Cystic and Cystic-Appearing Lesions of the Mandible: Review

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Objective

Cystic and cystic-appearing lesions of the mandible are commonly noted on head and neck imaging and present a diagnostic dilemma for the radiologist. This article aims to help outline the differential diagnosis for cystic mandibular lesions, outline the key imaging features, and suggest recommendations for further imaging and/or intervention when required.

Conclusion

After completing this article, the reader should have an improved ability to characterize cystic and cystic-appearing lesions of the mandible.

By definition, a cyst is an epithelium-lined cavity that contains fluid or semisolid material. Pathologic analysis of the epithelial lining and contents and clinical and radiographic findings are generally required to achieve a definitive diagnosis [1].

Clinically, cysts in the mandible can present as functional disturbances caused by bone remodeling and weakening. Furthermore, cysts can present after a secondary infection. Cysts occurring in the mandible appear radiographically as either unilocular or multilocular lucencies that vary in size and definition. Displaced or resorbed tooth roots, displaced mandibular canal and expansion, and uneruption of the tooth are often seen. The cyst’s spatial relationship to the tooth on imaging is an important diagnostic feature [1]. Accurate radiographic identification of cystic-appearing benign and malignant tumors is essential for appropriate clinical workup and management.

Based on the cell of origin, cystic lesions in the mandible are subdivided into odontogenic (Appendix 1) and non-odontogenic (Appendix 2) lesions. Odontogenic cysts arise from tooth derivatives, and they are frequently divided into inflammatory and developmental types. Further subdivision can be achieved with histologic analysis of the epithelial lining and with imaging to determine whether calcifications are present and in correlation with clinical findings; occasionally the pathogenesis is unclear [1]. The World Health Organization classification published in 2005 is widely accepted [2]. This classification defines cysts (odontogenic and nonodontogenic cysts) and tumors (benign and malignant types) and further subdivides the lesions on the basis of odontogenic tissue type [2].

The majority of these lesions may initially be identified by the patient’s dentist on either physical examination or routine dental radiographs. Further, cystic lesions are often identified as incidental lesions by the radiologist on imaging performed for different reasons. Collaborative interaction between the dentist, oral surgeon, and radiologist is essential for the appropriate evaluation, imaging, and treatment of cystic and cystic-appearing lesions of the mandible (Tables 1 and 2).

Odontogenic Lesions

Humans have 20 primary and 32 permanent teeth. Each tooth develops from ectoderm and mesenchyme. The ectoderm forms the enamel, whereas the mesenchymal cells form the dentin, cementum, periodontal ligament, and pulp contents [3, 4].

The dental lamina, a thickening of the oral epithelium, invaginates into the mesenchyme and the surrounding cells condense to form the tooth buds or tooth germs [3]. As the tooth bud grows, it develops into a cap shape with mesenchymal invagination, which forms the dental papilla [4]. The dental papilla forms both the dental pulp (the soft tissue in the root chamber of the tooth that contains nerves, vessels, and connective tissue) and odontoblasts, which form the dentin of the tooth. The ectoderm forms the enamel organ, which includes the outer enamel epithelium, the stellate reticulum, and the inner enamel epithelium. The inner enamel epithelium elongates into ameloblasts, which form the enamel of the tooth [4].

Odontogenic Cysts

Cysts commonly occur in the mandible and appear as unilocular or multilocular radiolucencies on dental radiographs. Cystic lesions within the mandible can cause bony remodeling that can weaken the bone, leading to functional changes and predisposing the patient to infection and
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Pathologic fracture [1]. The relationship of the cyst to adjacent structures is important, which includes features such as unerupted teeth, tooth displacement, root resorption, and canal displacement. Although many odontogenic cysts are developmental in origin, the most common type of odontogenic cyst, the periapical cyst, is acquired [5].

_Periapical (radicular) cysts—_The periapical (radicular) cyst is the most common type of odontogenic cyst. These lesions have a slight male predominance and peak incidence between the ages of 30 and 50 years [5]. Periapical cysts generally originate after trauma or dental caries. Dental caries cause inflammation of the pulp cavity leading to pulp necrosis [6]. The infection then spreads to the tooth apex of the root causing periapical periodontitis, which leads to either an acute abscess or a chronic granuloma. Persistent chronic infection can lead to formation of a periapical cyst [1]. Treatment options include tooth extraction, endodontic therapy, and apical surgery. If the periapical cyst persists after surgical extraction of the associated tooth, it is referred to as a “residual cyst” [5].

A periapical cyst presents as a well-circumscribed corticated radiolucency at the apex of the nonvital tooth. Cortical expansion may be seen with large lesions (Figs. 1 and 2). Periapical cysts can cause root resorption of the affected tooth and can displace adjacent structures including adjacent teeth and the mandibular canal. MRI of periapical cysts shows high T2 (due to high fluid content) and variable T1 signal intensity (Fig. 3). Contrast-enhanced MR images show an enhancing cystic wall consistent with inflammation [1].

_Dentigerous (follicular) cysts—_The dentigerous cyst is the second most common odontogenic cyst occurring in the mandible and is typically discovered in adults in the third and

**TABLE 1: Odontogenic Lesions**

<table>
<thead>
<tr>
<th>Odontogenic Lesions</th>
<th>Initial Radiographic Imaging</th>
<th>Additional Radiologic Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periapical cyst (radicular cyst)</td>
<td>Intraoral and panoramic radiography</td>
<td>Extent of cyst, adjacent tooth involvement, preoperative planning</td>
</tr>
<tr>
<td>Dentigerous cyst (follicular cyst)</td>
<td>Intraoral and panoramic radiography</td>
<td>Extent of cyst, adjacent tooth involvement, preoperative planning</td>
</tr>
<tr>
<td>Keratocystic odontogenic tumor</td>
<td>Intraoral and panoramic radiography</td>
<td>Extent of disease, presence of daughter cysts</td>
</tr>
<tr>
<td>Ameloblastoma</td>
<td>Intraoral and panoramic radiography</td>
<td>Extent of disease and osseous destruction, displacement of teeth</td>
</tr>
<tr>
<td>Odontogenic myxoma</td>
<td>Intraoral and panoramic radiography</td>
<td>Helps differentiate from hemangioma, central giant cell granuloma, ameloblastoma</td>
</tr>
</tbody>
</table>

Additional evaluation includes CT and MRI. PET/CT may be indicated for staging.

**TABLE 2: Nonodontogenic Lesions**

<table>
<thead>
<tr>
<th>Nonodontogenic Lesions</th>
<th>Initial Radiographic Imaging</th>
<th>Additional Radiologic Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple bone cyst (traumatic bone cyst)</td>
<td>Intraoral and panoramic radiography</td>
<td>None typically required</td>
</tr>
<tr>
<td>Aneurysmal bone cyst</td>
<td>Intraoral and panoramic radiography</td>
<td>Fluid-fluid levels better visualized</td>
</tr>
<tr>
<td>Static bone cavity (Stafne cyst)</td>
<td>Intraoral and panoramic radiography</td>
<td>If atypical features present, can aid in exclusion of other cystic lesions</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>Intraoral and panoramic radiography</td>
<td>Contrast-enhanced for better characterization of soft tissues and bones</td>
</tr>
<tr>
<td>Multiple myeloma and plasmacytoma</td>
<td>Intraoral and panoramic radiography</td>
<td>Contrast-enhanced for solid lesions and extrasosseous extension</td>
</tr>
</tbody>
</table>

Additional evaluation includes CT, MRI, and WBC or Gallium Scanning. PET/CT may be indicated for systemic staging and therapy response.

**Note—**NR = not required in routine cases when other imaging is diagnostic. SCC = squamous cell carcinoma.

fourth decades of life [7]. The cyst forms around the crown of an unerupted tooth as fluid collects between layers of epithelium or between the epithelium and enamel. The size of a typical follicle space is 2–3 mm; the presence of a dentigerous cyst should be suspected if the follicle space is greater than 5 mm [5]. Dentigerous cysts can vary in size but have the potential to grow large enough to cause significant expansion of the jaw and displacement of adjacent teeth; however, resorption of the root apex is uncommon [1, 8]. Superimposed infection and pathologic fractures can develop especially with larger lesions [1]. Small lesions are typically treated with enucleation, whereas larger lesions undergo surgical drainage and marsupialization to relieve the pressure inside the cyst and prevent damage to the involved permanent teeth. The presence of bilateral lesions is extremely rare in isolation and association with a syndrome, such as mucopolysaccharidosis (type 4) or cleidocranial dysplasia, should be suspected [9].

Radiographically, a dentigerous cyst appears as a well-circumscribed unilocular radiolucent lesion adjacent to the crown of an unerupted tooth [9], most commonly the third molar tooth (Fig. 4). CT is useful to evaluate large lesions and can show the origin, size, and internal contents of the cyst and evaluate the integrity of the cortical plate and its relationship to the adjacent anatomic structures [9]. Significant cortical expansion or thinning of the buccal and lingual cortical plates may be seen with larger lesions [1]. The roots of the affected tooth are typically outside the lesion. Large lesions can develop undulating borders due to uneven expansion rates and may mimic ameloblastomas and keratocystic odontogenic tumors [5]. MRI is not required for diagnosis in most cases; however, it may aid in the characterization of large lesions. MRI will typically show high T2 and low to intermediate T1 signal within the cyst, whereas the tooth will appear as a signal void. Contrast-enhanced images may show enhancement of the thin cyst wall. The presence of a thick irregular wall or a solid component raises the possibility of ameloblastoma [10]. FDG PET/CT shows background FDG uptake; however, if inflammation is present, mild FDG hypermetabolism can be noted [11].

**Other odontogenic cysts**—Other less common odontogenic cysts include entities such as lateral periapical cysts and buccal bifurcation cysts. Lateral periodontal cysts are developmental odontogenic cysts that are most common in adults. They most commonly occur in the mandibular premolar area and are typically discovered incidentally. Radiographically they appear as well-circumscribed lytic lesions associated with the tooth root in the premolar mandibular region. It is important to distinguish a lateral periodontal cyst from a keratocystic odontogenic tumor [12]. Buccal bifurcation cysts are extremely rare, likely secondary to inflammation, and arise from the buccal periodontium at the bifurcation of the roots of the mandibular molars [1]. The diagnosis of a buccal bifurcation cyst is made based solely on clinical and radiographic features. Buccal bifurcation cysts are typically unilateral; occur in the first or second molar; and are distinguished by the tipping of the involved molar, causing the root tips to be pushed into the lingual cortical plate of the mandible [5, 13].

![Fig. 1—42-year-old woman with periapical cyst. Cropped panoramic radiograph shows radiolucent lesion (arrowhead) in posterior body of ramus of mandible with displacement of mandibular canal (arrow). Combination of findings suggests benign disease.](image1)

![Fig. 2—25-year-old man with periapical cyst. A–C, Axial (A), sagittal (B), and volume-rendering 3D (C) CT images show well-circumscribed radiolucent lesions surrounding apex of first (white arrows, A and B) and second (black arrows, B and C) molars (teeth 18 and 19). Note large cavities in affected teeth with mild root resorption (arrowheads, B and C).](image2)
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Odontogenic Tumors

Odontogenic tumors arise from abnormal proliferation of the tissues and cells involved in odontogenesis. These tumors represent a varied group of lesions and are classified by their stage in tooth development [1, 2]. Many odontogenic tumors can show a cystic appearance including keratocystic odontogenic tumor, ameloblastoma, ameloblastic fibroma, odontogenic myxoma, primordial cyst, and central odontogenic fibroma [14, 15]. One distinguishing feature between benign and malignant lesions is close evaluation of the character of tooth root absorption: Benign lesions show directional root resorption secondary to pressure effects, whereas malignant lesions show nondirectional root resorption [16].

Keratocystic odontogenic tumor—Keratocystic odontogenic tumor was formally known as “odontogenic keratocyst” but recently was categorized as an odontogenic tumor rather than a cyst [2]. A keratocystic odontogenic tumor is a benign but locally aggressive developmental odontogenic tumor that is most commonly located in the mandibular ramus and body [17]. These lesions are typically found in adults in the second to fourth decades of life and represent 5–17% of all jaw cysts [15]. Keratocystic odontogenic tumors are lined with stratified keratinizing squamous epithelium [1] and arise from the dental lamina and overlying alveolar mucosa [18]. They can expand the cortical bone and erode the cortex. Keratocystic odontogenic tumors have a high postoperative recurrence rate [7].

The presence of multiple keratocystic odontogenic tumors should raise the possibility of basal cell nevus syndrome (i.e., Gorlin-Goltz syndrome) [17]. Findings associated with this autosomal-dominant disorder include midface hypoplasia, frontal bossing and prognathism, mental retardation, calcification of the falx cerebri and dura, bifid ribs, and multiple basal cell carcinomas of the skin [7]. Keratocystic odontogenic tumors may be unilocular or multiloculated and often contain daughter cysts that extend to the surrounding bone [7]. They typically extend into the marrow cavity with either a smooth border contributing to mild bulging of the cortex but without significant cortical expansion. Keratocystic odontogenic tumors can show a more aggressive growth pattern including multilocularity, cortical expansion, perforation of the cortical bone, tooth and mandibular canal displacement, root resorption, and extrusion of erupted teeth [15] (Fig. 5). Keratocystic odontogenic tumors show slight to no expansion within the body of the mandible; however, once they reach the mandibular ramus, they typically cause significant expansion [19].
CT shows a unilocular or multilocular cyst with corticated margins. Keratocystic odontogenic tumors typically occur in the body and ramus of the mandible in association with an impacted tooth [15]. MRI shows a thin-walled, minimally peripherally enhancing cyst with heterogeneous intensity fluid contents (intermediate T1 signal and intermediate to high T2 signal) because of variable proteinaceous content [10]. MRI can help distinguish keratocystic odontogenic tumor from ameloblastoma, the latter of which has a mixed pattern of solid and cystic components, irregular thick walls, and avid enhancement of solid components [10, 20]. In rare cases, malignant transformation into squamous cell carcinoma occurs; PET/CT will typically show intense FDG hypermetabolism similar to other head and neck squamous cell carcinomas (Fig. 6).

Ameloblastoma—Ameloblastoma is a benign but locally aggressive epithelial odontogenic tumor thought to arise from the surface epithelium, remnants of the dental lamina, or pluripotential epithelial cells lining odontogenic cysts. Approximately 5% of ameloblastomas arise from the epithelial lining of dentigerous cysts [21]. They account for 10% of odontogenic tumors, and 80% are located within the mandible [21].

Ameloblastomas are most commonly found in adults in the third and fourth decades without sex predominance. Ameloblastomas are slow-growing painless masses and may present with local swelling [21].

“Malignant ameloblastoma” is a term given to tumors with metastasis, even those with a histologically benign appearance, and “ameloblastic carcinoma” is a term given to tumors that display histologically malignant features with or without metastasis [14]. Treatment is surgical resection; however, wide margin en bloc resection is required for tumors that infiltrate through the cyst wall into adjacent bone [22].

Radiographically, the appearance of ameloblastomas is variable and dependent on the histopathology of the lesion (Fig. 7). There are multiple classification systems for ameloblastoma. On the basis of its clinical behavior, anatomic location, radiographic appearance, and histologic characteristics, ameloblastoma can be grouped into four main forms: multicystic, unicystic, extraosseous or peripheral, and desmoplastic [21].
Solid or multicystic ameloblastoma is the most common variant, accounting for 85% of all ameloblastomas. This variant is also the most aggressive and has a high recurrence rate compared with the other variants [21]. Radiographically the multicystic (solid) ameloblastoma variant typically appears multiloculated with internal septations manifested by a honeycomb or soap-bubble appearance. This variant can be confused with large keratocystic odontogenic tumors [14].

The unicystic variant is characterized by a single cystic cavity lined by epithelium. Luminal proliferation of the epithelial cells or mural infiltration of the cyst wall can occur [21]. Common radiographic findings of the unicystic variant include a unicocular, well-circumscribed, and well-corticated lucent lesion often associated with the crown of an unerupted or impacted tooth. This variant can resemble a dentigerous cyst [19]. The presence of solid components, including internal bony septa, aids in the distinction between an ameloblastoma and a dentigerous cyst [19]. Many authors have concluded that the unicystic variant is generally less aggressive than the other ameloblastoma variants [21].

The peripheral ameloblastoma variant represents a soft-tissue tumor that is histologically identical to an intraosseous ameloblastoma but occurs over the tooth-bearing parts of the jaw. These lesions appear solid on imaging, have a benign clinical course, and can be treated with local excision [21]. The desmoplastic variant can be distinguished from other variants by the presence of multiple coarse internal calcifications with significant surrounding cortical destruction.

The hallmark of ameloblastoma is extensive tooth root absorption. CT evaluation is useful to access the extent of the lesion, cortical perforation, and adjacent soft-tissue involvement [19, 21]. The presence of more aggressive imaging features such as large solid enhancing components, papillary projections, and extraosseous extension and invasion is suggestive of malignancy (e.g., ameloblastic carcinoma) [23] (Fig. 8), but...
preoperative diagnosis is very difficult. MRI is useful for evaluation of intra- and extraosseous extension and involvement of adjacent structures. Contrast-enhanced images show strong enhancement of the solid components including papillary projections, lesion wall, and internal septa [10, 23].

Malignant ameloblastoma and ameloblastic carcinoma show strong FDG avidity on PET/CT, which can be used for initial staging, therapy assessment, and postsurgical surveillance [24]. Preoperative cross-sectional imaging is very important for surgical planning. The suspicion of ameloblastic carcinoma or the presence of distant metastasis requires a larger, more extensive surgery followed by radiation and chemotherapy.

**Odontogenic myxoma**—Accounting for 0.2–17.7% of odontogenic tumors [25], odontogenic myxoma is a true odontogenic tumor originating from the mesodermal portion of the odontogenic apparatus. These lesions are most common in adults in the second and third decades of life [1]. Odontogenic myxomas are benign, slow-growing painless lesions; however, they tend to be locally aggressive, exhibiting rapid growth leading to extensive osseous destruction and cortical expansion [26]. They present equally within the maxilla and mandible, with the ramus as the most common mandibular location [1]. Odontogenic myxomas are treated with wide margin surgical resection because they tend to infiltrate and recur [14].

Radiographically, odontogenic myxoma lesions appear as radiolucent regions separated by bony trabeculae that form geographic compartments. They typically contain multiple thin septations and internal osseous trabeculae and exhibit honeycomb-like structures [7,14,15,25] (Fig. 9). The tumor margins are typically poorly defined. An odontogenic myxoma may simulate entities such as hemangioma, central giant cell granuloma, and ameloblastoma. This aggressive tumor shows little encapsulation, often extending through bone into the adjacent soft tissues [25]. Occasionally odontogenic myxomas infiltrate between the adjacent tooth roots causing displacement and resorption [26]. CT typically shows an expansile osteolytic lesion within the mandible [15, 25].

**Other odontogenic tumors**—Other less common odontogenic tumors that may show a cystic appearance include a primordial cyst, central odontogenic fibroma, and ameloblastic fibroma. A primordial cyst is an uncommon cystic lesion that develops instead of the tooth; however, most authors believe that all primordial cysts represent keratocystic odontogenic tumors [1]. Radiographically, a primordial cyst appears as a nonexpansile well-defined radiolucent lesion without an associated tooth [7].

A central odontogenic fibroma is a rare benign odontogenic neoplasm of the odontogenic apparatus (periodontal ligament and dental papilla). Radiographically a central odontogenic fibroma appears as a well-defined heterogeneous lesion causing cortical expansion [27].

An ameloblastic fibroma is composed of enamel and embryonic connective tissue. Radiographically, an ameloblastic fibroma typically appears as a well-defined, pericoronal radiolucent
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Lesion. Most are multiloculated and associated with impacted teeth, often in the posterior mandible. Although ameloblastic fibromas do not represent a variant of ameloblastomas, radiologically they can appear similar to a unilocular ameloblastoma [7].

Nonodontogenic Cysts and Pseudocysts

Nonodontogenic cysts and cystlike lesions can mimic odontogenic cystic lesions and include entities such as traumatic bone cyst and aneurysmal bone cyst (ABC). Nonodontogenic cystic lesions are typically acquired with unclear causes.

Nonodontogenic Cysts

*Simple bone cyst (traumatic bone cyst)*—The term “simple bone cyst” includes entities such as solitary bone cyst, hemorrhagic cyst, extravasation cyst, unicameral bone cyst, traumatic bone cyst, and idiopathic bone cavity. Despite its name, simple bone cyst lesions lack an epithelial lining and are not true cysts. Simple bone cysts are common lesions within the skeleton including the mandible [28]. Although the cause of a simple bone cyst is unknown, these lesions are thought to originate from intramedullary hemorrhage caused by trauma (including tooth extraction) [29]. Simple bone cysts are typically investigated surgically to exclude other processes [28]; after surgery, they heal by reossification.

Simple bone cysts most commonly occur in the mandible and less commonly within the maxilla [29]. They are commonly located in the mandibular marrow space, which extends posterior from the premolar region. Radiologically simple bone cysts are typically unilocular with well-defined borders, causing a scalloped appearance of the cyst between the tooth roots [28] (Fig. 10). A simple bone cyst is a simple cavity and should not be associated with root resorption or tooth displacement [8]. Large cysts can extend into the interdental space.

CT can characterize the high-density blood products commonly found within a simple bone cyst; however, the density can vary depending on the age of the blood products [1]. MRI can also show a thin rim of peripheral enhancement and the presence of blood products; however, signal characteristics vary on the basis of the stage of heme breakdown [1].

*Aneurysmal bone cyst*—ABCs are very rare lesions that are most common within the mandible of children with a slight female predominance [30, 31]. Clinically these lesions present with rapid painless facial swelling that can be disfiguring [31]. The origin of ABCs is controversial: Some investigators believe ABCs are primary congenital lesions or vascular malformations, whereas others believe they are acquired and arise after local hemodynamic disturbances from trauma [31]. Typically these lesions are surgically removed; however, because ABCs...
contain multiloculations and bony septa, complete excision can be challenging.

ABCs appear as uni- or multicystic radiolucencies causing expansion and destruction of the osseous cortex on radiographs [30]. They have a typical meshwork appearance on CT, which reflects the histopathologic appearance of a partially cystic, blood-filled meshwork divided by coarse septa [32]. Other CT features include the presence of an expansile hypodense lesion with numerous fluid-fluid levels [30]. MRI characterization is critical to further characterize the soft-tissue features of these lesions and differentiate ABCs from other entities including giant cell granuloma, odontogenic myxoma, keratoctytic odontogenic tumor, and ameloblastoma [35]. MRI shows multiple cystic lesions with fluid-fluid levels, enhancement of cyst wall, and enhancing septations [32].

**Nonodontogenic Lesions**

**Static bone cavity (Stafne cyst)—**A static bone cavity is a pseudocyst that appears as an inward bowing of the lingual mandibular cortex into the medullary space [33]. They are asymptomatic radiolucent cysts located at the angle of the mandible that represent a cortical defect with or without extension of submandibular salivary gland tissue [34]. A static bone cavity is a benign finding and no intervention is required [33].

The most common radiographic appearance is a unilateral, ovoid, radiolucent lingual cortical defect with a sclerotic margin near the angle of the mandible inferior to the mandibular canal [33]. The defect can extend deep to the buccal cortex [14]. Although no additional imaging is required, occasionally CT can be performed to exclude other cystic lesions [14] (Fig. 11). Static bone cavities are easily differentiated from odontogenic cysts by location [14]. CT shows a cortical defect in the lingual aspect of the mandibular angle filled with fat or, less commonly, continuity with the adjacent salivary gland [35]. Occasionally static bone cavities can have atypical features including multiple lobes, location superior to the inferior alveolar canal, or lack of a sclerotic border [36]. In these cases, MRI can aid in further characterization and can exclude other entities including traumatic bone cyst and ameloblastoma [35].

**Osteomyelitis—**Osteomyelitis is an inflammatory condition, typically of dental origin, that occurs within the medullary cavity and adjacent cortex. Osteomyelitis can occur from direct extension of a pulp infection [37] or from a secondary process, such as acute exacerbation of a periapical lesion, trauma, high-dose radiation therapy, or sepsis [1]. Healthy patients rarely develop osteomyelitis because of easy access to antimicrobial therapy [7]. Osteomyelitis is more commonly associated with a poorly controlled dental infection or overall debilitated medical state. Other considerations include diabetes; systemic immunosuppression; bisphosphonates; sickle cell anemia; and, in the correct demographic, tuberculosis [1]. It is essential to differentiate osteomyelitis from other conditions including neoplasms [37]. Treatment includes long-term IV antibiotic therapy and other supportive surgical measures such as débridement; sequestrectomy; and, if needed, resection of infected bone.

The imaging appearance of osteomyelitis will differ on the basis of the type and stage of disease (lytic, sclerotic, mixed, or with a sequestrum pattern). Standard and panoramic radiographs and panoramic radiographs may appear normal or show periosteal reaction or osteolytic change [1]. Contrast-enhanced CT allows better characterization of both osseous and soft-tissue findings; however, the appearance of osteomyelitis on CT is often nonspecific and differs depending on the stage of disease including lytic, sclerotic, mixed, or with a sequestrum pattern [37] (Fig. 12). Typically periosteal reaction and cortical plate disruption are seen, more commonly on the buccal surface [37]. Associated soft-tissue abscess and inflammatory change within the adjacent soft tissue are also common findings. Acute suppurative osteomyelitis is manifested by the sudden onset of severe constitutional symptoms; however, conventional radiographs may appear normal in the first 8–10 days [1]. Indium-labeled WBC or gallium scanning can be useful to diagnose acute osteomyelitis in the setting of negative radiographs. Low-grade infections can cause sclerosing osteomyelitis manifested by deposition of bone along the osseous cortex and trabeculae. These changes can be focal or diffuse [7].

The imaging appearances of osteomyelitis, radiation-induced osteonecrosis, bisphosphonate-associated osteonecrosis, and lytic metastatic lesions can overlap significantly. Close correlation with patient history and clinical findings is required for interpretation of the imaging findings.

**Other nonodontogenic pseudocysts—**Many other entities may present as lucent mandibular lesions including fibrous dysplasia, ossifying fibroma, cherubism, osteonecrosis, and Paget disease. Multiple other nonodontogenic lesions including osseous dysplasia can appear cystlike radiographic-

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**Fig. 13—** 58-year-old man with plasmacytoma. A and B, Lateral (A) and panoramic (B) mandibular radiographs show poorly marginated radiolucent lesion (arrow) within body of mandible. Adjacent teeth are unaffected by lesion.
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Nonodontogenic Tumors

Nonodontogenic tumors are typically disease processes that are not isolated to the mandible but can occur throughout the skeleton and will therefore have similar radiographic findings. Although most nonodontogenic tumors are solid, they may appear cystic, particularly on radiographs. These tumors include schwannoma, neurofibroma, central hemangioma, multiple myeloma (plasmacytoma), lymphoma, leukemia, and metastases [1]. Metastases to the mandible are four times more common that those to the maxilla. Because of the high narrow volume and vascularity, the angle and posterior body are the most common locations within the mandible [7]. The most common primary sites are lung, breast, thyroid, kidney, prostate, and gastrointestinal tract [1]. Recognition of malignant mandibular lesions is important because they may be asymptomatic and may be incidentally noted.

Multiple myeloma (plasmacytoma)—Multiple myeloma is a neoplasm of plasma cells at multiple locations, whereas plasmacytoma is limited to a single lesion. These lesions can be intramedullary or extramedullary and occur throughout the skeleton including the mandible. Because of the active hematopoietic activity within the mandible, the most common sites of involvement are the ramus, angle, and molar regions. After confirmation of a solitary lesion to exclude multiple myeloma is achieved, the lesion is treated with radiation [38]. However, systemic disease is treated with chemotherapy with or without bone marrow transplantation [16].

Multiple myeloma typically appears as multiple lytic lesions with poorly marginated, non sclerotic borders on radiography and CT [38] (Fig. 13). CT is useful to show solid lesions and extraosseous extension. These lesions typically show homogeneous soft-tissue density and enhancement. The MR signal intensity depends on the stage of disease [39]; however, lesions often show homogeneous intermediate signal intensity on both T1- and T2-weighted images and avid enhancement [38, 40]. MRI may have greater sensitivity for lesion detection but typically does not characterize the lesion better than CT [38]. PET/CT is increasingly used to diagnose multiple myeloma, assess multiple myeloma before and after transplantation, and determine the prognosis of patients with multiple myeloma. It is useful in identifying metabolically active disease and in staging [41].

Other nonodontogenic tumors—Other nonodontogenic tumors include squamous cell carcinoma, osteoblastoma, chondrosarcoma, lymphoma, leukemia, mucoepidermoid carcinoma, metastatic disease, and Langerhans cell histiocytosis.

Summary

Cystic lesions of the mandible arise from both odontogenic and nonodontogenic sources. Given the wide range of pathologic features but similar imaging findings, familiarity with embryologic characteristics and with secondary imaging findings is crucial. The prevalence and location in the mandible of a particular lesion often help narrow the differential diagnosis and direct the workup and treatment of a lesion. Imaging may not provide a specific diagnosis but should help narrow the differential diagnosis, thereby helping to guide patient treatment.

References

13. Thakkerissy S, Glazer KM, McNamara KK, Tatakis DN. Buccal bifurcation
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APPENDIX 1: Odontogenic Lesions

Cysts
- Periapical cyst (radicular cyst)
- Residual cyst (periapical cyst after the removal of periapical cyst)
- Dentigerous cyst (follicular cyst)
- Lateral periodontal buccal bifurcation cyst
- Paradental cyst
- Glandular odontogenic cyst

Cystlike
- Benign cementoblastoma (cementoblastoma, true cementoma)

Tumors
- Keratocystic odontogenic tumor (odontogenic keratocyst)
- Ameloblastoma
- Ameloblastic fibroma
- Odontogenic myxoma
- Central odontogenic fibroma
- Adenomatoid odontogenic tumor
- Calcifying epithelial odontogenic tumor (Pindborg tumor)
- Calcifying epithelial odontogenic tumor

Malignant
- Ameloblastic carcinoma

APPENDIX 2: Nonodontogenic Lesions

Cysts
- Simple bone cyst (traumatic bone cyst)
- Aneurysmal bone cyst

Cystlike
- Static bone cavity (Stafne cyst)
- Fibrous dysplasia
- Osteomyelitis
- Paget disease
- Central giant cell granuloma
- Ossifying fibroma
- Cherubism
- Radiation necrosis
- Cementoosseous dysplasia (periapical, focal, florid)

Tumors
- Neurofibroma
- Neurilemmoma (schwannoma)
- Central hemangioma
- Arteriovenous fistula

Malignant
- Multiple myeloma or plasmacytoma
- Squamous cell carcinoma
- Osteosarcoma
- Chondrosarcoma
- Chondroma
- Lymphoma
- Leukemia
- Mucoepidermoid carcinoma
- Metastatic lesions
- Langerhans cell histiocytosis