Chapter 17

Skull, Facial Bones, and Paranasal Sinuses

Learning Objectives

At the conclusion of this chapter, you will be able to:

- Name the principal bones that make up the cranium and the face and identify each on an anatomic diagram and on a radiograph
- Name and identify the four sets of paranasal sinuses on an anatomic diagram and on radiographs
- Identify significant positioning landmarks of the skull and face by palpation
- Demonstrate correct body and part positioning for routine projections and common special projections of the skull, facial bones, and paranasal sinuses
- Correctly evaluate radiographs of the skull, facial bones, and paranasal sinuses for positioning accuracy
- Describe and recognize on radiographs pathologic conditions that are common to the skull, facial bones, and paranasal sinuses

Key Terms

acanthion
blowout fracture
cerebral concussion
contrecoup injury
cranium
external auditory (acoustic) meatus (EAM)
external occipital protuberance
foramen magnum
glabella
gonion
lacrimal bones
mandible
maxilla
mental protuberance (point)
multiple myeloma
nasal concha (pl. conchae)
nasion
orbits
palatine bones
sella turcica
sutures
vomer
zygomas

Skull radiography is much less common than it once was. Today, the first choice for diagnostic imaging in cases of head trauma is the computed tomography (CT) scan, which provides information about the condition of the brain that cannot be obtained with routine radiography. CT is now also the principal imaging modality for the paranasal sinuses and some types of facial injuries.

On the other hand, radiography of the bones of the head is still a useful diagnostic tool. When a CT scanner is not immediately available, radiography can provide much valuable information. In addition, some types of pathologic conditions affecting the skull and facial injuries are still best evaluated radiographically.

The anatomy of the bones of the skull and face is complex. A comprehensive understanding of these structures requires diligent study. You will find it helpful to use a model of the skull that allows you to see both the internal and external structures in three-dimensional perspective.

ANATOMY

The skull consists of 22 bones. It is divided into the cranium, which protects the brain, and the facial bones, which provide the facial structure. These bones also contribute to the oral and nasal cavities and form the orbits.

Cranium

The term **cranium** refers to the bones that surround the brain (Fig. 17.1). The portion of the cranium on which the base of the brain rests is the floor and the remainder that surrounds the brain is called the *calvaria*. The cranium consists of eight bones: frontal, occipital, right and left parietal, right and left temporal, sphenoid, and ethmoid.

The frontal bone is the bone of the forehead and also constitutes the anterior portion of the top of the skull. The bony prominence on the frontal bone between the eyebrows is a palpable positioning landmark called the **glabella**. On either side of the glabella, the frontal bone forms the superior portions of the **orbits** (eye sockets).

The occipital bone is at the lower part of the back of the skull and also forms the posterior portion of the cranial floor or base. In the approximate center on the outer surface of the occipital bone is a palpable bony prominence called the **external occipital protuberance**. The large round hole in the anterior portion of the occipital bone is called the **foramen magnum**. It is the passage for the spinal cord between the skull and the spine. Between the frontal and the occipital bones are the two parietal bones.

The ethmoid bone forms the anterior floor of the cranium. It articulates with the underside of the frontal bone, extending inferiorly and posteriorly behind the nose. The ethmoid bone also forms a portion of each orbit.

The sphenoid bone is a complex bone that makes up part of the floor of the cranium and also portions of its lateral outer shell. The sphenoid bone is posterior to the ethmoid bone and is shaped somewhat like a bat (Fig. 17.2).

The rounded fossa in the center of the anterosuperior surface of the sphenoid bone, called the **sella turcica,** is the location of the pituitary gland. The bilateral inferior projections are called the *pterygoid processes*.

The temporal bones (Fig. 17.3) also form portions of both the floor and the lateral outer surface of the cranium. They articulate with the sphenoid bone anteriorly and the occipital bone posteriorly. On the inferolateral border is the **external auditory meatus**, also called the *external acoustic meatus*. Both terms are abbreviated *EAM*. The EAM is the opening to the ear canal and is an important positioning landmark. Extending medially from the EAM area is a dense pyramid of bone called the *petrous portion*, which contains the middle and inner ear structures. The mastoid portion of the temporal bone contains many small air cells, and the mastoid process is palpable just posterior to the earlobe. Just anterior to the EAM is the mandibular fossa, the socket that articulates with the condyle of the mandible. Just superior to the EAM is a long slender horizontal bony projection called the *zygomatic process*, which articulates anteriorly with the zygomatic (cheek) bone to form the zygomatic arch.

The joints that connect the bones of the cranium are synarthrodial (immovable) joints called **sutures**, which have individual names. The parietal bones are joined by the sagittal suture. Between the frontal bone and the parietal bones is the coronal suture. Between the parietal bones and the occipital bone is the lambdoidal suture. The joint that joins the parietal and temporal bones is the squamosal suture.

Facial Bones

The palpable bones of the face include the **maxilla, mandible** (jaw), **zygomas** (cheek bones), and nasal bones (Fig. 17.4).

The maxilla is actually two maxillary bones fused in the center beneath the nose. The maxilla is the largest immovable bone of the face and articulates with all of the other facial bones except the mandible. Its upper margins form the inferomedial orbital rims. Its inferior margin, called the *alveolar process*, contains the roots of the upper teeth. The junction of the two maxillary bones forms a superior prominence called the *anterior nasal spine*. This point, located at the junction of the nose and the upper lip, is a positioning landmark called the **acanthion**.

The nasal bones are situated between the orbits and articulate laterally with the maxillary bones and posteriorly with the ethmoid.

The zygoma, or zygomatic bone, can be palpated as the prominence of the cheek. Each zygoma articulates superiorly with the frontal bone, inferiorly with the maxilla, and posteriorly with the zygomatic process of the temporal

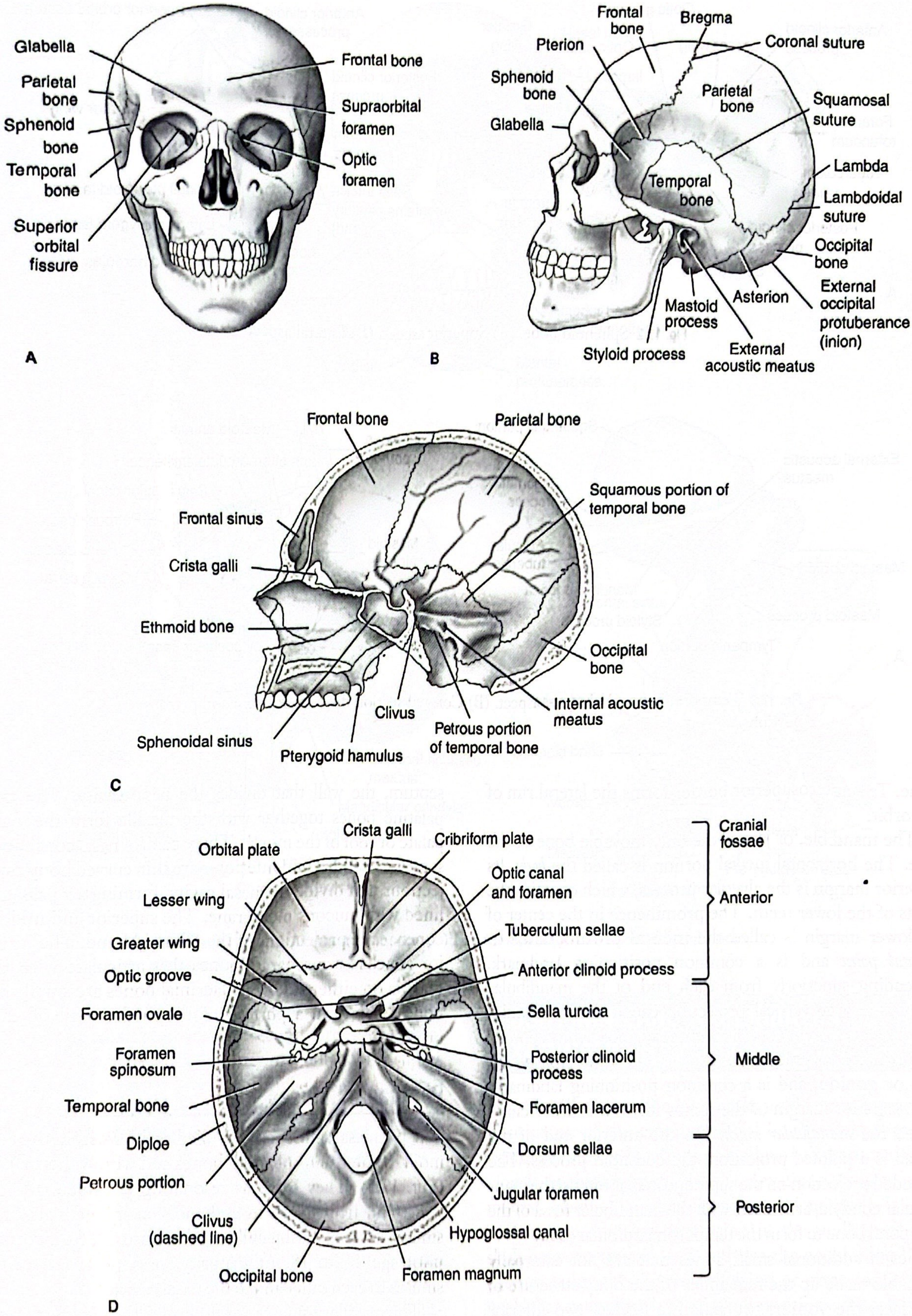

Fig. 17.1 Cranium. (A) Anterior aspect. (B) Lateral aspect. (C) Lateral aspect of interior of cranium. (D) Superior aspect of cranial base.

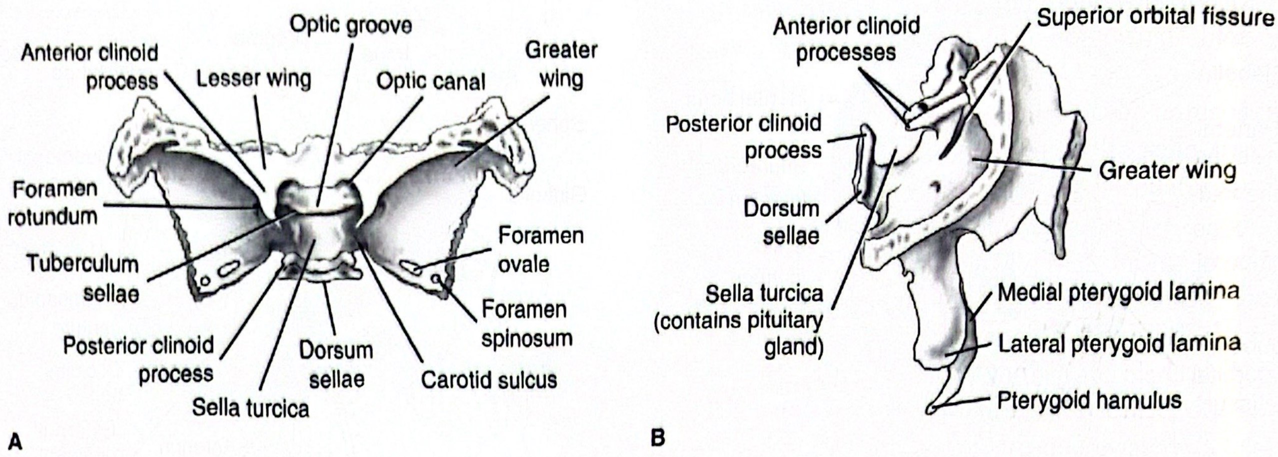

Fig. 17.2 Sphenoid bone. (A) Superior aspect. (B) Lateral aspect.

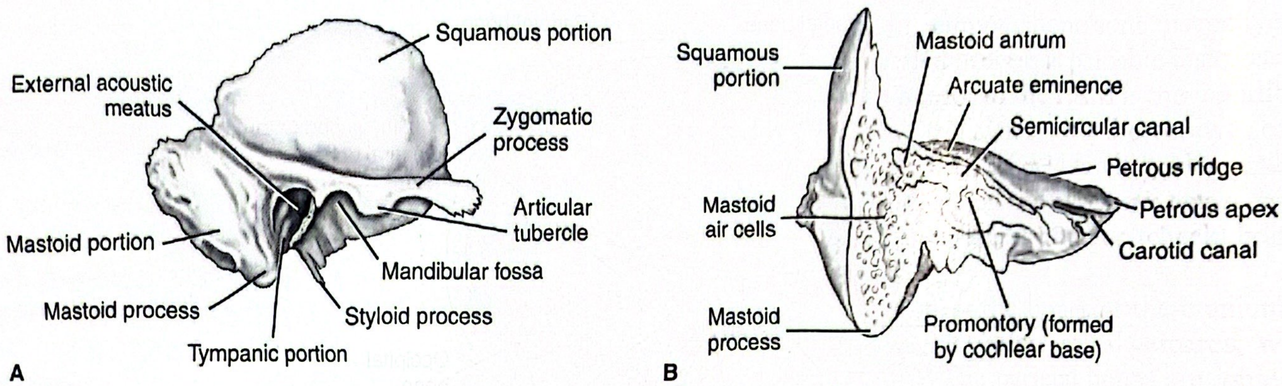

Fig. 17.3 Temporal bone. (A) Lateral aspect. (B) Coronal section through mastoid and petrous portions.

bone. The anterosuperior border forms the lateral rim of the orbit.

The mandible, or jaw, is the only movable bone of the face. The horizontal medial portion is called the *body*. Its superior margin is the alveolar process, which contains the roots of the lower teeth. The prominence in the center of its lower margin is called the **mental protuberance** or *mental point* and is a common positioning landmark. Extending superiorly from each end of the mandibular body is a large vertical projection called the mandibular *ramus* (plural, *rami*). The right angle formed by the contour of the inferoposterior ramus is called the *angle of the mandible*, or **gonion**, and is a common positioning landmark. The superior margin of the ramus forms a concave curve called the *mandibular notch*. On the anterior end of the notch is a pointed projection, the coronoid process. The rounded projection on the superoposterior ramus, the mandibular condyle, articulates with the mandibular fossa of the temporal bone to form the temporomandibular joint.

Seven additional small bones that are not externally palpable make up the remainder of the bony structure of the face: the **vomer**, two **palatine bones**, two inferior **nasal conchae**, and two **lacrimal bones**.

The vomer is posterior to the acanthion at the floor of the nasal cavity. It forms the inferior portion of the nasal septum, the wall that divides the nasal cavity. The two palatine bones together with the maxilla form the hard palate or roof of the mouth. Three pairs of nasal conchae—superior, middle, and inferior—are thin curved bony projections that divide the nasal cavity, forming air passages lined with mucous membrane. The superior and middle conchae are projections of the ethmoid bone. The inferior conchae are separate bones that articulate with the maxilla on either side. The lacrimal bones are small thin bones that form a portion of the medial wall of each orbit.

Paranasal Sinuses

The paranasal sinuses are air-filled cavities within the ethmoid, frontal, and sphenoid bones and within the maxilla (Fig. 17.5). They serve as resonating chambers for the voice and help to warm and moisten inhaled air. The sinuses develop during childhood and are not fully formed until age 16 to 18. At maturity, passages connect the sinuses to each other and to the nasal cavity.

The maxillary sinuses are also called the ***maxillary antra*** or the *antra of Highmore*. They are the largest paranasal sinuses and are located within the body of the maxilla on either side of the nasal cavity.

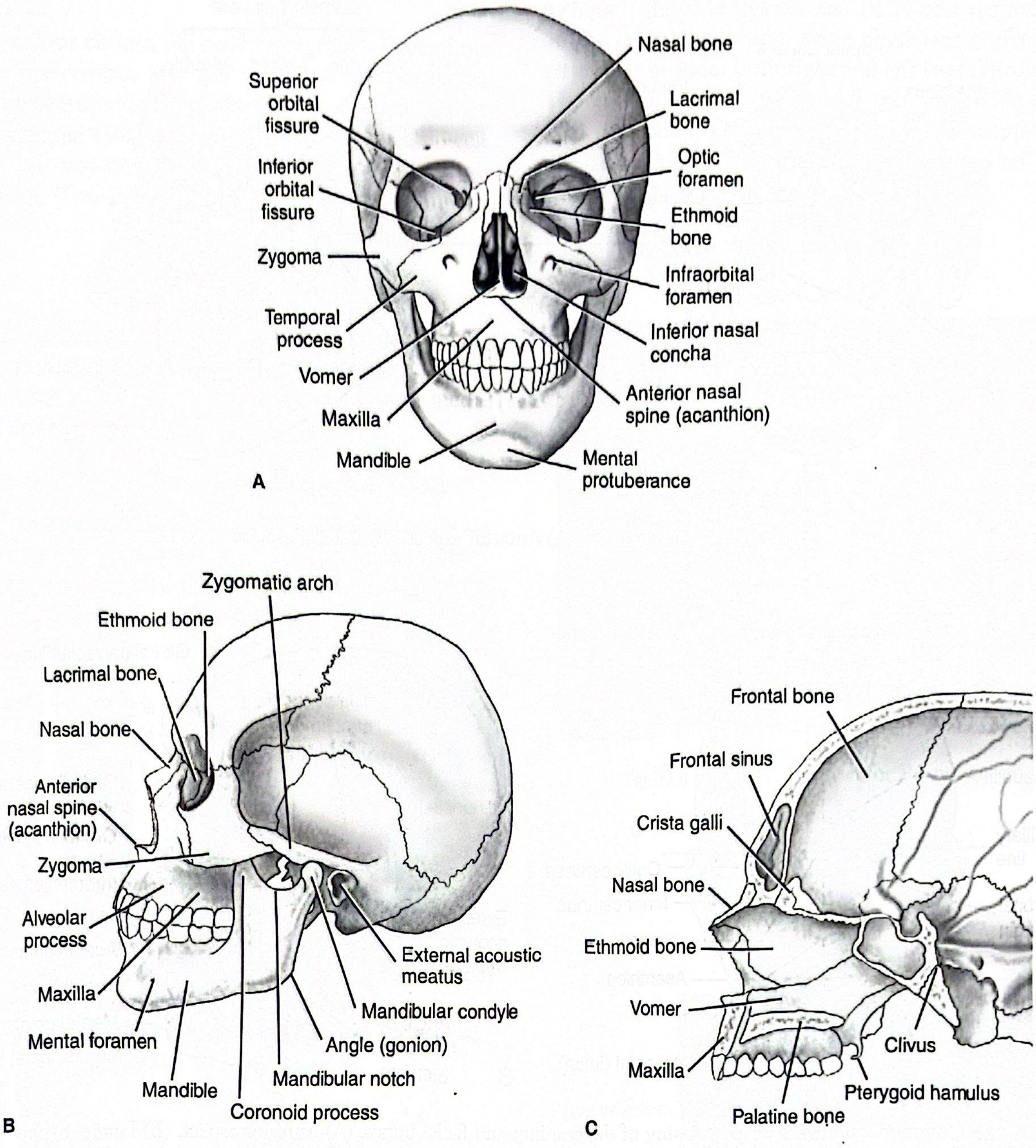

Fig. 17.4 Facial bones. (A) Anterior aspect. (B) Lateral aspect. (C) Interior of facial bones, lateral aspect.

The frontal sinuses are the second largest paranasal sinuses and are located in the anterior frontal bone, superior to the nasal cavity. They are divided by a central septum into right and left compartments and are usually further subdivided. They are not symmetric and may vary greatly in size and shape. Absence of frontal sinuses is a normal variant.

The sphenoidal sinuses occupy most of the body of the sphenoid bone and are located immediately inferior to the sella turcica. Although they normally occur as a pair of chambers, it is not unusual for only a single chamber to be present.

The two ethmoidal sinuses are located within the lateral masses of the ethmoid bone and consist of a varying number of small air cells. They are situated between and behind the orbits and anterior to the sphenoid sinuses.

POSITIONING AND RADIOGRAPHIC EXAMINATIONS

Fig. 17.6 illustrates the landmarks used for radiographic positioning of the cranium, facial bones, and paranasal sinuses. Note the locations of landmarks mentioned previously in this chapter: glabella, acanthion, gonion, and mental point. Another significant landmark is the **nasion**, the anterior depression in the midline of the skull between the orbits. Note also the positioning lines used to judge the degree of flexion or extension of the neck that is appropriate for skull positions. Those lines that are used in this text are the orbitomeatal line (OML), the infraorbitomeatal line (IOML), and the mentomeatal line (MML).

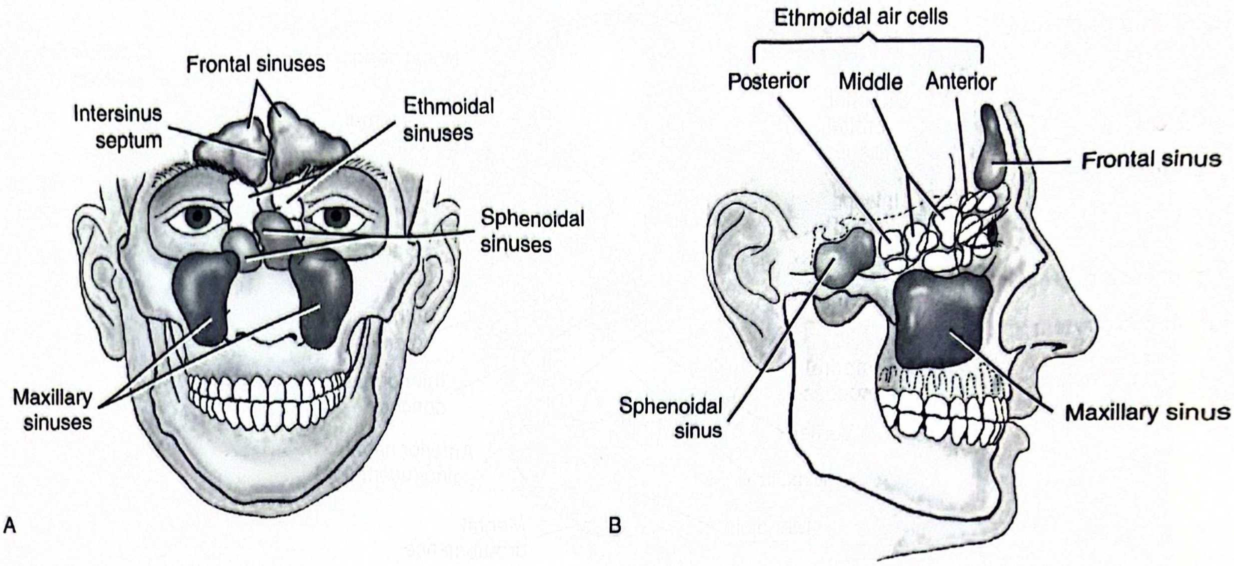

Fig. 17.5 Paranasal sinuses. (A) Anterior aspect. (B) Lateral aspect.

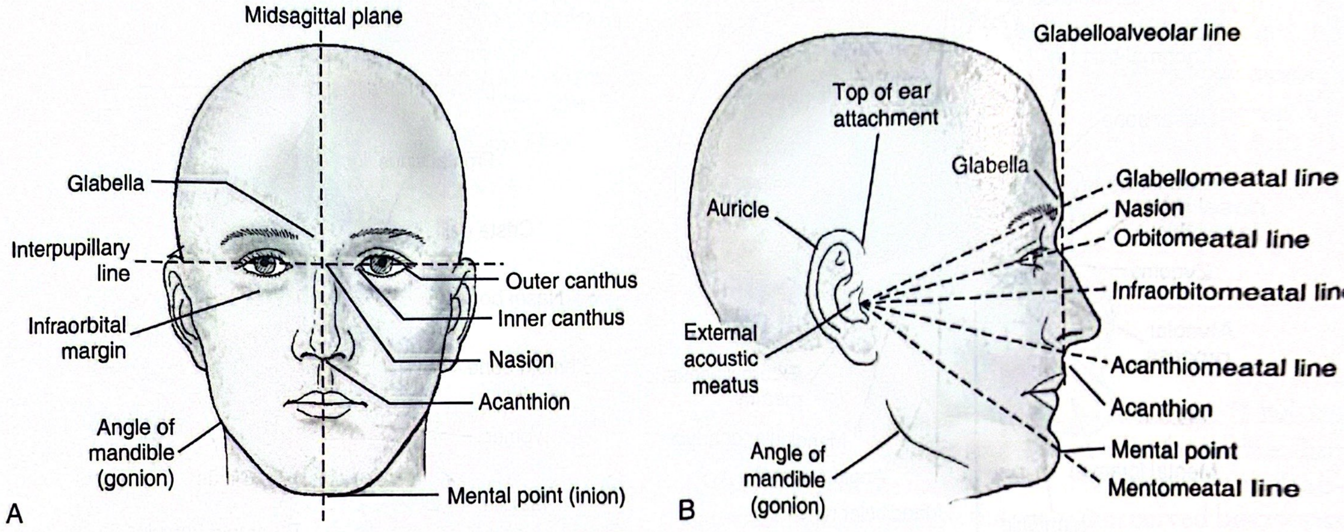

Fig. 17.6 Common landmarks for positioning of the cranium and facial bones. (A) Anterior aspect. (B) Lateral aspect.

Accurate positioning for radiographic examinations of the skull requires precise attention to all three body planes: coronal, sagittal, and transverse. The coronal and sagittal planes are adjusted by body position and rotation of the head. The transverse plane alignment depends on the flexion or extension of the neck. To determine the alignment between body planes or positioning lines and the image receptor (IR) plane, it is helpful to use a tool called an *Angligner* (Fig. 17.7). In the absence of such a tool, a simple protractor or triangles cut from cardboard can provide a useful guide.

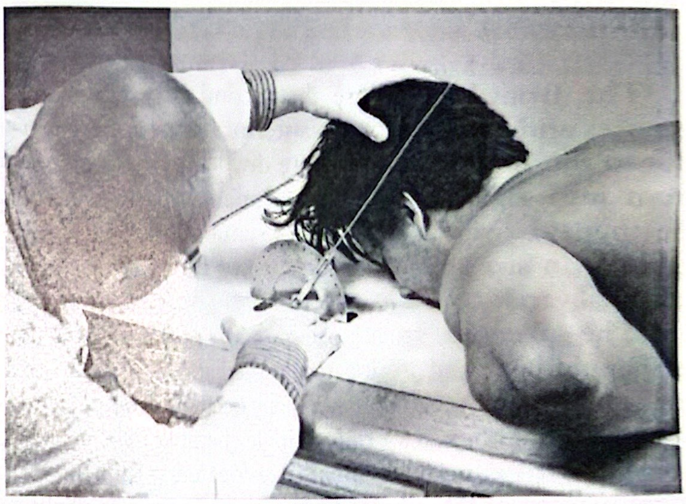

Fig. 17.7 Angligner assists in positioning the skull with baselines correctly aligned with regard to the IR.

Cranium

The projections chosen for skull radiography depend on physician preferences and the ability of the patient to assume the required body positions. For example, either a posteroanterior (PA) or a PA axial projection (Caldwell method), but not both, will be included in the routine examination. The PA axial projection is most common. Although the side nearest the IR is best demonstrated on the lateral projection, some physicians prefer a basic series that includes both right and left lateral projections. The anteroposterior (AP) or AP axial projection and PA axial projection (Haas method) can be substituted when the patient cannot assume the positions needed for the customary projections.

ROUTINE EXAMINATION

The routine examination of the cranium includes the PA or PA axial (Caldwell method), AP axial (Towne method), and lateral projections.

PA AND PA AXIAL PROJECTION (CALDWELL METHOD)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Prone or seated facing upright Bucky.

> **TIP:** When the prone patient crosses the arms under the chest, this elevation of the thorax allows greater flexion of the neck; it facilitates accurate positioning and relieves pressure on the nose.

Part position: Sagittal plane of skull is perpendicular to center of IR, with forehead and nose resting on table or against upright Bucky. Neck flexion adjusted to place OML perpendicular to IR (Fig. 17.8).

Central ray:

PA: Perpendicular to center of IR through nasion.

PA axial (Caldwell method): Angled 15 degrees caudad to center of IR through nasion (Fig. 17.10).

Collimation: Adjust light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Frontal bone and outer contours of cranium from frontal perspective. When perpendicular central ray is used, petrous pyramids are projected within orbits (Fig. 17.9). When a 15-degree caudad angle with the Caldwell method is used, petrous pyramids are projected through the lower third of the orbit and the orbital margins are more clearly demonstrated (Fig. 17.11).

Fig. 17.8 Cranium. Position for PA projection.

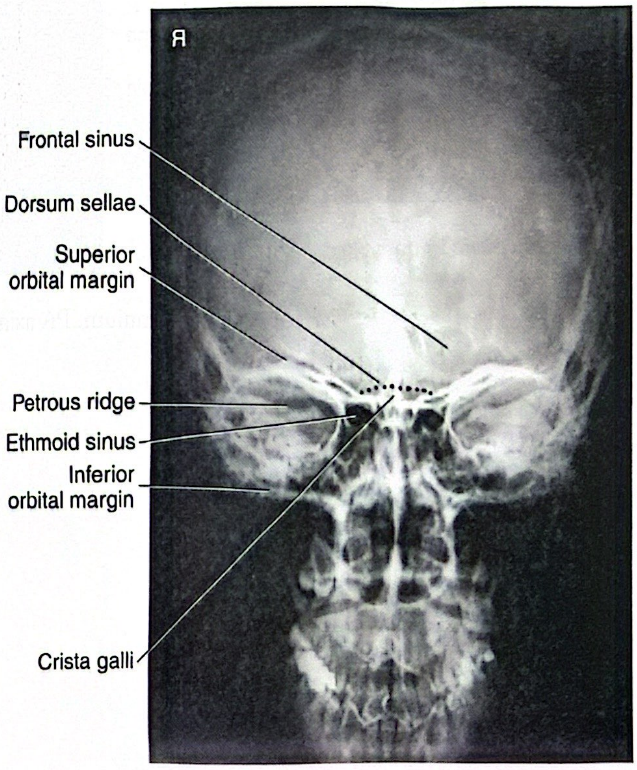

Fig. 17.9 Cranium. PA projection.

Fig. 17.10 Cranium. Position for PA axial projection (Caldwell method).

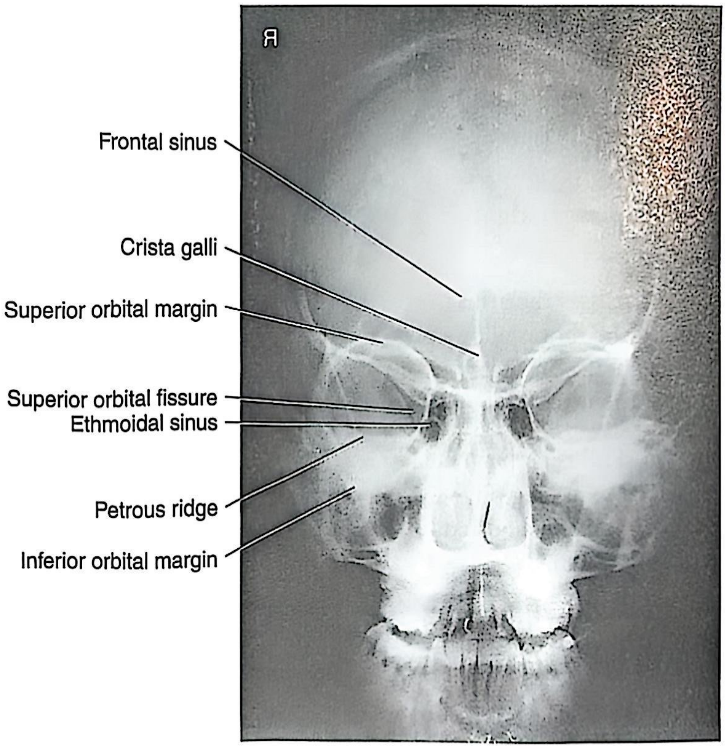

Fig. 17.11 Cranium. PA axial projection (Caldwell method).

AP AXIAL PROJECTION (TOWNE METHOD)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Supine or seated.

Part position: Sagittal plane of skull is perpendicular to IR with back of head resting on table or against upright Bucky. Neck flexion adjusted to place OML perpendicular to IR (Fig. 17.12).

> **TIP:** If patient is unable to flex neck sufficiently to get OML perpendicular to IR, placement of a wedge sponge under the head may assist in attaining the correct position.

Central ray: Angled 30 degrees caudad to center of IR through the foramen magnum at the level of the EAM. Central ray enters skull in midsagittal plane, approximately 2.5 inches superior to the glabella.

> **TIP:** If the patient is unable to flex the neck sufficiently to get the OML perpendicular to the IR, the IOML can be placed perpendicular and the central ray angled 37 degrees caudad.

Collimation: Adjust light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Occipital bone, posterior parietal bones, foramen magnum, and petrous portions of temporal bones (Fig. 17.13)

Fig. 17.12 Cranium. Position for AP axial projection (Towne method).

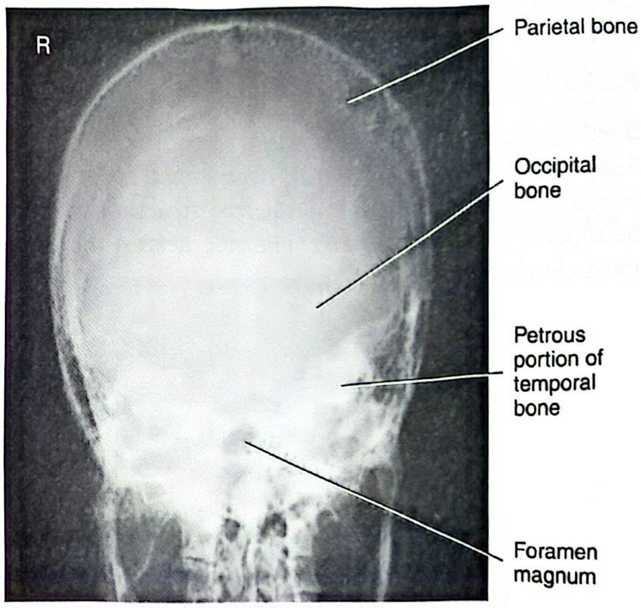

Fig. 17.13 Cranium. AP axial projection (Towne method).

LATERAL PROJECTION

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) crosswise.

Grid: Yes

SID: 40 inches minimum

Body position: Recumbent or seated in an anterior oblique body position with side of interest nearest IR (Fig. 17.14).

Part position: Sagittal plane of head is parallel to IR and interpupillary line is perpendicular to it (Fig. 17.15). Support under mandible may assist in maintaining this position. Neck flexion is adjusted to place the IOML parallel to the long axis of the IR.

Central ray: Perpendicular to center of IR through a point approximately 2 inches superior to the EAM.

Collimation: Adjust the light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Lateral image of entire cranium. Sella turcica is seen in profile. There should be no rotation or tilt of the cranium, and paired structures should be superimposed (Fig. 17.16). The side nearest the IR is most clearly seen.

Fig. 17.14 Cranium. Body position for lateral projection.

Fig. 17.15 Cranium. Position for lateral projection.

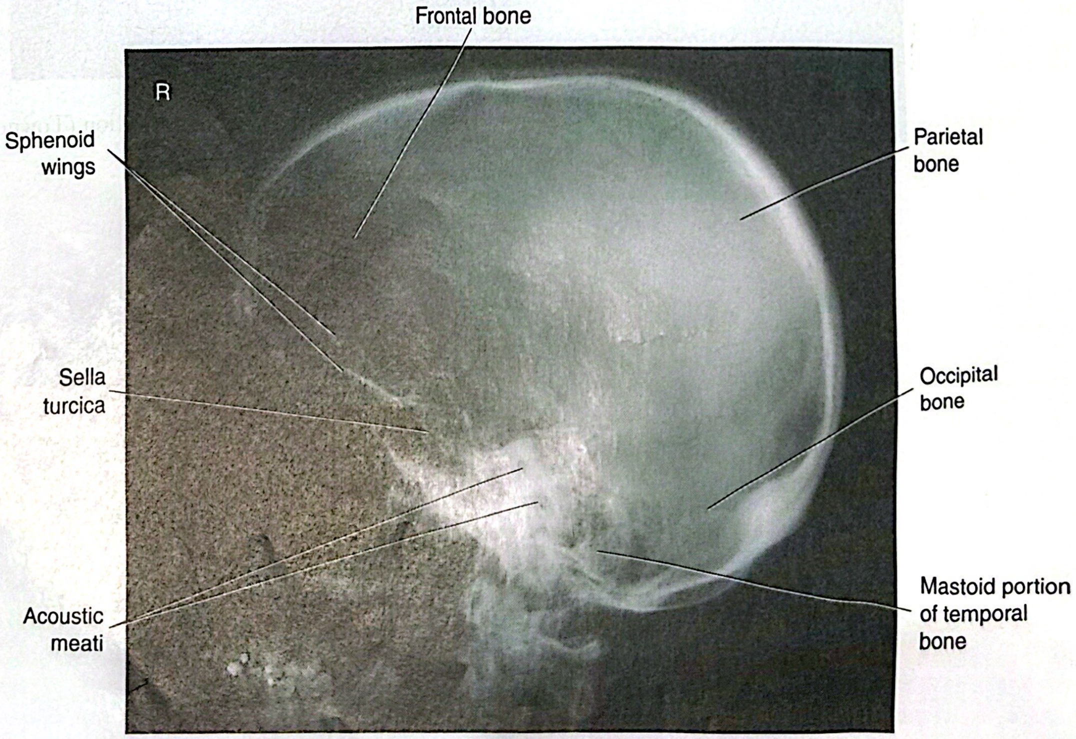

Fig. 17.16 Cranium. Lateral projection.

ALTERNATIVE PROJECTIONS

AP AND AP AXIAL ("REVERSE" CALDWELL METHOD) PROJECTIONS

When obesity or injury makes it difficult to position the patient prone, an AP projection may be substituted for the PA or PA axial (Caldwell method) projection. Radiation dose to the eyes and thyroid gland is increased compared with the PA projections.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Supine or seated.

Part position: Sagittal plane of the skull is perpendicular to the IR with back of head resting on table or against upright Bucky. Neck flexion is adjusted to place the OML perpendicular to the IR (Fig. 17.17).

> **TIP:** If the patient is unable to flex the neck sufficiently to get the OML perpendicular to the IR, placement of a wedge sponge under the head may assist in maintaining the correct position.

Central ray:

AP: Perpendicular to the center of the IR through the nasion.

AP axial ("reverse" Caldwell method): Angled 15 degrees cephalad through nasion.

Collimation: Adjust light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Frontal bone and outer contours of the cranium from a frontal perspective. When a perpendicular central ray is used, petrous pyramids are projected within the orbits (Fig. 17.18). With the "reverse" Caldwell method, using a 15-degree cephalad angle, petrous pyramids are projected through the lower third of the orbit and the orbital margins are more clearly demonstrated. The orbits and other anterior structures are magnified in comparison with PA projections.

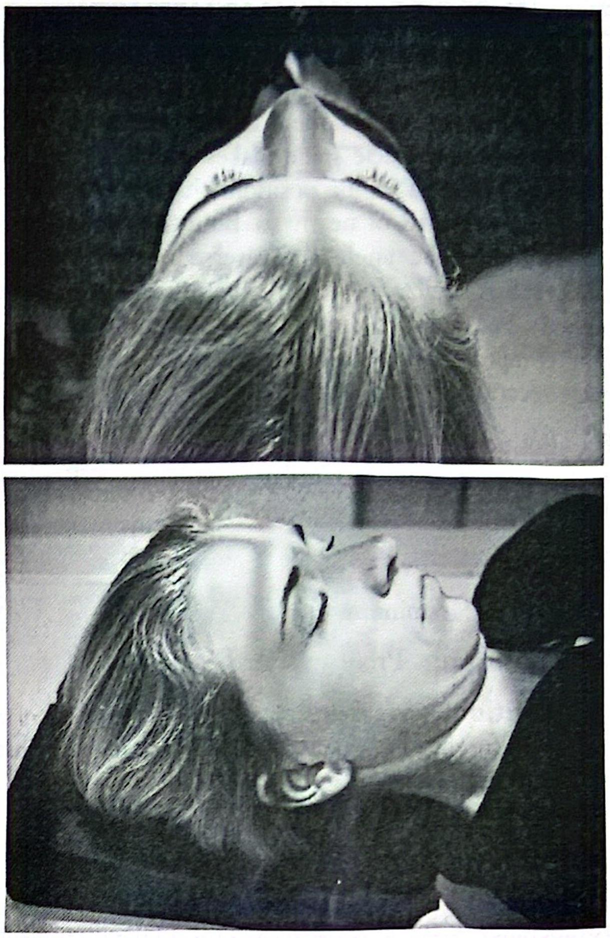

Fig. 17.17 Cranium. Position for AP projection.

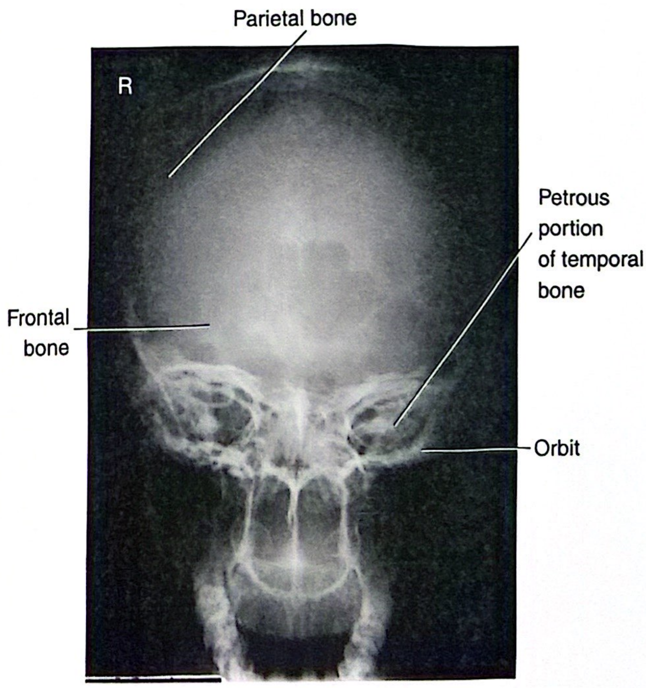

Fig. 17.18 Cranium. AP projection.

PA AXIAL PROJECTION (HAAS METHOD)

The PA axial projection (Haas method) may be used instead of the AP axial projection (Towne method). The Haas method is useful when obesity or exaggerated kyphosis of the thoracic spine makes it difficult for the patient to assume a supine position with the OML perpendicular to the IR or nearly so. Both the patient position and the tube angle are reversed. The resulting radiograph is similar to the AP axial projection (Towne method), but detail of the posterior structures is somewhat compromised because of the increased object–image receptor distance (OID).

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Prone or seated facing IR.

Part position: Sagittal plane of skull is perpendicular to IR with forehead and nose resting on table or against upright Bucky. Neck flexion is adjusted to place OML perpendicular to IR (Fig. 17.19).

Central ray: Angled 25 degrees cephalad to center of IR through a point 1.5 inches below external occipital protuberance. Central ray exits skull in midsagittal plane at location approximately 1.5 inches superior to nasion.

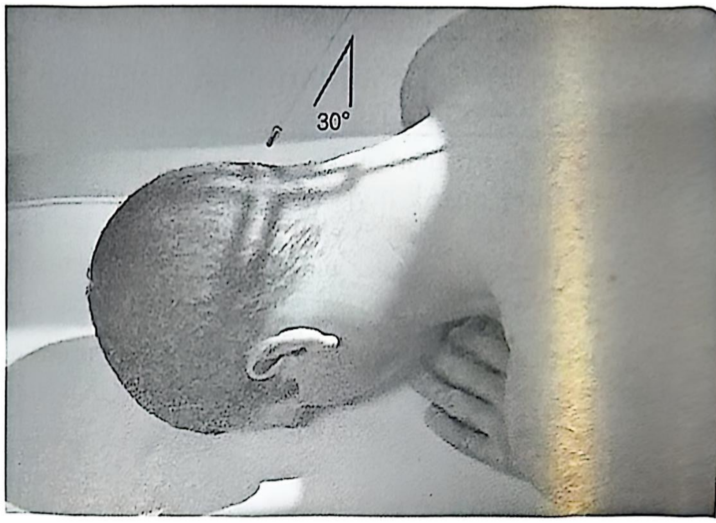

Fig. 17.19 Cranium. Position for PA axial projection (Haas method).

Collimation: Adjust light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Occipital bone, posterior parietal bones, foramen magnum, and petrous portions of the temporal bones (Fig. 17.20).

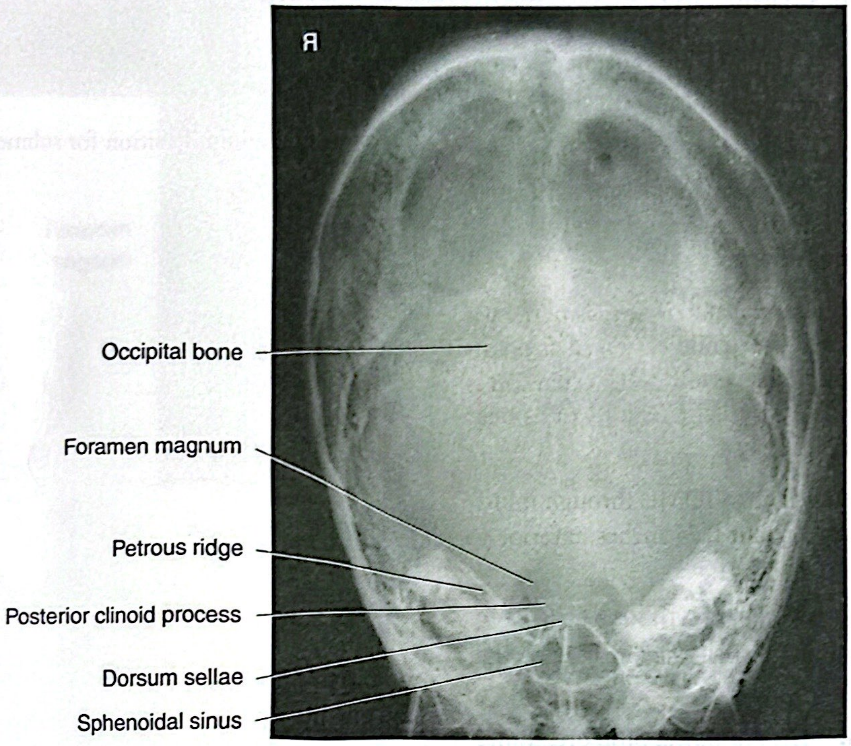

Fig. 17.20 Cranium. PA axial projection (Haas method).

SUPPLEMENTAL PROJECTION

SUBMENTOVERTICAL PROJECTION

The submentovertical projection is added to the routine examination when it is desired to demonstrate the structures of the cranial base more completely than they are seen with the Towne method. It is especially helpful for demonstration of the sphenoid bone and the cranial foramina.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 10 × 12 inches (24 × 30 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Supine with shoulders and thorax elevated and supported to place top of head against table or seated with back to IR and back arched to place top of head against upright Bucky.

Part position: The sagittal plane of head is perpendicular to the IR. The neck is extended as much as possible with the head resting on its vertex. Neck extension is adjusted to place the IOML parallel to the IR or as near parallel as possible (Fig. 17.21).

Central ray: Perpendicular to IOML through midline and passing through a point 0.75 inches anterior to the level of the EAM.

Collimation: Adjust light field to 10 × 12 inches (24 × 30 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Fig. 17.21 Cranium. Position for submentovertical projection.

Structures seen: Cranial base, including the occipital bone, foramen magnum, sphenoid and ethmoid bones, and petrous portions of temporal bone (Fig. 17.22). Foramina ovale and spinosum are also demonstrated on this projection.

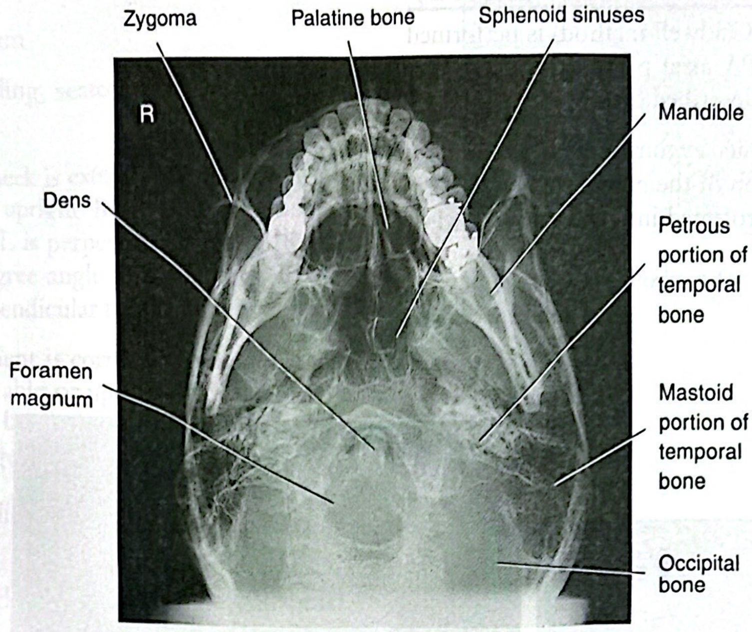

Fig. 17.22 Cranium. Submentovertical projection.

Facial Bones

ROUTINE EXAMINATION

The routine examination of the facial bones includes the PA axial (Caldwell method), parietoacanthial (Waters method), and lateral projections.

PA AXIAL PROJECTION (CALDWELL METHOD)

The PA axial projection (Caldwell method) is performed in the same way as the PA axial projection of the cranium (Caldwell method) described earlier.

Structures seen: Orbits, zygomatic bones, maxilla, nasal septum, and a portion of the mandible (Fig. 17.23). The petrous ridges are projected into the lower third of the orbits.

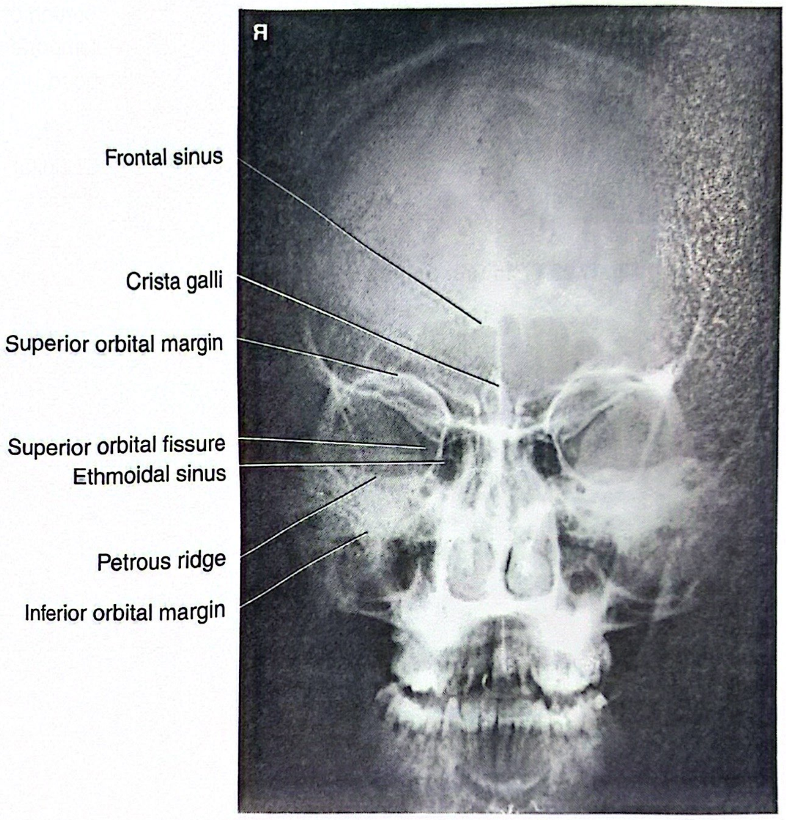

Fig. 17.23 Facial bones. PA axial projection (Caldwell method).

PARIETOACANTHIAL PROJECTION (WATERS METHOD)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Standing, seated, or recumbent, facing IR.

Part position: The neck is extended with the chin resting on the table or upright Bucky. Neck flexion is adjusted so that the MML is perpendicular to the IR and the OML forms a 37-degree angle to the IR (Fig. 17.24). The sagittal plane is perpendicular to the IR.

> **TIP:** When the patient is correctly positioned, the distance between the table or upright Bucky and the tip of the nose should be about 0.75 inches, or the width of the index finger.

Central ray: Perpendicular to the IR to exit at the acanthion.

> **NOTE:** Should be done upright with a horizontal beam to show air-fluid levels.

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Maxilla, orbits, zygomatic arches, and nasal septum (Fig. 17.25).

> **TIP:** The petrous portion of the temporal bone should be projected beneath the maxillary sinus. If it is superimposed over the floor of the sinus, a greater degree of neck extension is necessary.

Fig. 17.24 Facial bones. Position for parietoacanthial projection (Waters method).

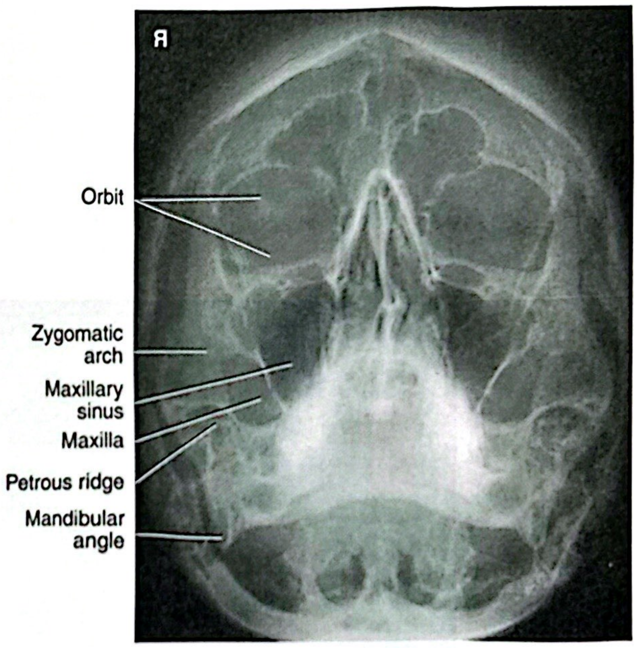

Fig. 17.25 Facial bones. Parietoacanthial projection (Waters method).

LATERAL PROJECTION

The lateral projection is performed in the same way as for the lateral projection of the cranium described earlier, with the following exceptions:

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) lengthwise.

Central ray: Perpendicular to the center of the IR through a point approximately halfway between the outer canthus and the EAM (Fig. 17.26).

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Structures seen: Lateral image of all facial bones, with superimposition of paired bones (Fig. 17.27).

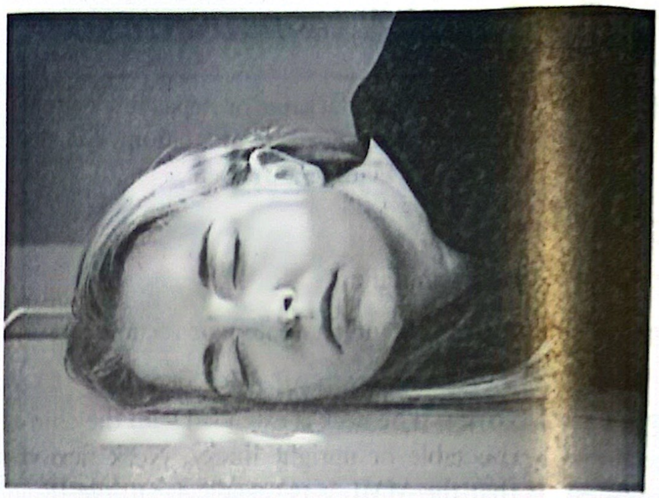

Fig. 17.26 Facial bones. Position for lateral projection.

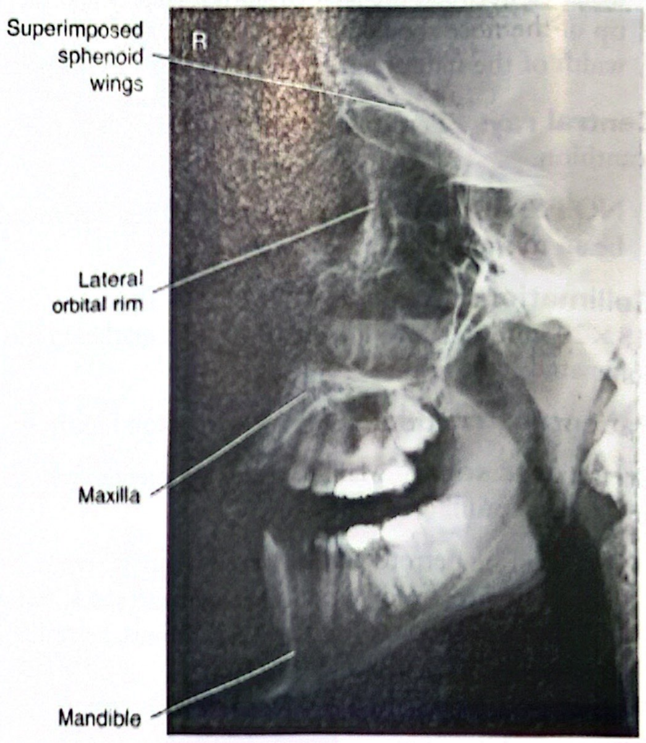

Fig. 17.27 Facial bones. Lateral projection.

SUPPLEMENTAL PROJECTIONS

VERTICOSUBMENTAL PROJECTION OF ZYGOMATIC ARCHES

The zygomatic arches are seen on the submentovertical projection of the skull. Alternatively, the position may be reversed to provide a verticosubmental projection.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) crosswise.

Body position: Prone or seated facing IR.

Part position: The neck is extended with the chin resting on the table or upright Bucky. Neck flexion is adjusted to place the IOML nearly parallel to the IR (Fig. 17.28). The sagittal plane is perpendicular to the IR.

Central ray: Angled caudad, perpendicular to the IOML and passing through the midsagittal plane 1.5 inches posterior to the level of the outer canthus.

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Zygomatic arches free of superimposition (Fig. 17.29).

Fig. 17.28 Zygomatic arches. Position for verticosubmental projection.

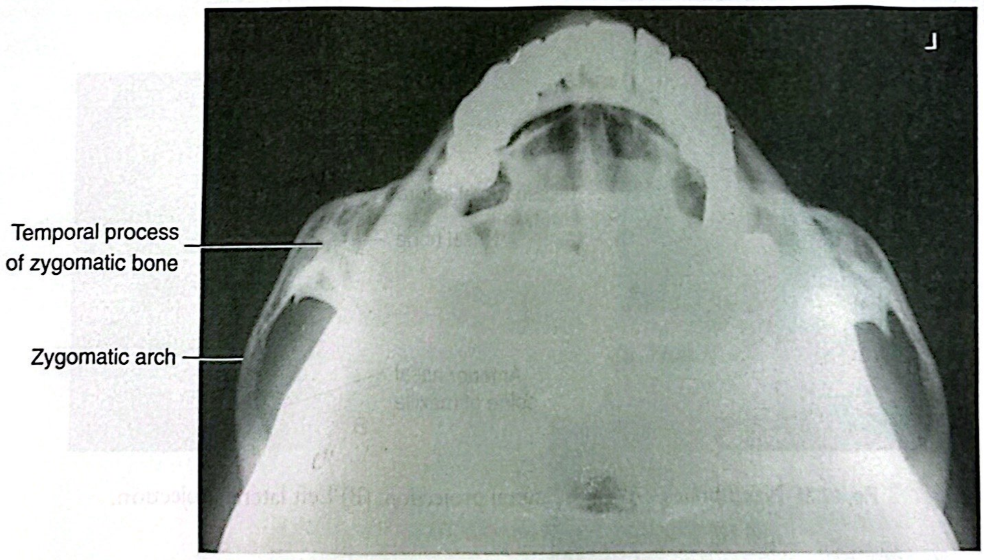

Fig. 17.29 Zygomatic arches. Verticosubmental projection.

LATERAL PROJECTION OF NASAL BONES

The nasal bones are very thin, so exposure factors similar to those used for a finger are used. Both lateral projections may be performed on a single IR because these are paired bones.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) crosswise for two exposures on one IR.

Grid: No

SID: 40 inches minimum

Body position: Same as for cranium and facial bones.

Part position: Same as for cranium and facial bones (Fig. 17.30).

Central ray: Perpendicular to IR to midpoint of nasal bone.

Collimation: Adjust light field to 3 × 3 inches (8 × 8 cm) on the collimator, with the field extending from the glabella to the acanthion and 0.5 inches (1.3 cm) beyond the tip of the nose. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Lateral image of the nasal bone closest to the IR, the anterior nasal spine, and associated soft tissue (Fig. 17.31). Both lateral projections are usually taken.

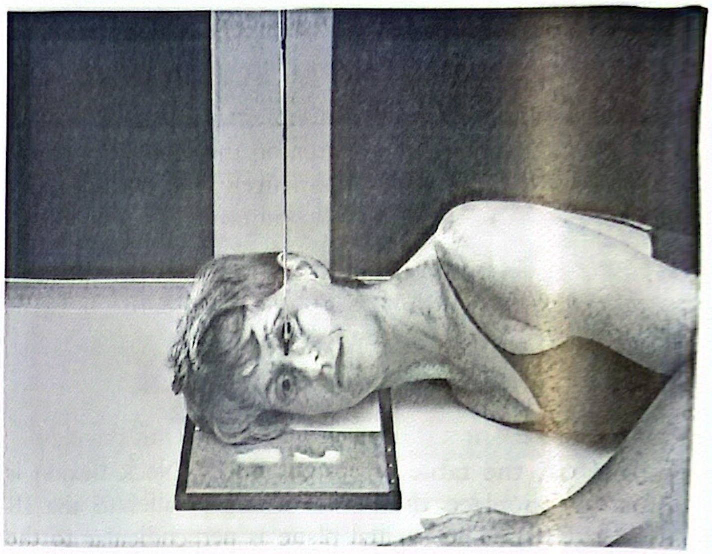

Fig. 17.30 Nasal bones. Position for lateral projection.

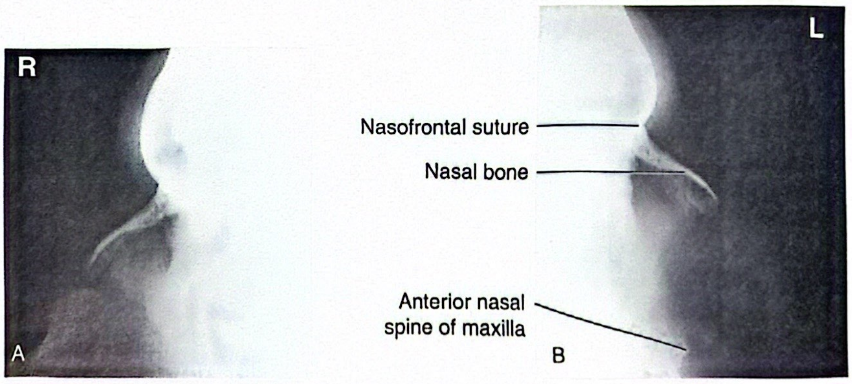

Fig. 17.31 Nasal bones. (A) Right lateral projection. (B) Left lateral projection.

Mandible

ROUTINE EXAMINATION

The routine examination of the mandible includes the PA, lateral, and axiolateral projections. It also may include AP axial projection for mandibular condyles and temporomandibular joints.

PA PROJECTION

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Prone or seated facing IR.

Part position: Sagittal plane of skull is perpendicular to center of IR with forehead and nose resting on table or against upright Bucky. Neck flexion adjusted to place OML perpendicular to IR (Fig. 17.32).

Central ray: Perpendicular to center of IR to exit through acanthion.

> **NOTE:** PA axial projection may be performed with central ray angled 20 to 25 degrees cephalad.

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Entire mandible (Fig. 17.33). Rami are symmetric.

Fig. 17.32 Mandible. Position for PA projection.

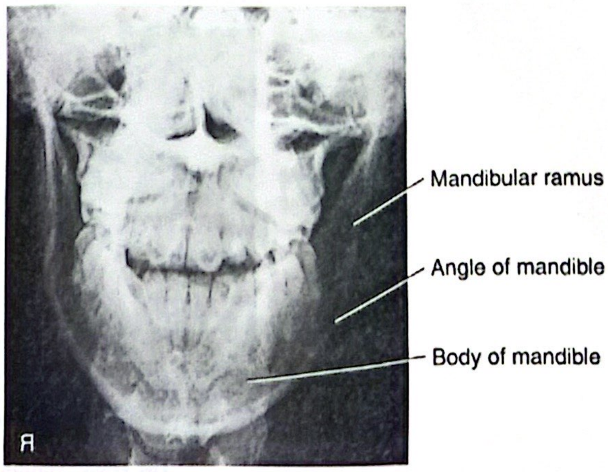

Fig. 17.33 Mandible. PA projection.

AXIOLATERAL PROJECTION

IR: 8 × 10 inches (18 × 24 cm) crosswise.

Grid: Yes

SID: 40 inches minimum

Body position: Seated, facing IR with coronal plane of body somewhat oblique, as for lateral projection.

Part position: Neck is extended somewhat and flexed laterally so that sagittal plane of skull forms a 15-degree angle to IR (Fig. 17.34).

Central ray: Angled 10 degrees cephalad through the mandible.

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing.

Structures seen: Mandibular ramus and portion of body nearest IR (Fig. 17.35). Mandibular condyle should be well demonstrated.

TIP: This projection can also be achieved by placing the head in a true lateral position and angling the central ray 25 degrees cephalad.

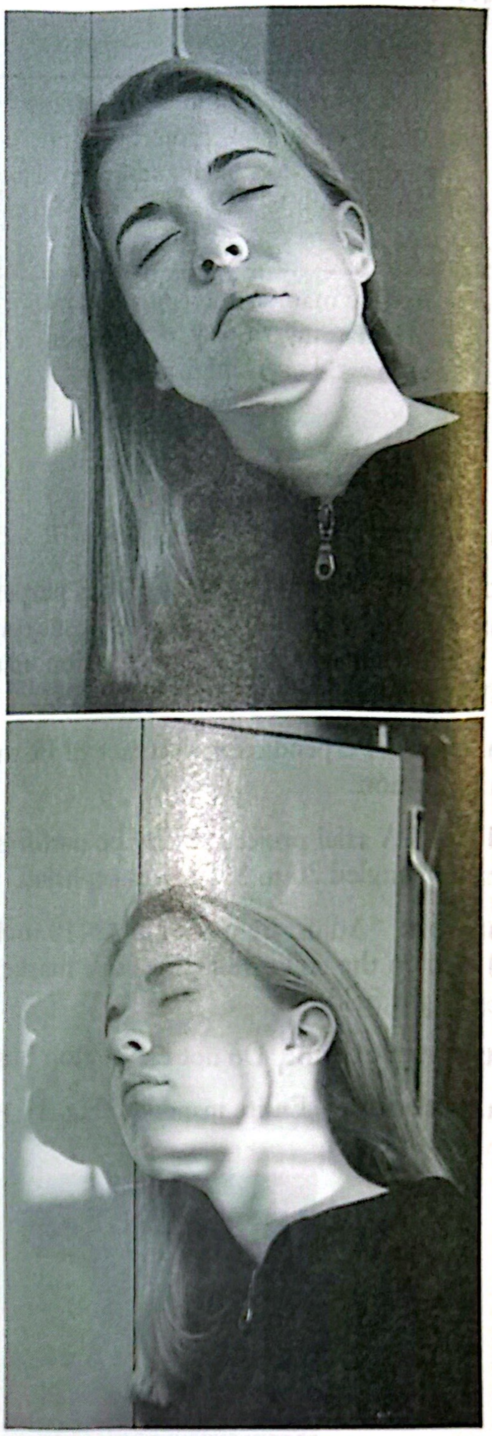

Fig. 17.34 Mandible. Position for axiolateral projection.

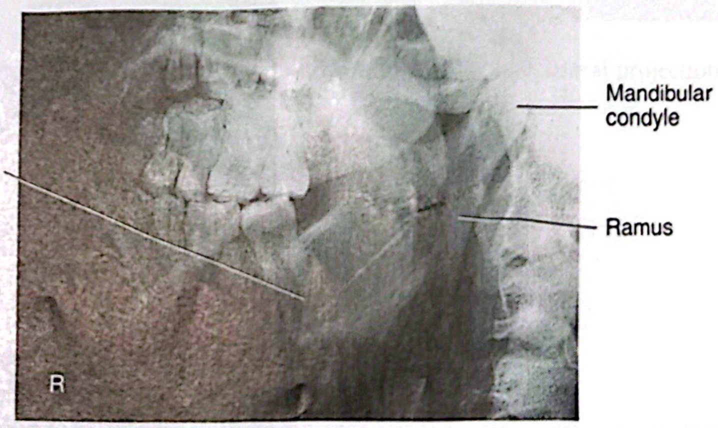

Fig. 17.35 Mandible. Axiolateral projection.

AP AXIAL PROJECTION

An AP axial projection may be used to demonstrate the mandibular condyles and temporomandibular joints. The procedure is the same as for the AP axial projection of the cranium (Towne method) with the following exceptions.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 8 × 10 inches (18 × 24 cm) lengthwise.

Central ray: Directed 35 degrees caudad through midsagittal plane, entering at a point approximately 3 inches above the nasion (Fig. 17.36).

Collimation: Adjust light field to 8 × 10 inches (18 × 24 cm) on the collimator. Place side marker in the collimated light field.

Structures seen: Mandibular condyles and mandibular fossae of the temporal bones (Fig. 17.37).

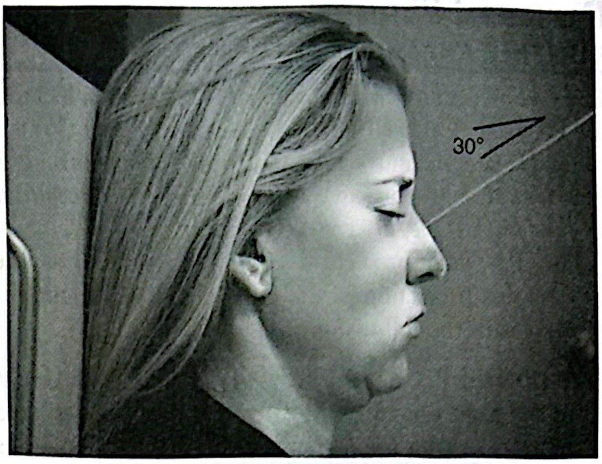

Fig. 17.36 Mandible. Position for AP axial projection.

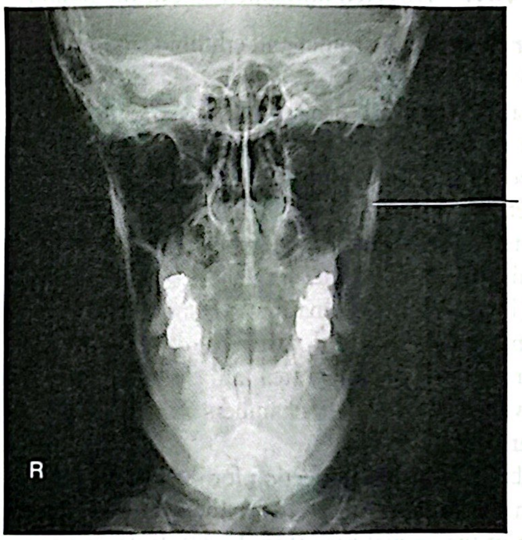

Fig. 17.37 Mandible. AP axial projection.

Paranasal Sinuses

ROUTINE EXAMINATION

The routine examination of the paranasal sinuses includes the PA axial (Caldwell method), parietoacanthial (Waters method), lateral, and submentovertical projections. *It is important that all projections be done upright to demonstrate air-fluid levels if they are present.*

The PA axial projection (Caldwell method) is the same as this projection of the facial bones in the upright position with the following exceptions.

Part position: Extend the patient's neck, with the tip of the nose touching the IR and the nasion centered to the IR. Position the patient's head so the OML forms a 15-degree angle with the horizontal central ray. A radiolucent sponge may be placed between the forehead and grid to provide support (Fig. 17.38).

Central ray: Directed horizontal to exit the nasion.

Structures seen: Frontal and ethmoid sinuses (Fig. 17.39).

The parietoacanthial projection (Waters method) is the same as this projection of the facial bones in the upright position (Fig. 17.40). It demonstrates the maxillary and ethmoid sinuses (Fig. 17.41).

The lateral projection for the sinuses is the same as the lateral projection of the facial bones in the upright position (Fig. 17.42). Collimation is restricted anteriorly just beyond the glabella and posterior to the EAM. The lateral projection demonstrates all of the paranasal sinuses, with right and left chambers superimposed on each other (Fig. 17.43).

The submentovertical projection for the sinuses is taken upright in the same position as for the submentovertical projection of the cranial base (Fig. 17.44). It demonstrates the sphenoid and ethmoid sinuses (Fig. 17.45). The exposure is the same as that used for the cranial base.

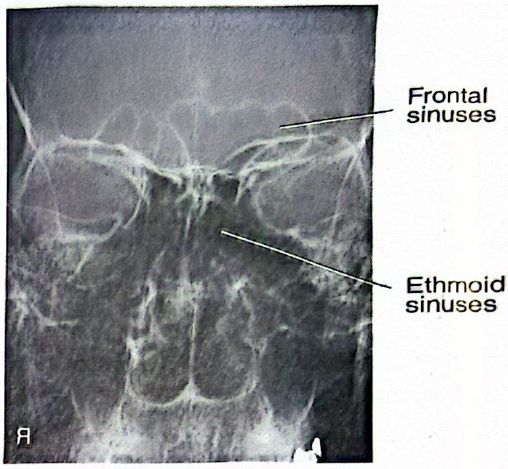

Fig. 17.39 Paranasal sinuses. PA axial projection (Caldwell method).

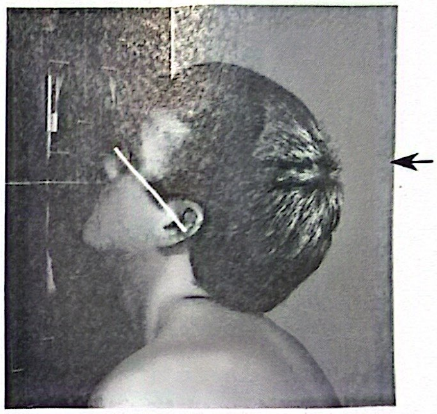

Fig. 17.40 Paranasal sinuses. Position for parietoacanthial projection (Waters method), patient upright.

Fig. 17.38 Paranasal sinuses. Position for PA axial projection (Caldwell method), patient upright.

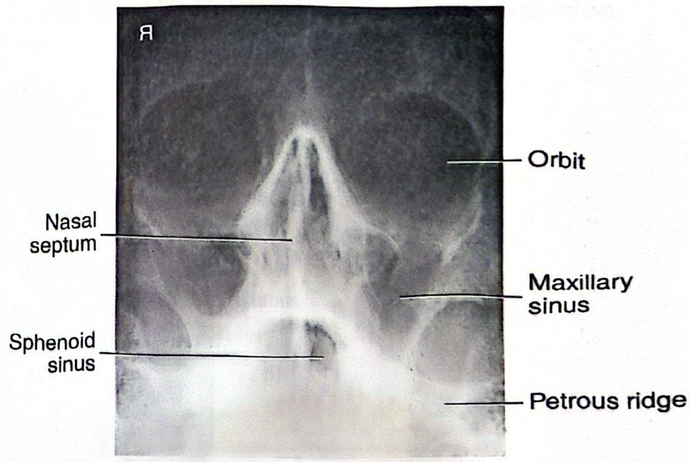

Fig. 17.41 Paranasal sinuses. Parietoacanthial projection (Waters method).

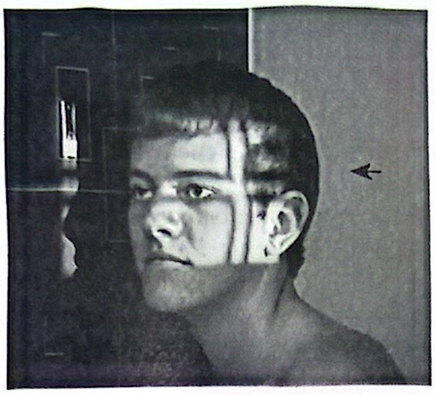

Fig. 17.42 Paranasal sinuses. Position for lateral projection, patient upright.

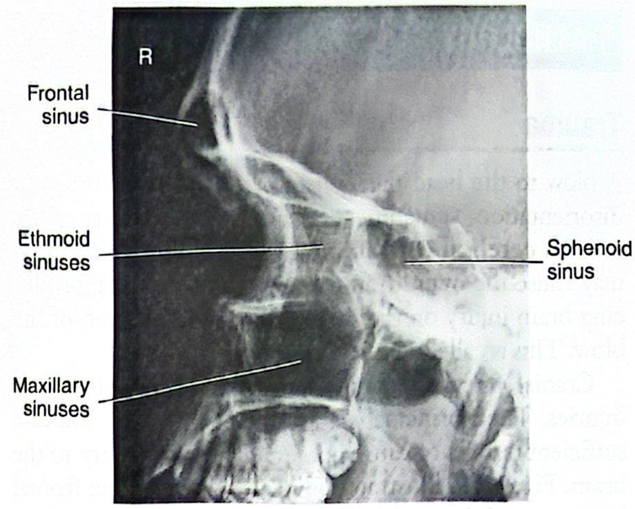

Fig. 17.43 Paranasal sinuses. Lateral projection.

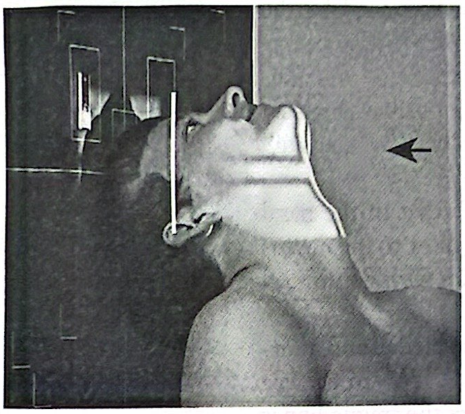

Fig. 17.44 Paranasal sinuses. Position for submentovertical projection, patient upright.

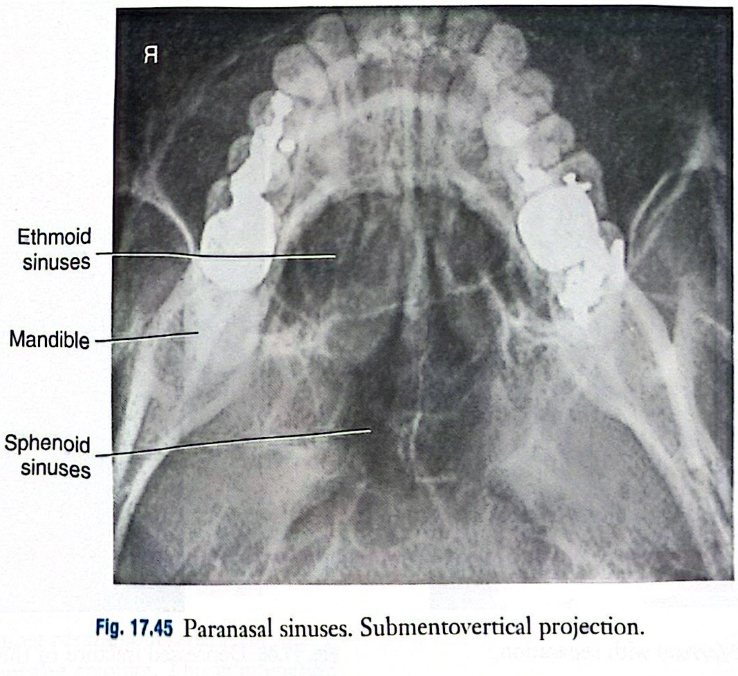

Fig. 17.45 Paranasal sinuses. Submentovertical projection.

PATHOLOGY

Trauma

A blow to the head that causes brief unconsciousness or disorientation, sometimes described as "seeing stars," is called a **cerebral concussion**. A severe blow to the head may cause the brain to move within the cranium, producing brain injury on the side opposite the location of the blow. This is called a **contrecoup injury**.

Cranial fractures may or may not represent serious injuries. Their principal significance is that they indicate sufficient trauma to cause potentially serious injury to the brain. Fig. 17.46 illustrates a linear fracture of the frontal bone caused by a head-on fall onto a hard surface. Fig. 17.47 is a depressed skull fracture, a type that occurs with a blow by an object, in this case a baseball bat. Fractures of the cranial base are more difficult to see radiographically. They are sometimes diagnosed by the presence of air-fluid levels in the sphenoid sinuses, resulting from leakage of blood and/or spinal fluid into the sinus cavity. For this reason, when basal skull fractures are suspected, upright lateral or AP decubitus views of the skull may be requested.

The most common facial fracture is that of the nasal bones. The typical fracture caused by a blow to the nose is a transverse fracture of both nasal bones with depression of the fragments (Fig. 17.48).

The weakest areas of the orbit are the medial and inferior walls, posterior to the orbital rims. A blow to the eye may cause sufficient pressure to fracture the fragile bones of the orbit. Fracture of the orbital floor is called a **blowout fracture** (Fig. 17.49). Bone fragments and soft tissues of the eye are forced into the maxillary sinus.

Blows to the side of the face may fracture the zygomatic arches (Fig. 17.50), and a direct blow near the center of the face sometimes causes multiple fractures (Fig. 17.51). Fractures of the mandible may occur in the body, the ramus, or the narrow superior portion of the ramus just below the condyle. The structure of the mandible is such that sufficient force to cause a fracture in one area causes a wrenching stress in other portions of the bone. For this reason, mandible fractures often occur in pairs (Fig. 17.52).

Fig. 17.47 Depressed skull fracture *(arrow)*.

Fig. 17.46 Linear skull fracture *(arrow)* with separation, branching posteriorly.

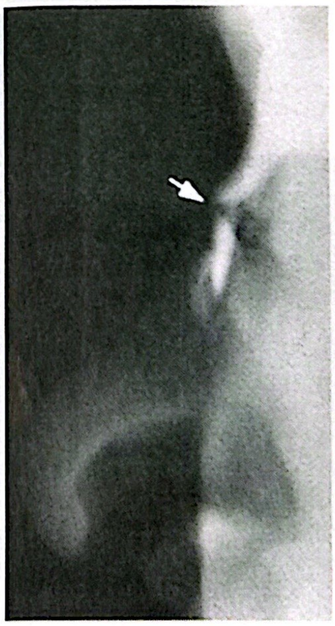

Fig. 17.48 Depressed fracture of the nasal bones *(arrow)*. Note demonstration of the nasal spine.

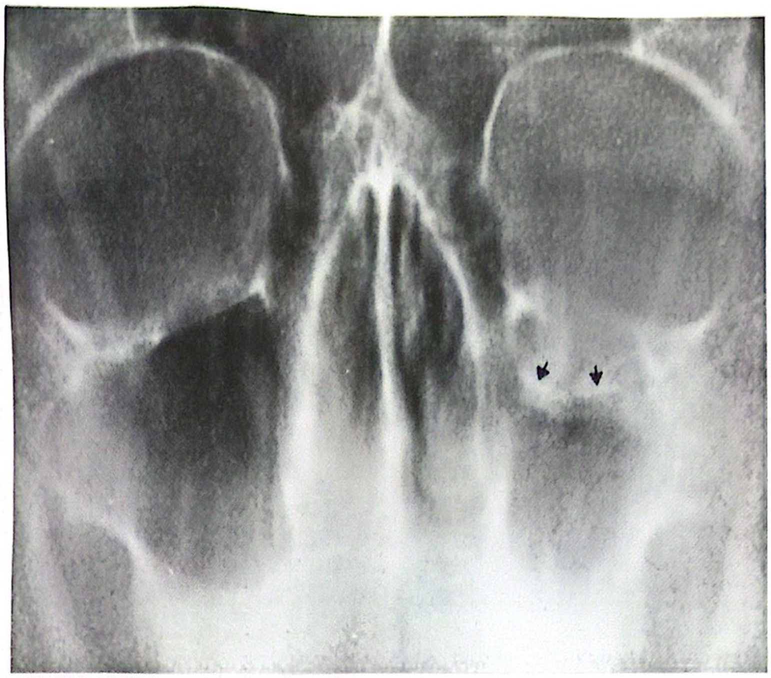

Fig. 17.49 Blowout fracture of the left orbit. Note periorbital soft tissue protruding into the superior portion of the left maxillary sinus *(arrows)*.

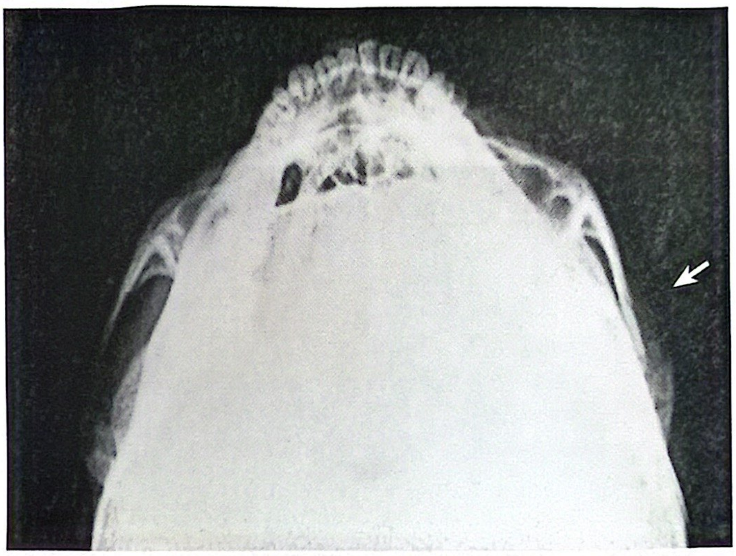

Fig. 17.50 Fracture with depression of left zygomatic arch *(arrow)*.

Fig. 17.51 Multiple facial fractures resulting in separation of a large fragment of the face from the cranium. This combination of fractures, called *LeFort II*, results from a powerful frontal blow.

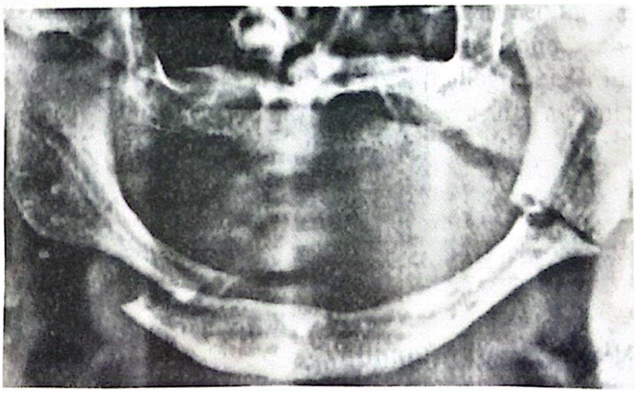

Fig. 17.52 Mandibular fractures often occur in pairs.

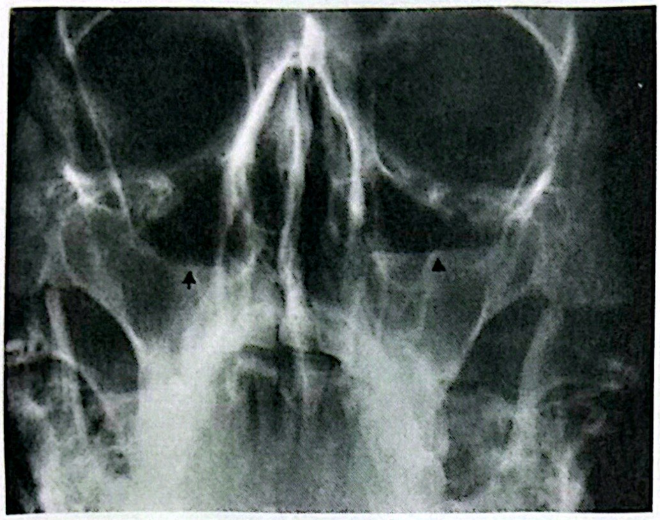

Fig. 17.53 Acute sinusitis. Air-fluid levels are demonstrated in both maxillary sinuses *(arrows)*.

Fig. 17.54 Chronic sinusitis shows characteristic thickening of the walls of the maxillary sinuses *(arrows)*.

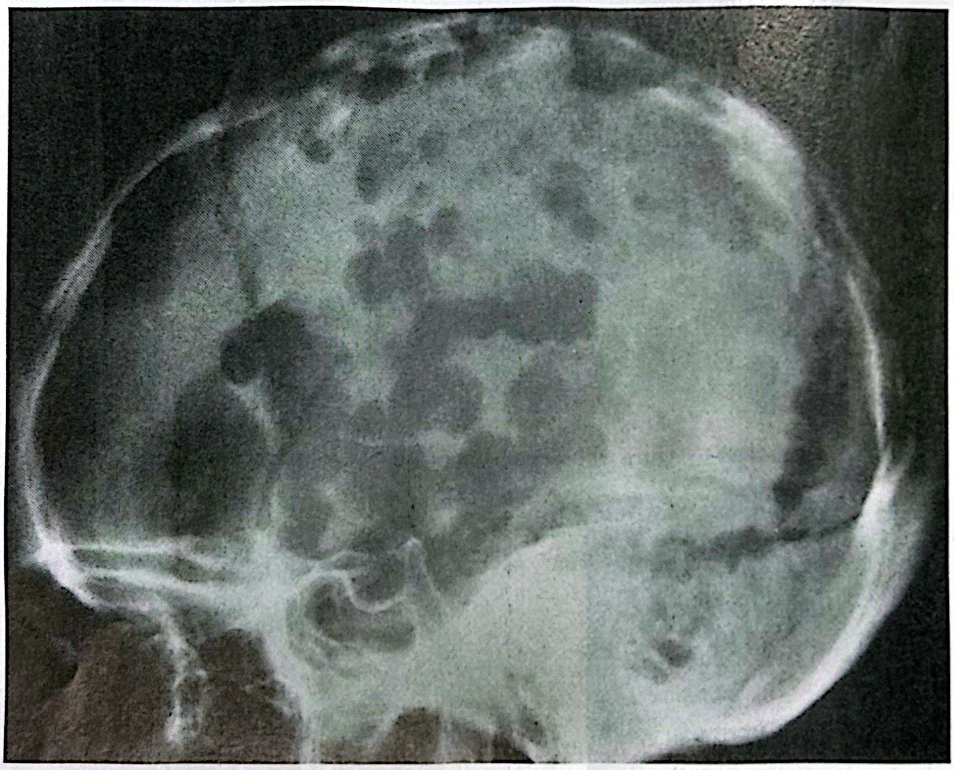

Fig. 17.55 Osteomyelitis of the skull.

Nontraumatic Conditions

Allergies or upper respiratory tract infections may cause inflammation of the paranasal sinuses. Because the sinuses communicate with the outside of the body via the nasal passages, they are common sites of infection within the skull. Fig. 17.53 shows air-fluid levels in the maxillary sinuses and is an example of acute sinusitis. Fig. 17.54, on the other hand, shows the thickening of the walls of the maxillary antra that is typical of chronic sinusitis. Fig. 17.55 illustrates the destruction caused by osteomyelitis of the bones of the cranium. In this case, the infection had spread from severe sinusitis.

Tumors within the brain are usually diagnosed by means of CT or magnetic resonance imaging (MRI) scans. Tumors that affect the bones of the cranium, however,

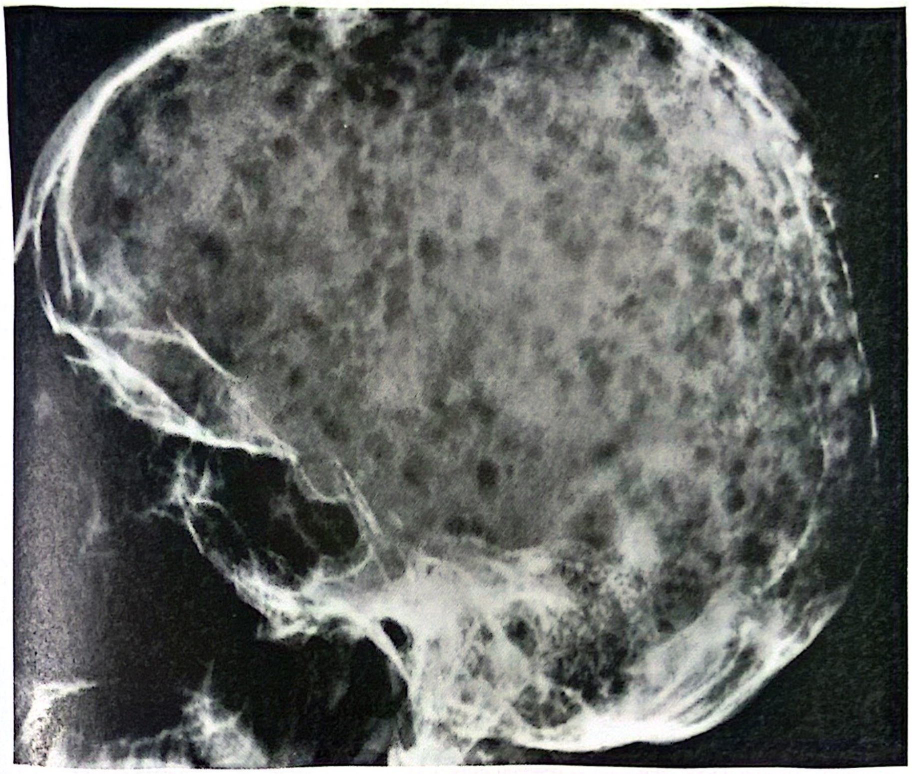

Fig. 17.56 Multiple myeloma as manifested in the skull.

may be evaluated by radiography. Fig. 17.56 illustrates multiple lytic lesions of **multiple myeloma**, a malignant bone disease that may involve many bones of the body.

SUMMARY

Radiography of the skull, facial bones, and paranasal sinuses is less common than it once was, having been replaced in many cases by CT studies and sometimes MRI. Radiography of the head is most common today for the evaluation of bone disease in the skull, screening for facial fractures, and evaluating the paranasal sinuses when CT is not readily available.

The bones that make up the cranium and facial structures are complex and require careful study. All are immovable with the exception of the mandible and are joined by synarthrodial joints called *sutures*. Proper positioning requires attention to all three body planes and the use of bony landmarks and positioning lines. The most common positioning line for alignment of the transverse plane is the OML between the midpoint of the lateral orbital margin and the EAM.

The basic projections for radiography of the skull, face, and sinuses are AP, PA, lateral, submentovertical, and parietoacanthial (Waters method). Variations in tube angle are used to project structures of interest with the least distortion and free of superimposition by structures that could compromise visualization. The submentovertical and verticosubmental projections are used to demonstrate the cranial base, zygomatic arches, and sphenoid sinuses.

There are four sets of paranasal sinuses named for the bones in which they are located: maxillary, frontal, ethmoid, and sphenoid. The sinuses are radiographed with the patient in the upright position to visualize air-fluid levels.