Teeth Simplified for the Practicing Neuroradiologist

[1]Phaethon Philbrook, MD, PhD, [2]Kelsey Casano, MD, [1]John Vasilios Dennison, MD

[1]Emory University, Department of Radiology and Imaging Sciences, Atlanta, GA 30322

[2]Ochsner Medical Center, Department of Radiology and Diagnostic Imaging, Jefferson, LA 70121

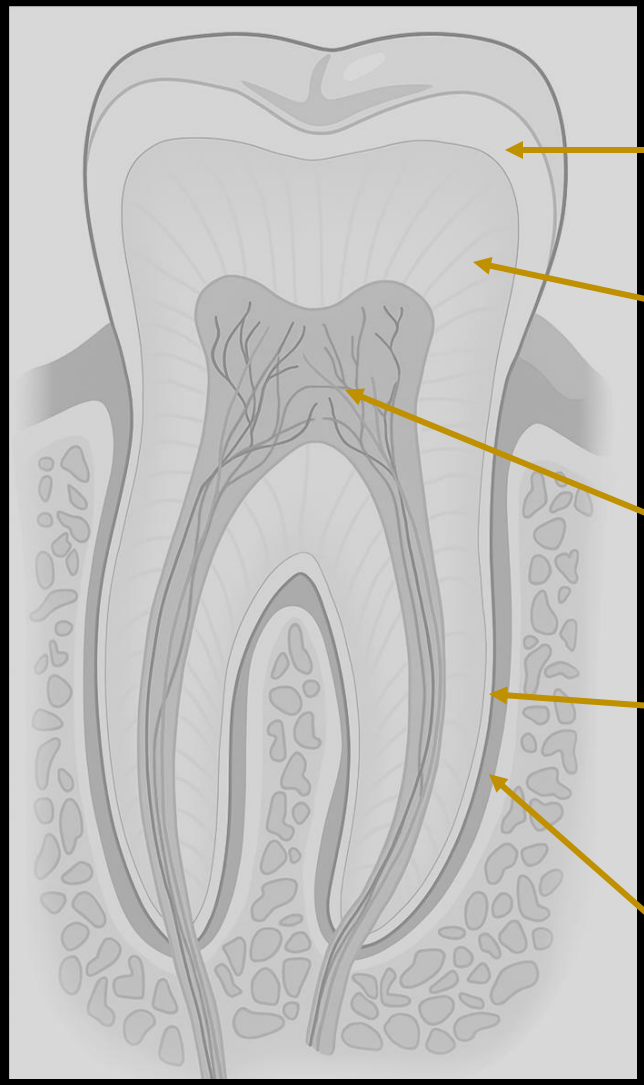
Outline

- An overview of dental anatomy
- Common radiographical findings of early dental disease
- Complications of localized disease
- Complications of untreated dental disease
- Commonly encountered odontogenic masses
- Dental related trauma

Teaching Points

- Understanding the natural progression of dental disease
- Distinguish between localized sequelae and more advanced complications
- Differentiate between various common odontogenic lesions

Imaging Findings



Enamel: Hyperdense outermost surface along the crown of the tooth

Dentin: Less dense inner layer deep to the enamel and cementum

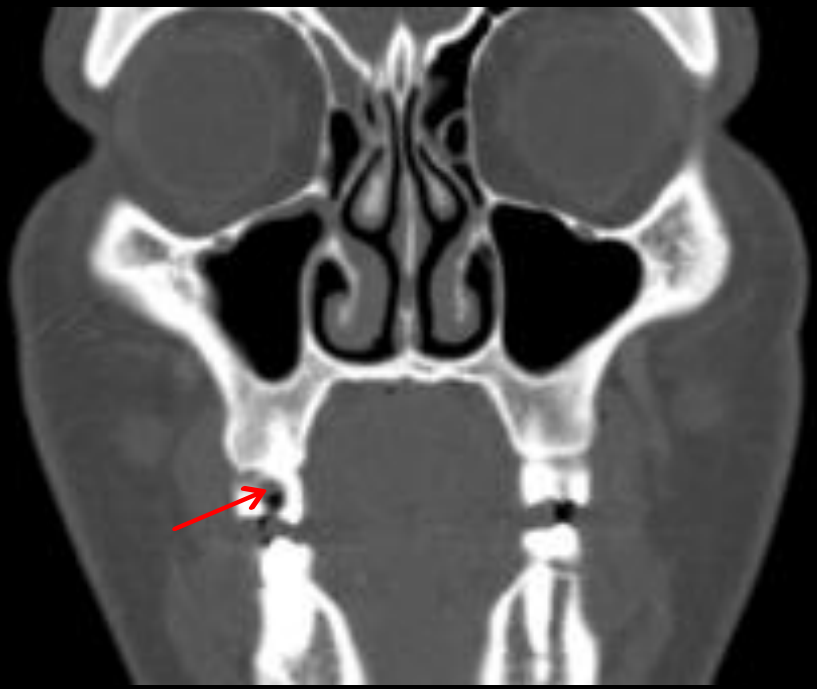
Pulp: Hypodense central component, deep to the dentin layer

Cementum: Thin, hyperdense line outlining the root of the tooth

Periodontal ligament: Thin, hypodense linear structure surrounding the root of the tooth

[Normal Tooth Anatomy]

Enamel: Mineralized hard layer produced by ameloblasts.
Cementum: Mineralized hard layer produced by cementoblasts.
Dentin: Mineralized bulk of tooth produced by odontoblasts.
Pulp Cavity: Soft tissue inner chamber.
Periodontal ligament: anchors the to the alveolar bony socket.



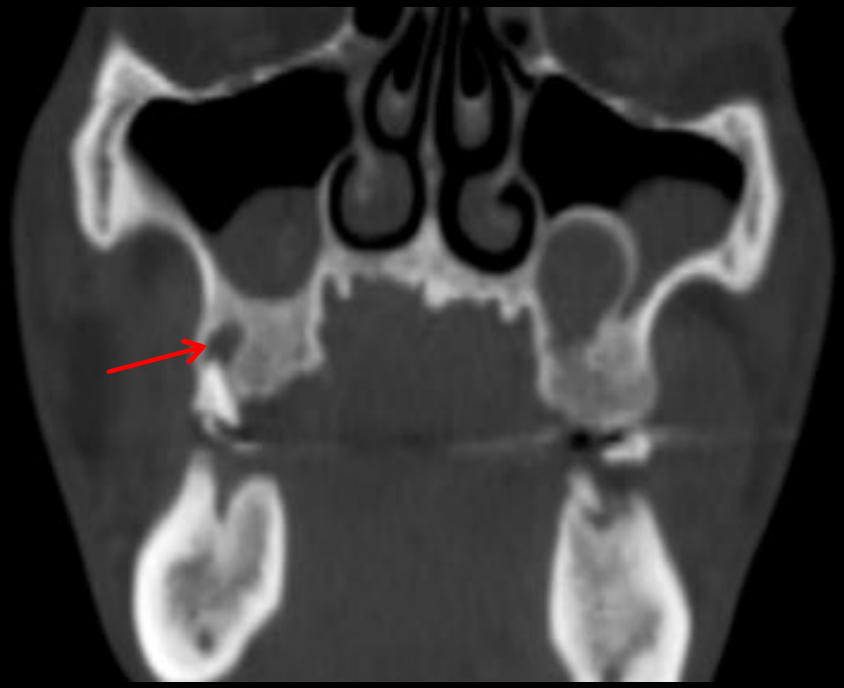
[Carious Disease]

Pathophysiology:

- Bacteria metabolizes sugars found on tooth surface -> generate acid -> demineralizes enamel/dentin.

Imaging Findings:

- Focal erosions of the enamel and dentin layers of the tooth (⟵)



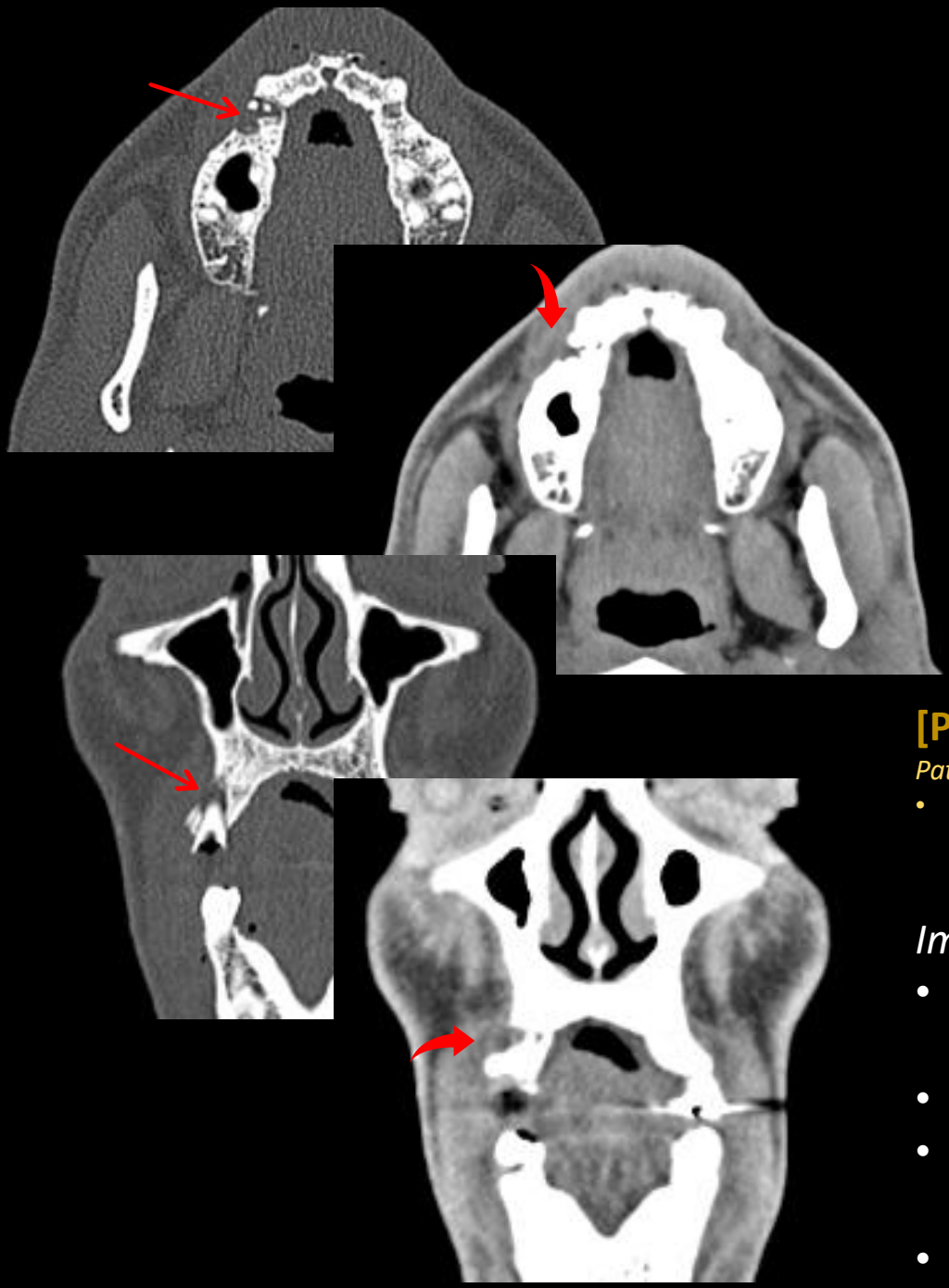
[Periapical Lucency]

Pathophysiology:

- Bacterial translocation through the path of least resistance:
  - Enamel -> Dentin -> Pulp cavity -> Root Apex -> Inflammation -> Bony erosion -> Periapical lucency -> Periodontal ligament space widening.
- Pulp cavity is contiguous with the root apex and where infection becomes established.

Imaging Findings:

- Well circumscribed hypodensity with loss of internal trabeculations (⟵)
- Cortical thinning (↶)
- Typically does not enhance



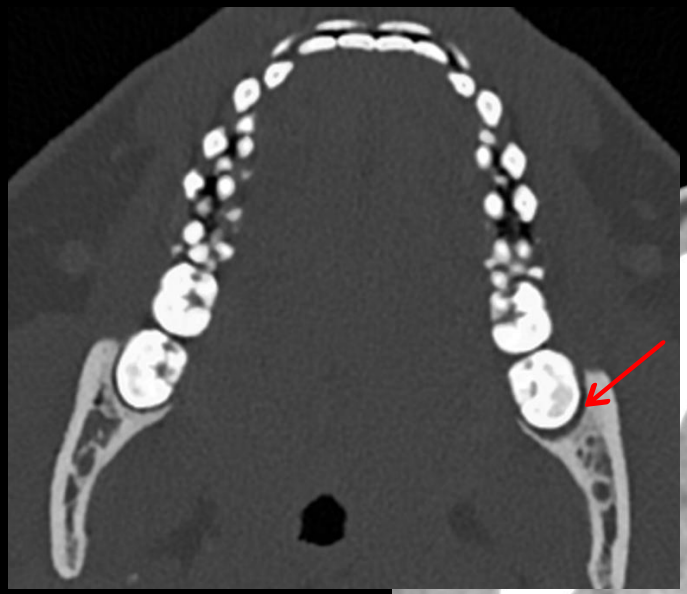
[Periapical Abscess]

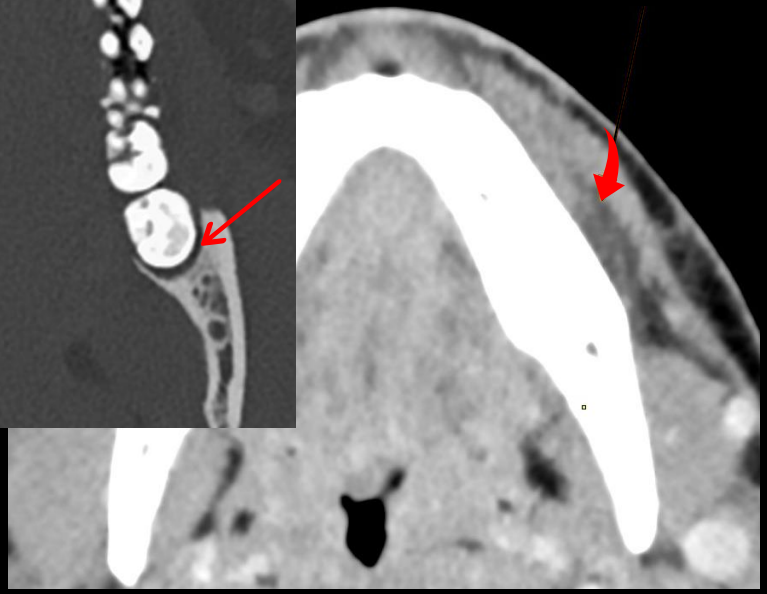
Pathophysiology:

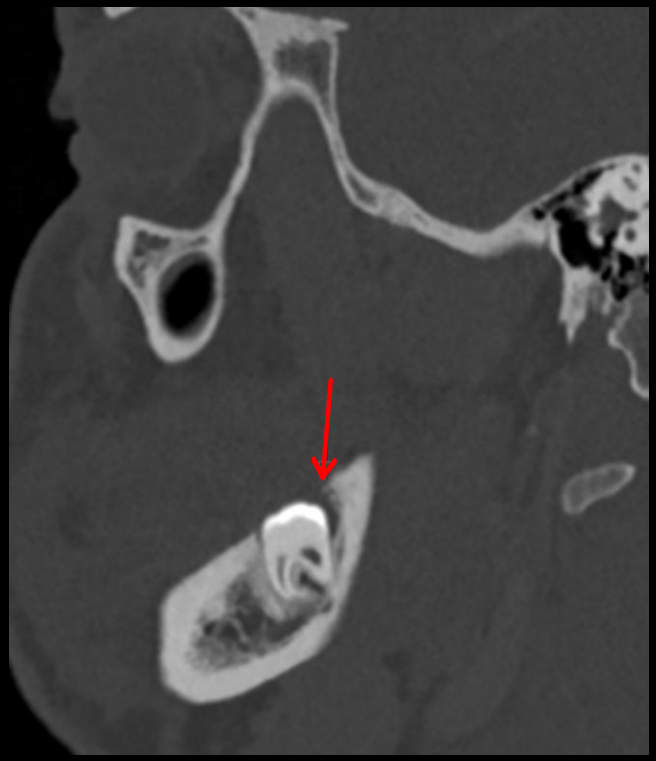
- Spread of an underlying infection of the adjacent tooth pulp leads into the periapical tissue leading to a collection.

Imaging Findings:

- Associated cortical thinning +/- cortical dehiscence (⟵)
- Adjacent soft tissue swelling (↶)
- Well circumscribed hypodense fluid collection
- Well-defined rim of enhancement







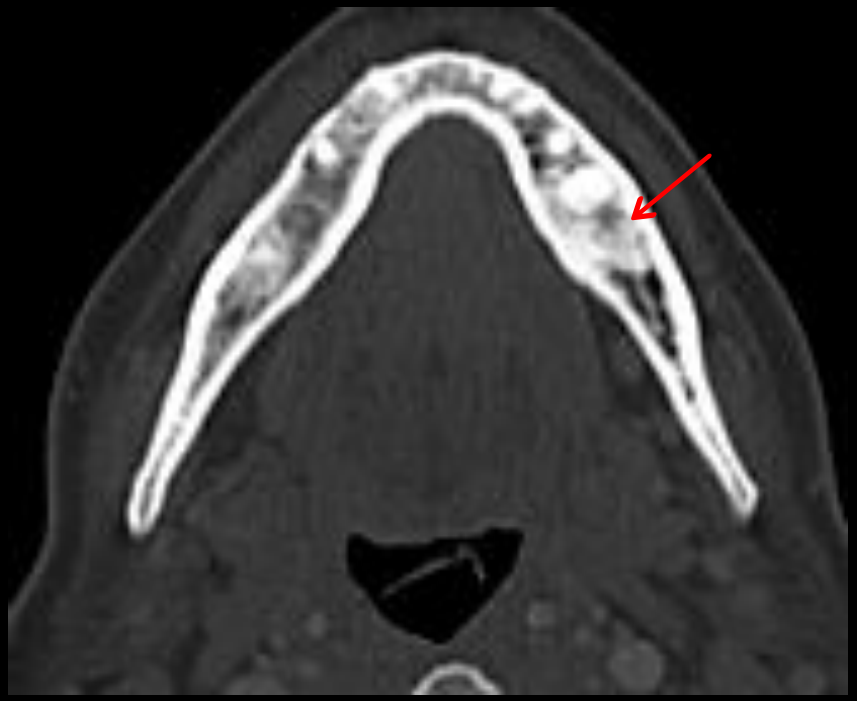
[Pericoronitis]

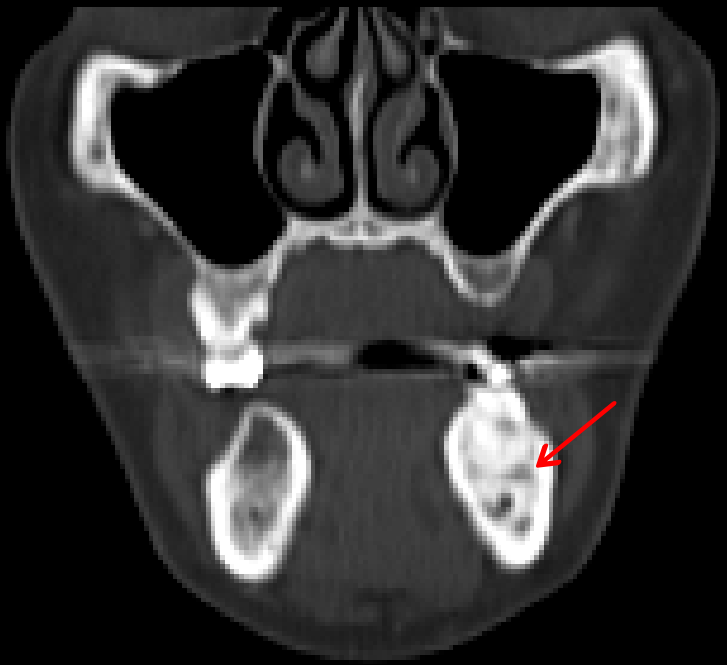
Pathophysiology:

- Inflammation of the gum tissue surrounding a partially erupted tooth seeds a superficial bacterial infection.

Imaging Findings:

- Adjacent soft tissue swelling (⟵)
- Enhancement of the pericoronal soft tissue (↲)





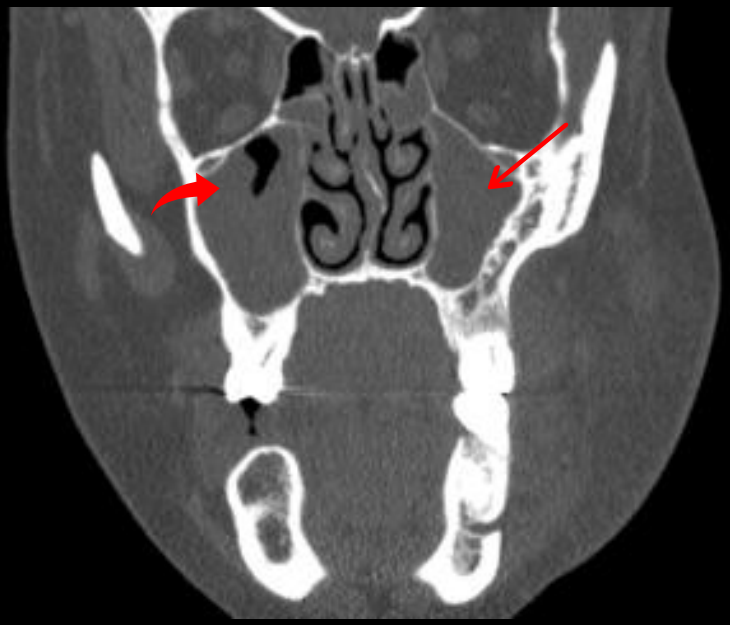
[Condensing Osteitis]

Pathophysiology:

- Chronic inflammation leads to osteoblastic activity and deposition of adjacent sclerotic lamellar bone.

Imaging Findings:

- Increased hyperdense focal bone sclerosis with loss of normal trabeculation (⟵)



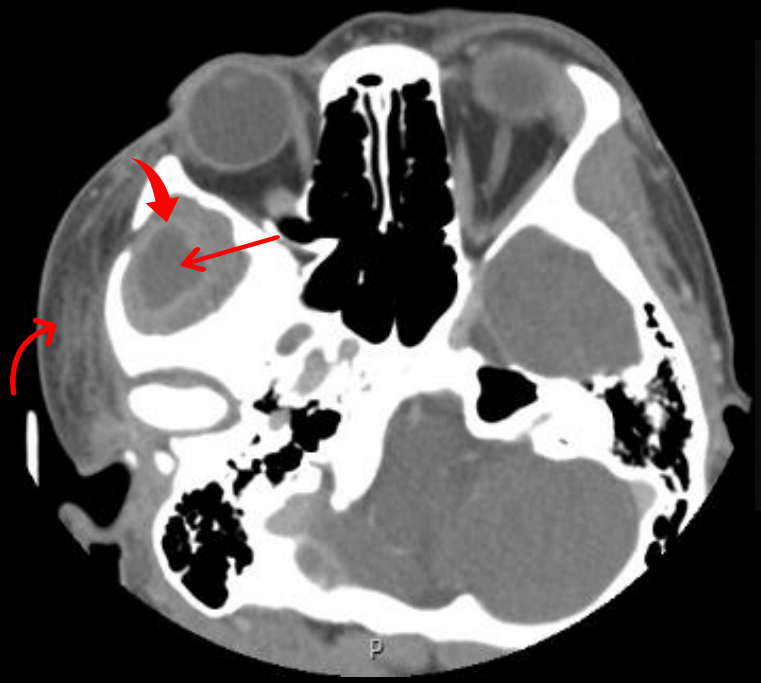
[Odontogenic Sinusitis]

Pathophysiology:

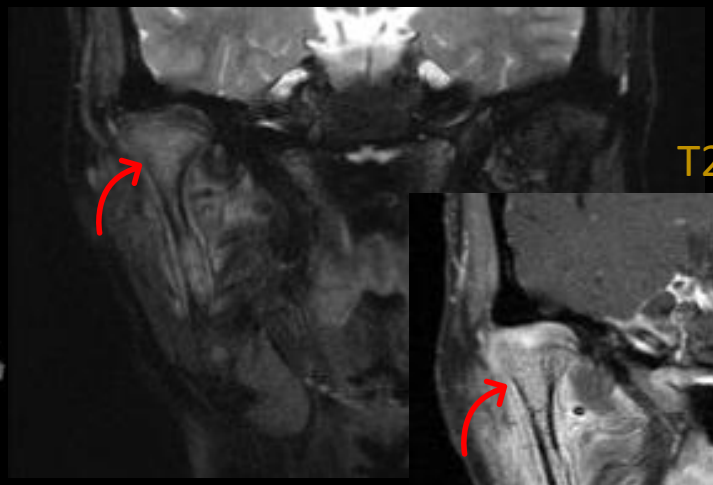
- Infectious extension beyond the periapical regions into the maxillary sinuses.

Imaging Findings:

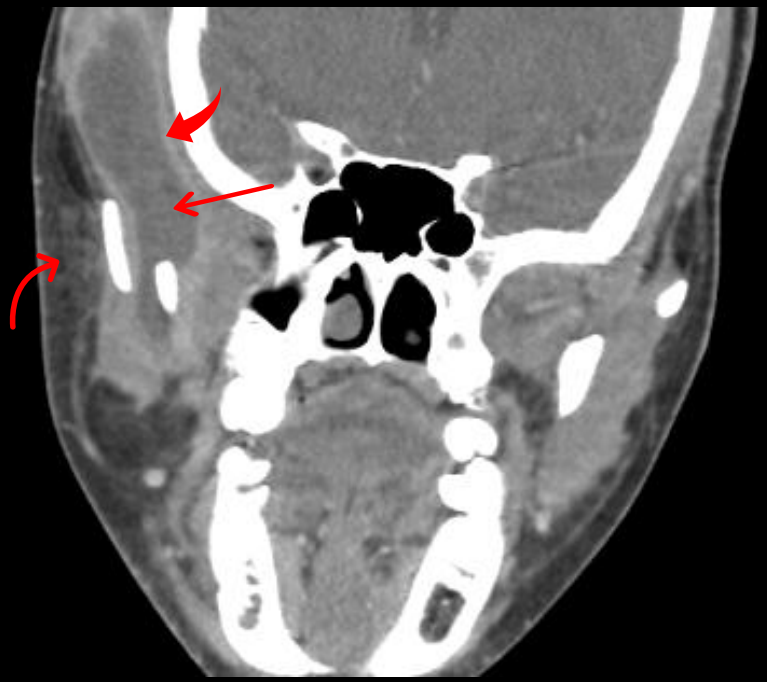
- Opacification of the overlying maxillary sinus from adjacent infection (⟵)
- Associated thickening of the sinus mucosa (↩)



T1+C FS



T2 FS



[Abscess Extension]

Pathophysiology:

- Infection or abscess extension beyond the adjacent bony cortex into the surrounding soft tissue.

Imaging Findings:

- Well circumscribed hypodense soft tissue fluid collection (⟵)
- Well-defined rim of enhancement (↶)
- Adjacent soft tissue swelling and bone marrow edema (↶)

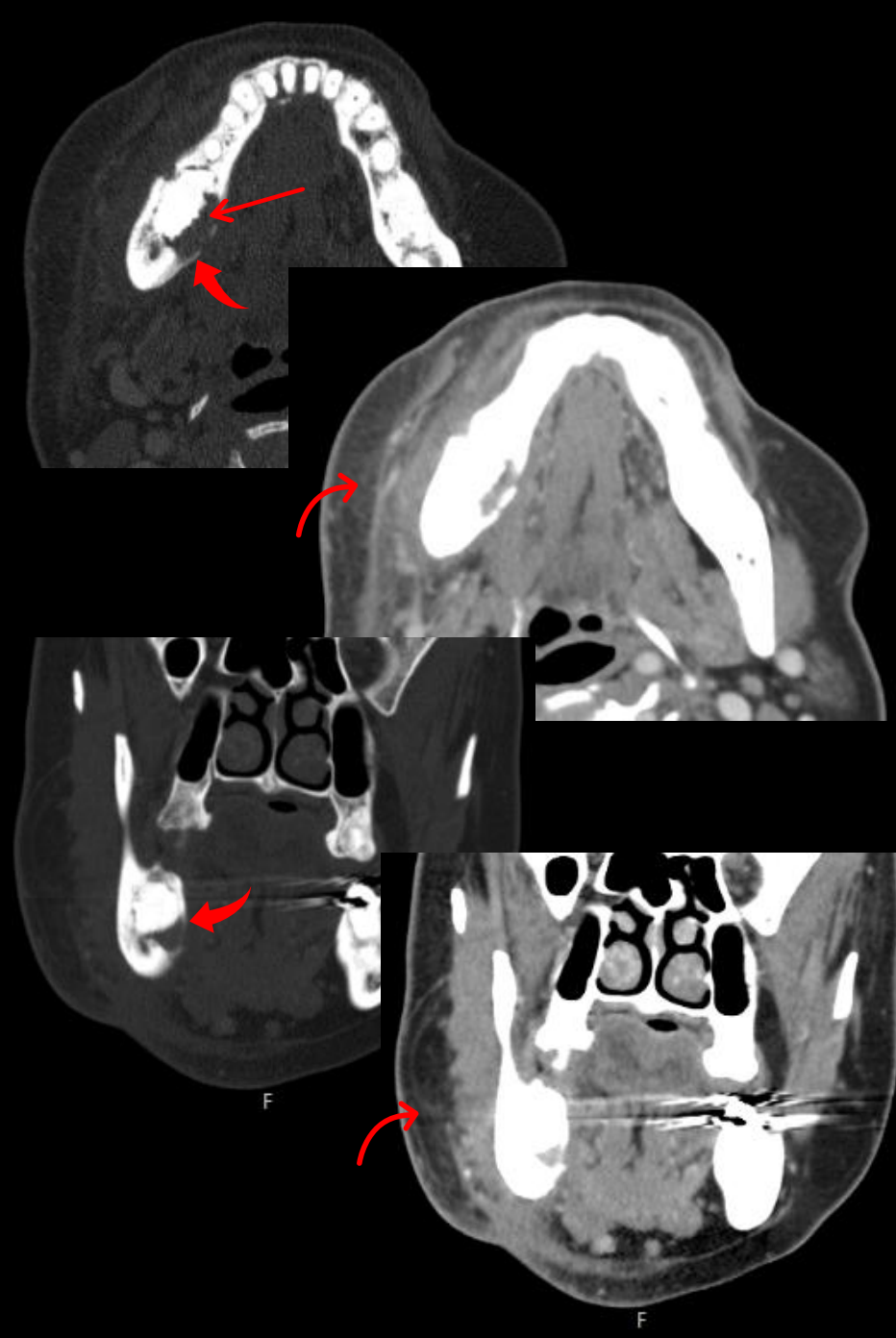
[Thrombophlebitis]

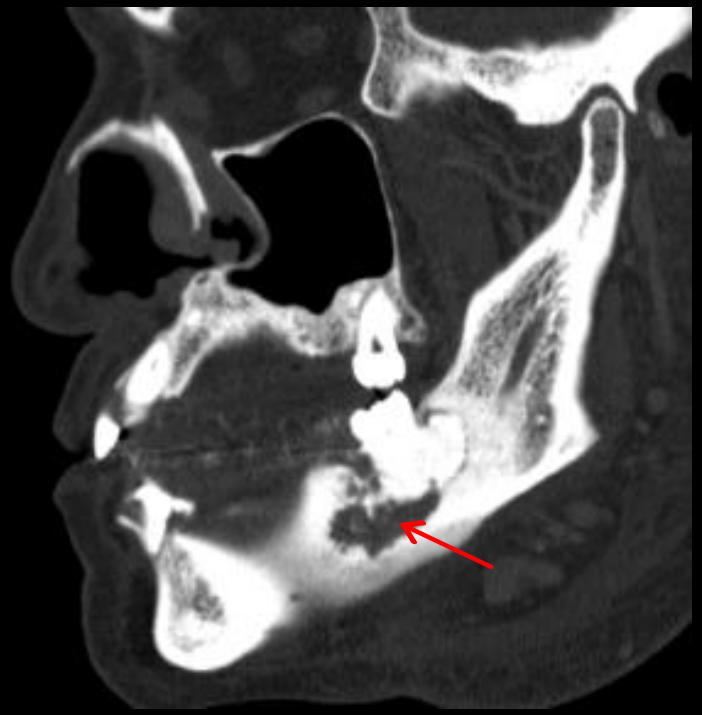
Pathophysiology:

- Thrombus formation and associated inflammation in a venous structure.

Imaging Findings:

- Filling defect (⟵)
- Adjacent soft tissue swelling (↙)
- Enhancement of the vessel wall and perivascular tissue





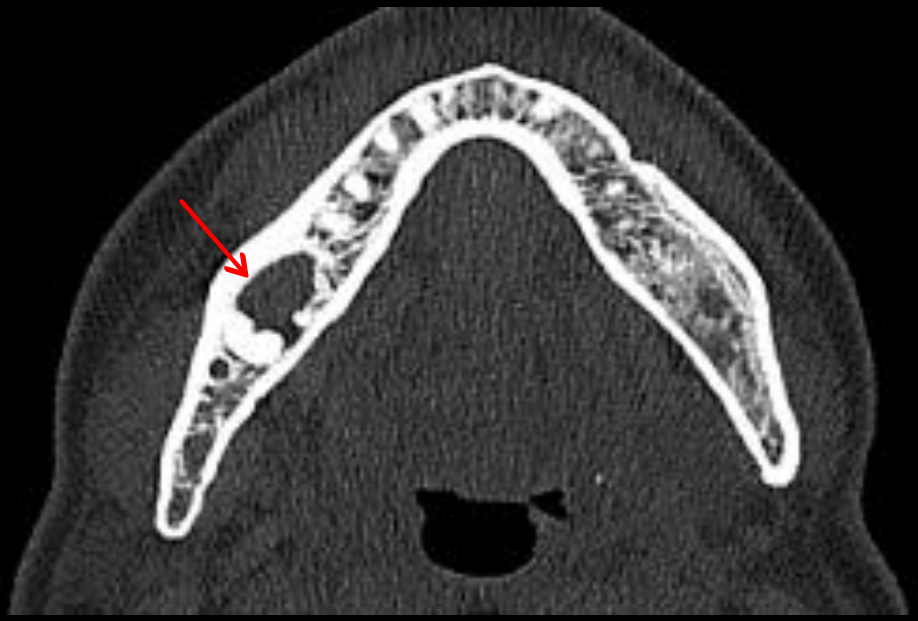
[Osteomyelitis]

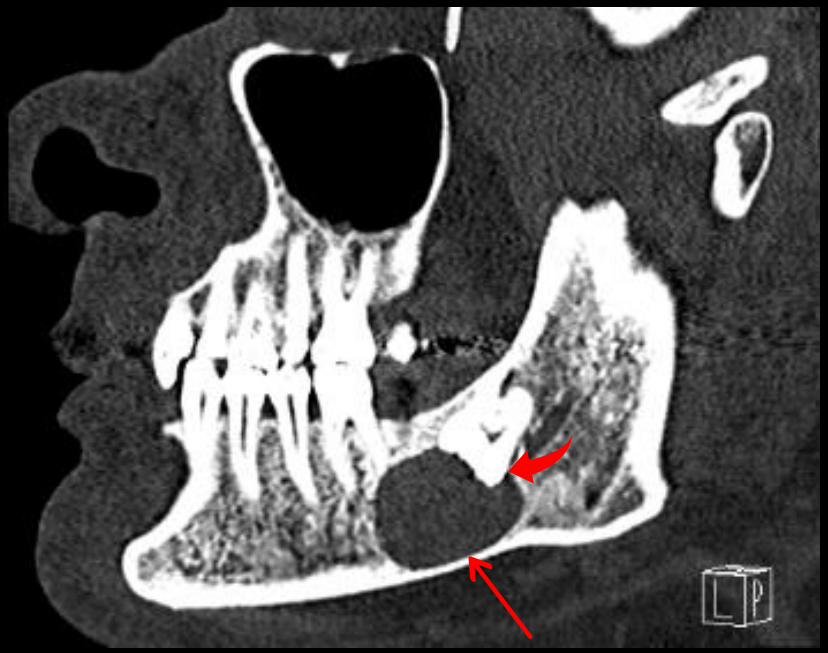
Pathophysiology:

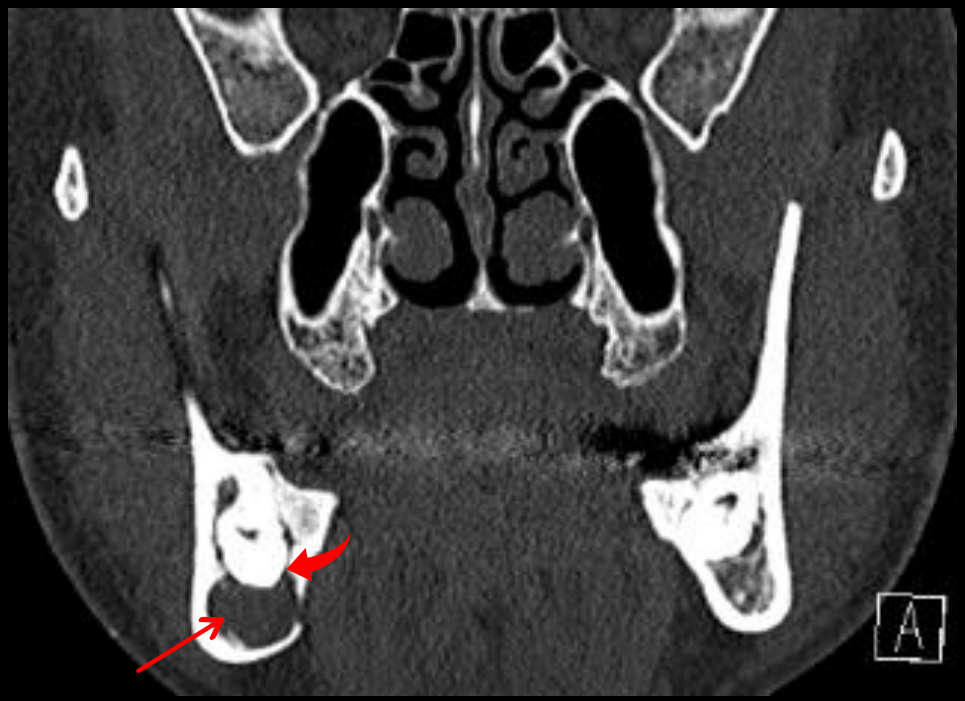
- Infectious spread into the surrounding bone.

Imaging Findings:

- Vague, ill-defined central bony lucency with ragged border and indistinct cortex (⟵)
- Hyperdense periosteal reaction (↶)
- Adjacent soft tissue swelling (↶)







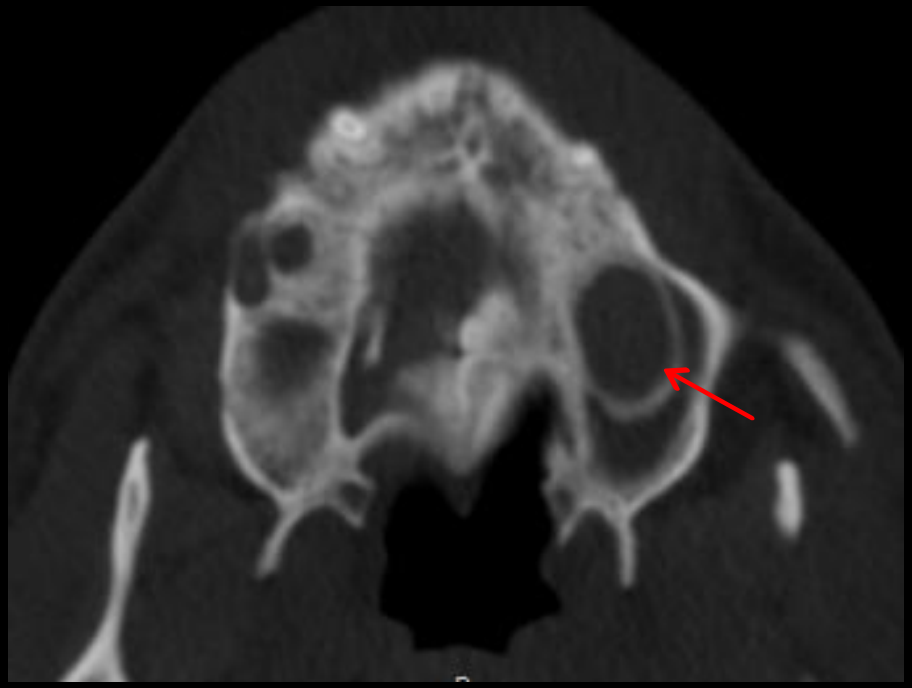
[Dentigerous cyst]

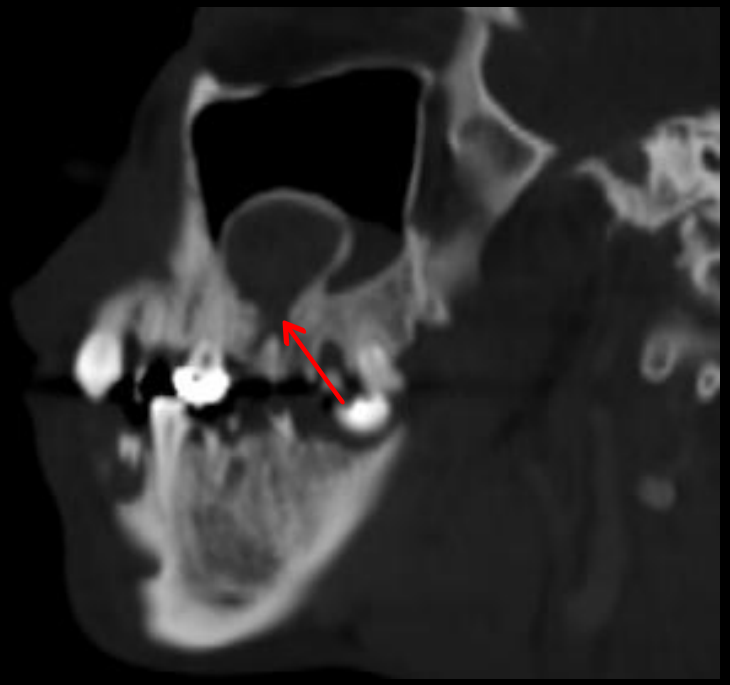
Pathophysiology:

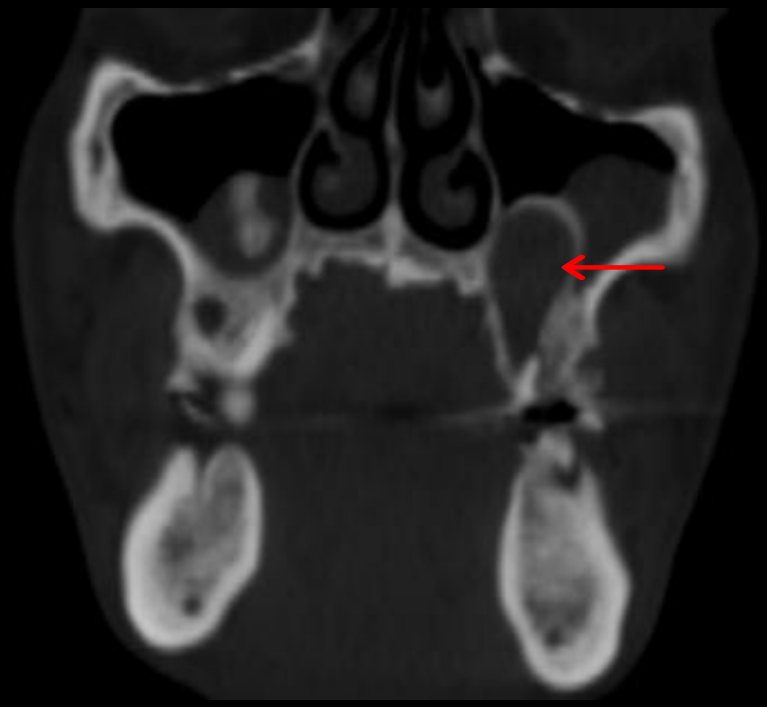
- Accumulation of fluid between the reduced enamel epithelium and the enamel of an unerupted tooth.

Imaging Findings:

- Hypodense, well-circumscribed cyst which envelops the crown of an unerupted tooth (⟵)
- Cystic lesion terminates at the cementoenamel junction of the tooth (↙)







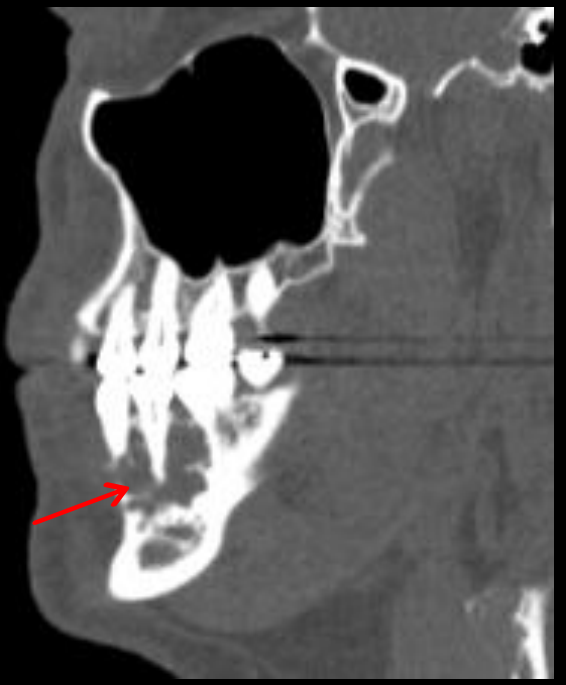
[Periapical (radicular) cyst]

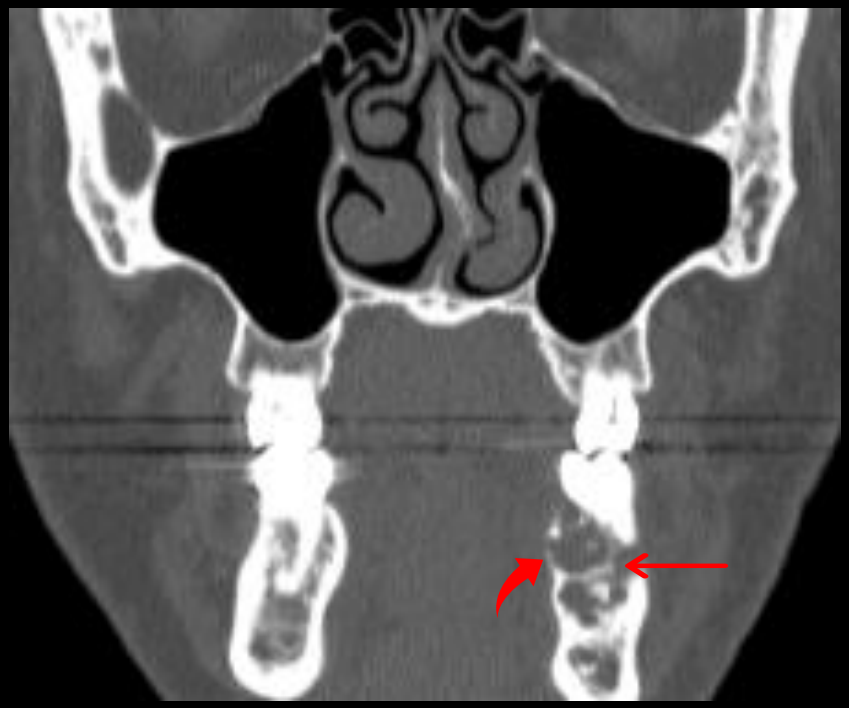
Pathophysiology:

- Periapical inflammation leads to epithelial proliferation, cystic formation, and surrounding bone resorption.

Imaging Findings:

- Hypodense, well-circumscribed cyst at the apex of a tooth (⟵)





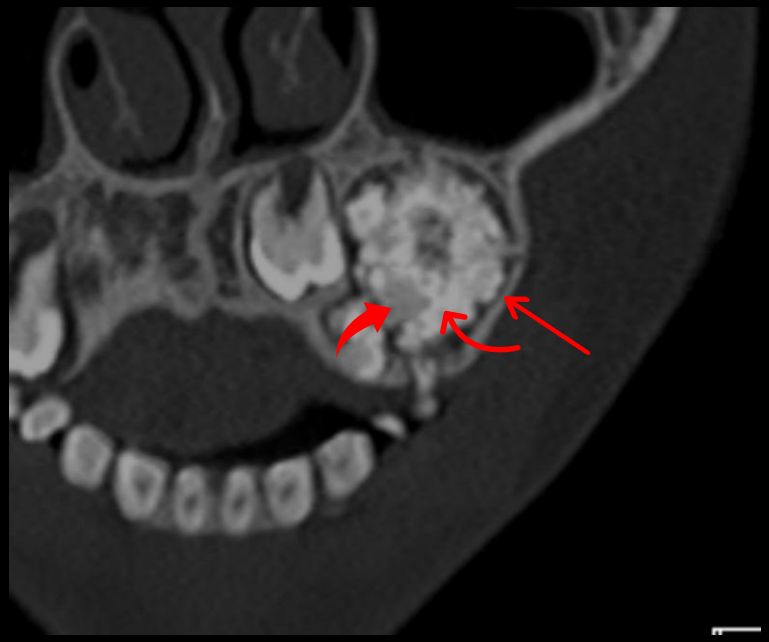
[Ameloblastoma]

Pathophysiology:

- Benign neoplastic transformation of enamel-depositing ameloblast cells resulting in various solid-cystic/cystic patterns.

Imaging Findings:

- Expansile, multi/uni-cystic lesion in a "soap bubble" appearance (⟵)
- Associated cortical thinning (↶)
- Enhancement of solid regions
- May erode adjacent teeth



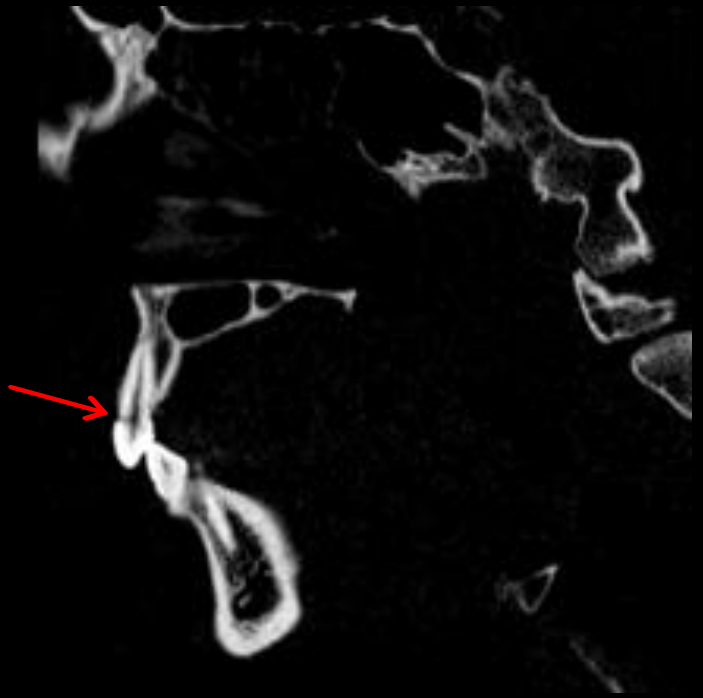
[Odontoma]

Pathophysiology:

- Disordered development of dental tissue (e.g. enamel, dentin, pulp), leading to a hamartomatous growth in various degrees of organization.

Imaging Findings:

- Heterogeneously hyperdense, well-circumscribed mass (←) with varying complexity (↶) (↷)
- [Compound Odontoma]: hyperdense tooth-like structure
- [Complex Odontoma]: disorganized, amorphous, hyperdense mineralized mass



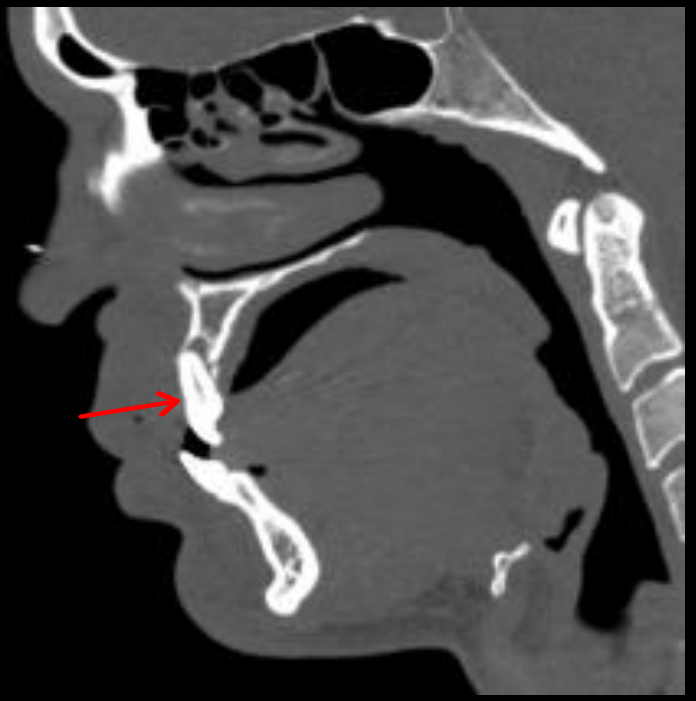
[Dental Fracture]

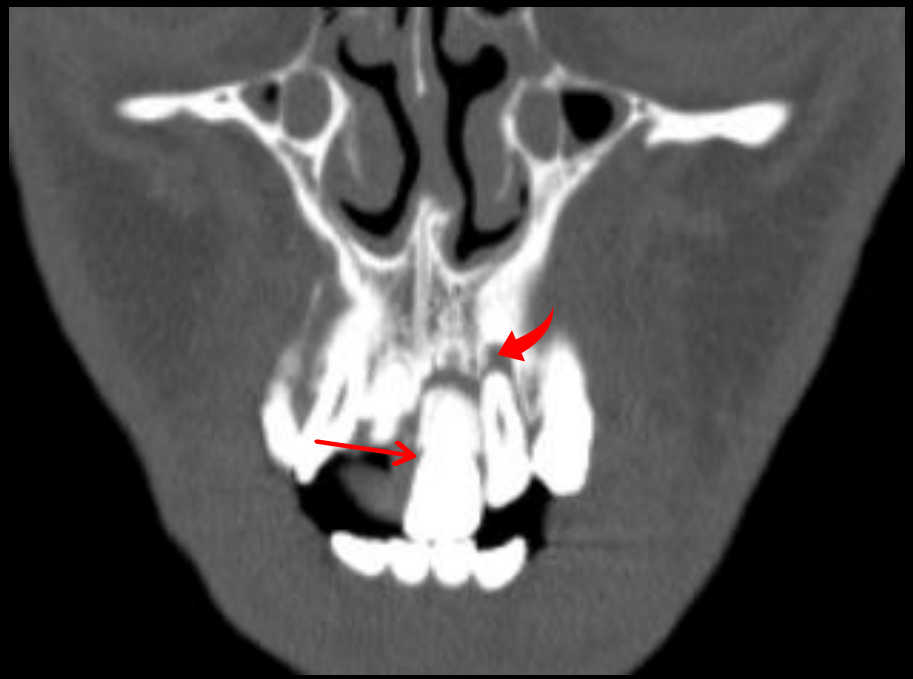
Pathophysiology:

- Traumatic injury leading to discontinuity among the components of a tooth (enamel, dentin, pulp).

Imaging Findings:

- Linear hypodense line through the tooth (⟵)
- Complete fracture can lead to displacement of the fracture fragment





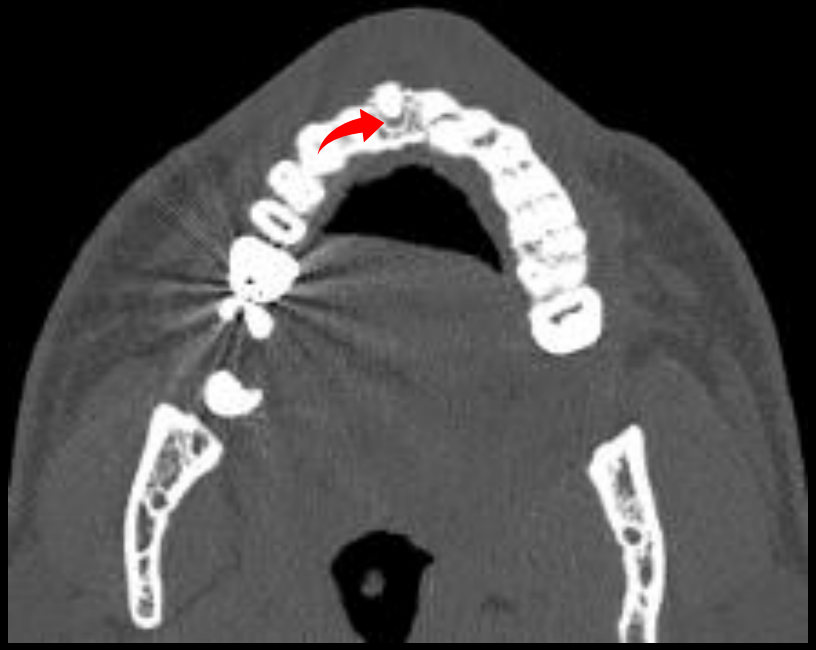
[Dental Luxation, Extrusive]

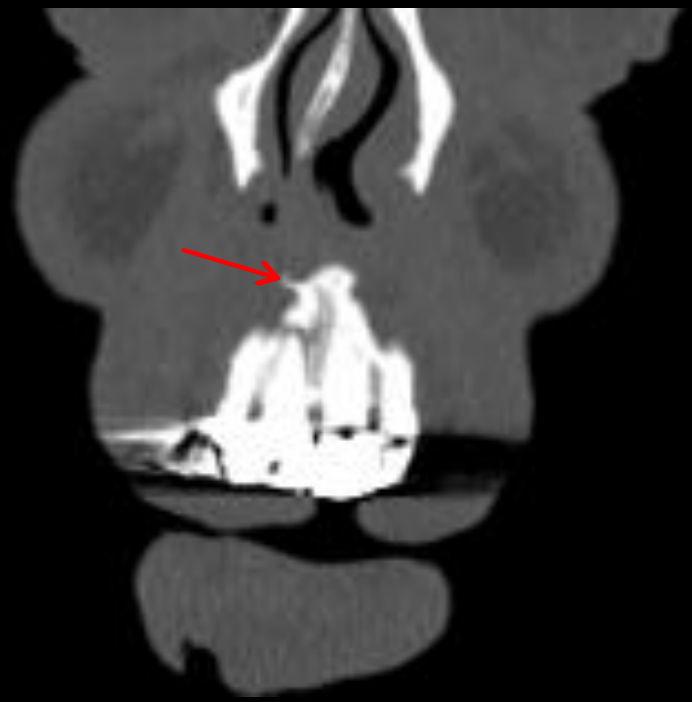
Pathophysiology:

- Traumatic injury leading to laxity/partial tearing of the periodontal ligament and partial dislocation of the tooth.

Imaging Findings:

- Hyperdense, displaced tooth *out* of socket
- Tooth appears longer (⟵)
- Widening of the periodontal ligament space (↶)





[Dental Luxation, Lateral]

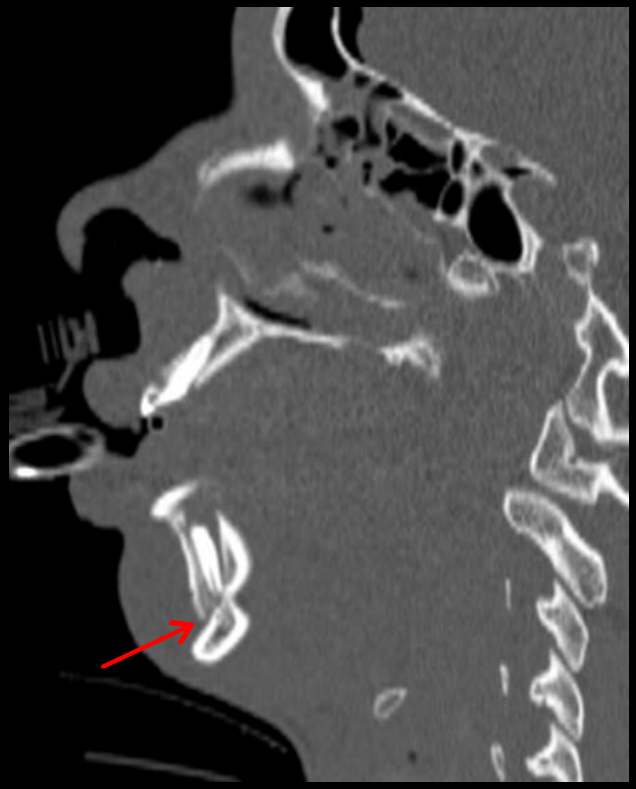
[Subtype: Labial]

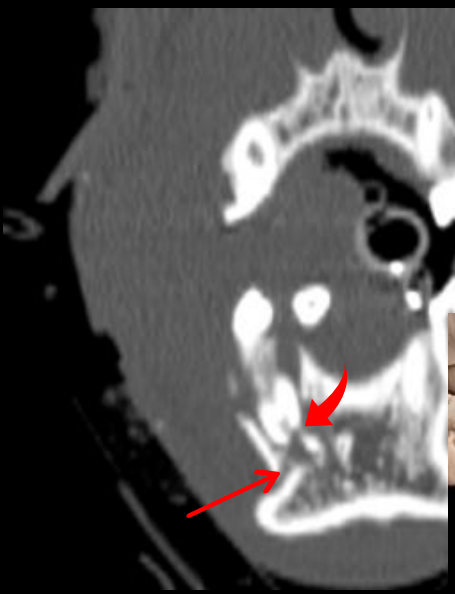
Pathophysiology:

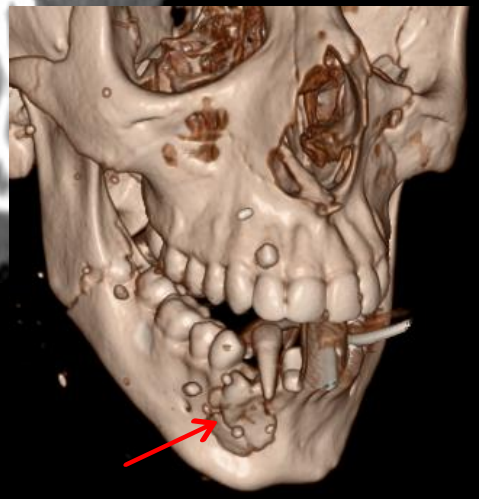
- Traumatic injury leading to laxity/partial tearing of the periodontal ligament and partial dislocation of the tooth.
- Subcategorized as labial (towards lips) or lingual (towards tongue)

Imaging Findings:

- Hyperdense, *laterally* displaced tooth
- Often resulting in fracture of supporting alveolar bone (⟵)
- Widening of the periodontal ligament space ( )







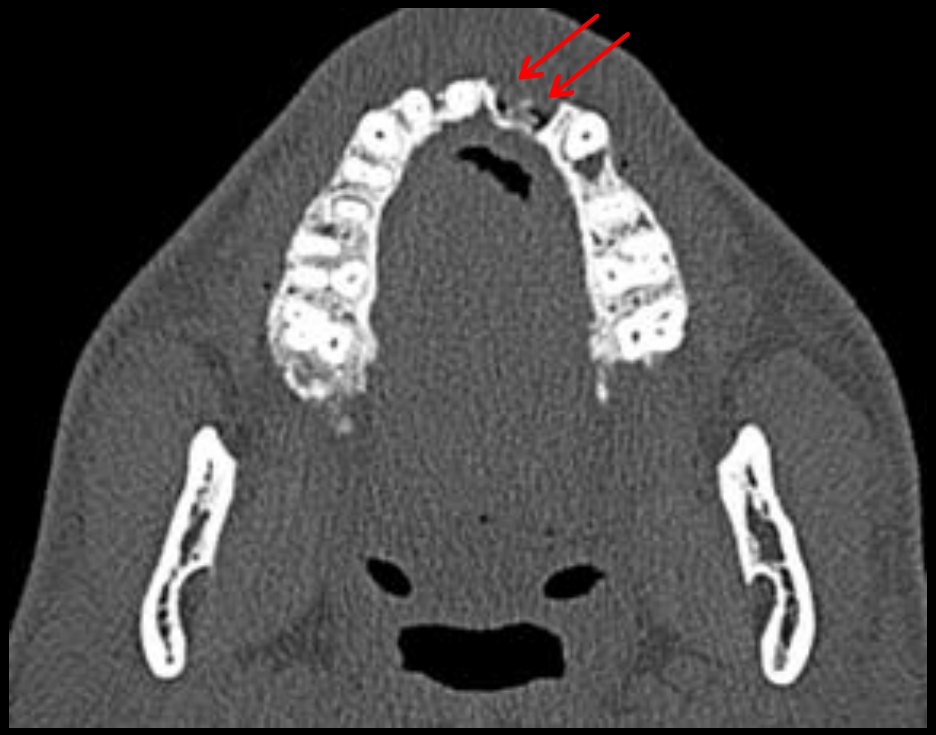
[Dental Luxation, Intrusive]

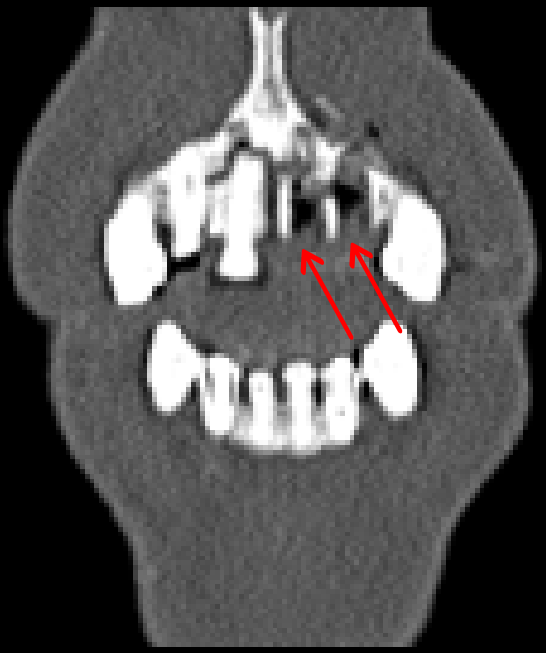
Pathophysiology:

- Traumatic injury leading to laxity/partial tearing of the periodontal ligament and partial dislocation of the tooth.
- A type of impaction injury

Imaging Findings:

- Hyperdense, displaced tooth *into* socket
- Tooth appears foreshortened (⟵)
- Often results in fracture/crush of the root of tooth and supporting alveolar bone ( )





[Dental Avulsion]

Pathophysiology:

- Traumatic injury leading to complete tearing of the periodontal ligament and complete dislocation of the tooth from the socket.

Imaging Findings:

- Empty socket (⟵)

References

Biology Explaining Tooth Repair and Regeneration: A Mini-Review.
Balic A.
Gerontology. 2018;64(4):382-388. doi:10.1159/000486592.

The Intricate Anatomy of the Periodontal Ligament and Its Development: Lessons for Periodontal Regeneration.
de Jong T, Bakker AD, Everts V, Smit TH.
Journal of Periodontal Research. 2017;52(6):965-974. doi:10.1111/jre.12477.

Elemental Mapping of Human Teeth Enamel, Dentine and Cementum in View of Their Microstructure.
Sarna-Boś K, Skic K, Boguta P, et al.
Micron (Oxford, England : 1993). 2023;172:103485. doi:10.1016/j.micron.2023.103485.

Teeth: What Radiologists Should Know.
Scheinfeld MH, Shifteh K, Avery LL, Dym H, Dym RJ.
Radiographics : A Review Publication of the Radiological Society of North America, Inc. 2012 Nov-Dec;32(7):1927-44. doi:10.1148/rg.327125717.

Periapical Lucency Around the Tooth: Radiologic Evaluation and Differential Diagnosis.
Chapman MN, Nadgir RN, Akman AS, et al.
Radiographics : A Review Publication of the Radiological Society of North America, Inc. 2013 Jan-Feb;33(1):E15-32. doi:10.1148/rg.331125172.

Imaging of Odontogenic Infections.
Mardini S, Gohel A.
Radiologic Clinics of North America. 2018;56(1):31-44. doi:10.1016/j.rcl.2017.08.003.

Inflammatory Disease of the Jaw: Appearance on Reformatted CT Scans.
Abrahams JJ, Berger SB.
AJR. American Journal of Roentgenology. 1998;170(4):1085-91. doi:10.2214/ajr.170.4.9530065.

Dental Anatomy and Pathology Encountered on Routine CT of the Head and Neck.
Steinklein J, Nguyen V.
AJR. American Journal of Roentgenology. 2013;201(6):W843-53. doi:10.2214/AJR.12.9616.

Odontogenic Orofacial Infections.
Bertossi D, Barone A, Iurlaro A, et al.
The Journal of Craniofacial Surgery. 2017;28(1):197-202. doi:10.1097/SCS.0000000000003250.

Inflammatory Disease of the Jaw: Appearance on Reformatted CT Scans.
Abrahams JJ, Berger SB.
AJR. American Journal of Roentgenology. 1998;170(4):1085-91. doi:10.2214/ajr.170.4.9530065.

Dental Anatomy and Pathology Encountered on Routine CT of the Head and Neck.
Steinklein J, Nguyen V.
AJR. American Journal of Roentgenology. 2013;201(6):W843-53. doi:10.2214/AJR.12.9616.

Cysts and Cystic Lesions of the Mandible: Clinical and Radiologic-Histopathologic Review.
Scholl RJ, Kellett HM, Neumann DP, Lurie AG.
Radiographics : A Review Publication of the Radiological Society of North America, Inc. 1999 Sep-Oct;19(5):1107-24. doi:10.1148/radiographics.19.5.g99se021107.