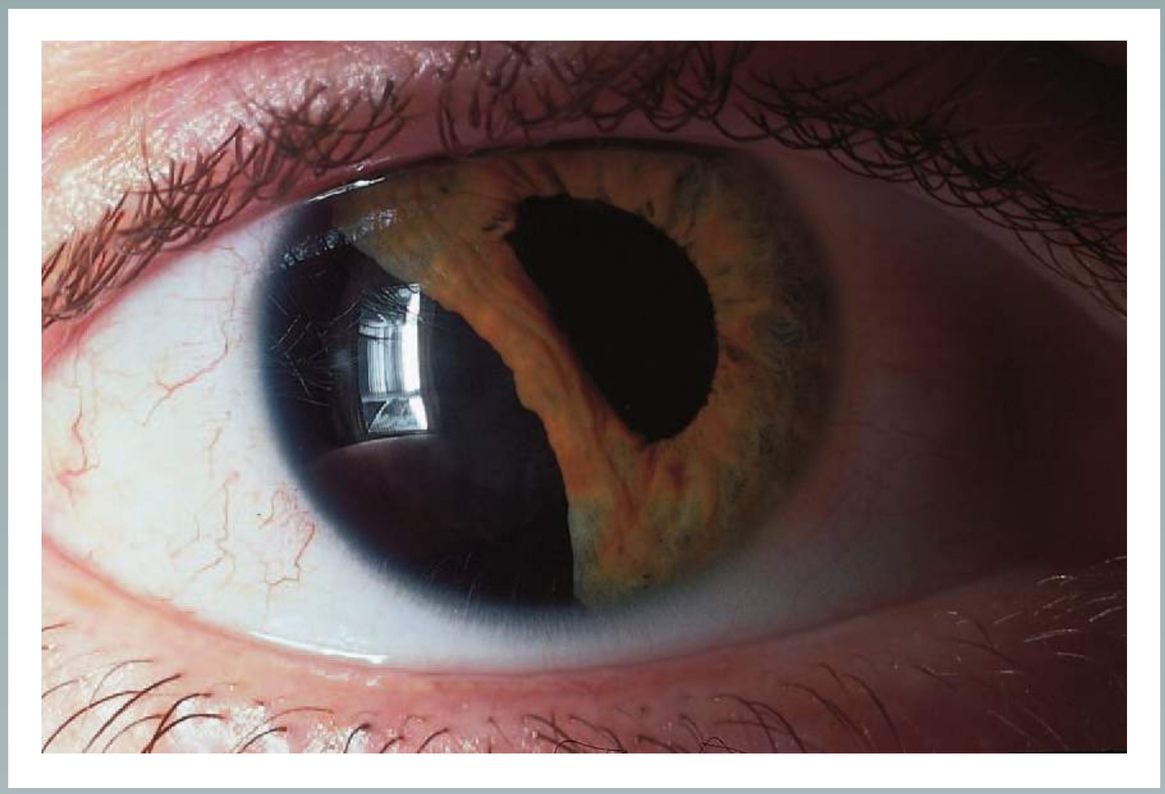
PART 1

Regional Anatomy



Chapter 1

HEAD AND FACIAL TRAUMA

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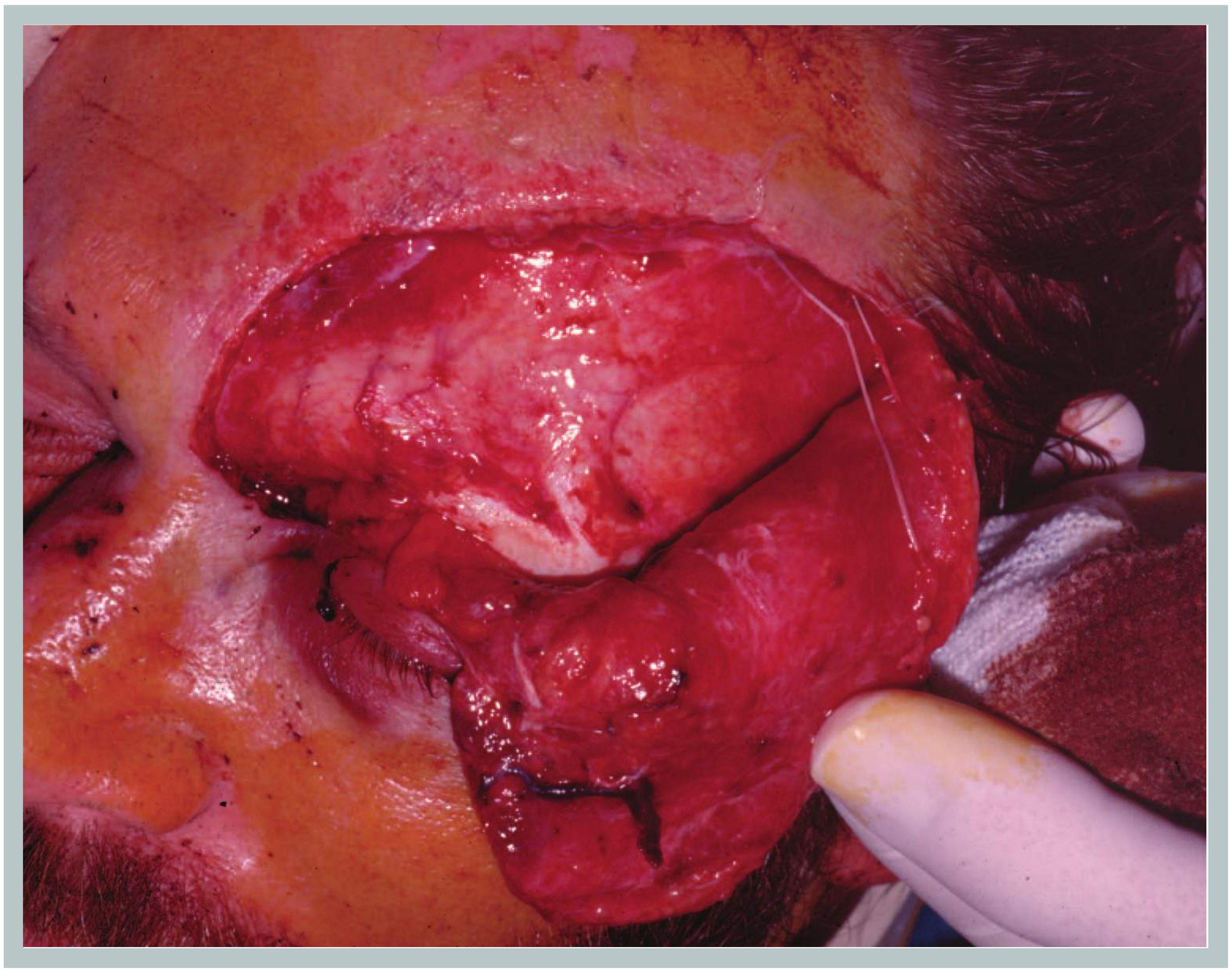


Exposed Galea. Partial forehead degloving injury after a motor vehicle crash. Galea overlying the frontal bone is demonstrated just prior to repair. (Photo contributor: Lawrence B. Stack MD)

Clinical Summary

The skull "base" comprises the frontal bone, occiput, occipital condyles, clivus, carotid canals, petrous portion of the temporal bones, and the posterior sphenoid wall. A basilar skull fracture is basically a linear fracture of the skull base. Trauma resulting in fractures to this area typically does not have localizing symptoms. Indirect signs of the injury may include visible evidence of bleeding from the fracture into surrounding soft tissue, such as a Battle sign or "raccoon eyes." Bleeding into other structures—including hemotympanum or blood in the sphenoid sinus seen as an air-fluid level on computed tomography (CT)—may also be seen. Cerebrospinal fluid (CSF) leaks may also be evident and noted as clear or pink rhinorrhea. If CSF is present, a dextrose stick test may be positive. The fluid can be placed on filter paper and a "halo" or double ring may be seen.

Management and Disposition

Identify underlying brain injury, which is best accomplished by CT. CT is also the best diagnostic tool for identifying the fracture site, but fractures may not always be evident. Evidence of open communication, such as a CSF leak, mandates neurosurgical consultation and admission. Otherwise, the decision for admission is based on the patient's clinical condition, other associated injuries, and evidence of underlying brain injury as seen on CT. The use of antibiotics in the presence of a CSF leak is controversial because of the possibility of selecting resistant organisms.

FIGURE 1.1 ■ **Battle Sign.** Ecchymosis in the postauricular area develops when the fracture line communicates with the mastoid air cells, resulting in blood accumulating in the cutaneous tissue. This patient had sustained injuries several days prior to presentation. (Photo contributor: Frank Birinyi, MD.)

FIGURE 1.2 ■ **Battle Sign.** A striking Battle sign is seen in this patient with head trauma. This finding may take hours to days to develop. (Photo contributor: David Effron, MD.)

Pearls

1. Clinical manifestations of basilar skull fracture may take several hours to fully develop.
2. There should be a low threshold for head CT in any patient with head trauma, loss of consciousness, change in mental status, severe headache, visual changes, or nausea or vomiting.
3. The use of filter paper or a dextrose stick test to determine if CSF is present in rhinorrhea is not 100% reliable.

FIGURE 1.3 ■ **Raccoon Eyes.** Acute periorbital ecchymosis seen in this patient with a basilar skull fracture. These findings may also be caused by facial fractures. (Photo contributor: Shannon Koh, MD.)

FIGURE 1.4 ■ **Early Raccoon Eyes.** Subtle periorbital ecchymosis manifests 1 hour after a blast injury. (Photo contributor: Kevin J. Knoop, MD, MS.)

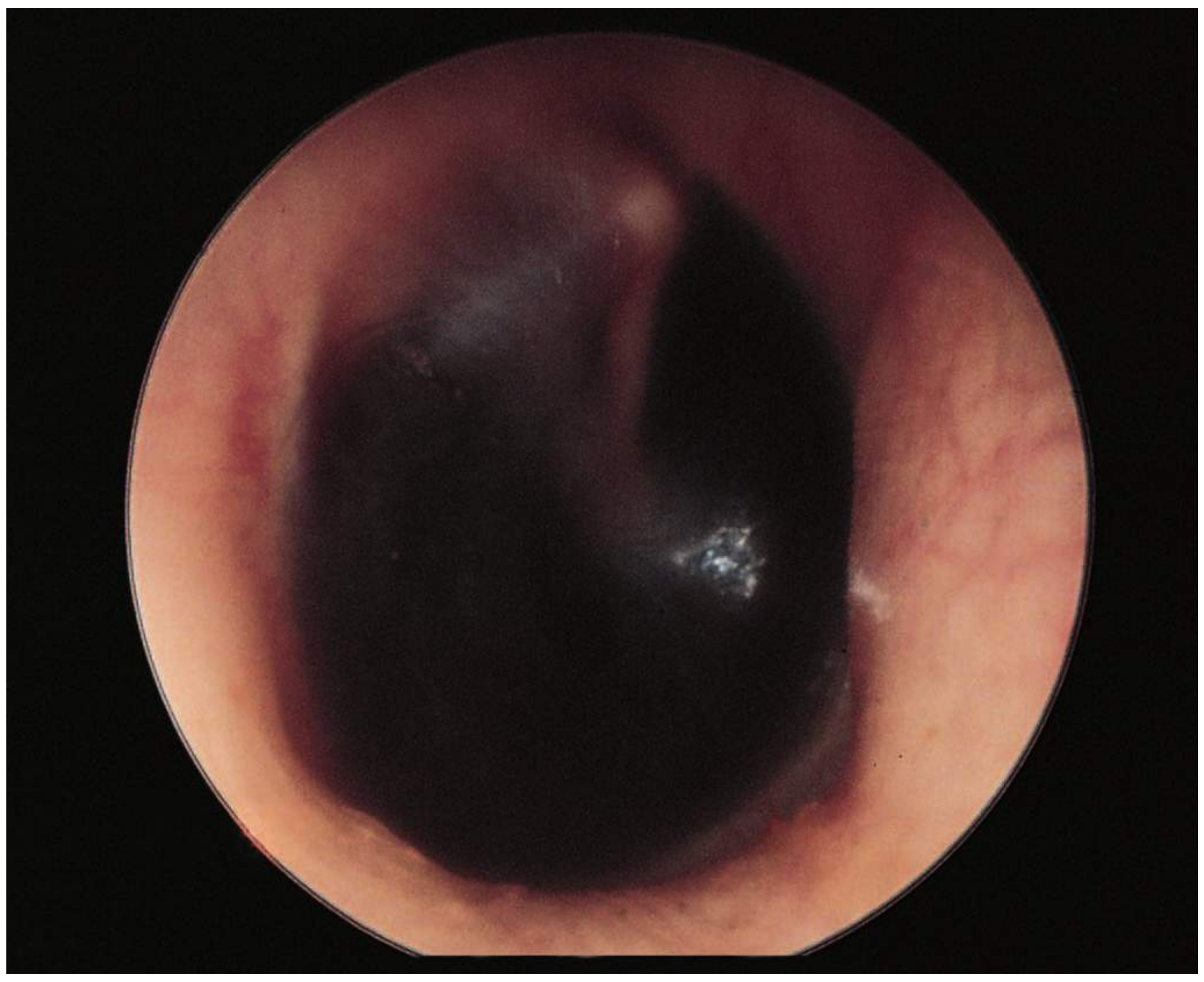


FIGURE 1.5 ■ **Hemotympanum.** Seen in a basilar skull fracture when the fracture line communicates with the auditory canal, resulting in bleeding into the middle ear. Blood can be seen behind the tympanic membrane. (Photo contributor: Richard A. Chole, MD, PhD.)

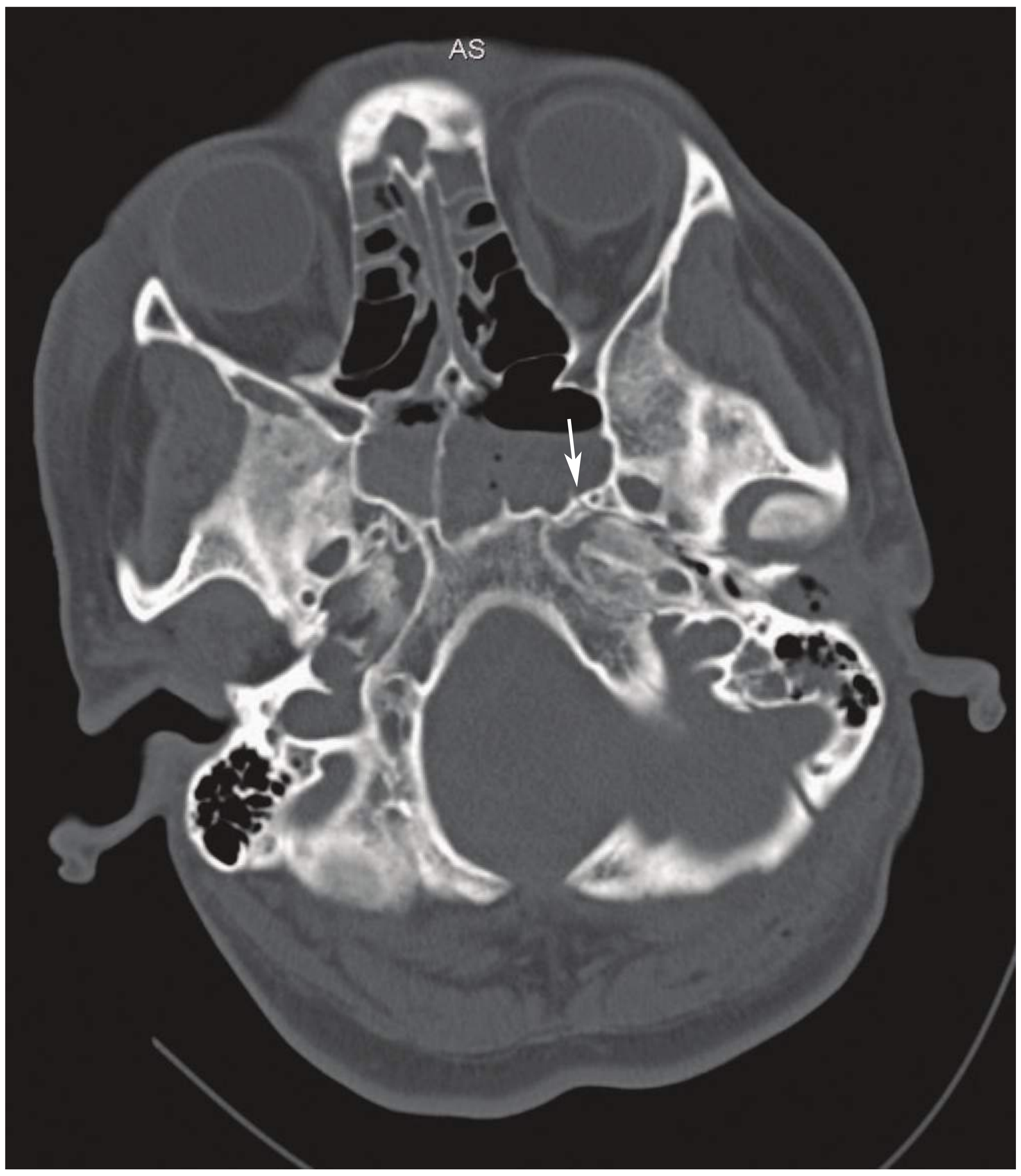


FIGURE 1.6 ■ **CT of Basilar Skull Fracture.** CT bone window demonstrates a fracture of the posterior wall left sphenoid sinus (arrow) and an air-fluid level. (Photo contributor: Jared McKinney, MD.)

FIGURE 1.7 ■ **Halo Sign—Cerebrospinal Fluid Leak.** Otorrhea on bed sheet demonstrating a halo sign from a patient with severe head trauma. The distinctive double-ring sign, seen here, comprises blood (inner ring) and CSF (outer ring). The reliability of this test has been questioned. (Photo contributor: Suzanne Bryce, MD.)

DEPRESSED SKULL FRACTURE

Clinical Summary

Depressed skull fractures typically occur when a large force is applied over a small area. They are classified as open if the skin above them is lacerated. Abrasions, contusions, and hematomas may also be present over the fracture site. The patient's mental status is dependent upon the degree of underlying brain injury. Direct trauma can cause abrasions, contusions, hematomas, and lacerations without an underlying depressed skull fracture. Evidence of other injuries such as a basilar fracture, facial fractures, or cervical spinal injuries may also be present.

Management and Disposition

Explore all scalp lacerations to exclude a depressed fracture. CT should be performed in all suspected depressed skull fractures to determine the extent of underlying brain injury. Depressed skull fractures require immediate neurosurgical consultation. Treat open fractures with antibiotics and tetanus prophylaxis as indicated. The decision to observe or operate immediately is made by the neurosurgeon. Children below 2 years of age with skull fractures can develop leptomeningeal cysts, which are extrusion of CSF or brain through dural defects. For this reason, children below age 2 with skull fractures require close follow-up or admission.

FIGURE 1.8 ■ **Depressed Skull Fracture.** A scalp laceration overlying a depressed skull fracture. Scalp lacerations should undergo sterile exploration for skull fracture. (Photo contributor: David W. Munter, MD.)

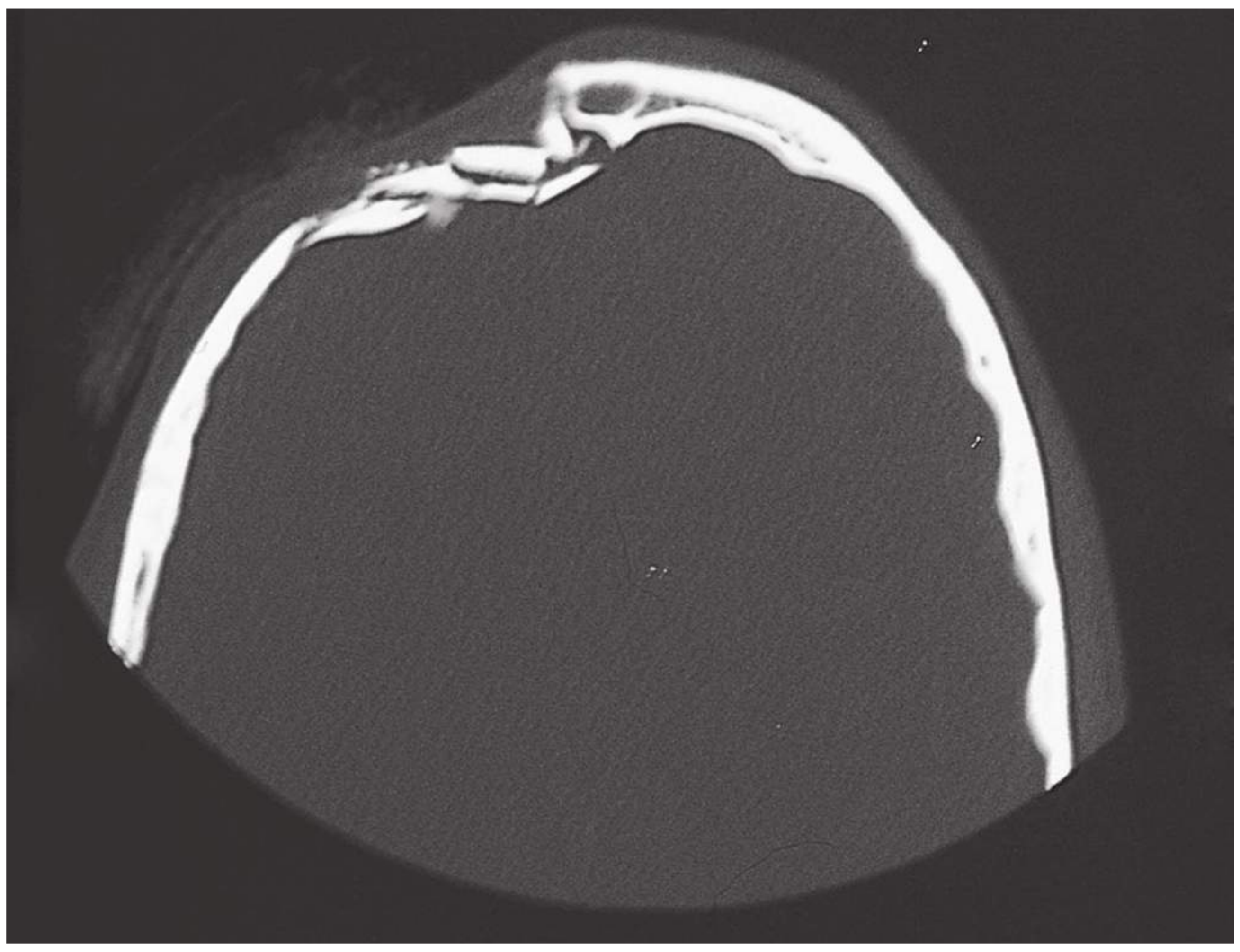


FIGURE 1.9 ■ **Depressed Skull Fracture.** CT demonstrating depressed skull fracture. (Photo contributor: David W. Munter, MD.)

Pearls

1. Examine all scalp injuries including lacerations for evidence of fractures or depression. When fragments are depressed 5 mm below the inner table, penetration of the dura and injury to the cortex are more likely.
2. Children with depressed skull fractures are more likely to develop epilepsy.
3. Ping pong ball skull fractures can occur from a forceps delivery or from compression by mother's sacral promontory during delivery.
4. Patients with head injuries must be evaluated for cervical spine injuries.

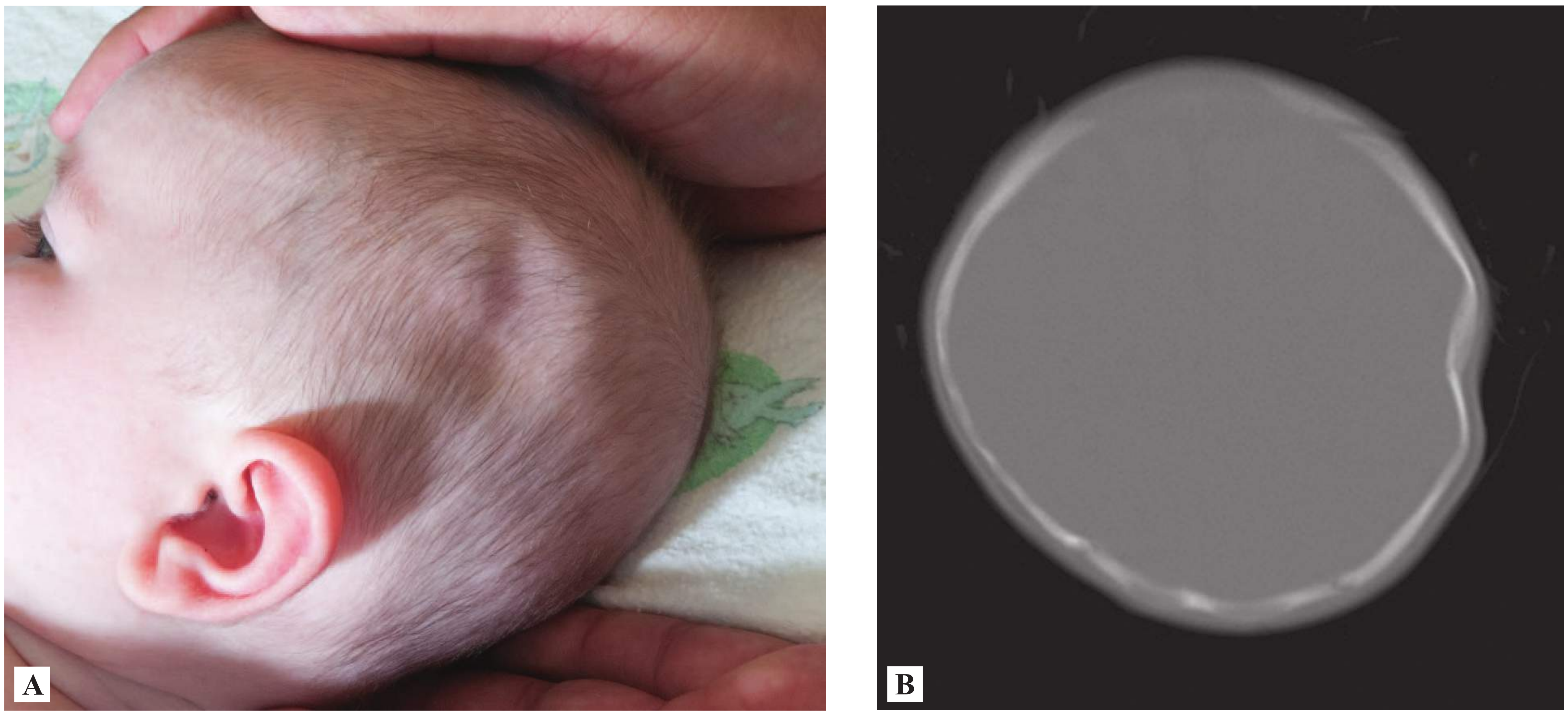


FIGURE 1.10 ■ **Ping Pong Ball Skull Fracture.** (**A**) Akin to the greenstick fracture, a ping pong ball fracture occurs when a newborn or infant's relatively soft skull is indented by the corner of a table or similar object without causing a frank break in the bone. (**B**) CT demonstrates the ping pong ball effect. (Photo contributor: Johnny Wei, BS.)

Clinical Summary

Clinically significant nasal fractures are almost always evident with deformity, swelling, and ecchymosis. Fractures to adjacent bony structures, including the orbit, frontal sinus, or cribriform plate, often occur. Epistaxis may be due to a septal or turbinate laceration but can also be seen with fractures of adjacent bones, including the cribriform plate. Septal hematoma is a rare but important complication that, if untreated, may result in necrosis of the septal cartilage and a resultant "saddle-nose" deformity. A frontonasoethmoid fracture has nasal or frontal crepitus and may have telecanthus or obstruction of the nasolacrimal duct.

FIGURE 1.11 ■ **Nasal Fracture.** Deformity is evident on examination. Note periocular ecchymosis indicating the possibility of other facial fractures (or injuries). The decision to obtain radiographs is based on clinical findings. A radiograph is not indicated for an isolated simple nasal fracture. (Photo contributor: David W. Munter, MD.)

Management and Disposition

Look for more serious injuries first. Patients with associated facial bone deformity or tenderness may require CT to rule out facial fractures. Isolated nasal fractures rarely require radiographs. Refer obvious deformities within 2 to 5 days for reduction, after the swelling has subsided. Nasal fractures with mild angulation and without displacement may be reduced in the emergency department (ED). Nasal injuries without deformity need only conservative therapy with an analgesic and possibly a nasal decongestant. Immediately drain septal hematomas, with packing placed to prevent reaccumulation. Uncontrolled epistaxis may require nasal packing. Vigorously irrigate and suture lacerations overlying a simple nasal fracture and place the patient on antibiotic coverage. Complex nasal lacerations with underlying fractures should be repaired by a facial surgeon.

Pearls

1. Control epistaxis to perform a good intranasal examination. If obvious deformity is present, including a new septal deviation or deformity, treat with ice and analgesics and provide ENT referral in 2 to 5 days for reduction.
2. Although the effectiveness of prophylactic antibiotics to prevent toxic shock syndrome is unproven, patients discharged with nasal packing should be placed on antistaphylococcal antibiotics and referred to ENT in 2 to 3 days.
3. Consider cribriform plate fractures in patients with clear rhinorrhea after nasal injury, with the understanding that this finding may be delayed.
4. Patients with facial trauma should be examined for a septal hematoma.

FIGURE 1.12 ■ **Septal Hematoma.** A bluish, grapelike mass on the nasal septum. If untreated, this can result in septal necrosis and a saddle-nose deformity. An incision, drainage, and packing are indicated. (Photo contributor: Lawrence B. Stack, MD.)

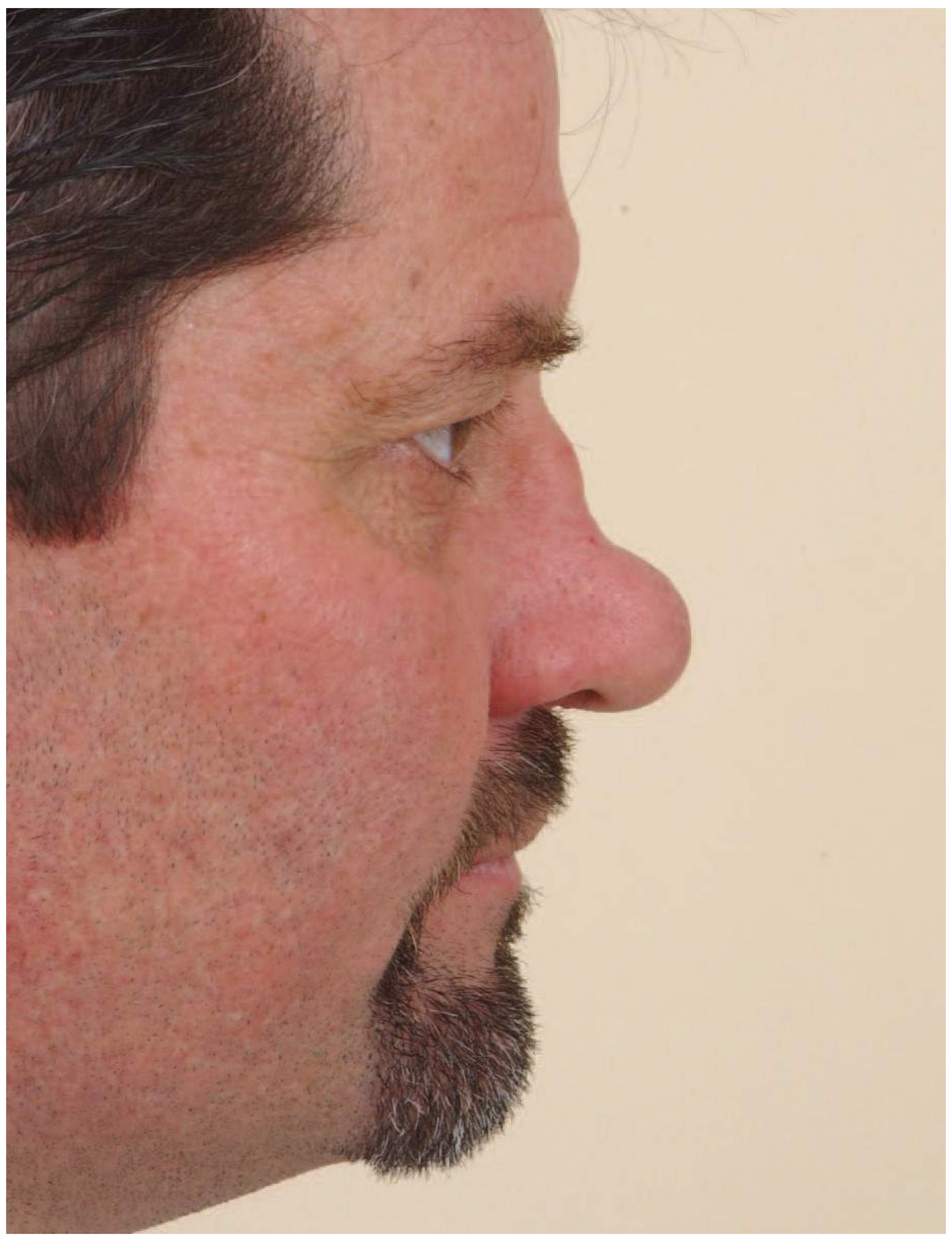


FIGURE 1.13 ■ **Saddle-Nose Deformity.** Nasal septal necrosis resulting in saddle-nose deformity. (Photo contributor: David Effron, MD.)

FIGURE 1.14 ■ **Open Nasal Fracture.** Lacerations with underlying fracture that require multilayer closure that should be repaired by a facial surgeon and require antibiotics. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.15 ■ **Minimally Displaced Nasal Fracture.** Plain radiograph of a fracture of the nasal spine. (Photo contributor: Lorenz F. Lassen, MD.)

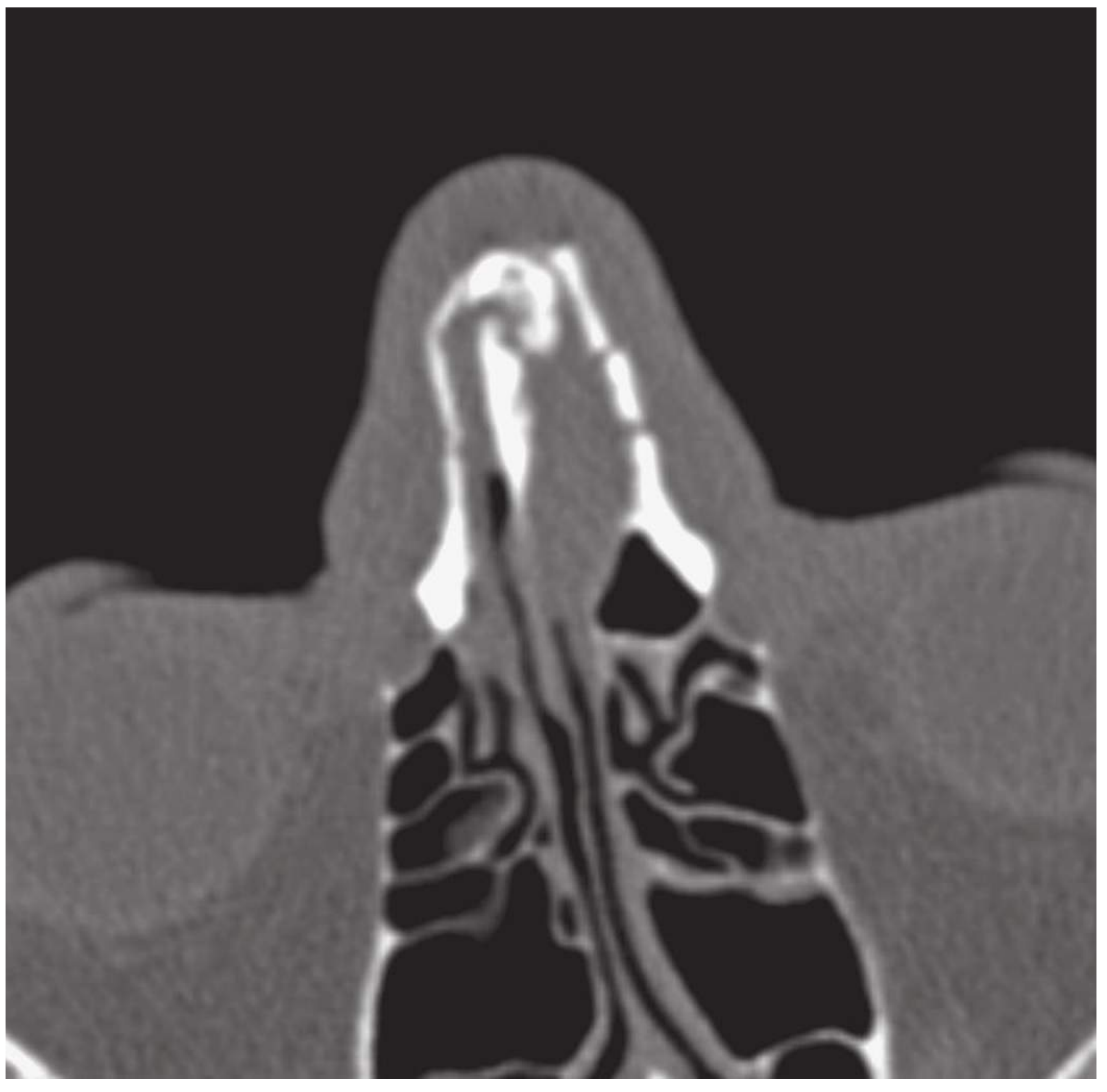


FIGURE 1.16 ■ **Comminuted Nasal Fracture.** CT demonstrates a comminuted nasal bone fracture. (Photo contributor: Lawrence B. Stack, MD.)

Clinical Summary

The zygoma bone has two major components, the zygomatic arch and the body. The arch forms the inferior and lateral orbit, and the body forms the malar eminence of the face. Direct blows to the arch can result in isolated arch fractures. These present clinically with pain on opening the mouth secondary to the insertion of the temporalis muscle at the arch or impingement on the coronoid process. More extensive trauma can result in the "tripod fracture," which consists of fractures through three structures: the frontozygomatic suture; the maxillary process of the zygoma including the inferior orbital floor, inferior orbital rim, and lateral wall of the maxillary sinus; and the zygomatic arch. Clinically, patients present with a flattened malar eminence and edema and ecchymosis to the area, with a palpable step-off on examination. Injury to the infraorbital nerve may result in infraorbital paresthesia, and gaze disturbances may result from injury to orbital contents. Subcutaneous emphysema may be present.

Management and Disposition

Maxillofacial CT best identifies zygoma fractures. Treat simple zygomatic arch or tripod fractures without eye injury with ice and analgesics and refer for delayed operative consideration in 5 to 7 days. Refer extensive tripod fractures or those with eye injuries urgently. Decongestants and broad-spectrum antibiotics are generally recommended for tripod fractures, since the fracture crosses into the maxillary sinus. Fractures with blood in the sinus should also be treated with antibiotics.

FIGURE 1.17 ■ **Zygomatic Arch Fracture.** Axial cut of a facial CT which reveals a minimally depressed zygomatic arch fracture. (Photo contributor: Lawrence B. Stack, MD.)

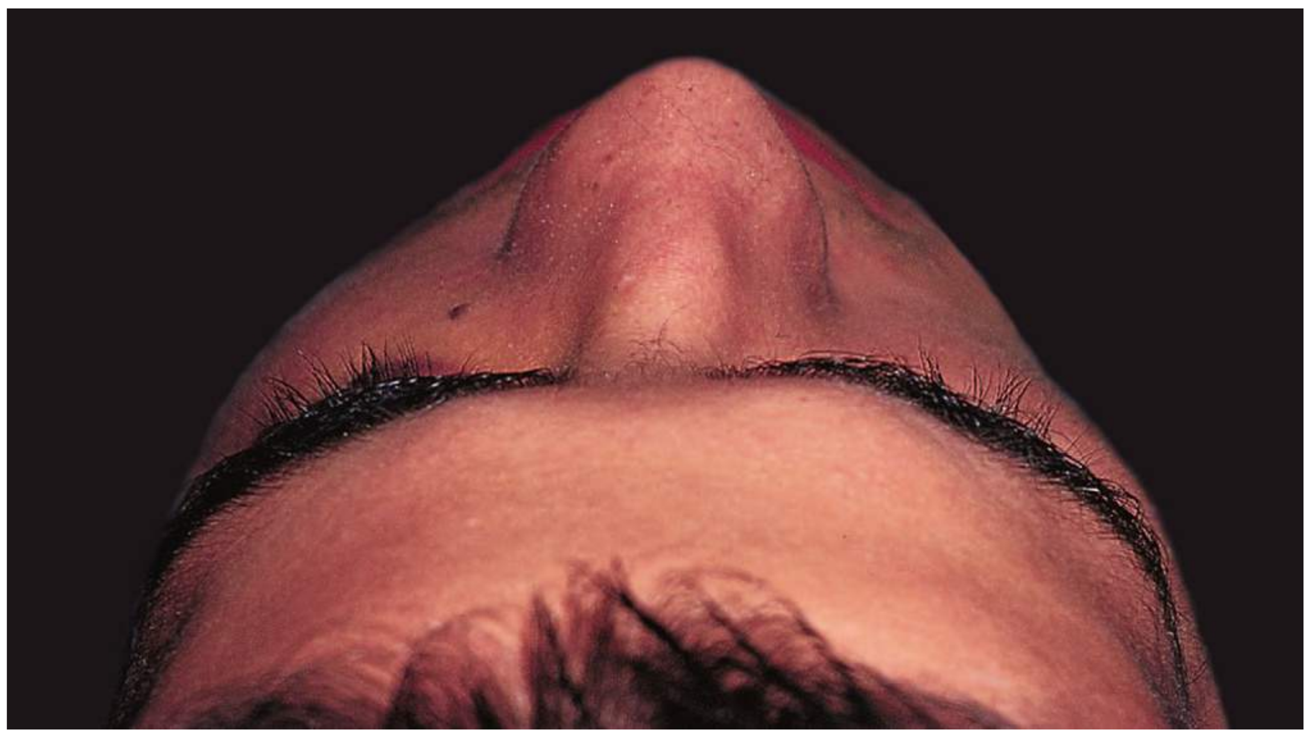


FIGURE 1.18 ■ **Zygomatic Arch Fracture.** Patient with blunt trauma to the zygoma. Flattening of the right malar eminence is evident. (Photo contributor: Edward S. Amrhein, DDS.)

Pearls

1. Tripod fractures are often associated with orbital and ocular trauma. Palpate the zygomatic arch and orbital rims carefully for a step-off deformity.
2. Examine for eye findings such as diplopia, hyphema, or retinal detachment. Check for infraorbital paresthesia indicating injury or impingement of the second division of cranial nerve V.
3. Visual inspection of the malar eminence from several angles (especially by viewing the area from over the head of the patient in the coronal plane) allows detection of a subtle abnormality.

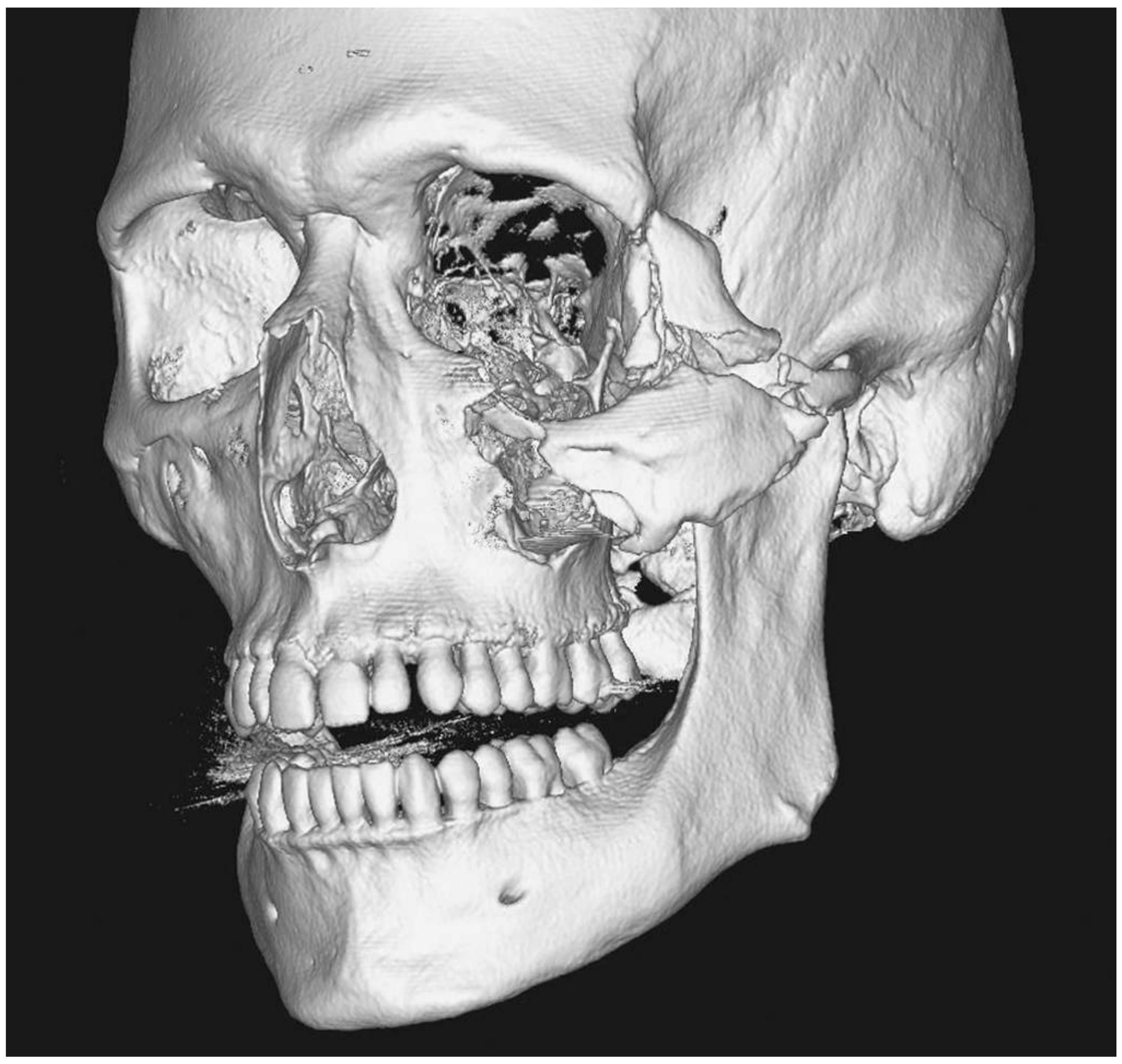


FIGURE 1.19 ■ **Tripod Fracture.** The fracture lines involved in a tripod fracture are demonstrated in this three-dimensional CT reconstruction. (Photo contributor: Patrick W. Lappert, MD.)

Clinical Summary

All LeFort facial fractures involve the maxilla. Clinically, the patient has facial injuries, swelling, and ecchymosis. LeFort I fractures are those involving an area under the nasal fossa. LeFort II fractures involve a pyramidal area including the maxilla, nasal bones, and medial orbits. LeFort III fractures, sometimes described as craniofacial dissociation, involve the maxilla, zygoma, nasal and ethmoid bones, and the bones of the base of the skull. LeFort IV fractures have been described as a LeFort III fracture that also involves the frontal bone. Patients may have different LeFort fractures on each side of their face. Airway compromise may be associated with LeFort II and III fractures. Physical examination is sometimes helpful in distinguishing the four. The examiner places fingers on the bridge of the nose and tries to move the central maxillary incisors with the other hand. If only the maxilla moves, a LeFort I is present; movement of the upper jaw and nose indicates a LeFort II; and movement of the entire midface and zygoma indicates a LeFort III. Because of the extent of LeFort II and III fractures, they may be associated with cribriform plate fractures and CSF rhinorrhea. The force required to sustain a LeFort II or III fracture is considerable, and associated brain or cervical spine injuries or other facial fractures are common.

Management and Disposition

Attend to the airway and life-threatening injuries first. Maxillofacial CT best identifies LeFort injuries. Management of LeFort I fractures may involve only dental splinting and oral surgery referral. Consult on all LeFort II and III fractures for admission because of the need for operative repair. Epistaxis may be difficult to control in LeFort II and III fractures, in rare cases requiring intraoperative arterial ligation.

Pearls

1. Attention should be focused on immediate airway management, since the massive edema associated with LeFort II and III fractures may quickly lead to airway compromise.
2. Avoid nasotracheal intubation because of the possibility of intracranial passage.
3. Serious facial trauma is often associated with cervical spine injuries.
4. Associated cranial injuries are common, obtain head CT.
5. If not recognized, an occult CSF leak may result in significant morbidity. Suspected CSF leaks require neurosurgical consultation.

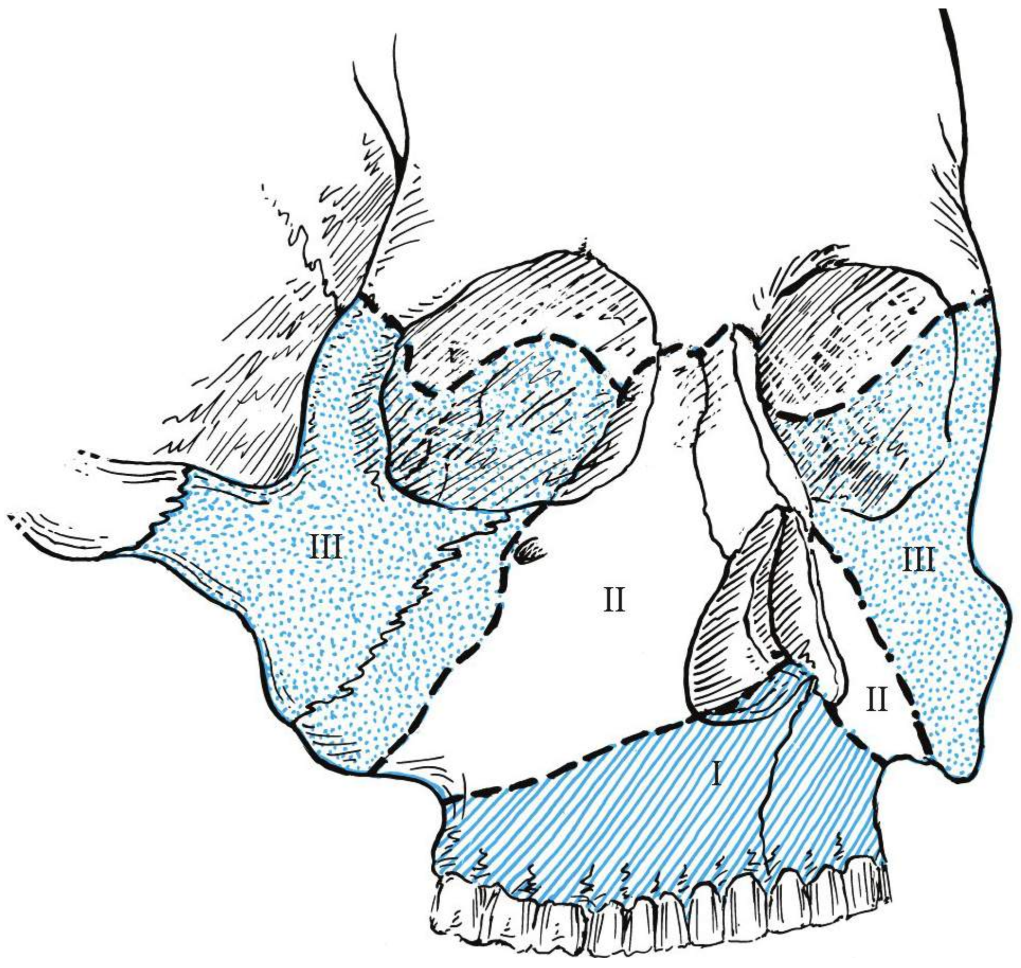


FIGURE 1.20 ■ **LeFort Fractures.** Illustration of the fracture lines of LeFort I (alveolar), LeFort II (zygomatic maxillary complex), and LeFort III (cranial facial dysostosis) fractures.

FIGURE 1.21 ■ **LeFort Facial Fractures.** Patient with blunt facial trauma. Note the ecchymosis and edema. This patient sustained a left LeFort II fracture and a right LeFort III, and intracranial hemorrhages. (Photo contributor: Stephen Corbett, MD.)

FIGURE 1.22 ■ **LeFort Facial Fractures.** Patient with blunt facial trauma who demonstrates the classic "dish face" deformity (depressed midface) associated with bilateral LeFort III fractures. (Photo contributor: Robert Schnarrs, MD.)

Clinical Summary

Orbital floor fractures are produced by two distinct mechanisms. The first is a true "blowout" fracture where all the energy is transmitted from a blunt object to the globe, causing increased orbital pressure blowing out either the orbital floor (most frequently) or medial wall. Fists and balls are the most common causative agents. This mechanism of injury is more likely to cause entrapment and globe injury. The second mechanism of injury occurs when the energy from the blow is transmitted to the infraorbital rim, causing a buckling of the orbital floor. Patients with blowout fractures have periorbital ecchymosis and lid edema but may also sustain globe injuries, including chemosis, subconjunctival hemorrhage, or infraorbital numbness from injury to the infraorbital nerve. Other globe injuries seen with orbital wall fractures include corneal abrasion, hyphema, enophthalmos, proptosis, iridoplegia, dislocated lens, retinal tear, retinal detachment, and ruptured globe. Diplopia with upward gaze suggests entrapment of the inferior rectus or its supporting structures. Diplopia with lateral gaze suggests entrapment of the medical rectus muscle. Periorbital subcutaneous emphysema is frequently seen with orbital wall fractures because of the proximity to the sinuses.

Management and Disposition

Maxillofacial CT best identifies orbital wall fractures. Treat patients without eye injury or entrapment conservatively with ice and analgesics, and refer for follow-up in 2 to 3 days. Treat patients with blood in the maxillary sinus with antibiotics. Strongly consider an ophthalmology consultation in patients with a true blowout fracture, as 30% of these patients sustain a significant globe injury. Immediately refer patients with entrapment, as muscle necrosis may occur if muscle blood supply is compromised by the entrapment.

Pearls

1. Enophthalmos, limited upward gaze, diplopia with upward gaze, or infraorbital anesthesia from entrapment or injury to the infraorbital nerve should heighten suspicion of an orbital floor fracture.
2. Compare the pupillary level on the affected side with the unaffected side, since it may be lower from prolapse of the orbital contents into the maxillary sinus. Subtle abnormalities may be appreciated as an asymmetric corneal light reflex (Hirschberg reflex).
3. Subcutaneous emphysema, a soft-tissue teardrop along the roof of the maxillary sinus on plain film, or an air-fluid level in the maxillary sinus on plain film should also be interpreted as evidence of an orbital floor fracture.
4. Patients with orbital wall fracture may present with subcutaneous emphysema after blowing their nose or air bubbles emanating from the tear duct.
5. Carefully examine the eye for visual acuity, hyphema, or retinal detachment, and nose for septal hematoma.

FIGURE 1.23 ■ **Orbital Floor Fracture.** Sustained from blunt trauma to infraorbital rim causing buckling of the orbital floor. Facial CT is similar to that in Fig. 1.25. Infraorbital hypesthesias and lack of entrapment suggest the buckling mechanism of injury. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.24 ■ **Inferior Rectus Entrapment.** The right inferior rectus muscle is entrapped within this orbital floor fracture limiting upward gaze. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.26 ■ **Medial Wall Orbital Fracture.** Periorbital ecchymosis and swelling is seen in this patient with a medial wall orbital fracture. The patient blew her nose after the injury and the swelling became more prominent. (Photo contributor: Lawrence B. Stack, MD.)

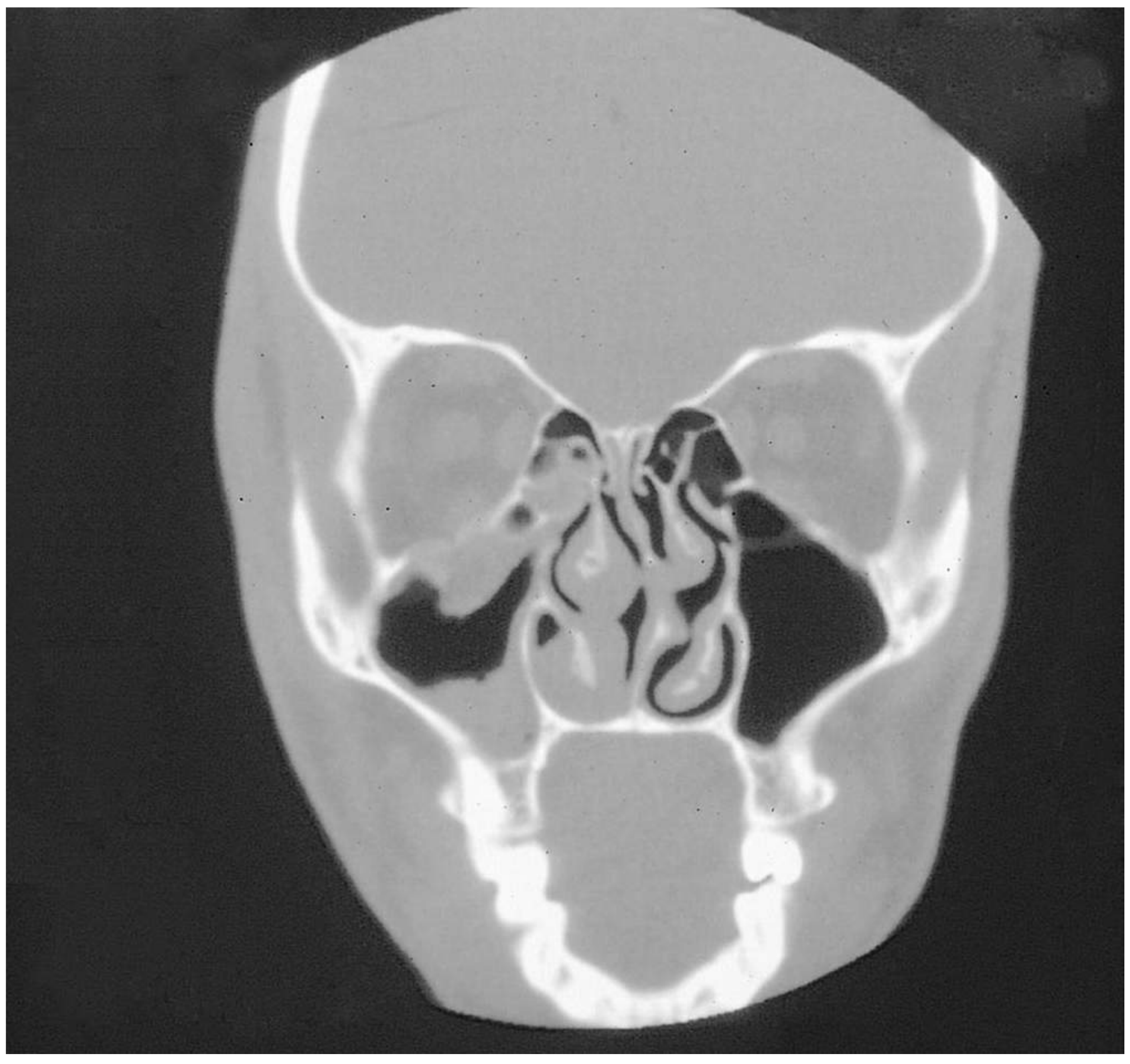


FIGURE 1.25 ■ **Orbital Floor Fracture with Entrapment.** Coronal CT of the patient in Fig. 1.24 demonstrating the entrapped muscle extruding into the maxillary sinus. (Photo contributor: Lawrence B. Stack, MD.)

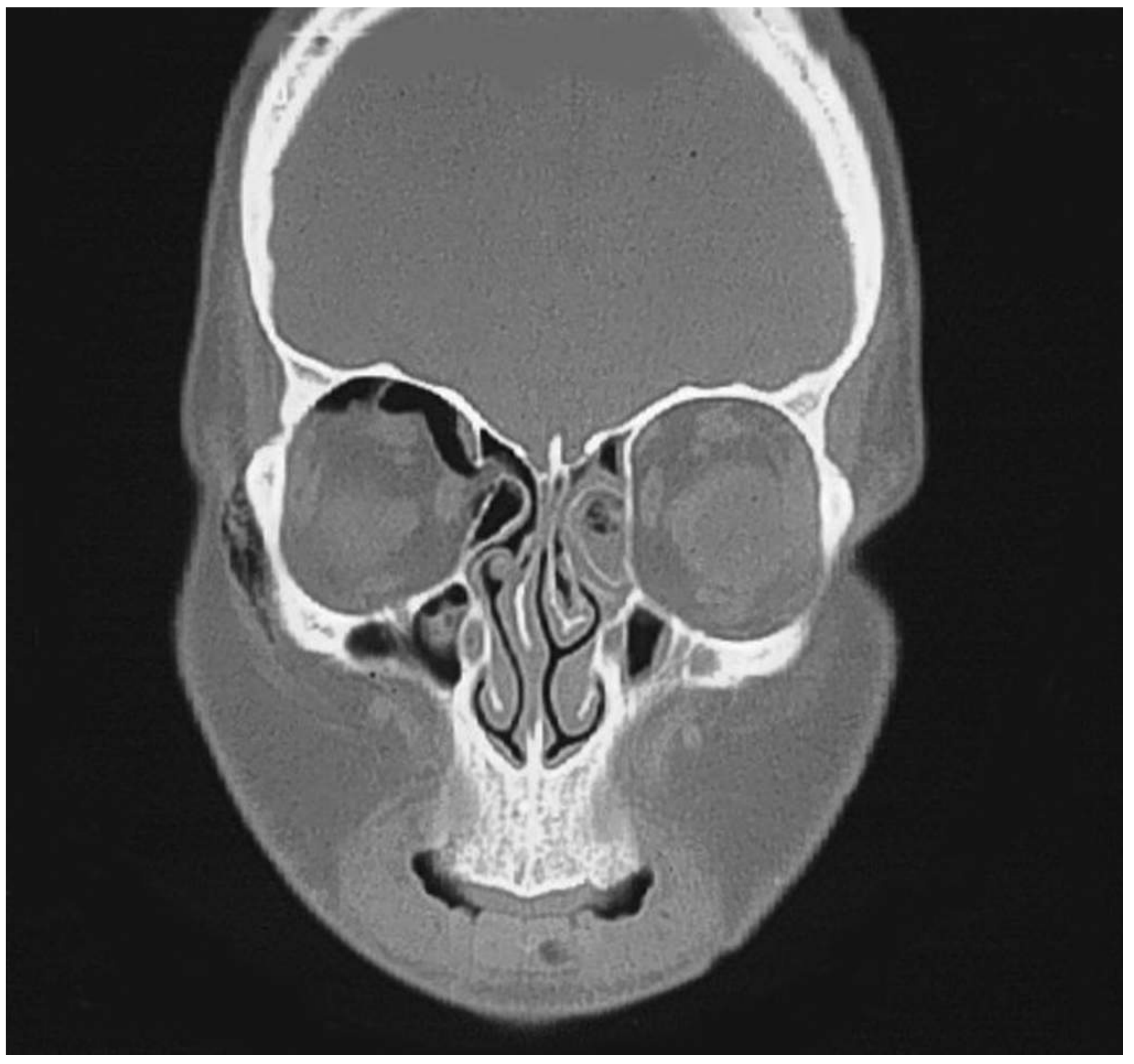


FIGURE 1.27 ■ **CT of Medial Wall Orbital Fracture.** Coronal CT of the patient in Fig. 1.26. Subcutaneous emphysema and orbital air is seen. An opening between the orbit and ethmoid air cells can be seen. (Photo contributor: Lawrence B. Stack, MD.)

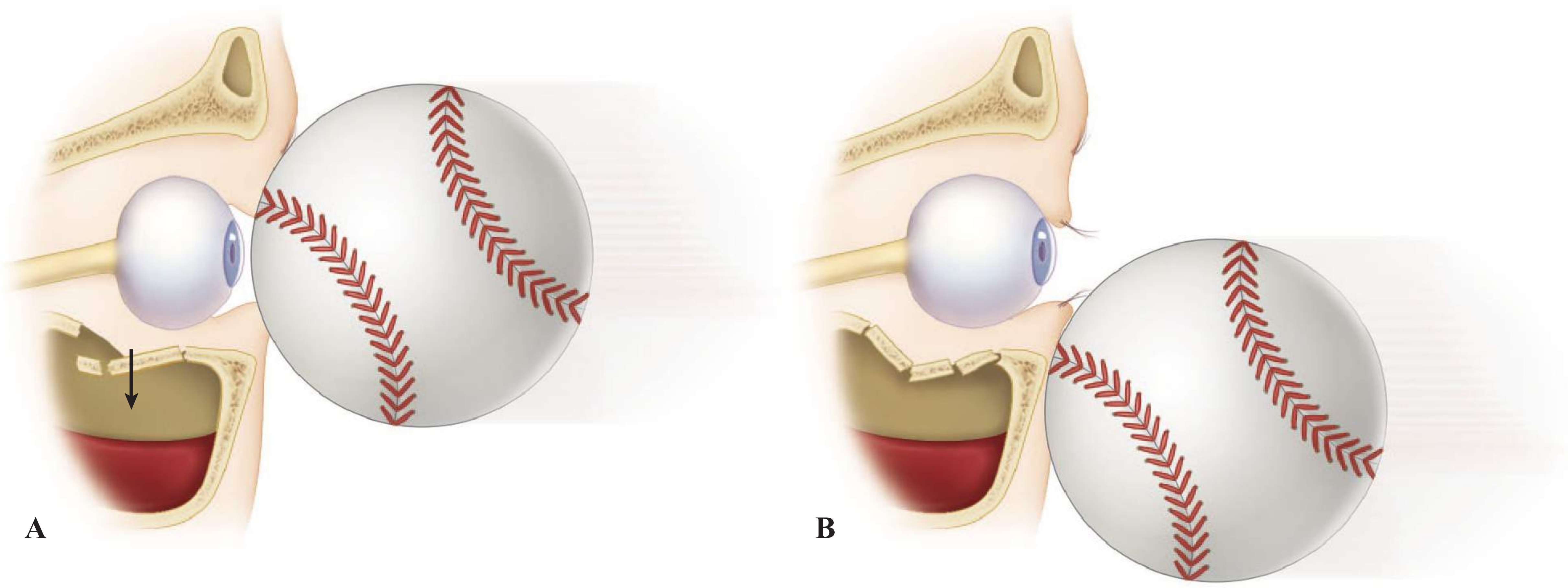


FIGURE 1.28 ■ **Mechanisms of Orbital Wall Injury.** (**A**) True “blowout” mechanism where all energy is transmitted to globe. (**B**) Buckle injury where energy is transmitted to inferior orbital rim, causing a buckling of the orbital floor.

Clinical Summary

Blunt trauma, mandibular pain, and malocclusion are typically seen in patients with mandibular fractures. A step-off in the dental line or ecchymosis or hematoma to the floor of the mouth is often present. Mandibular fractures may be open to the oral cavity, as manifested by gum lacerations. Dental trauma is frequently seen. Other clinical features include inferior alveolar or mental nerve paresthesia, loose or missing teeth, dysphagia, trismus, or ecchymosis of the floor of the mouth (considered pathognomonic). Multiple mandibular fractures are present in more than 50% of cases because of the ringlike structure of the mandible. Mandibular fractures are often classified as "favorable" or "unfavorable." Fractures displaced by masseter muscle contraction are unfavorable and inevitably require fixation, whereas fractures that are not displaced by masseter contraction are favorable and in most cases will not require fixation. Injuries creating unstable mandibular fractures may create airway obstruction because the support for the tongue is lost. Mandibular fractures are also classified based on the anatomic location of the fracture. Dislocation of the mandibular condyles may also result from blunt trauma and will always have associated malocclusion, typified by an inability to close the mouth.

Management and Disposition

A dental panoramic film is the best diagnostic image for evaluating mandibular trauma. If only plain films are available, obtain anteroposterior, bilateral oblique, and Towne views to evaluate the condyles. Treat nondisplaced fractures with analgesics, soft diet, and referral to oral surgery in 1 to 2 days. Displaced fractures, open fractures, and fractures with associated dental trauma need more urgent referral. Treat all mandibular fractures with antibiotics effective against anaerobic oral flora (clindamycin, amoxicillin/clavulanate) and give tetanus prophylaxis if needed. The Barton bandage has been suggested to immobilize the jaw in the ED.

Pearls

1. The most sensitive sign of a mandibular fracture is malocclusion. The jaw will deviate toward the side of a unilateral condylar fracture on maximal opening of the mouth.
2. A nonfractured mandible should be able to hold a tongue blade between the molars tightly enough to break it off. There should be no pain in attempting to rotate the tongue blade between the molars.
3. Bilateral parasymphyseal fractures may cause acute airway obstruction in the supine patient. This is relieved by pulling the subluxed mandible and soft tissue forward and, in patients in whom the cervical spine has been cleared, by elevating the patient to a sitting position.

FIGURE 1.29 ■ **Open Mandibular Fracture.** An open fracture is suggested by the misaligned teeth and gingival disruption. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.30 ■ **Sublingual Hemorrhage.** Hemorrhage or ecchymosis in the sublingual area is pathognomonic for mandibular fracture. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.32 ■ **Favorable Mandibular Fracture.** Dental panoramic view showing two nondisplaced mandibular fractures that are amenable to conservative therapy. (Photo contributor: David W. Munter, MD.)

FIGURE 1.31 ■ **Bilateral Mandibular Fracture.** The diagnosis is suggested by the bilateral ecchymosis seen in this patient. (Photo contributor: Lawrence B. Stack, MD.)

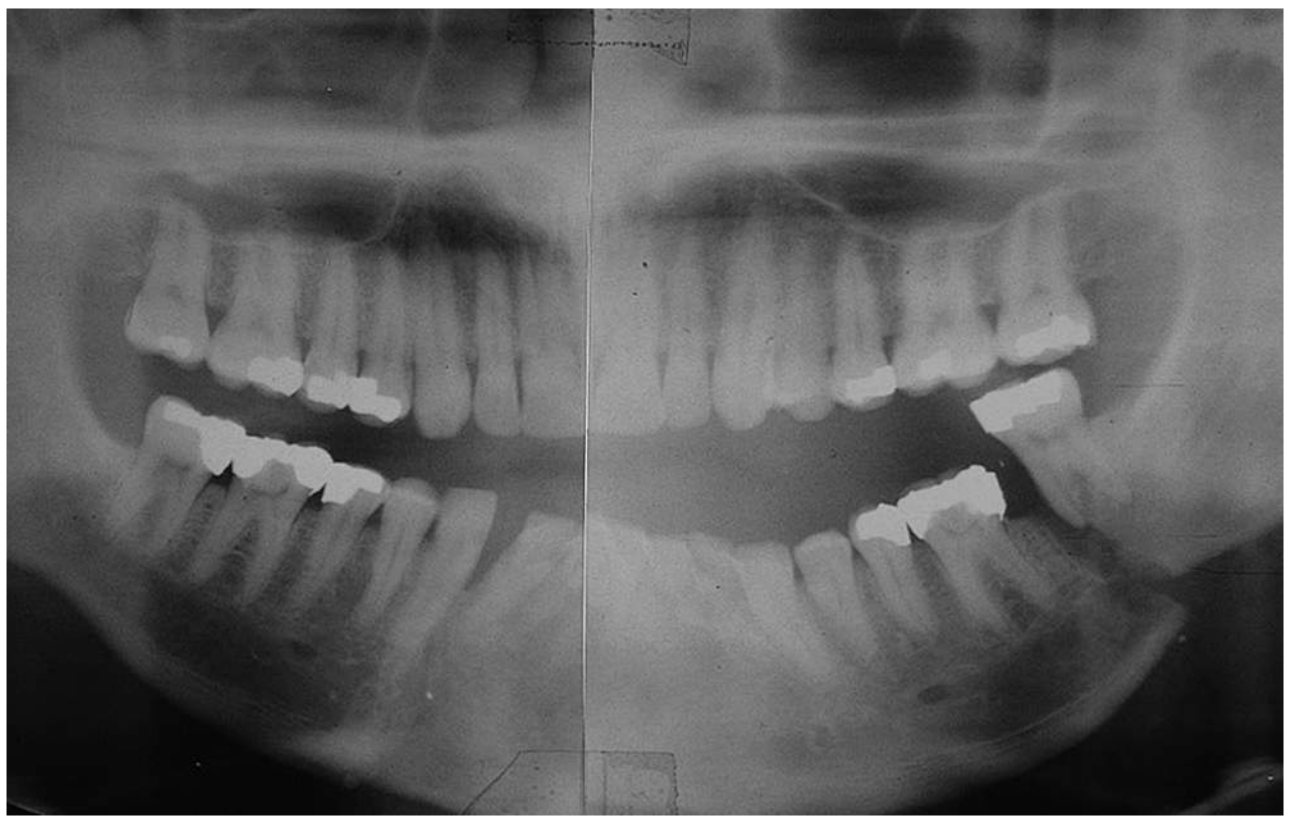


FIGURE 1.33 ■ **Unfavorable Mandibular Fracture.** Dental panoramic view demonstrating a mandibular fracture with obvious misalignment due to the distracting forces of the masseter muscle. (Photo contributor: Edward S. Amrhein, DDS.)

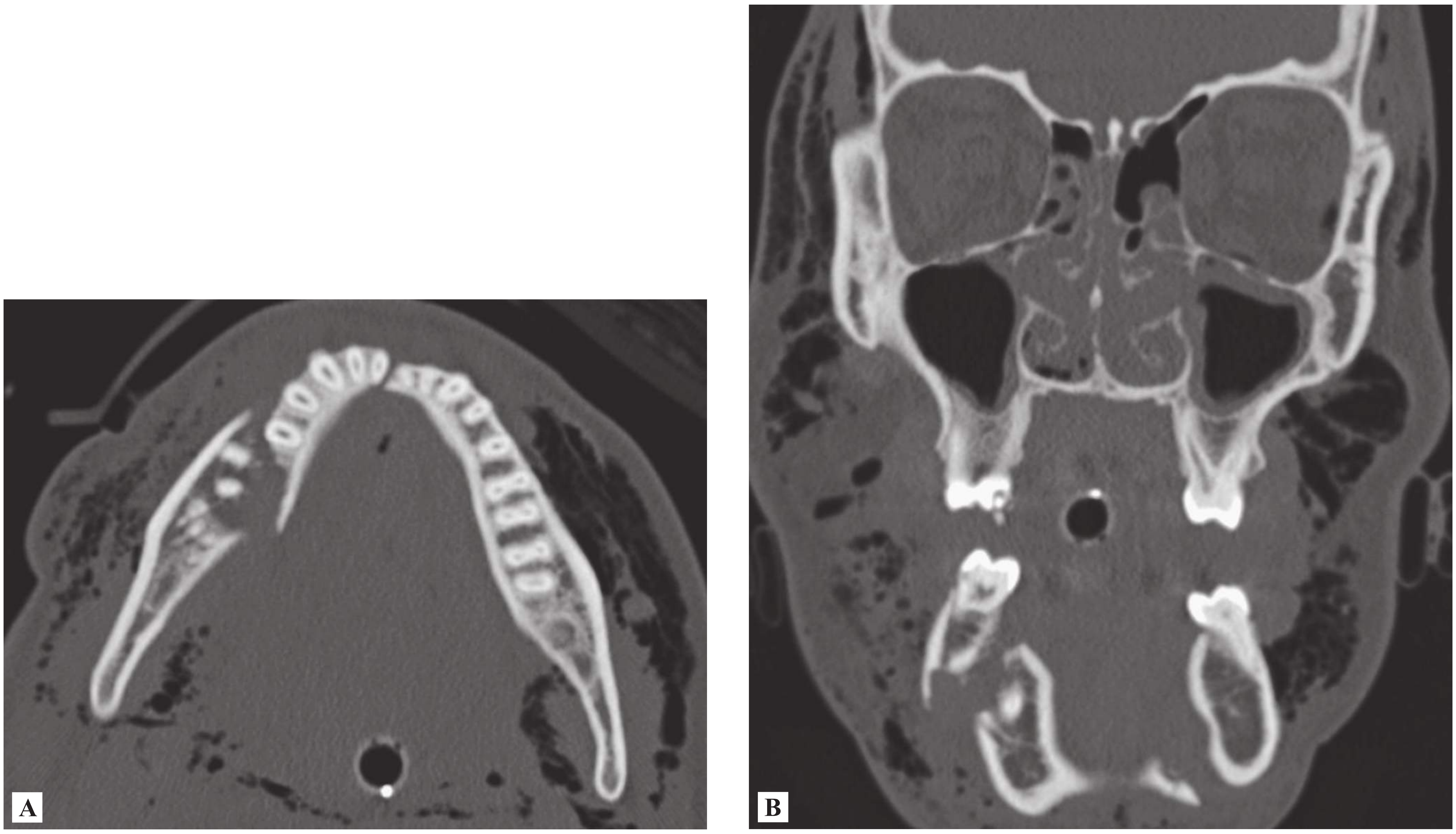


FIGURE 1.34 ■ **Mandibular Fractures.** Axial (**A**) and coronal (**B**) views of a maxillofacial CT reveal a right mandibular body and a parasymphyseal fracture. (Reproduced with permission from Block J, Jordanov MI, Stack, LB, and Thurman RJ (eds). The Atlas of Emergency Radiology. New York: McGraw-Hill; 2013; Fig. 1-99A and B.)

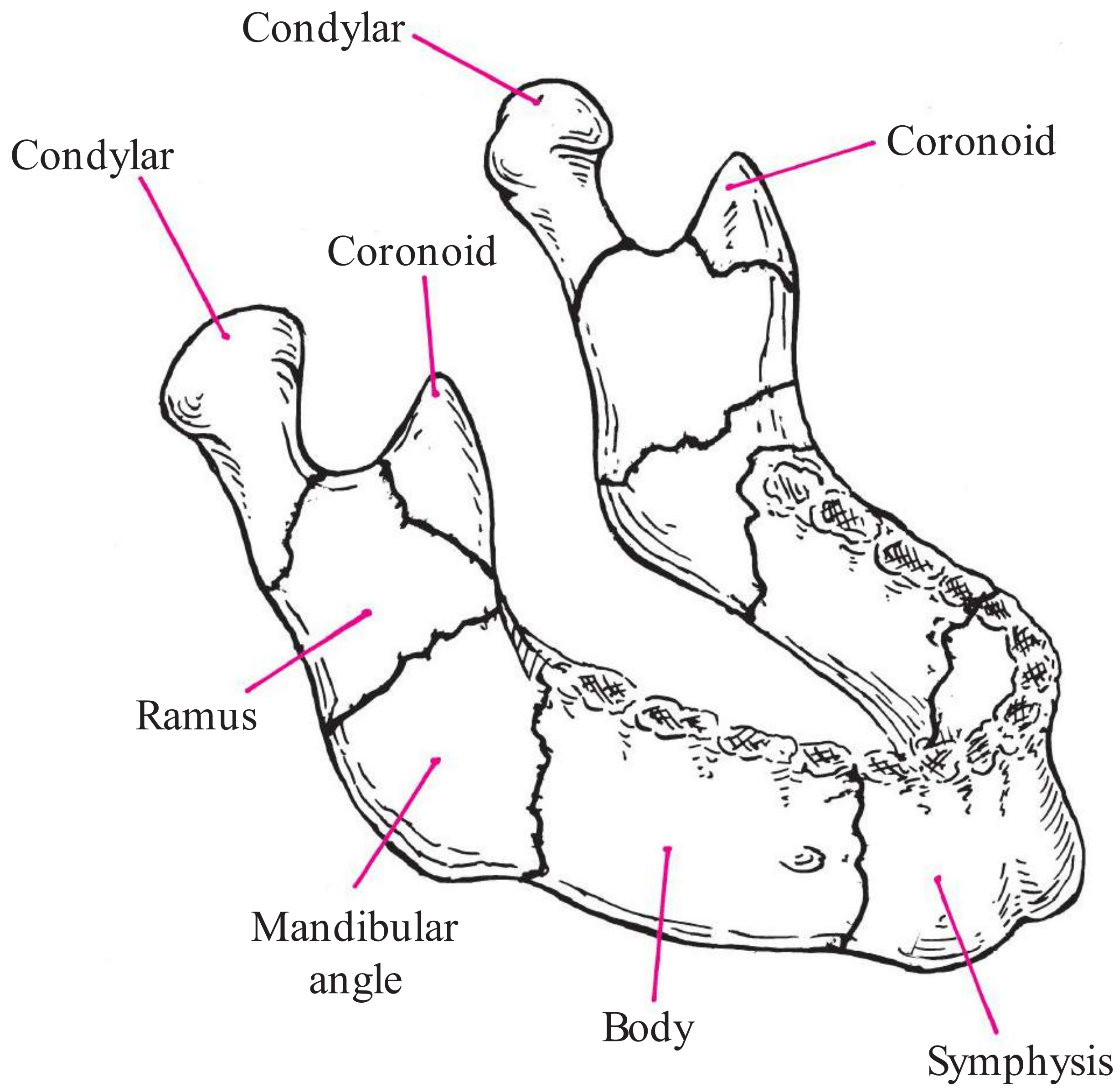


FIGURE 1.35 ■ **Classification of Mandibular Fractures**. Classification based on anatomic location of the fracture.

Clinical Summary

Injuries to the external ear may be open or closed. Blunt external ear trauma may cause a hematoma (otohematoma) of the pinna, which, if untreated, may result in cartilage necrosis and chronic scarring or further cartilage formation and permanent deformity ("cauliflower ear"). Open injuries include lacerations (with and without cartilage exposure) and avulsions.

Management and Disposition

Pinna hematomas must undergo incision and drainage or large needle aspiration using sterile technique, followed by a pressure dressing to prevent reaccumulation of the hematoma. This procedure may need to be repeated several times; hence, after ED drainage, the patient is treated with antistaphylococcal antibiotics and referred to ENT or plastic surgery for follow-up in 24 hours. Lacerations must be carefully examined for cartilage involvement; if this is present, copious irrigation, closure, and postrepair oral antibiotics covering skin flora are

FIGURE 1.37 ■ **Pinna Hematoma.** A hematoma has developed, characterized by swelling, discoloration, ecchymosis, and flocculence. Immediate incision and drainage or aspiration is indicated, followed by an ear compression dressing. (Photo contributor: C. Bruce MacDonald, MD.)

FIGURE 1.36 ■ **Pinna Contusion.** Contusion without hematoma is present. Reevaluation in 24 hours is recommended to ensure a drainable hematoma has not formed. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.38 ■ **Cauliflower Ear.** Repeated trauma to the pinna or undrained hematomas can result in cartilage necrosis and subsequent deforming scar formation. (Photo contributor: Timothy D. McGuirk, DO.)

FIGURE 1.39 ■ **Complete Avulsion of Partial Pinna.** This ear injury, sustained in a fight, resulted when the pinna was bitten off. Plastic repair is needed. The avulsed part was wrapped in sterile gauze soaked with saline and placed in a sterile container on ice. (Photo contributor: David W. Munter, MD.)

indicated. Simple skin lacerations may be repaired primarily with nonabsorbable 6-0 sutures. The dressing after laceration repair is just as important as the primary repair. If a compression dressing is not placed, hematoma formation can occur. Complex lacerations or avulsions normally require ENT or plastic surgery consultation.

Pearls

1. Pinna hematomas may take hours to develop, so give patients with blunt ear trauma careful discharge instructions, with a follow-up in 12 to 24 hours to check for hematoma development.
2. Failure to adequately drain a hematoma, reaccumulation of the hematoma owing to a faulty pressure dressing, or inadequate follow-up increases the risk of infection of the pinna (perichondritis) or of a disfiguring cauliflower ear.
3. Copiously irrigate injuries with lacerated cartilage, which can usually be managed by primary closure of the overlying skin.

FIGURE 1.40 ■ **Partial Avulsion of Pinna.** Partial avulsion of the pinna seen at its superior junction with the scalp. Cartilage exposure and injury prompts ENT consultation for repair. (Photo contributor: Eric Wu, MD.)

Direct closure of the cartilage is rarely necessary and is indicated only for proper alignment, which helps lessen later distortion. Use a minimal number of absorbable 5-0 or 6-0 sutures through the perichondrium.

4. Lacerations to the lateral aspect of the pinna should be minimally debrided because of the lack of tissue at this site to cover the exposed cartilage.
5. In the case of an avulsion injury, the avulsed part should be cleansed, wrapped in saline-moistened gauze, placed in a sterile container, and then placed on ice to await reimplantation by ENT.

FIGURE 1.41 ■ **Complete Avulsion of Entire Pinna.** This injury occurred as a result of a motor vehicle crash. The pinna was not found. (Photo contributor: Ian T. McClure, MD.)

Clinical Summary

Blunt trauma to the frontal area may result in a depressed frontal sinus fracture. Often, there is an associated laceration. Isolated frontal fractures normally do not have the associated features of massive blunt facial trauma such as seen in LeFort II and III fractures. Careful nasal speculum examination may reveal blood or CSF leak high in the nasal cavity. Posterior table involvement can lead to mucopyocele or epidural empyema as late sequelae. Involvement of the posterior wall of the frontal sinus may occur and result in cranial injury or dural tear. Frontal fractures may be part of a complex of facial fractures, as seen in frontonasoethmoid fractures, but generally more extensive facial trauma is required.

Management and Disposition

Obtain head CT with bone windows on patients suspected of frontal sinus fractures. Fractures involving only the anterior table of the frontal sinus can be treated conservatively with referral to ENT or plastic surgery in 1 to 2 days. Fractures involving the posterior table require urgent neurosurgical consultation. Treat frontal sinus fractures with broad-spectrum antibiotics against both skin and sinus flora. ED management also includes control of epistaxis, application of ice packs, and analgesia.

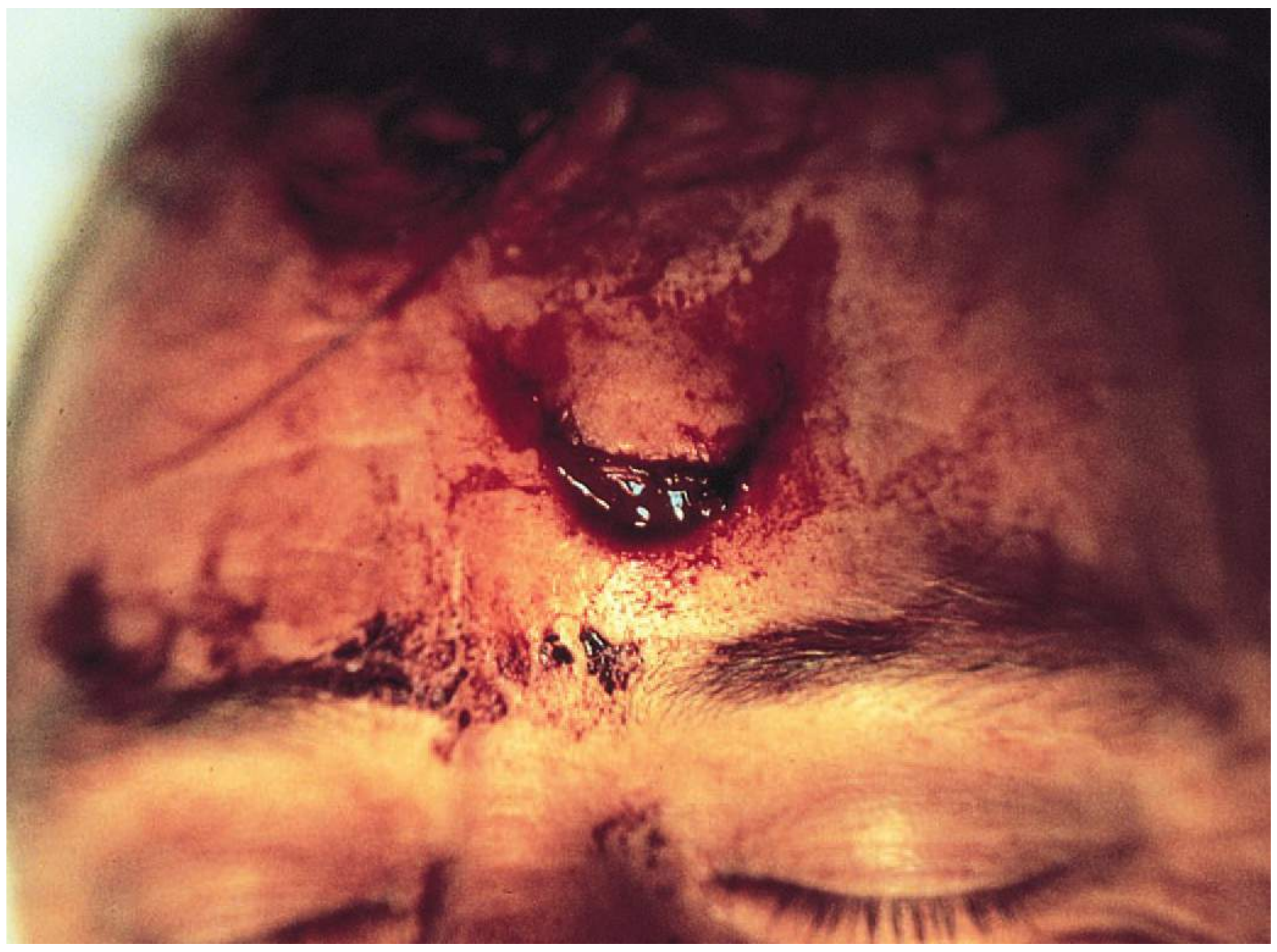


FIGURE 1.42 ■ **Frontal Laceration.** Any laceration over the frontal sinuses should be explored to rule out a fracture. This laceration was found to have an associated frontal fracture. (Photo contributor: David W. Munter, MD.)

Pearls

1. Explore every frontal laceration digitally before repair. Digital palpation is sensitive for identifying frontal fractures, although false positives from lacerations extending through the periosteum can occur.
2. Communication of irrigating solutions with the nose or mouth indicates a breach in the frontal sinus.
3. For serious injuries, a CT scan is mandatory to assess the posterior aspect of the sinus and for possible intracranial injury.

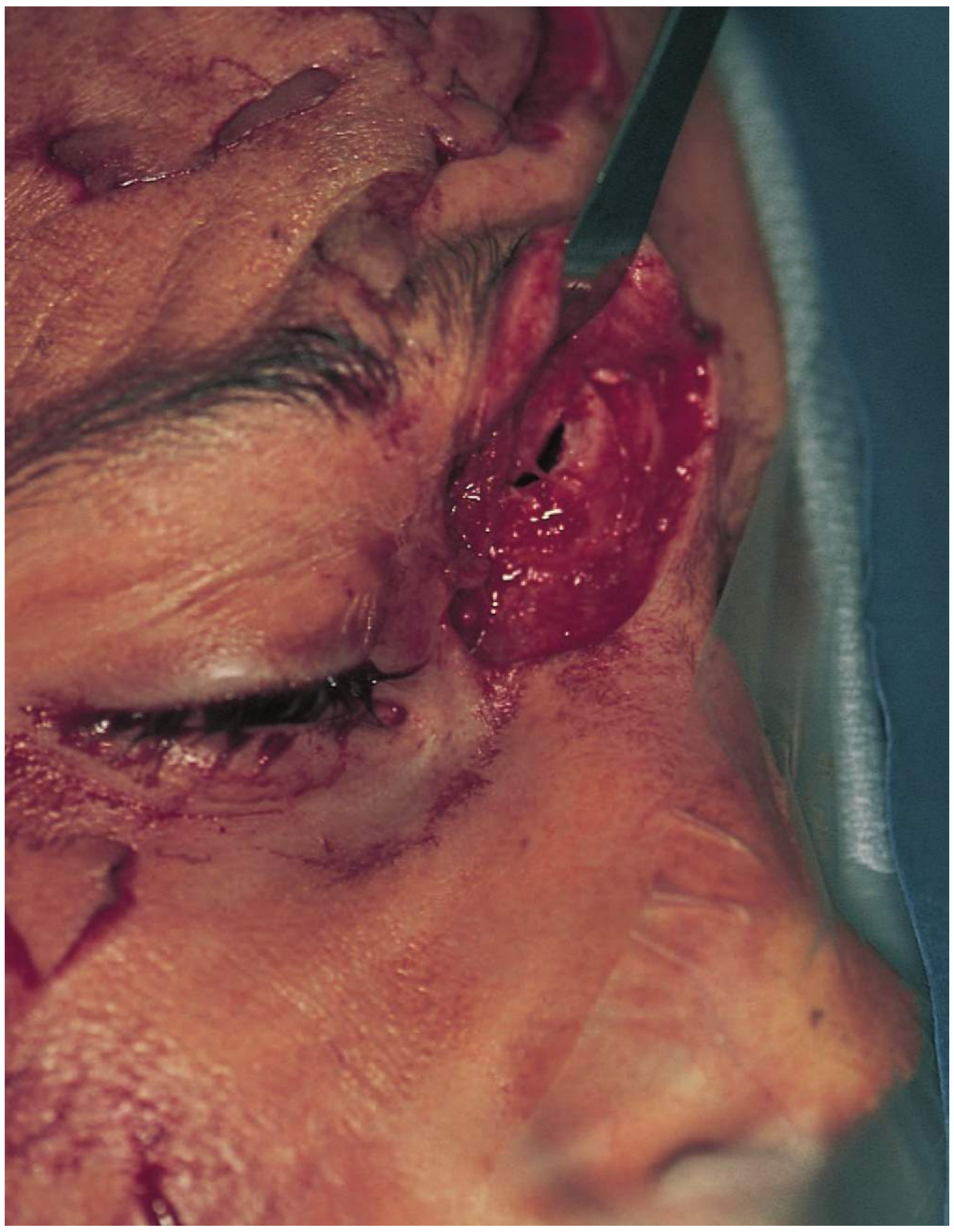


FIGURE 1.43 ■ **Frontal Sinus Fracture.** Fracture defect seen at the base of a laceration over the frontal sinus. (Photo contributor: Jeffrey Kuhn, MD.)

FIGURE 1.44 ■ **Frontal Sinus Fracture.** Fracture of the outer table of the frontal sinus is seen under this forehead laceration. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.45 ■ **Frontal Sinus Fracture.** CT of the patient in Fig. 1.42 demonstrating a fracture of the anterior table of the frontal sinus. (Photo contributor: David W. Munter, MD.)

Clinical Summary

Typically the result of blunt orbital trauma, traumatic exophthalmos develops as a retrobulbar hematoma pushes the globe anteriorly. Patients present with periorbital edema, ecchymosis, a marked decrease in visual acuity, and an afferent pupillary defect in the involved eye. The exophthalmos, which may be obscured by periorbital edema, can be better appreciated from a superior view. Visual acuity may be affected by the direct trauma to the eye (retinal detachment, hyphema, globe rupture), compression of the retinal artery, or, more rarely, neuropraxia of the optic nerve.

Management and Disposition

Maxillofacial or orbital CT best delineates the presence and extent of a retrobulbar hematoma and associated facial or orbital fractures. Emergent ENT and ophthalmology consultation is indicated. Emergent lateral canthotomy and cantholysis to decompress the orbit can be sight-saving.

Pearls

1. The retrobulbar hematoma and exophthalmos may not develop for hours after the injury.
2. A subtle exophthalmos may be detected by looking down over the head of the patient and viewing the eye from the coronal plane.
3. Elevated intraocular pressure, relative afferent pupillary defect, and diminished visual acuity in patients with traumatic exophthalmos should strongly be considered for emergent lateral canthotomy and cantholysis.

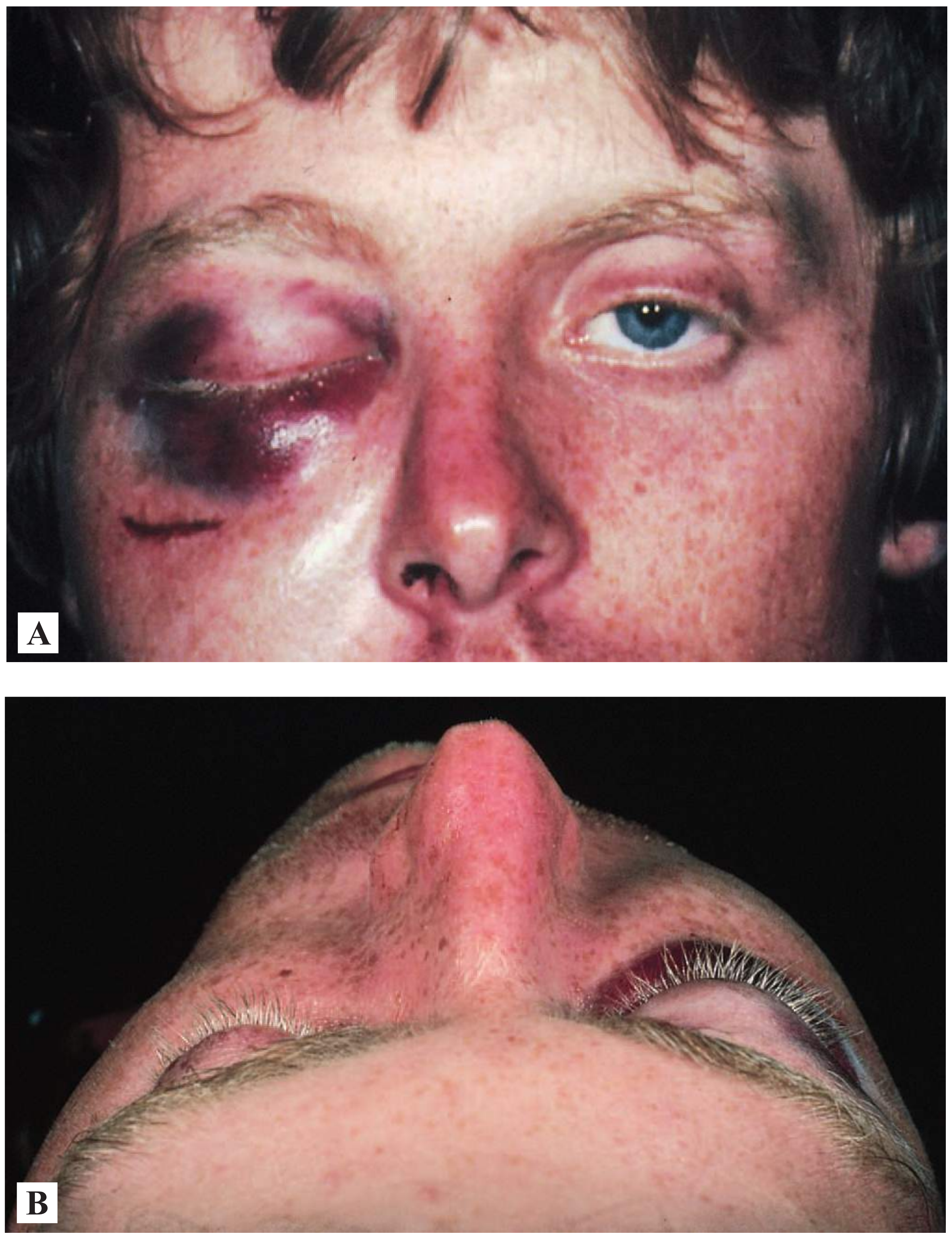


FIGURE 1.46 ■ **Traumatic Exophthalmos.** (**A**) Blunt trauma resulting in periorbital edema and ecchymosis, which obscures the exophthalmos in this patient. The exophthalmos is not obvious in the AP view and can therefore be initially unappreciated. (**B**) The same patient viewed in the coronal plane from over the forehead demonstrating right eye exophthalmos. (Photo contributor: Frank Birinyi, MD.)

FIGURE 1.47 ■ **Retrobulbar Hematoma.** CT of the patient in Fig. 1.46 with right retrobulbar hematoma and traumatic exophthalmos. (Photo contributor: Frank Birinyi, MD.)

FIGURE 1.48 ■ **Traumatic Exophthalmos.** Proptosis, hyphema, periorbital ecchymosis, and marked swelling in the patient with a retrobulbar hematoma from severe head and face trauma. Examination findings are more obvious than Fig. 1.46. (Photo contributor: David Effron, MD.)

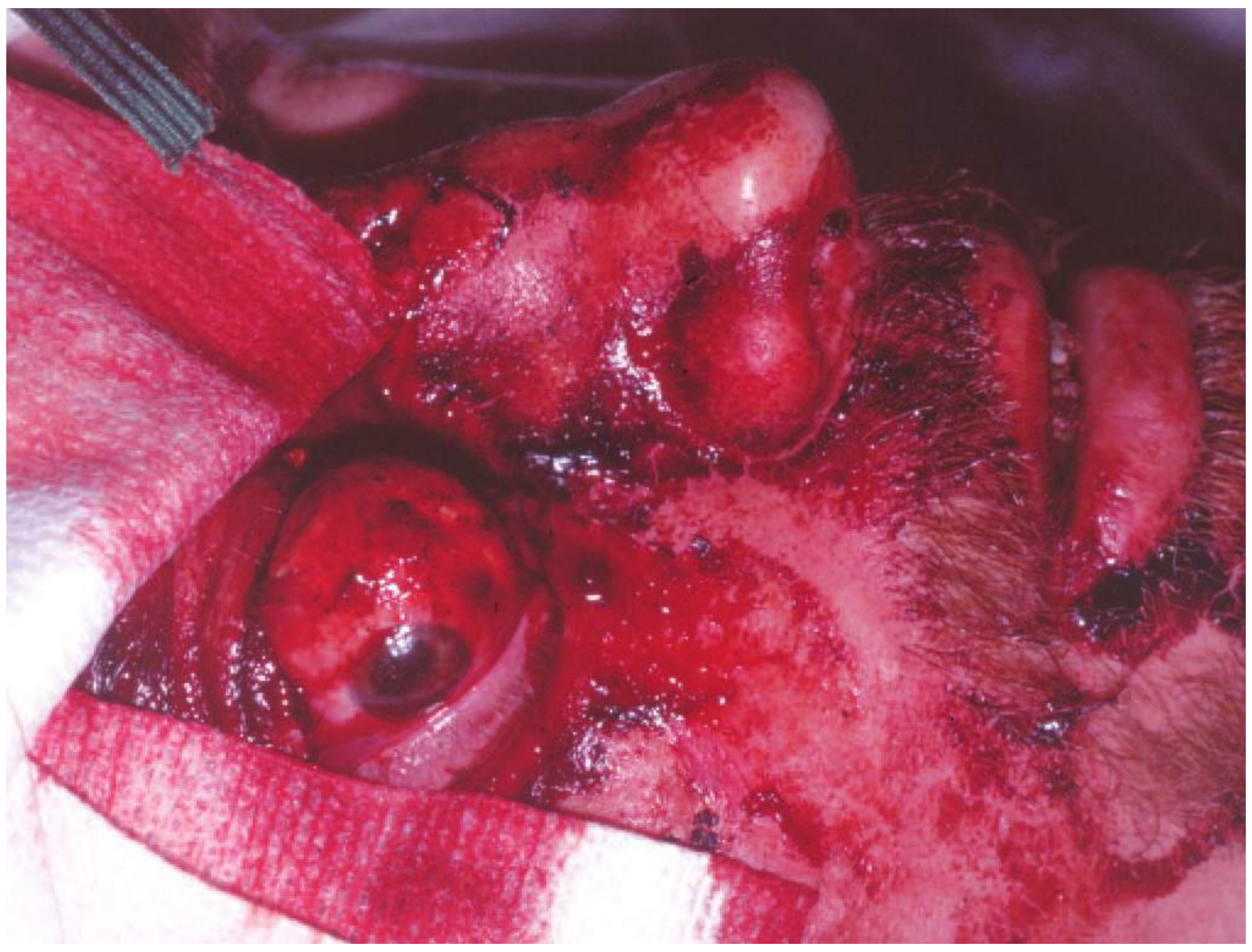
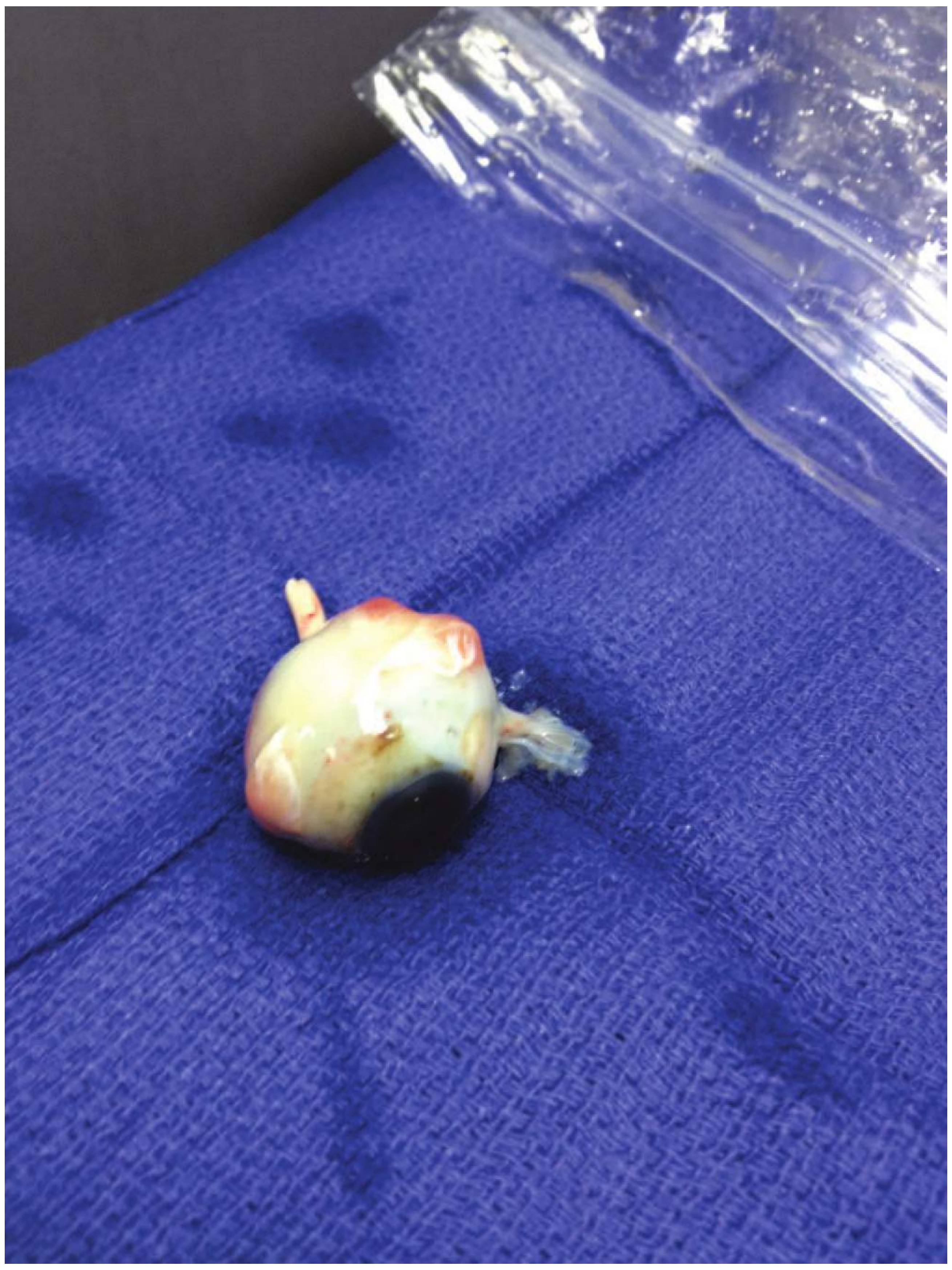


FIGURE 1.49 ■ **Traumatic Exophthalmos.** Anterior globe dislocation due to high energy facial trauma. There is no retrobulbar hematoma in this patient (Photo contributor: Lawrence B. Stack, MD.)



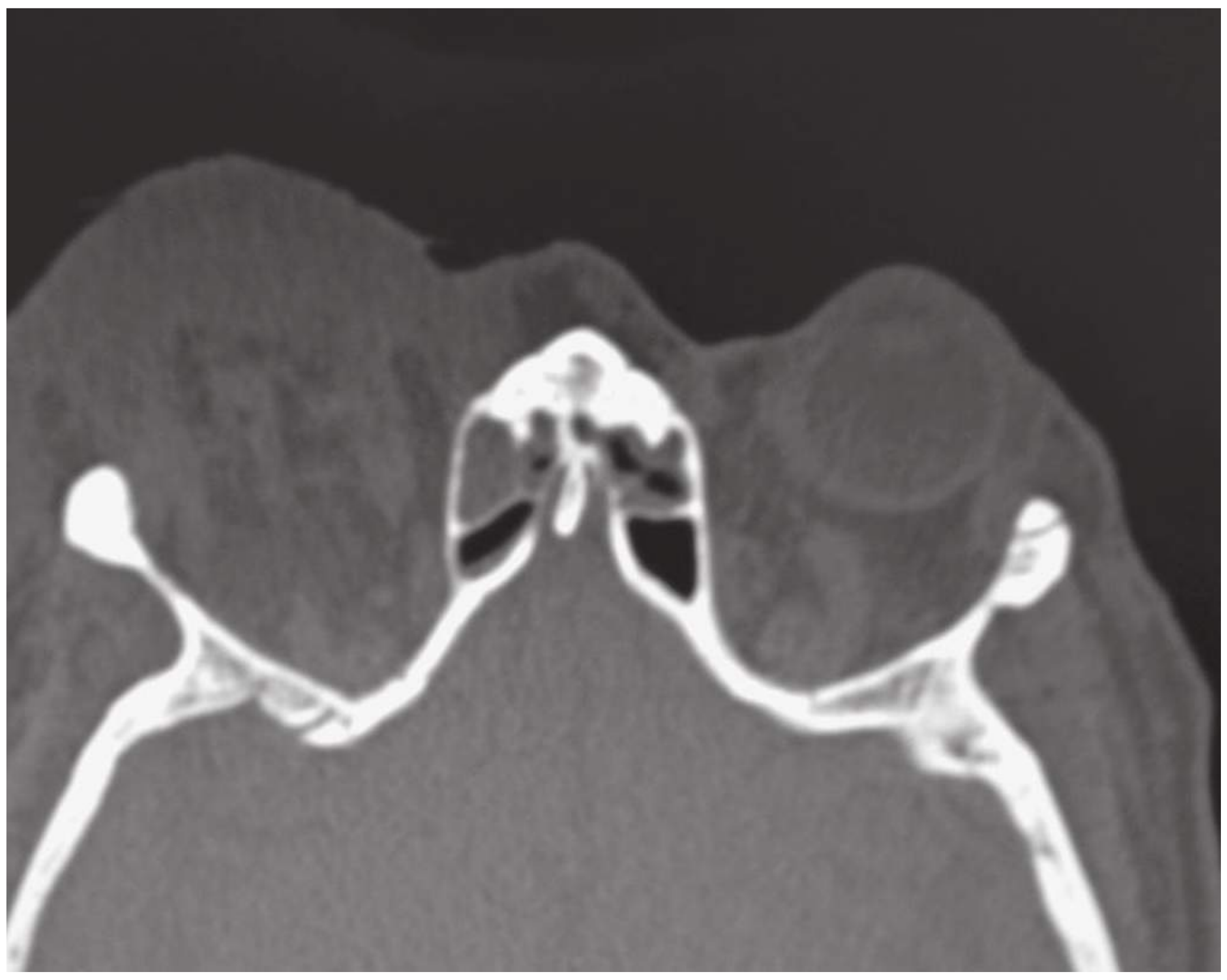


FIGURE 1.50 ■ **Traumatic Enucleation.** Complete enucleation of the right eye after a mechanical fall and hitting their face on the corner of a table. Family came with the patient with the eye in a plastic bag. No other injury is seen on orbit CT scan. (Photo contributor: Kevin S. Barlotta, MD)

Clinical Summary

Injury patterns of penetrating facial trauma can be predicted based on projectile type, entry location, and path. Midface injuries extend from the supraorbital rim superiorly to the oral commissure inferiorly and to the external auditory meatus posteriorly. Mandibular injuries extend from the oral commissure superiorly and to the lower border of the mandible inferiorly. Shotgun wounds typically involve both facial zones and will involve one or both eyes in 50% of patients. Fifty percent of patients with gunshot wounds (GSWs) to the mandible will require an emergency airway. Stab wounds are less likely to require emergency airway than GSWs. Additional structures that require consideration during the ED evaluation include brain, blood vessels, and esophagus.

Management and Disposition

After the primary survey, strongly consider intubation in patients with any gunshot injury to the mandible, blood or swelling in the oropharynx, or any close range (<7 m) shotgun injury. If evidence suggests a projectile remains in the face or cranium, obtain plain films in two planes to help guide subsequent evaluation such as CT angiogram or fine cuts of the orbits. CT will provide more detailed information in the injured structures to guide therapy. Removal of any projectile should only be performed after significant structure injury has been excluded and preparation for the consequences of removal is complete.

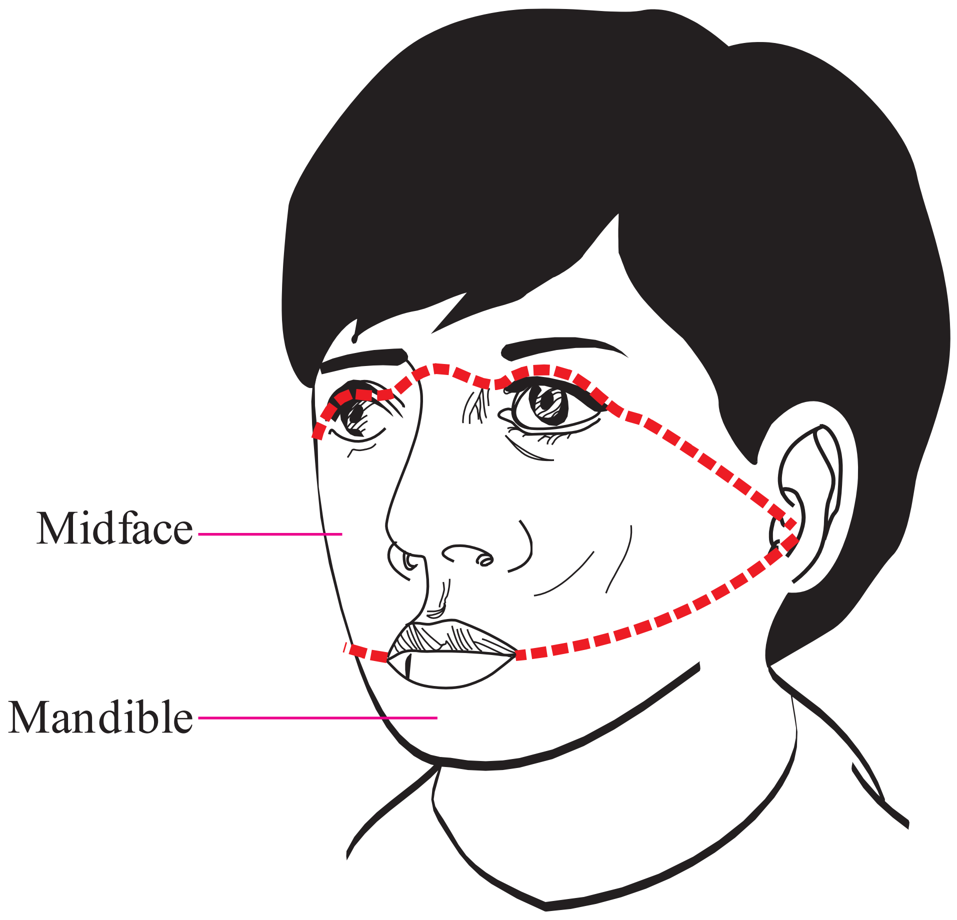


FIGURE 1.51 ■ **Facial Zones of Injury.** (Reproduced with permission from Chen AY, Stewart MG, Raup G. Penetrating injuries of the face. Otolaryngol Head Neck Surg. 1996;115:464-470.)

Pearls

1. Due to the likelihood of multisystem injury (vascular, ocular, cranial, face) penetrating facial trauma, the patient should be transferred to a facility with comprehensive subspecialty trauma care.
2. Intubation should be strongly considered in all patients with GSWs to the mandible or in GSWs to the midface if there is any blood or swelling in the oral cavity.
3. Removal of any projectile is best done in the operating room.

FIGURE 1.52 ■ **Midface Injury.** A jackhammer bit is lodged into the right maxillary sinus. (Photo contributor: R. Jason Thurman, MD.)

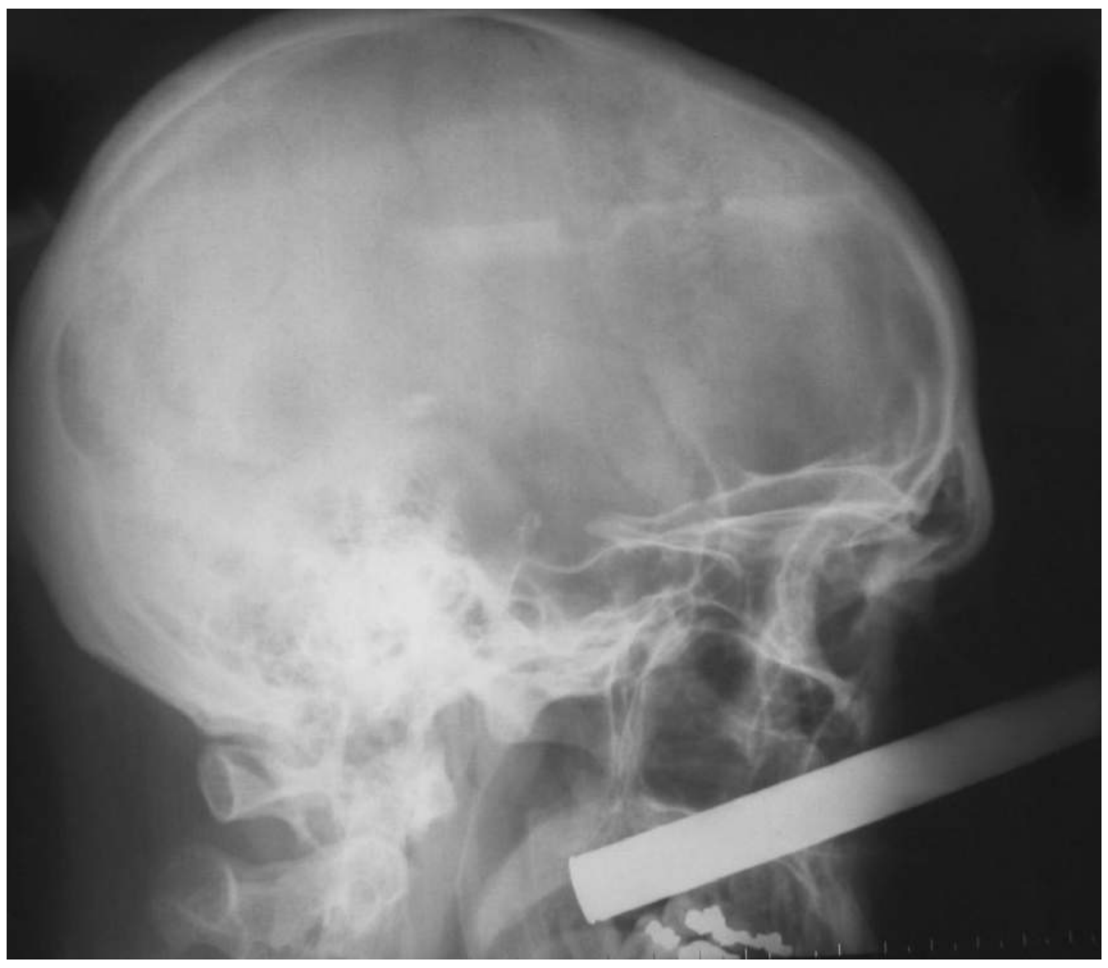


FIGURE 1.53 ■ **Midface Injury Radiograph.** Plain film of patient in Fig. 1.52. CT confirmed no other injury. Projectile was removed in the OR. (Photo contributor: R. Jason Thurman, MD.)

Clinical Summary

Severe head injury can result in extra-axial hematoma, cerebral contusion, or diffuse cerebral edema which, in turn, may cause one of five brain herniation syndromes: uncal, central transtentorial, cerebellotonsillar, subfalcine, and external. Uncal herniation occurs when the uncus of the temporal lobe is displaced inferiorly through the medial edge of the tentorium. Compression of cranial nerve III can cause an ipsilateral dilated pupil. Typically, patients with uncal herniation are unconscious and require intubation. A contusion to the eye may also result in a dilated, nonresponsive pupil and arouse suspicion for severe head injury and uncal herniation but typically these patients will be alert.

FIGURE 1.55 ■ **Ipsilateral Dilated Pupil due to Uncal Herniation.** CT revealed an epidural hematoma and unilateral effacement of the quadrigeminal cistern. (Photo contributor: Lawrence B. Stack, MD.)

Management and Disposition

Intubate unconscious head trauma patients with a unilateral dilated pupil and transfer them immediately to a facility capable of caring for traumatic brain injury. A noncontrasted head CT scan can identify a subdural or epidural hematoma, diffuse edema, or temporal lobe contusion. These conditions often cause midline shift of cerebral structures and compression of the quadrigeminal cistern. Unilateral effacement of the quadrigeminal cistern confirms uncal herniation. Initial management focuses on maintaining cerebral perfusion pressure and normal tissue oxygenation as hypotension and hypoxia significantly contribute to secondary brain injury. Mannitol, hypertonic saline, burr holes, and hyperventilation should be considered in ED patients with uncal herniation. Definitive care requires neurosurgical consultation.

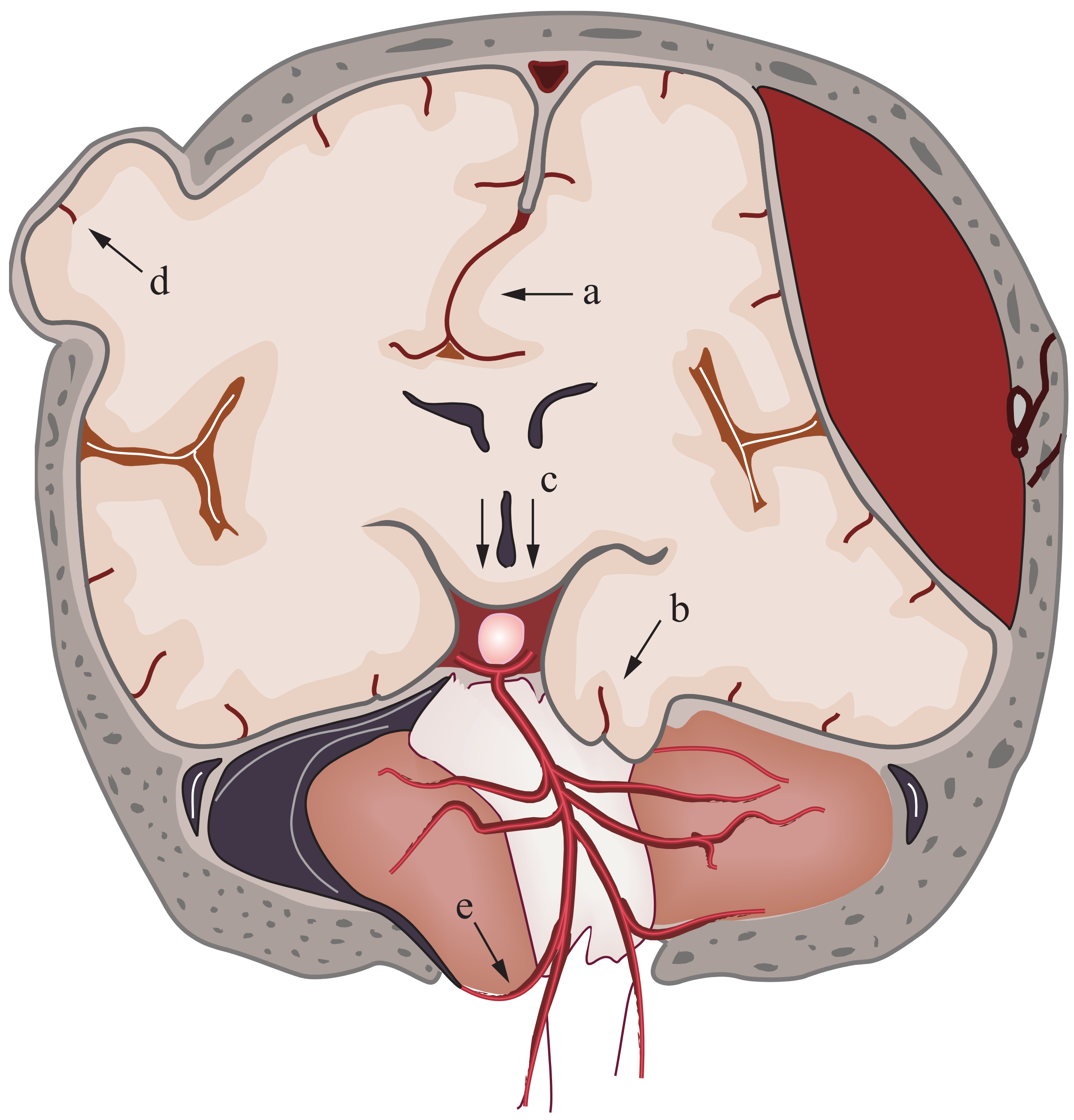


FIGURE 1.54 ■ **Herniation Syndromes. a.** Subfalcine; **b.** uncal; **c.** central transtentorial; **d.** external; **e.** cerebellotonsillar.

Pearls

1. Uncal herniation is the most common of the five herniation syndromes.
2. If a patient has a unilateral dilated pupil after head and face trauma but is awake and talking, be suspicious for isolated traumatic anisocoria.
3. Steroids have no role in the ED management of traumatic brain injury.
4. A temporal lobe contusion in an initially neurologically intact patient may continue to expand and cause uncal herniation.
5. Excessive hyperventilation ($PaCO_2$ < 25 mm Hg) in patients with severe traumatic brain injury is associated with cerebral ischemia.
6. Effacement of the quadrigeminal cistern is the hallmark CT finding of uncal herniation.

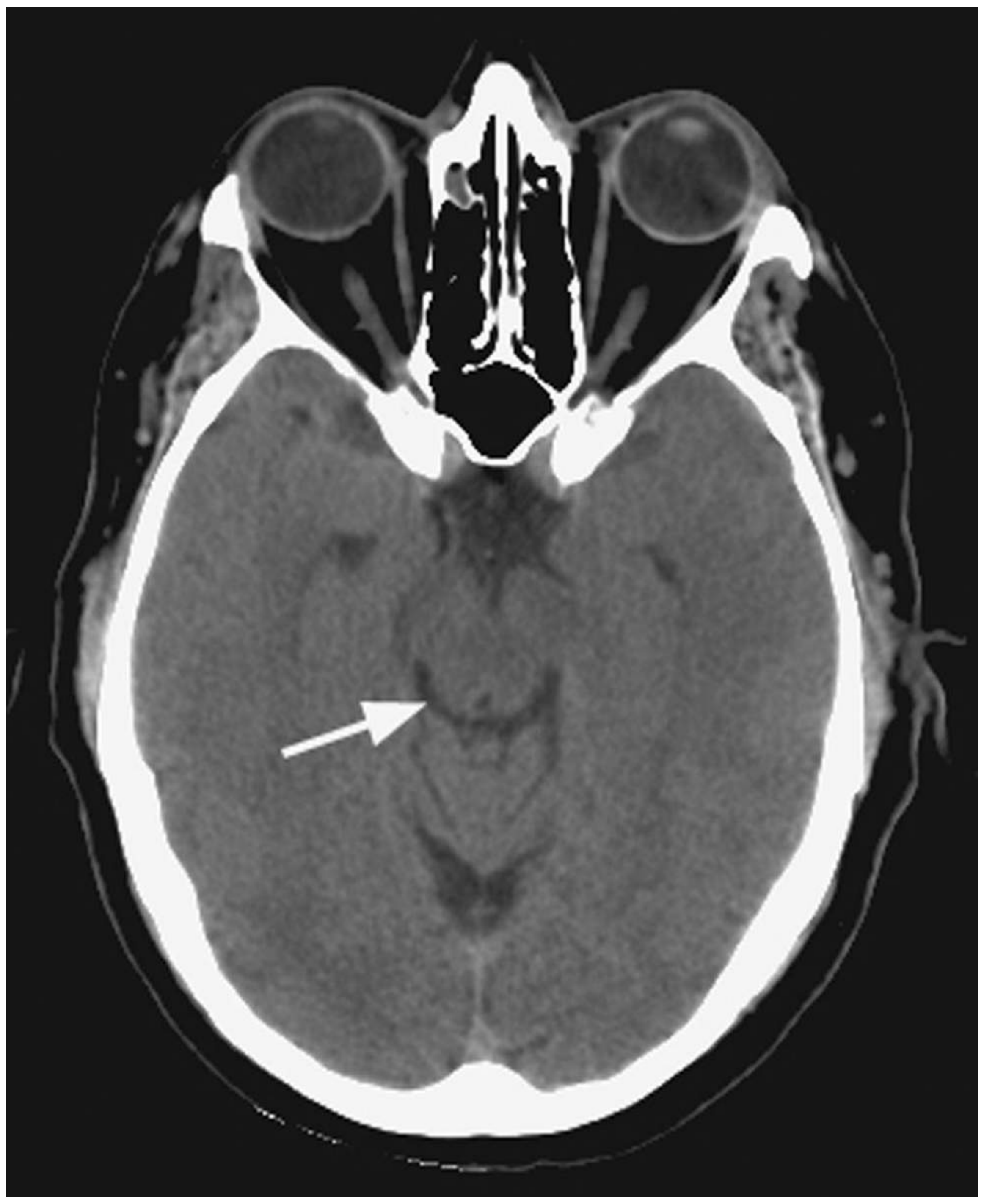


FIGURE 1.56 ■ **Normal Quadrigeminal Cistern.** The normal appearance of this CSF space is shaped like a baby's bottom (see arrow). It is located within two cuts superiorly of the dorsum sella. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.57 ■ **Epidural Hematoma.** A lens-shaped epidural hematoma is seen on the left. The quadrigeminal cistern should be seen on this slice and is completely effaced, suggesting herniation. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.58 ■ **Subdural Hematoma**. A crescent-shaped subdural hematoma is seen on the left. The quadrigeminal cistern should be seen on this slice and is completely effaced, suggesting herniation. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 1.59 ■ **Temporal Lobe Contusion.** A temporal lobe contusion is seen on the right. The quadrigeminal cistern is partially effaced suggesting early herniation. (Photo contributor: Lawrence B. Stack, MD.)