogenic cyst	Retained as distinct from OKC
Lateral periodontal / botryoid odontogenic cyst	Developmental odontogenic cyst	Lateral periodontal cyst and botryoid odontogenic cyst	Retained
Calcifying odontogenic cyst	Developmental odontogenic cyst	Calcifying odontogenic cyst	Retained as a cystic entity
Glandular odontogenic cyst	Developmental odontogenic cyst	Glandular odontogenic cyst	Retained
Odontogenic keratocyst	Developmental odontogenic cyst	Odontogenic keratocyst	Cystic classification retained
Surgical ciliated cyst	Not included in this framework	Surgical ciliated cyst	Added to "Cysts of the Jaws"
Nasopalatine duct cyst	Developmental/non-odontogenic cyst	Nasopalatine duct cyst	Included under "Cysts of the Jaws"
Diagnostic framework	Conventional diagnostic descriptions	Essential and desirable diagnostic criteria	Standardized diagnostic criteria introduced

4. INFLAMMATORY ODONTOGENIC CYSTS

Although the 2022 WHO classification no longer formally categorizes odontogenic cysts according to inflammatory or developmental origin, this etiopathogenetic distinction remains useful for understanding their pathogenesis and clinical characteristics. Therefore, for organizational clarity, inflammatory odontogenic cysts are discussed together in this review. These lesions are generally associated with inflammatory processes involving odontogenic tissues and include radicular cysts and inflammatory collateral cysts, with residual cysts representing lesions that persist after extraction of the associated tooth.

4.1. Radicular Cyst

The radicular cyst is the most common odontogenic cyst of the jaws, accounting for approximately 70% of all odontogenic cysts (7). It is an inflammatory odontogenic cyst that typically develops in the periapical region of an erupted, non-vital tooth. Its pathogenesis involves the proliferation of the epithelial rests of Malassez within the periodontal ligament as a result of chronic periapical inflammation secondary to pulp necrosis. Similar to other odontogenic cysts, cyst enlargement is believed to occur through the accumulation of intracystic fluid and the resulting increase in hydrostatic pressure (8).

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Radicular cysts occur most frequently between the third and sixth decades of life and are predominantly located in the anterior maxilla. However, they may rarely occur during childhood and in the primary dentition (9).

Clinically, most radicular cysts are asymptomatic and are detected incidentally during routine radiographic examinations. As the lesion enlarges, however, symptoms such as pain, swelling, cortical bone expansion, tooth mobility, displacement of adjacent teeth, and facial asymmetry may develop. In rare cases, large lesions may cause extensive destruction of the jawbones, resulting in pathological fractures. Furthermore, they may expand into adjacent anatomical structures, including the inferior alveolar canal, infraorbital foramen, maxillary sinus, and nasal cavity (7, 8).

Radiographically, radicular cysts typically present as well-defined, corticated, unilocular radiolucent lesions with a round or oval shape. The lesion is most commonly associated with the apex of the affected non-vital tooth. Although uncommon, cases of radicular cysts containing dystrophic calcifications have been reported in the literature. Such lesions may exhibit a mixed radiographic appearance, which can complicate the differential diagnosis by mimicking other odontogenic lesions (8).

Histopathologically, radicular cysts are lined by non-keratinized stratified squamous epithelium of variable thickness. The cyst wall consists of fibrous connective tissue with dense chronic inflammatory cell infiltration. Arcading epithelial proliferations may be observed within the epithelial lining. Long-standing lesions may exhibit cholesterol clefts, foam cells, hemosiderin deposits, and foci of dystrophic calcification. In addition, eosinophilic hyaline structures known as Rushton bodies represent characteristic histopathological findings of radicular cysts (10).

Large radicular cysts may cause thinning and perforation of the cortical bone. In rare cases, soft tissue involvement and the formation of cutaneous fistulas have been reported. For example, the development of a cutaneous fistula has been described in a large radicular cyst associated with a luxated mandibular tooth (7, 11).

Pulp necrosis may lead to the development of apical periodontitis, a periapical granuloma, or a radicular cyst. Although lesion size may influence the probability of a cystic lesion, lesion dimensions alone cannot reliably distinguish a periapical granuloma from a radicular cyst. Definitive diagnosis requires histopathological examination. Histologically, periapical granulomas lack an epithelial lining, and some investigators have suggested that they may represent precursor lesions in the development of radicular cysts (12).

Treatment planning should take into account the size and location of the lesion, its relationship to adjacent anatomical structures, and the prognosis of the associated tooth. For teeth that can be preserved, nonsurgical root canal treatment should generally be considered the initial treatment

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approach, as many inflammatory periapical lesions, including cyst-like lesions, may resolve following adequate endodontic treatment. Surgical treatment may be considered when the lesion persists, when endodontic treatment is not feasible, or when histopathological diagnosis is required. Apical pocket cysts may have a greater potential to heal following nonsurgical endodontic treatment than true cysts; however, this distinction cannot be reliably established radiographically (11, 12).

In larger cystic lesions, marsupialization, which involves creating a surgical window in the cyst wall to reduce intracystic pressure, may be performed. Marsupialization can be used as a definitive treatment or followed by enucleation after sufficient reduction in lesion size has been achieved (7, 11).

The main advantages of marsupialization include preservation of adjacent anatomical structures, reduced surgical morbidity, and a more conservative approach for the management of large lesions. However, its disadvantages include the inability to evaluate the entire cyst lining histopathologically, the need for regular irrigation, and prolonged follow-up. Therefore, it is particularly recommended for large cysts and in cases where preservation of critical anatomical structures is desirable (13).

Following enucleation, spontaneous osseous healing may occur without bone grafting. Bone graft materials may be considered in selected cases; however, grafting is not routinely required after cyst enucleation and should be determined according to the size and characteristics of the residual defect, the presence of infection, and patient-related factors. Radicular cysts generally have a favorable prognosis following appropriate treatment, with a very low recurrence rate. Recurrences are usually associated with incomplete removal of the cystic lining (7, 11).

4.1.1. Residual Cyst

A residual cyst is an inflammatory odontogenic cyst that develops when a radicular cyst remains untreated or when cystic tissue is not completely removed during tooth extraction. Because it represents the persistence of a radicular cyst within the jaw following extraction of the associated tooth, it is regarded as the residual form of a radicular cyst. Residual cysts account for approximately 10% of all odontogenic cysts. Their clinical and radiographic features are largely similar to those of radicular cysts. Residual cysts may remain within the jawbone for 1–20 years after tooth extraction, and in asymptomatic cases, the lesion may decrease in size with advancing age. Their pathogenesis is associated with the persistence of cystic epithelium, granulation tissue, or remnants of the periodontal ligament within the extraction socket (14, 15).

Only a limited number of studies have investigated residual cysts. One of the main reasons is that these lesions are usually asymptomatic and often overlooked because of their benign radiographic appearance (14). Residual cysts are most frequently observed in middle-aged and older individuals

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and are typically found in edentulous areas. Although most cases are detected incidentally during routine radiographic examinations, enlargement of the lesion may result in cortical bone expansion, facial asymmetry, pain, and swelling. If left untreated, large lesions may also cause displacement of adjacent anatomical structures and extensive bone destruction (14, 15).

Although residual cysts may occur at any age, they are more commonly diagnosed in older adults. In a study by Titinchi and Morkel involving 64 histopathologically confirmed residual cysts, the patients ranged in age from 11 to 82 years, with a mean age of 48 years. Approximately 46.8% of the patients were older than 50 years, and a slight male predominance was observed. In the same study, 73.4% of the lesions were located in the mandible and 51.6% were found in the posterior regions (14). In a clinical study by Pechalova et al. involving 621 jaw cysts in 594 patients, 70.1% of the cysts were inflammatory and 97% were of odontogenic origin, while residual cysts accounted for 18% of all cysts (16). In contrast, Selvamani et al. evaluated 2,275 biopsy reports and identified jaw cysts in 194 cases (8.5%), of which 69.3% were radicular cysts, 20.3% dentigerous cysts, 5.2% odontogenic keratocysts, 3.3% residual cysts, and 1.9% other odontogenic cysts (17). These differences may be explained by variations in study populations and diagnostic methods.

Histopathologically, residual cysts closely resemble radicular cysts. The cyst wall is lined by non-keratinized stratified squamous epithelium and contains fibrous connective tissue with varying degrees of chronic inflammatory cell infiltration. Long-standing lesions may exhibit cholesterol clefts, foam cells, hemosiderin deposits, foreign-body giant cell reactions, and dystrophic calcifications. Rare cases have also demonstrated epithelial dysplasia and malignant transformation (14, 18).

Radiographically, residual cysts typically appear as well-defined, corticated, unilocular radiolucent lesions with a round or oval configuration, most commonly located in edentulous regions. Although their imaging features closely resemble those of radicular cysts, the absence of the associated tooth is an important clue in the differential diagnosis. As the lesion enlarges, cortical bone thinning and expansion may occur, and internal calcifications may occasionally be observed (15). In Titinchi and Morkel's study, 95.3% of the lesions were unilocular, 93.7% were well defined, and 85.9% exhibited smooth corticated margins. Furthermore, the prevalence of residual cysts was significantly higher in completely edentulous individuals than in dentate patients ($p < 0.01$) (14).

In some cases, residual cysts may clinically and radiographically mimic more aggressive benign lesions or malignant neoplasms of the jaws. Therefore, residual cysts should always be considered in the differential diagnosis of cystic radiolucent lesions identified in elderly edentulous patients. Although malignant transformation of odontogenic cyst epithelium is considered rare, cases of primary intraosseous carcinoma, NOS arising in association with residual cysts have been reported. Consequently, in addition to radiographic assessment, biopsy and histopathological examination are essential to establish a definitive diagnosis and exclude the possibility of malignant transformation (14).

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The primary treatment for residual cysts is complete surgical removal of the lesion. The choice of treatment depends on the size and location of the cyst and its relationship to adjacent anatomical structures. Enucleation is generally sufficient for small- and medium-sized lesions, whereas marsupialization or marsupialization followed by enucleation may be preferred for larger cysts to preserve important anatomical structures (11, 15). In the series by Titinchi and Morkel, 95.3% of the lesions were treated by enucleation, with recurrence observed in only one case, corresponding to a recurrence rate of 1.6%. Marsupialization may also serve as an effective treatment option for extensive lesions. Because spontaneous resolution is not expected, surgical treatment is recommended for all diagnosed residual cysts. Regular clinical and radiographic follow-up is essential after surgery. In the retrospective series by Titinchi and Morkel, squamous cell carcinoma arising from the cyst lining was identified in 2 of 64 lesions. However, this finding represents an observation within this specific cohort and should not be interpreted as an estimated malignant transformation rate for residual cysts in general (14).

4.2. Inflammatory Collateral Cyst (Mandibular Buccal Bifurcation Cyst and Paradental Cyst)

Inflammatory collateral cysts are inflammatory odontogenic cysts that account for approximately 3–5% of all odontogenic cysts and are divided into two subtypes: the mandibular buccal bifurcation cyst and the paradental cyst (4). These lesions are typically associated with mandibular molars. Mandibular buccal bifurcation cysts occur in the furcation region of the first and second mandibular molars, whereas paradental cysts are found on the distal aspect of the third molars. Mandibular buccal bifurcation cysts are most commonly observed in children between 6 and 15 years of age, whereas paradental cysts occur more frequently in young adults and are usually associated with third molars (19).

Inflammation is considered the primary etiological factor in the development of these cysts. It has also been suggested that the reduced enamel epithelium, epithelial rests of Malassez, or epithelial remnants associated with tooth eruption may contribute to lesion formation (20). According to the current understanding, proliferation of the junctional epithelium within the gingival sulcus or periodontal pocket in response to inflammatory stimuli initiates cyst development (3, 4).

Inflammatory collateral cysts most commonly occur in erupting or erupted mandibular molars, and the associated teeth are generally vital. Clinically, gingival erythema, edema, increased probing depth, and a history of pericoronitis are common findings (4).

A mandibular buccal bifurcation cyst typically develops on the buccal and furcal aspects of an erupting mandibular first or second molar, most commonly in younger patients, while the associated tooth generally remains vital. Radiographically, it usually presents as a well-defined radiolucency involving the buccal and furcation regions of the affected tooth. In contrast, a paradental cyst most

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commonly develops on the buccal or distal aspect of a partially erupted mandibular third molar and is frequently associated with recurrent pericoronitis (12, 20).

Because histopathological findings are not specific, clinical and radiographic evaluation plays a crucial role in establishing the diagnosis. The differential diagnosis should include dentigerous cyst, odontogenic keratocyst, unicystic ameloblastoma, lateral periodontal cyst, and radicular cyst. The vitality of the associated tooth is a particularly important feature for distinguishing inflammatory collateral cysts from radicular cysts (19).

Enucleation is the treatment of choice in most cases. In mandibular buccal bifurcation cysts, preservation of the involved permanent molar is frequently possible. In paradental cysts associated with mandibular third molars, extraction of the involved tooth may accompany surgical management when otherwise clinically indicated. Recurrence is uncommon in both lesions (12).

5. DEVELOPMENTAL ODONTOGENIC CYSTS

Although developmental odontogenic cysts are no longer presented as a separate formal category in the 2022 WHO classification, grouping these lesions according to their developmental origin remains useful for understanding their pathogenesis and clinicopathological characteristics. For organizational clarity, developmental odontogenic cysts are therefore discussed together in this review. This group includes dentigerous cysts, gingival cysts, lateral periodontal and botryoid odontogenic cysts, orthokeratinized odontogenic cysts, calcifying odontogenic cysts, glandular odontogenic cysts, and odontogenic keratocysts. The eruption cyst is discussed as the superficial soft-tissue subtype of the dentigerous cyst, in accordance with the current WHO framework (6).

5.1. Odontogenic Keratocyst

Odontogenic keratocyst (OKC), first described in 1956, is a developmental odontogenic lesion that accounts for approximately 7–8% of all odontogenic cysts. It occurs most frequently during the second and third decades of life, shows a higher prevalence in males, and is predominantly located in the mandible (21-24). It is believed to originate from remnants of the dental lamina or primordial odontogenic tissues. Although benign in nature, OKCs may exhibit aggressive behavior, and rare cases of malignant transformation have been reported (21-24).

The classification of odontogenic keratocyst has undergone important changes over time. In the 2005 WHO classification, the lesion was reclassified as a keratocystic odontogenic tumor because of its locally aggressive behavior, high recurrence potential, and molecular alterations. However, it was returned to the odontogenic cyst category in the 2017 WHO classification and was retained as an odontogenic keratocyst in the 2022 classification (6). Molecular studies have demonstrated frequent PTCH1 alterations in odontogenic keratocysts. In one genomic analysis, PTCH1 mutations were identified in 30 of 38 (79%) sporadic OKCs, supporting the central role of the sonic hedgehog (SHH)

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signaling pathway in their molecular pathogenesis (25). Nevertheless, the biological implications of these molecular alterations and the cyst-versus-neoplasm debate remain subjects of discussion (6).

One of the most clinically important characteristics of odontogenic keratocysts is their tendency to recur. Reported recurrence rates vary considerably and are strongly influenced by treatment modality, lesion characteristics, syndromic status, and duration of follow-up. Factors such as lesion size, multilocularity, patient age, and radiographic characteristics have also been associated with recurrence. The thin and fragile cyst lining, incomplete surgical removal, and the presence of daughter (satellite) cysts may further contribute to recurrence. Therefore, recurrence rates should be interpreted in the context of the treatment approach, lesion characteristics, and follow-up duration rather than as a single overall estimate (1, 26).

Odontogenic keratocysts generally exhibit slow growth and may remain asymptomatic unless they become infected. When secondary infection occurs, clinical manifestations such as pain, swelling, and purulent discharge may develop. Radiographically, they appear as either unilocular or multilocular radiolucent lesions. A definitive diagnosis requires histopathological examination (21).

Histopathologically, odontogenic keratocysts are lined by a parakeratinized stratified squamous epithelium, typically 6–10 cell layers thick. The epithelial surface demonstrates a characteristic corrugated keratin layer, while the basal cells exhibit a palisaded arrangement. The interface between the epithelium and connective tissue is generally flat, and in the absence of inflammation, the epithelial lining can be easily separated from the underlying connective tissue. Daughter (satellite) cysts and odontogenic epithelial islands may also be present within the cyst wall and are considered important contributors to the high recurrence rate (24, 27).

The differential diagnosis should include dentigerous cyst, lateral periodontal cyst, ameloblastoma, ameloblastic fibroma, central giant cell granuloma, and traumatic bone cyst (27).

Aspiration biopsy, incisional biopsy, and advanced imaging techniques may be used to establish the diagnosis. The presence of keratin and a low protein concentration in the aspirated fluid are supportive findings for odontogenic keratocyst (24).

Treatment of odontogenic keratocysts should be individualized according to lesion size, location, radiographic characteristics, recurrence status, syndromic association, and proximity to important anatomical structures. Treatment approaches include enucleation alone, enucleation combined with peripheral ostectomy, decompression or marsupialization followed by enucleation, and adjunctive therapies such as Carnoy's solution (CS), modified Carnoy's solution (MCS), 5-fluorouracil (5-FU), or cryotherapy. Resection may be considered in selected extensive, aggressive, or recurrent lesions but is associated with greater morbidity. No single treatment approach has unequivocally resolved the morbidity-versus-recurrence dilemma (27–30). Original Carnoy's solution and modified

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Carnoy's solution should be distinguished because they differ in composition. Original Carnoy's solution contains chloroform, whereas modified Carnoy's solution is formulated without chloroform; therefore, recurrence outcomes reported for these formulations should be interpreted separately (31).

A recent systematic review and meta-analysis evaluated recurrence and postoperative complications in OKCs treated with CS, MCS, and 5-FU. Among the included studies, recurrence was reported in 15 of 153 cases treated with CS and 37 of 200 cases treated with MCS, whereas no recurrence was reported in cases treated with 5-FU. Postoperative paresthesia was observed in 17 of 74 cases treated with CS/MCS and in 12 of 72 cases treated with 5-FU. The pooled analysis demonstrated a significantly lower risk of recurrence with 5-FU compared with CS/MCS (RR = 0.13, 95% CI: 0.02–0.68; p = 0.015). These findings suggest that 5-FU may represent a promising adjunct for reducing recurrence and postoperative morbidity; however, further high-quality studies with longer follow-up periods are required to establish its long-term effectiveness and safety (32).

Decompression or marsupialization followed by enucleation may be considered as a conservative treatment approach, particularly for selected large lesions in which preservation of adjacent anatomical structures is desirable. As an illustrative clinical example, Şen et al. reported no recurrence during a two-year follow-up after enucleation performed following marsupialization (33). However, this limited follow-up from a single case should not be interpreted as evidence of the long-term effectiveness of this treatment strategy. Because odontogenic keratocysts may recur after prolonged disease-free intervals, long-term clinical and radiographic surveillance is essential. Follow-up should not be limited to the early postoperative period, as late recurrences may occur (33, 34).

Furthermore, patients presenting with multiple odontogenic keratocysts should be thoroughly evaluated for hereditary syndromes, particularly Gorlin–Goltz syndrome (nevoid basal cell carcinoma syndrome) (26).

5.2. Dentigerous Cyst

Dentigerous cysts are among the most common developmental odontogenic cysts of the jaws, accounting for approximately 15.2–33.7% of all odontogenic cysts. First described by Paget in 1863, these lesions are most frequently encountered during the second to fourth decades of life and are often detected incidentally during routine radiographic examinations because they are usually asymptomatic. Dentigerous cysts are believed to arise from the reduced enamel epithelium surrounding the crown of an unerupted or impacted tooth and are characteristically attached at the cementoenamel junction. They are most commonly associated with mandibular third molars and maxillary canines but may also occur around premolars, supernumerary teeth, and odontomas (35).

Radiographically, dentigerous cysts typically present as well-defined, corticated, unilocular radiolucencies associated with the crown of an unerupted or impacted tooth and are usually attached

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near the cementoenamel junction. Three principal radiographic relationships have been described: central, lateral, and circumferential. In the central type, the radiolucency symmetrically surrounds the crown; in the lateral type, the lesion extends along one aspect of the crown and root; and in the circumferential type, the radiolucency surrounds the crown and extends apically along the root surface. Larger lesions may occasionally exhibit scalloped or apparently multilocular appearances and may cause displacement of adjacent teeth, root resorption, cortical expansion, or displacement of anatomical structures. However, radiographic appearance alone cannot reliably distinguish a dentigerous cyst from other pericoronal cystic or neoplastic lesions, and definitive diagnosis may require correlation with clinical and histopathological findings (35, 36).

Dentigerous cysts are generally solitary lesions. Bilateral or multiple dentigerous cysts are more commonly associated with syndromic conditions such as cleidocranial dysplasia and Maroteaux–Lamy syndrome, as well as certain systemic diseases. Bilateral dentigerous cysts occurring in the absence of an associated syndrome are considered extremely rare. These reported cases suggest that dentigerous cysts may be associated not only with local pathology but also with developmental disorders (37).

Histopathologically, dentigerous cysts are typically lined by a thin, non-keratinized stratified squamous epithelium consisting of two to four cell layers. The cyst wall is composed of loose fibrous connective tissue, and in the presence of secondary infection, epithelial hyperplasia and chronic inflammatory cell infiltration may be observed (2, 38).

Because dentigerous cysts are usually asymptomatic, some lesions may remain undetected for prolonged periods and eventually reach considerable size. Progressive enlargement of the cyst may result in displacement of the associated tooth, failure of eruption, or compression of adjacent anatomical structures. In advanced cases, surgical treatment may require the removal of multiple teeth or tooth germs, and the vitality of adjacent teeth may be compromised. Therefore, treatment should be individualized according to lesion characteristics, patient age, stage of dental development, and the status of the associated tooth (39, 40).

The differential diagnosis of a dentigerous cyst should include a hyperplastic dental follicle, odontogenic keratocyst, unicystic ameloblastoma, adenomatoid odontogenic tumor, calcifying odontogenic cyst, and ameloblastic fibroma. Patient age, lesion location, relationship to the involved tooth, internal radiographic characteristics, and associated clinical findings may help narrow the differential diagnosis (41).

Adenomatoid odontogenic tumor should be particularly considered according to the patient's age and lesion location, whereas ameloblastic fibroma is an important consideration in younger patients (39).

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Enucleation, marsupialization, and decompression are commonly employed treatment modalities for dentigerous cysts, and treatment should be individualized according to patient age, lesion size and location, stage of dental development, and the relationship of the lesion to adjacent anatomical structures. In children and young patients with developing dentition, decompression or marsupialization may be considered in selected cases to preserve the associated permanent tooth and facilitate its eruption (40-42). In adult patients, particularly when preservation of the associated impacted tooth is not feasible or clinically indicated, enucleation with removal of the involved tooth may be more appropriate (39). However, treatment selection should be individualized according to the clinical characteristics of each case.

5.2.1. Eruption Cyst (Eruption Hematoma)

The eruption cyst is considered the soft tissue counterpart of the dentigerous cyst and represents a small proportion of odontogenic cysts (12). It typically develops during the eruption of primary incisors and permanent mandibular first molars (3). The lesion is believed to result from the accumulation of fluid or blood between the crown of an erupting tooth and its dental follicle, leading to expansion of the follicular space (4).

Clinically, eruption cysts present as soft, fluctuant, translucent, bluish swellings located on the alveolar ridge. When blood is present within the cystic cavity, the lesion appears dark blue or purple and is referred to as an eruption hematoma (43, 44). Although most lesions are asymptomatic, some patients may experience pain, tenderness, or difficulty with mastication.

Radiographic examination generally reveals no obvious osseous lesion. However, the diagnosis can be established by correlating the presence of a soft tissue swelling overlying the crown of an erupting tooth with the clinical findings (4).

Histopathologically, eruption cysts resemble dentigerous cysts and are lined by a thin, non-keratinized stratified squamous epithelium. The cyst wall consists of fibrous connective tissue, and hemorrhagic areas are commonly observed, particularly in eruption hematomas (44).

The differential diagnosis includes Epstein pearls, Bohn's nodules, gingival cysts, pyogenic granuloma, and other soft tissue lesions (4).

Eruption cysts generally resolve spontaneously as the erupting tooth emerges into the oral cavity. Consequently, most cases do not require treatment. However, when symptoms develop, infection occurs, or tooth eruption is delayed, simple surgical procedures such as excision of the overlying soft tissue or marsupialization may be indicated. The prognosis is excellent, and recurrence is rare (4, 44).

5.3. Calcifying Odontogenic Cyst

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The calcifying odontogenic cyst (COC) was first described by Gorlin and colleagues in 1962 (45). In 1971, the WHO included the calcifying odontogenic cyst in the histological classification of jaw cysts and tumors (46).

According to the 2022 WHO classification, calcifying odontogenic cyst is classified as a cystic odontogenic lesion characterized principally by the presence of ghost cells within the epithelial lining, which frequently undergo calcification. Ameloblastoma-like epithelial features may be present but are not considered essential for diagnosis (6).

Calcifying odontogenic cysts can occur over a wide age range but are most commonly diagnosed during the second and third decades of life. They occur with similar frequency in the maxilla and mandible and show no significant sex predilection (47).

COCs are frequently associated with impacted teeth and may coexist with odontomas because of the calcified structures they contain. Clinically and radiographically, approximately 65% of cases occur in the anterior region of the jaws. These lesions typically present as well-defined, unilocular radiolucencies, although a multilocular appearance may occasionally be observed. Irregular calcifications or tooth-like radiopaque structures are detected in approximately half of the cases. In addition, the lesions may cause displacement of adjacent teeth and root resorption (47-49).

Histopathologically, calcifying odontogenic cysts are characterized principally by the presence of eosinophilic anucleate ghost cells within the epithelial lining. These ghost cells may undergo dystrophic calcification, and dentinoid-like hard tissue formation may occasionally be observed. Ameloblastoma-like epithelial features, including columnar basal cells and overlying stellate-reticulum-like cells, may be present but are not essential for diagnosis according to the current WHO classification (6, 45, 46).

The differential diagnosis includes dentigerous cyst, adenomatoid odontogenic tumor, ameloblastoma, odontoma, calcifying epithelial odontogenic tumor, and odontogenic keratocyst (47).

Enucleation is the treatment of choice for most calcifying odontogenic cysts. The prognosis is generally favorable, and recurrence is uncommon. Treatment planning should nevertheless be individualized according to lesion size, location, and relationship to adjacent anatomical structures (48, 49). In the current WHO classification, calcifying odontogenic cyst is classified as a cystic lesion and should be distinguished from dentinogenic ghost cell tumor, which is recognized as a distinct benign odontogenic neoplasm (6). Appropriate use of imaging modalities, histopathological confirmation by biopsy, and selection of an optimal surgical approach are important factors in minimizing recurrence (49).

5.4. Glandular Odontogenic Cyst

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Glandular odontogenic cyst (GOC) is a rare odontogenic cyst of the jaws that was initially described by Padayachee and Van Wyk as a sialo-odontogenic cyst and was later renamed by Gardner and colleagues using the terminology currently in use (50, 51). In 1992, the WHO classified GOC as a developmental odontogenic cyst. Because of its aggressive growth pattern and high recurrence potential, GOC is considered a clinically significant lesion (52).

Glandular odontogenic cysts are rare lesions, accounting for approximately 0.2–1.3% of all odontogenic cysts. They occur most frequently during the fifth and sixth decades of life, show a slight male predominance, and are predominantly located in the anterior mandible (52, 53).

Although some glandular odontogenic cysts remain asymptomatic, others may present with pain, swelling, and displacement of adjacent teeth (53, 54). Radiographically, they typically appear as well-defined unilocular or multilocular radiolucent lesions and may cause expansion, cortical thinning, erosion, or perforation of the surrounding bone (55).

Histopathological findings support the hypothesis that GOC originates from remnants of the dental lamina. Microscopically, the lesion is characterized by a cystic cavity lined with non-keratinized stratified squamous epithelium containing plaque-like epithelial thickenings and numerous mucous (goblet) cells along the epithelial surface. Intraepithelial microcysts, gland-like structures, and occasional ciliated cells may also be observed. These features are considered characteristic histopathological findings of glandular odontogenic cysts (56).

Because of its histological characteristics, a particularly important differential diagnosis is central (intraosseous) mucoepidermoid carcinoma, which may show overlapping histopathological features with GOC, including mucous cells and microcystic or duct-like spaces. MAML2 rearrangement testing may provide useful ancillary information when mucoepidermoid carcinoma is suspected; however, the results should be interpreted in conjunction with clinical, radiographic, and histopathological findings rather than as an isolated diagnostic criterion (57). In addition, ameloblastoma, central giant cell granuloma, odontogenic myxoma, botryoid odontogenic cyst, and odontogenic keratocyst may exhibit similar radiographic features, making the differential diagnosis challenging (56).

According to the 2022 WHO classification, the diagnosis of GOC is based on a combination of characteristic histopathological features, including variable epithelial thickness, hobnail or cuboidal eosinophilic luminal cells, mucous cells, and intraepithelial microcysts or duct-like spaces. A rigid minimum number of histological features is no longer required; rather, diagnostic confidence increases as multiple characteristic features are identified (6).

Treatment of glandular odontogenic cyst should be individualized according to lesion size, location, cortical involvement, and other clinical characteristics. Treatment options include

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marsupialization, curettage, enucleation, and, in selected cases, more aggressive surgical approaches such as marginal resection. Recurrence appears to be influenced by the treatment modality, and conservative surgical approaches may be associated with a greater risk of recurrence in selected lesions. Importantly, recurrence may occur several years after treatment. Therefore, long-term clinical and radiographic surveillance is essential, and follow-up for at least five years has been recommended (52, 56, 58).

Glandular odontogenic cyst is a lesion that requires long-term follow-up because of its locally aggressive behavior and potential for recurrence. A recent systematic review of recurrent GOCs found no conclusive association between recurrence and any single histopathological feature or combination of features; rather, the type of treatment showed the strongest association with recurrence. Furthermore, because recurrences were reported more frequently between 3 and 5 years after treatment, a minimum follow-up period of five years is recommended (59).

5.5. Lateral Periodontal Cyst and Botryoid Odontogenic Cyst

The lateral periodontal cyst (LPC) is a developmental odontogenic cyst that accounts for less than 1% of all jaw cysts. It is most commonly located on the lateral aspect of the roots of vital teeth in the mandibular canine–premolar region and typically occurs during the fifth to seventh decades of life (60, 61).

Radiographically, lateral periodontal cysts usually appear as well-defined, corticated, unilocular radiolucent lesions with an oval or teardrop-shaped appearance. In most cases, the lesion measures less than 1 cm in diameter and is associated with vital teeth. Occasionally, the lesion may appear superimposed on the root surface (60, 61).

Histopathologically, lateral periodontal cysts are lined by a thin, non-keratinized odontogenic epithelium. Characteristic focal epithelial thickenings (epithelial plaques) and glycogen-rich clear cells may be present within the epithelial lining. The cyst wall is generally composed of thin fibrous connective tissue (60).

The botryoid odontogenic cyst (BOC) is considered the polycystic or multilocular variant of the lateral periodontal cyst. The term botryoid is derived from the Greek word botrys, meaning "a bunch of grapes," referring to the multilocular appearance of the lesion. Botryoid odontogenic cysts are generally larger than lateral periodontal cysts and exhibit more aggressive clinical behavior (62).

Histopathologically, botryoid odontogenic cysts are characterized by multiple cystic spaces, focal epithelial thickenings, and glycogen-rich clear cells. Owing to their multicystic architecture, complete surgical enucleation is often more difficult than for lateral periodontal cysts, and this is considered one of the main reasons for their higher recurrence rate (62, 63).

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The differential diagnosis includes ameloblastoma, ameloblastic fibroma, odontogenic keratocyst, odontogenic myxoma, and central odontogenic fibroma. Glandular odontogenic cyst should also be considered, particularly in botryoid or multicystic lesions, because epithelial plaques and clear-cell or microcystic changes may result in overlapping histopathological features (63).

Previous studies have shown that botryoid odontogenic cysts occur most frequently during the fifth decade of life, exhibit a slight female predominance (53.5% vs. 46.5% in males), and are predominantly located in the mandible (83.3%) (63).

The recurrence rate of botryoid odontogenic cysts is considerably higher than that of lateral periodontal cysts. In the systematic review by Chrcanovic and Gomez, recurrence rates were reported as 2.4% for lateral periodontal cysts and 21.7% for botryoid odontogenic cysts. The higher recurrence rate of botryoid odontogenic cysts may be related to their multilocular or multicystic architecture and the difficulty of achieving complete surgical removal of all cystic compartments. Therefore, long-term clinical and radiographic follow-up is recommended, particularly for the botryoid variant (64).

Conservative surgical treatment, particularly enucleation, is generally considered adequate for lateral periodontal cysts. Because botryoid odontogenic cysts exhibit a higher recurrence rate and more aggressive behavior, adjunctive treatment following enucleation may be considered in selected cases (60, 64).

5.6. Orthokeratinized Odontogenic Cyst

Orthokeratinized odontogenic cyst (OOC) is a rare developmental odontogenic cyst that was historically considered an orthokeratinized variant of the odontogenic keratocyst (OKC). However, accumulating clinicopathological and molecular evidence has demonstrated important differences between these lesions, and OOC is currently recognized as a distinct entity from OKC in the 2022 WHO classification (65). OOC generally exhibits less aggressive biological behavior and a lower recurrence potential than OKC (65, 66).

OOC predominantly affects the mandible and shows a slight male predilection. In a clinicopathological and radiographic study of 48 patients, the mean age was 33.5 years, and mandibular involvement was approximately five times more frequent than maxillary involvement. Radiographically, all lesions were well-defined unilocular radiolucencies. CT evaluation demonstrated loss of continuity of the buccal or lingual cortical plates in 30 of 36 evaluated lesions, whereas root resorption and tooth displacement were uncommon. These findings indicate that buccolingual expansion and cortical involvement may be important radiographic features of OOC (67).

Histopathologically, OOC is characterized by an orthokeratinized stratified squamous epithelial lining with a prominent granular cell layer, in contrast to the parakeratinized epithelium, corrugated keratin surface, and palisaded basal cells characteristic of OKC (65). Immunohistochemical findings

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further support this distinction, as Ki-67 and cyclin D1 expression have been reported to be significantly lower in OOC than in OKC, indicating lower epithelial proliferative activity (67). The PTCH1 mutation was detected in up to 93% of sporadic OKCs. In addition, 5% of all OKCs occur as part of nevoid basal cell carcinoma syndrome (NBCCS) caused by PTCH1 mutation. However, pathogenic PTCH1 mutations have not been detected in OOC (68).

Conservative surgical management is generally appropriate for OOC. Enucleation is the preferred treatment, while decompression followed by enucleation may be considered for selected lesions (67). Sankari et al. reported an excellent prognosis and cited recurrence rates below 2% (65). In the 48-patient series, however, two recurrences occurred among 45 patients with follow-up data, corresponding to an overall recurrence rate of 4.44% during a mean follow-up period of approximately 32.5 months (67). Thus, available evidence indicates that OOC has a relatively low recurrence potential compared with OKC, although reported recurrence rates should be interpreted according to study design, treatment modality, and duration of follow-up.

5.7. Gingival Cysts

Gingival cyst of the adult (GCA) is a rare, benign odontogenic cyst, accounting for approximately 0.3% of odontogenic cysts. It is most commonly observed on the facial attached gingiva in the mandibular canine–premolar region, particularly in adults in the fifth and sixth decades of life, with a female predominance. Clinically, it usually presents as a solitary, small, slow-growing, painless nodule or vesicle, typically measuring approximately 3–4 mm and ranging in color from normal mucosal color to bluish (69, 70).

Radiographically, GCA generally shows no osseous involvement, although superficial bone resorption may occasionally occur. Histopathologically, it consists of a cystic cavity within the subepithelial connective tissue lined by a thin squamous or cuboidal epithelium, which may contain focal glycogen-rich clear cells. The differential diagnosis includes fibroma, epulis, lateral periodontal cyst, vascular lesions, and peripheral odontogenic tumors. Treatment consists of conservative surgical excision, and recurrence is considered very uncommon (69, 70).

6. COMPARATIVE RADIOGRAPHIC DIAGNOSIS

Odontogenic cysts frequently demonstrate overlapping radiographic appearances, and a definitive diagnosis cannot always be established on the basis of imaging findings alone. Nevertheless, lesion location, relationship with teeth, border characteristics, internal structure, effects on adjacent anatomical structures, and patterns of cortical expansion provide important clues for differential diagnosis. CBCT may provide additional three-dimensional information, particularly for large or anatomically complex lesions and for assessing cortical involvement and relationships with adjacent

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structures. The principal radiographic features and differential diagnoses of odontogenic cysts are summarized in Table 2.

Table 2. Comparative radiographic features and differential diagnosis of odontogenic cysts.

Lesion	Typical Location / Relationship	Border and Internal Structure	Effects on Adjacent Structures	Main Differential Diagnoses
Radicular cyst	Periapical region of a non-vital tooth; commonly anterior maxilla	Usually well-defined, corticated, unilocular radiolucency	Cortical expansion, displacement of adjacent structures, and root resorption may occur in larger lesions	Periapical granuloma, periapical cemento-osseous dysplasia, OKC
Residual cyst	Edentulous region at the site of a previously extracted tooth	Well-defined, usually corticated unilocular radiolucency	Expansion may occur in larger lesions	Residual inflammatory lesion, OKC, other intraosseous radiolucent lesions
Paradental cyst	Buccal/distal aspect of a partially erupted mandibular molar, particularly third molar	Well-defined unilocular radiolucency	Usually associated with vital teeth; localized cortical expansion may occur	Dentigerous cyst, pericoronitis-associated changes, OKC
Mandibular buccal bifurcation cyst	Buccal aspect and furcation region of erupting mandibular first or second molars in children	Well-defined radiolucency involving the buccal/furcation region	Buccal expansion, tilting or altered eruption of the associated tooth	Dentigerous cyst, inflammatory lesions
Dentigerous cyst	Pericoronal region of an unerupted/ impacted tooth; attached near the CEJ	Usually well-defined, corticated, unilocular radiolucency; central, lateral, or circumferential relationship	Tooth displacement, root resorption, and cortical expansion may occur	Hyperplastic dental follicle, OKC, unicystic ameloblastoma, AOT, COC, ameloblastic fibroma
Eruption cyst	Soft tissue overlying the crown of an erupting tooth	Superficial soft-tissue lesion; conventional radiographs may show little or no osseous abnormality	Usually no significant bone involvement	Eruption hematoma, other gingival/ soft-tissue lesions
Lateral periodontal cyst	Lateral root surface of a vital tooth; classically mandibular canine–premolar region	Small, well-defined, corticated unilocular radiolucency	Usually minimal effect on adjacent structures	OKC, lateral radicular cyst, central odontogenic fibroma
Botryoid odontogenic cyst	Similar distribution to LPC but generally larger	Multilocular or "grape-like" radiolucency may occur	Greater potential for expansion than conventional LPC	GOC, ameloblastoma, OKC, odontogenic myxoma, central odontogenic fibroma
Orthokeratinized odontogenic cyst	Posterior mandible; may be associated with an impacted tooth	Usually well-defined unilocular radiolucency; occasionally multilocular	Expansion and displacement may occur	OKC, dentigerous cyst, unicystic ameloblastoma
Calcifying odontogenic cyst	Tooth-bearing regions of either jaw; may be associated with an unerupted tooth	Well-defined unilocular radiolucency, sometimes containing variable calcified material	Tooth displacement and root resorption may occur	AOT, calcifying epithelial odontogenic tumor, dentigerous cyst, odontoma-associated lesions
Glandular odontogenic cyst	Predominantly mandible, often anterior region; may cross the midline	Well-defined unilocular or multilocular radiolucency	Cortical expansion/perforation, tooth displacement, and root resorption may occur	Central mucoepidermoid carcinoma, ameloblastoma, OKC, BOC
Odontogenic keratocyst	Posterior mandible and ramus are common; may occur in any jaw region	Well-defined corticated unilocular or multilocular radiolucency	May extend extensively anteroposteriorly with relatively limited buccolingual expansion; displacement/resorption may occur	Dentigerous cyst, ameloblastoma, odontogenic myxoma, simple bone cyst

Abbreviations: CEJ, cementoenamel junction; OKC, odontogenic keratocyst; AOT, adenomatoid odontogenic tumor; OOC, calcifying odontogenic cyst; LPC, lateral periodontal cyst; GOC, glandular odontogenic cyst; BOC, botryoid odontogenic cyst.

7. CONTEMPORARY TREATMENT AND FOLLOW-UP

Treatment of odontogenic cysts should be individualized according to the type, size, location, biological behavior of the lesion, its relationship with adjacent anatomical structures, and patient-related factors. Although conservative surgical approaches are adequate for many odontogenic cysts, lesions with a higher recurrence potential may require adjunctive treatment and more intensive long-term surveillance. In particular, odontogenic keratocysts, glandular odontogenic cysts, and botryoid odontogenic cysts warrant careful follow-up because of their clinically relevant recurrence potential. The principal treatment approaches, recurrence tendencies, and follow-up considerations for odontogenic cysts are summarized in Table 3.

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Table 3. Contemporary treatment approaches, recurrence tendency and follow-up considerations of odontogenic cysts.

Lesion	Primary Treatment	Alternative / Adjunctive Approaches	Recurrence Tendency	Follow-up Considerations
Radicular cyst	Endodontic treatment when appropriate; enucleation for persistent or larger cystic lesions	Decompression/marsupialization may be considered for selected large lesions	Generally low after adequate treatment	Clinical and radiographic follow-up until satisfactory healing is demonstrated
Residual cyst	Enucleation	Decompression may be considered for large lesions or when anatomical structures are at risk	Generally low after complete removal	Radiographic follow-up until adequate osseous healing
Paradental cyst	Enucleation with management of the associated tooth according to clinical circumstances	Tooth preservation may be possible in selected cases	Generally low	Clinical and radiographic assessment of healing and associated tooth
Mandibular buccal bifurcation cyst	Conservative surgical management with preservation of the involved tooth when feasible	Enucleation or other conservative approaches according to lesion extent	Generally low	Follow eruption and development of the associated permanent tooth
Dentigerous cyst	Enucleation, frequently with removal of the associated impacted tooth in adults	Marsupialization/decompression may be preferred in selected young patients to preserve the permanent tooth and facilitate eruption	Generally low after adequate treatment	Follow-up should assess bone healing and, in conservative pediatric management, eruption of the associated tooth
Eruption cyst	Usually observation; surgical exposure may be performed when eruption is delayed or symptoms occur	—	Very low	Usually limited clinical follow-up
Lateral periodontal cyst	Conservative enucleation	—	Low	Routine clinical and radiographic follow-up
Botryoid odontogenic cyst	Enucleation	Adjunctive treatment following enucleation may be considered in selected larger or multilocular lesions (e.g., peripheral ostectomy, Carnoy's solution)	Higher than conventional LPC	Longer-term radiographic follow-up is advisable because of clinically relevant recurrence potential
Orthokeratinized odontogenic cyst	Enucleation	Marsupialization/decompression may be considered according to lesion size and location	Lower than OKC	Clinical and radiographic follow-up; intensity may be lower than for OKC
Calcifying odontogenic cyst	Enucleation	Treatment individualized according to size, location, and associated odontogenic lesions	Generally low for conventional cystic COC	Clinical and radiographic follow-up after treatment
Glandular odontogenic cyst	Enucleation for appropriately selected lesions	Peripheral ostectomy or more extensive surgery may be considered for large, recurrent, or locally aggressive lesions	Clinically significant; influenced by treatment approach	Long-term surveillance is required; follow-up for at least 5 years is advisable (recurrences may occur 3–5 years after treatment)
Odontogenic keratocyst	Enucleation with peripheral ostectomy, with treatment individualized according to lesion characteristics	Decompression/marsupialization followed by enucleation; Carnoy's solution, modified Carnoy's solution, cryotherapy, or topical 5-FU as adjuncts; resection in selected aggressive/recurrent cases	Relatively high and strongly influenced by treatment modality and lesion characteristics	Long-term clinical and radiographic surveillance is recommended because recurrence may occur years after treatment

Abbreviations: LPC, lateral periodontal cyst; OKC, odontogenic keratocyst; COC, calcifying odontogenic cyst; 5-FU, 5-fluorouracil.

SUMMARY / SONUÇ

Odontogenic cysts are among the most common pathological lesions affecting the jaws and exhibit a wide range of clinical, radiographic, and histopathological characteristics. Although the 2022 WHO classification no longer uses the inflammatory–developmental distinction as the primary formal classification structure, this distinction remains useful for understanding the etiopathogenesis of odontogenic cysts. From a clinical perspective, common inflammatory and developmental cysts generally have favorable outcomes and low recurrence rates when appropriately managed, whereas some cystic lesions may show significant clinical, radiographic, and histopathological overlap with odontogenic tumors, requiring careful differential diagnosis. In addition, odontogenic keratocyst, glandular odontogenic cyst, and botryoid odontogenic cyst warrant particular attention because of their clinically relevant recurrence potential and the need for appropriate long-term follow-up.

Imaging modalities, including panoramic radiography, periapical radiography, and CBCT, provide valuable information regarding lesion location, extent, internal characteristics, effects on adjacent structures, and treatment planning. In particular, CBCT offers three-dimensional assessment of large or anatomically complex lesions and their relationships with adjacent structures. However, imaging findings alone are not sufficient to establish a definitive diagnosis in all cases. Accurate

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diagnosis and appropriate management therefore require integration of clinical and radiographic findings and, when indicated, histopathological evaluation.

Follow-up strategies should be tailored to the biological behavior and recurrence potential of each lesion. Long-term clinical and radiographic surveillance is particularly important for lesions with a higher recurrence potential, such as odontogenic keratocysts, glandular odontogenic cysts, and botryoid odontogenic cysts, whereas less intensive follow-up may be appropriate for cysts with a low recurrence risk after adequate treatment. The current WHO classification provides an important framework for distinguishing cystic lesions from odontogenic neoplasms and supports more consistent diagnostic terminology and clinical decision-making. Future studies should focus on establishing standardized diagnostic criteria, treatment protocols, and evidence-based follow-up strategies through well-designed prospective and multicenter studies, particularly for rare lesions and cysts with higher recurrence potential.

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