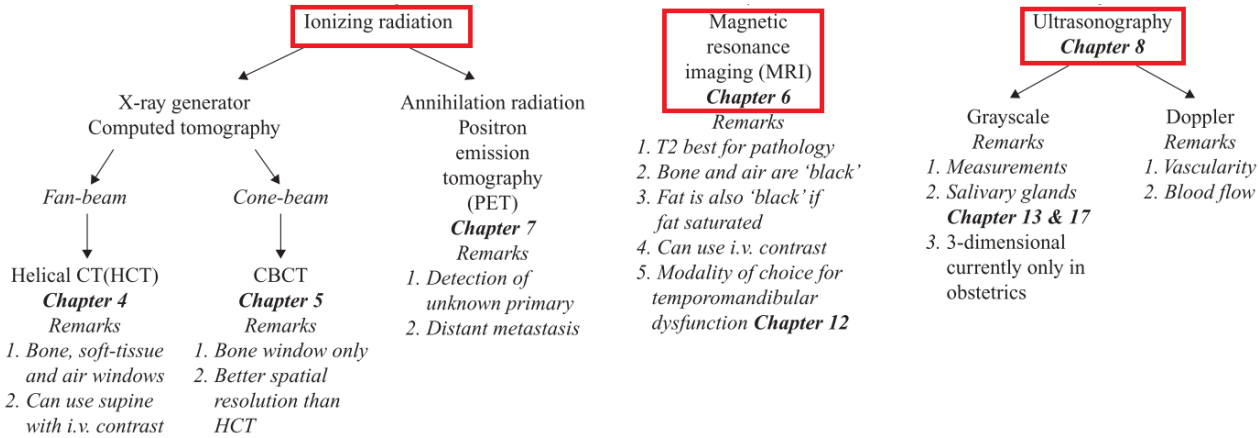
Introduction

- **What is conventional imaging? List its pros/cons**
  - Panoramic radiographs, intra-oral radiographs, lateral cephalometrics
  - Advantages: superior spatial resolution, low cost, easy access (readily available)
  - Disadvantages: 2D image of a 3D structure – vulnerable to superimpositions
  - Intraoral radiographs have the best spatial resolution whereas panoramics have moderate resolution, but allow us to see the whole jaw. Panoramics also have distortion in the horizontal plane
- **What is advanced imaging? List its pros/cons**



  - Advantages: primary diagnosis of maxillary antrum, facial fractures, lesions in base of skull, soft tissue lesions of head and neck. More accurate measurement, and allows more refinement of the differential diagnosis
  - Disadvantages: poor spatial resolution
- **Which advanced imaging modalities most likely to contribute to the lesions of the face and jaws?**
  - Cone beam CT, helical CT, magnetic resonance imaging
  - CBCT is excellent technology in assisting with diagnosis
- **Why should you image prior to biopsy and other surgery?**
  - Less invasive, interpreted sooner
  - May not need a biopsy if diagnosis can be made on imaging
  - Biopsy may disrupt the tissues, nullifying possible diagnoses with imaging techniques in the future
    - Do not rush into a biopsy until imaging is completed
  - Example: overzealous biopsies in patients with fibrous dysplasia disrupted the tissues. Many years later, imaging was done due to suspicion of reactivation and many artifacts were found, and even invasion of the pathology into the soft tissues
- **What lesson does the BC case, Holsten (patient) and Card (dentist), teach us?**
  - Bitewing of the 3rd molar was taken, but the whole area was not captured adequately
  - 3rd molar extraction was performed without realizing proximity to the IAN
  - Patient got persistent mental paresthesia
  - Informed consent and adequate radiographs are essential
- **What kind of lesion/s is a poorly defined margin directing you towards?**
  - Infection or a malignant lesion
- **What kind of lesion is suggested by a multilocular presentation?**
  - Ameloblastoma, odontogenic keratocyst, odontogenic myxoma
  - Look for the 3 key multilocular patterns: soap bubble, honey comb, or tennis racket
- **What kind of lesions are suggested by root resorption?**
  - All lesions with radiolucencies eventually cause root resorption
  - Especially prevalent with odontogenic neoplasms
- **How can you best determine the size of a lesion on a panoramic radiograph?**
  - Metric, imperial, or dental units (1 tooth = 1 unit, 1 lower incisor = ½ unit)

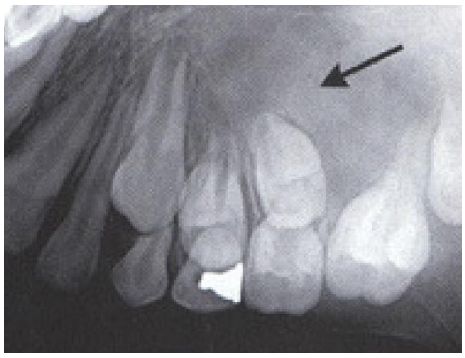
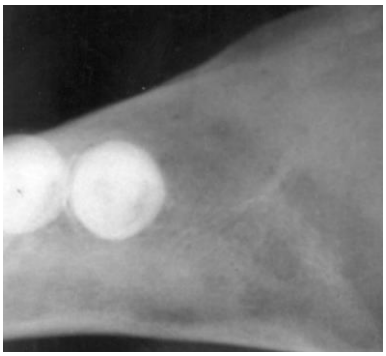
- What are the 5Ss? Where does the 3Ds fit in?

Shade	-Radiolucent**:** absence of mineralized tissue, usually bone -Radiopaque**:** excess mineralized tissue, usually abnormal bone -Mixed**:** white areas within black areas, usually deposition of mineralized tissue in an area where normal bone was previously removed **Types of radiopacities** -Anatomical: normal denser bone like the inferior alveolar canal, or hyoid bone -Artifactual: ghost image or superimposition of another structure (vertebral column), shaking of the machine, underexposure -Pathological: bone cell deposited (neoplasia/dysplasia) or non bone cell deposited (dystrophic) -Iatrogenic: overfilled RCT's, implants -Idiopathic
Shape	-Spherical: cysts, benign neoplasms limited by cyst linings, capsules. Spread is even in all directions, unless limited by an anatomic structure -Unilocular: lesion is 1 space, although the borders may be scalloped -Multilocular: partitions divide the lesion into rooms, but don't confuse a multilocular lesion with a unilocular scalloped lesion. Described as honeycomb, soap bubble, or tennis racket pattern. Generally associated with more severe pathologies and may require resection of the lesion -Fusiform: spindle shaped -Irregular: unrestrained spread of lesion, likely an infection or malignant neoplasm
Site	-Single: local cause -Multiple: medical/systemic cause -Jaw: max/mand, anterior/posterior -Relationship to inferior alveolar canal: above (odontogenic lesion), within (neurogenic lesion), or below (non-odontogenic lesion) -Relationship to hard palate: above (non-odontgenic lesion), below (odontogenic lesion) -Relationship to tooth: if odontogenic, is it related to an unerupted crown or an erupted root? -Relationship apex of an erupted tooth: is it separated from the apex by PDL space (black line)? -Yes: lesion arising adjacent to apex (usually a fibroosseus lesion) -No: arising from cementum; hypercementosis of cemental lesion
Size	-mm, cm -In relation to size of another anatomic structure
Surroundings	-Transition between normal tissue and lesion tissue -<1mm: lesion is considered "well defined" ->1mm: lesion is considered "poorly defined" and indicative of an infection or malignancy -There are 3 further types of well defined peripheries -Punched out: normal tissue right up to the lesion -Cortex: shell of radiopaque margin surrounding the lesion -Sclerosis: zone of radiopacity around the lesion that gradually fades to normal bone -Mach Effect -Involuntary phenomenon due to lateral inhibition in the retina "you are seeing things" -Enhances contrast at edges between two densities -Diagnostic danger
Diameter	-Best seen in hollow structures like the inferior alveolar canal and mental foramen -If the diameter of this structure is increased, then the lesion is within it -If the diameter is reduced, then the lesion is outside it
Density	-Changes can be seen in teeth, cortices, and hollow structures
Displacement	-Teeth, cortices, hollow structures, lower border of the mandible, antral floor

Developmental disease

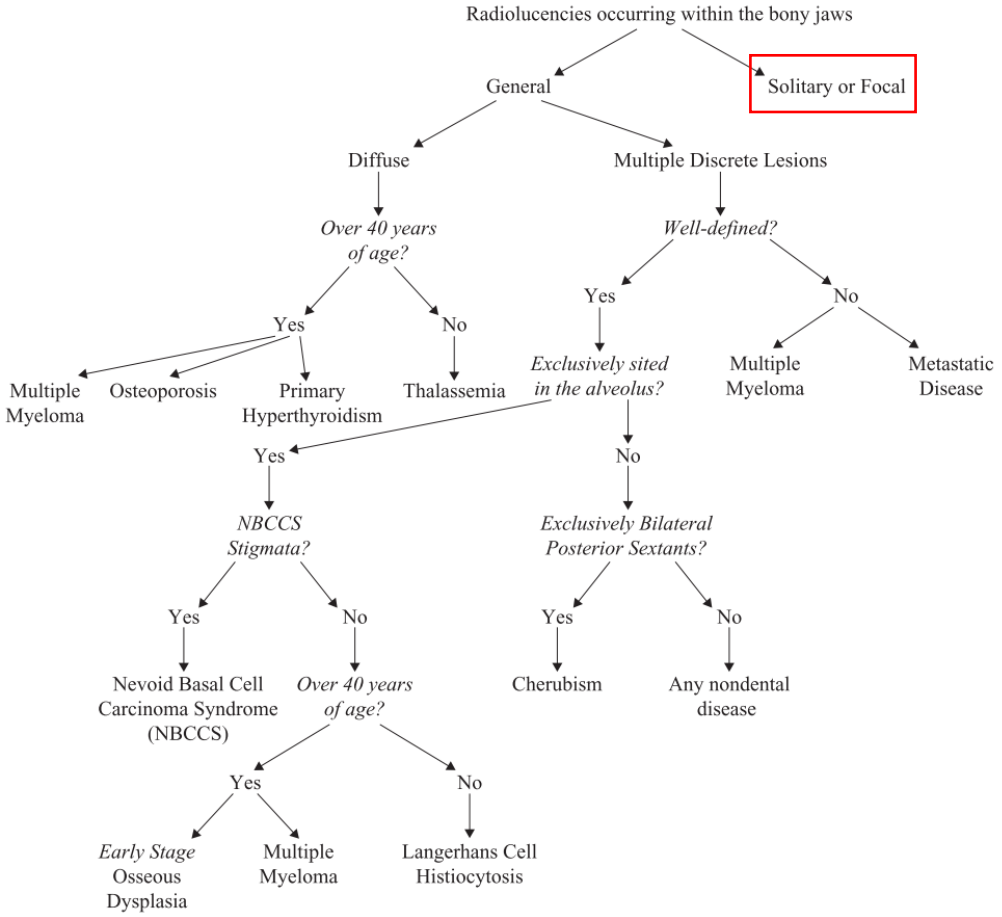
- **Why is radiology not as important as a thorough clinical examination for most developmental lesions?**
  - Age, gender, ethnic origin, chief complaint, and medical history should also be considered
- **What information can radiology provide, which is NOT obtainable by clinical examination alone?**
  - Early diagnosis of lesions, and distinguishing them between a malignant and benign lesion
  - Confirmation of diagnoses
  - Prompt diagnosis of locally invasive benign neoplasms so that the most appropriate treatment can be given, and to minimize its recurrence
  - Prompt diagnosis of hemangiomas so that the most appropriate treatment can be given, to avoid potential fatal exsanguination
- **How would you evaluate a panoramic radiograph which your CDA has just taken which displays a large jaw on one side?**
  - Observe the patient – is their face symmetrical?
  - If it is, then the panoramic was taken with operator error (head was turned)
- **What would you suspect if the jaw was not only enlarged on one side, but also the teeth?**
  - Hemangioma, neurofibroma. Fibrous dysplasia would affect only jaws, not teeth
- **What is a haemangioma and how does it differ from a vascular malformation? (Chapter 9)**
  - Hemangioma
    - Proliferates for the first year after birth, then 80% of them regress completely within 7 years of age
    - Benign tumor formed by a collection of excess blood vessels
    - May present as a "port wine stain" on the skin, which may blanch under pressure
    - Only treated if the baby has low platelets, or if it presents in the liver (causes massive shunt of blood)
  - Vascular malformation
    - Is present at birth, never proliferates, and never involutes
    - We are more likely to encounter vascular malformations
    - Higher risk: may cause bleeding or clots to spread throughout the body
- **What is fibrous dysplasia?**

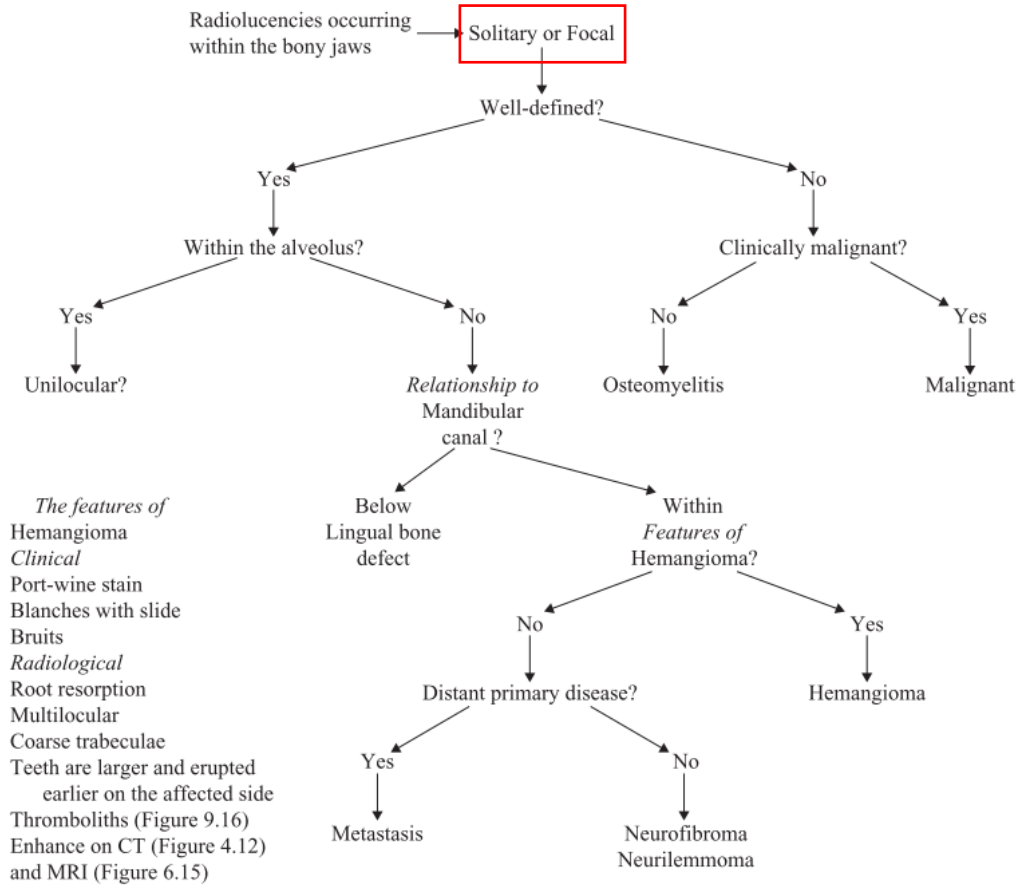
Epidemiology	-Majority presents over 20 years old, with the mean being 24 years old -Patients are first aware of their disease 5.2 years before first presentation/diagnosis (19 years old)
Types	-**Monostotic FD**: 1 bone affected, represents 80~85% of cases. Commonly seen in mandible. More difficult to diagnose as many cases are asymptomatic -**Craniofacial FD**: multiple adjacent craniofacial bones affected -**Polyostotic FD**: 1+ bones affected -**Jaffe Lichtenstein syndrome**: polyostotic fibrous dysplasia + café au lait macules -**McCune Albright syndrome**: polyostotic fibrous dysplasia + café au lait macules + endocrinopathy -Endocrinopathies: sexual precocity, pituitary adenoma, hyperthyroidism
Presentation	-Usually monostotic and unilateral -Monostotis FD rarely affects the eye, but could cause blindness if it narrows the optic canal -Presents with swelling and pain in the affected bone, and even severe deformation -**Pathological fracture:** fracture caused by weakening of the bone. Rare in jaws
Radiography (see next page)	-Asymmetric, homogenous, ill defined radiopacities that blend into normal bone -Lesion descriptors: ground glass appearance, peau d'orange, fingerprint, cotton wool -Thin corticies and bone expansion -Best seen on CT scans on bone
Pathogenesis	-Genetic disorder that causes $G_s\alpha$ (a signaling molecule) to be expressed constitutively -Osteoblasts mature sporadically, stromal cell differentiation is favoured -Leads to medullary bone being replaced with fibrous tissue instead -Fibrous tissue expands the bone and deforms it **Is fibrous dysplasia a hamartoma or neoplasm?** -Hamartoma: benign, localized malformation. Appears neoplastic (genetic aberrations and disorganized structuring), but grows at the same rate as its surroundings -Neoplasm: cells with genetic aberrations have no organization and grow uncontrollably -FD is neither, because it can be activated/reactivated in adult life by factors like pregnancy
Treatment	-Surgery can be done, but only performed if there is a threat to vision or appalling esthetics -Steroids can be given immediately to safeguard vision, followed by surgery -Do not irradiate as it can cause sarcomatous changes

Radiolucencies

- **What is a radiolucency?**
  - Greater transparency to X rays, appearing darker on radiographs
  - Generally associated with a lack of bone due to disease
- **In which areas of the jaws on dental images, will you see a radiolucency?**
  - Maxilla: maxillary suture, sinus, incisive foramen, nasolacrimal canal
  - Mandible: mandibular canal, mental foramen
  - Both: PDL space, trabeculae of cancellous bone, nutrient canal
- **On what imaging modalities currently used in dental practice do you expect radiolucencies to be present?**
  - Conventional radiograph, panoramic radiograph, CBCT
- **When you encounter a radiolucency what features will you consider first?**
  - See flowchart on next page
  - Localized or multiple lesions
  - Clinical presentations and medical history
  - Start with the most common diagnoses then narrow it down
- **What does multiple radiolucencies suggest to you?**
  - Systemic cause
  - Most commonly cherubism and KCOTs
- **What features are more likely to distinguish a malignant lesion from a benign one?**
  - Benign: well defined and encapsulated. May displace structures, but will not erode them
  - Malignant: poorly defined margins, root resorption, “floating tooth” on radiolucencies
- **Gorlin Goltz syndrome (Nevoid basal cell carcinoma syndrome)**
  - Symptoms
    - Multiple OKC’s are an early manifestation (A single keratocyst in a young child)
    - Multiple basal cell carcinomas on the skin, calcified falx cerebri, abnormal Ca and PO_4 metabolism
    - CNS: ophthalmic dysfunction, 5~10% develop a brain malignancy (medulloblastoma)
    - Carcinomas can recur, but not likely
  - Multidisciplinary treatment with dermatology, opthalmology
  - Dentist can be the first to spot the syndrome


Radiolucencies occurring within the bony jaws
General
Solitary or Focal
Diffuse
Multiple Discrete Lesions
Over 40 years of age?
Well-defined?
Yes
No
Yes
No
Multiple Myeloma
Osteoporosis
Primary Hyperthyroidism
Thalassemia
Exclusively sited in the alveolus?
Multiple Myeloma
Metastatic Disease
Yes
No
NBCCS Stigmata?
Exclusively Bilateral Posterior Sextants?
Yes
No
Yes
No
Nevoid Basal Cell Carcinoma Syndrome (NBCCS)
Over 40 years of age?
Cherubism
Any nondental disease
Yes
No
Early Stage Osseous Dysplasia
Multiple Myeloma
Langerhans Cell Histiocytosis


Radiolucencies occurring within the bony jaws
Solitary or Focal
Well-defined?
Yes
No
Within the alveolus?
Clinically malignant?
Yes
No
No
Yes
Unilocular?
Relationship to Mandibular canal ?
Osteomyelitis
Malignant
Below Lingual bone defect
Within
Features of Hemangioma?
No
Yes
Distant primary disease?
Hemangioma
Yes
No
Metastasis
Neurofibroma Neurilemmoma
The features of Hemangioma
Clinical
Port-wine stain
Blanches with slide
Bruits
Radiological
Root resorption
Multilocular
Coarse trabeculae
Teeth are larger and erupted earlier on the affected side
Thromboliths (Figure 9.16)
Enhance on CT (Figure 4.12) and MRI (Figure 6.15)

- **Radiolucent lesions**

Lesion	Differential	About	Presentation	Pathogenesis	Treatment
Periapical radiolucency (inflammatory origin)	-Early intraosseous SCC (ruled out if tooth is non-vital) -Ameloblastoma -Giant cell lesion -Odontogenic keratocyst	-Types: granuloma, radicular cyst, abscess -Similar radiographically, different histologically -Radicular cysts are the most common -Radicular cysts mostly affect men 30~40 in the maxillary anteriors	-Non vital tooth -Initial thickening of PDL with tenderness on percussion -Grows into a ill defined, localized, unilocular lesion -May be better defined in long standing lesions -Centered on tooth ->1.5cm is likely a radicular cyst	-Infection of pulp → spreads out the apex -Bone cells protect body by degrading bone around the apex -Radicular cysts are formed from epithelial residues on PDL in response to inflammation	-Endodontics or extraction of the tooth -Should resolve within a year of endodontic therapy
Dentigerous cyst	-Normal follicle -Ameloblastoma -OKC -Unicystic ameloblastoma -Eruption cyst	-Cyst surrounding an unerupted tooth -Mand 8 > max 3 > max 8 > mand 5 -Asymptomatic when small, painless expansion of bone when large	-Unilocular radiolucency w. borders attaching at CEJ -No root resorption of adjacent teeth, but could displace them -Asymptomatic, but possible pain and swelling **3 types** Central, classic: -Cyst attaches to M+D CEJ's; -Tooth may displace apically as cyst expands Lateral: -Cyst attaches to side of crown, leading to mesial/vertical impaction; -Attached to CEJ on one side, coronal to CEJ on other side Circum-ferential: -Tooth can no longer be displaced apically, but cyst continues to grow; -Cyst expands beyond CEJ, separates from root by a bony sleeve	-Originates at cemento-enamel junction -Accumulation of fluid between the reduced enamel epithelium and the crown, or between layers of reduced enamel epithelium	**If tooth cannot erupt** -Enucleate + extract **If tooth can erupt** -Partial removal of cyst and watchful waiting -Ortho Tx possible **Very large cyst** -Marsupialize to shrink it, then remove when smaller
Ameloblastoma	-Odondogenic myxoma -OKC -Residual cyst -Cemento-osseous dysplasia	-Most common odontogenic tumor -High rate of recurrence -91% present in the posterior mandible -Solid type = polycystic + desmoplastic	-Slow growing, could progress to facial deformity -Swelling (70%), pain, paresthesia, numbness, discharge, fistula, ulceration -Well defined radiolucency -Bucco-lingual bony expansion (pathognomic) -Tooth displacement, root resorption	-Locally invasive epithelial odontogenic tumor **Possible sources:** -Reduced enamel epithelium of the follicle -Epithelium of an odontogenic cyst -Epithelial rests -Basal cell of overlying alveolar mucosa -Virtually no tendency to metastasize -Could metastasize to lungs	**Solid** -Resect with 1cm margins **Unicystic** -Conservative tx with enucleation and cytotoxic solution (Carnoy's solution) -Recurrence drops from 30% to 10% with Carnoy's -If in posterior maxilla, then resection is preferred
		Common (polycystic): 80%; -More common in East Asians and sub-Saharan Africans in their mid-30's	-Multilocular with a soap bubble appearance		
		Unicystic: 20%; -More common in East Asians and sub-Saharan Africans in their mid-30's	-May appear unilocular -Majority are connected to a tooth, mimicking a dentigerous cyst **3 subtypes:** -Luminal: ameloblastic cyst epithelium lining (↓ recur) -Intra-luminal: ameloblastic mass protrudes into lumen -Mural (95%): ameloblastic mass invades into adjacent fibrous tissue walls		
		Desmoplastic: -More common in North Americans and Europeans in mid-40's	-Poorly defined radiolucent/opaque -Common in maxilla* -Low recurrence		
		Peripheral (extraosseous): -Rare			

<table>
<tr><th>Lesion</th><th>Differential</th><th>About</th><th>Presentation</th><th>Pathogenesis</th><th>Treatment</th></tr>
<tr><td>Odontogenic keratocyst (para-keratinized)

Note: ortho-keratinized odontogenic keratocysts differ in that they: have less recurrence, and have massive B-L expansion</td><td>-Dentigerous cyst
-Ameloblastoma
-Odontogenic myxoma</td><td>-Mostly affects females ~10 and males 10~40
-70~80% presents in mandible (mostly posterior body and ramus)
-Could be identical to dentigerous cysts radiographically and surgically
-Recurrence of 25%
-If multiple OKC's are seen, could be associated with a systemic condition called Nevoid Basal Cell Carcinoma Syndrome (Gorlin Goltz syndrome)</td><td>-Swelling, pain
-Grows in cancellous bone, and spreads aggressively
-Maxilla: usually a small, round radiolucency with defined radiopaque margins
-Mandible: unilocular +/- scalloped margins are most common, but could also be multilocular
-Lined by para-keratinized stratified squamous epithelium
-Minimal bucco-lingual expansion, compared to ameloblastoma
-Corticated borders around radiolucency</td><td>-Locally invasive epithelial odontogenic tumor
-Arises from rests of the dental lamina (rests of Malassez)
-Cystic degeneration
-Locally invasive but does not metastasize</td><td>-Marsupialization: open cyst and let cyst shrink over time
-Decompression: let it drain over 3~6 months
-Then, remove cyst (peripheral ostectomy) + chemical curettage with Carnoy's solution</td></tr>
<tr><td>Odontogenic myxoma</td><td>-OKC
-Ameloblastoma</td><td>-An intraosseous neoplasm
-When ↑↑ collagen is present, it is called a myxofibroma
-Affects females in mid 30's
-55% in posterior mandible
-Have to use MRI to distinguish from ameloblastoma</td><td>-Swelling, pain, numbness, displaced teeth
-Like ameloblastoma, could have buccolingual expansion and root resorption (but to a lesser extent)
-Unilocular or multilocular radiolucency with poorly defined margins with a tennis racket pattern
-Fusiform expansion, like fibrous dysplasia</td><td>-Stellate and spindle-shaped cells embedded in an abundant myxoid or mucoid ECM
-Locally invasive, but histologically benign</td><td>-Needs to be surgically removed completely or else it grows back</td></tr>
<tr><td>Cherubism</td><td></td><td>-Almost always diagnosed before 5
-Jaw expands starting at age 7~10, reaches a maximum buccal expansion at 12, and completely involutes by 30</td><td><table><tr><th>Type 1</th><th>Type 2</th><th>Type 3</th></tr><tr><td>-Bilateral rami and 3rd molar regions</td><td>-At least anterior to mental foramen
-May include posterior maxilla</td><td>-Entire mandible and maxilla
-Will not cross maxillary sutures
-May have open bite</td></tr></table>-Multilocular radiolucencies with a sketched outline
-Radiolucencies are filled with normal bone</td><td>-Autosomal dominant disease
-Symmetrical distention of the jaws
-Histologically indistinguishable from a central giant cell lesion</td><td>-Conservative management until functional or emotional disturbances demand surgical intervention
-Maybe chemo tx
-Avoid radiotherapy</td></tr>
<tr><td>Simple bone cyst (traumatic bone cyst)</td><td>-Aneurysmal bone cyst
-Lateral cyst
-Unicystic ameloblastoma
-OKC</td><td>-Pseudocyst
-94% present in the mandible
-If seen in middle aged East Asian females, suspect osseous dysplasia
-25% recurrence in 2.5 years</td><td>-Cyst has no epithelial lining, only a thin loose CT lining
-Can be empty or filled with blood
-Associated teeth remain vital
-Unilocular radiolucency with barely any B-L expansion and well corticated borders
-Scalloping between roots
-No root resorption
-Usually asymptomatic</td><td>-Could happen to children secondary to ortho treatment
-Associated with trauma</td><td>-Self limiting, will heal in 1~1.5 years</td></tr>
<tr><td>Nasopalatine duct cyst</td><td></td><td>-Most common non-odontogenic cyst
-Most common in males in their 40s</td><td>-Palatal and buccal swelling
-Radiolucency >5mm wide, >10mm long btwn 11+21
-Occasional root resorption
-May be heart shaped if it overlaps with anterior nasal spine</td><td>-From epithelial residues in nasopalatine canal</td><td>-Enucleation</td></tr>
<tr><td>Lingual bone defect (Stafne's bone cyst)</td><td>-Residual cyst</td><td>-Not a true cyst
-Concavity in the lingual face of the posterior mandible
-Most common in males in their 40s
-Increased risk of mand fracture</td><td>-Well defined ovoid radiolucency between the mandibular canal and lower border of the mandible
-Dense borders, thicker on superior aspect<table><tr><td>Lingual posterior</td><td>-Due to SM salivary gland
-Most common</td></tr><tr><td>Lingual anterior</td><td>-Due to SL salivary gland
-May mimic PARL, borders less well defined</td></tr><tr><td>Buccal ramus</td><td rowspan="2">-Due to parotid gland
-Below neck of condyle</td></tr><tr><td>Lingual ramus</td></tr></table></td><td>-Ectopic, hyperplastic salivary gland tissue
-Puts pressure on adjacent bone
-Leads to resorption of bone</td><td>-None</td></tr>
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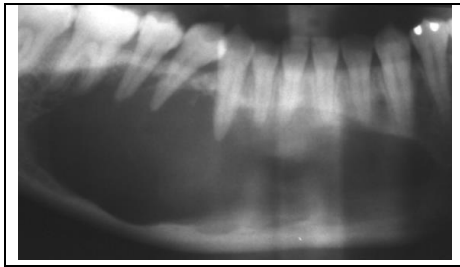
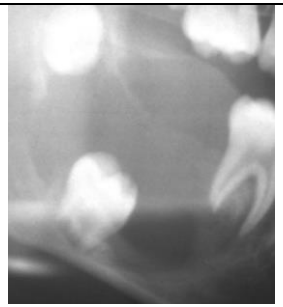
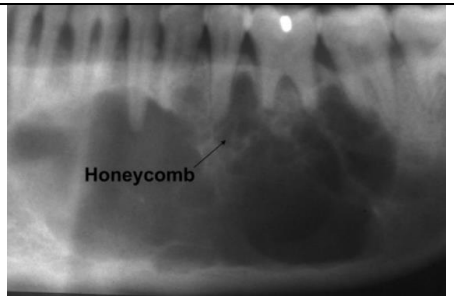
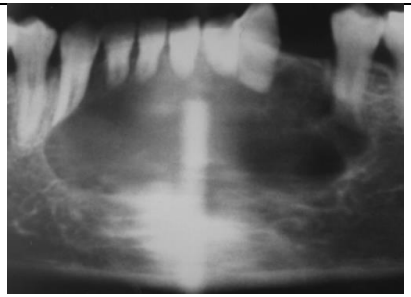
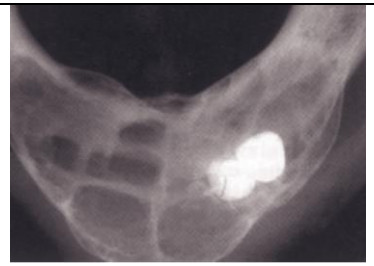
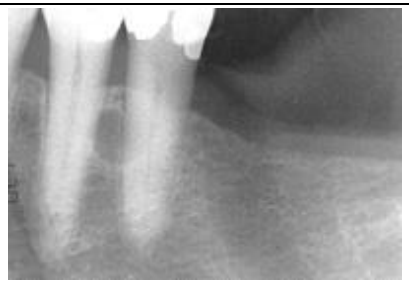
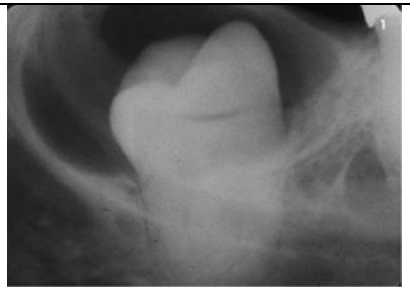
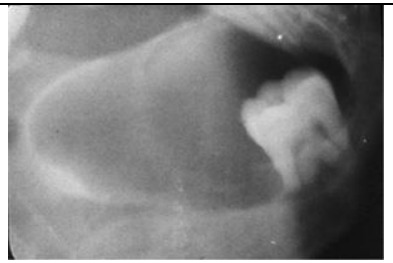
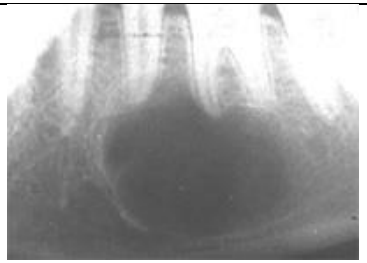
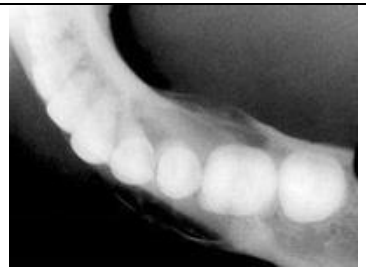
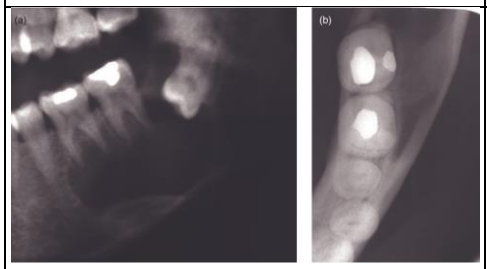
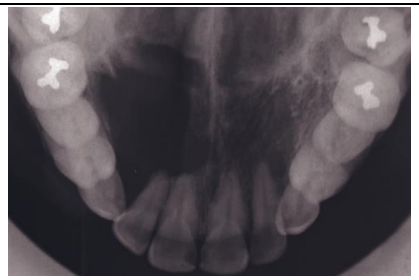
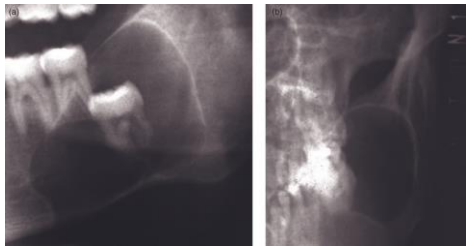
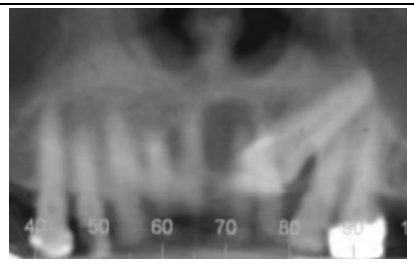
			
-Well defined unilocular RL -RR on 45 -44 possibly displaced	-44 displaced buccal -B-L expansion -RR on 44	-RR on 35 -Some extruded RCT filling material	-RR on 47, 46 -Multilocular
-Unicystic ameloblastoma	**-Unicystic ameloblastoma**	**-Ameloblastoma**	**-Unicystic ameloblastoma**

			
-RR on 37, 38 -38 displaced to border of mandible -Not attached to CEJ → not dentigerous cyst -Unilocular	-47 displaced inferiorly, 48 superiorly -Unilocular radiolucency -RR of 46 distal root (very subtle) -Lesion expansion past the alveolar ridge between 46 and 48	-Well defined borders -Soap bubble or honey comb appearance -Root resorption	-Well defined borders -Multilocular -Root resorption
-Unicystic ameloblastoma	**-Unicystic ameloblastoma**	**-Solid multilocular ameloblastoma**	**-Solid multilocular ameloblastoma**

			
-Tennis racket appearance -No capsules, radiolucencies are masses with a jello-like consistency	-Unilocular RL around apices -Thickening of PDL -Indistinct border of lesion and normal bone	-Well defined corticated unilocular RL -Round or tear shaped -Along lateral root surface	-Well defined unilocular RL on unerupted tooth -No RR -Attached to or just below CEJ
-Odontogenic myxoma	**-Periapical abscess**	**-Lateral periodontal cyst**	**-Central dentigerous cyst**

			
-Well defined unilocular RL on unerupted -Attached just below CEJ	-Associated teeth have no PDL widening or RR -RL lesion is well corticated with some scalloping between roots -Small B-L expansion		-RL with an inferiorly displaced 38 -Cyst is contacting the 37 -Small radiopacities in tonsil area
-Circumferential dentigerous cyst	**-Traumatic bone cyst**		**-Dentigerous cyst + tonsilloliths**

			
-Well defined unilocular RL linked to 38 -RR on 37 distal root -Minimal B-L expansion, more M-D	-Large unilocular RL with displacement of teeth -Appears to originate between lateral and canine, hence displacement	-Large multilocular radiolucency -2 lines at lower border of mandible = indicates massive B-L expansion -No RR	-Well defined RL on 38, unilocular, and substantial B-L expansion -No RR on 38
-Odontogenic keratocyst	**-Odontogenic keratocyst (if other teeth were non vital, could be radicular cyst)**	**-Orthokeratinized odontogenic keratocyst**	**-Orthokeratinized odontogenic keratocyst**

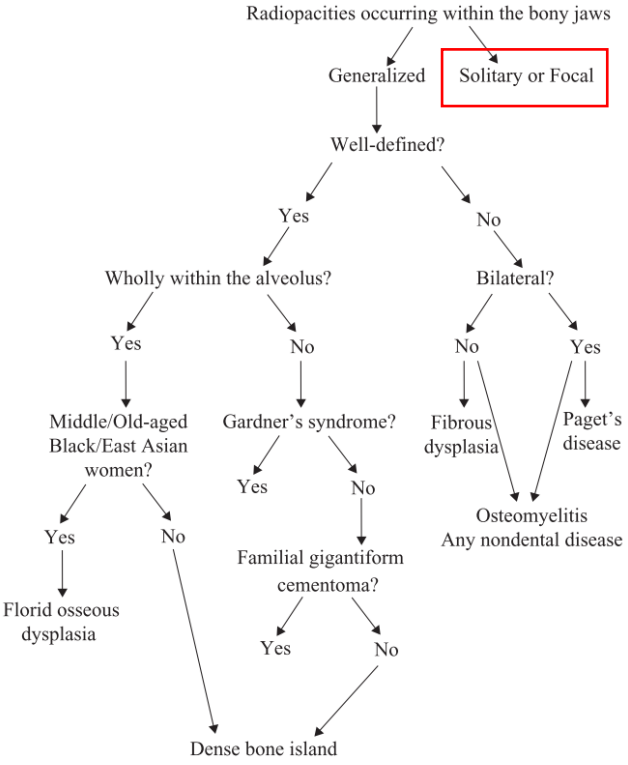
			
-CBCT of the 23 -Cyst attached to CEJ on one side, and coronal to CEJ on the other side	-Multilocular RL with scalloped, radiopaque margins -No RR or apparent B-L expansion	-Multilocular soap bubble RL -RR present	-RL around nasopalatine duct -Heart shaped, as it overlaps with anterior nasal spine
-Lateral dentigerous cyst	**-Odontogenic keratocyst**	**-Ameloblastoma**	**-Nasopalatine duct cyst**

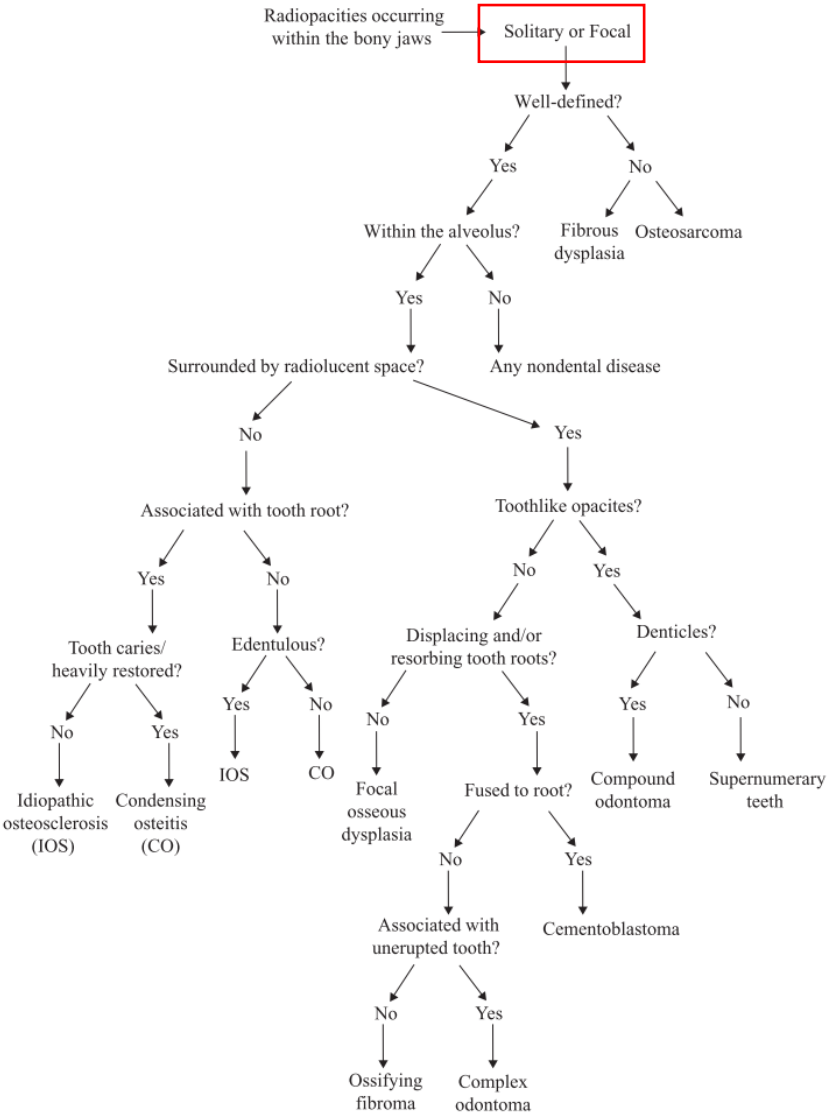
Radiopacities

- **What is a radiopacity?**
  - White area on a radiograph, indicating the presence of a denser material capable of absorbing X rays
  - Normal structures: teeth, jaw bones, stylohyoid complex, skull base, cervical vertebrae
  - Abnormal structures would only be radiopaque if they were depositing mineralized tissue
  - Deposition may be directly due to neoplastic bone cells or indirectly from non-bone cells (chronic inflammation causing tonsil stones, atherosclerosis depositing plaques)
- **Besides the bony jaws whereas would you expect to find radiopacities?**
  - Calcified carotid artery atheroma, calcified lymph nodes, tonsils, acne scars
  - Stylohyoid ligament mineralization
  - Thyroid cartilage calcification (common in aged population)
  - Fracture causing overlapping structures
  - Incorrect radiographic technique
- **When you encounter a radiopacity what features will you consider first? Why?**
  - See flowchart on next page
- **Can you identify calcifications of the stylohyoid complex, carotid arteries, tonsilloliths etc confidently?**

Stylohyoid complex calcification	Carotid artery calcification	Tonsilloliths
-12 patterns of this complex, based on 4 developmental regions: 1) Skull base 2) Stylohyal 3) Ceratohyal 4) Hypohyal -Styloid process runs anterior and medial to hyoid bone	**Medial calcific sclerosis (Monckeberg's arteriosclerosis)** -Affects tunica media layer -Looks like a pipestem pattern on imaging -Associated with parathyroidism and osteoporosis -Benign -More common in legs, not H&N **Calcified carotid artery atheroma** -Affects tunica media layer -Round opacity initially, but becomes elongated as it grows -Often seen as 2 parallel lines between C3 and C4	-Frequently seen on panoramic radiographs -Most commonly superimposed with the mandibular foramen -Due to episodes of tonsillitis earlier in life -Observed in younger patients -Can cause halitosis and dysphagia

- **What does multiple radiopacities suggest to you?**
  - Cause of the lesion is more systemic, not due to local factors
  - Important to diagnose and manage early, as it could have significant complications for the patient
  - Consider Paget's disease, Gardner's syndrome, or Leontiasis Ossea
- **Why is Gardner's syndrome important for you to identify and diagnose?**
  - Condition involving the formation of hard tissue lesions in the jaws and polyps in the GI tract
  - Polyp condition is called familial adenomatous polyposis (FAP), and involves polyp formation in the large intestine after the age of 20. These are dangerous as they could become malignant
    - 10% of FAP patients will have Gardner's
  - Hard tissue lesions present in the jaws prior to the polyps
    - Osteomas (most worrisome), odontomas, supernumerary teeth, impacted teeth
    - Most likely to see these structures on a panoramic
    - If these are seen, then refer to gastroenterologist for endoscopy

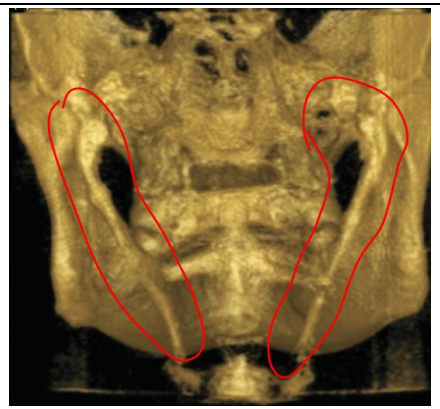
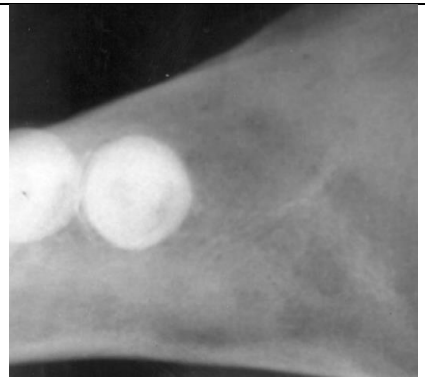
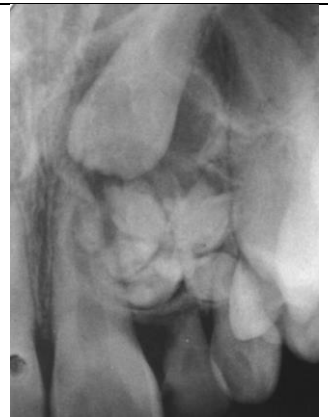

Radiopacities occurring within the bony jaws
Generalized
Solitary or Focal
Well-defined?
Yes
No
Wholly within the alveolus?
Bilateral?
Yes
No
No
Yes
Middle/Old-aged Black/East Asian women?
Gardner's syndrome?
Fibrous dysplasia
Paget's disease
Yes
No
Yes
No
Osteomyelitis
Any nondental disease
Florid osseous dysplasia
Familial gigantiform cementoma?
Yes
No
Dense bone island

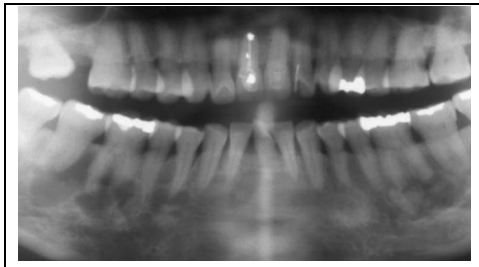
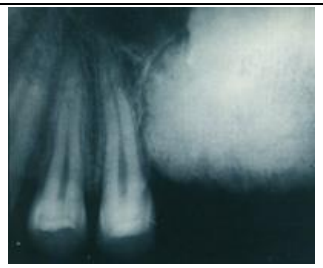

Radiopacities occurring within the bony jaws
Solitary or Focal
Well-defined?
Yes
No
Within the alveolus?
Fibrous dysplasia
Osteosarcoma
Yes
No
Surrounded by radiolucent space?
Any nondental disease
No
Yes
Associated with tooth root?
Toothlike opacites?
Yes
No
No
Yes
Tooth caries/ heavily restored?
Edentulous?
Displacing and/or resorbing tooth roots?
Denticles?
No
Yes
Yes
No
No
Yes
Yes
No
Idiopathic osteosclerosis (IOS)
Condensing osteitis (CO)
IOS
CO
Focal osseous dysplasia
Fused to root?
Compound odontoma
Supernumerary teeth
No
Yes
Cementoblastoma
Associated with unerupted tooth?
No
Yes
Ossifying fibroma
Complex odontoma

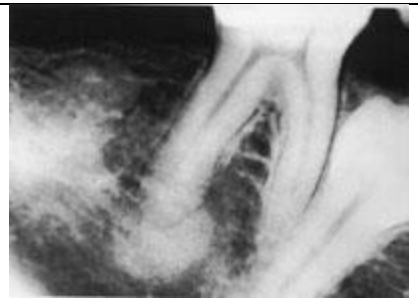
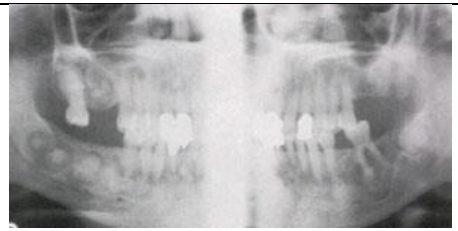
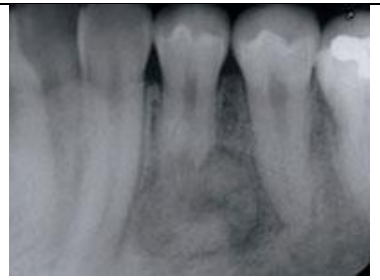
- **Radiopaque lesions**

Lesion	Differential	About	Presentation		Pathogenesis	Treatment
Osteomyelitis		-Can be diffuse or localized -Only a concern when it is diffuse (chance of spreading out) -Most common in mandible	-Infected bone on a radiograph appears radiopaque and laminated, like an onion skin -Can be associated with a PARL -Resembles fibrous dysplasia, as it expands the bone -Spreads from alveolar process → basal process -Mandibular appears more accentuated		-From infections like caries that spread to bone -Induces more bone formation	-Antibiotics
Medication related osteo-necrosis of the jaw		-Due to bisphosphonate therapy, especially if given IV (for chemo) or for a long duration (>3 years)	-Poor wound healing, post surgical breakdown and exposure of underlying bone -Osteomyelitis +/- fever and pain -Radiopaque findings very similar to osteomyelitis -Expansion is often seen			
Fibrous dysplasia	-Collectively called fibro-osseous lesions -Central to the DDx of radiopacities in the jaws	-See developmental disorders for full details -Typically self limiting and regresses in adulthood -Could reactivate again in pregnancy, but goes away after giving birth -Not related to teeth	-Fusiform multiloculated radiopacity -Ground glass, peau d'orange, fingerprint, cotton wool -Poorly defined blending to normal bone -Maxillary sinus frequently obliterated -B-L expansion, thinning of lower border of mandible -Loss of lamina dura in the lesion -Possible eye involvement	-Histologically all look the same -Fibrous stroma with calcified structures ranging from osteoid to cementoid -Biopsy + good clinical + radiographic info needed to make a diagnosis	-Benign dysplasia -Stromal cells favoured → more fibre synthesis	-Surgery for esthetics or function -Do not irradiate
Ossifying fibroma		-Benign slow growing neoplastic lesion -More common in mandible -Variant called Juvenile ossifying fibroma in pts <15 yo. Has high recurrence -Not related to teeth	-Asymptomatic -Appears similar to FD, but is well defined with a sharp radiolucent border -Majority have ball-like B-L expansion -Can be radiolucent, radiopaque, or both -Classically, radiopacity within radiolucency		-Expansile lesion of fibrous tissue and randomly oriented bone	-Recurrence unusual, unless juvenile -Easily enucleated
Osseous dysplasia		-Benign odontogenic neoplasm -Most common in Sub Saharan Africans and East Asians -Frequently presents as PARL's on mandibular incisors, but are vital teeth -Grows with age **Types:** -Focal (88%): lesions in 1 sextant -Periapical: confined to mandible -Florid: 1+ sextant, usually bilateral. 100% mandible, 67% maxilla	-May have pain, swelling, and discharge -Always above the mandibular canal, confined to the alveolar process -B-L expansion, but most are well positioned and do not cause expansion -Cotton wool radiopacities **Possible presentations** -Radiolucency +/- small central opacities -Radiopacity with radiolucent borders -Complete radiopacity		-Calcified spheres called cementicles are deposited -Irregular pieces of woven bone are deposited in a loose fibrous CT matrix	-Remove if it becomes exposed (like due to ridge resorption), as it may cause osteomyelitis -Also remove if planning implants on that site
Cemento-blastoma	-Sclerosing osteitis -Dense bone island	-Benign odontogenic neoplasm -Radiographic findings are pathognomic, so histologic analysis not necessary -More common on mandible 6's area -Rarely affects children, onset is usually in the 20's	-Pain and swelling on biting -Round opacity surrounded by a radiolucency -May resorb the root or fuse to it -Could fuse 3~4 teeth together -Loss of root outline, PDL destruction -Tooth usually remains vital -Lesions are ~2cm		-Cementum-like tissue connected to tooth roots	-Enucleation to prevent recurrence -Possible exo of tooth -Recurrent lesions may expand or undergo cortical perforation

Lesion	Differential	About	Presentation		Pathogenesis	Treatment
Odontoma		-Most common <u>odontogenic</u> neoplasm -2 types: complex and compound	**Complex** -Enamel, dentin, sometimes cementum present -Swelling, but rarely non-eruption of teeth -Very large and demarcated by a radiolucent space	**Compound** -Frequently presents as non-eruption of permanent teeth -Not often swelling -"Bag of teeth" on radiograph -Frequently maxillary anterior sextant	-Tumor-like malformation (hamartoma)	-Complex could recur (suggests neoplastic features) -Compound does not recur
Dense bone island	-Retained primary molar roots -Mandibular tori -Focal osseous dysplasia -Ossifying fibroma	-Prevalent when high [F] in water -More common in posterior mandible	-No associated symptoms -Associated with vital teeth -May cause root resorption -5+ DBI's → suspect Gardner's	-Radiopacities in the bone represents thickening of the trabeculae -No radiolucent margins	-Idiopathic osteosclerosis	-Does not regress when tooth is extracted
Sclerosing (condensing) osteitis			-Necrotic pulp -Non vital teeth -Usually associated a carious or heavily restored tooth		-Idiopathic osteosclerosis -In response to periapical inflammation	-Regresses if associated tooth is extracted

			
-Long RO on left of this image	-Long calcified structure where the styloid process is	-RO of ill defined margin, fusiform -Ground glass appearance -Loss of B-L cortical thickness	-Teeth like structures preventing eruption of permanent dentition
-Normal styloid process. Can extend as far as the mandibular foramen	**-Calcified stylohyoid ligament** -No problems if asymptomatic, but may also cause earache, neck pain, dysphagia, sore throat, compression of carotid, tinnitus, or otalgia -**Eagle syndrome**: glossopharyngeal neuralga + dysphagia + dizziness when turning head (due to compression of carotid)	**-Fibrous dysplasia**	**-Compound odontoma**

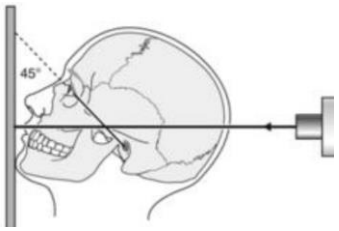
			
-Many RO's, but also RL's associated with apices of teeth -Affecting more than 1 sextant	-RO that is large and filling up the sinus -Capsular, as it is surrounded by a RL line -RO is similar to RO of teeth	-RO on mesial root of 46 -RL line surrounding RO	-RO on 46, surrounded by RL line -RO on apex of 44, with carious tooth -IAN very prominent due RO's
-Florid osseous dysplasia	**-Complex odontoma**	**-Cementoblastoma**	**-46: cementoblastoma** **-44: condensing osteitis** **-Near IAN: focal sclerosing osteitis**

			
-Poorly defined RO -Ground glass, peau d'orange	-Round RO surrounded by RL -Displacement of tooth	-Many RO's, but also RL's associated with apices of teeth -Affecting more than 1 sextant	-Well defined RO mass with RL outline -Fused to tooth root, obscuring PDL -RR present
-Fibrous dysplasia	**-Ossifying fibroma**	**-Florid osseous dysplasia**	**-Cementoblastoma**

			
-RO masses, similar densities to teeth -"Bag of teeth"	-RO around the 46, round shaped -Surrounded by large RL -Cortical expansion without perforation	-Well defined RO mass with RL outline -Fused to tooth root, obscuring PDL -RR present	-RO right at apex of tooth, with a carious tooth
-Compound odontoma	**-Ossifying fibroma**	**-Cementoblastoma**	**-Focal sclerosing osteitis**

Maxillary Antrum (or sinus)

- **Describe the anatomy of the maxillary sinus**
  - Occupies a large part of the mid-face
  - Surrounded by the orbits, nasal cavities, oral cavities, ethmoid sinus, pterygopalatine, and infratemporal fossae
  - Forms an inverted pyramid, with the apex on the lateral surface of the root of the temporal process of the zygoma
  - Ostium: structure found ½ up the medial wall above the inferior turbinate. It communicates with the nasal cavity, allowing drainage of sinus fluids
- **How does the maxillary antrum present on a panoramic radiograph?**
  - Radiolucent structure above the maxillary teeth, with the deepest part by the maxillary first premolars
  - Limitation: only gives a 2D image. Also, the sinus is wider than the focal trough of the panoramic, so the full anatomy of the sinus cannot be captured accurately and clearly
  - Conventional CT or a cone beam CT should be used instead
- **How does infection/ inflammation present on radiographs of the maxillary antrum?**

Sinusitis	-Pain, tenderness of anterior maxilla, sensitive premolar and molars to percussion or bite -Fluid will be seen in the sinus -Sinus walls may appear thickened in chronic sinusitis -Polyps may appear in cases of allergic sinusitis -Osteomyelitis of the sinus is rare and usually presents in children. In OM, the sinus does not grow **How to assess fluid levels in the sinus** -Radiograph taken on patient in a occipito-mental projection with patient sitting upright -Then, re-radiograph the area with a 30 degree tilt to one side 
Ostium blockage	-Mucocele develops and expands in the sinus → expansion then erosion of the sinus walls -However, seen more often in frontal and ethmoid sinuses, not maxillary sinus
Thalassemia	-Entire sinus is overtaken by hematopoietic stem cells, as the body tries to replenish the blood cells -There is no empty space in the sinus, rather it is occupied completely by bone
Osteosarcoma	-Sunray spicules
Malignancy	-Loss of sinus floor, much of the tuberosity, and posterior wall

- **How can you distinguish between a mucosal antral pseudocyst and polyp?**

Mucosal antral pseudocyst		Antral polyp
-Accumulation of fluid n the antral mucosa without an epithelial lining -Most frequent intrinsic lesion in maxillary sinus -On pano: more frequently seen on antral floor -On helical CT: seen on lateral walls too -Soft tissue dense structure partially filling the sinus -Subtle silhouette outlines the lesion, as it is made of soft tissue. It is not clear as bone		-Solid appearance -Well demarcated borders -If there is more than one, it is more likely to be polyps than a pseudocyst

- **How do odontogenic cysts and neoplasms and fibrous dysplasia present in the maxillary antrum?**

Dentigerous cyst	-Arises from canines and supernumeraries -On pan and CT, can see unerupted canine with incomplete roots in the sinus
Orthokeratinized odontogenic cyst	-Often associated with an unerupted tooth -Radiopaque lesion in sinus that is in close contact with the unerupted tooth
Odontogenic keratocyst	-Radiopacity above the hard palate (soft tissue vs air) and radiolucency below (soft tissue vs bone) -Unilocular and early presentation
Ossifying fibroma	-Hard to differentiate from odontomas on a conventional radiograph, but are more likely to occupy the entire vertical dimension of the sinus
Fibrous dysplasia	-FD can originate from the alveolus or base of the skull, and spread to involve the sinus -Sinus appears like ground glass, bone expands vertically + horizontally, sclerosis, rarefaction
Ameloblastoma	-Can invade the maxillary sinus if it is large enough
Odontogenic myxoma	-Erosion and displacement of the maxillary sinus -Leaves a soap bubble appearance of the sinus

- **What is a sinus-lift graft? Why should you be aware of it?**
  - Procedure to lift the sinus and thicken the alveolar process in the maxilla, to support an implant
  - Bilateral well defined radiopacities in posterior sextants may appear as pathologies, but are graft tissues

Balty Case

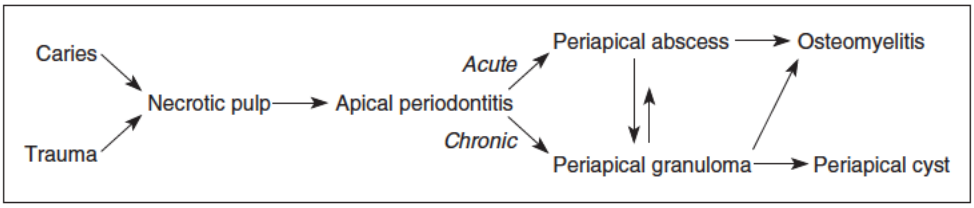
- **Paralleling vs bisecting technique for endodontics?**
  - Paralleling: easier, more reproducible, and less root length distortion
- **Analog, PSP, CCD and CMOS. Which are best for endodontics? What about CBCT?**
  - CCD's and CMOS' are the most efficient, since endos require so many radiographs per session
  - Sensor is electric and plugs in directly to the computer
  - These conventional radiographs in paralleling technique are adequate for virgin, uncomplicated teeth
  - CBCT is useful when performing retreatment or for a tooth with complicated anatomy
- **What are the endodontic indications for the use of CBCT?**
  - Finding missed canals in previously treated teeth
  - See canal anatomy in multi rooted, multi canalled teeth
  - Analyze calcified canals and how much instrumentation needs to be done to remove calcification
  - Assessment of teeth close to anatomic structures
  - Only 1/12 cases in grad clinic require CBCT
- **Describe CBCT - What are FOV, spatial resolution (what are its measurements?), contrast resolution (what are its measurements?).**
  - Large field of view and with a large detector
  - Spatial resolution: 6.5 line pairs per mm, or 0.076mm minimum voxel size (higher than helical CT)
  - However, the contrast resolution is only 12~14 bits (lower than helical CT)
  - In summary, CBCT has the best spatial resolution of all imaging techniques, but the poor contrast limits it to high contrast structures like bone. Soft tissues are hard to distinguish
  - In dentistry, we mainly use CBCT's for hard tissues only, so this limitation is not really an issue
- **What are the advantages and disadvantages to CBCT?**

Table 15.3. Cone-beam computed tomography versus helical computed tomography

Advantages	
1.	Cost of CBCT is approximately 4–8 times less than HCT.
2.	Because the CBCT is substantially lighter; no floor strengthening is required.
3.	The CBCT's footprint is smaller.
4.	CBCTs have better spatial resolution (i.e., smaller pixels) than the best HCT; 0.1 to 0.4 mm voxel size, respectively. The spatial resolution of CBCT is often higher than practically needed for implants, which is usually 0.2 mm voxel size.
5.	CBCT, unlike HCT, uses isotropic cuberilles; therefore, the spatial resolution is just as good in the Z (long) axis as it is in the XY (axial) plane. See Chapters 4 and 5.
6.	No special electrical requirements are needed for CBCT.
7.	Unlike HCT, the room does not need to be cooled for CBCT.
8.	CBCT is very easy to operate and to maintain; little technician training is required.
9.	Radiation dose is considerably less than with a medical CT. Radiation dose can vary substantially between different CBCT makes.
10.	CBCT exposes the patient in the upright position, the same as for a panoramic radiograph, and is associated with good patient tolerance
11.	When the use of CBCT units with a field of view (FOV) of 8 cm × 8 cm or less and is confined to the jaws, they need to be read only by a specially trained general dental practitioner or specialist.
Disadvantages	
1.	Because the contrast resolution for CBCT is only 12 to 14 bits in contrast to 16 to 24 bits for HCT, differences between soft tissues can be appreciated only in the latter.
2.	Both because of the preceding point and the fact that the patient is investigated in the upright position in CBCT, intravenous contrast cannot be used for CBCT.
3.	CBCT units using a lower kilovoltage may experience spray artifacts from titanium implants. Titanium may cause less artifact with high kilovoltages because of its lower atomic mass (see discussion in text).
4.	Related to Advantage Point 11, when the (FOV) of the dataset of HCT is greater than 8 cm x 8 cm and/or includes extragnathic structures, the images need to be reviewed and reported on by a radiologist.

- **What are the ideal parameters (see previous question) a CBCT for endodontic reasons?**
  - Focused on a small field of view (5x5cm or smaller)
  - Excessive imaging outside of the field of view is not necessary

- **How can you reduce the radiation dose of a CBCT investigation?**
  - Smaller field of view produces a higher spatial resolution and reduces dose
  - Lead shield to block radiation to the cervical spine and thyroid
  - CBCT is already inherently dose-conservative compared to a helical CT, as it only requires a single 360 degree rotation and a short exposure time
  - Mobile CBCT units only do a 180 degree rotation, which decreases dose even further (less radiation to the parotid than panoramics)
- **Which patient groups are most vulnerable to radiation induced damage?**
  - Children under 19 (rapid cell division, longer lifetime for ill effects to show up)
  - However, needing a CBCT for an endo on a young patient is uncommon
  - Those who received radiation before 19 showed 24% greater cancer incidence
- **In addition to increasing the radiation dose, what other issues are raised by using a large FOV for endodontic assessments**
  - Since a large FOV CT will involve structures outside of the teeth, it is important to refer it to a medical radiologist
  - Not referring to interpret the eyes, brain, and neck areas can be considered negligence of the dentist
  - Dental professionals with medical qualification may interpret these extragnathic areas
  - Can avoid this issue by taking a narrow FOV CT of just the teeth
- **Describe the stages of development of periapical radiolucency of inflammatory origin.**



  - PARL's can form due to pulp necrosis or extensive periodontal disease
  - Toxic metabolites from the necrotic pulp exit the root apex
  - Triggers an inflammatory reaction in the apical bone and PDL → acute apical periodontitis
    - Inflammatory infiltrate containing lymphocytes and PMN's
    - Neutrophils may collect to form pus, causing an apical abscess
  - Body attempts to heal from acute apical periodontitis by making granulation tissue → chronic apical periodontitis
    - Inflammatory infiltrate containing lymphocytes, plasma cells, histiocytes
    - Entrapped epithelial cells (rests of Malassez) may proliferate to form a radicular or apical cyst
  - If the body cannot contain the infection, then it may progress to osteomyelitis
    - Not related to size of lesion, but more dependent on severity of the reaction
    - Distinguishing between periapical inflammation or osteomyelitis:
      - Simple periapical periodontitis will be centered around the tooth
      - If the lesion extends farther, then osteomyelitis is a possible diagnosis
      - Sequestra being present are suggestive of osteomyelitis
    - Progression is rare, and may be due to compromised host defenses or increased virulence
- **Describe radiological stages of healing (complete and partial) or failure to heal or recur.**
  - Causes of failure or recurrence
    - Reinfection due to leakage or short fill
    - Foreign material protruding past the apex, causing inflammation
  - Radiographically, seen as a lesion that does not shrink or grows bigger