

Radiographical Approach to Multilocular Radiolucent Lesions of the Jaws-A Review

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Abstract

Multilocular radiolucent jaw lesions are difficult to distinguish on radiography due to similar radiographic appearance. Radiography is still used as first line imaging modality. The patient's history and an analytical approach to radiographs which includes location, margin, density, internal structure, relation to tooth and surrounding structures help in narrowing down the differential diagnosis. This article describes the outline of differential diagnosis for multilocular jaw lesions, and its key imaging features to ensure patient care and to recognize the indications and appropriate imaging studies like CT for evaluation of bony lesions and MRI for characterization of soft-tissue lesions for further treatment options.

Keywords: Unilocular; Multilocular; Odontogenic; Nonodontogenic; Benign; Malignancy

Introduction

Multilocular radiolucencies are formed by multiple adjacent, frequently coalescing and overlapping pathologic compartments in bone [1,2]. Radiographically bony lesions can be divided into unilocular/multilocular lesions based on the presence of their locules. Multilocular lesions occur in maxilla but are found much more commonly in mandible. These lesions with well-defined borders indicate a benign yet aggressive process and higher recurrence rate. Unilocular lesions are composed of a single compartment bone. These are with well-defined borders usually indicate a slow proliferating benign process [2].

Multilocular lesions can be categorized into different classifications

Classification based on location

Common Unilateral	Uncommon Unilateral	Rare unilateral	Rare Bilateral
Normal anatomic appearance	Mucoepidermoid tumor	Calcifying epithelial odontogenic tumor (Pindborg tumor)	Normal variation for maxillary sinuses
Ameloblastoma	Aneurysmal bone cyst	Central fibroma	Cherubism
Keratocystic Odontogenic Tumor	Arterio-venous malformation	Chondroma	Cerebroside lipoidosis (Gaucher's disease)
Central Giant Cell Granuloma	Central hemangioma	Sporotrichosis	Multiple nevoid basal cell carcinoma syndrome (Gorlin and Goltz syndrome)
Cherubism	Ameloblastic fibroma	Cerebroside lipoidosis (Gaucher's disease)	Oxalosis [3].
Odontogenic myxoma	Calcifying odontogenic cyst	Oxalosis	
Multilocular radicular or Residual cyst	Early fibrous dysplasia		
	Developing odontoma		
	Langerhans' cell disease		

Classification based on origin

Benign		Malignant	
Odontogenic	Non-odontogenic	Odontogenic	Nonodontogenic
Ameloblastoma	Central giant cell granuloma	Ameloblastic carcinoma	Osteosarcoma
Odontogenic myxoma	Arteriovenous Malformation	Metastatic ameloblastic	Chondrosarcoma
Pindborg tumor	Central hemangioma		Metastasis
Ameloblastic fibroma			Squamous cell carcinoma
			Multiple myeloma

Radiographical approach to multilocular radiolucency

Radiographical appearance of multilocular lesions are often difficult to differentiate from one another. Despite development of various cross-sectional imaging modalities, the radiograph still remains the first and the most important investigation.

Radiographical approach to the differential diagnosis of multilocular lesions based on:

1. Location and extent
2. Osteolytic and osteoblastic
3. Characteristic of lesional tissue
4. Internal margins
5. Supporting structures of the teeth
6. Relationship to teeth
7. Cortical changes
8. Periosteal reactions [1,4,5].

Location and extent

Odontogenic lesions typically involve only one tooth or a specific part of the tooth. Non-odontogenic lesions usually have no specific relationship to the dentition or can involve the bone around two or more teeth [4].

- **Anterior to first and second Molar:** Central Giant cell Granuloma, Aneurysmal bone cyst, Brown tumor can be seen.
- **Posterior involving Ramus:** Ameloblastoma, Pindborg tumor, Cherubism and Odontogenic Myxoma.
- **No site predilection:** Central Hemangioma, Fibrous Dysplasia, Gorlin Goltz Syndrome [4].

Osteolytic and osteoblastic

“Multilocular/Unilocular” these terms are used only as a radiographic findings, not a microscopic description. Radiolucent areas are not empty spaces, but these are pathologic compartments usually filled with neoplastic tissue or with blood, cystic fluid, soft tissue, un-mineralized matrix of bone and air [2,3].

- **Radiolucent Lesions:** Associated with bone destruction. Keratocystic Odontogenic Tumor, Ameloblastoma, Central Giant cell Granuloma.
- **Radio-opaque Lesions:** Fibrous dysplasia, Florid cemento-osseous dysplasia, Pagets disease.
- **Mixed Radio-opaque and Radiolucent Lesions:** Inflammatory lesions, metabolic conditions, Fibro-osseous, and Metastasis lesions [4].

Characteristic of lesional tissue

Based on bone destruction pattern it is divided into:

- **Geographic pattern:** This denotes larger area of bony destruction. Eg: Multiple myeloma, Metastatic lesion.
- **Moth eaten pattern:** This suggests several small area of bone lysis. Eg: Chronic osteomyelitis, Metastasis and Malignant diseases.
- **Permeative pattern:** This pattern seen in rapidly destructive malignant diseases [4].

Patterns of multilocular radiolucencies

Honeycomb pattern	Soap-bubble pattern	Spider/spoke	Tennis racket pattern	Scalloped/ Crenated
Compartments are small and uniform in size. Early change Eg: Aneurysmal bone cyst Ameloblastoma Metastatic tumors to the jaws Central hemangioma of bone Odontogenic myxoma	Lesions consisting of several circular compartments that vary in size and usually appear to overlap. Eg: Multilocular cyst Ameloblastoma Odontogenic keratocyst Central giant cell granuloma Giant cell lesion of hyperparathyroidism Cherubism Odontogenic myxoma Aneurysmal bone cyst Metastatic tumors to the jaws.	Variant of soap bubble pattern. Septa radiate from a central body, giving the appearance of a spider. Eg: Ameloblastoma	Composed of angular rather than rounded compartments that result from the development of more or less straight septa. compartments tend to be triangular, rectangular, or square. Eg: Odontogenic myxoma	Scalloped/wave pattern margin less prominent septa Later changes to intramedullary expansion rather than cortical expansion Eg: Odontogenic keratocyst Central giant cell granuloma [1,2,4].

Internal margins

Lesions with well-defined borders are usually benign, whereas lesions with ill-defined borders invariably represent aggressive, inflammatory or neoplastic processes [5]. The internal margin relates to the appearance of the interface between the lesion and the host bone. The margin can be divided in to 2 types based on the host bone's reaction to the disturbance.

- **Narrow zone of transition:** Seen when the lesion is not aggressive. Host bone lays down a layer of sclerotic bone. Eg: Odontogenic myxoma, multiple myeloma.
- **Wide zone of transition:** Seen in aggressive lesion, and the margin between healthy and abnormal bone becomes progressively less well defined.eg: Central giant cell Granuloma [4].

Supporting structures of the teeth: Expansion of the multilocular lesions affects periodontal membrane space, the lamina dura, and the alveolar bone.

- **Periodontal membrane space (PMS):** Widening of PMS around the root gives floating tooth appearance. Eg: Aggressive malignant tumor of bone.
- **Lamina dura:** Loss of Lamina dura seen in Paget's disease and fibrous dysplasia.
- **Alveolar bone:** Localised enlargement of alveolar bone seen in early osteosarcoma and chondrosarcoma [4].

Relationship to teeth

Resorption of the tooth/root usually occurs in more chronic and slow-growing lesions; however, malignant lesions also occasionally resorb teeth.

- **Knife edge pattern:** This pattern of root resorption seen in Ameloblastoma.
- **Multiple root planes:** Central Giant cell granuloma.
- **Spiking:** Resorption of both sides of apices leads to pointed appearance of root. Eg: Osteosarcoma, Chondrosarcoma, malignant diseases [4].

Cortical changes

Slow-growing lesions often cause expansion with cortical bone while cortical destruction denotes aggressive inflammatory or neoplastic lesions.

- **Intact and visible:** Cortical expansion seen in Ameloblastoma.
- **Intact and Invisible:** Eg: Ameloblastic fibroma.
- **Perforated cortex:** Seen in malignant conditions.
- **Scalloping:** Occurs at the endosteal surface of the cortex. Eg: Keratocystic Odontogenic Tumor and Central Giant cell granuloma.
- **Saucerization:** Eroding of outer cortex. Eg: Ewing's sarcoma [4].

Periosteal reactions

Periosteal reactions are mainly due to the different patterns of subperiosteal bone formation.

1. Lamellar: uninterrupted, or continuous- eg: Acute osteomyelitis.
2. Lamellar: interrupted, or discontinuous- eg: Osteo sarcoma.
3. Onion skin or layered: eg: Osteo sarcoma, Ewing's sarcoma and Garre's osteomyelitis.
4. Solid, thick, compact and smooth: eg: Garre's osteomyelitis.
5. Solid, irregular mass: eg: Osteo sarcoma.
6. Buttress: eg: Ameloblastoma, Ameloblastic fibroma.
7. Codman's triangles: eg: Bony sarcoma.
8. Sunburst, divergent: eg: Osteo sarcoma, Chondrosarcoma, Multiple myeloma, Odontogenic myxoma.
9. Hair on end, parallel or speculated: eg: Ewing's sarcoma.
10. Irregular spicules: eg: Osteo sarcoma [4].

Discussion

Many lesions that occur in the jaw have a similar radiographical appearance and it is often difficult to differentiate among them. So "when you see a multilocular radiolucent lesion, think odontogenic keratocyst, botryoid odontogenic cyst, ameloblastoma, odontogenic myxoma, central giant cell granuloma, and central hemangioma" these are the very commonly occurring multilocular lesions of the jaws [1,4].

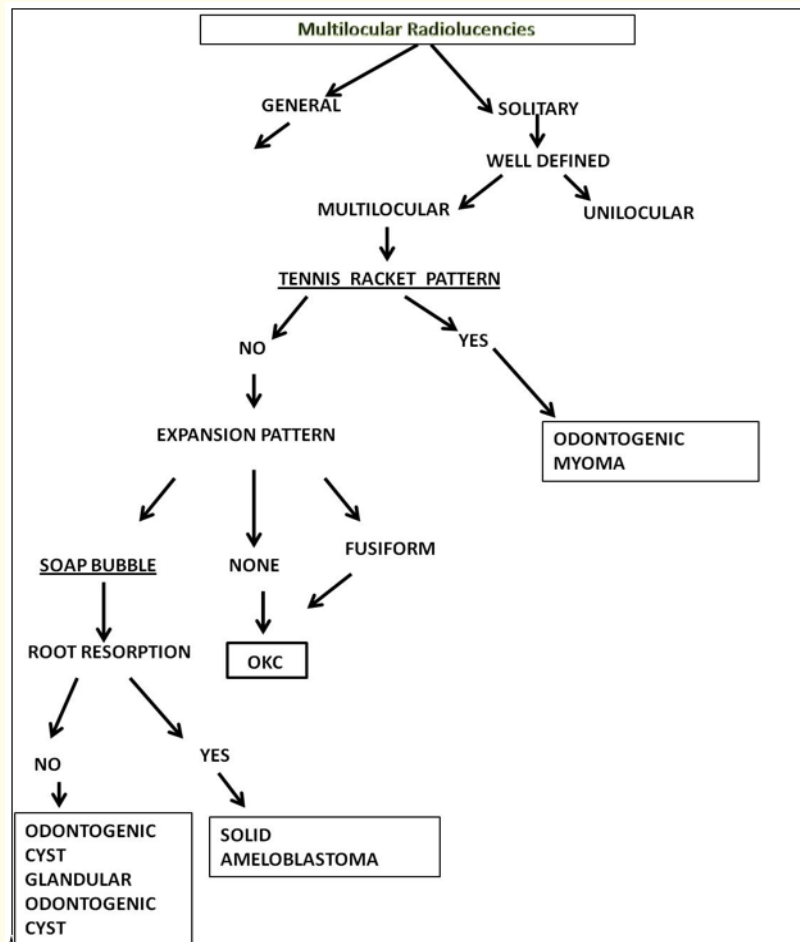


Figure 1: Schematic representation of differential diagnosis of multilocular lesions [1,4].

Keratocystic Odontogenic Tumor:(Odontogenic Keratocyst or OKC)

“A benign uni- or multicystic, intraosseous tumour of odontogenic origin, with a characteristic lining of parakeratinized stratified squamous epithelium and potential aggressive, infiltrative behaviour” (WHO) [5].

These lesions are typically found in adults in the second to fourth decades of life and represent 5 - 17% of all jaw cysts [6]. Slight Male predilection. Asymptomatic pain less swelling unless occasionally paresthesia or pathological fracture of the bone. Commonly seen in posterior body of mandible. Radiographically well-defined Uni or Multilocular lucency with or without scalloped border. Radiolucent lesion with Cloudy interior appearance due to presence of internal Keratin (Milky-way lumen/luminal haze). 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 [6,7].

The naevoid basal cell carcinoma syndrome

Gorlin-Goltz syndrome is an uncommon autosomal dominant inherited disorder which is characterized by numerous basal cell carcinomas (seen in 50 - 97% of people with the syndrome), odontogenic keratocysts (present in about 75% of patients) at the age of second to third decade of life. Musculoskeletal malformations like bifid ribs, agenesis and/or synostosis of ribs, kyphoscoliosis, vertebral fusion, temporoparietal bossing and CNS abnormalities (calcification of falx Cerebri), Midface hypoplasia, frontal bossing and prognathism, mental retardation, calcification of the falx cerebri and dura, bifid ribs also seen [8,9].

The lateral periodontal cyst

This cyst most likely occurs due to inflammatory irritation on the remnants of odontogenic epithelia. More common in males than in females. Less common in the maxilla than in the mandible. Commonly seen after the age of 50 and located near roots of vital teeth in the premolar regions of the mandible. Monolocular, very occasionally Multilocular, Round lesion with smooth, well defined and corticated borders. Uniformly radiolucent. In case of large lesions buccal expansion is seen [7,10,11].

Glandular Odontogenic Cyst (GOC)

“Cyst arising in tooth-bearing areas and characterized by epithelial lining with cuboidal or columnar cells both at surface and lining crypts or cyst-like spaces within thickness of epithelium (WHO)” [5].

Slight female predilection and age ranging from 46 to 50 years. Anterior mandible and anterior maxilla is usual location. Scalloped borders with High rate of multilocularity in GOC (48%) compared with other odontogenic cysts, and its greater tendency for cortical expansion (87%) [7,12].

Solid ameloblastoma

“Slowly growing, locally invasive epithelial odontogenic tumor of the jaws with a high rate of recurrence, but with virtually no tendency to metastasize (WHO)” [5].

Ameloblastoma can be grouped into four main forms: multicystic, unicystic, extraosseous or peripheral, and desmoplastic. 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 variant. Radiographically the multicystic (solid) ameloblastoma variant typically appears as multilocular lesion [13,14]. Ameloblastomas are most commonly found in adults in the third and fourth decades without sex predominance [15]. Common site is the angle of the mandible. Small lesion confined in alveolar process to trans-mental spread. Multiloculated with internal septations manifested by a honeycomb or soap-bubble appearance. Extensive tooth root absorption is key feature of ameloblastoma [16].

Odontogenic myxoma

“Odontogenic myxoma is an intraosseous neoplasm characterized by stellate and spindle-shaped cells embedded in an abundant myxoid or mucoid extracellular matrix. When a relatively greater amount of collagen is evident, the term myxofibroma may be used (WHO) [5]”.

This is a benign, intraosseous neoplasm that arise from odontogenic ectomesenchyme and resembles mesenchymal portion of dental papilla. These lesions are most common in adults in the second and third decades of life. Located equally within the maxilla and mandible, with the ramus as the most common mandibular location [16,17].

Radiographically the lesion usually is well defined, and it may have a corticated margin but most often is poorly defined margins in the maxilla. Mixed radiolucent and radio-opaque lesion [16]. They typically contain multiple thin septations and internal osseous trabeculae and exhibit honeycomb-like structures [14]. Tennis racket-like or stepladder-like pattern, but this pattern is rarely seen. Occasionally odontogenic myxomas infiltrate between the adjacent tooth roots causing displacement and resorption [18].

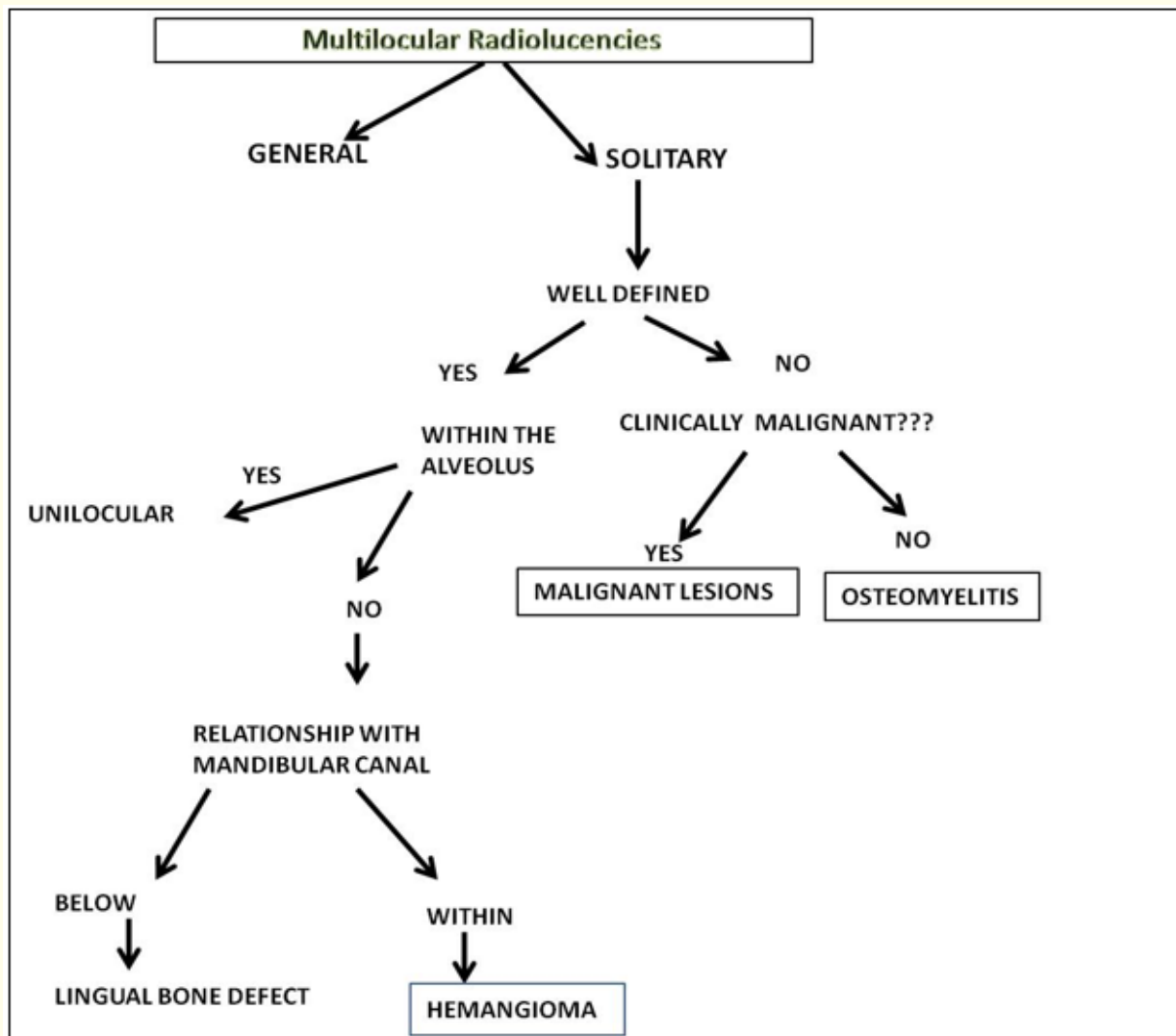


Figure 2: Schematic representation of differential diagnosis of multilocular lesions [1,4].

Central hemangioma

A hemangioma is a proliferation of blood vessels creating a mass that resembles a neoplasm. The central (intraosseous) type most often is found in the vertebrae and skull. The posterior region of the mandible is the most frequent site of occurrence. The tumor is seen in children and teenagers; and females are affected twice as often as males. The lesion produces a hard nontender slow-growing swelling bluish mass, discomfort, pulsatile sensation and mobile teeth. Located around ramus and retromolar area of the mandible and involve the mandibular canal.

Radiographically the margins usually are well defined and corticated. A tortuous path of an enlarged vessel in bone may give a multilocular appearance or radiolucency with small (honeycomb appearance) or large (soap-bubble appearance) loculations [19]. Some radiographic patterns, such as the spoke-like and sunray appearance also reported [19,20].

Osteomyelitis

Osteomyelitis is an inflammation of bone and bone marrow, may develop in the jaw as a result of odontogenic infection or the sequelae of various other conditions including underlying systemic diseases (immunocompromise) and focal injuries such as trauma, complicated fractures, and large doses of radiation therapy. Osteomyelitis may present radiographically as 1. suppurative osteomyelitis, 2. sclerosing osteomyelitis, 3. osteomyelitis with periostitis, 4. tuberculous osteomyelitis, and 5. Osteoradionecrosis [21,22].

The primary cause of chronic osteomyelitis of the jaws is infection by odontogenic microorganisms. It may also arise as a complication of dental extractions and surgery, maxillofacial trauma and the subsequent inadequate treatment of a fracture, and/or irradiation to the mandible.

The typical age of presentation is in the fifties to the sixties, with males more likely to be affected. The commonest site is the posterior body of the mandible [23-26].

Very early stage of disease, no changes are seen in radiographs. Later stages Sequestra will form this is nothing but a region of bone destruction (radiolucency) surrounded by larger segments of radiopaque bone. An onion-skin appearance if bone is also seen which is due to the periosteal new bone formation [27].

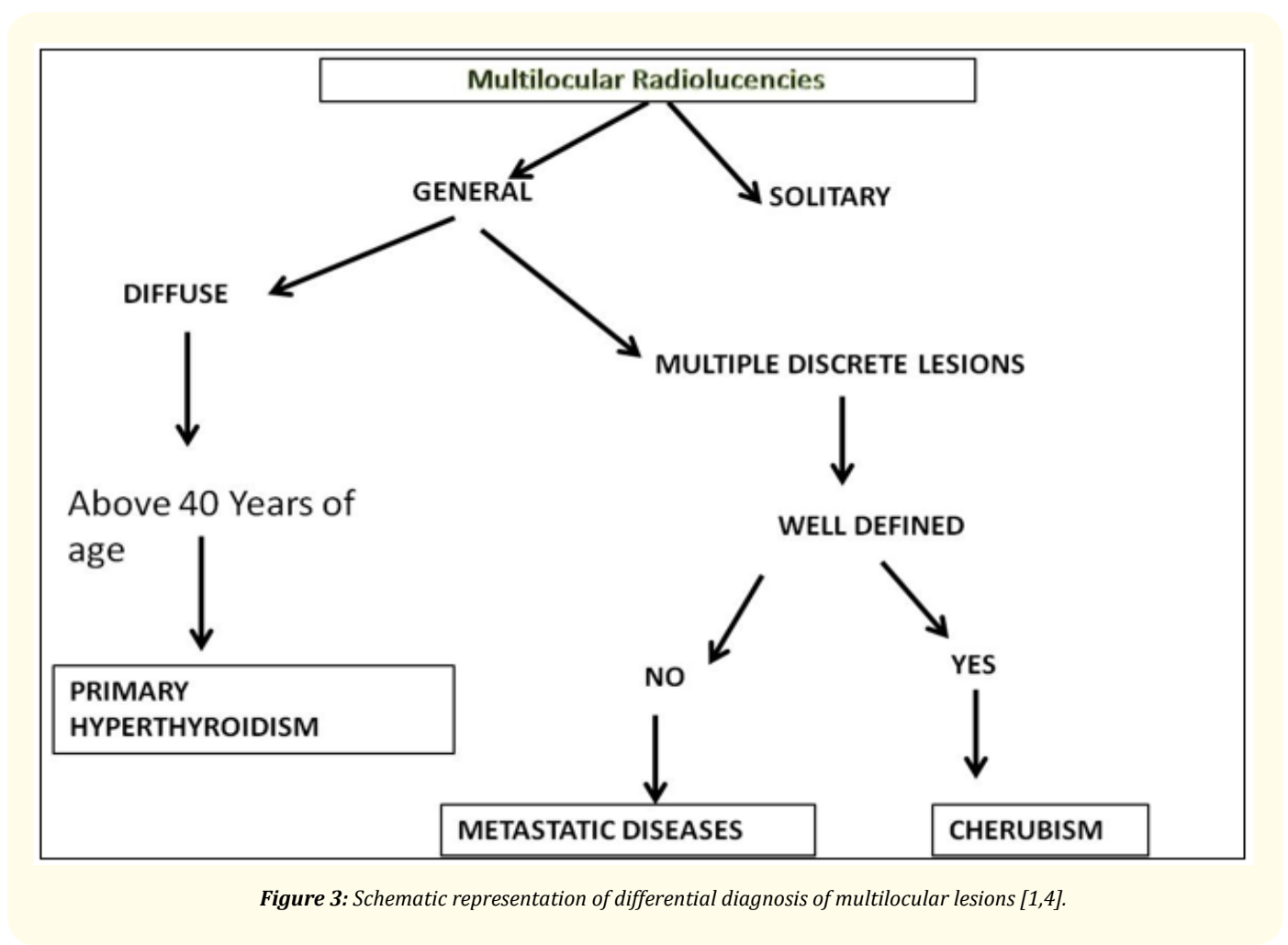


Figure 3: Schematic representation of differential diagnosis of multilocular lesions [1,4].

Cherubism (Familial multilocular cystic disease of the jaws)

“Autosomal dominant inherited disease characterized by a symmetrical distension of the jaw, often leading to a typical facial expression. The histology is indistinguishable from giant cell granuloma” (WHO) [5].

Cherubism is a rare hereditary condition characterized by painless, bilateral, symmetrical expansion of the jaws commonly begin to manifest as painless, bilateral, symmetric expansion of the jaws between 2 and 5 years of age.

Radiographically, expansive radiolucent, multiloculated lesions clearly delimited by cortical bone seen.

Bone changes generally starts in the region of the angle and ascending ramus of the mandible, continue to the mandibular body, displacing the mandibular canal, and in some cases extending to the coronoid process.

Condyle is rare involved. In the maxilla, maxillary tuberosity region is affected with infiltration of the orbital cavities may leads to exacerbated exophthalmia and limiting ocular movements. Involvement of facial sinuses frequently appear to be obliterated. The mandibular canal is often displaced.

The lesions of cherubism can be classified according to their extent:

- **Grade I:** Bilateral involvement of the ascending ramus of mandible;
- **Grade II:** Bilateral involvement of the ascending ramus of mandible and maxillary tuberosity;
- **Grade III:** Complete involvement of the maxilla and mandible compromising the coronoid.

The teeth are found to be displaced and impacted. Root resorption leads to “floating tooth appearance” [28,29].

Hyperparathyroidism

Hyperparathyroidism is an endocrine abnormality in which there is an excess of circulating parathyroid hormone (PTH). An excess of serum PTH increases bone remodeling and leads of osteoclastic resorption of bone. This lesion appears radiographically as a well-defined unilocular or multilocular radiolucency of the jaws. Trabecular pattern changes to ground-glass appearance. Brown tumours are one of the bony complications of hyperparathyroidism. The mandible is the predominantly affected site in the maxillofacial area. Maxillary involvement is rare Brown tumour is actually a giant cell lesion and often appears as an expansile osteolytic lesion of the bone. The lesion usually presents as a slight swelling in the jaw bones [30,31].

Generalised or localised loss of Lamina Dura surrounding the tooth give the root a tapered appearance because of loss of image contrast.

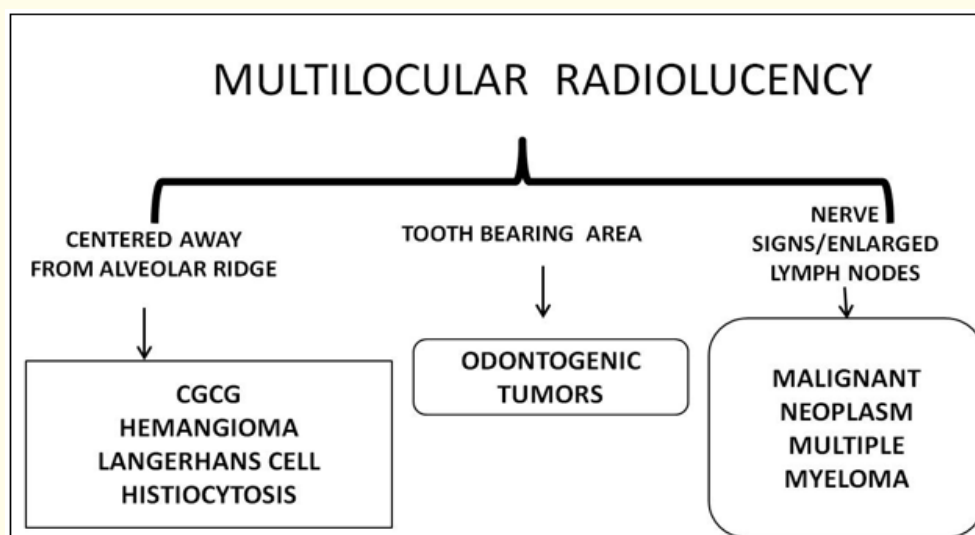


Figure 4: Schematic representation of differential diagnosis of multilocular lesions [1,4].

Central Giant Cell Granuloma (CGCG)

Central Giant Cell Granuloma is a localized benign but sometimes aggressive osteolytic proliferation consisting of fibrous tissue with haemorrhage and haemosiderin deposits, presence of osteoclast-like giant cells and reactive bone formation.

Etiology is unknown but inflammation, haemorrhage and local trauma have been suggested as the cause of origin of CGCG. This lesion could be a reactive lesion, a developmental anomaly or a benign neoplasm.

Majority occur in females with lesions develop twice as often in the mandible with an epicentre anterior to the first molar in young patients and occur in the posterior aspect of the jaws after the first two decades of life. In the maxilla more commonly anterior to the canine.

Radiographically they appeared as well-defined unilocular or multilocular radiolucencies with undulating borders. Aggressive lesions were seen in a younger patients and tends to grow faster and recur more often. with ill-defined borders with variable amounts of cortical destruction [32-34].

Malignant conditions

Ameloblastic carcinoma, Metastatic ameloblastic, Intraosseous carcinoma, Osteosarcoma, Chondrosarcoma, Metastasis, Squamous cell carcinoma, Acute leukemia, Burkitt's Lymphoma, Ewings Sarcoma, Lymphosarcoma and Hodgkins disease are the common malignant conditions which affects the jaws.

Location: Primary carcinomas are seen in soft tissues of oral and maxillofacial region and invades the jaws. Metastatic tumors seen in posterior maxilla and mandible.

Periphery and Shape: Radiographically classical appearance of malignant lesion is with ill-defined border, lack of cortication, absence of encapsulation. Bay and Promitories appearance of Bone destruction.

Internal Structure: Commonly radiolucent in appearance but sometimes shows radio-opacity due to presence of sclerotic bone in case of osteosarcomas.

Effects on surrounding structures: Destruction of supporting alveolar bone gives floating teeth appearance. Root resorption is very common in sarcomas and multiple myeloma. Internal trabeculae bone is destroyed along with surrounding structures. Loss of periodontal ligament space, irregular widening or destruction of lamina dura, widening of inferior alveolar canal are seen. "Hair-on-end" or "sunburst" appearance is seen osteosarcoma [35].

Conclusion

This review article helps us to diagnose different multilocular lesions affecting both maxilla and mandible, the location of lesion, its internal architecture, and characteristic radiographical alteration of adjacent structures. Radiographical imaging may not provide a specific diagnosis but should help narrow the differential diagnosis, thereby helping to guide patient treatment.

Conflict of Interest

Nil.

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