Radiographical approach to jaw lesions
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ABSTRACT
Many lesions that occur in the jaw have a similar radiographical appearance and it is often difficult to differentiate among them. Despite development of various cross-sectional imaging modalities, the radiograph still remains the first and the most important investigation. Radiographical evaluation of jaw lesion characteristics, which include location, margin, density, relation to tooth, along with knowledge of the clinical data, generally helps in narrowing the differential diagnosis.

Keywords: dental lesion, jaw lesion, maxillary lesion, mandible lesion, radiography

INTRODUCTION
Even after development of many modern imaging modalities, radiography still remains the most important mode of investigation for the evaluation of jaw lesions. Intraoral radiographs offer a highly detailed view of the teeth and bone in the area exposed, but it cannot be used for lesions larger than 3 cm, because of the small film size. Extraoral radiographs are used to examine larger lesions and to visualise the skull and facial structures. Panoramic radiography is a special technique, which includes a broad area with low radiation dose, and it can be used in patients who are unable to open their mouths. Although the whole spectrum of jaw lesions is beyond the scope of this article, we have presented the characteristic imaging findings of commonly-encountered jaw lesions.

Jaw lesions are difficult to distinguish from each other on radiography. The patient’s history and an analytical approach to radiographs help in narrowing down the differential diagnosis. Any jaw lesion should be evaluated taking into consideration the following radiological features:

Density of lesion, margin, locularity
Jaw lesions can be described as having either a radiolucent, radiopaque, or mixed appearance, relative to density of the adjacent bone (Table I). The majority of jaw lesions are radiolucent (> 80%). Unilocular radiolucent lesions with well-defined borders usually indicate a slow proliferating benign process. Multilocular lesions with well-defined borders indicate a benign yet aggressive process. Radiopaque lesions which are well-defined, usually represent a benign or inflammatory aetiology. In general, lesions with well-defined borders are usually benign, whereas lesions with ill-defined borders invariably represent aggressive, inflammatory or neoplastic processes. Mixed radiolucent-radiopaque lesions can be due to inflammatory, metabolic conditions, fibro-osseous lesions, or less commonly, malignant processes.

Anatomical location, relation to dentition
Certain lesions have a predilection for a particular site, whereas others can occur anywhere in the jaw (Table II). Non-odontogenic lesions usually have no specific relationship to the dentition or can involve the bone around two or more teeth, whereas odontogenic lesions typically involve only one tooth or a specific part of the tooth. Relationship of the lesion with respect to the inferior alveolar canal indicates tissue types that compose the lesion. Lesions above the canal are likely to be odontogenic, whereas lesions below it are usually non-odontogenic in nature. If the abnormal appearance affects all the structure of maxillofacial region, systemic disorders such as metabolic or endocrine abnormality should be considered.

Cortical integrity, periosseal reaction and soft tissue
Slow-growing lesions often cause expansion with cortical bowing, while cortical destruction denotes aggressive inflammatory or neoplastic lesions. Presence of periosseal reaction and soft tissue is also suggestive of an inflammatory or malignant aetiology. Some types of periosseal reactions are quite specific, like the sunburst type in osteosarcoma.

Effect on surrounding structures
Evaluating the effect of a lesion on the surrounding structure helps in inferring behaviour of the lesion. Displacement of teeth is seen more commonly with slow-growing, space-occupying lesions. Lesions with an epicentre above the crown of the tooth (i.e., dentigerous cyst and occasionally odontomas) displace the tooth apically. Lesions that start in the ramus, such as cherubism, may push teeth in the anterior direction. Resorption of the tooth usually occurs in more chronic and slow-growing processes; however, malignant lesions also occasionally resorb teeth. If a lesion involves only one tooth, it is important to note the degree of tooth development, relationship of the lesion with portion of tooth (crown vs. root vs. entire tooth) and any signs of tooth resorption. Malignant lesions can quickly grow down the ligament space, resulting in irregular widening and destruction of lamina dura. Widening of inferior alveolar canal with maintenance of a cortical boundary may indicate presence of benign lesion of vascular or neural origin.
In the following sections, the commonly-encountered jaw lesions will be discussed, with emphasis on their radiographical features.

**CYSTS OF THE JAWS**

**Primordial cyst**
A primordial cyst forms when a developing tooth undergoes cystic degeneration before the calcification. The most common location is the mandibular third molar and at the sites of supernumerary teeth. Radiographically, it is seen as a well-defined radiolucent lesion without an associated tooth (Fig. 1).

**Radicular cyst**
Radicular (periapical) cyst is the most common odontogenic cyst of the jaw. Most cysts (60%) are found in maxilla, especially around incisors and canines. They are usually less than 1 cm in diameter, well-defined, unilocular lucent lesions in the periapical region associated with a carious tooth (Fig. 2). The term residual cyst is used for a radicular cyst that has been left behind or that develops after extraction of a tooth.

**Dentigerous cyst**
Most dentigerous cysts manifest in adolescents and young adults, and often occur in the region of maxillary or mandibular third molar. On radiographs, it is seen as a well-defined, expansile, unilocular lucent lesion, associated with an unerupted teeth. An important diagnostic point is that the cyst attaches to cemento-enamel junction of the involved tooth with the crown projecting inside cystic cavity (Fig. 3). No associated periosteal reaction or soft tissue is seen.

**Odontogenic keratocyst**
The most common location of odontogenic keratocyst is the posterior mandibular body and ramus. Multiple
lesions are associated with basal cell nevus syndrome (Gorlin-Goltz syndrome). Radiographically, it presents as a well-circumscribed, unilocular or multilocular lucent lesion with well-corticated borders (Fig. 4). However, it can mimic a primodial cyst if associated with absence of a tooth, a dentigerous cyst if it occurs pericoronally, or an ameloblastoma.\(^4\) An important feature of the odontogenic keratocyst is its tendency to grow in a predominantly anteroposterior direction while causing minimal cortical expansion.

**Simple bone cyst**

Simple bone cyst is also known as traumatic or haemorrhagic bone cyst. The exact aetiology is unknown. However, it is believed to be secondary to localised trauma, leading to intramedullary haemorrhage and subsequent resorption of bone.\(^{1,2}\) On radiographs, it presents as a well-defined radiolucent lesion, mostly in the posterior mandible. Characteristic imaging findings are extension between roots of adjacent teeth, preservation of lamina dura and internal cortical scalloping.

**ODONTOGENIC TUMOURS**

**Odontoma**

Odontomas are considered to be a hamartomatous lesion rather than a neoplasm.\(^3\) Most cases are diagnosed in the second decade of life, and are usually associated with an impacted tooth. Radiologically, it is seen as a radiopaque mass surrounded by thin radiolucent space. The compound odontomas are composed of multiple well-formed teeth
(Fig. 5), whereas the complex odontomas appear as an irregular calcified tissue (Fig. 6). A related but very rare lesion is ameloblastic fibro-odontoma. Most cases occur in young males involving posterior jaws and may expand into the ramus (5). The amount of radiolucent internal structure exceeds the odontoma component (Fig. 7).

**Ameloblastoma**

The majority of ameloblastomas are benign, with less than 1% showing malignant behaviour (4). The most common site of ameloblastoma is the ascending ramus and proximal body of the mandible (80%). Ameloblastomas are divided into two subtypes, based on radiological appearance. Multicystic ameloblastomas account for approximately 85% of all ameloblastomas and occur in the third to seventh decades of life. On radiographs, there is marked buccolingual cortical expansion with internal osseous septae, giving rise to a “soap bubble” appearance (Fig. 8). Tooth displacement or root resorption may occur. unicystic ameloblastomas occur in a younger age group and tend to be non-invasive. They present as a well-circumscribed, unicystic, radiolucent lesion, mostly in the region of the mandibular third molar (Fig. 9).

**Odontogenic myxoma**

Odontogenic myxoma is a rare, locally-aggressive benign tumour and manifests in the second to fourth decades of life (5). Clinically and radiologically, it closely resembles
ameloblastoma. Myxomas occur more commonly in the mandible, with tooth-bearing area involved mostly. It appears as multilocular radiolucency with well-developed internal bony septae which may be lost as the lesion grows (Fig. 10). Root resorption and teeth displacement may occur.

TUMOURS AND OTHER LESIONS RELATED TO BONE
Prominent mandibular angle
A prominent mandibular angle is sometimes encountered in the oriental population and produces a characteristic square, coarse, and muscular appearance of the face. On radiographs, the mandibular angle projects posterior with lateral flaring (Fig. 11). Mandibular angle resection has described in female patients for cosmetic reasons.

Osteoma
An osteoma is a benign bone-forming tumour that almost always occurs in the skull and face. The common location in jaw includes the lingual side of the ramus or the inferior mandibular border below the molars. These lesions are usually asymptomatic and can occur at any age. Radiologically, an osteoma is seen as a well-defined, dense, radiopaque mass (Fig. 12). Multiple osteomas should raise the possibility of Gardner syndrome.

Torus
Tori are exostosis in specific locations in the jaw and are named accordingly. Torus palatinus are nodular bony protuberances arising in the middle of the hard palate. Torus mandibularis are located on the lingual aspect of the mandible and usually bilateral (Fig. 13).

Cemento-ossifying fibroma
Previously, these lesions were classified into ossifying fibroma and cementifying fibroma depending on whether bone or cementum was the predominant calcified product. However, now the two are thought to represent a spectrum of one disease. Cemento-ossifying fibroma (COF) occurs predominantly in women in the third and fourth decades of life. COF almost exclusively occurs in the facial bone, with the mandible being most commonly affected, typically inferior to molars and premolars, and superior to the inferior alveolar canal. COF is seen as a well-defined expansile lesion, often surrounded by a thick or thin radiodense rim. The internal structure is a mixture of radiolucent and radiopaque density depending on the stage of development and amount of mineralised matrix (Fig. 14). When the lesion contains a large amount of cementum-like material, it shows markedly increased...
density (Fig. 15). Large mandibular lesions demonstrate a downward bowing of inferior border. The differential diagnosis of the ossifying fibroma is primarily with fibrous dysplasia (FD). In COF, there is usually a moderately thick radiodense rim, whereas FD blends with surrounding bone. FD usually maintains the shape of the outer wall of the involved bone, whereas COF has a more convex shape, as it behaves like a tumour rather than dysplasia.

**Fibrous dysplasia**

FD is an idiopathic, nonheritable condition, in which normal bone is replaced with fibro-osseous tissue. FD mostly affects patients younger than 30 years of age, and may be a monostotic (70%) or polyostotic type (30%). Association of polyostotic FD with endocrine disorders and cutaneous hyperpigmentation is known as the McCune-Albright syndrome. It occurs more frequently in the maxilla than in the mandible. Radiographical changes range from lucent zones to diffuse areas of sclerosis, depending on amount of fibrous tissue and bony matrix. Radiographically, craniofacial FD has been classified into three types: pagetoid, sclerotic, and cyst-like. The pagetoid type is characterised by bone expansion and alternate areas of radiodensity and radiolucency. The sclerotic type appears as bone expansion with homogeneous radiodensity, giving the classic “ground-glass appearance” (Fig. 16). The cyst-like lesion appears as solitary, round or oval well-defined radiolucent lesion with sclerotic margin. In FD, the cortex remains intact and no periosteal reaction is seen.
Cherubism
Cherubism is a rare, inherited developmental abnormality developing in early childhood (2–6 years of age) and lesions tend to regress with age. It is almost always bilaterally symmetrical with an epicentre in the ramus of the mandible or tuberosity of maxilla. Lesions are usually well-defined, expansile, with fine trabeculae forming a multilocular pattern (Fig. 17).

Periapical cemento-osseous dysplasia
It occurs around the root apices of vital tooth in middle-aged women with a predilection for mandibular incisors. In the early stage, it appears as a well-defined radiolucent lesion which gradually becomes totally radiopaque with a thin lucent rim. Florid cemento-osseous dysplasia is a diffuse form characterised by multiple periapical lesions involving one entire jaw.

Osteogenic sarcoma
Osteogenic sarcoma is an osteoid-producing highly malignant tumour of the bone. Primary osteogenic sarcoma of the jaw is quite uncommon, with peak incidence between 30 and 39 years of age. Lesions can occur anywhere in jaw but the posterior part of the mandible is most commonly affected. Osteogenic sarcoma can cause lytic bone destruction with indefinite margins (osteolytic type), areas of sclerosis (osteoblastic type), or a mixed pattern. The osteoblastic type is the most common in the jaw and may show a sunburst type of periosteal reaction caused by radiating mineralised spicules (Figs. 18 & 19).
In early stage, findings may be a very subtle widening of the periodontal ligament or a localised radiolucency around one or more teeth.

**Direct neoplastic extension from adjacent soft tissue**

Advance carcinomas arising in the oral cavity and maxillary sinus frequently invade the mandible and maxilla. The osseous involvement manifests early at the alveolar ridge with a saucer-shaped erosive defect (Fig. 20). The radiographical appearances may include an irregular cavity of variable size, multiple lytic foci which may coalesce to form a large irregular lesion, and moth-eaten appearance. There is usually no evidence of bony sclerosis or periosteal reaction. Similarly, other malignant soft tissue lesions can also invade jaw and cause destruction.

**Metastatic jaw tumours**

Metastases to the mandible are four times more common than to the maxilla, and the most common primary tumour sites are the breast, lung, kidney, thyroid and prostate. In most instances, the lesions are radiolucent with ill-defined margins; however, mixed osteolytic and osteoblastic, or diffuse osteoblastic metastasis, may be seen.

**Multiple myeloma**

Multiple myeloma is a malignant neoplasm of plasma cells, with peak incidence in the sixth decade of life. In the jaw, the mandible is more commonly affected. Multiple myeloma is characterised by multiple punched-out, oval or rounded radiolucent lesions without any surrounding bone reaction. A localised form of this disorder is known as solitary plasmacytoma of bone (SPB), which is potentially
capable of progressing into generalised myelomatosis. Three main radiographical presentations of SPB of jaw are multilocular soap bubble lesions, unilocular radiolucency with a cystic appearance, and ill-defined destructive bone resorption (Fig. 21).

Eosinophilic granuloma
Eosinophilic granuloma is a benign form of Langerhans’ cell histiocytosis, and usually occurs in children and young adults. Radiologically, these lesions are totally radiolucent and the margins may be smooth or somewhat irregular. Based on the location, jaw lesions are divided into the alveolar and intraosseous types. The alveolar type of lesions are commonly multiple and involve the alveolar process, whereas intraosseous lesions occur elsewhere in jaw. Alveolar type commonly starts in mid-root region of tooth and with progression, a scooped-out appearance of alveolar process is seen (Fig. 22). The bone around the teeth, including lamina is destroyed; as a result, the “floating teeth appearance” may be seen. Intraosseous type lesions are usually solitary with mandibular ramus most commonly involved. Intraosseous lesion may be irregular, oval or round and may stimulate periosteal bone formation.

Central giant cell granulomas
Central giant cell granulomas (CGCG) typically occur in patients younger than 30 years of age, more often in females. The lesion is more common in the anterior part of mandible with a tendency to cross the midline. In the early stage, the lesion manifests as a small unilocular lucent lesion. However, with development, it appears multilocular with fine trabeculae. They may cause a variable degree of bony expansion, divergence of roots and root resorption (Fig. 23). Brown tumour of hyperparathyroidism can mimic CGCGs radiologically as well as pathologically; however, the patient’s age, radiological changes in other bones, and biochemical findings help in differentiation.

Arteriovenous malformations
Arteriovenous malformation (AVM) is an abnormal communication between an artery and vein. Recognition of an AVM is important because extraction of an associated tooth may lead to fatal haemorrhage. Radiographically, it appears as a multilocular cystic lesion, and angiography is usually necessary to demonstrate the vascular nature of the lesion (Fig. 24).
INFLAMMATORY LESIONS

Periapical sclerosing osteitis
Sclerosing osteitis occurs as a response of bone around the apex of a tooth secondary to periodontal disease.\(^1\) It is characterised by sclerosis in the periapical region of the involved tooth (Fig. 25).

Acute osteomyelitis
In the jaw, osteomyelitis is more common in the mandible, mostly secondary to a tooth abscess or post-surgical infection. Radiographical findings usually appear 1–2 weeks later and include ill-definition of trabeculae, single or multiple ill-defined radiolucent areas, and loss of lamina dura between the tooth and adjacent lesion.\(^2\) Later in the disease course, there may be sclerosis, sequestrum formation and periosteal reaction.

Chronic osteomyelitis
Chronic osteomyelitis results from either an inadequately-treated acute infection or a long-term low-grade infection.\(^4,14\) Three forms of chronic osteomyelitis have been described in the jaw, viz., (1) chronic sclerosing osteomyelitis presents as mixed sclerotic and lytic zones or have a predominantly sclerotic component; (2) chronic suppurative osteomyelitis is characterised by areas of bone destruction, sequestrum formation and periosteal reaction (Fig. 26); and (3) Gärre’s osteomyelitis occurs in children and adolescents, and are radiographically

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Fig. 22 Eosinophilic granuloma. (a) Panoramic radiograph shows destruction of the alveolar process with loss of bone and lamina dura around remaining mandibular teeth (arrow). (b) Radiograph shows the characteristic lytic lesions with beveled edges in the calvarium (arrow).

Fig. 23 Central giant cell granuloma. (a) Panoramic radiograph shows a unilocular radiolucent lesion anterior part of mandible causing divergence of roots of adjacent teeth (arrow). (b) Radiograph of a different patient shows a large midline destructive lesion causing displacement of teeth and root resorption.
Arteriovenous malformation.

Fig. 24 (a) Lateral oblique radiograph of the mandible shows multilocular cystic lesion with poorly-defined margins (arrow). (b) External carotid angiogram (different patient) shows an abnormal bunch of vessels supplied by the lingual artery.

Periapical sclerosing osteitis. Marked sclerosis seen around the apex of a carious third molar (arrow).

Fig. 25

Chronic suppurative osteomyelitis. Lateral oblique radiograph shows scattered areas of bone destruction and sclerosis with sequestrum formation.

Fig. 26

SYSTEMIC DISEASES MANIFESTED IN THE JAWS

Brown tumours

Brown tumours are reactive bony lesions caused by long standing primary or secondary hyperparathyroidism and do not have neoplastic potential. There may be multiple lesions in a single bone. These lesions have variable well-defined or ill-defined margins, and may produce cortical expansion (Fig. 27). Associated changes, such as decreased density of jaw, granular texture of bony trabeculae, and loss of lamina dura along with biochemical parameters, help in correct diagnosis.

Osteopetrosis

Osteopetrosis is characterised by a generalised increase in bone mass due to abnormal osteoclast function. These dense bones are more susceptible to osteomyelitis due to poor vascularity (Fig. 28). A diffuse osteosclerosis may also be seen in other sclerosing bony dysplasias, fluorosis and renal osteodystrophy.

SUMMARY

The radiological diagnosis of various jaw lesions is based on the patient’s history, the location of lesion, its internal architecture, and characteristic radiographical alteration...
of adjacent structures. It is not always possible to pinpoint a single diagnosis. However, by careful evaluation of the jaw lesion, the list of differentials can be further narrowed.

REFERENCES

**SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME**  
Multiple Choice Questions (Code SMJ 200802B)

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<th>Question</th>
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<tr>
<td><strong>Question 1.</strong> What differentials will you consider in a well-circumscribed radiolucent lesion of the jaw?</td>
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<td>(a) Dentigerous cyst.</td>
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<td>(b) Metastasis.</td>
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<td>(c) Ameloblastoma.</td>
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<td>(d) Acute osteomyelitis.</td>
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<th>Question 2. Regarding odontogenic keratocyst:</th>
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<td>(a) It can mimic a primodial cyst, a dentigerous cyst or an ameloblastoma.</td>
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<td>(b) The most common location is the posterior mandibular body and ramus.</td>
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<td>(c) Multiple lesions are associated with the Gorlin-Goltz syndrome.</td>
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<td>(d) It causes marked cortical expansion.</td>
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<th>Question 3. Regarding systemic diseases affecting the jaw:</th>
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<td>(a) Brown tumours are caused by long-standing hyperparathyroidism.</td>
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<td>(b) Brown tumours have neoplastic potential.</td>
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<td>(c) In hyperparathyroidism after appropriate therapy, all radiographical changes tend to return to normal.</td>
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<td>(d) Osteopetrosis predisposes bones to osteomyelitis.</td>
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<th>Question 4. What differential diagnosis will be considered in multiple lytic lesions involving the jaw?</th>
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<td>(a) Multiple myeloma.</td>
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<td>(b) Langerhans cell histiocytosis.</td>
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<td>(c) Ameloblastoma.</td>
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<td>(d) Metastasis.</td>
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<th>Question 5. Regarding odontomas:</th>
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<td>(a) These are hamartomatous lesions.</td>
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<td>(b) Complex odontomas are composed of multiple well-formed teeth.</td>
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<td>(c) Odontomas do not tend to recur after surgical resection.</td>
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<td>(d) Odontoma is premalignant lesion.</td>
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**Doctor’s particulars:**

Name in full: __________________________________________
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(1) Log on at the SMJ website: www.sma.org.sg/cme/smj and select the appropriate set of questions. (2) Select your answers and provide your name, email address and MCR number. Click on “Submit answers” to submit.

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