Dental Radiology

2

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Contents

Abstract

This chapter focusses on the very basic concepts in dental radiology that a general dental practitioner should be aware of, including radiation safety and protection, current ADA imaging guidelines, radiographic exposure from common radiographic exams, normal radiographic anatomy, radiographic interpretation, radiographic features of common disease categories, and advanced imaging techniques.

2.1 Radiation Safety and Protection

- Check with local state board of dentistry for rules and regulations regarding use of radiation.
- Register all new x-ray equipment with the local state agency for radiation control.

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Table 2.1 Effective dose from radiographic examinations and equivalent background exposure (White and Pharoah 2014)

Examination	Effective dose (μSv)	Equivalent background exposure (days)
Intraoral		
Rectangular collimation		
Posterior bitewings: PSP or F- speed film	5	0.6
Full-mouth: PSP or F-speed film	35	4
Full-mouth: CCD sensor (estimated)	17	2
Round collimation		
Full-mouth: D-speed film	388	46
Full-mouth: PSP or F-speed film	171	20
Full-mouth: CCD sensor (estimated)	85	10
Extraoral		
Panoramic	9–24	1–3
Cephalometric	2–6	0.3–0.7
Cone-beam CT		
Large field of view	68–1073	8–126
Medium field of view	45–860	5–101
Small field of view	19–652	2–77
Multi-slice CT		
Head: conventional protocol	860–1500	101–177
Head: low-dose protocol	180–534	21–63
Abdomen	5300	624
Chest	5800	682
Plain films		
Skull	70	8
Chest	20	2
Barium enema	7200	847

CCD charge-coupled device, *PSP* photostimulable phosphor

- Do clinical examination and justify the need for each radiograph before ordering it. Refer to ADA/FDA selection criteria for prescribing radiographs (http://www.fda.gov/RadiationEmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm116503.htm).
- Follow 'ALARA' principle (As Low As Reasonably Achievable) for optimizing radiation dose based on specific diagnostic tasks.
- Use fastest speed films (F-speed)/photostimulable phosphor (PSP) plates/digital receptors.
- Rectangular collimation reduces patient dose by five times compared to round collimation.
- Use protective aprons and thyroid collars when appropriate.
- Develop a radiographic quality assurance program and document the steps taken to follow it. For digital radiography, periodically check the sensors for any physical damage, resolution, contrast, and density by comparing to good reference radiographs. Calibrate monitors periodically.
- See table 2.1 for effective radiation dose from common radiographic procedures and equivalent background radiation.

2.2 Normal Radiographic Anatomy (Fig. 2.1)

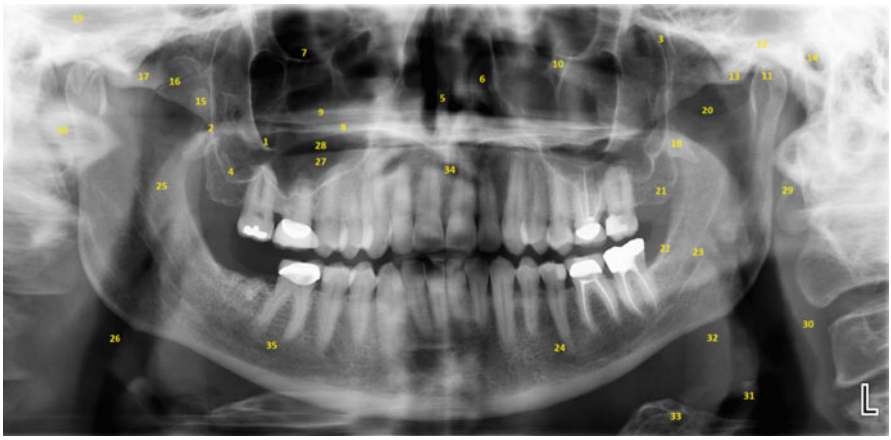

Fig. 2.1 Panoramic radiograph showing normal anatomical structures. Use the numbers in the radiograph to correspond to the key
Key: *1* zygomatic process of the maxilla, *2* posterior wall of the maxillary sinus, *3* pterygomaxillary fissure, *4* floor of the maxillary sinus, *5* nasal septum, *6* inferior nasal concha, *7* inferior orbital rim, *8* hard palate, *9* ghost image of opposite hard palate, *10* infraorbital canal, *11* mandibular condyle, *12* glenoid fossa, *13* articular eminence, *14* external auditory meatus, *15* coronoid process of the mandible, *16* zygomatico-temporal suture, *17* zygomatic arch, *18* pterygoid plate, *19* middle cranial fossa, *20* sigmoid notch, *21* maxillary tuberosity, *22* external oblique ridge, *23* mandibular canal, *24* mental foramen, *25* soft palate, *26* pharyngeal airway, *27* dorsal surface of tongue, *28* palatoglossal airway, *29* styloid process, *30* posterior pharyngeal wall, *31* epiglottis, *32* base of tongue, *33* hyoid bone, *34* intervertebral disk space between C1 and C2, *35* submandibular salivary gland fossa, *36* anterior arch of C1

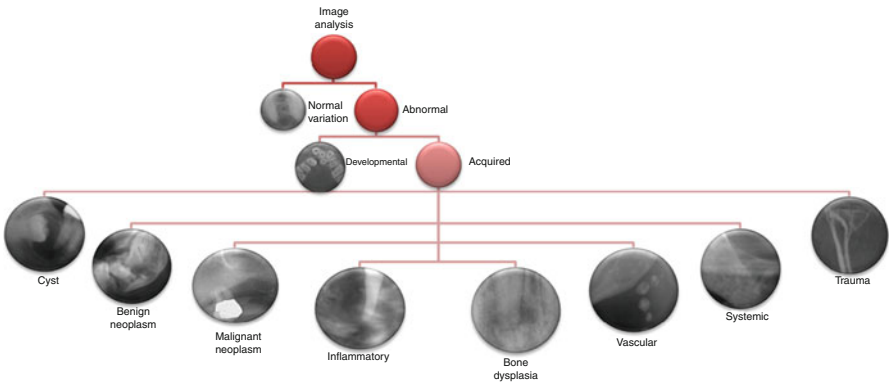

Fig 2.2 Radiographic image analysis algorithm representing the diagnostic process

2.3 Radiographic Interpretation (Fig. 2.2)

Considerations when a lesion is noted on a radiograph:

- Location: in relation to teeth, inferior alveolar canal; localized vs. generalized, unilateral vs. bilateral, single vs. multifocal
- Shape: regular vs. irregular, hydraulic
- Size: extension
- Periphery: well-defined, moderately well-defined or poorly defined
  - Corticated vs. noncorticated
- Internal structure: radiolucent, mixed, radiopaque, unilocular vs. multilocular
- See table 2.2 for characteristic radiographic features of common disease categories effect on surrounding structures: root resorption/displacement, cortical bone expansion/resorption, inferior alveolar nerve (IAN) canal, maxillary sinus floor

Radiographs showing a variety of radiolucent, mixed and radiopaque lesions. (Figs. 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.26, 2.27, and 2.28)

For more examples, refer to chapter "Oral Pathology" on section "Radiopaque and Radiolucent Lesions."

2.4 Advanced Imaging

When three-dimensional information is necessary to provide direct benefit in patient's diagnosis and treatment, advanced imaging procedures may be used. This should be considered on a case by case basis. When a lesion is detected on conventional radiographs, an oral and maxillofacial radiologist may be consulted to seek advice on further investigations and management of the lesion.

- Cone-beam computed tomography (CBCT)
  - Can be used in implant planning, TMJ disorders, dental anomalies, fractures, extent of disease, and craniofacial relationships.
  - Available in small, medium, and large fields of view.
  - Small field of view usually gives better resolution, less noise, and less radiation dose to the patient as compared to large field of view. It also reduces the liability for any incidental findings by reducing the scan volume.
  - All CBCT scans must be accompanied by a formal interpretation report. The referring dentist has liability for all the findings in the scan, including areas not in the region of interest. Oral and maxillofacial radiology interpretation services may be utilized if the dentist does not want to take the liability for radiographic findings.
- Multidetector/medical computed tomography (MDCT)
  - Gives better soft tissue contrast than CBCT.
  - Radiation dose is usually higher than CBCT.
  - Used when both soft tissue and bone details are needed, e.g., extent of craniofacial disease, malignancies, aggressive benign lesions, and fractures.

Table 2.2 Radiographic features of lesions by categories

	Location	Shape	Periphery	Internal structure	Effect on adjacent roots	Effects on adjacent bone
Cysts	Odontogenic: teeth-bearing areas. Dentigerous: around crown. Radicular: periapical or lateral. Lateral periodontal: lateral to root Non-odontogenic: fissural, e.g., nasopalatine canal cyst	Regular, round/ hydraulic	Well-defined, corticated (May lose cortication or cause sclerotic borders if infected)	Radiolucent	Displacement Can cause resorption if long standing	Expansion
Benign neoplasms	Odontogenic: superior to the IAN Non-odontogenic: inferior to the IAN	Regular +/– irregular; scalloped	Well-defined, corticated, or noncorticated; may show soft tissue capsule	Unilocular or multilocular Completely radiolucent/radiopaque/ mixed; may show internal septations or calcifications	Horizontal/directional root resorption and/or displacement	Expansion: can perforate if aggressive or long standing
Malignant neoplasms	Specific to tissue of origin Could be generalized/ multifocal in hematogenic malignancies/ metastasis	Irregular; Regular in multiple myeloma (MM)	Poorly defined, invasive, ragged Punched out in MM No peripheral sclerosis unless secondarily infected	Completely radiolucent/ radiopaque/mixed	May cause vertical root resorption, irregular widening of PDL space, coronal displacement of developing teeth in leukemia, lymphoma, Langerhans' cell histiocytosis	Destruction/perforation; can cause speculated/ sunray-type periosteal reaction

(continued)

Table 2.2 (continued)

	Location	Shape	Periphery	Internal structure	Effect on adjacent roots	Effects on adjacent bone
Inflammatory lesions	Periapical or lateral to the root; involves basal bone in osteomyelitis	Irregular	Poorly defined with a zone of peripheral reactive sclerosis	Radiolucent Radiopaque in sclerosing osteitis and sclerosing osteomyelitis	Loss of lamina dura; may cause resorption if chronic	May perforate cortex, sinus tract, periosteal reaction in chronic cases
Vascular lesions	More common in mandible	Regular or irregular	Well-defined or poorly defined	Radiolucent or mixed	Root resorption, displacement, advanced development/eruption on the affected side	May enhance bone development on affected side, course trabecular pattern; may cause sunray periosteal reaction, irregular widening (serpiginous) of IAN
Endocrine/ metabolic disorders	Multifocal/generalized: maybe syndromic			May cause generalized increased or decreased bone density, altered trabecular pattern	May cause generalized widening of PDL space (systemic sclerosis), generalized loss of lamina dura (hyperparathyroidism)	May cause increased or decreased rate of bone development in endocrine disorders

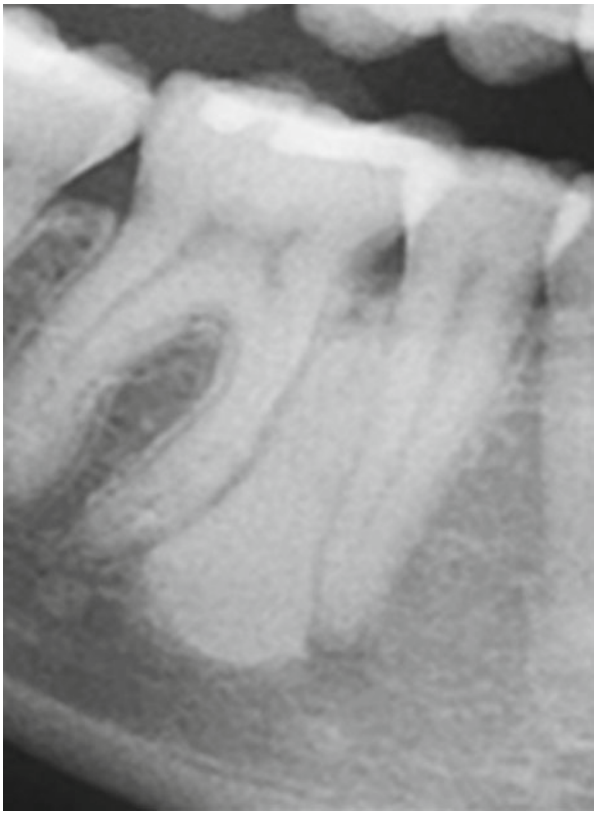

Fig 2.3 Idiopathic osteosclerosis. Note radiopaque area between the roots of #29 and 30

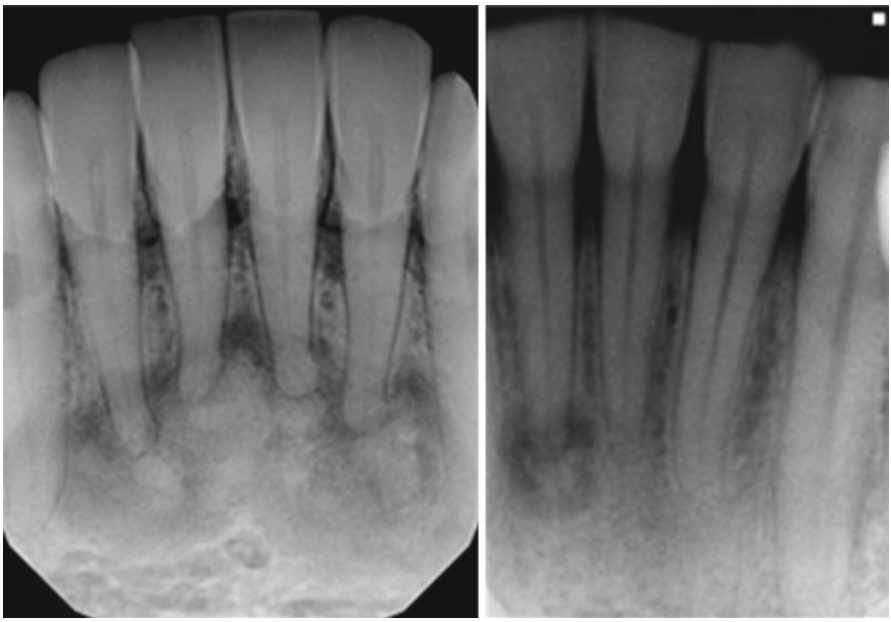

Fig 2.4 Periapical cemento-osseous dysplasia. Note mixed density lesions associated with the roots of mandibular incisors

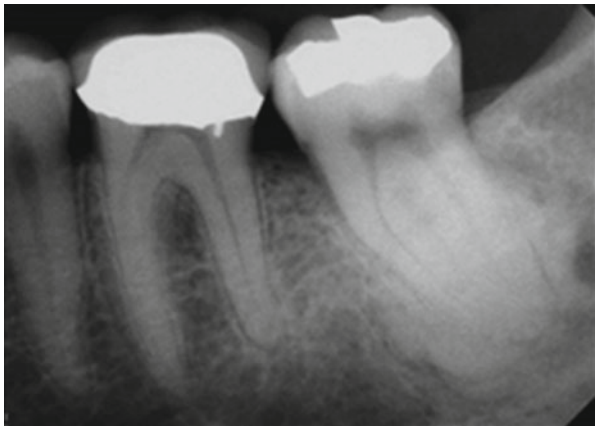

Fig 2.5 Cementoblastoma associated with #18. Note radiopaque lesion continuous with the roots and surrounded by radiolucent rim

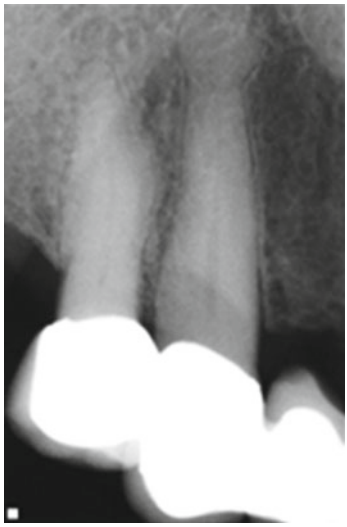

Fig. 2.6 Hypercementosis with #5 and 6

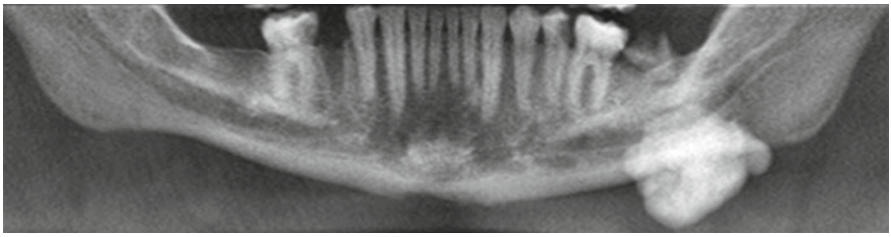

Fig. 2.7 Osteoma arising from left body of the mandible

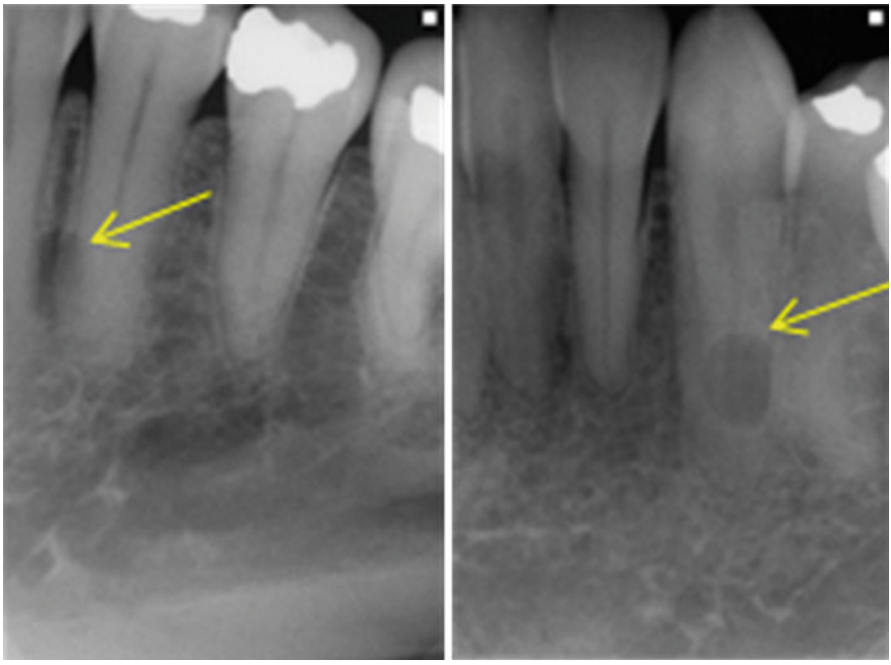

Fig. 2.8 Lateral periodontal cyst. *Arrows* denoting a well-defined corticated radiolucent lesion between the roots of mandibular canine and first premolar

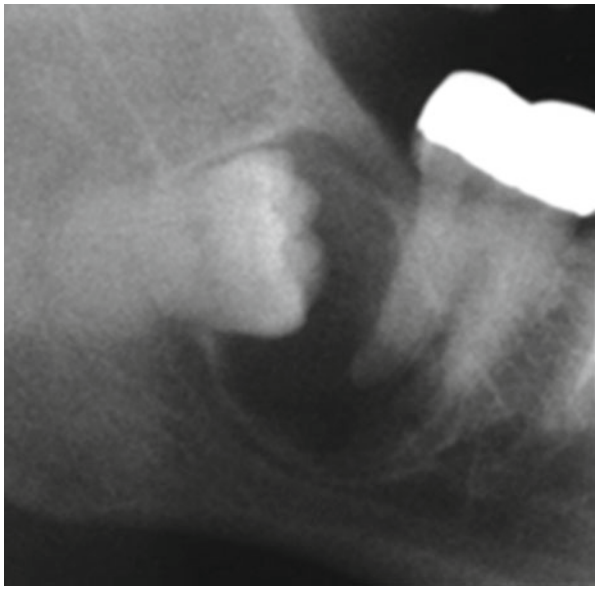

Fig. 2.9 Dentigerous cyst associated with impacted #32. Note pericoronal radiolucent area displacing the inferior alveolar canal

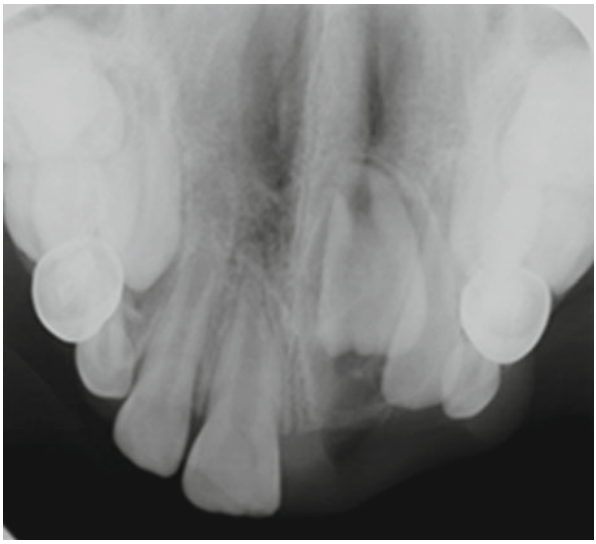

Fig. 2.10 Ameloblastic fibro-odontoma with impacted #9

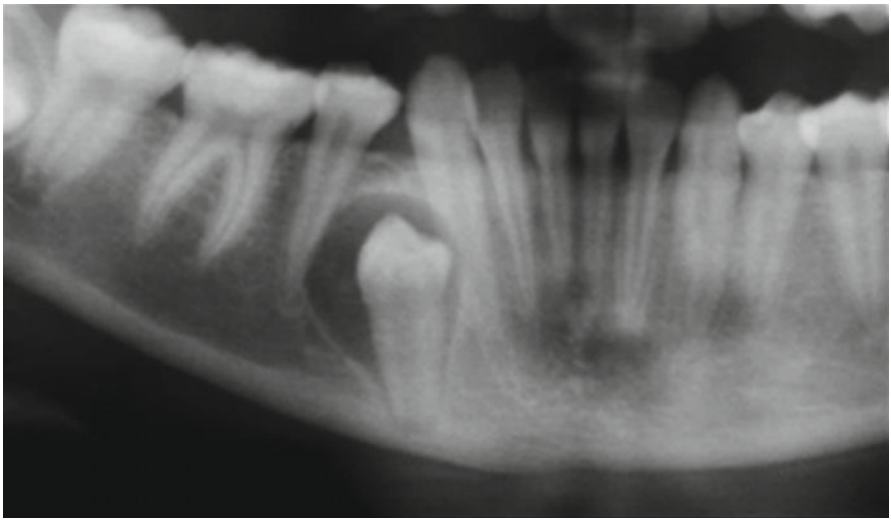

Fig. 2.11 Adenomatoid odontogenic tumor with impacted #27

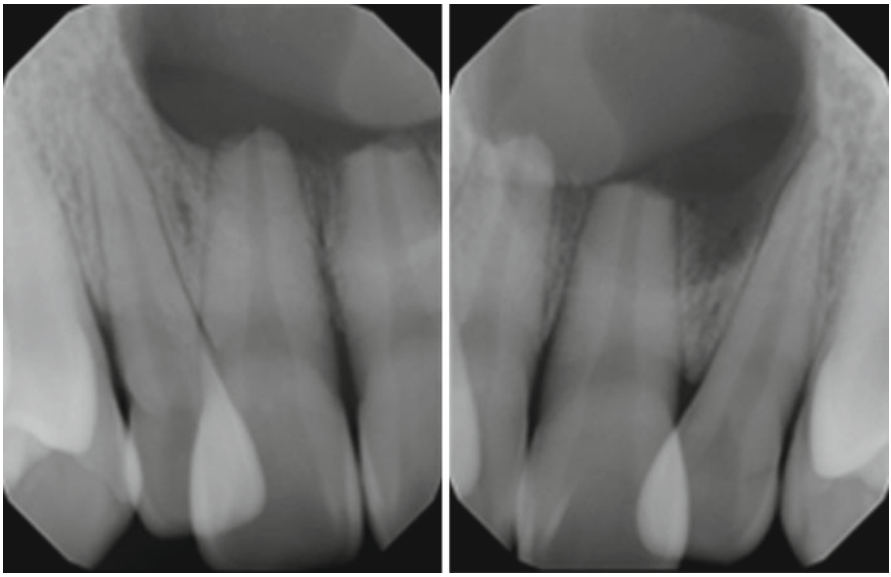

Fig. 2.12 Radicular cyst with #8 and 9 with evidence of root resorption

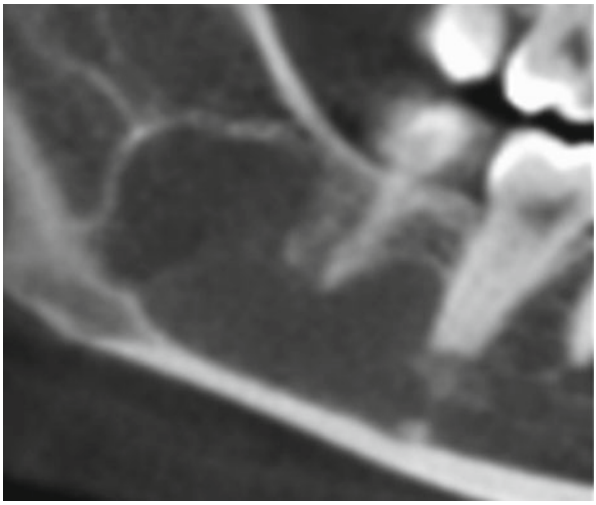

Fig. 2.13 Simple bone cyst in right mandibular molar region. Note scalloping between the molar roots

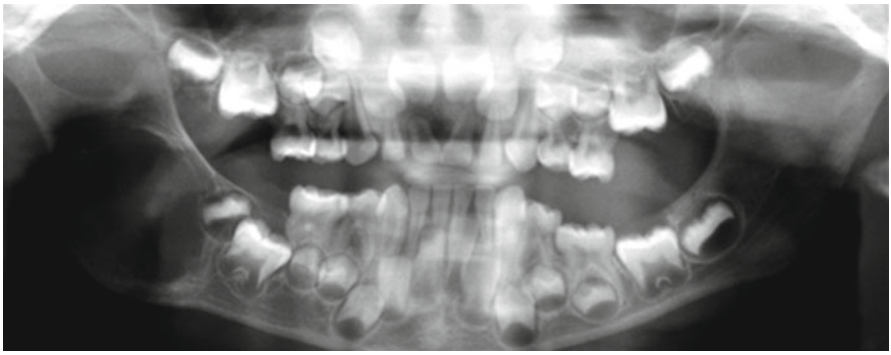

Fig. 2.14 Neurofibroma right posterior mandible. Note expansile radiolucent lesion causing displacement of unerupted tooth buds

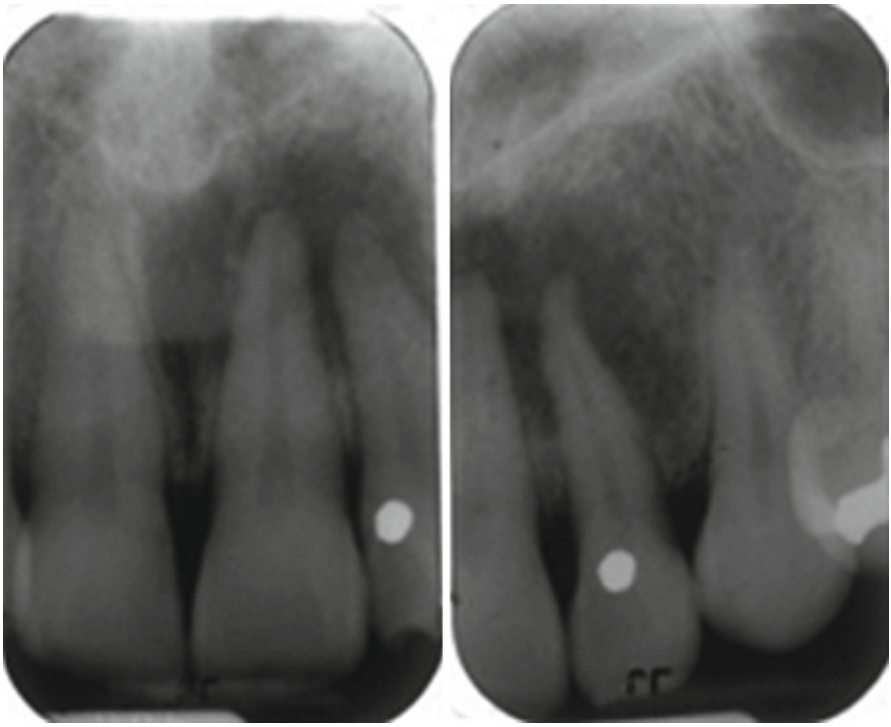

Fig. 2.15 Langerhans cell histiocytosis. Note ill-defined radiolucent lesion surrounding the roots of #s 7–8

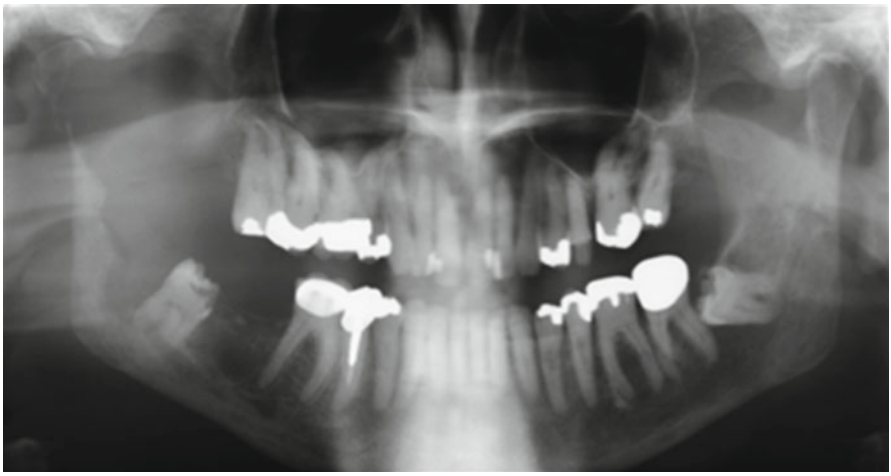

Fig. 2.16 Squamous cell carcinoma right mandible. Note extensive irregular bone destruction with pathological fracture of right condylar neck

- Magnetic resonance imaging (MRI)
  - Best for soft tissue detail.
  - Used to determine soft tissue extent of lesions, malignant involvement of lymph nodes, perineural spread of malignant neoplasms, salivary gland lesions, articular disk derangement in TMJ, articular disk, and surrounding soft tissue disorders in TMJ.
- Ultrasonography
  - Can be used for evaluation of neoplasms in thyroid, parathyroid, salivary glands, lymph nodes, sialoliths, and atherosclerotic plaques in carotid arteries.
- Nuclear medicine
  - Used to assess physiological change such as functions of the brain, thyroid, heart, and lungs and for diagnosis and follow-up of metastatic disease, bone tumors, and infection.
  - Involves use of radionuclides with gamma camera or advanced imaging such as SPECT, PET, PET/CT, and PET/MRI.

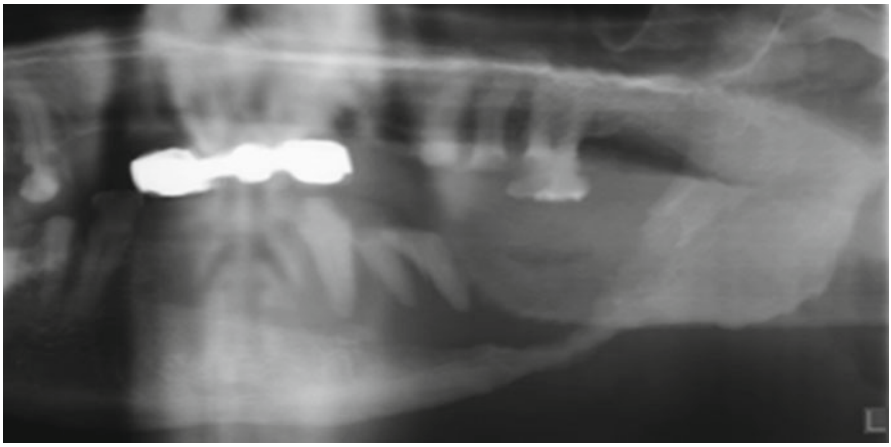

Fig. 2.17 Squamous cell carcinoma left mandible. Note irregular ill-defined bone destruction with floating teeth appearance

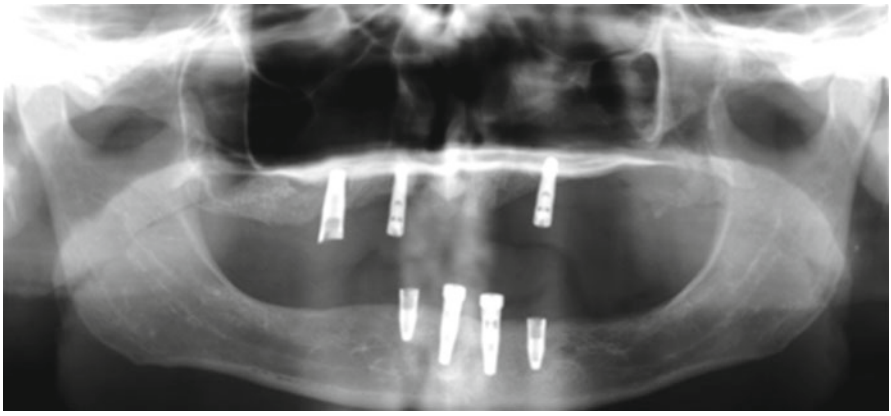

Fig. 2.18 Squamous cell carcinoma left maxilla. Note loss of cortical borders of left maxilla and maxillary sinus

Fig. 2.19 Meningioma right maxillary sinus. Note destruction of the posterior wall of the sinus with soft tissue opacification in the sinus

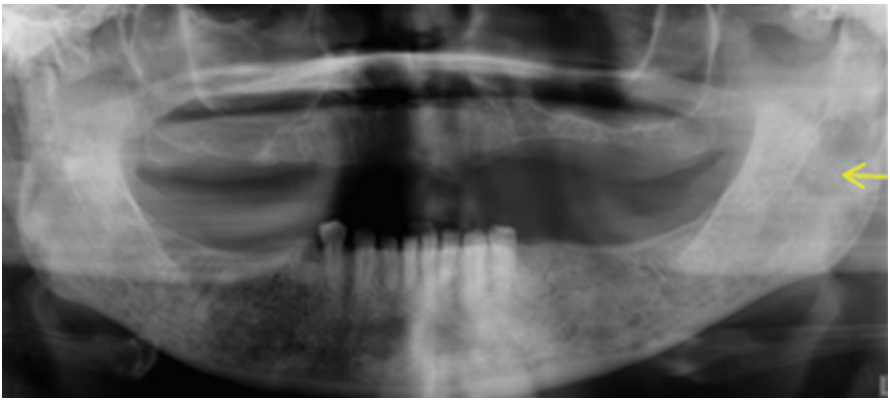

Fig. 2.20 Multiple myeloma. Generalized punched out radiolucent lesions in mandible. Note involvement of the left inferior alveolar canal (*arrow*)

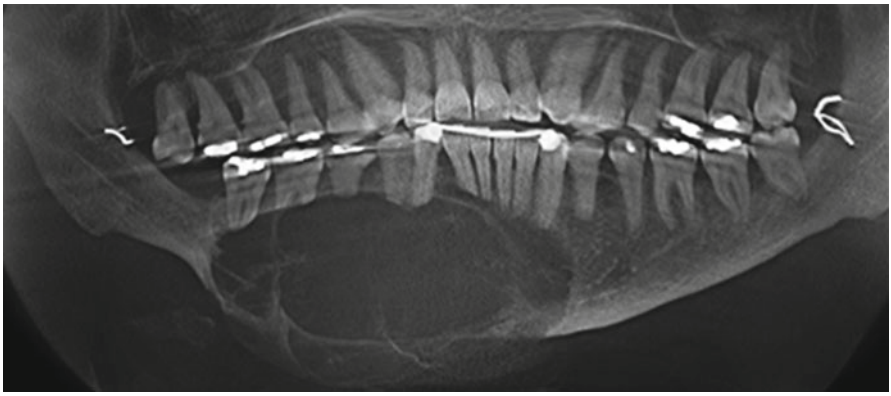

Fig. 2.21 Ossifying fibroma of mandible. Note expansile lesion with evidence of root resorption

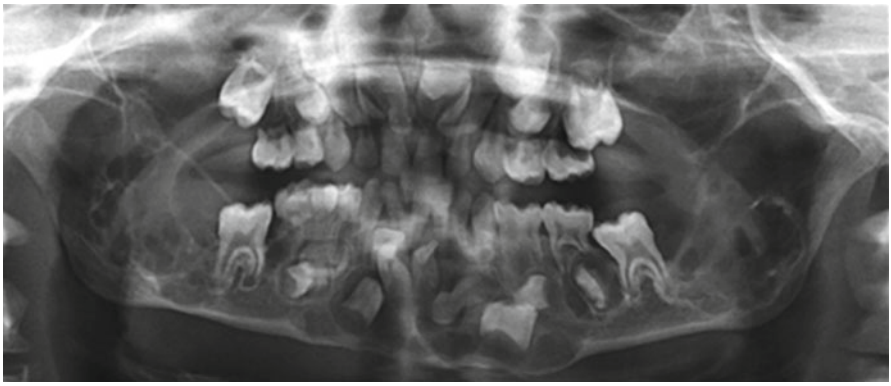

Fig. 2.22 Cherubism involving bilateral maxilla and mandible

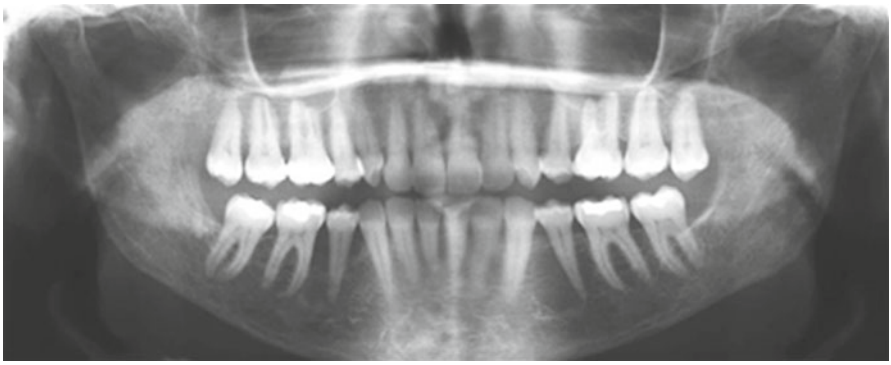

Fig. 2.23 Brown tumor of hyperparathyroidism. Note moderately defined radiolucent lesion in mandibular left premolar region

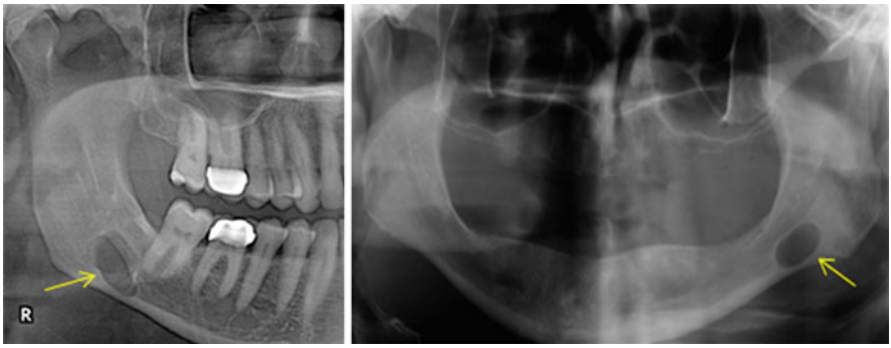

Fig. 2.24 Submandibular salivary gland inclusion defect (Stafne defect)

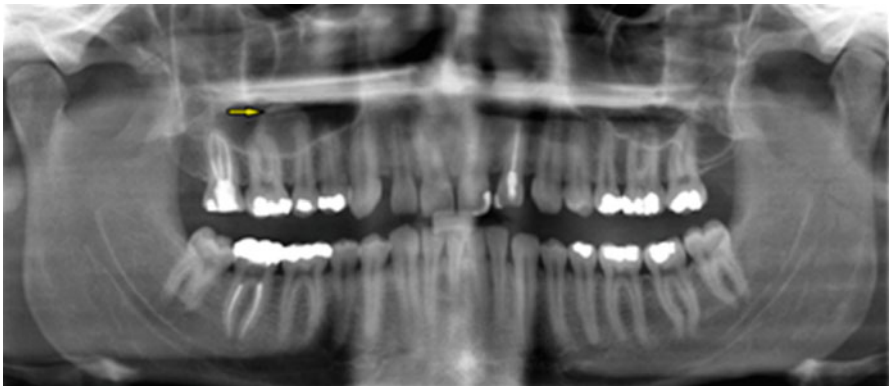

Fig. 2.25 Mucus retention phenomenon in right maxillary sinus

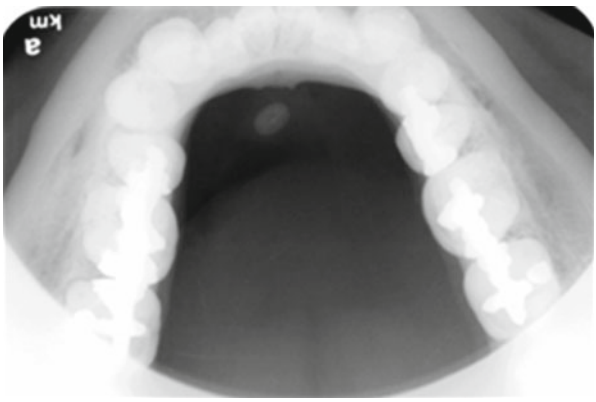

Fig. 2.26 Sublingual sialolith

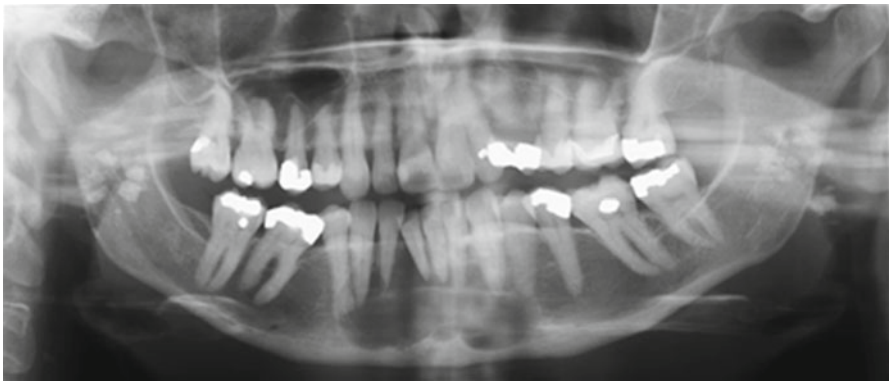

Fig. 2.27 Bilateral tonsilloliths superimposed over mandibular rami. Also note a well-defined corticated lesion in anterior mandible which was diagnosed as glandular odontogenic cyst

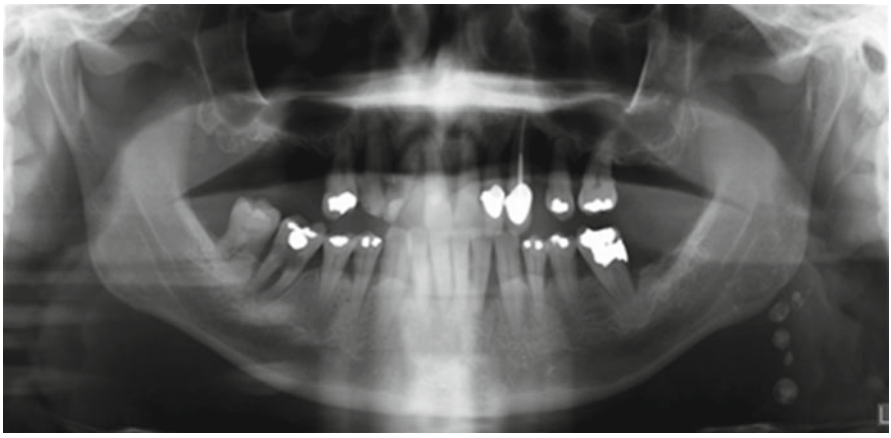

Fig. 2.28 Phleboliths in hemangioma. Note multiple circular radiopaque entities in the soft tissue inferior to the left mandibular angle, representing calcifications in soft tissue hemangioma

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