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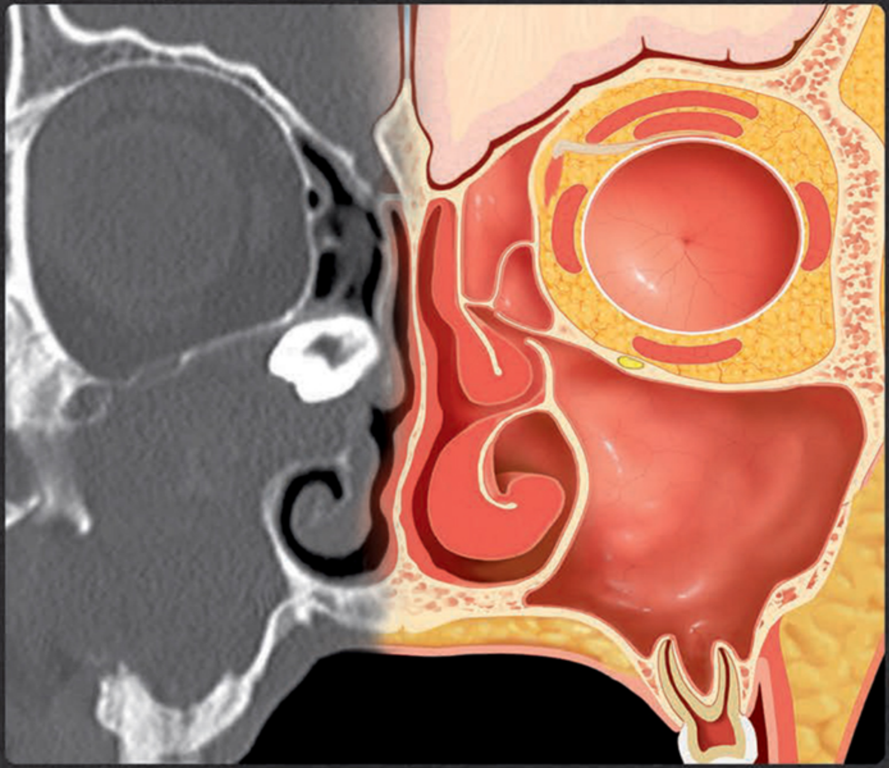
Diagnostic Imaging

Oral and Maxillofacial

SECOND EDITION



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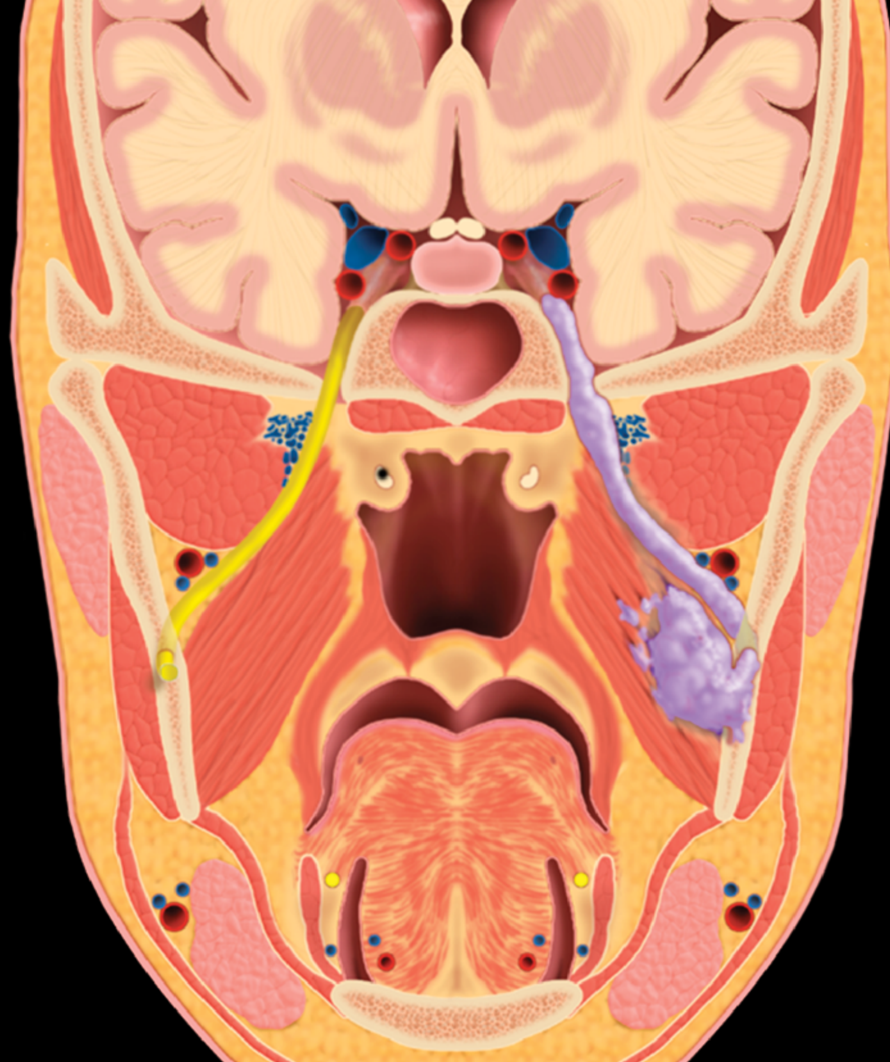

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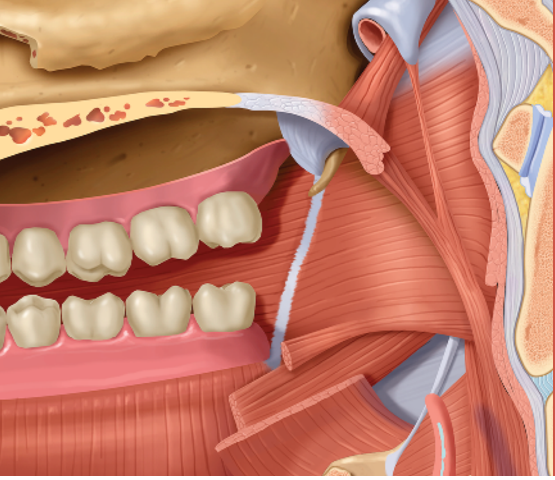

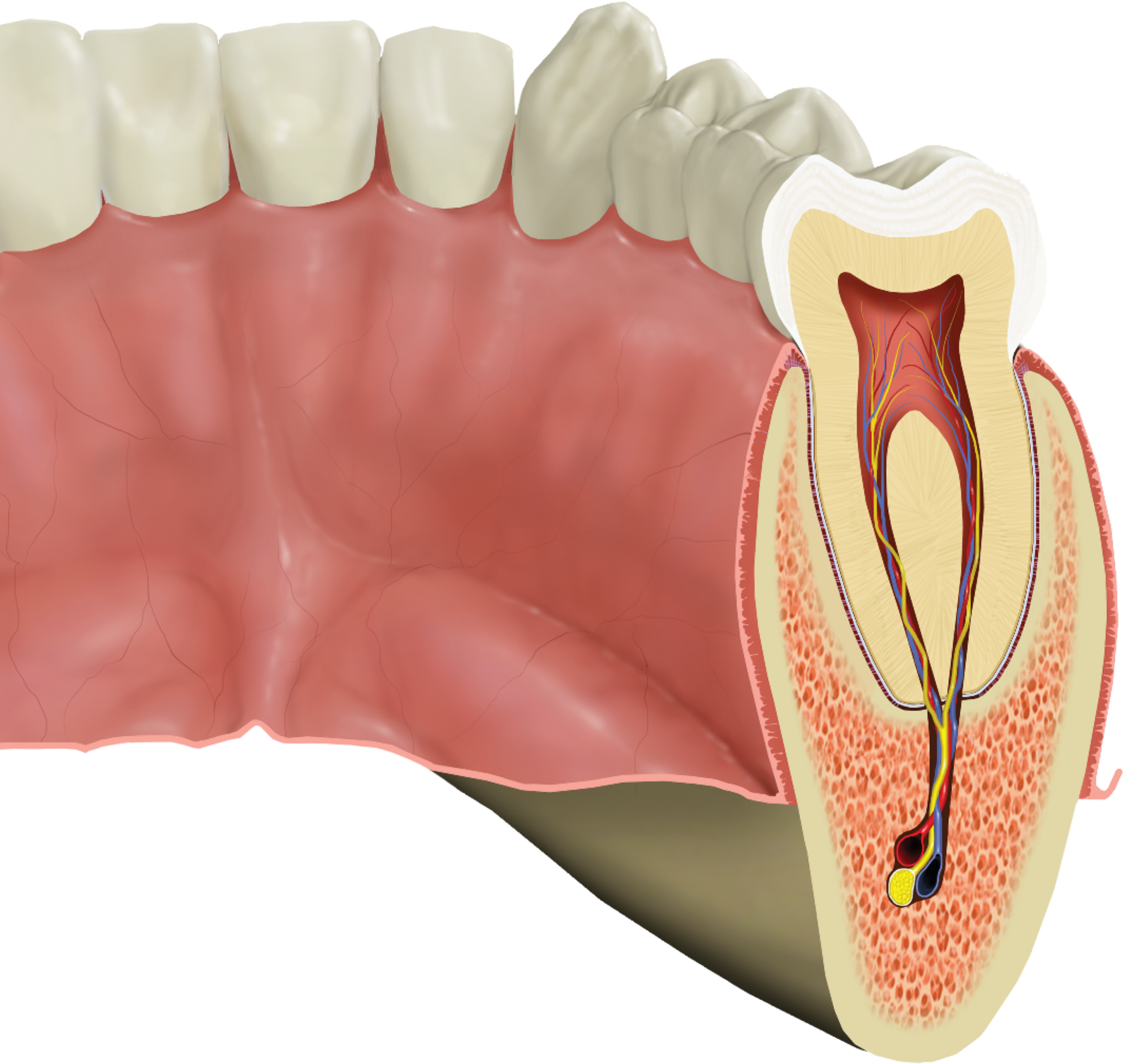

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Dedications

To my children, Sophie, Ben, Alex, Jack, and especially Natalie and baby Raphi, who have kept me grounded; my friend Esme, who made me food; and my students and patients who inspire me.

LJK

Dedicated to all the incredible teachers I've had in my life, most notably my parents and children. Time management and compassion are the most precious of skills.

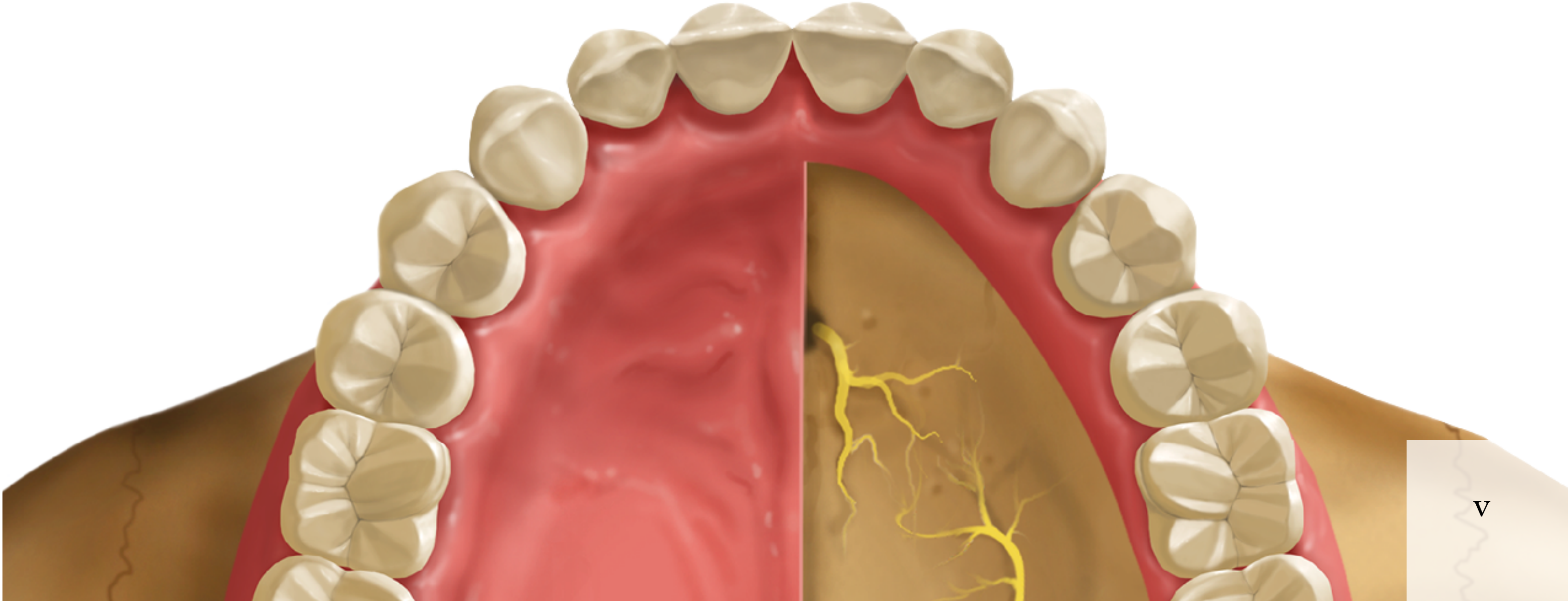
DT

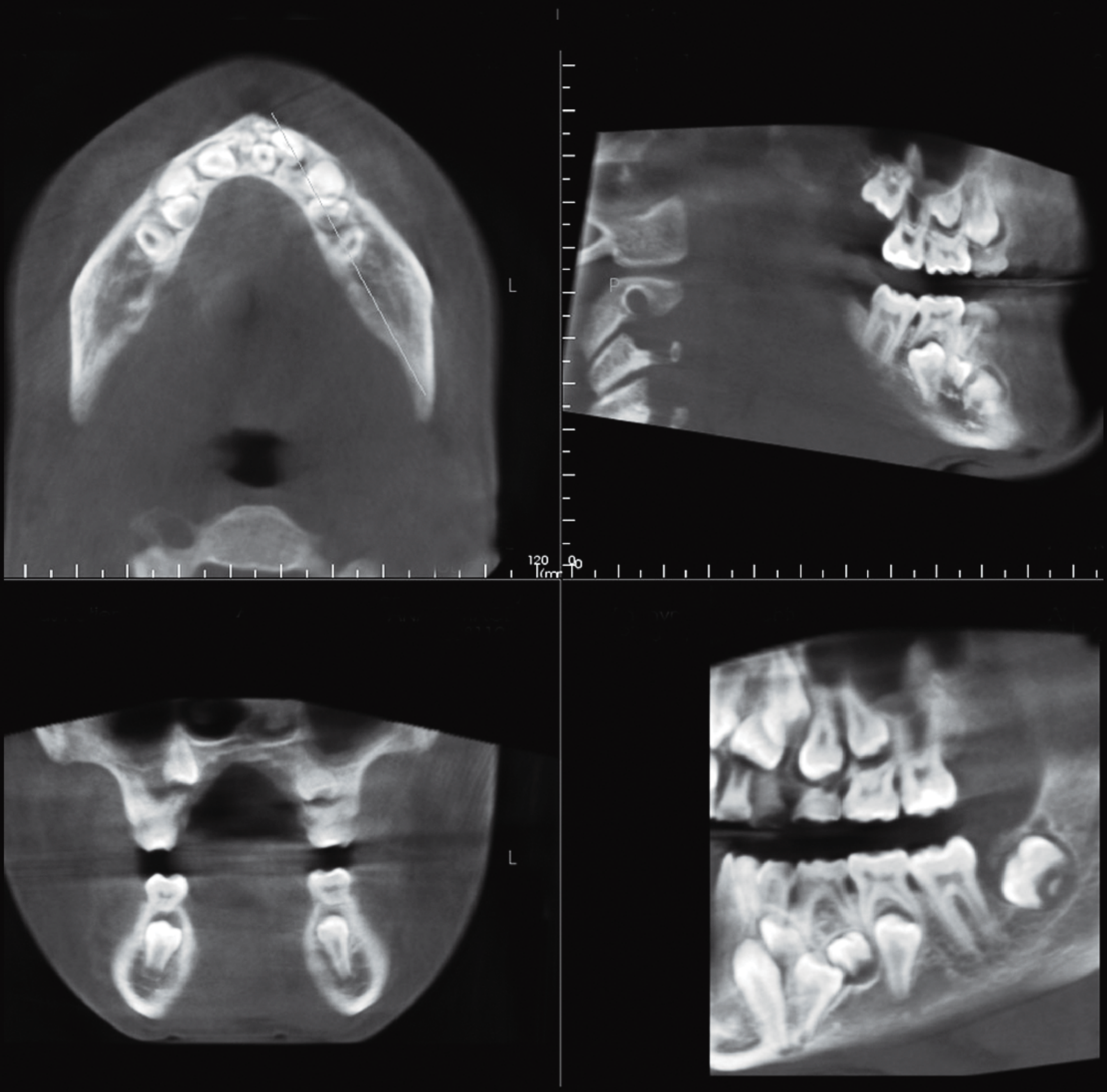
Thank you to my parents for encouraging me to pursue a career in dentistry during a time when women comprised only a small minority in dental school classes. Thanks also to my teachers and mentors during my oral radiology training, as well as my coauthors, colleagues, and editors, who so generously shared their knowledge and experience as this book was being written. My biggest thanks go to my husband and best friend, Eggert Boehlau, who has so generously supported me, both in my work as a radiologist, which puts food on the table, and my passion as a musician, which feeds the soul.

CGP

To my teachers: For showing me the path.
To my students: For keeping me on it.
To Mom, Dad, and Kristina: For your enthusiasm.
To Anya and Daphne: For always sleeping while I wrote.
To Mark: For always staying up…I love you.

SEP

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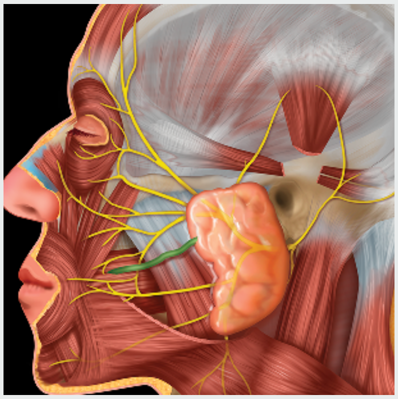

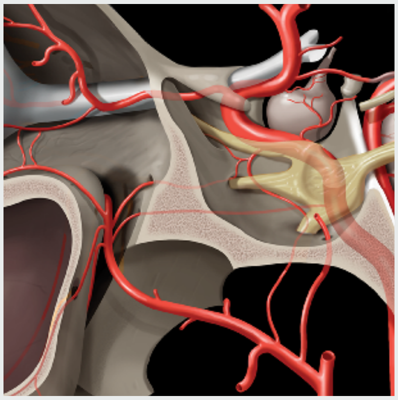

Preface

We are very proud to present the second edition of our Diagnostic Imaging text dedicated to oral and maxillofacial radiology. As in the first edition, the book is divided into three parts: Anatomy, Diagnoses, and Differential Diagnoses. The Anatomy part has seen the addition of a chapter on the posterior skull base that reflects the increasing need for oral and maxillofacial radiologists to interpret larger fields of view. In this regard, the Diagnoses part includes 18 new chapters dedicated to the more common findings in the cervical spine. There are also extended chapters on TMJ and airway evaluation. The Diagnoses part now contains over 200 chapters.

You will also find in this second edition new graphics from our expert illustrators, exquisitely detailing the Anatomy and Diagnoses parts and serving to enhance the learning experience. Each chapter has been meticulously updated with the addition of new references and images wherever possible.

Purchase of the book comes with an electronic version, Expert Consult, that allows for easy navigation between chapters and access to many more images, as well as text that was excluded from the print version due to page constraints.

We trust that this second edition, like the first, will appeal to both the beginning and the experienced radiologist, as well as the increasing number of general dental practitioners and specialists who are using CBCT technology in their offices. For medical radiologists, the book will also serve as a valuable companion text to *Diagnostic Imaging: Head and Neck*, third edition.

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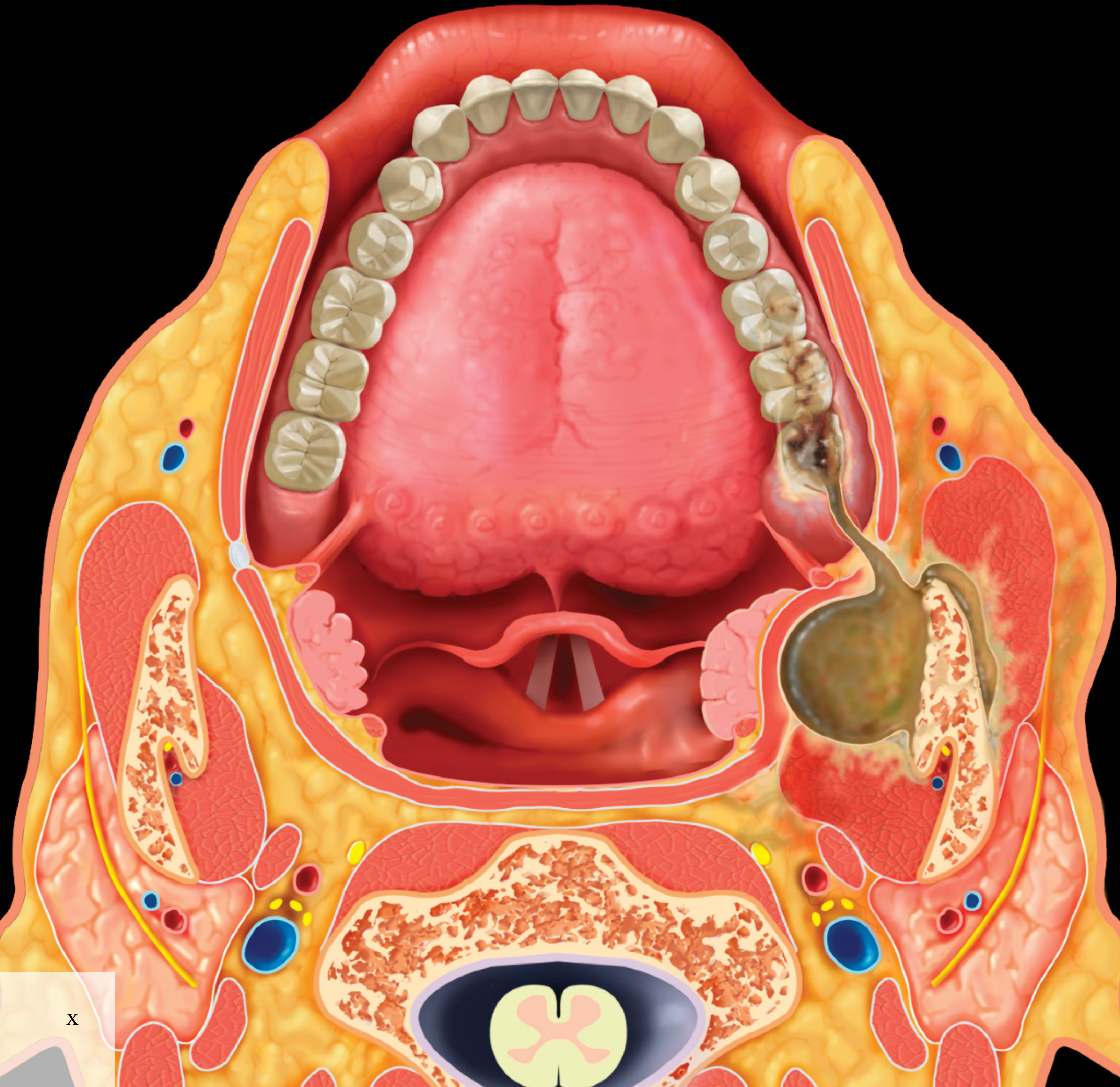

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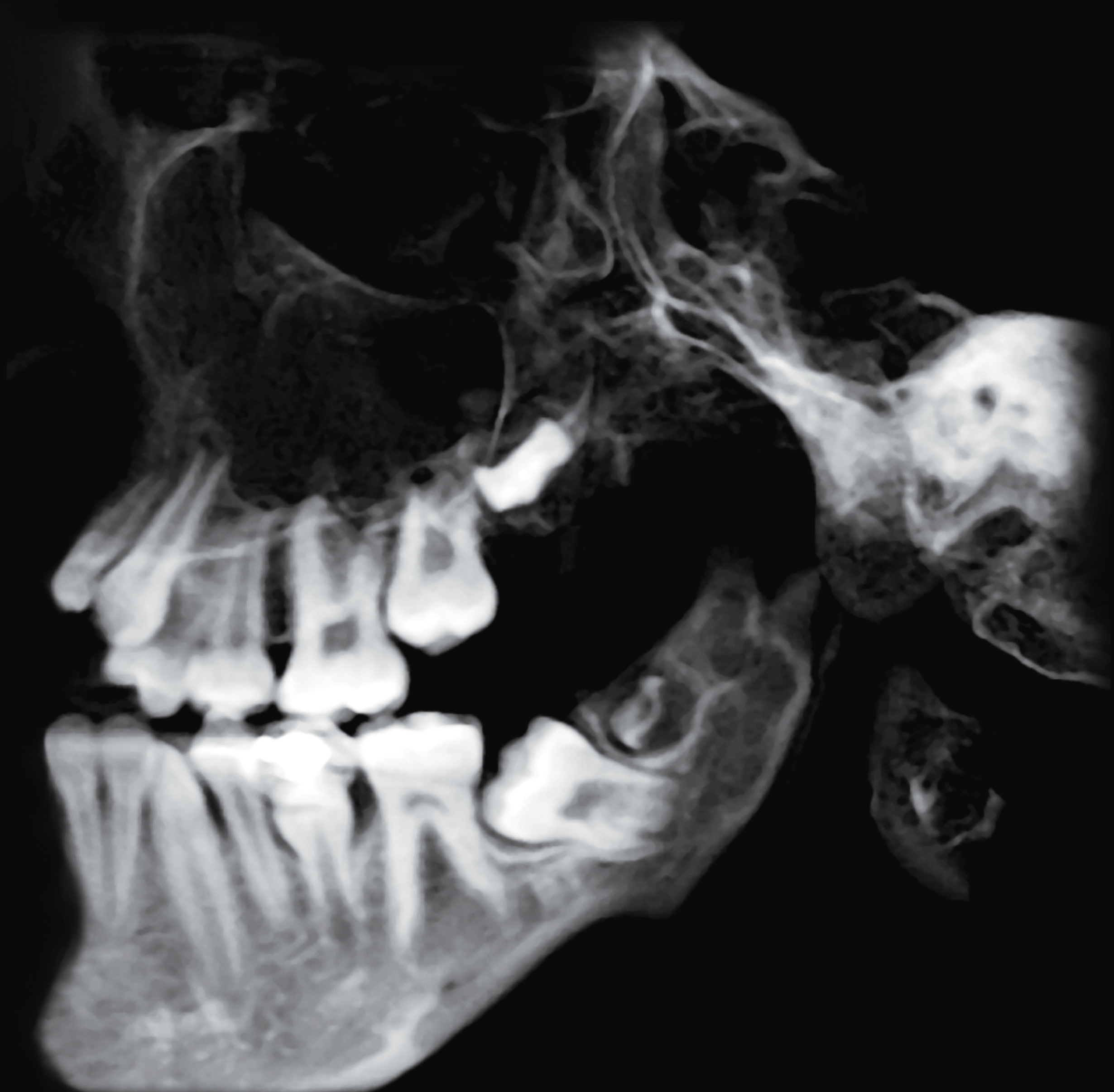

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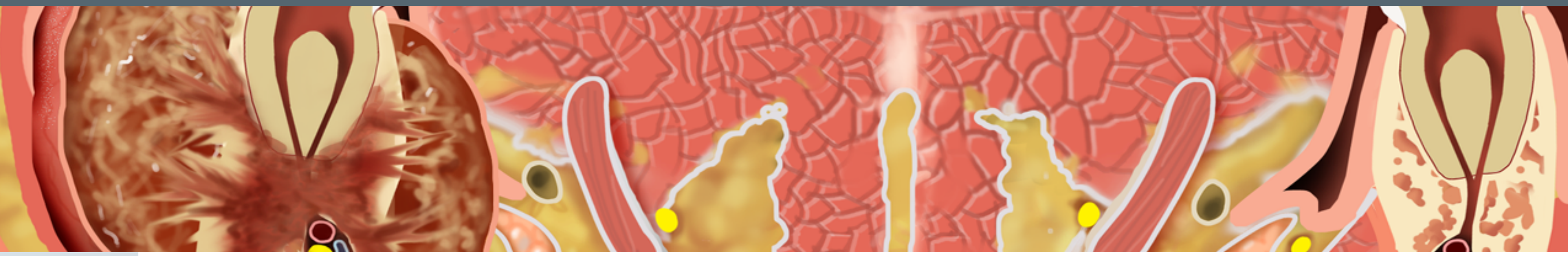

Part I: Anatomy

Part II: Diagnoses

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NASAL LESIONS

SINUS LESIONS

MISCELLANEOUS

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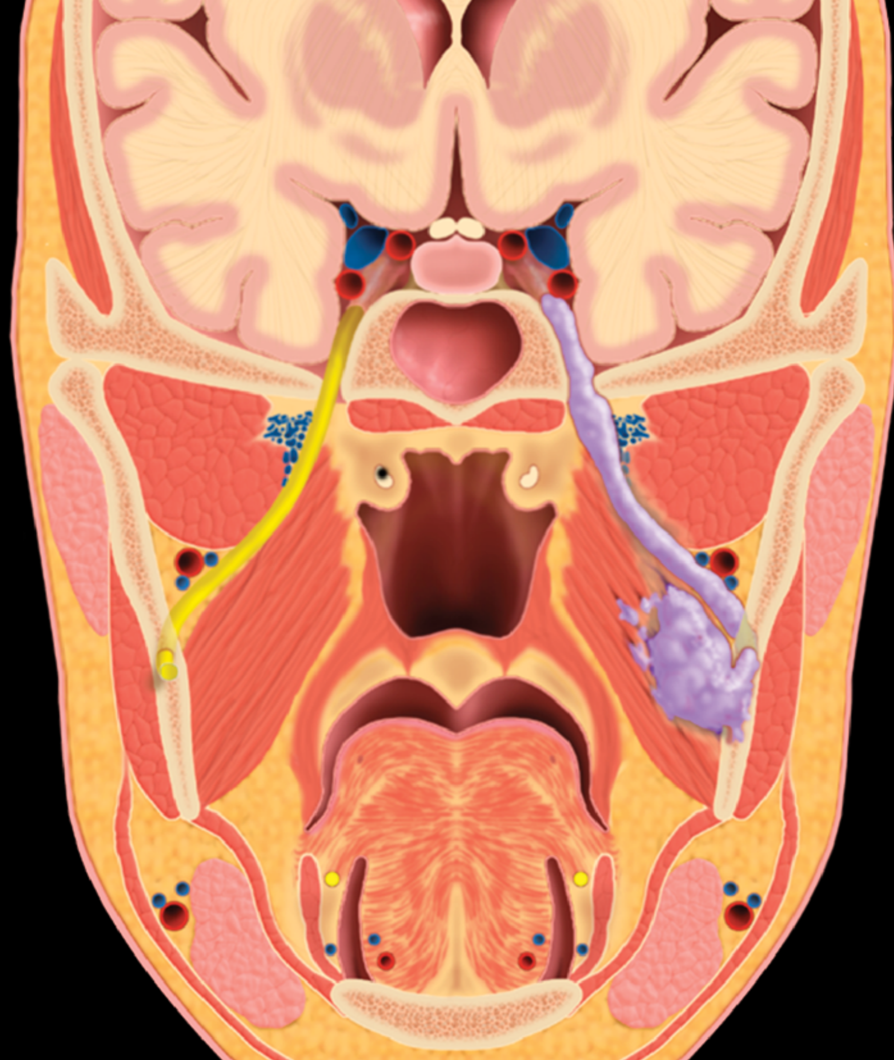

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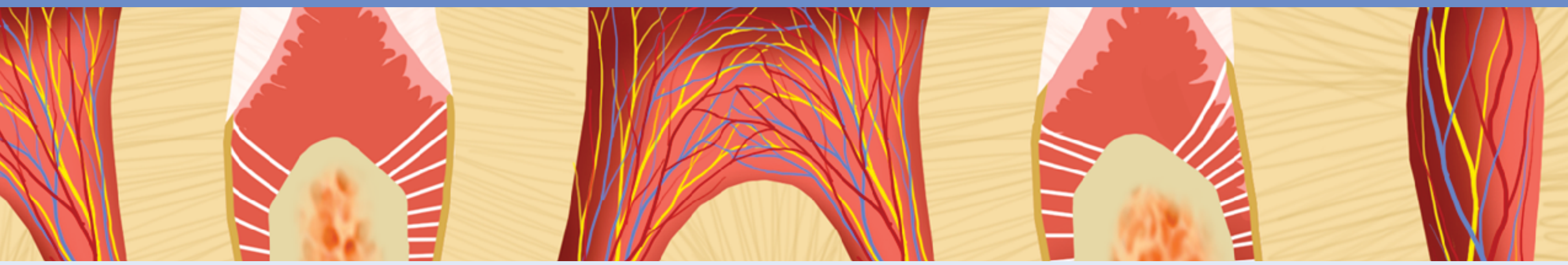
PART I
SECTION 1
Oral Cavity



TERMINOLOGY

Abbreviations

- Incisor (Inc), canine (C), premolar (PM), molar (M)

Synonyms

- Cuspid = canine
- Bicuspid = premolar

IMAGING ANATOMY

Overview

- Humans have 2 dentitions: **Primary** and **permanent**
- Teeth are divided into **maxillary** (upper) and **mandibular** (lower)
- Each jaw is divided into 2 quadrants: **Right** and **left** separated by midline
- Each quadrant has **5 primary** and **8 permanent teeth**
  - **Primary**: 2 Incs (central and lateral), 1 C, 2 Ms (1st and 2nd)
  - **Permanent**: 2 Incs (central and lateral), 1 C, 2 PMs (1st and 2nd), 3 Ms (1st, 2nd, and 3rd)
- Teeth can be **named** or **numbered**
- Naming teeth should follow this sequence: Dentition → jaw → side → tooth name
  - Example: **Primary maxillary right 1st M**; permanent mandibular left C
  - Exceptions are PMs and 3rd Ms: Only present in permanent dentition, so no need to use "permanent"
  - If only permanent teeth are present (all primary teeth have been exfoliated), no need to use "permanent"
- **Numbering teeth depends on country**
  - Most countries use **FDI (Federation Dentaire International) system for numbering**
    - **Quadrants are numbered**
    - Permanent: Upper right (UR) = 1, upper left (UL) = 2, lower left (LL) = 3, lower right (LR) = 4
    - Primary: UR = 5, UL = 6, LL = 7, LR = 8
    - **Teeth are numbered**
    - Permanent: Central Inc = 1, lateral Inc = 2, C = 3, 1st PM = 4, 2nd PM = 5, 1st M = 6, 2nd M = 7, 3rd M = 8
    - Primary: Central Inc = 1, lateral Inc = 2, C = 3, 1st M = 4, 2nd M = 5
    - Example: Permanent mandibular right 1st M = tooth #46 **(pronounced four six)**
  - United States uses **universal system**
    - **Only teeth are numbered**
    - Permanent teeth start with #1 (maxillary right 3rd M) and go to #16 (maxillary left 3rd M) pronounced **sixteen**
    - Mandibular left 3rd M is #17 **(seventeen)** and goes to mandibular right 3rd M #32 **(thirty two)**
    - Primary teeth are labeled with letters A → T starting with last M on UR: UR → UL→ LL → LR
  - Other tooth numbering systems exist; check with local dental organization
  - When in doubt, **describe teeth by name**

Anatomy Relationships

- When describing teeth or objects in relation to teeth, **conventional anatomic positions** (inferior, posterior, medial, lateral, anterior, posterior) **are not used**
- Position is described in relation to
  - **Midline of arch** (i.e., line between central Incs), **not anatomical midline**
    - All **surfaces** of teeth that are **in direction** of midline of arch are **"mesial"**
    - All **surfaces** of teeth **away** from midline of arch are **"distal"**
  - **Inside or outside of arch**
    - Surfaces toward face are **facial** (can use buccal if posterior, labial if anterior)
    - Surfaces toward tongue are **lingual** (can use palatal if maxillary)
  - **Anatomic tooth**
    - If **above crown** of tooth, use **"coronal to"**
    - If **below apices** of tooth, use **"apical to"**

Eruption Patterns

- 3 phases of eruption: Primary, mixed, and permanent dentitions
- **Primary dentition**
  - **Starts to erupt between 6-12 months**
  - 1st teeth are usually lower central Incs; last teeth are 2nd Ms
- **Mixed dentition**
  - **Combination of primary and permanent teeth** have erupted
  - 1st permanent teeth are permanent 1st Ms at 6 years
  - Exfoliation of primary Incs followed by eruption of permanent Incs (6-9 years)
  - Exfoliation of primary mandibular Cs followed by eruption of permanent mandibular Cs (9-10 years)
  - Exfoliation of primary Ms followed by eruption of PMs (10-12 years)
  - Exfoliation of primary maxillary Cs followed by eruption of permanent Cs (11-12 years)
    - **May get crowded out of arch**, either impacted or malerupted
    - **High incidence of dentigerous cyst formation** with impaction of these teeth
- **Permanent dentition**
  - **No more primary teeth in jaws**
  - Eruption of permanent 2nd Ms (11-13 years)
  - Eruption of 3rd Ms (17-21 years)
    - **Impactions are common**; **dentigerous cysts** may occur around crown of impacted tooth

Tooth Anatomy

- Teeth are made up of 4 basic anatomic structures: Enamel, dentin, cementum, and pulp
  - **Enamel**
    - Hardest substance in body = most mineralized (95% calcified) = highest radiographic density
    - Covers crown of tooth; contacts dentin at **dentinoenamel junction**
    - Contacts cementum at **cementoenamel junction (CEJ)**
    - Develops from ameloblasts
  - **Dentin**
    - Makes up majority of tooth; provides resiliency to hard overlying enamel; 75% calcified

- Contains dentinoblastic processes: Tooth becomes sensitive when dentin is exposed
- **Cementum**
  - Thin layer of calcified material covering root of tooth and providing attachment for periodontal ligament (PDL)
  - Not visible radiographically unless hypercementosis occurs
- **Pulp** (a.k.a. "nerve")
  - Vital portion of tooth (tooth "dies" when pulp dies)
  - Contains nerves and vessels that enter and emerge through **apical foramen** of tooth
  - Most radiolucent portion of tooth
  - Crown portion called **pulp chamber** with pointy **pulp horns**; root portion called **pulp canal**
- Teeth are made up of **crown** and **root**
  - **Crown**: Everything above CEJ
    - Further subdivided into **occlusal/incisal, middle, and cervical 1/3rds**
    - Incs have incisal edges as functional component; all other teeth have cusps
  - **Root**: Everything below CEJ
    - Further subdivided into **cervical, middle, and apical 1/3rds**
    - Teeth can have single root or be multirooted; area between roots of tooth is called **furcation area**
    - Roots are named according to location in alveolar process: **Buccal, lingual, mesial, distal, mesiobuccal, distobuccal**

Periodontium

- Primary function is to support teeth; **when teeth are lost, periodontal bone recedes**
- Made up of **periodontal bone**, **PDLs**, and **gingiva**
  - **Periodontal bone**
    - Portion of alveolar processes of maxilla and mandible that come in direct contact with teeth
    - Most cervical aspect called **crest**; **corticated when healthy**
    - If **tooth is lost**, most cervical aspect of bone is called **residual ridge**
    - Bone at apex of tooth called **periapical bone**
    - Bone in furcation area called **furcal bone**
    - Thin radiopaque line seen radiographically lining tooth socket is called **lamina dura**
  - **PDL**
    - Multidirectional fibers that attach tooth to socket; offer resilience to tooth during function
    - Radiographically seen as uniform **radiolucent line on inside of lamina dura**
    - **If loses uniformity, suspect pathology**
    - Houses **epithelial rests of Malassez**, which may contribute to formation of cyst lining for odontogenic cysts
    - Position in relation to tooth can determine if lesion is attached to tooth structure (inside PDL) or not (outside PDL)
  - **Gingiva** (a.k.a. gums)
    - Soft tissue component covering periodontal bone
    - Attaches to root to form small gingival sulcus with crown; **cannot be visualized radiographically**

Tooth Development and Tumorigenesis

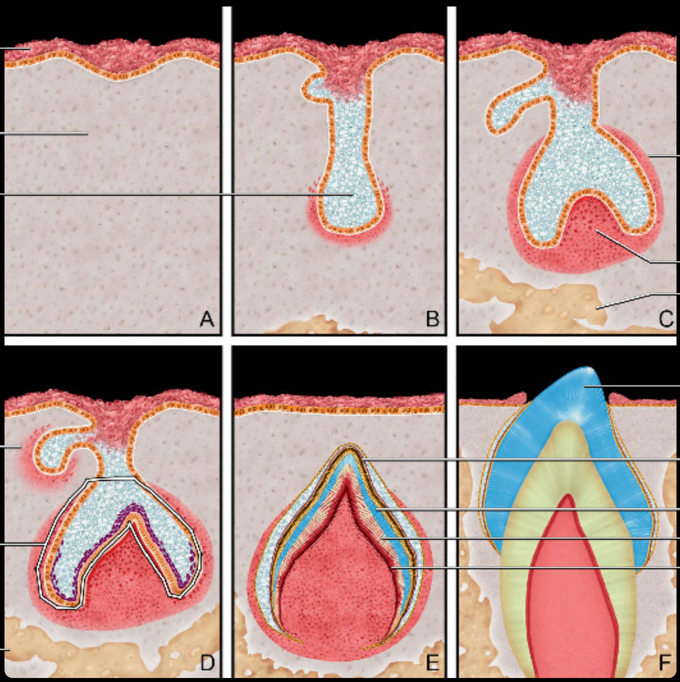
- Potential sources for development of tumors
  - **Prefunctional dental lamina** (odontogenic epithelium with ability to produce tooth); more abundant distal to lower 3rd Ms
  - **Postfunctional dental lamina**: Epithelial remnants, such as rests of Serres, in fibrous gingival tissue; epithelial cell rests of Malassez in PDL and reduced enamel organ epithelium (covers enamel surface until tooth eruption)
  - **Basal cell layer of gingival epithelium** (source of dental lamina)
  - **Dental papilla** (origin of dental pulp); can be induced to produce odontoblasts and synthesize dentin &/or dentinoid material
  - **Dental follicle**
  - **PDL**: Can induce production of fibrous and cemento-osseous mineralized material

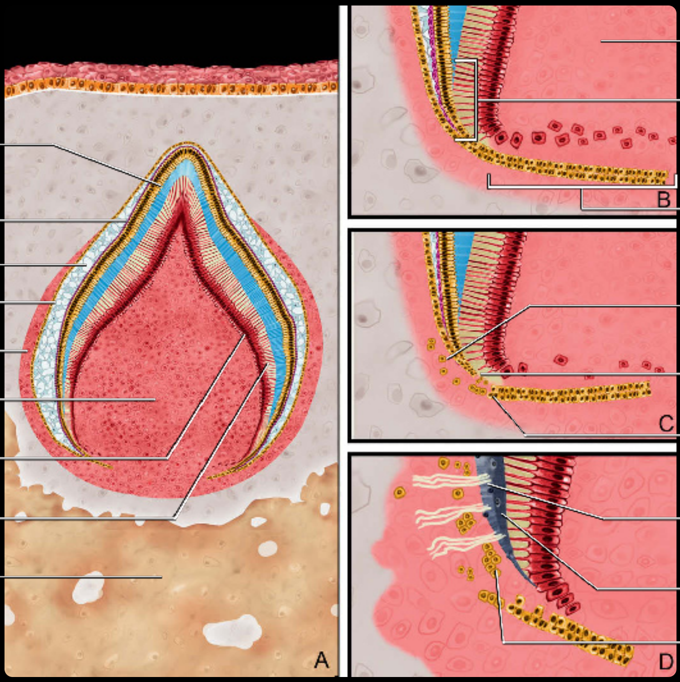
ANATOMY IMAGING ISSUES

Imaging Recommendations

- For imaging of teeth for **caries, periapical or periodontal disease, intraoral radiography** is recommended
  - **Horizontal bitewings for caries** and early periodontal disease detection
  - **Vertical bitewings** for moderate to severe **periodontal disease**
  - **Periapical radiographs** if **periapical pathology** is suspected
  - **Pros**: High-resolution images showing fine changes in demineralization; low radiation dose, especially if F-speed film or digital radiography is used
  - **Cons**: Limited to dimensions of intraoral film, cannot see lesions or impacted teeth if they extend beyond
- **For general overview of teeth in jaws**: **Panoramic radiography**
  - Shows eruption pattern and impactions of teeth; presence of intraosseous pathology
  - **Pros**: Cost effective; lower radiation dose when compared to CBCT
  - **Cons**: Distortion, magnification, and blurring can impede evaluation
- **For relationship of impacted teeth with vital anatomic structures: CBCT**
  - Can show inferior alveolar nerve canals in relation to 3rd Ms if extraction is planned
  - Can show relationship of impacted Cs to anterior superior alveolar canal, nasopalatine canal, and floor of nasal cavity
  - **Pros**: 3D representation of 3D structures; 3D reformations can be obtained to give exact visualization of anatomy
  - **Cons**: Expensive imaging modality, generally not covered by insurance; higher radiation dose
  - If unable to obtain CBCT or CT, use intraoral radiography and **SLOB** (**s**ame **l**ingual, **o**pposite **b**uccal) **rule** and **2 images at right angles** to one another

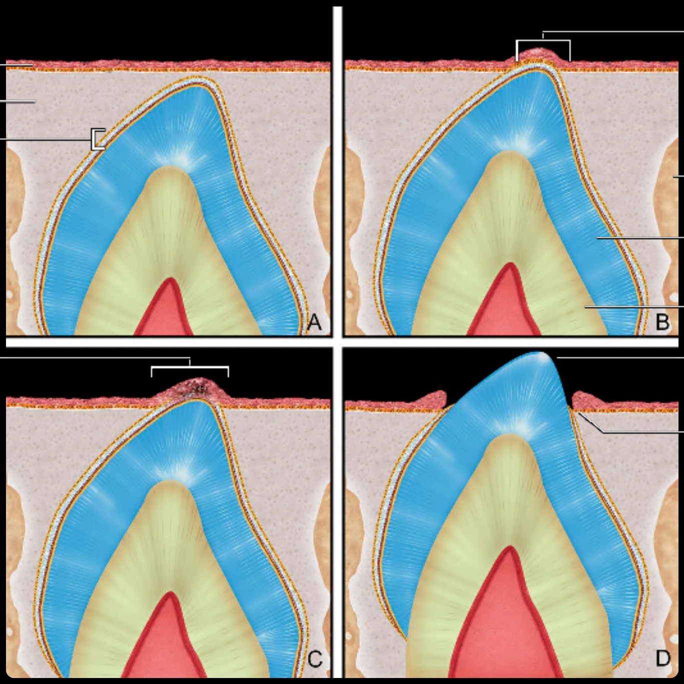
TOOTH DEVELOPMENT

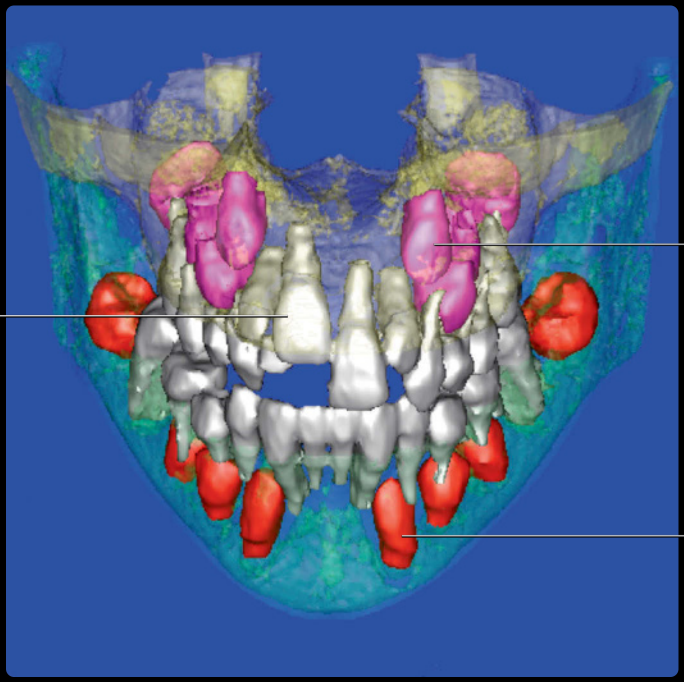




(Top) *Graphic shows stages of tooth development: (A) Initiation: Ectoderm develops oral epithelium and dental lamina, (B) bud stage: Dental lamina grows into bud penetrating the ectomesenchyme, (C) cap stage: Enamel organ forms cap surrounding dental papilla and surrounded by dental sac, (D) bell stage: Differentiation of enamel organ and dental papilla into different cells types, (E) apposition stage: Secretion of dental tissue matrix, and (F) maturation: Full mineralization of dental tissues.* **(Bottom)** *Graphic shows stages of root development: (A) Apposition stage, (B) enamel deposition completion at the cervical loop and formation of Hertwig epithelial root sheath from inner and outer enamel epithelium cells, (C) root sheath disintegration and fragmentation of some of its cells into epithelial rests of Malassez, and (D) formation of cementum and periodontal ligaments with persistence of these epithelial remnants, which may be the source of the epithelial component of some odontogenic cysts and tumors.*

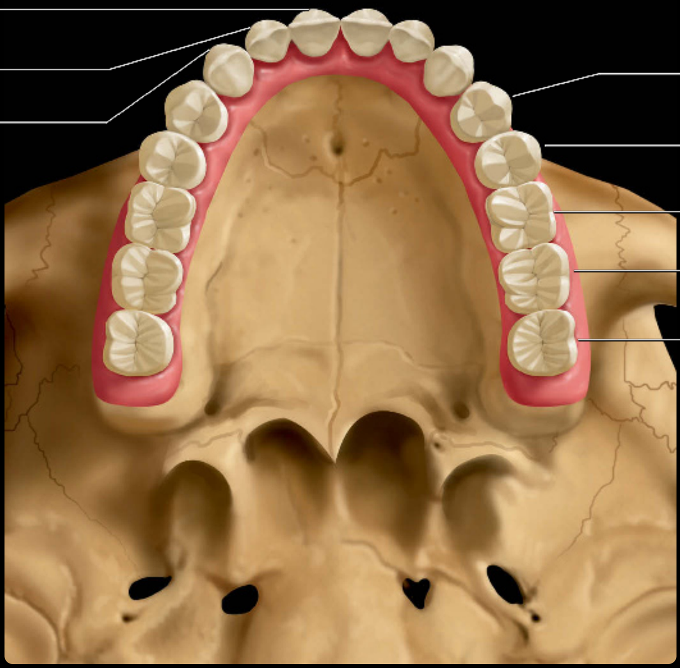
TOOTH ERUPTION

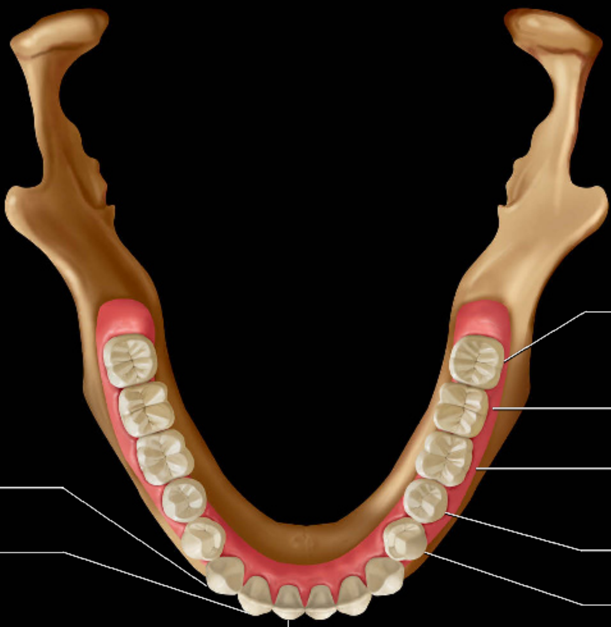




(Top) *Graphic shows process of tooth eruption: (A) Enamel organ reduces to thin layers covering enamel and secretes enzymes, (B) fusion of the reduced enamel epithelium with the oral epithelium, (C) disintegration of the central fused tissues, leaving a canal for tooth movement, and (D) peripheral-fused tissues peel back from the crown as the tooth erupts and form initial junctional epithelium that migrate cervically to cementoenamel junction.* **(Bottom)** *The age of the patient can be determined by examining the eruption of the teeth. This CBCT 3D reformation shows that the permanent incisors and 1st molars have erupted, but the premolars have not. This puts the patient's age at between 8-10 years. 3D reformations can be helpful in evaluation of erupting teeth if malocclusion and malalignment are present. Note that the maxillary right central incisor has not fully erupted, although the apical foramen is almost closed. This may be due to ankylosis (loss of periodontal ligament) of the tooth. (Courtesy 3D Diagnostix, Inc.)*

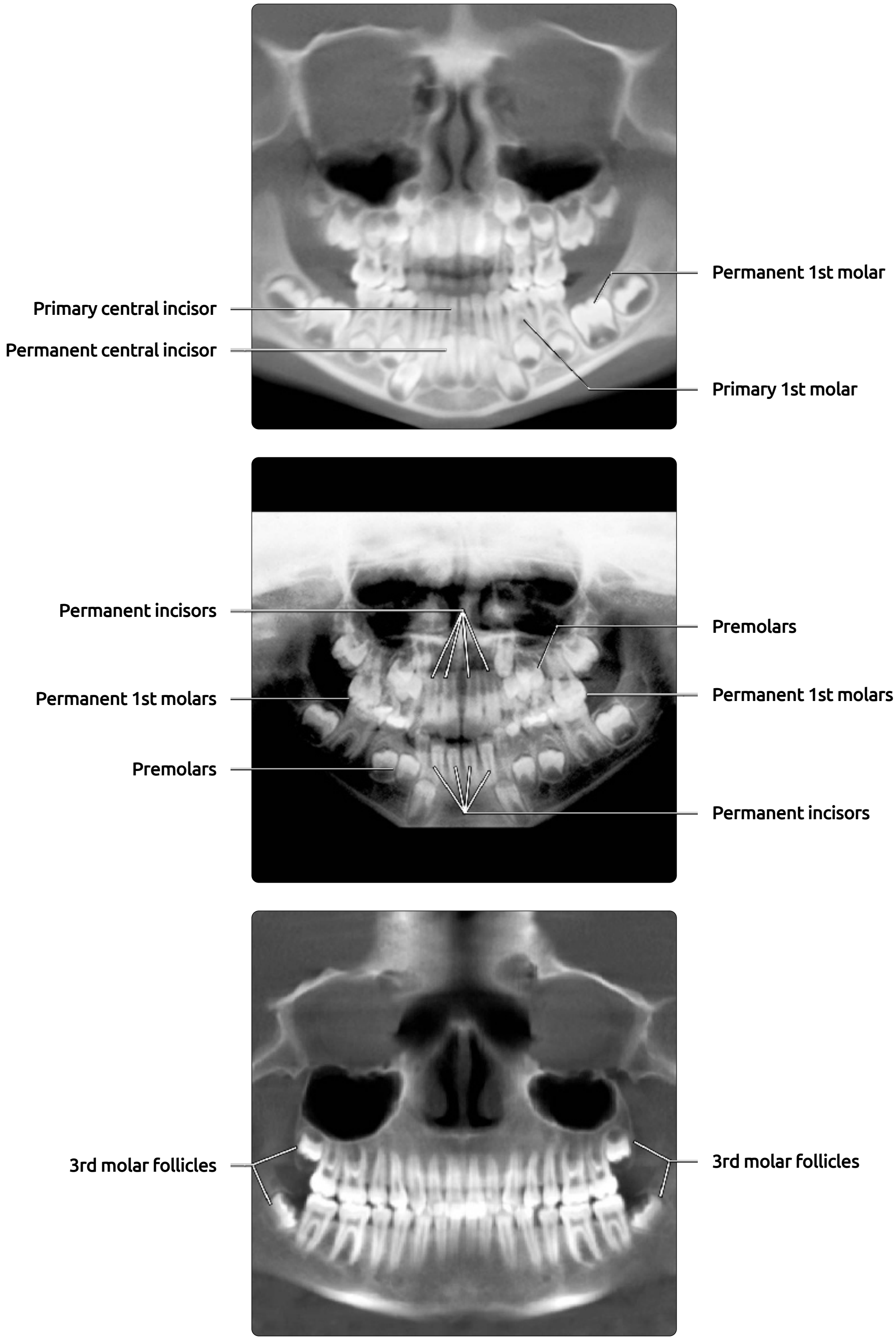
TEETH NOMENCLATURE AND ERUPTION AGES





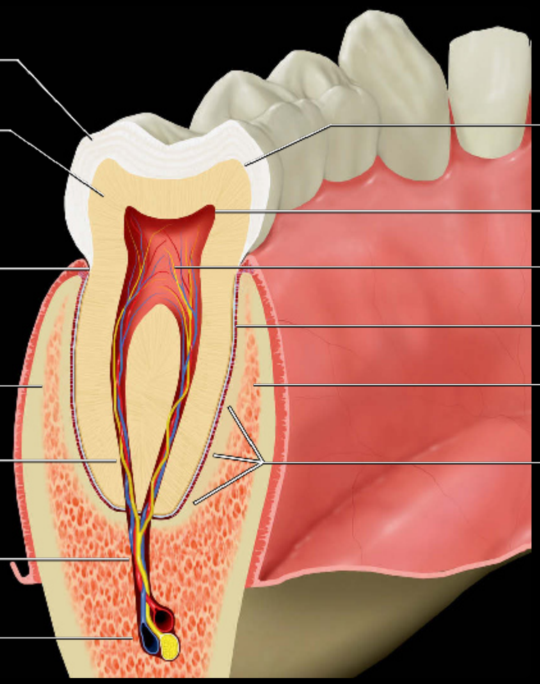
(Top) *The maxilla has 16 permanent teeth arranged in 2 quadrants: The upper right quadrant, also known as quadrant 1, and the upper left quadrant, also known as quadrant 2. Eruption ages are in parenthesis. The functional cusps on the maxillary posterior teeth are lingual (palatal) cusps.* **(Bottom)** *The mandible has 16 permanent teeth arranged in 2 quadrants: The lower left quadrant, also known as quadrant 3, and the lower right quadrant, also known as quadrant 4. Eruption ages are noted in parenthesis. The functional cusps on the mandibular posterior teeth are the buccal (facial) cusps. The permanent maxillary and mandibular incisors and canines have similarly named deciduous predecessors. The predecessors of the 1st and 2nd premolar teeth are the 1st and 2nd deciduous molars, respectively. The deciduous incisors and canines have a single root, the mandibular deciduous molars have 2 roots, and the maxillary deciduous molars have 3 roots.*

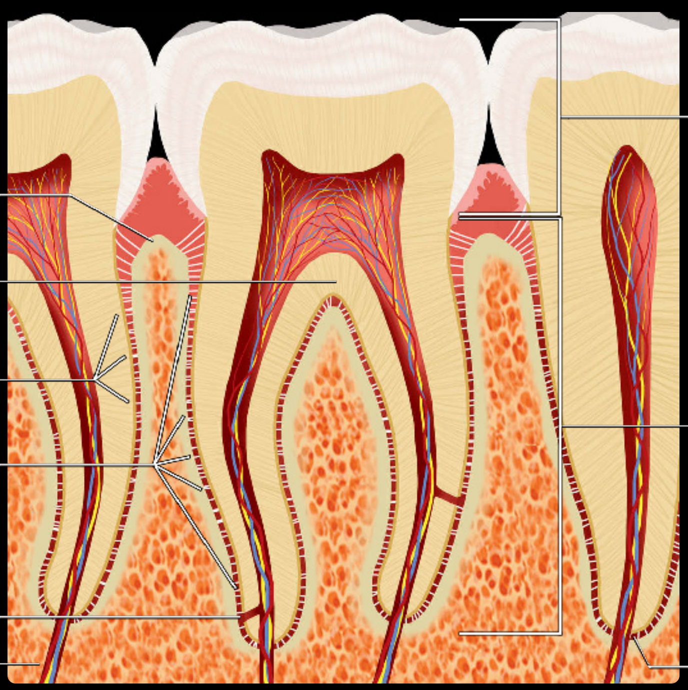
HUMAN DENTITIONS



(Top) *Panoramic reformat of CBCT data shows a patient at the primary dentition stage. All 20 primary teeth have erupted into the oral cavity and are in occlusion, but all permanent teeth are still unerupted. Examination of the follicles of the permanent teeth for any displacement or expansion is recommended when evaluating images for the primary dentition phase. It is also important to note any missing permanent teeth to aid in future orthodontic treatment planning.* **(Middle)** *Panoramic radiograph shows a patient at the mixed dentition stage. The upper and lower permanent 1st molars have erupted as well as the upper and lower incisors. As the premolars have not erupted yet, it means the patient's age is between 8-10 years.* **(Bottom)** *CBCT panoramic reformat shows a patient in the permanent dentition/late adolescence stage. All erupted teeth are permanent. The developing 3rd molars are present but unerupted. The stage of 3rd molar development indicates that the patient's age is between 17-20 years.*

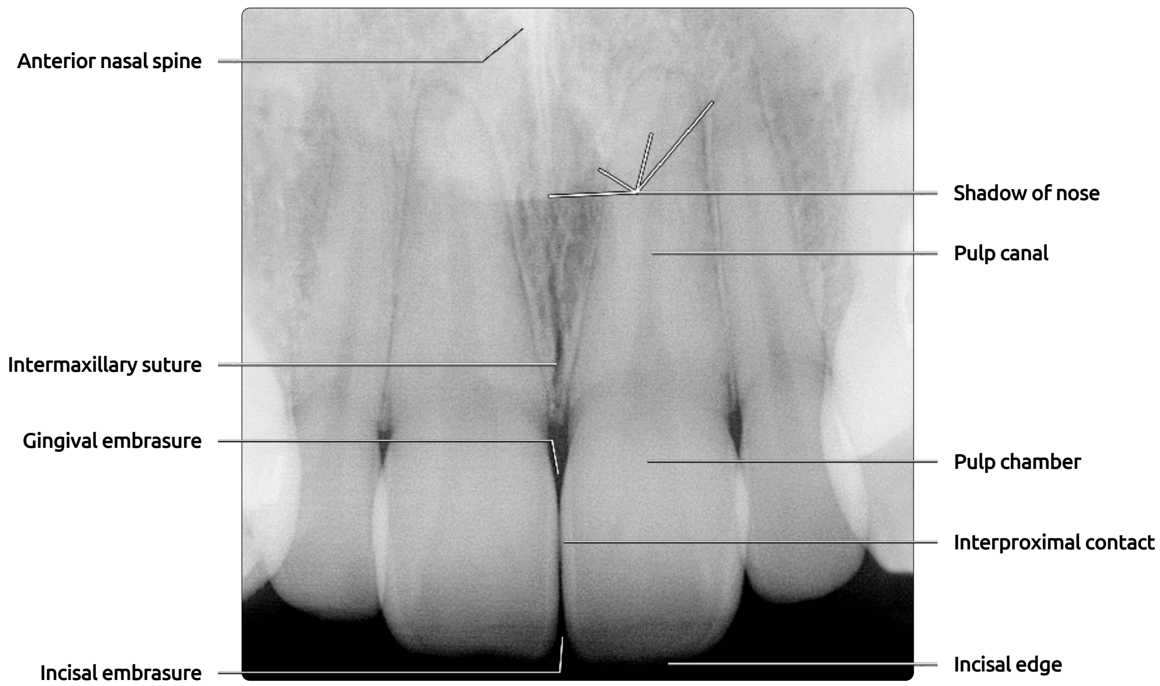
DENTAL ANATOMY





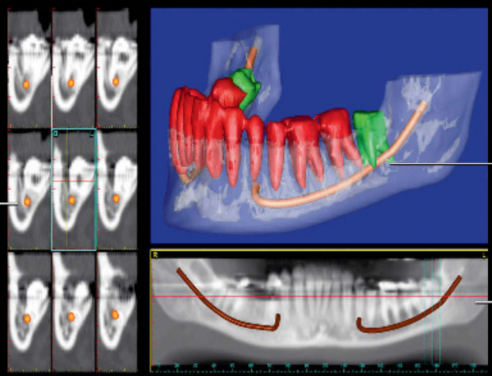
(Top) *Graphic representation shows a mandibular 1st molar in coronal cross section through the mesial root. Identification of the location of pathology in relation to the DEJ and CEJ helps in classifying caries and periodontal disease. Cross sections of the teeth are the most common reformation for dental applications, such as implant and impaction analysis, as they allow for evaluation of alveolar bone width and height and accurate localization of the inferior alveolar nerve canal.* **(Bottom)** *Graphic representation shows sagittal cross section of a mandibular 1st molar. The tooth is attached to the socket through the periodontal ligaments. The crest of the healthy alveolar bone is located about 1-2 mm apical to the CEJ of a tooth. Innervation and vasculature exit through the apical foramen, but on occasion, lateral canals may exit through the lateral aspects of the root. If pulpal death occurs, bacteria can seep through the lateral canals, causing lateral radicular abscesses and cysts, and through the apical foramina, causing periapical inflammation.*

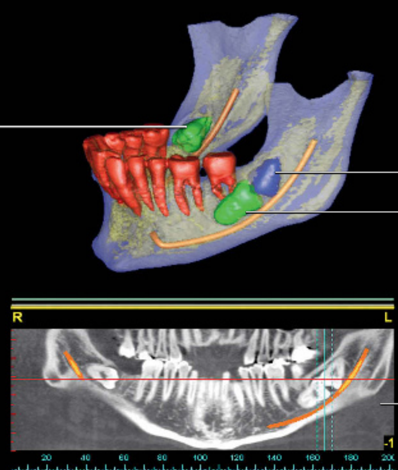
DENTAL RADIOGRAPHIC ANATOMY

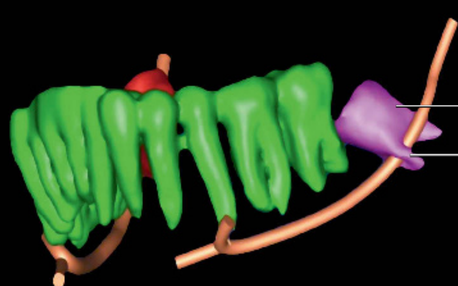


(Top) *Periapical radiograph shows normal dental and periodontal anatomy. The periodontal ligament space is a thin radiolucent line that surrounds the root of the tooth. The lamina dura is a thin radiopaque line that surrounds the tooth socket radiographically. Healthy alveolar bone crests (crestal laminae dura) are corticated. Nutrient canals may appear as small corticated canals within the bone connected to the apical foramen. (Courtesy M. Kroona, DXT.)* **(Bottom)** *Periapical radiograph of the central incisors shows the normal anatomic landmarks in this area. It is important to realize that soft and hard tissue superimpositions may occur when imaging teeth, and their recognition is necessary to determine normal from abnormal. Evaluation of the interproximal contact point and crown contours is important as caries tends to occur cervical to the contact point, and incomplete contact or improper crown contour may lead to plaque accumulation and resulting caries and periodontal disease. (Courtesy M. Kroona, DXT.)*

TOOTH IMPACTIONS

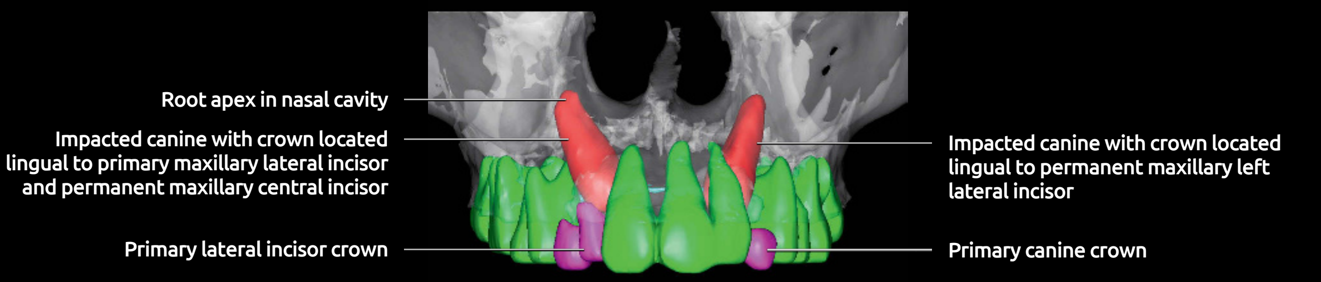


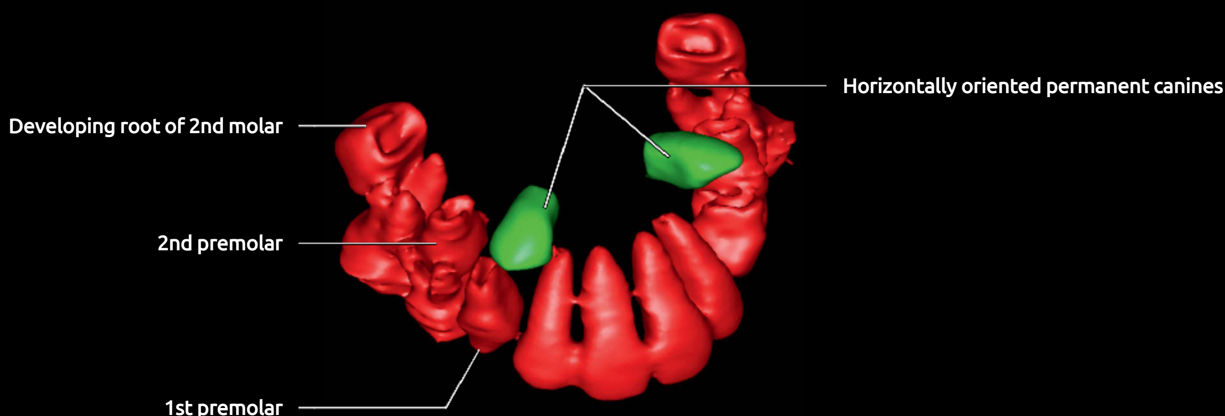


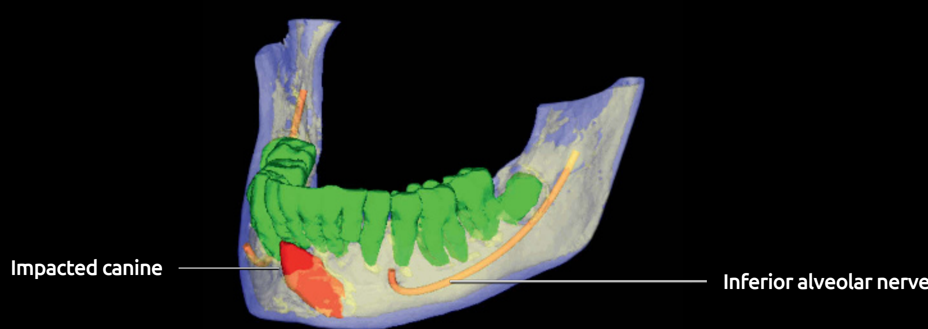


(Top) *Cross sections, panoramic, 3D reformations using Simplant software show the inferior alveolar nerve canal traveling between the roots of the distoangularly impacted mandibular left 3rd molar. (Courtesy 3D Diagnostix, Inc.)* **(Middle)** *Panoramic and 3D reformations show a horizontally impacted left 3rd molar with its crown oriented distally and an impacted supernumerary tooth (4th molar) with its crown oriented mesially, both lying on top of the left inferior alveolar nerve canal. The right 3rd molar is horizontally impacted with its crown oriented mesially. CBCT imaging can aid in predicting and preventing nerve damage when removing 3rd molars surgically. (Courtesy 3D Diagnostix, Inc.)* **(Bottom)** *3D reformation shows the left inferior alveolar nerve going through the mesial root of the mesioangularly impacted mandibular left 3rd molar. This occurs during tooth development due to proximity of the tooth follicle to the inferior alveolar nerve, which is engulfed by the root as it develops and calcifies. (Courtesy 3D Diagnostix, Inc.)*

TOOTH IMPACTIONS







(Top) *CBCT 3D reformation with transparent bone shows the vertical impaction of the permanent canines with lingual placement of the crowns and slight facial tipping of the roots. Knowledge of this orientation aids the surgeon in deciding on the entry point for either extraction or exposure of the crowns for placement of an orthodontic bracket. (Courtesy 3D Diagnostix, Inc.)* **(Middle)** *The bone can also be made transparent on CBCT 3D reformations and segmentations to further visualize the relationship of the teeth with one another. This image shows unerupted maxillary canines with the crowns oriented facially. The roots are not completely formed. (Courtesy 3D Diagnostix, Inc.)* **(Bottom)** *CBCT 3D reformation and segmentation using Simplant software shows an impacted mandibular canine. The position of the impacted tooth in relation to the erupted dentition can easily be determined with 3D reformation. Virtual extractions (digital removal of teeth) can also be performed. (Courtesy 3D Diagnostix, Inc.)*

TERMINOLOGY

Definitions

- Materials used to restore form and function of teeth or to enhance dental aesthetics

IMAGING ANATOMY

Restorative Materials

- **Amalgam**
  - Traditional silver filling material; **metallic** in density
  - Combination of silver, mercury, tin, and copper and sometimes zinc, indium, and palladium
- **Composite**
  - Tooth-colored restoration that binds to enamel through acid-etching bonding
  - **Historically radiolucent, now mixed with radiopaque fillers**
  - More radiodense than enamel, but less than metal
- **Glass ionomer**
  - Tooth-colored restoration that binds to dentin chemically
  - **Used on root lesions** where there is no enamel present for acid etching
  - Also used as **base** under other large restorations

Prosthetic

- **Crowns**
  - Full or partial tooth coverage
  - **Full cast metal**, full **porcelain**, or porcelain fused to metal
  - Tooth must be **prepped**: Ground down to specific dimensions to create space for crown material
- **Bridges**
  - Replace missing teeth by crowning at least 2 adjacent teeth (**abutments**)
  - Portion that replaces missing tooth called **pontic**
  - Bridge can be supported by implants
- **Post and core**
  - **Post**: Metal rod affixed to, or cast with, core to anchor it to root canal
  - **Core**: Cast metal replacement of tooth structure to mimic crown prep; crown placed on top of it
- **Implants**
  - Osseointegrated root form replacement of teeth restored with crown
- **Complete and partial dentures**
  - Removable dentures used when several or all teeth are missing
  - Should be removed from mouth prior to imaging to prevent metal artifact unless scan with denture is requested

Endodontics

- **Gutta percha**
  - Cone-shaped flexible radiopaque material that can be condensed to fill tapering prepared root canal
  - Should be ≤ 1 mm from apex within root
    - 0.5 mm is ideal
  - If it extends beyond apex, called overfill
    - If it is 1 mm from apex (within root canal), called underfilled or short
- **Sealer cement**
  - Viscous radiopaque material that seals gaps between gutta percha cones
  - May extend beyond apex of tooth and cause rarefaction of bone; most are biocompatible

Orthodontics

- **Brackets**
  - Traditionally fixed to facial aspect of teeth with resin; lingual brackets available
- **Bands**
  - Placed on posterior teeth as anchors for appliance
- **Archwire**
  - Stainless steel wires that follow outline of arch fixed to brackets and bands with elastic &/or ligature wire
- **Other fixed appliances**
  - Anchored to posterior teeth through bands
  - May have several metallic spring and loop components as well as acrylic components

Pediatrics

- **Stainless steel crown**
  - Prefabricated crown
  - Used when tooth structure cannot be restored by amalgam alone or when tooth is root canal-treated (pulpotomy or pulpectomy)
- **Space maintainer**
  - Teeth will drift mesially when adjacent mesial tooth is extracted
  - To ensure enough space for permanent successor tooth, space maintainer is placed on tooth adjacent to edentulous space
  - Many different types: Fixed and removable; unilateral and bilateral
  - Band and loop space maintainer: Made of band soldered to thick wire formed to abut with tooth mesial to edentulous space, thus preventing drift

ANATOMY IMAGING ISSUES

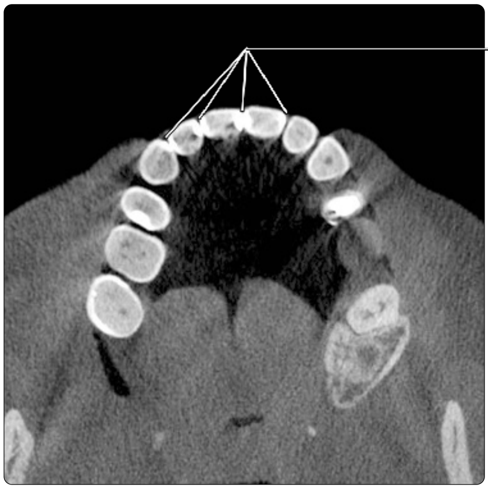
Imaging Recommendations

- **MR for orthodontic patients**
  - If MR of head and neck
    - **Temporary removal** of orthodontic appliances to prevent signal void artifact
  - If MR of other body structures
    - **Stainless steel archwire is magnetic** and should be removed
    - All orthodontic brackets and bands **should be secured**

Imaging Pitfalls

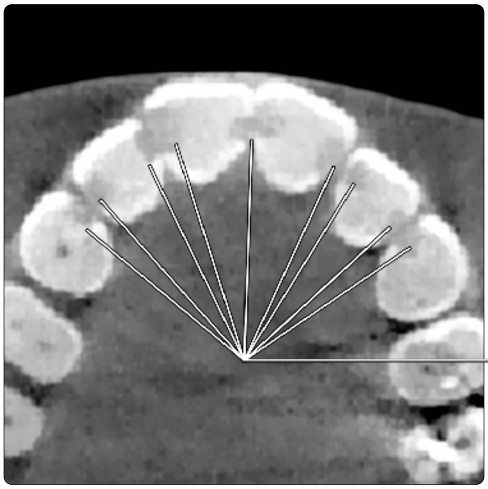
- Dental restorations can cause metal streaking and beam-hardening artifact on CT and signal voids on MR, thus marring evaluation of adjacent bone and soft tissue
  - 2D imaging radiographic and clinical examination is recommended for evaluation of bone and dental lesions if artifact is excessive on CBCT or CT
  - To reduce artifact when examining oral cavity soft tissues on CT and MR, obtain scans without teeth crowns in field of view (modified axial)

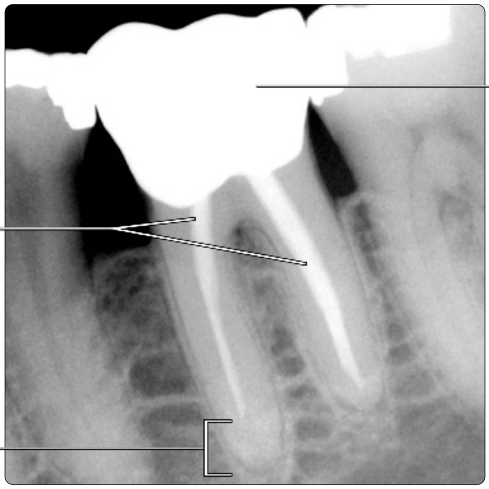
PERIAPICALS AND AXIAL CBCT

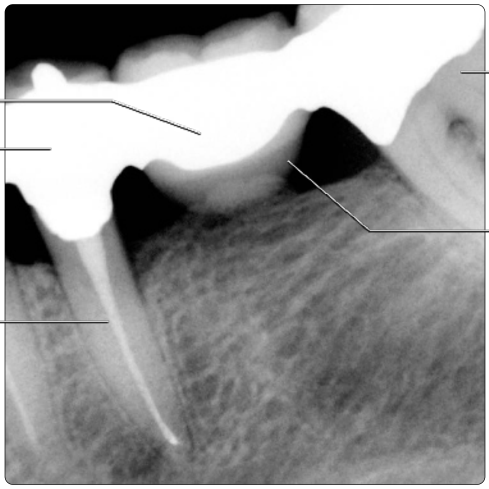


(Top) *Bitewing radiograph shows several posterior restorations. Amalgam is metallic and, therefore, appears completely radiopaque (image void). Posterior composite restorations can be used for more aesthetic results if clinically indicated and appear radiolucent (if of 1st-generation composites), posing a diagnostic challenge if evaluating for recurrent caries. Composites with radiopaque fillers appear moderately radiopaque. (Courtesy B. Friedland, BDS.)* **(Middle)** *Bitewing radiograph shows 2 types of amalgam restorations that are named according to surfaces replaced [occlusal (class I), mesio- or disto-occlusal (class II), amalgam build-up, etc.]. If treatment of a tooth has not been completed or if a period of pulpal healing is required after deep caries excavation, a temporary (interim) filling may be placed. If a root canal-treated tooth is awaiting a crown, a cotton ball is placed to separate the gutta percha from the sticky temporary filling. (Courtesy B. Friedland, BDS.)* **(Bottom)** *Axial CBCT shows several anterior composite restorations.*

AXIAL CBCT AND PERIAPICALS

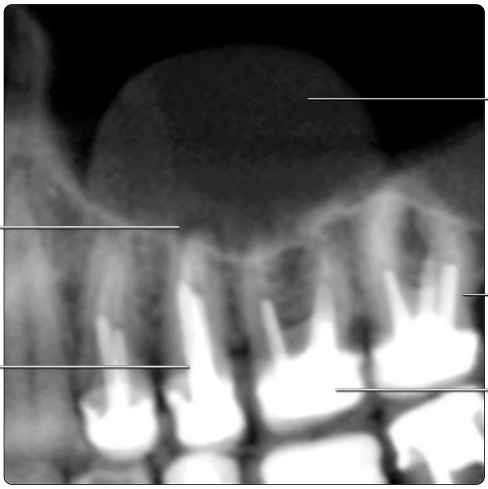


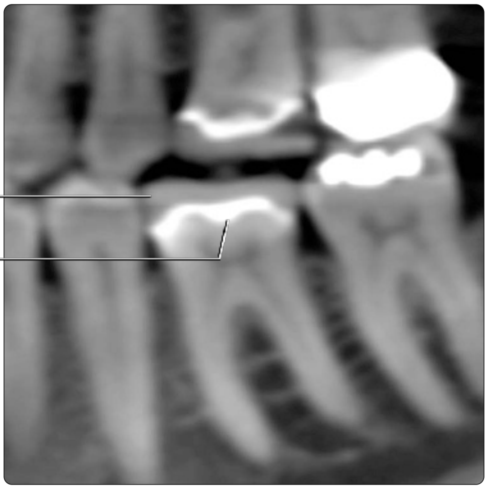




(Top) *Axial CBCT shows multiple rounded well-defined radiolucencies on the proximal surfaces of the teeth, representing radiolucent old-generation composite restorations.* **(Middle)** *A periapical radiograph shows a full metal coverage crown on the mandibular left 1st molar. The contours of the crown should follow the original contours of the tooth with no overhangs or open margins. This tooth is root canal treated, and the filling material in the mesial root is short, which may mean that a portion of the root canal was not instrumented to remove debris, presenting a risk for periapical rarefying osteitis. (Courtesy B. Friedland, BDS.)* **(Bottom)** *A periapical radiograph shows a porcelain fused to metal (PFM) bridge. The teeth onto which the bridge is fixed are called abutments and are covered with crowns. The portion that replaces the missing tooth is called a pontic. According to the number of teeth involved and replaced, the bridge is called a 3-unit, 4-unit, 5-unit, etc. bridge. (Courtesy B. Friedland, BDS.)*

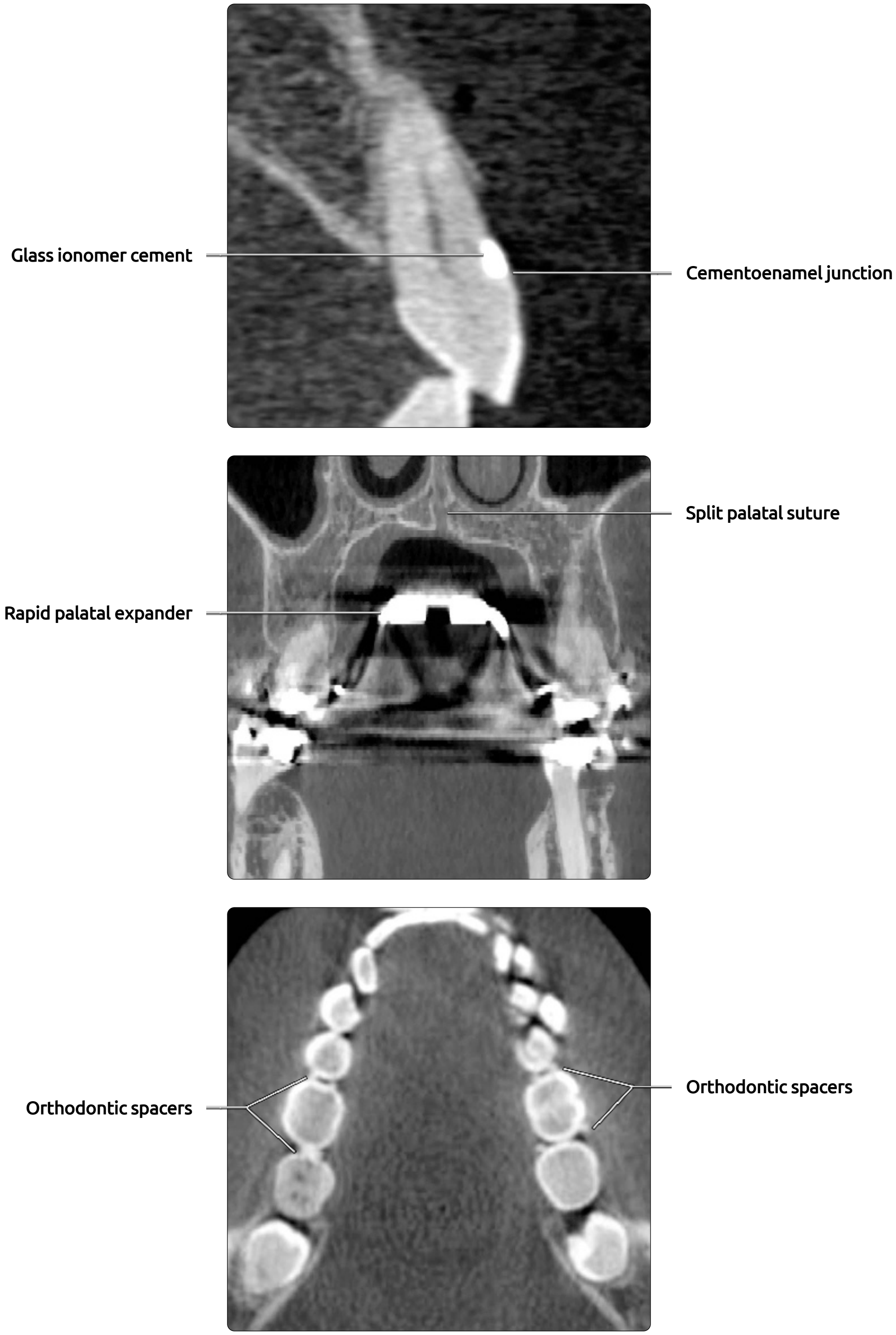
CBCT REFORMATS





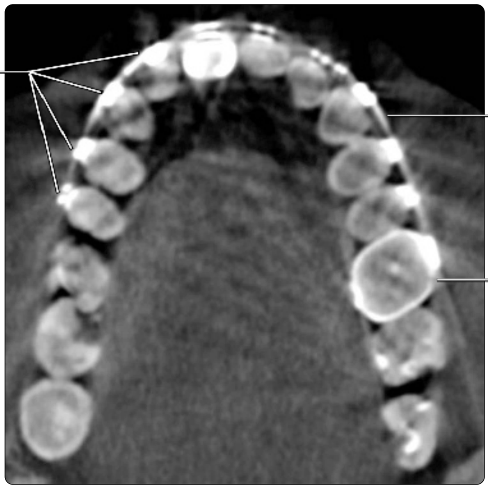
(Top) *CBCT cropped panoramic reformat shows multiple root canal-treated teeth that have been restored with post and core restorations followed by crowns. A core recreates proper crown preparation outline when tooth structure is inadequate to support seating of the crown restoration. A post anchors the core to the root and should not extend more than 2/3 of the root length. Note large mucus retention pseudocyst in left maxillary sinus.* **(Middle)** *CBCT sagittal section shows root canal overfill of the central incisor with post and core not in line with the pulp canal. Perforation of the tooth structure with the post can occur during preparation of the tooth. Root canal filling in the periapical tissues may be attached to the apex or may be dissociated from it. This foreign body may illicit an inflammatory reaction with symptoms of pain, or it may be asymptomatic.* **(Bottom)** *CBCT panoramic reformat shows full porcelain coverage crowns in the maxillary and mandibular 1st molars. These are cemented to the tooth with radiopaque cement.*

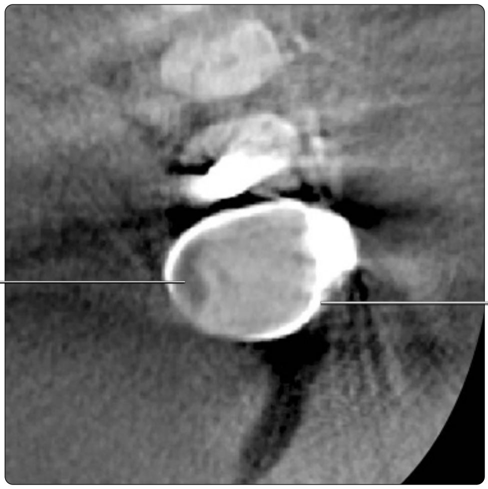
CBCT REFORMATS



(Top) *CBCT sagittal reformat shows a restoration of glass ionomer cement (GIC) in the buccal cervical region of this anterior tooth. GICs are used to restore carious or tooth wear lesions that occur on the root surface of the tooth, or partially in enamel and partially in dentin.* **(Middle)** *Coronal CBCT shows a rapid palatal expander, which is a type of fixed appliance that is used to quickly increase the width of the maxillary arch by splitting the intermaxillary suture before puberty. It is cemented onto the posterior teeth of the patient.* **(Bottom)** *Axial CBCT shows orthodontic separators (spacers) that are placed between the molars before fixed appliances, such as a palatal expander or orthodontic bands, are applied. Spacers are circular rubber bands about a centimeter in diameter placed between adjacent molars. There may be 1-12 spacers applied. The spacers stay between the teeth for 1-2 weeks and move the teeth apart slowly until they are far apart enough so that the dentist can fit an orthodontic band in between them.*

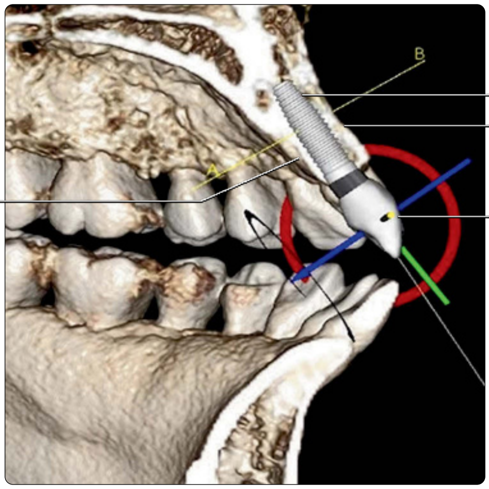
CBCT REFORMATS

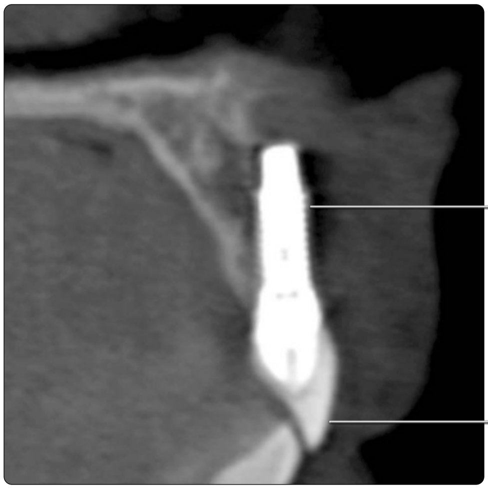


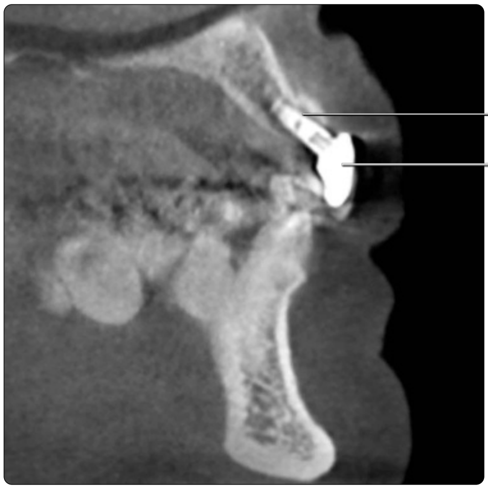


(Top) *Axial CBCT shows a traditional fixed orthodontic appliance, which consists of brackets fixed to the facial surfaces of teeth, bands that are cemented to 1 posterior tooth bilaterally, and archwire that is fixed to the brackets with elastic bands. Stainless steel archwire is ferromagnetic, and metal hardware may cause degradation of image quality on MR.* **(Middle)** *Axial CBCT shows caries in a tooth with an orthodontic band and bracket. Meticulous oral hygiene should be maintained for the duration of the orthodontic treatment to prevent plaque accumulation and the development of caries.* **(Bottom)** *Orthodontic brackets are placed on the crown of the tooth, and force is applied through the tightening of the orthodontic wire attached to them. With the movement of the teeth, widening of the periodontal ligament (PDL) space along the surface of the tooth away from the direction of the movement of the root is commonly seen. In this cross-sectional CBCT, the widening is noted on the lingual surface of the root due to the facial torquing of the root.*

CBCT REFORMATS

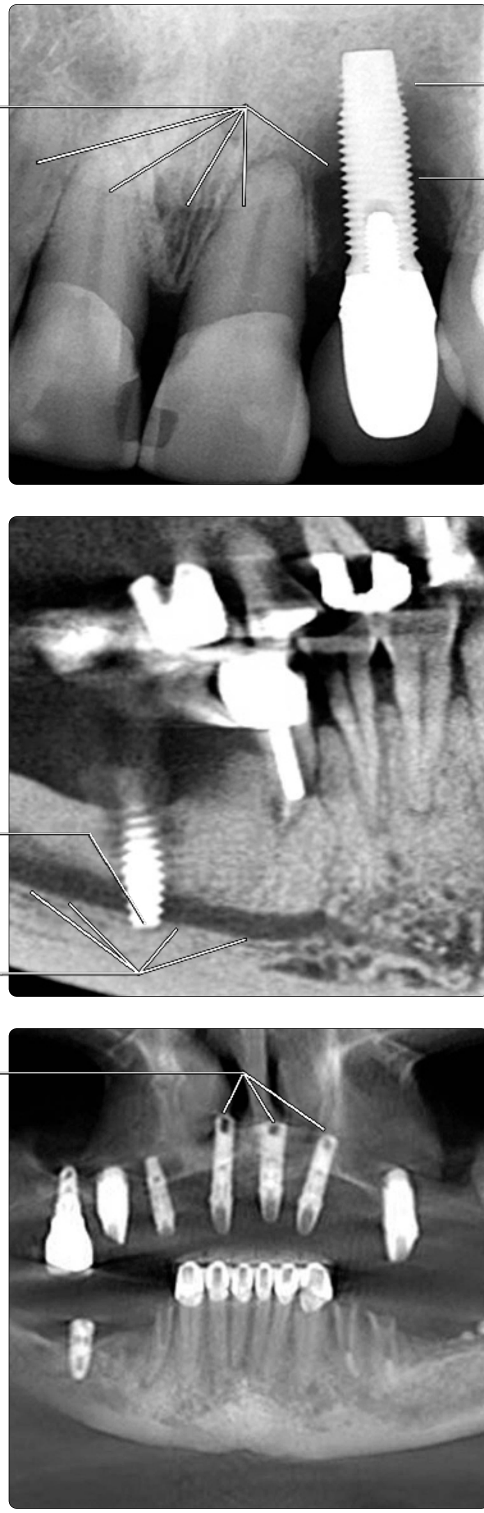






(Top) *CBCT 3D surface rendering shows implant planning for an edentulous maxillary anterior alveolar process. The simulated implant is positioned in the alveolar process following several rules: The crown restoration should function against the opposing dentition, there should be at least 2 mm of facial alveolar bone and 1 mm of lingual alveolar bone, and there should be 1.5- to 2.0-mm between the implant and the adjacent teeth. The anatomy should be evaluated to prevent violation of vital anatomical structures. (Courtesy D. Chenin, DDS.)* **(Middle)** *CBCT cross section of a central incisor implant that was positioned to bring the crown into contact with the opposing teeth, but no ridge augmentation, was performed, resulting in no bone coverage on the facial aspect of the implant.* **(Bottom)** *Sagittal CBCT shows an implant that was centered in the alveolar process but without considering the position of the final restoration. A tilted abutment was used to bring the crown into occlusion (in this case, not biomechanically ideal for load distribution).*

PERIAPICAL RADIOGRAPH AND CBCT REFORMATS



(Top) *Periapical radiograph of an implant replacing the left lateral incisor shows severe peri-implant bone loss, extending to the apical portion of the implant. Vertical bitewings or periapical radiographs in which the central x-ray beams pass through the threads (resulting in a crisp image of the threads) are ideal for evaluation of peri-implant bone loss, as metal artifact does not obscure evaluation on these intraoral 2D imaging.* **(Middle)** *CBCT panoramic reformat shows the apex of an implant passing through the right inferior alveolar canal. Cross-sectional reformations of the alveolar process are the gold standard during implant treatment planning to avoid violating important anatomy.* **(Bottom)** *CBCT panoramic reformation shows maxillary anterior implants placed in the right and left nasal cavities. Evaluation of the amount of bone present and its angulation in relation to the opposing dentition is necessary prior to placement of implants to determine the need for alveolar process augmentation. (Courtesy T. Sawisch, DDS.)*

TERMINOLOGY

Abbreviations

- Maxilla (Mx)

IMAGING ANATOMY

Overview

- Forms majority of midface skeleton and upper jaw
- Contains maxillary sinuses
- There are 2 maxillae that fuse in midline (intermaxillary suture)
- Presence of "premaxilla" in humans widely contested
  - Exists in early embryonic human development
  - Disappears early by fusing to anterior aspect of maxillary bones
  - Has implications for cleft palate development

Anatomy Relationships

- Articulates with
  - Opposite Mx
  - Frontal, sphenoid, nasal, vomer, and ethmoid bones
  - Inferior nasal concha
  - Palatine, lacrimal, and zygomatic bones
  - Septal and nasal cartilages

Internal Contents

- **Maxillary bone**
  - **Body**
    - Major part of bone
    - Pyramid-like shape
    - Gives borders to 4 different regions: Orbit, nasal cavity, infratemporal fossa, middle 1/3 of face
    - Infraorbital canal and foramen pass from orbit region to face region
    - Anterior nasal spine: Pointed prominence in midline
    - Nasal notch: Concave rims lateral to anterior nasal spine that form floor of piriform aperture
  - **Frontal process**
    - Articulates superiorly with nasal, frontal, ethmoid, and lacrimal bones
    - Forms posterior boundary of lacrimal fossa and houses lacrimal canal
  - **Zygomatic process**
    - Articulates laterally with maxillary process of zygomatic bone
  - **Palatine process**
    - Extends medially to form majority of hard palate
    - Articulates with palatine process of opposite Mx in midline
    - Articulates with horizontal plate of palatine bone posteriorly
    - Incisive foramen located anteriorly and **may be in midline or slightly shifted**
    - In axial plane, palate may be U shaped or V shaped (high palatal vault)
  - **Alveolar process**
    - Supports maxillary teeth
    - Extends inferiorly from Mx
    - Each maxillary bone **normally contains 5 primary and 8 permanent teeth**
    - Alveolar bone is resorbed when tooth is lost
    - Bone overlying tooth roots forms wave-like eminences
    - Bulky part surrounding facial aspect of canine called **canine eminence**
    - Concavity noted on facial surface mesial to canine called **incisive fossa** (a.k.a. lateral fossa)
    - Concavity noted on facial surface distal to canine called **canine fossa**
    - Most posterior aspect called **maxillary tuberosity**
    - Site of extracted tooth called **tooth or extraction socket**
    - Early tooth extractions may cause localized developmental hypoplasia
- **Innervation**
  - **Infraorbital nerve**
    - Continuation of V2
    - Passes anteriorly through infraorbital groove and infraorbital canal and exits onto face via infraorbital foramen
    - Gives rise to 2 alveolar branches: Middle superior and anterior superior
  - **Middle superior alveolar nerve**
    - May or may not be present
    - As it descends to form superior dental plexus, innervates part of maxillary sinus, premolars, and mesiobuccal root of 1st molar, and gingiva and mucosa of same teeth
    - Not usually visualized radiographically
  - **Anterior superior alveolar nerve**
    - As it descends to form superior dental plexus, innervates part of maxillary sinus, maxillary anterior teeth, and gingiva and mucosa of these teeth
    - Vertical component may be seen on coronals and cross sections lateral to lateral wall of nasal cavity in canine/premolar region
    - Horizontal component may be seen on axials extending from inferior aspect of vertical component to midline
  - **Posterior superior alveolar nerve**
    - Branch of V2
    - In infratemporal fossa: Passes on posterior surface of Mx along region of maxillary tuberosity
    - Gives rise to gingival branch that innervates buccal gingiva alongside maxillary molars
    - Enters posterior surface of Mx and supplies maxillary sinus and maxillary molars, except mesiobuccal root of 1st molar
  - **Nasopalatine nerve** (V2 sensory branch) travels from superior portion of nasal cavity to nasal septum, then travels anteroinferiorly to go through incisive (nasopalatine) canal and exit through incisive foramen (foramen of Stenson)
    - Supplies sensory fibers to gingiva and mucosa of anterior hard palate from central incisor to canine
    - May be single, fused, paired, or have multiple canals ± single large incisive canal
    - Canals located lateral to incisive foramen are called foramina of Scarpa
  - **Greater palatine nerve** descends palatine canal in palatine bone

- Exits greater palatine foramen at junction of palatine and maxillary bones and passes anteriorly to hard palate and gingival mucosa
- Supplies palatal gingiva and mucosa from premolar region to posterior border of hard palate to midline

- **Minor salivary glands**
  - Numerous minor salivary glands live in mucosa of hard palate
  - Supplied by postganglionic parasympathetic fibers that arise from pterygopalatine ganglion and are distributed by V2
  - Predominantly mucous secretions
  - Usually not visible on imaging unless affected by salivary gland pathology; on CBCT, will not show unless causing remodeling or erosion of underlying bone

ANATOMY IMAGING ISSUES

Imaging Recommendations

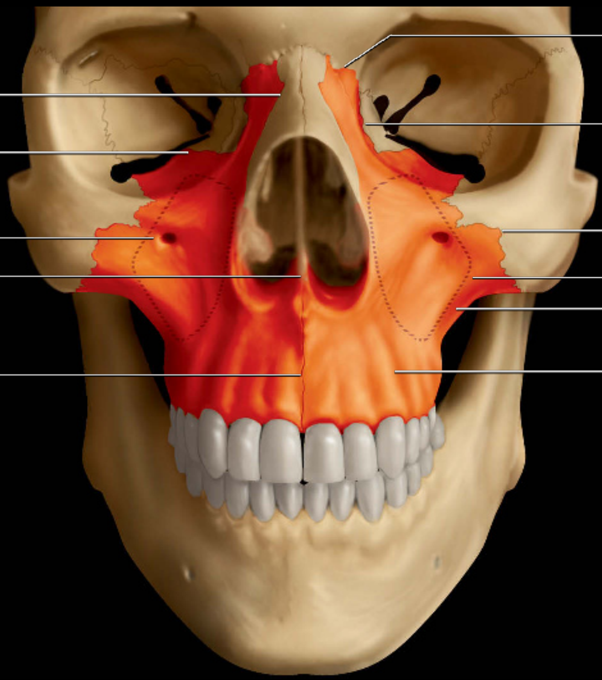
- Intraoral 2D imaging for caries, periapical, and periodontal disease
- CBCT
  - Dental cross sections for implant analysis, 3rd molar analysis
- CECT or MR if soft tissue tumor or malignancy suspected

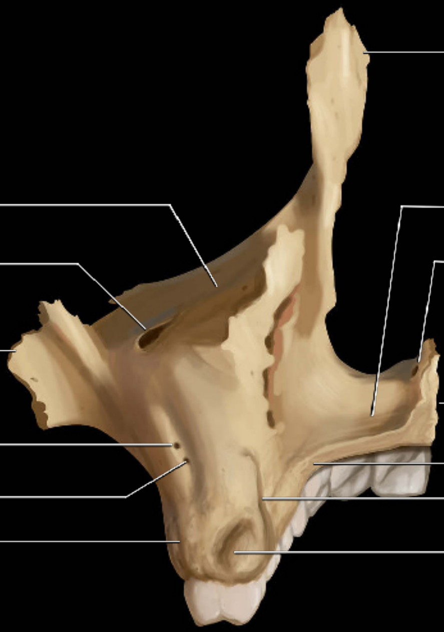
CLINICAL IMPLICATIONS

Clinical Importance

- Pain in maxilla can refer to TMJ
  - Sources of pain that may refer to TMJ
    - Pulpal or periodontal disease
    - Suboptimal root canal filling procedure (overfill, underfill)
    - Sinus inflammation
- Temporalis middle and posterior attachment trigger points can refer pain to maxilla
- Masseter superficial layer musculotendinous junction trigger points can refer pain to maxilla
- **Proximity of apices of maxillary teeth to maxillary sinus and nasal cavity**
  - Spread of odontogenic infection **(odontogenic sinusitis)**
  - Spread of odontogenic tumors
  - Displacement of tooth or tooth root into maxillary sinus
  - Root canal filling may be found in maxillary sinus if tooth is overfilled
- **V2 perineural spread of malignant tumor**
  - If malignancy affects skin of upper lip, **hard palate**, soft palate, or cheek overlying infraorbital foramen, check for V2 perineural tumor (PNT) spread
  - Major locations to identify V2 PNT extend from incisive canal to greater palatine foramen or infraorbital foramen to root entry zone of V nerve in lateral pons
  - If imaging for V2 PNT, check incisive canal, greater and lesser palatine foramen, pterygopalatine canal and fossa, foramen rotundum, Meckel cave, preganglionic segment of CNV, and root entry zone
  - Advanced imaging, such as C+ MR, recommended if suspected
- **Minor salivary gland pathology**
  - Due to proximity to hard palate, large pathology can be visualized on CBCT as remodeling or destruction of bony cortices of hard palate
  - On coronal, evaluate palatine processes of maxillae for asymmetry or erosion of bony cortices
  - Conditions that may occur include pleomorphic adenoma, necrotizing sialometaplasia, adenoid cystic carcinoma, and mucoepidermoid carcinoma
  - Salivary gland malignancy more common in these glands than other salivary glands
  - Aggressive soft tissue pathology should be imaged with imaging techniques that show soft tissue extent &/or perineural spread
- **Maxillary 3rd molar evaluation should include relationship to**
  - Greater palatine nerve
  - Maxillary sinus
  - Pterygopalatine fissure
  - Posterior border of maxillary tuberosity
  - Adjacent tooth
- **Maxillary midline suture** (intermaxillary suture, midpalatine suture, median suture)
  - Can be site of developmental or acquired pathology
    - Cleft palate can run along entire length of maxillary midline suture
    - Nasopalatine duct cyst develops in midline
    - Wegener granulomatosis or midline lethal granuloma develop in midline
- **Fracture of maxilla analysis**
  - In cases of trauma (motor vehicle accident or otherwise), evaluation for fractures should involve maxilla
  - Should put into consideration major nerves that run in areas of fracture
    - **Le Fort 1**: Incisive, posterior superior alveolar and greater palatine nerves
    - **Le Fort 2**: Infraorbital nerve
    - **Le Fort 3**: Can involve V2 distribution at level of V2 as it exits foramen rotundum; may sever lacrimal duct
- **Maxillary hypoplasia (micrognathia)**
  - Underdevelopment of maxillary bone
  - Gives appearance of concave profile ("dish face") clinically and on sagittal view
  - Mandibular protrusion is illusion; cephalometric analysis shows retruded relationship of maxilla to skull base
  - Associated with Crouzon syndrome, Apert syndrome, Binder syndrome, cleft palate, cleidocranial dysplasia
- **Anterior nasal spine hypoplasia**
  - May require augmentation
- **Bimaxillary protrusion**
  - Increased protrusion and proclination of maxillary and mandibular incisors
  - Etiology: Genetic and environmental (mouth breathing, thumb sucking, and other oral habits), size of tongue
  - Associated with short posterior cranial base, longer Mx, and mild class II skeletal pattern

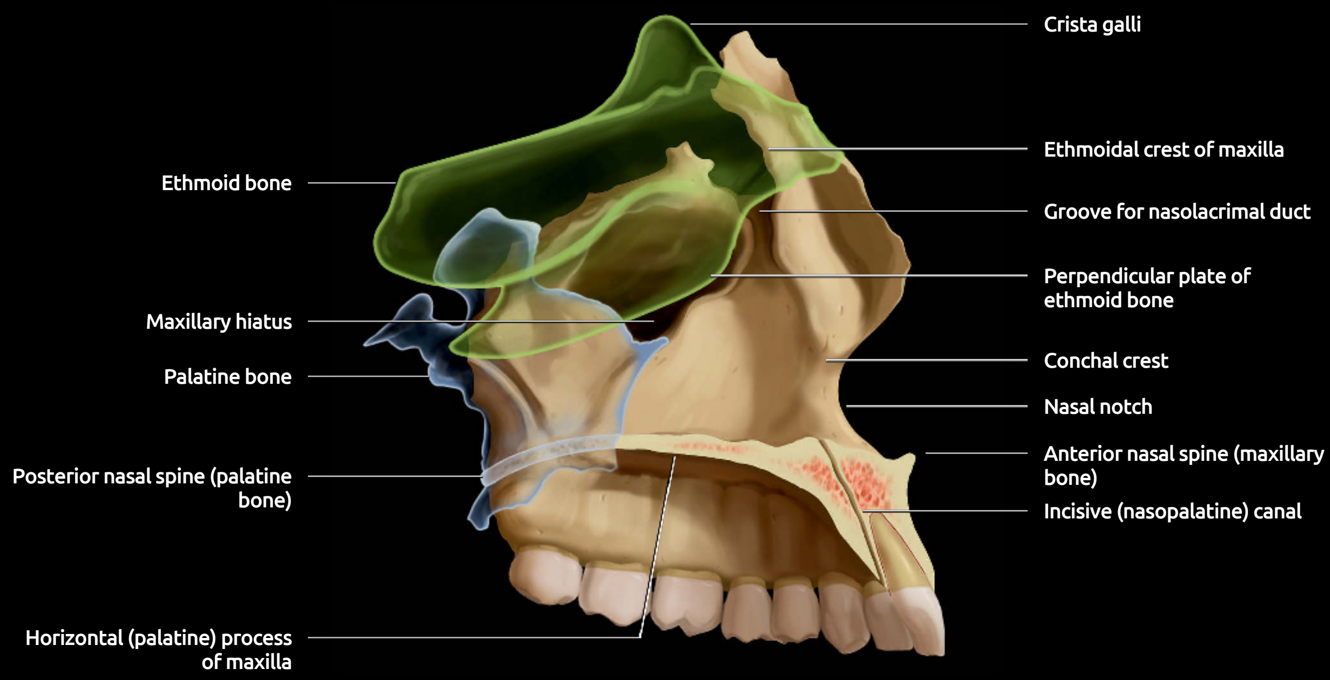
GRAPHICS

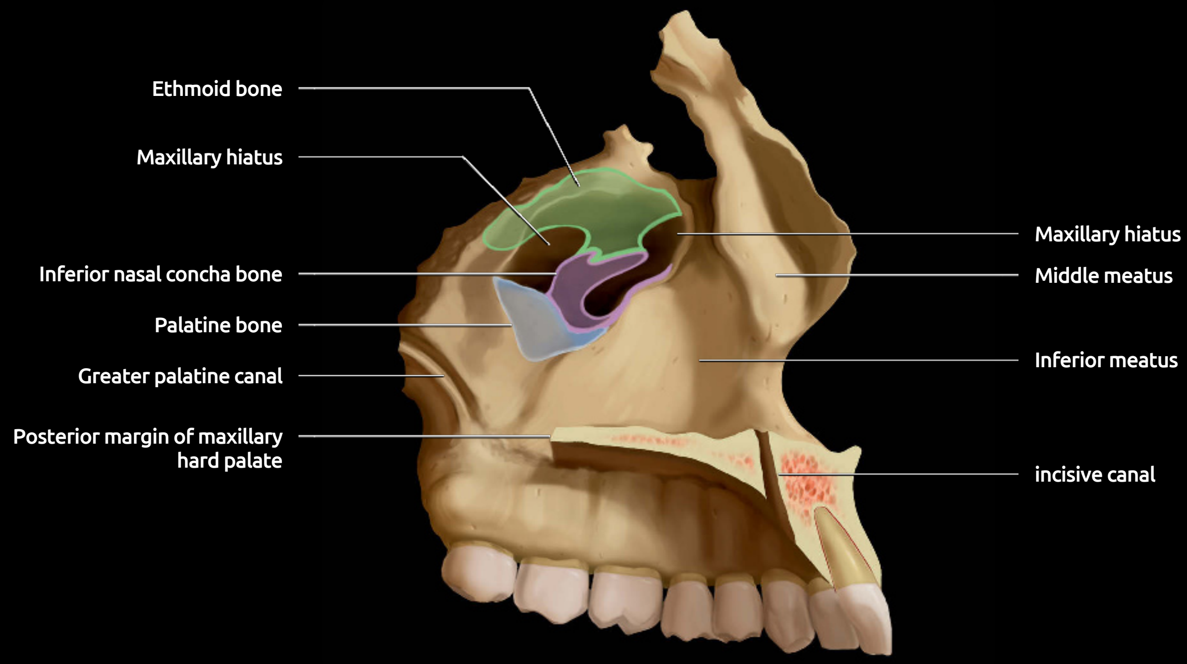




(Top) *Graphic shows an anterior view of the maxilla (highlighted in orange) and its relationship to the other facial bones. There are 2 maxillae that meet in the midline. These house the maxillary sinuses and make up the majority of the midface. The extent of the maxilla and its relationships with the adjacent bones should be considered when planning a palatal expansion to increase its transverse dimension.* **(Bottom)** *Graphic depicts one disarticulated maxilla as viewed from the posterior aspect. The foramina for multiple branches of CNV2 and the maxillary artery are seen. The greater palatine nerve branches off the pterygopalatine ganglion and courses down the greater palatine canal, partially formed by the maxilla. The nasopalatine nerve also branches off the pterygopalatine ganglion, runs along the nasal septum, and enters the nasopalatine canal. The middle superior alveolar neurovascular bundle may or may not be present. The posterior alveolar neurovascular bundle enters the posterior aspect of the maxilla.*

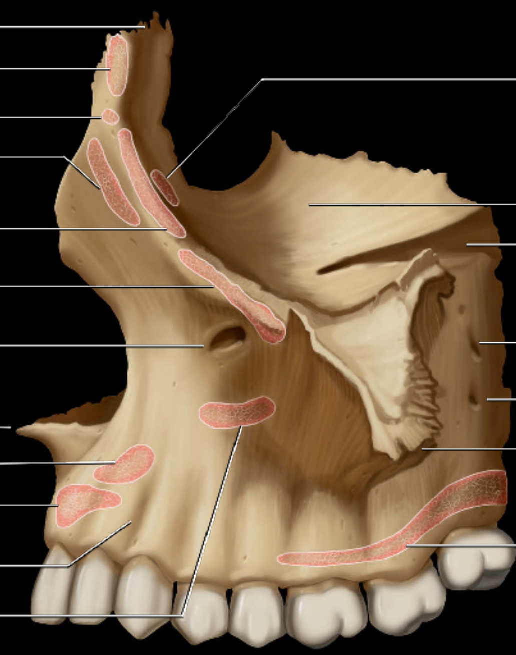
GRAPHICS

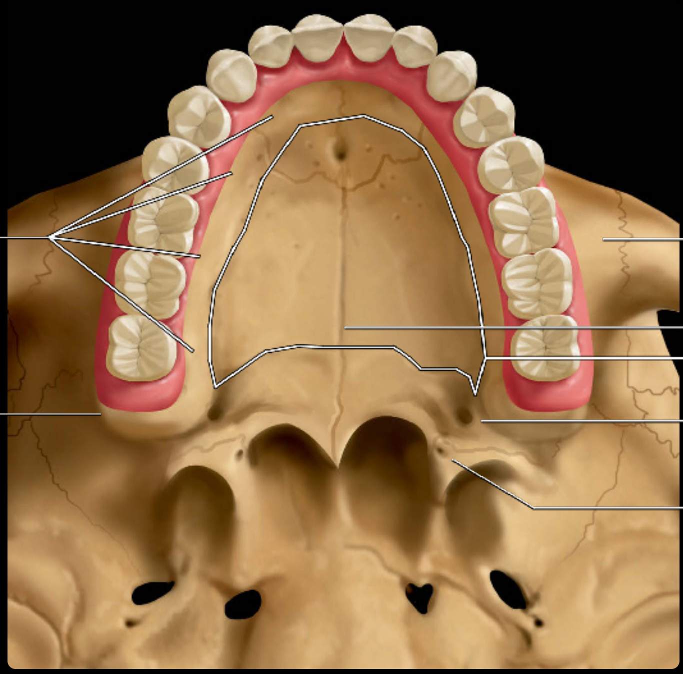




(Top) *Graphic of the medial aspect of the maxilla shows its relationship to the ethmoid (transparent green) and palatine (transparent blue) bones. The inferior nasal concha articulates at the conchal crest. The hard palate line passes through 2 anatomic points: The anterior nasal spine, which is part of the maxilla, and the posterior nasal spine, which is part of the palatine bone.* **(Bottom)** *Graphic of the medial aspect of the maxilla shows the bones that partially cover the maxillary hiatus and form the ostiomeatal complex.*

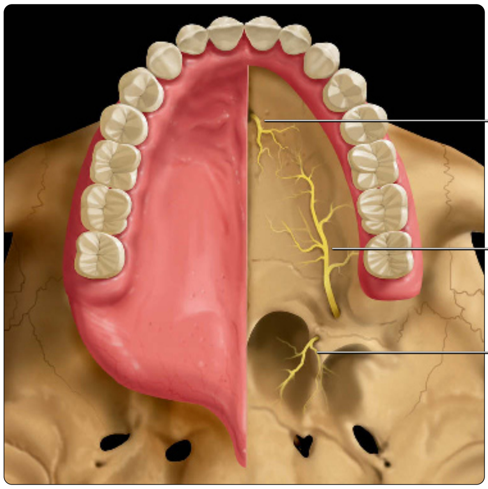
GRAPHICS

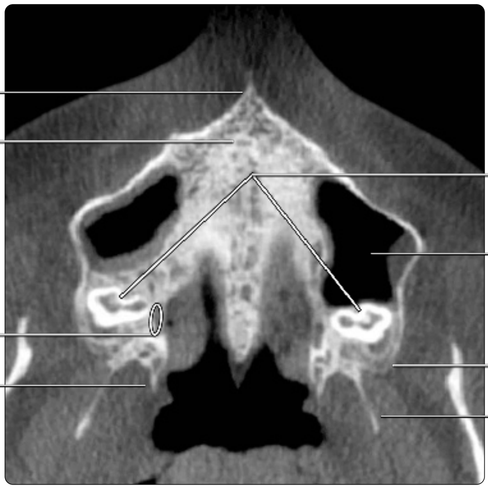




(Top) *Graphic shows the lateral aspect of a disarticulated maxilla with muscle origins and insertions outlined. CNV2 enters through the posterior aspect of the orbital floor, courses anteriorly in a groove or fully formed infraorbital canal, and exits anteriorly through the infraorbital foramen. The zygomatic process of the maxilla is a thick portion of bone that is usually avoided during LeFort 1 osteotomies or Caldwell-Luc procedures.* **(Bottom)** *Graphic of hard palate and maxillary alveolar ridge viewed from below shows the palatine processes of the maxillary bone. The premaxilla is an embryonic process and does not form a separate bone in adult humans. The 2 palatine processes meet in the midline in the maxillary midline suture (midpalatal suture, intermaxillary suture, or median suture). The horizontal plate of the palatine bone completes the hard palate posteriorly. Note the incisive foramen in the anterior midline and the greater and lesser palatine foramina at the junction of the maxilla and the palatine bones and in the palatine bone, respectively.*

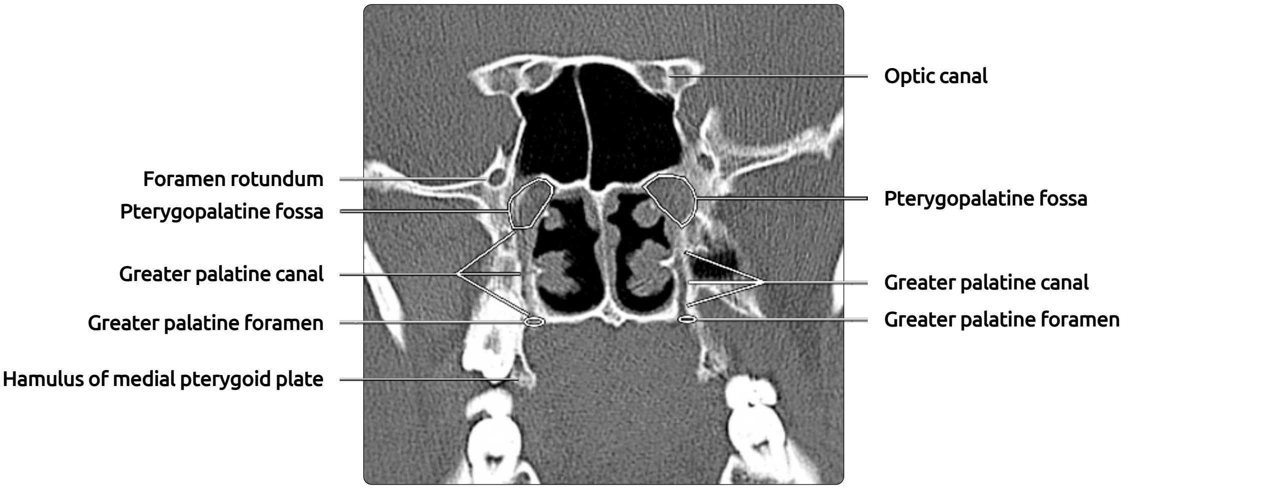
GRAPHIC AND BONE CT

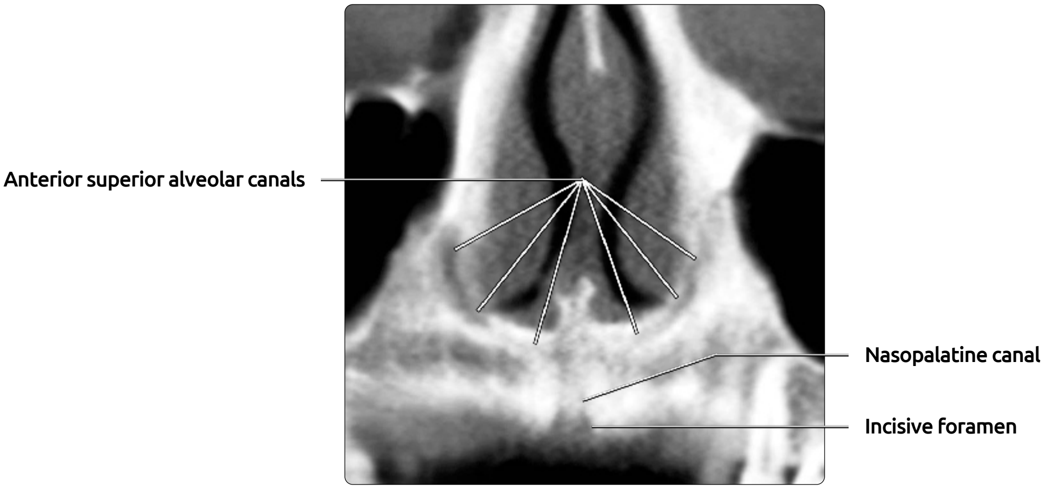


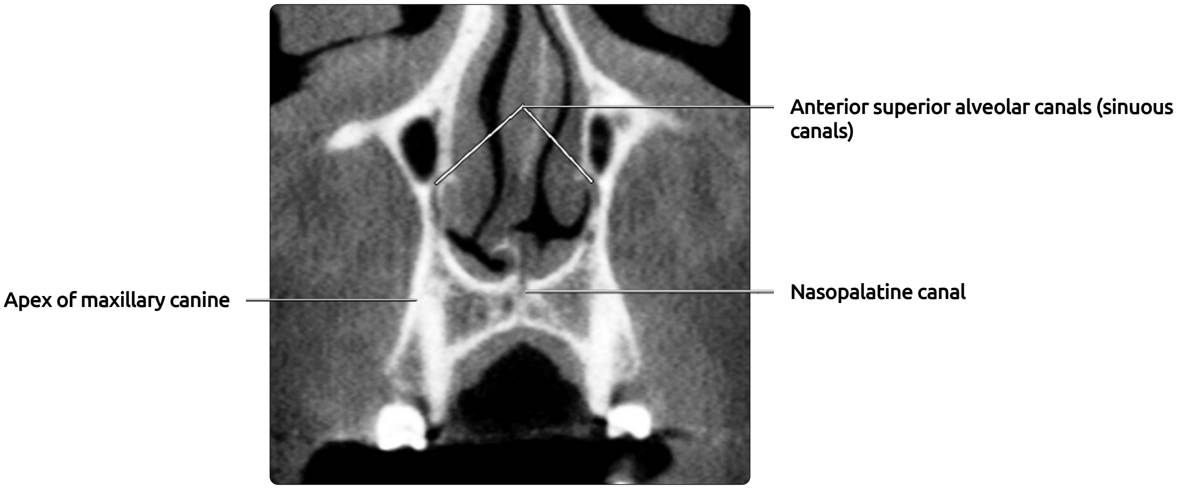


(Top) *Graphic of the hard palate viewed from below, with mucosa removed on right side, shows the hard palate sensory innervation. The anterior 1/3 of the hard palate is supplied by the nasopalatine nerve, and the posterior 2/3 of the hard palate is supplied by the greater palatine nerve. The greater palatine nerve often indents the junction of the palatine and the alveolar processes of the maxilla (greater palatine groove), as can be seen on coronal series.* **(Middle)** *The incisive foramen may be single (as shown) or paired and may be centered or slightly lateral to the midline (as shown). There may be several canals seen lateral to the main canal(s), the foramina of Scarpa.* **(Bottom)** *When examining the maxilla for 3rd molar impactions, it is important to localize the adjacent anatomical structures and note proximity to teeth if removal is planned. These structures are the maxillary sinuses, the greater palatine canals and foramina, the pterygoid plates, and the maxillary tuberosities. Axial CBCT shows the relation of the developing 3rd molars to these structures.*

AXIAL AND CORONAL CBCT

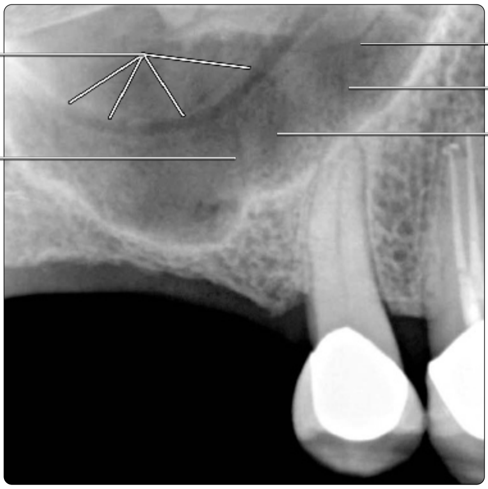


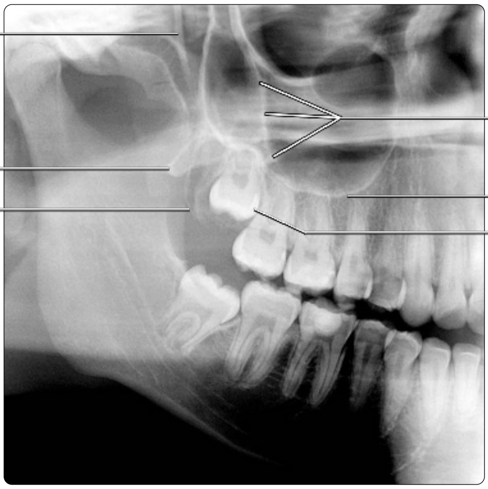


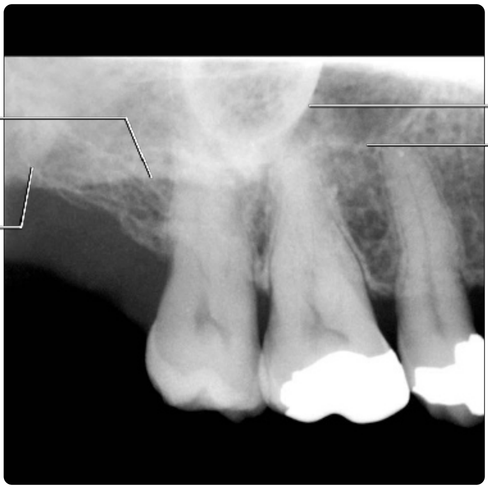


(Top) *Coronal bone CT through the vertical aspect of greater palatine canal shows this canal connecting the pterygopalatine fossa above with the greater palatine foramen below. The greater palatine nerve uses the greater palatine canal to access the palate.* **(Middle)** *Panoramic 1.5-mm reformat shows the right and left anterior superior alveolar canals descending to form the superior dental plexus. These can meet in the midline in the area of the nasopalatine canal as seen in this image. Care should be taken if implant placement is planned in this area.* **(Bottom)** *Coronal CBCT shows the anterior superior alveolar canal after it leaves the infraorbital canal and descends along the anterior aspect of the lateral wall of the nasal cavity. The course of this nerve often comes close to the apices of the maxillary canines.*

PERIAPICAL AND PANORAMIC







(Top) *The posterior superior alveolar canal may sometimes be visible as a radiolucent curved line that appears to be inside the sinus on periapical radiographs of the posterior maxilla. The canal is usually located along the lateral wall of the sinus. The middle superior alveolar nerve, when present, supplies the maxillary premolars and the mesiobuccal root of the maxillary 1st molar. These nerves are usually difficult to visualize on CBCT. (Courtesy I. Angel, DDS.)* **(Middle)** *Cropped panoramic radiograph shows normal maxillary anatomical landmarks commonly encountered when evaluating this type of image. Superimposition of structures may confound evaluation.* **(Bottom)** *Periapical radiograph shows the zygomatic process of the maxilla and the inferior border of the zygomatic bone superimposing over the inferior aspect of the maxillary sinus, the apices of the maxillary molars, and the maxillary tuberosity.*

TERMINOLOGY

Abbreviations

- Mandible (Md)

IMAGING ANATOMY

Overview

- Unpaired horseshoe-shaped bone

Anatomy Relationships

- All muscles of mastication attach to Md

Internal Contents

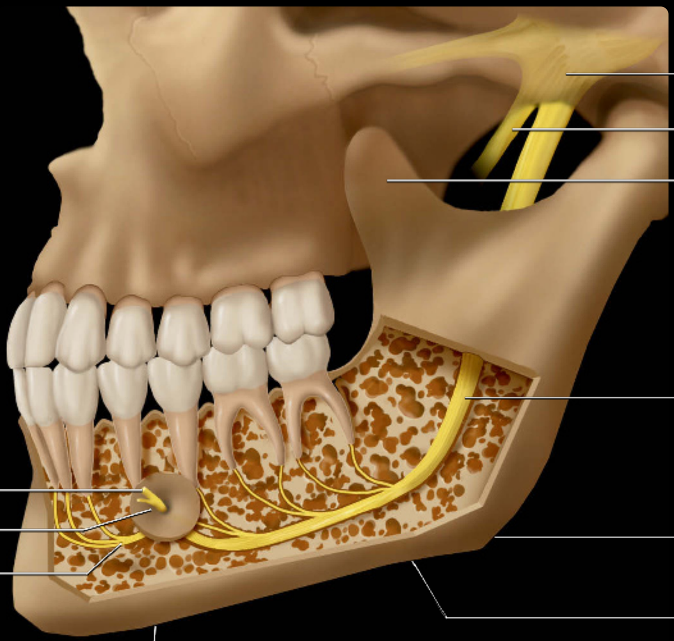
- Bone
  - **Mandibular body**
    - U-shaped, horizontal body; fuses in early childhood in anterior midline at **symphysis**
    - **Mental protuberance**: Bony prominence of chin; more prominent in males
    - **Mental foramen**: Transmits mental nerve; located buccally in premolar/1st molar regions
    - **Genial tubercles (mental spines)**: Small projections on lingual aspect of anterior Md; genioglossus and geniohyoid attach here
    - **Lingual foramen**: Small foramen on lingual aspect of anterior Md in midline; conducts terminal branch of incisive nerve and often small branch of lingual artery
    - **Internal oblique/mylohyoid ridge**: Bony ridge on lingual Md body; origin of mylohyoid muscle and divides sublingual from submandibular fossae
    - **Mylohyoid groove**: Impression of nerve to mylohyoid as it leaves V3 before V3 enters mandibular foramen
    - **Submandibular fossa**: Indentation on lingual aspect of Md inferior to mylohyoid ridge; impression of submandibular salivary gland
    - **Antegonial notch**: Indentation in inferior border anterior to angle; masseter insertion
    - **External oblique ridge/line**: Bony ridge on lateral posterior aspect adjacent to molars; buccal shelf is superior to it
  - **Ramus**
    - Meets body of Md at angle of Md on each side
    - Masseter muscle attaches to lateral side
    - Medial pterygoid muscle and sphenomandibular ligament attach to medial side
    - Mandibular ramus divides masticator space into lateral and medial compartments
    - **Mandibular foramen**: Center medial surface of ramus
    - **Lingula**: Small, osseous lip on medial surface of ramus extending from anterior aspect of mandibular foramen
    - **Antilingula**: Anatomic and surgical landmark on lateral surface of ramus at level of lingula
    - **Coronoid notch**: Deepest point on anterior border of ramus
  - **Condylar process**
    - **Condyle**: Articulates with temporal bone in TMJ
    - **Condylar neck**: Attaches condylar head to ramus
    - Superior belly and most of inferior belly of lateral pterygoid muscle insert into **pterygoid fovea** on neck
  - **Coronoid process**
    - Temporalis attaches here
    - **Mandibular (sigmoid) notch** separates coronoid process and condylar neck
  - **Alveolar process**
    - Bone that supports teeth with thick facial and thin lingual cortical plates
    - Alveolar bone is resorbed when teeth are lost
  - **Inferior alveolar (mandibular) canal**
    - Lies within distal ramus and proximal body of Md
    - Extends from mandibular to mental foramen
    - Contains inferior alveolar nerve (IAN) and vessels
    - May have anomalous branches and foramina
- **Nerves**
  - **IAN**
    - Extends from mandibular foramen through mandibular canal to mental foramen
    - Innervates ipsilateral premolars and molars
    - Divides into mental and incisive branches
  - **Mental nerve**
    - Anterior extraosseous branch of IAN
    - Exits mental foramen
    - Provides sensory innervation to skin and mucosa of lower lip and labial gingiva
  - **Incisive nerve**
    - Anterior intraosseous branch of IAN
    - Innervates ipsilateral canine and incisors
    - May reach midline → cross-innervation

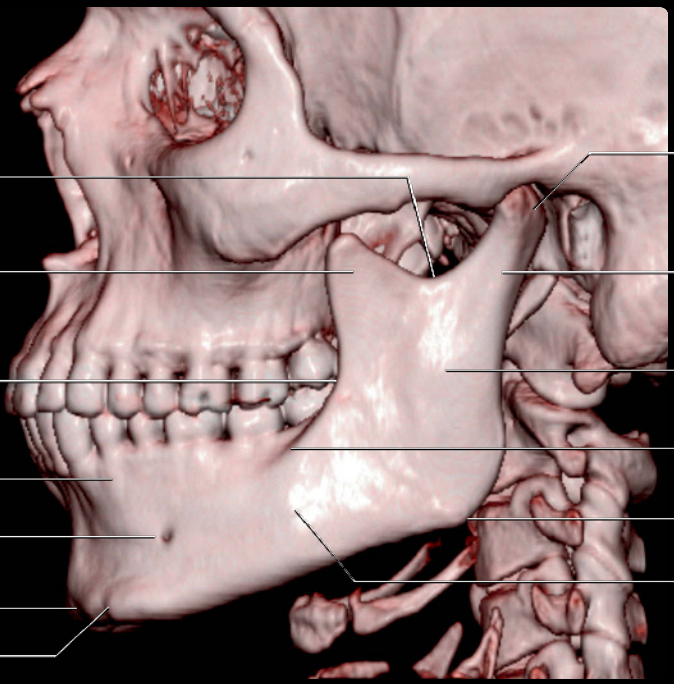
ANATOMY IMAGING ISSUES

Questions

- **Deepened mandibular notch**
  - Consider **neurofibromatosis**
- **Deepened antegonial notch**
  - Consider conditions that cause **clockwise growth pattern of Md due to condylar height reduction** (juvenile idiopathic arthritis or progressive condylar resorption), masseteric hyperfunction, scleroderma
  - Check TMJs for dysfunction or degenerative changes
- **Coronoid hyperplasia**
  - Consider if limitation of opening is noted clinically
- **Asymmetrical mandibular ramus and body height**
  - Degenerative disease of TMJ or condylar hypoplasia on smaller side
  - Condylar hyperplasia on larger side
  - Hemifacial microsomia
- **Steep mandibular plane**
  - May be associated with small condyles bilaterally
    - Bilateral small condyles may be due to degenerative changes, juvenile idiopathic arthritis, rheumatoid arthritis
- **V3 malignant perineural tumor (PNT) spread**
  - If malignant tumor of skin of chin, mandibular alveolar ridge, or masticator space, check for V3 PNT
  - If imaging for V3 PNT, check entire length of V3 to root entry zone
    - Pay special attention to mental foramen, mandibular canal, mandibular foramen, and masticator space

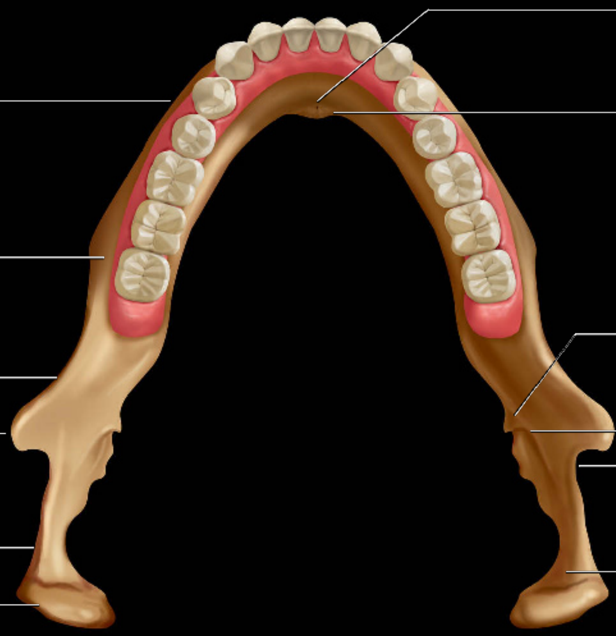
GRAPHIC, 3D REFORMATION

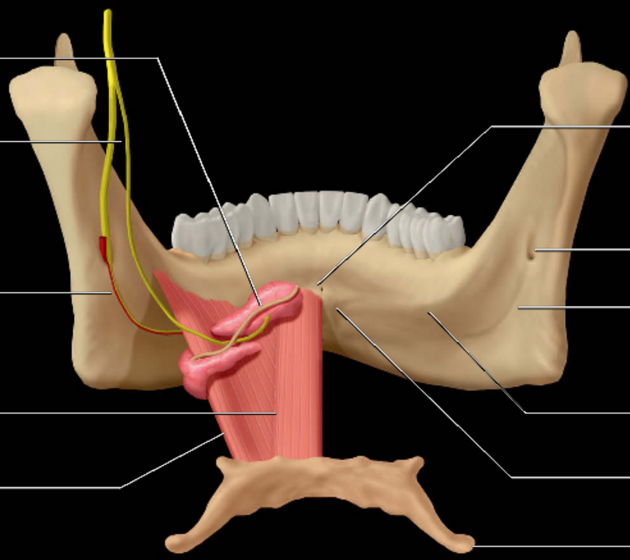




(Top) *Lateral graphic of the mandible with the buccal cortex removed reveals the mandibular nerve entering the mandible as the inferior alveolar nerve. The inferior alveolar nerve divides anteriorly into mental and incisive branches. The mental nerve branch reaches the superficial chin through the mental foramen. The incisive nerve continues to the areas of the incisors, sometimes reaching the midline and providing cross-innervation to the contralateral side. This may or may not be visible radiographically.* **(Bottom)** *Lateral view shows 3D reconstruction of facial bones. The mandible can be divided into condylar process, coronoid process, ramus, body, and alveolar process. The mental foramen is seen in the anterior portion of the body and transmits the mental nerve, which is sensory to the skin and mucosa of the lower lip. The coronoid notch is an important landmark when determining the entry point for an inferior alveolar nerve block anesthesia.*

GRAPHICS





(Top) *Axial graphic of the mandible seen from above demonstrates the condyle and condylar neck leading to the more inferior ramus. The mandibular foramen is seen on the inner surface of the mandibular ramus. The superiorly projecting coronoid processes attach the temporalis muscle tendons. The lateral pterygoid muscle (superior belly and most of the inferior belly) inserts in the pterygoid fovea. The lingula is a lip-like projection at the inferior anterior aspect of the mandibular foramen.* **(Bottom)** *Graphic shows the posterior view of the mandible. The nerve to the mylohyoid muscle branches off V3 before it enters the mandibular canal and creates a slight impression in the bone called the mylohyoid groove. The mylohyoid muscle attaches to the mylohyoid ridge, and the geniohyoid muscle attaches to the genial tubercles. The lingual foramen exits superior to the genial tubercles in the midline.*