SECTION 1

Anatomic Landmarks

Objectives:

- Recognize, define, and describe the soft tissue structures and landmarks of the anterior and posterior oral cavity.
- Recognize, define, and describe the soft tissue structures and landmarks of the floor of the mouth, tongue, and palate.
- Recognize, define, and describe the soft tissue structures and landmarks of the periodontium.
- Recognize, define, and describe the bony structures and landmarks of the maxilla and mandible and adjacent regions.
- Recognize, define, and describe common variants of normal.
- In the clinical setting, identify intraoral soft tissue structures and anatomic landmarks in a patient's mouth.

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LANDMARKS OF THE ORAL CAVITY

Lips (Fig. 1.1) The lips form the outer border of the oral cavity. They are covered by mucosa and a surface layer of parakeratin. Beneath this is connective tissue and rich blood supply. Deeper are muscles that control lip movement (orbicularis oris, levator, and depressor oris). Lips appear pink-red but can vary in color depending on the age and pigmentation of the patient, sun exposure, and history of trauma. The junction of the lips with the labial mucosa is the **wet line**, the point of contact of the upper and lower lips. The **vermilion** is the portion external to the wet line. The **vermilion border** is the junction of the lip with the skin. The lips should be visually inspected and palpated by everting during the oral examination. The surface should be smooth and uniform in color; the border should be smooth and well delineated.

Labial Mucosa (Fig. 1.2) is the thin, pink parakeratotic epithelium lining the lips. The **labial mucosa** is usually pink or brownish-pink with small red capillaries nourishing the region. Minor **salivary gland ducts** empty onto the surface of the mucosa. These ducts appear as small orifices that emit mucinous saliva.

Buccal Mucosa (Fig. 1.3) is the inner epithelial lining of the cheeks. The **buccal mucosa** broadens bilaterally from the labial mucosa to the retromolar pad and extends to the pterygomandibular raphe. Deposits of fat within the buccal connective tissue can make it appear yellow or tan. Accessory salivary glands are present in this region and moisten the oral mucosa. The **caliculus angularis** is a normal pinkish papule located in the buccal mucosa at the commissure.

Parotid Papilla (Fig. 1.4) is a triangular, raised, pink papule on the buccal mucosa adjacent to the maxillary first molars bilaterally. The **parotid papilla** forms the end of **Stensen duct**, the excretory duct of the parotid gland. The gland is milked by drying the papilla with gauze, pressing the fingers below the mandible, and extending pressure upward and over the gland. In health, clear saliva should flow from the duct.

Floor of the Mouth (Fig. 1.5) is the region below the front, anterior half of the tongue. It is composed of thin, pink parakeratinized epithelium, connective tissue, salivary glands, and associated nerves and blood vessels. The **floor of the mouth** has U-shaped boundaries bordered anterolaterally by the dental arch and posteriorly by the ventral tongue surface. The anterior portion is smooth, uniform, and covered by mucosa. The **lingual frenum** is located along the midline of the posterior portion. Between the two halves is an elevated area under which **Wharton duct** of the submandibular gland lies. Saliva from the submandibular gland exits through an elevated papule called the **sublingual caruncle** to moisten the floor of the mouth. Along the posterior portion of the caruncle are multiple small openings, the "**ducts of Rivinus**," that carry saliva from the sublingual salivary gland. Beneath these structures lies a pair of **mylohyoid muscles** that function in lifting the tongue and hyoid bone.

Hard Palate (Fig. 1.6) forms the roof of the oral cavity. The **hard palate** is composed of squamous epithelium, connective tissue, minor salivary glands and ducts (in the posterior two thirds only), **periosteum**, and the palatine processes of the maxilla. Anatomically, it consists of several structures. The **incisive papilla** is directly behind and between the maxillary incisors. It is a raised, pink ovoid structure that overlies the nasopalatine foramen. The **rugae** are fibrous ridges that are located slightly posterior to the incisive papilla, in the anterior third of the palate. They run laterally from the midline to within several millimeters of the attached gingiva of the anterior teeth. A little further back are the **lateral vaults**, alveolar bones that support the palatal aspects of the posterior teeth. In the center of the hard palate is the **median palatal raphe**, a yellow-white fibrous band that appears at the junction of the right and left palatine processes.

Soft Palate (Fig. 1.7) is located posterior to the hard palate. It is unique from the hard palate in that the soft palate lacks bony support and has more minor salivary glands and lymphoid and fatty tissue than the hard palate. The **soft palate** functions during mastication and swallowing. It is elevated during swallowing by the levator palati and tensor palati muscles and motor innervated by cranial nerves IX and X. The **median palatal raphe** is more prominent and thicker in the soft palate. Just lateral to the raphe are the **fovea palatinae**. The foveae are 2-mm excretory ducts of minor salivary glands. They are landmarks of the junction between the hard and soft palates. At the midline distal aspect of the soft palate is the **uvula**, which hangs down.

Oropharynx and Tonsils (Fig. 1.8) The **oropharynx** is the junction between the mouth and the esophagus. The borders of the oropharynx are the uvula along the anterior aspect, the two tonsillar pillars (fauces) along the anterolateral aspect, and the pharyngeal wall at the posterior aspect. The tonsils are lymphoid tissue located within two pillars. The anterior tonsillar pillar is formed by the palatoglossus muscle that runs downward, outward, and forward to the base of the tongue. The posterior pillar is larger and runs posteriorly. It is formed by the palatopharyngeus muscle. The **tonsils** are dome-shaped soft tissue structures that have surface crypts and invaginations (folds), which serve to capture invading microbes. Tonsils enlarge during adolescence (a lymphoid growth period) and during infectious, inflammatory, and neoplastic processes. Islands of tonsillar tissue are seen on the surface of the posterior pharyngeal wall. **Waldeyer ring** is the ring of adenoid tissue formed by the tonsillar tissue found on the posterior tongue (lingual tonsils), pharynx (pharyngeal tonsils), and fauces (tonsillar pillars).

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Fig. 1.1. Lips: normal, healthy appearance.



Fig. 1.2. Labial mucosa: inner lining of the lips.



Fig. 1.3. Buccal mucosa: and caliculus angularis.



Fig. 1.4. Parotid papilla: adjacent to maxillary first molar.



Fig. 1.5. Floor of the mouth: with central lingual frenum.



Fig. 1.6. Hard palate: incisive papilla and rugae in anterior third.



Fig. 1.7. Soft palate: fovea palatinae and median palatal raphe.

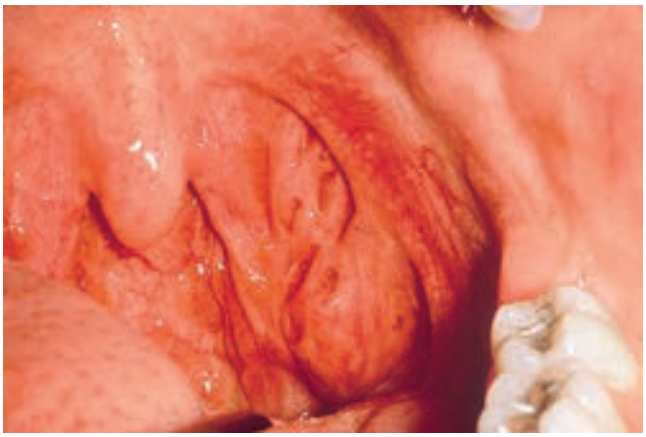


Fig. 1.8. Oropharynx and tonsillar pillars.

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Normal Tongue Anatomy (Figs. 2.1–2.5) The tongue is a compact organ composed of skeletal muscles that has important functions in taste, chewing, swallowing (deglutition), and speech. The **dorsum** (upper surface) of the tongue is covered by a protective layer of stratified squamous epithelium and numerous mucosal projections that form papillae. Four types of papillae cover the dorsum of the tongue: filiform, fungiform, circumvallate, and foliate papillae. **Filiform papillae** are the smallest but the most numerous. They are slender, hairlike, cornified stalks that serve to protect the tongue. They appear pink in patients with good oral hygiene but may be red or white if irritated or inflamed. Elongated papillae or atrophy/loss of papillae are associated with disease. **Fungiform papillae** are noncornified, round, mushroom-shaped papillae found interspersed between and slightly elevated above the filiform papillae. They are brighter red, broader in width, and fewer in number (approximately 300 to 500) than the filiform papillae. Each fungiform papilla contains two to four taste buds that confer the ability to taste (salty, sweet, sour, and bitter). Fungiform papillae are most numerous on the anterior tip and lateral border of the tongue and can be stained with blue food color and viewed. Fungiform papillae sometimes contain brown pigmentation, especially in melanoderms.

The largest papillae, the **circumvallate papillae**, also contain taste buds. There are 8 to 12 circumvallate papillae arranged in a V-shaped row at the posterior aspect of the dorsum of the tongue. They appear as 2- to 4-mm pink elevations surrounded by a narrow trench, the **sulcus terminalis**.

Careful examination of the lateral border of the posterior region of the tongue reveals the **foliate papillae**. These papillae are leaflike projections oriented as vertical folds. Foliate papillae are more prominent in children and young adults than in older adults. Corrugated hypertrophic lymphoid tissue (**lingual tonsil**) extending into this area from the posterior dorsal root of the tongue may sometimes be mistakenly called foliate papillae.

On the ventral surface (underside) of the tongue are linear projections known as the **plica fimbriata**. The plica fimbriata has little known function in humans but contains taste buds in newborns and other primates. Occasionally, the fimbriata is brown in dark-skinned individuals.

Fissured Tongue (Plicated Tongue, Scrotal Tongue) (Fig. 2.6) is a variation of normal tongue anatomy that consists of a single midline fissure, double fissures, or multiple fissures of the anterior two thirds of the dorsal surface of the tongue. Various patterns, lengths, and depths of fissures have been observed. The cause of **fissured tongue** is often unknown, but it often develops with increasing age and in patients who have hyposalivation. About 1% to 5% of the population is affected. The frequency of the condition is equal in men and women. It occurs commonly in patients with Down syndrome and in combination with geographic tongue. Fissured tongue is a component of the **Melkersson-Rosenthal syndrome** (fissured tongue, cheilitis granulomatosa, and unilateral facial nerve paralysis).

Tongue fissures may become secondarily inflamed and cause halitosis as a result of food impaction; thus, brushing the tongue to keep the fissures clean is recommended. The condition is benign and does not cause pain.

Ankyloglossia (Fig. 2.7) The **lingual frenum** is normally attached to the ventral tongue and genial tubercles of the mandible. If the frenum fails to attach properly to the tongue and genial tubercles, but instead fuses to the floor of the mouth or lingual gingiva and the ventral tip of the tongue, the condition is called **ankyloglossia** or "tongue-tie." This congenital condition is characterized by (i) an abnormally short, malpositioned, and thickened lingual frenum and (ii) a tongue that cannot be extended or retracted. The fusion may be partial or complete. Partial fusion is more common. If the condition is severe, speech may be affected. Surgical correction and speech therapy are necessary if speech is defective or if a mandibular denture or removable partial denture is planned. The estimated frequency of ankyloglossia is one case per 1,000 births.

Lingual Varicosities (Phlebectasia) (Fig. 2.8), enlarged dilated veins on the ventral surface of the tongue, are a common finding in elderly adults. The cause of these vascular dilatations is either a blockage of the vein by an internal foreign body, such as an atherosclerotic plaque, or the loss of elasticity of the vascular wall as a result of aging. Intraoral **varicosities** most commonly appear superficially on the ventral surface of the anterior two thirds of the tongue and may extend onto the lateral border and floor of the mouth. Men and women are affected equally.

Varicosities appear as red-blue to purple fluctuant papules or nodules. Individual varices may be prominent and tortuous or small and punctate. Palpation does not elicit pain but can move the blood temporarily out of the vessel, thereby flattening the surface appearance. **Diascopy** (pressing against the lesion with a clear plastic tube or glass slide) causes varices to blanch. When many lingual veins are prominent, the condition is called "**phlebectasia linguae**" or "**caviar tongue**." The lip and labial commissure are other frequent sites of phlebectasia. Treatment of this condition is not required, unless for cosmetic reasons.

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Fig. 2.1. Filiform and fungiform papillae of the tongue.

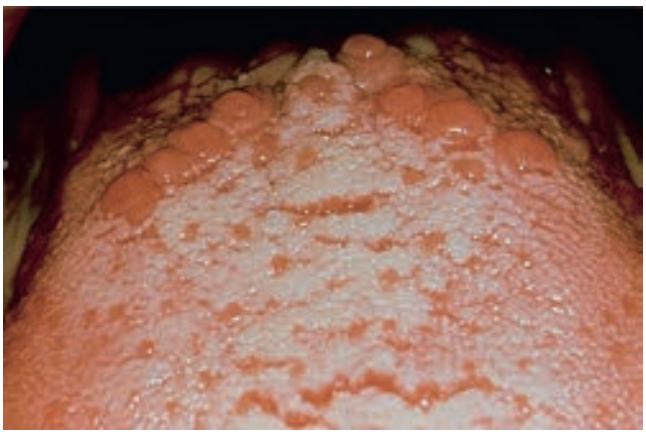


Fig. 2.2. Circumvallate papillae forming a V-shaped row.



Fig. 2.3. Foliate papilla: posterolateral aspect of the tongue.



Fig. 2.4. Lingual tonsil at dorsolateral aspect of the tongue.



Fig. 2.5. Plica fimbriata in person who is pigmented.



Fig. 2.6. Fissured tongue: dorsal aspect.



Fig. 2.7. Ankyloglossia: not causing a speech impediment.

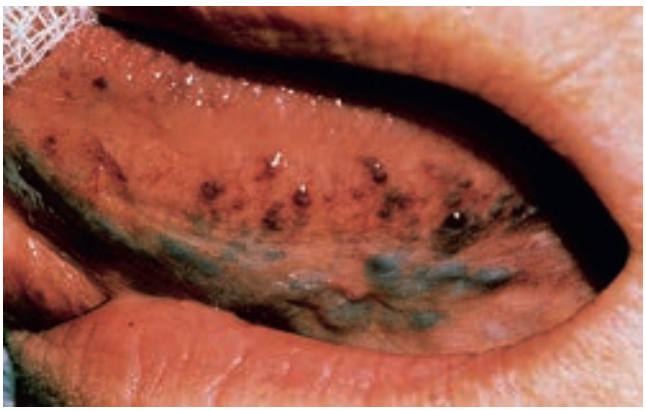


Fig. 2.8. Lingual varicosities: on ventral tongue.

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Periodontium (Figs. 3.1 and 3.2) is the tissue that immediately surrounds and supports the teeth. It consists of alveolar bone, periosteum, periodontal ligament, gingival sulcus, and gingiva; each of these components contributes to stabilizing the tooth within the jaws. The **alveolar bone** is composed of cancellous or spongy bone. It is located between the cortical plates and is penetrated by blood vessels and marrow spaces. The **periosteum** is the dense connective tissue attached to and covering the outer surface of the alveolar bone. Teeth are anchored to alveolar bone by the periodontal ligament that attaches to the cementum that covers the roots of teeth. The **periodontal ligament** is composed of cells and collagen type 1, 3, and 5 fibers. It supports and surrounds the tooth root and extends from the apex of the root to the base of the **gingival sulcus**. The gingival sulcus, the space between the free gingiva and the tooth surface, is lined internally by a thin layer of epithelial cells. The base of the sulcus is formed by the **junctional epithelium**, a specialized type of epithelium that attaches the gingiva to the root. This epithelium provides the barrier to the ingress of bacteria. In health, the gingival sulcus is less than 3 mm deep as measured by a periodontal probe from the **cementoenamel junction (CEJ)** to the base of the sulcus. Colonization of bacteria within the sulcus promotes inflammation that eventually leads to breakdown of the **epithelial attachment**. Evidence of chronic inflammation is the apical extension of the epithelial attachment beyond 3 mm. Although accumulation of **bacterial plaque** is the most important factor influencing the health of the **periodontium**, position of the tooth within the arch, occlusal loading, parafunctional habits, appliances, drugs, and frenal attachments also affect periodontal health and the development of periodontal pockets.

Alveolar Mucosa and Frenal Attachments (Figs. 3.3 and 3.4) The **mucosa** is the epithelium and loose connective tissue covering the oral cavity. The **alveolar mucosa** is a movable mucosa that overlies alveolar bone and borders the apical extent of the periodontium. It is movable because it is not bound down to the underlying periosteum and bone. The alveolar mucosa is thin and highly vascular. Accordingly, it appears pinkish-red, red, or bright red. On close inspection, small arteries and capillaries can be seen within the alveolar mucosa. These vessels provide nutrients, oxygen, and blood cells to the region. The mucosa is generally identified as either **buccal mucosa** (if it is located laterally or posteriorly) or **labial mucosa** (if it is located anteriorly).

Frena are lip and cheek muscle attachments at specific locations within the alveolar mucosa. They appear as arclike rims of flexible fibrous tissue when the lips or cheeks are distended. Six oral frena have been identified. The **maxillary labial frenum** is located at the midline between the maxillary central incisors, about 4 to 7 mm apical to the interdental region. The **mandibular labial frenum** appears similarly below and between mandibular central incisors within the alveolar mucosa. The two **maxillary** and two **mandibular buccal frena** are located within the alveolar mucosa near the first premolar on the right and left sides. Although frena do not directly contribute to periodontal support, those that attach within 3 mm of the CEJ of a tooth can pull on periodontal tissues and contribute to the development of gingival recession.

Mucogingival Junction (Fig. 3.5) is an anatomic landmark representing the border between the unattached alveolar mucosa and the attached gingiva. The **mucogingival junction** is about 3 to 6 mm below the CEJ and extends around the buccal and lingual aspects of the arches. Visibility of the junction depends on the difference in vascularity and color of the two tissues. It is easily distinguished when the alveolar mucosa is red and the attached gingiva is pink and because it is the junction between the moveable alveolar mucosa and the nonmoveable attached gingiva.

Attached Gingiva and Free Marginal Gingiva (Figs. 3.6–3.8) The attached gingiva and free marginal gingiva cover the outer aspect of the gingival sulcus. The **attached gingiva** extends coronally from the alveolar mucosa to the free marginal gingiva. It is covered by keratinized epithelium, is bound down to periosteum, and cannot be moved. In health, the attached gingiva is pink, firm, and 2 to 7 mm wide. Its surface is slightly convex and stippled, like the surface of an orange. **Interdental grooves** can be seen in the attached gingiva as vertical grooves or narrow depressions located between the roots of the teeth.

The **marginal gingiva** provides the gingival collar around the cervix of the tooth. It is pink and keratinized like the attached gingiva, with a smooth rounded edge. Unlike the attached gingiva, the marginal gingiva is not attached to periosteum, nor is it stippled. Its freely movable nature allows a periodontal probe to be passed under it during pocket depth assessment. Accordingly, it is also termed the **free marginal gingiva**. The junction between the marginal gingiva and the attached gingiva is called the **free gingival groove**.

The **interdental papilla** is the triangular projection of marginal gingiva that extends incisally between adjacent teeth. The papilla has a buccal and lingual surface and an interdental region (the **col**) that is concave, depressed, and covered by free marginal gingiva. In health, papillae are pink and knife-edged, can barely be moved by the periodontal probe, and extend near to the interdental contact region. The presence of inflammation and disease (i.e., gingivitis) alters the color, contour, and consistency of the free marginal gingiva and interdental papillae, causing the marginal gingiva to appear red-purple, soft, swollen, and tender, and the papillae to relax away from the tooth.

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Fig. 3.1. Healthy periodontium: anterior view.



Fig. 3.2. Healthy periodontium: lingual aspect.



Fig. 3.3. Healthy periodontium and buccal frenum.



Fig. 3.4. Red alveolar mucosa and labial frenum.



Fig. 3.5. Mucogingival junction: identified by *arrow*.

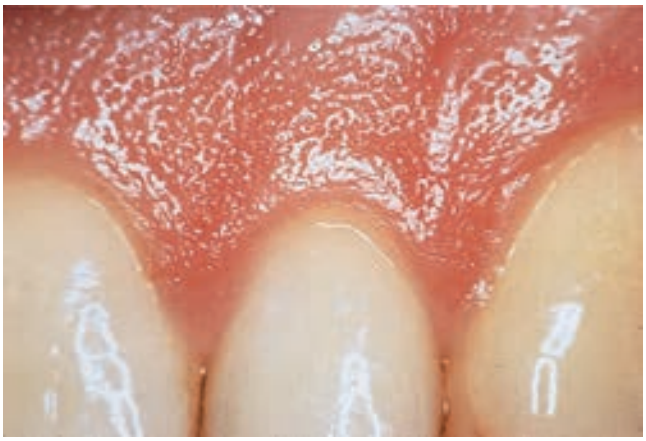


Fig. 3.6. Attached gingiva: stippled texture.



Fig. 3.7. Interdental grooves.

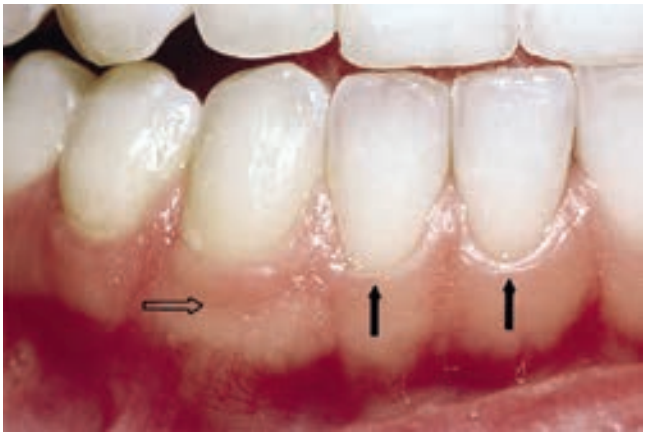


Fig. 3.8. Marginal gingiva (*closed arrows*) and gingival groove (*open arrow*).

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Occlusion is the relation of the maxillary and mandibular teeth during functional contact. The term is used to describe the way teeth are aligned and fit together. In an ideal occlusion, all the maxillary teeth fit slightly over the mandibular teeth, the cusps of the upper molars fit into the buccal grooves of the lower molars, and the midline is aligned. Few people have perfect occlusion, and **malocclusion** (abnormal positional relationship of the maxillary teeth with the mandibular teeth) is a common reason for patients to seek orthodontic care. Although most malocclusions do not require treatment, correcting a malocclusion can enhance the patient's appearance and ability to clean their teeth and reduce the risk of developing oral disease.

Malocclusion is often hereditary. It results when the upper and lower jaws are disproportionate in size, the size of the teeth is too large or small for the jaws, or the spacing/eruption of teeth is abnormal. The following is a summary of the modified classification of occlusion first established by the orthodontist Edward Hartley Angle, who based his classification (**Angle classification**) on the occlusal relationships of the permanent first molars.

Class I Occlusion (Figs. 4.1–4.3) is considered to be the ideal (normal) occlusion and normal anteroposterior relationship of the jaws. In **Class I occlusion**, the mesiobuccal cusp of the permanent maxillary first molar occludes (fits) into the buccal groove of the permanent mandibular first molar. Also, the maxillary canine occludes into the interproximal space between the mandibular canine and first premolar.

Class II Occlusion (Figs. 4.4–4.9) occurs when the maxillary teeth appear anterior to the normal relationship with the mandibular teeth. In **Class II occlusion**, the mesiobuccal cusp of the permanent maxillary first molar occludes mesial (anterior) to the buccal groove of the permanent mandibular first molar. There are two divisions. **Class II Division 1** is when the maxillary teeth are protruded (labioversion, producing a large overjet) and the maxillary first molar is anterior to the normal relationship. **Class II Division 2** is where the maxillary central incisors are intruded (linguoversion, producing a deep overbite) and the maxillary first molar is anterior to the normal relationship.

Class III Occlusion (Figs. 4.10–4.12) is where the mesiobuccal cusp of the permanent maxillary first molar occludes distal (posterior) to the buccal groove of the permanent mandibular first molar. This condition produces a prognathic profile (the lower jaw projects forward) and occurs in about 3% of the U.S. population.

Overbite: The vertical overlap of the maxillary teeth over the mandibular teeth when the posterior teeth are in contact in centric occlusion.

Overjet: The horizontal overlap (protrusion) of the maxillary anterior/posterior teeth beyond the mandibular teeth when the mandible is in centric occlusion.

Subdivision: A unilateral condition on the left or right side only.

Note: Patients can have different classes of malocclusion on the left and right sides.



Fig. 4.1. Angle Class I: normal occlusion, right.



Fig. 4.4. Angle Class II Division 1: malocclusion, right.



Fig. 4.7. Angle Class II Division 2: malocclusion, right.



Fig. 4.10. Angle Class III: malocclusion, right.

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Fig. 4.2. Angle Class I: normal occlusion, center.



Fig. 4.3. Angle Class I: normal occlusion, left.



Fig. 4.5. Angle Class II Division 1: malocclusion, center.



Fig. 4.6. Angle Class II Division 1: malocclusion, left.



Fig. 4.8. Angle Class II Division 2: malocclusion, center.



Fig. 4.9. Angle Class II Division 2: malocclusion, left.



Fig. 4.11. Angle Class III: malocclusion, center.



Fig. 4.12. Angle Class III: malocclusion, left.

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Anterior Midline Region (Figs. 5.1 and 5.2) The anterior maxillary radiographic image contains several important anatomic landmarks and structures. The **incisive foramen** is an ovoid depression in the anterior midline of the **hard palate** that contains the nasopalatine nerve and blood vessels. Radiographically, it appears as an ovoid radiolucency with a fine radiopaque margin. The foramen overlies the median palatal suture and is located between the roots of the central incisors. The **median palatal suture** appears as a midline radiolucent line bordered by a radiopaque margin. It runs vertically and apically between the roots of the central incisors to the V-shaped **anterior nasal spine**. The **soft tissue outline of the nose** extends to the apices of the incisors, and the **soft tissue outline of the upper lip** is often seen as a light radiopacity bisecting the crowns of the central incisors. Alveolar bone in this region appears as fine, interspersed radiopaque **trabeculae** that surround radiolucent **marrow spaces**. The **cementoenamel junction (CEJ)**, or cervical line, of the incisors is seen as a smooth, curved line delineating the crown and root portions of the tooth. Apically, the CEJ is a more subtle round line above the **crest of the alveolar bone**. In Figure 5.2, the root structure between the CEJ and alveolar crest is not covered by bone owing to destruction by periodontal disease.

Anterior Lateral Region (Fig. 5.3) The **superior foramen of the incisive canal** is seen as a round radiolucent landmark within the **nasal fossa** and above the root apex of the central incisor and the radiopaque line representing the **floor of the nasal fossa**. The radiolucent **incisive canal** runs vertically below the incisive foramen. The **soft tissue outline of the nose** is seen bisecting the roots of the central and lateral incisors. The radiolucent **periodontal ligament (PDL) space** and radiopaque **lamina dura** surround the roots. On radiographs, the PDL space is typically 0.5 to 1.5 mm in width, and the lamina dura is 0.2 and 0.5 in average width. The crowns demonstrate a radiopaque **enamel** outer layer, a less dense inner layer of **dentin**, and a centrally located radiolucent **pulp chamber**. Each tooth root has an outer layer of **cementum** that is not normally visible on radiographs, unless excessive amounts, called **hypercementosis**, are present. Beneath the cementum is the dentin of the root that appears immediately adjacent to the radiolucent periodontal membrane space. Centrally within the root is the **root canal space**, which contains the pulp. In the central and lateral incisors shown in Figure 5.3, note the **cervical line** crossing the junction between the crown and roots of the teeth. Because of the excess vertical angulation of the beam in this example, the buccal cervical line is projected downward and the lingual cervical line is projected upward. Distal to the lateral incisor root is a slightly more radiolucent area called the **lateral fossa**, which is a depression on the labial bone between the lateral and canine roots.

Canine Region (Fig. 5.4) The **inverted Y** is prominently seen in the top portion of the canine image. It is composed of two structures: the floor of the nasal cavity (fossa) and the anterolateral wall of the maxillary sinus. The more anterior arm of the inverted Y consists of the floor of the nasal cavity (fossa); the more posterior curved arm is the anterolateral wall of the maxillary sinus. The **soft tissue outline of the nasal mucosa** is delineated by a thin radiolucent line representing an airspace between the nasal turbinate and nasal mucosa.

Premolar Region (Fig. 5.5) The **floor of the maxillary sinus** is located above the premolar and in molar roots. The normal floor of the maxillary sinus appears as an irregular, slightly wavy radiopaque line. Above the floor and within the lateral sinus wall is the curved radiolucent line representing the **canal of the posterior superior alveolar nerve, artery, and vein**. Notice that this canal has thin radiopaque margins. Above the second molar root is the radiopaque **zygomatic process of the maxilla**, sometimes referred to as the **malar process**. It is the anterior root of the zygomatic arch. Sometimes on a premolar image, the nasolabial fold bisects the root of the first premolar. Note the elongated palatal root of the first molar and the shortened buccal roots owing to incorrect positioning (excessive vertical angulation) of the **beam-indicating device (BID)** during image exposure.

Molar Region (Fig. 5.6) A prominent landmark in the maxillary molar image is the radiopaque U-shaped "malar shadow," which is the **zygomatic process of the maxilla**. It delineates the most anterior extent of the **zygomatic arch** (cheek bone). The zygomatic arch is buccal and lateral to the maxilla and extends horizontally across the upper portion of the molar image. In this example, it extends across the posterior portion of the **maxillary sinus**. Distal to the second molar is the **maxillary tuberosity**—a bony structure covered by connective tissue and mucosa.

Tuberosity Region (Figs. 5.7 and 5.8) Distal to the second molar is the **maxillary tuberosity**, the **lateral pterygoid plate**, and small **hamular process** of the medial pterygoid plate. Superior and lateral to this region is the **zygomatic arch**. The anterior half of the zygomatic arch is delineated from the posterior portion by the **zygomaticotemporal suture** (Fig. 5.7). The **coronoid process** of the mandible can be seen overlying the inferior portion of this region (Figs. 5.6–5.8).

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Fig. 5.1. Maxilla: lingual aspect of central incisor region.



Fig. 5.2. Maxilla: central incisor region radiograph.



Fig. 5.3. Maxilla: lateral incisor radiograph.



Fig. 5.4. Maxilla: canine periapical image.



Fig. 5.5. Maxilla: premolar periapical image.



Fig. 5.6. Maxilla: molar periapical image.



Fig. 5.7. Maxilla: tuberosity region on skull.

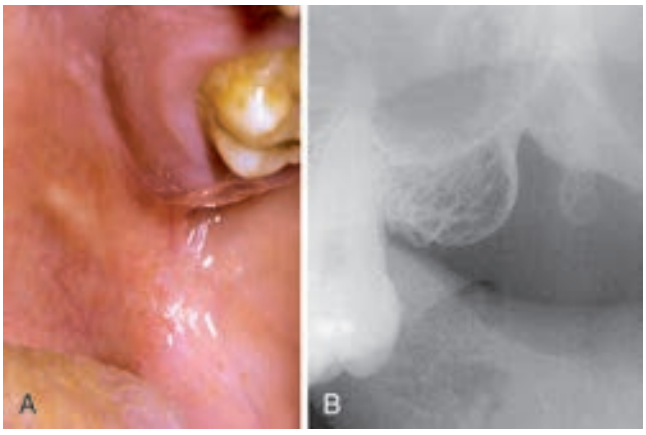


Fig. 5.8. Maxilla: clinical photograph **(A)** and radiograph **(B)** of tuberosity region.

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Incisor-Canine Region (Figs. 6.1 and 6.2) On the lingual aspect of the mandible, the incisor image reveals the **lingual foramen** located several millimeters below the root apices. This radiolucent landmark is surrounded by the four **genial tubercles**. The superior tubercles serve as the attachment site of the **geniоglossus muscle**, and the inferior pair anchors the **geniohyoid muscle**. The **inferior border** of the mandible below this area is delineated by a thick cortex (outer covering). Radiographically, the **genial tubercles** appear as round doughnut-shaped radiopacities. In this case, the **lingual canal** extends inferiorly from this region. Below this is the **inferior cortex** of the mandible. In Figure 6.2, the inverted V-shaped thick radiopaque line that extends posteriorly along the incisor root apices is the **mental ridge**; it is located on the buccal aspect of the mandible.

Premolar and Molar Regions (Figs. 6.3 and 6.4) In the photographs of the skull, the **mental foramen** is located near the root apex of the second premolar, and the **external oblique ridge** is highlighted (i.e., reflecting light from the flash) distal to the second molar. Both are landmarks of the **buccal aspect** of the mandible. On the lingual side of the mandible is the **internal oblique** or **mylohyoid ridge**. It is anterior, more horizontal, and longer than the external oblique ridge. Beneath the mylohyoid ridge is a **fossa** or **depression** within which lies the submandibular salivary gland.

Premolar Region (Fig. 6.5) Radiographically, the **mental foramen** is a round or ovoid radiolucency about 2 to 3 mm in diameter that lacks a distinct radiopaque corticated margin. Its location varies from the distal aspect of the canine to the distal aspect of the second premolar near and below the root apex region. In this radiograph, a mixed **trabecular pattern** is seen with a denser (more radiopaque) pattern toward the alveolar crest and a looser (more radiolucent) pattern in the apical area. Loose and dense trabecular patterns depend on the number of bone trabeculae present in the region. In this radiograph, the radiopaque **lamina dura** and radiolucent **periodontal membrane space** are well illustrated in the second premolar. The radiopaque **crestal alveolar bone** between the premolars is pointed and healthy. When the alveolar bone starts to resorb as a result of periodontal disease, the crestal bone (radiopaque line) is lost. The densely radiopaque material in the crowns of the second premolar and molar is **amalgam**. Notice that the gingival margins of the restorations are smooth and continuous with the remaining tooth structure in the interproximal areas, which helps to maintain proper periodontal health. In this view, the buccal cusps are slightly higher than the lingual cusps owing to excess negative vertical angulation of the BID during the exposure.

Buccal Aspect Molar Region (Fig. 6.6) The **external and internal oblique ridges** are densely radiopaque structures, approximately 2 to 6 mm in width, that sometimes parallel each other. The external oblique ridge is above and posterior to the internal oblique ridge. The smooth, round radiopaque area at the bifurcation of the first molar is frequently mistaken for an enamel pearl or pulp stone. Actually, it is an anatomic artifact (due to superimposition of buccal and lingual root structure at the bifurcation) produced by incorrect horizontal angulation of the BID. The artifact disappears when the correct horizontal angulation of the BID is used—in cases in which it does not disappear, an enamel pearl or pulp stone should be suspected.

Lingual Aspect Molar Region (Fig. 6.7) The **submandibular fossa** is a broad radiolucent area immediately beneath the mylohyoid ridge and above the **inferior cortex** of the mandible. It is seen more often when excessive negative vertical angulation of the BID is used.

Internal Aspect Molar Region (Fig. 6.8) The **inferior alveolar canal** (or mandibular canal)—containing the inferior alveolar nerve and blood vessels—appears as a 6-mm wide radiolucent canal in the molar image. The canal is outlined by parallel radiopaque cortical lines representing the canal walls and often runs below or in close proximity to the molar apices or to developing third molars. This close relationship to third molars is important when considering the removal of the third molars. A **stepladder trabecular pattern** is sometimes seen between the roots of mandibular first molars (and central incisors). This usually represents a variation of normal. However, if generalized in appearance, it may indicate a severe form of anemia. In this instance, the trabeculae are horizontal, in a limited region, and more or less parallel to each other. Note the fractured distal surface of the first molar, the subtle occlusal caries in the second molar, and the developing third molar.

Author comment: We purposely used no. 2 size image in these examples to provide as many landmarks as possible in the limited space available. Some views in the standard full-mouth radiographic series were omitted because of space limitations. Similar landmarks can be seen in the narrower and popular no. 1 image. Also, some landmarks are seen variably, depending on individual patient differences and whether the bisecting angle or paralleling techniques are used or whether excessive vertical or horizontal angulation of the BID is used. Landmarks and structures are not indicated by arrows as they can obscure adjacent anatomic structures.

Remember, the recognition of normal is an absolute prerequisite to recognizing and identifying disorders and diseases. As we have often said, learning should be fun, and we hope this descriptive and illustrative approach helps.

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Fig. 6.1. Mandible: lingual aspect incisor-canine region.



Fig. 6.2. Mandible: incisor-canine periapical image.



Fig. 6.3. Mandible: external oblique ridge; see Figure 6.6.



Fig. 6.4. Mandible: internal oblique ridge; see Figure 6.6.



Fig. 6.5. Mandible: premolar periapical image.



Fig. 6.6. Mandible: molar periapical image.



Fig. 6.7. Mandible: molar periapical image.



Fig. 6.8. Mandible: molar periapical image.

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Normal Anatomy (Figs. 7.1 and 7.2) The **temporomandibular joint (TMJ)** is composed of several major hard and soft tissue structures. The bony structures (visible in radiographic images) include the head of the **condyle** and condylar **neck**. The soft tissue components, shown in the diagram (Fig. 7.1) and anatomic specimen (Fig. 7.2), include the **disk** and **joint capsule**. The disk is made of fibrous cartilage disk, is hourglass shaped, and lies above the condyle and below the glenoid fossa. The disk is located within the joint capsule that contains the synovial fluid. The disk and synovial fluid cushion the head of the condyle from the bones of the glenoid fossa. The disk divides the joint capsule into the upper and lower joint spaces. It is attached posteriorly to the joint capsule, superiorly to the temporal bone, inferiorly to the posterior condyle, and anteriorly to the capsule and external pterygoid muscle. When the jaws are closed, the condyle is centered in the glenoid fossa of the temporal bone. During opening, the condyle first "rotates" in the glenoid fossa and then "translates" as the mouth opens wider. Upon normal maximum opening, the condylar head approximates the articular eminence of the base of the skull.

All of the components of the TMJ are subject to functional and/or pathologic change. Some of the major clinically observable features of TMJ function or dysfunction are illustrated. The major observable **signs** of TMJ disorders are swelling in the TMJ area; redness of the overlying skin; pain/tenderness to palpation of the TMJ; atrophy, hypertrophy, or paralysis or restricted movement of the muscles of mastication; pain on palpation of the muscles of mastication or their attachments; abnormal audible sounds, such as popping or crepitus (grinding); facial asymmetry; occlusal abnormalities, such as unilateral posterior open bite (apertognathia); crossbite; acquired anterior open bite; a shift in the anterior midline; and radiographic changes. Common **symptoms** elicited with TMJ disorders include reports of popping (or crepitus) sounds; pain at rest, on opening, or on chewing; limited opening; ringing in the ear; headaches or earaches; changes in the face, such as "my face or jaw looks crooked or swollen"; inability to chew or eat properly; and the inability to fully open or close the jaw.

Normal Opening (Fig. 7.3) is assessed in terms of the amount of opening and amount of deviation. How much opening is usually expressed in millimeters (mm) measured between the incisal edges of the upper and lower central incisors, during **maximal opening**. Normal opening in a healthy adult is usually at least 40 mm. However, patients vary greatly in size, and a simple quick assessment can be made by asking the patient if he or she can open fully to accommodate three fingers (the index, middle, and ring fingers) between the incisal edges of the maxillary and mandibular teeth. Limited opening consists of a width less than three fingers, but seldom are functional reports made unless the opening is severely restricted (less than two fingers).

Deviation on Opening (Fig. 7.4) The assessment of **deviation** is performed by observing the relationship of the mandibular midline (between the central incisors) with the maxillary midline during opening. When the midlines do not line up during opening, this is called deviation. Deviation on opening can occur to one side only, or first to one side and then the other.

Posterior Open Bite (Fig. 7.5) is also referred to as apertognathia. The term ipsilateral apertognathia is used when the **posterior open bite** is on the same side as the TMJ disorder (usually a tumor). The term contralateral apertognathia is used when the open bite is on the opposite side as the TMJ problem. This may happen after condylectomy or TMJ fractures. In Figure 7.5, the patient is in centric occlusion; he had an ipsilateral apertognathia, deviation of the midline at rest, and a **crossbite** (see Fig. 7.7) that is due to an osteochondroma on his right condyle.

Anterior Open Bite (Fig. 7.6) Patients can have an **anterior open bite** from childhood habits such as tongue thrusting or thumb sucking. In these instances, the mamelons of the incisors may persist well into adult life. Anterior open bite is also seen with certain developmental anomalies of the TMJ and conditions that alter the height of the TMJ condyle or condylar neck. Bilateral fractures of the condyles or bilateral condylectomies are traumatic causes of anterior open bite. One of the most common causes of anterior open bite in aging adults is resorption of the condyles because of degenerative diseases such as rheumatoid arthritis. With this disease, the superior condylar surface is slowly destroyed, producing wear facets and a loss of vertical height of the head of the condyles.

Crossbite (Figs. 7.7 and 7.8) can be a sign of a TMJ abnormality or neoplasm. In this example, a growth deficit resulted in a contralateral crossbite (Fig. 7.7), especially evident in the lower third molar region, which contributed to facial asymmetry (Fig. 7.8). Some patient's hemihypertrophy involves the condylar neck, making this structure longer on one side than the other. In another example (Fig. 56.3), there is a **crossbite** due to unilateral enlargement of the tongue (hemihypertrophy).

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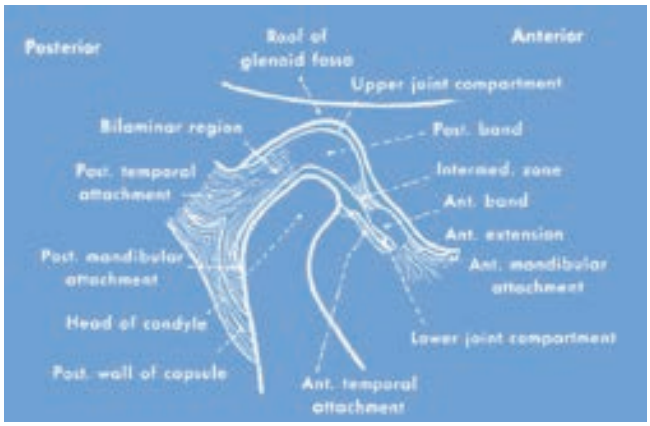


Fig. 7.1. TMJ: anatomy diagram of hard and soft tissues.

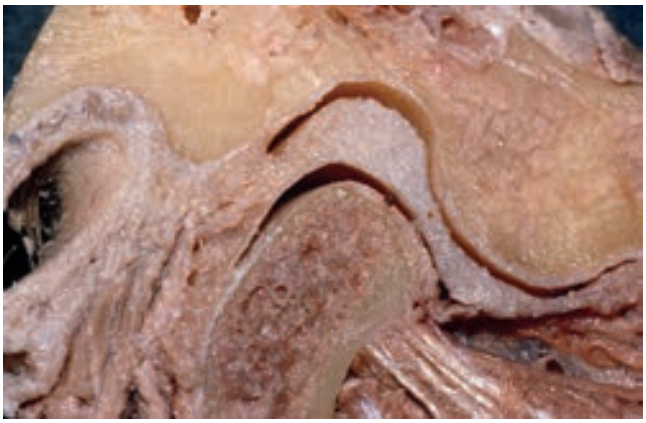


Fig. 7.2. TMJ: anatomic section; correlate with Figure 7.1.



Fig. 7.3. TMJ: normal opening; patient's three fingers.



Fig. 7.4. TMJ: limited opening with significant deviation.



Fig. 7.5. TMJ: posterior open bite, midline deviation, and crossbite.



Fig. 7.6. TMJ: anterior open bite in rheumatoid arthritis.



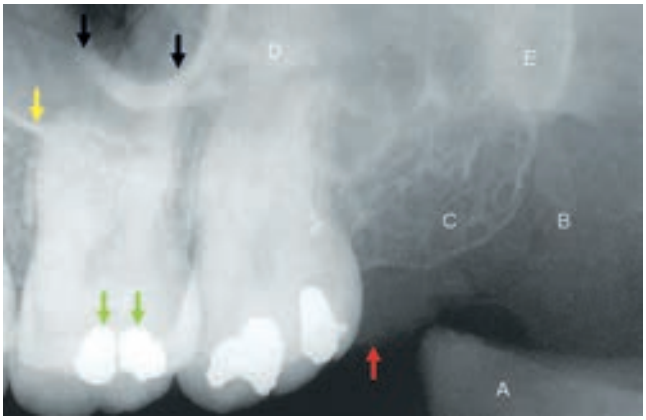
Fig. 7.7. TMJ: developmental crossbite; long condylar neck.



Fig. 7.8. TMJ: facial asymmetry in same patient as Figure 7.7.

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CASE 1. (FIG. 7.9)



1. Identify what region is shown in this periapical radiographic image.
2. Identify the structure labeled *A*.
3. Is this a normal finding of the maxilla?
4. Identify the structures labeled *B* and *E*.
5. Identify the structure labeled *C*.
6. Identify the structure labeled *D*.
7. Identify the structure labeled by the black arrows.
8. Identify the structure labeled by the yellow arrow.
9. Identify the structures labeled by the green and red arrows.
10. Based on this radiographic image, would a dental hygienist need to communicate to the dentist any concerns about anatomic structures or dental caries?

CASE 2. (FIG. 7.10)

This 22-year-old young lady presents to your dental office for routine dental care.



1. Identify the structure labeled *A*.
2. Identify the structure labeled by the yellow arrows.
3. Identify the structure labeled by the green arrow. Is this structure normal or abnormal, and how is it contributing to the dentition?
4. Identify the gingival tissue that is light brown in color. Why is it brown? Is this a normal finding, a variant of normal, or disease?
5. True or false: The marginal gingiva in this patient is pigmented.
6. Identify the structure labeled by the black arrow.
7. Identify the structure labeled by the red arrow. Is this structure healthy or diseased?
8. What questions might you ask the patient relative to the structure identified by the green arrow?

Additional cases to enhance your learning and understanding of this section are available Online through the book's Navigate 2 Advantage Access site.

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