RadioGraphics

Temporal Bone Trauma and the Role of Multidetector CT in the Emergency Department[1]

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CME FEATURE

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LEARNING OBJECTIVES FOR TEST 6

After completing this journal-based CME activity, participants will be able to:

- Describe the normal temporal bone anatomy.
- Discuss the role of multidetector CT with MPR in evaluating patients with head trauma in the emergency department.
- Review the role of multidetector CT in classifying temporal bone fractures and identifying injury to critical structures.

TEACHING POINTS

See last page

The temporal bone anatomy is complex, with many critical structures in close association with one another. The temporal bone region comprises cranial nerves V, VI, VII, and VIII; vascular structures such as the internal carotid and middle meningeal arteries; sigmoid sinus; jugular bulb; and sensorineural and membranous structures of the inner ear. Most temporal bone fractures are a result of high-energy blunt head trauma. Multidetector computed tomography (CT) plays a fundamental role in the initial evaluation of patients with polytrauma in the emergency department. Multidetector CT may help identify important structural injuries that may have devastating complications such as sensorineural hearing loss, conductive hearing loss, dizziness and balance dysfunction, perilymphatic fistulas, cerebrospinal fluid leaks, facial nerve paralysis, and vascular injury. Although classifying temporal bone fractures helps physicians understand and predict trauma-associated complications and guide treatment, identifying injury to critical structures is more important for guiding management and determining prognosis than is simply classifying temporal bone fractures into a general category. Many temporal bone fractures and complications may be readily identified and characterized at routine cervical, maxillofacial, and head multidetector CT performed in patients with polytrauma, without the need for dedicated temporal bone multidetector CT. Dedicated temporal bone multidetector CT should be considered when there is a high degree of suspicion for temporal bone fractures and no fractures are identified at head, cervical, or maxillofacial CT.

Abbreviation: MPR = multiplanar reformation

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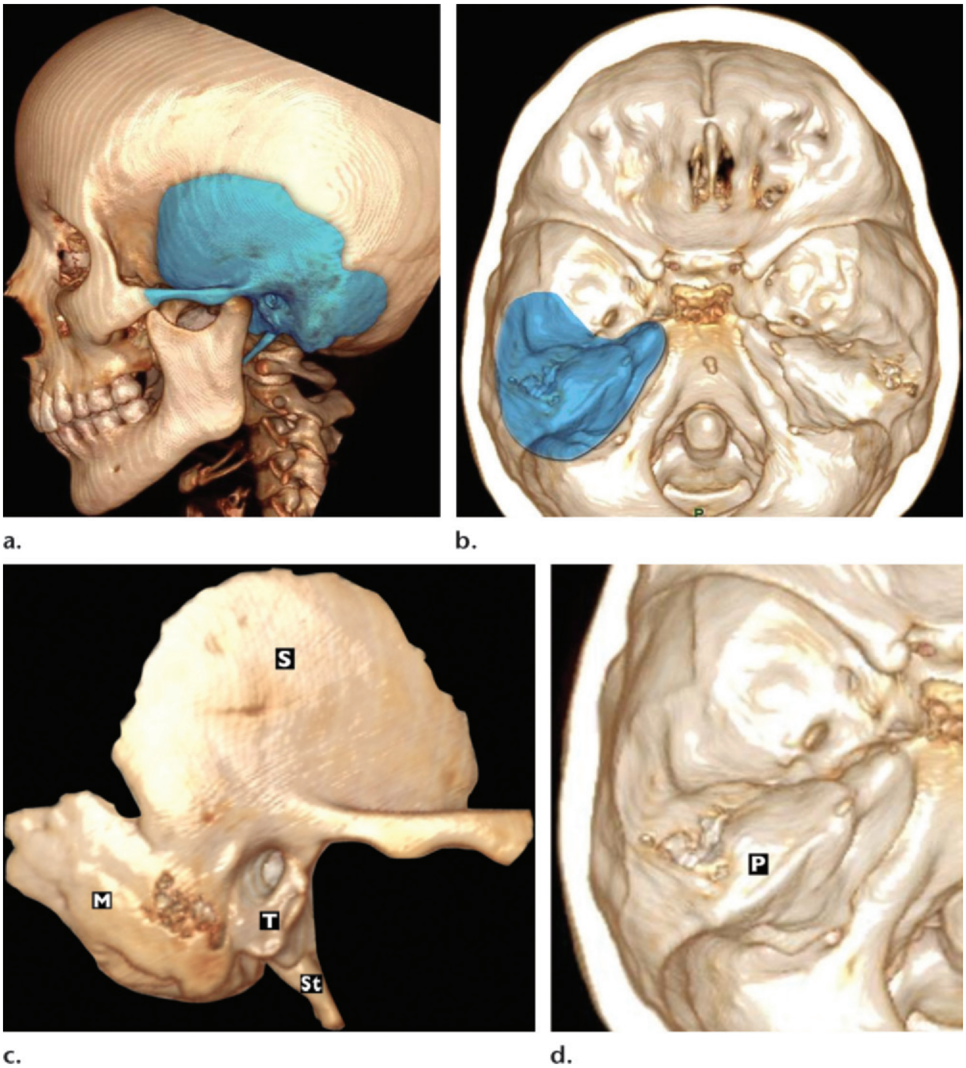


Figure 1. The temporal bone. **(a, b)** Three-dimensional multidetector CT reconstruction images of the skull, obtained from a lateral **(a)** and superior **(b)** view, show the spatial relationship of the temporal bone (blue area) with other osseous structures. **(c, d)** Three-dimensional lateral **(c)** and superior **(d)** multidetector CT reconstruction images of the temporal bone show the five osseous components: the squamous *(S)*, mastoid *(M)*, petrous *(P)*, tympanic *(T)*, and styloid *(St)*.

Introduction

Multidetector computed tomography (CT) plays a fundamental role in the initial evaluation of patients who present to the emergency department with polytrauma. With its relatively short scanning time and minimal amount of manipulation required, multidetector CT is an important tool for the detection of critical injuries in severely injured patients. In addition, its ability to rapidly process image data with the use of multiplanar reformation (MPR) allows detailed evaluation of the base of the skull and temporal bone anatomy. Multidetector CT with MPR is a fundamental tool for determining the extent of injury involving specific structures and directly affects patient care. Approximately 10% of patients with head trauma sustain a basilar skull fracture, which may be better visualized at maxillofacial and cervical multidetector CT than at head CT, studies that are commonly performed in patients with head trauma (1).

Most temporal bone fractures are a result of high-energy blunt head trauma, with temporal bone injury present in 14%–22% of patients with

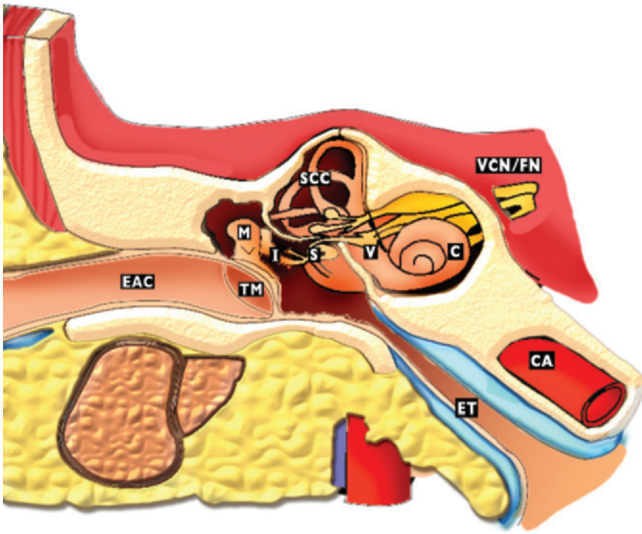


Figure 2. Normal anatomy of the temporal bone. Drawing shows the normal anatomy of the temporal bone, which comprises the external auditory canal *(EAC)*, tympanic membrane *(TM)*, malleus *(M)*, incus *(I)*, stapes *(S)*, vestibule *(V)*, semicircular canals *(SCC)*, cochlea *(C)*, vestibulocochlear nerve *(VCN)*, facial nerve *(FN)*, carotid artery *(CA)*, and eustachian tube *(ET)*.

skull fractures (2,3). The most common mechanism of injury is motor vehicle crashes (which are responsible in 45%–47% of cases of head injuries), followed by falls (responsible for 31%–33% of head injuries), and assaults (responsible for 11%–12% of head injuries) (1,2,4). Patients with skull fracture also frequently experience critical intracranial injuries—such as subarachnoid, subdural, and epidural hemorrhage; brain contusions; and cerebral edema—that often require early management.

In this article, we review the normal anatomy of the temporal bone and its fracture patterns and classifications. In addition, we discuss the normal and posttraumatic CT appearances of important structures that should be identified in the evaluation of patients with temporal bone trauma. These structures include the external ear canal, ossicles, carotid canal, facial nerve canal, cochlea, vestibule, and semicircular canals. Finally, we discuss the importance of routine cervical, maxillofacial, and head CT in the evaluation of patients with temporal bone trauma.

Temporal Bone Anatomy

The temporal bone is composed of five osseous parts: the squamous, mastoid, petrous, tympanic, and styloid (Fig 1). The temporal bone anatomy is complex, with many critical structures closely associated with one another, including cranial nerves V, VI, VII, and VIII and vascular structures such as the internal carotid and middle meningeal arteries, the sigmoid sinus, and the jugular bulb. The temporal bone anatomy also harbors the sensorineural and membranous structures of the inner ear (Fig 2). The osseous portions of the temporal bone that are most commonly involved in trauma are the petrous and mastoid.

External Ear

The external ear consists of the auricle and the external auditory canal, which is located in the tympanic portion of the temporal bone (Fig 3). The external auditory canal has a slight S shape, with the lateral one-third of the canal composed of fibrocartilage, and the medial two-thirds composed of bone. The medial boundary is marked by the tympanic membrane, which separates the external ear from the middle ear. The anterior wall of the external auditory canal is composed of the posterior border of the glenoid fossa, which houses the temporomandibular joint.

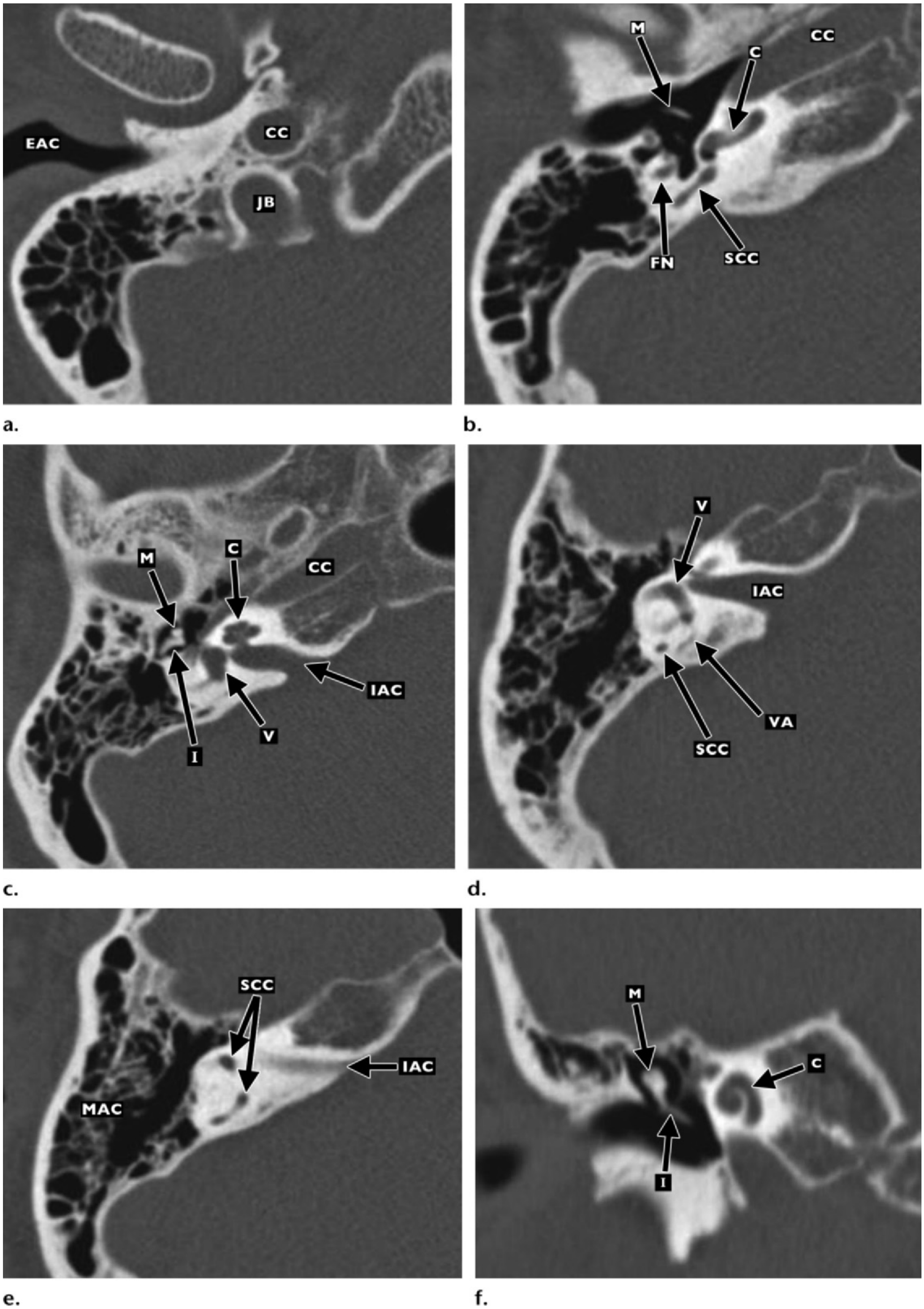


Figure 3. Normal anatomy of the temporal bone. Axial high-resolution **(a–e)** and coronal MPR **(f)** multidetector CT images of the temporal bone show the external auditory canal *(EAC)*, carotid canal *(CC)* and jugular bulb *(JB)*, malleus *(M)*, facial nerve *(FN)*, cochlea *(C)*, semicircular canals *(SCC)*, internal auditory canal *(IAC)*, incus *(I)*, vestibule *(V)*, vestibular aqueduct *(VA)*, and mastoid air cells *(MAC)*.

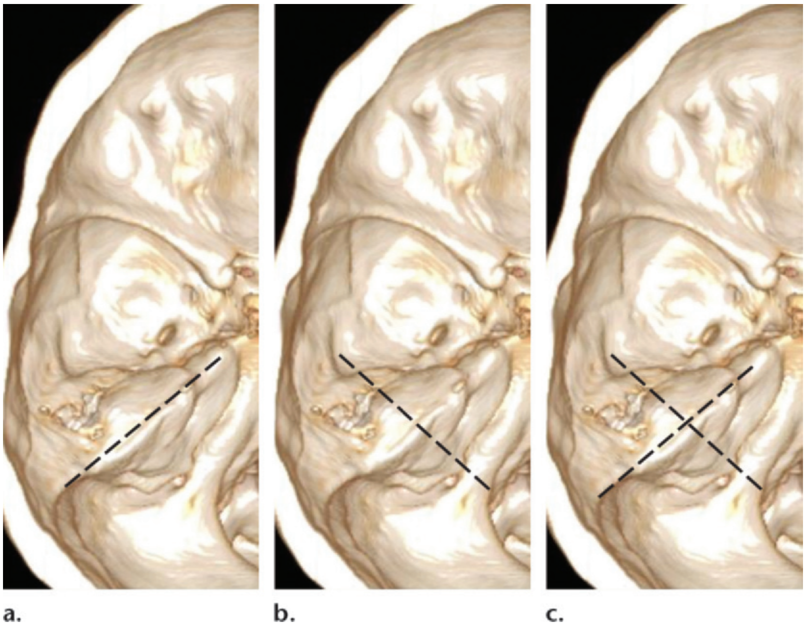


Figure 4. Temporal bone fracture patterns. Three-dimensional multidetector CT reconstruction images of the skull, obtained from a superior view, show longitudinal **(a)**, transverse **(b)**, and mixed **(c)** temporal bone fractures (dashed lines).

Middle Ear

The middle ear is located in the petrous portion of the temporal bone and is bounded laterally by the tympanic membrane and lateral attic wall, medially by the capsule of the inner ear, superiorly by the tegmen tympani, and inferiorly by the hypotympanic floor. The middle ear may be divided into three parts: the mesotympanum, or the tympanic cavity proper, which is opposite the tympanic membrane and contains the three ossicles; the epitympanum, or the attic, which is cephalad to the tympanic membrane; and the hypotympanum, which is inferior to the tympanic membrane. The ossicular chain is composed of the malleus, the incus, and the stapes (Fig 3). The malleus attaches to the tympanic membrane and consists of the head, neck, anterior process, lateral process, and manubrium. The incus is formed by a body and a long, short, and lenticular process. The stapes is the most medial ossicle, consisting of a head, anterior and posterior crura, and a foot plate. The head of the malleus, located in the epitympanum, articulates with the body of the incus. The lenticular process of the incus articulates with the head of the stapes. The foot plate of the stapes is attached to the oval window. The short process and the body of the incus (the "cone"), which is located within the fossa incudis, and the head of the malleus (the "ice cream") constitute the "ice cream cone" configuration of the incudomalleal articulation at the level of the attic (Fig 3).

Inner Ear

The inner ear contains the labyrinth, which lies within the petrous portion of the temporal bone. The osseous labyrinth encloses the membranous labyrinth, which is surrounded by perilymphatic fluid. The osseous labyrinth (otic capsule) is divided into three components: the vestibule, cochlea, and three semicircular canals (Fig 3). The membranous labyrinth, which is filled with endolymph, is formed by the utricle and saccule, three semicircular ducts and their ampullae, the cochlear duct, and the endolymphatic duct and sac.

Classification of Temporal Bone Fractures

Traditional Classification

Classifying temporal bone fractures helps physicians understand and predict trauma-associated complications and guide management and treatment. The traditional classification system indicates the relationship of the fracture line with the long axis of the petrous portion of the temporal bone (Fig 4) (4). In 1926, Ulrich (5) classified

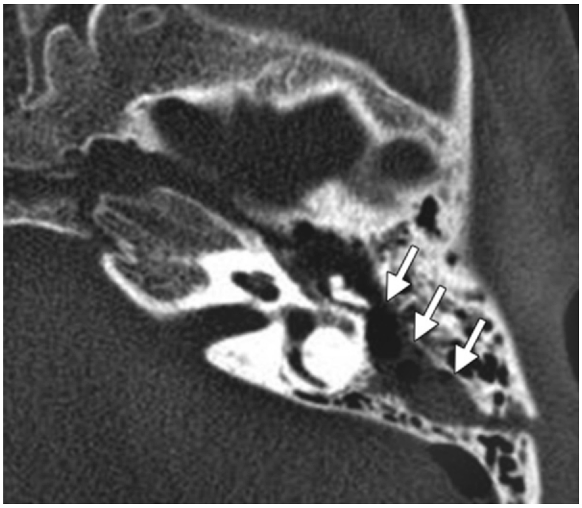


Figure 5. Longitudinal fracture. Axial high-resolution multidetector CT image of the temporal bone shows a longitudinal fracture (arrows) that extends into the middle ear. The otic capsule is spared. Longitudinal fractures most commonly are associated with ossicular injury, tympanic membrane rupture, and hemotympanum, with conductive hearing loss.

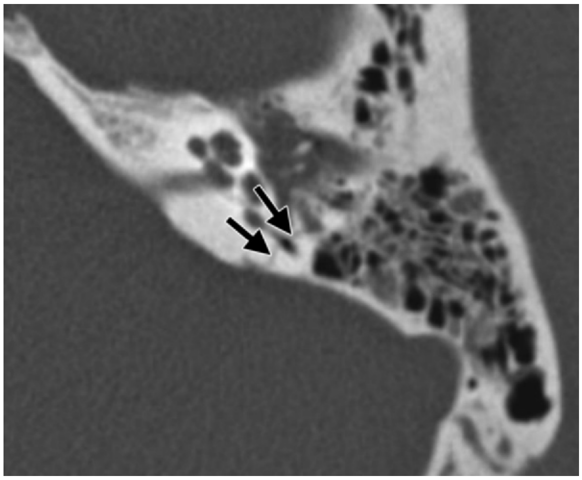


Figure 6. Transverse fracture. Axial high-resolution multidetector CT image of the temporal bone shows a transverse fracture (arrows) involving the semicircular canal, with opacification of the mastoid air cells. Transverse fractures more often result in sensorineural hearing loss and facial paralysis than do longitudinal fractures.

temporal bone fractures as transverse or longitudinal. In the 1940s, experiments performed by Guardjian and Lissner (6) in cadaveric human heads further strengthened the concept put forth by Ulrich. With this classification system, 70%–90% of temporal bone fractures are longitudinal, and 10%–30% are transverse (7).

Longitudinal Fractures.—Longitudinal fractures are characterized by a line of force that runs, roughly, lateral to medial; the temporal squamosa and parietal bone are commonly involved (8,9). At multidetector CT, a line parallel to the long axis of the petrous bone is seen (Fig 5). Involvement of the otic capsule is rare because the fracture line extends along the path of least resistance toward the petrous apex (10). The most common complications of longitudinal fractures are ossicular injury, tympanic membrane rupture, and hemotympanum with conductive hearing loss (11). Less commonly, the facial nerve also may be injured.

Transverse Fractures.—Transverse fractures typically result from trauma to the occipital or frontal regions or the craniocervical junction, with the line of force extending anterior to posterior (11). The fracture line is perpendicular to the long axis of the petrous bone and usually originates in the vicinity of the jugular foramen or foramen magnum with extension into the middle cranial

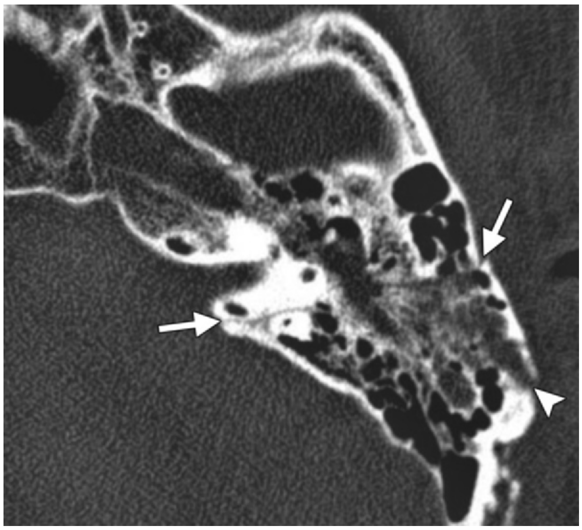
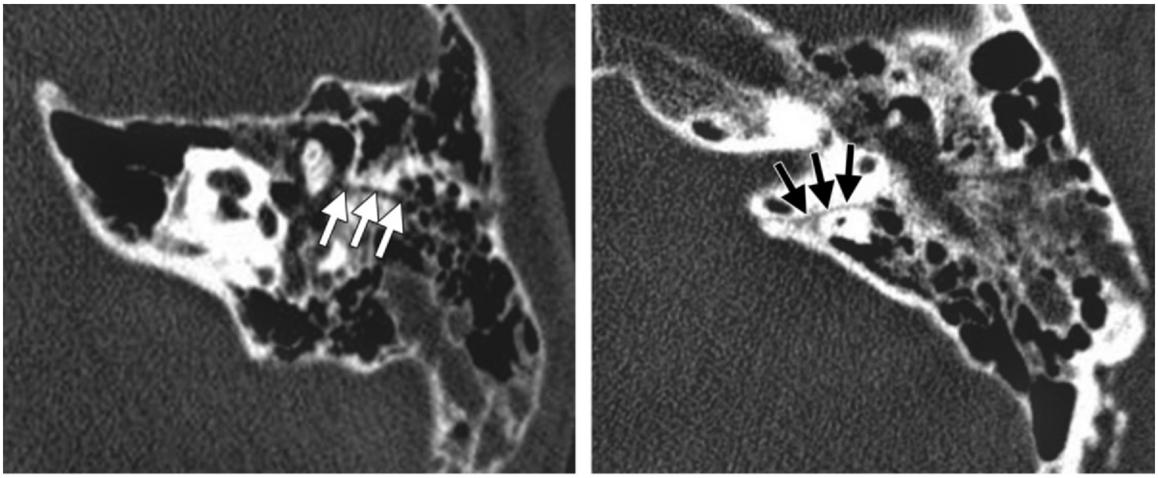


Figure 7. Mixed fracture. Axial high-resolution multidetector CT image of the temporal bone shows a fracture with transverse (arrows) and longitudinal (arrowhead) components, findings indicative of a mixed fracture. Note that the transverse component extends into the otic capsule.

fossa (Fig 6) (7,11). Sensorineural hearing loss is more common in patients with a transverse fracture than those with a longitudinal fracture and may be secondary to injury to the labyrinthine structures, transection of the cochlear nerve, or stapes footplate injury, which results in perilymphatic fistula (12). Facial paralysis is more common in patients with a transverse fracture and may be immediate and complete (13–15).

Classifying fractures with the transverse-longitudinal scheme forces a complex fracture



a. b.

Figure 8. Otic capsule–sparing and otic capsule–violating fractures. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows an otic capsule–sparing fracture (arrows). **(b)** Axial high-resolution multidetector CT image of the temporal bone shows an otic capsule–violating fracture (arrows).

Figure 9. Nonpetrous temporal bone fracture. Axial high-resolution multidetector CT image of the temporal bone shows a nonpetrous fracture (arrow).

line into a limited geometric category that was created mainly on the basis of simulated impact studies in cadaver skulls (6). This system is not representative of temporal bone trauma, which most frequently results from motor vehicle accidents. However, with the advent of multidetector CT and because many temporal bone fractures contain both longitudinal and transverse components, a new classification scheme was proposed. This type of fracture is referred to as a mixed temporal bone fracture (Fig 4) (16–18).

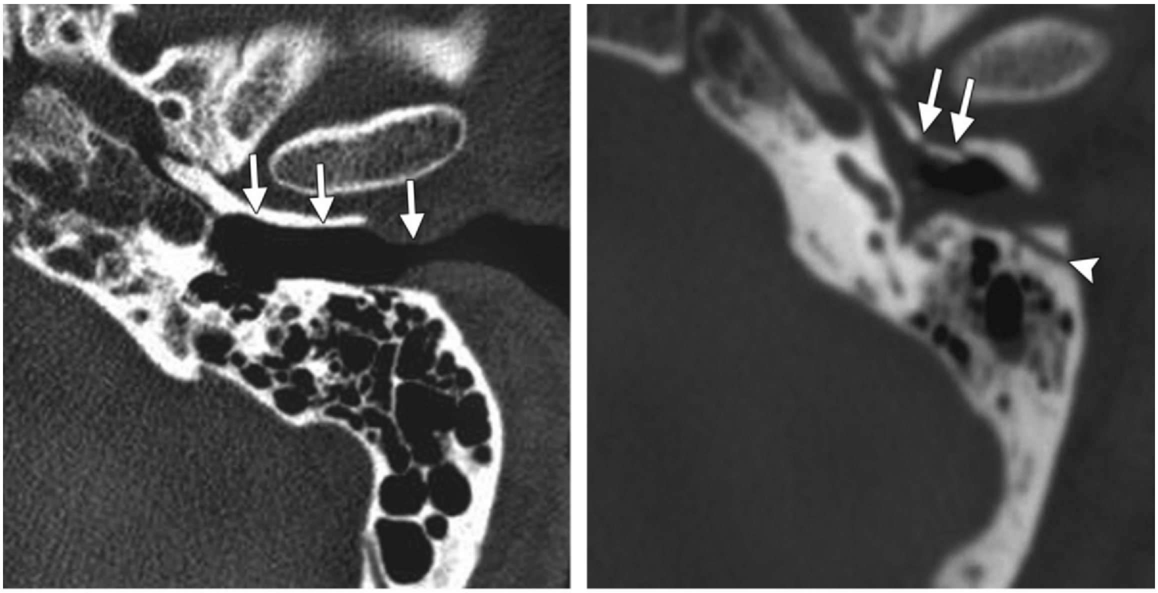
Mixed Fractures.—Most temporal bone fractures may not be strictly classified as longitudinal or transverse. Mixed fractures include both longitudinal and transverse elements, with frequent involvement of the otic capsule, which leads to sensorineural hearing loss (Fig 7) (19). Ossicular injury may result in conductive hearing loss. Recent studies have assessed the clinical prognostic value and practicality of the traditional classification system and have found that clinical findings do not necessarily correlate with the traditional classification of fractures (1,3,20).

Otic Capsule–violating and Otic Capsule–sparing Fractures

Brodie et al (2) described classification of temporal bone fractures on the basis of whether the otic capsule is involved or spared (Fig 8) (1). Otic capsule–violating fractures course through the labyrinth—the cochlea, vestibule, or semicircular canals—and are more commonly associated with complications such as sensorineural hearing loss, cerebrospinal fluid otorrhea, and facial nerve injury than otic capsule–violating fractures (1,21). Otic capsule–sparing fractures are more commonly associated with intracranial injuries such as epidural hematomas and subarachnoid hemorrhages (1).

Petrous and Nonpetrous Fractures

Ishman and Friedland (4) proposed a classification system that divides fractures into two groups: petrous and nonpetrous. Petrous fractures extend into the petrous apex or the otic capsule. Patients with petrous fracture are more likely to develop cerebrospinal leak and facial nerve injury. Nonpetrous fractures involve neither the petrous apex nor the otic capsule (Fig 9). However, they may extend into the middle ear or mastoid and are more likely to lead to conductive hearing loss (3).



a. b.

Figure 10. External auditory canal. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows the external auditory canal (arrows), which is intact. **(b)** In a different patient, axial multidetector CT image of the cervical spine shows a longitudinal fracture (arrowhead) that extends into the external auditory canal (arrows).

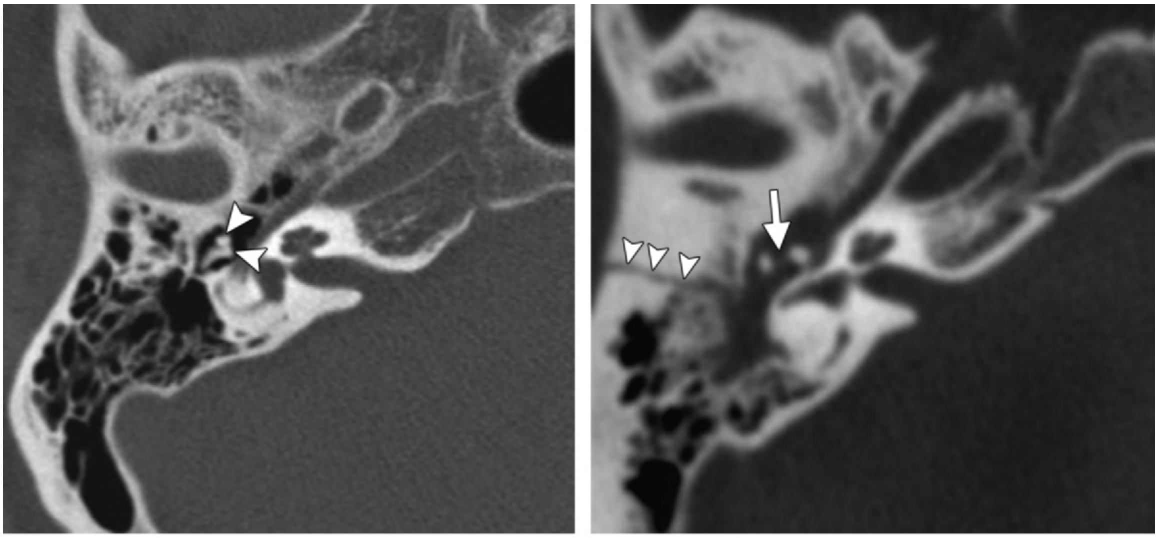
The otic capsule–sparing or otic capsule–violating classification system appears to be the most valuable in offering clinicians guidance to help predict clinical outcomes and direct surgical planning and treatment of patients with temporal bone fractures. In a study performed by Dahiya et al (1) comparing otic capsule–sparing and otic capsule–violating fractures, patients with an otic capsule–violating fracture were approximately twice as likely to develop facial paralysis, four times as likely to develop cerebrospinal leak, seven times as likely to experience profound hearing loss, and more likely to sustain intracranial complications, such as epidural hematoma and subarachnoid hemorrhage, than those with an otic capsule–sparing fracture. Similarly, in a different study, Little and Kesser (21) reported that use of the otic capsule–based system resulted in a statistically significant ability to anticipate complications such as facial nerve injury and sensorineural hearing loss. Identification of these complications is critical for clinicians; each presents a new challenge to the surgical and medical management of temporal bone fractures, and most require a multidisciplinary effort from different subspecialties (22).

Including the terms *longitudinal* and *transverse* in radiologic reports remains important because they give physicians a conceptual idea of the fracture pattern. However, including these terms will not relay significant clinical information related to patients' prognosis. Extending the description to include terms such as *otic capsule–violating* and *otic capsule–sparing* and whether important structures are involved is of more clinical relevance and conveys a more meaningful and accurate picture of the extent of injury.

Temporal Bone Fracture: Identification of Important Structures

The ability to rapidly process multidetector CT data with the use of MPR allows detailed evaluation of the temporal bone anatomy. The use of multidetector CT with MPR is fundamental in determining whether specific structures are involved, which directly affects patient care. Multidetector CT may be used to identify injury to important structures that may have devastating complications, such as sensorineural hearing loss, conductive hearing loss, dizziness and balance dysfunction, perilymphatic fistulas, cerebrospinal fluid leaks, facial nerve paralysis, and vascular injury.

Teaching Point



a. b.

Figure 11. Ossicles. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows the normal incudomalleal relationship (arrowheads). **(b)** In a different patient, axial multidetector CT image of the cervical spine shows incudomalleal dislocation (arrow) secondary to a transverse fracture (arrowheads). The fracture line does not extend into the otic capsule.

Teaching Point

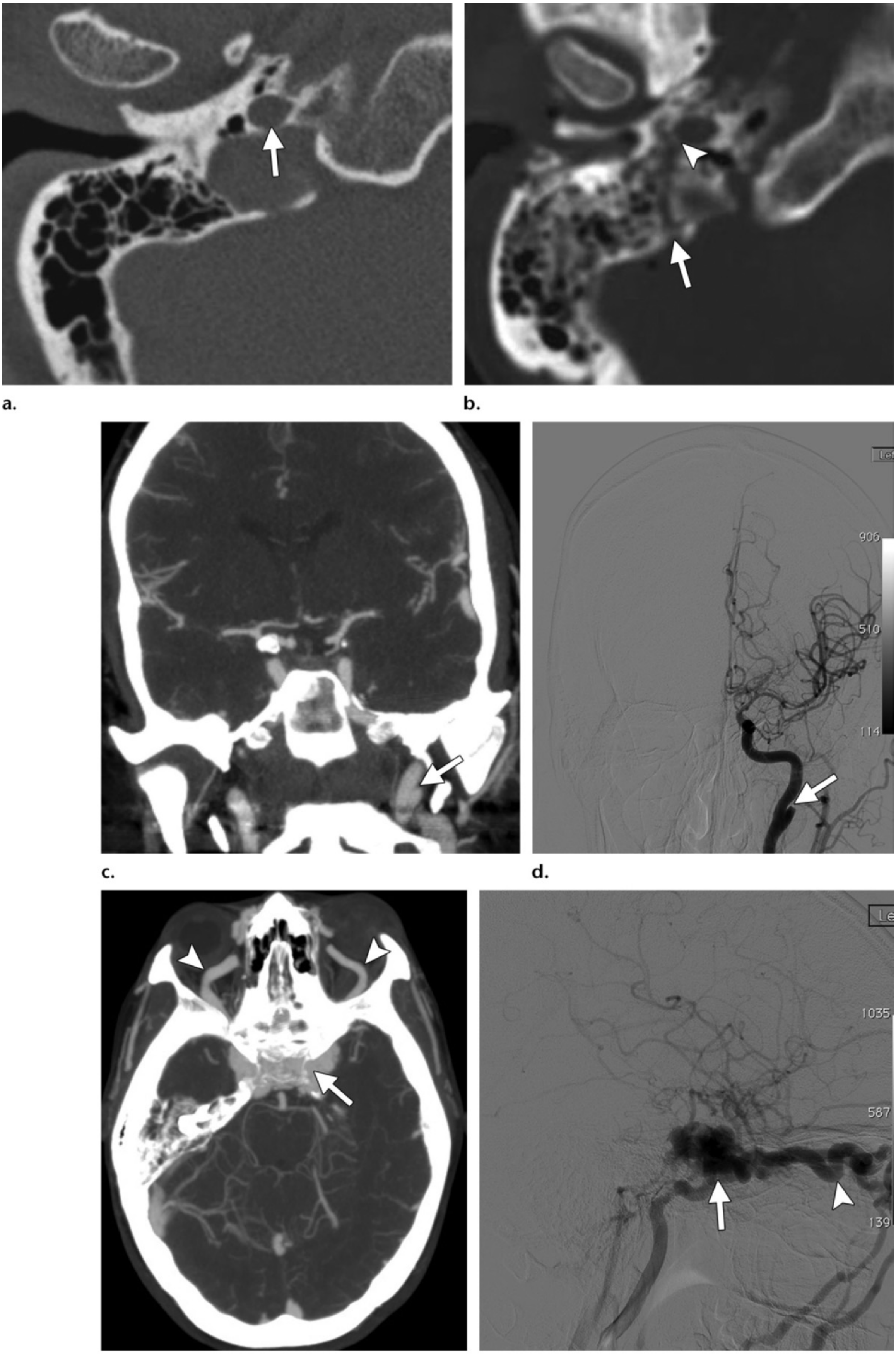
Identifying injury to critical structures is more important to guiding case management and establishing a prognosis than is simply classifying temporal bone fractures as a general category.

External Auditory Canal

The anterior wall of the external auditory canal is formed by the posterior border of the glenoid fossa, which houses the temporomandibular joint (Fig 10a). The entire length of the external auditory canal and its relationship with the temporomandibular joint may be adequately evaluated in the axial and coronal MPR planes. Fracture of the anterior aspect of the external wall of the auditory canal may result from impaction of the condyle into the posterior wall of the temporomandibular joint. It also may be a direct consequence of a fracture line extending into the external auditory canal (Fig 10b). Untreated fractures may lead to subsequent canal stenosis. Because canal stenosis may be prevented by temporarily packing the canal, recognition of external auditory canal fractures is important (23).

Ossicles

The ossicular chain may be disrupted at multiple sites. Among patients with temporal bone trauma, conductive hearing loss most commonly results from ossicular injury, with ossicular dislocation more common than ossicular fracture (24). The presence of a persistent conductive hearing deficit after tympanic membrane healing or repair and resorption of middle ear debris is suspicious for ossicular injury (7,12,25–27). When evaluating for ossicular dislocation, use of the axial plane provides the best view of ossicular continuity. Coronal MPR images may be used to evaluate the long process of the incus and its relationship to the malleus (Fig 3f). There are five general types of dislocation: incudomalleolar joint separation, incudostapedial joint separation, dislocation of the incus, dislocation of the malleoincudal complex, and stapediovestibular dislocation (28). The incus has minimal ligament support and therefore is most prone to displacement (29). Incudostapedial joint separation is the most common posttraumatic ossicular derangement, followed by complete incus dislocation from both its incudomalleolar and incudostapedial articulations (12,27,28). Stapediovestibular dislocation is a rare type of ossicular injury (24). Subluxations or dislocations involving the incudomalleal articulation result in alteration of the normal ice cream cone appearance of the malleolar head and incus, a finding that may be readily seen on axial CT images (Fig 11) (24). Fractures most commonly occur at the long process of the incus because of its lack of support, followed by the crura of the stapes (30). Fracture of the malleus is least common and usually involves the neck region (31).



a. b. c. d. e. f.

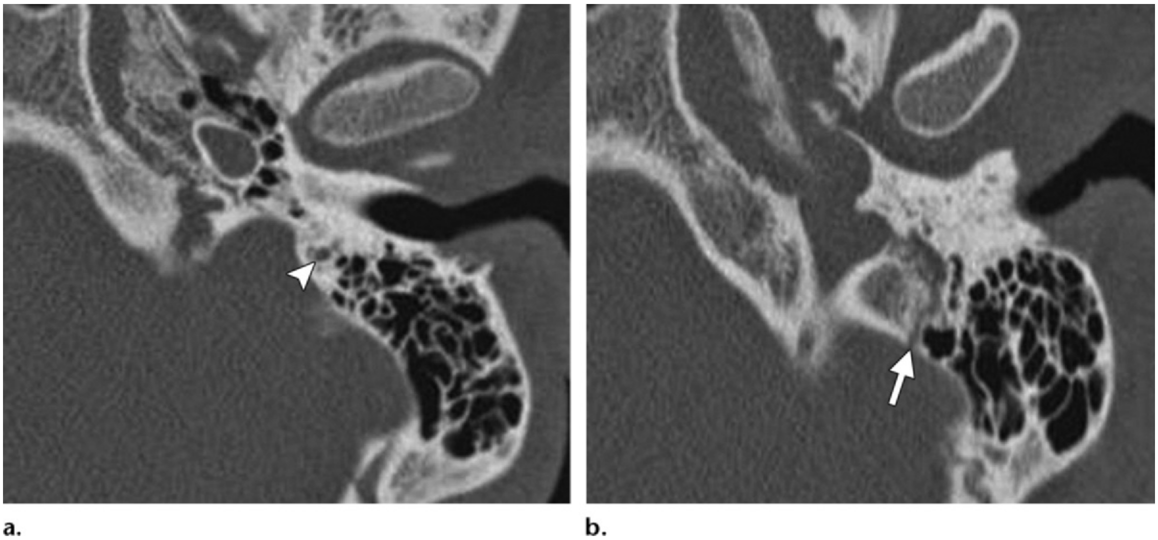


Figure 13. The facial nerve. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows an intact facial nerve canal (arrowhead). **(b)** In a different patient, axial high-resolution multidetector CT image of the temporal bone shows a transverse fracture that extends through the facial nerve canal (arrow).

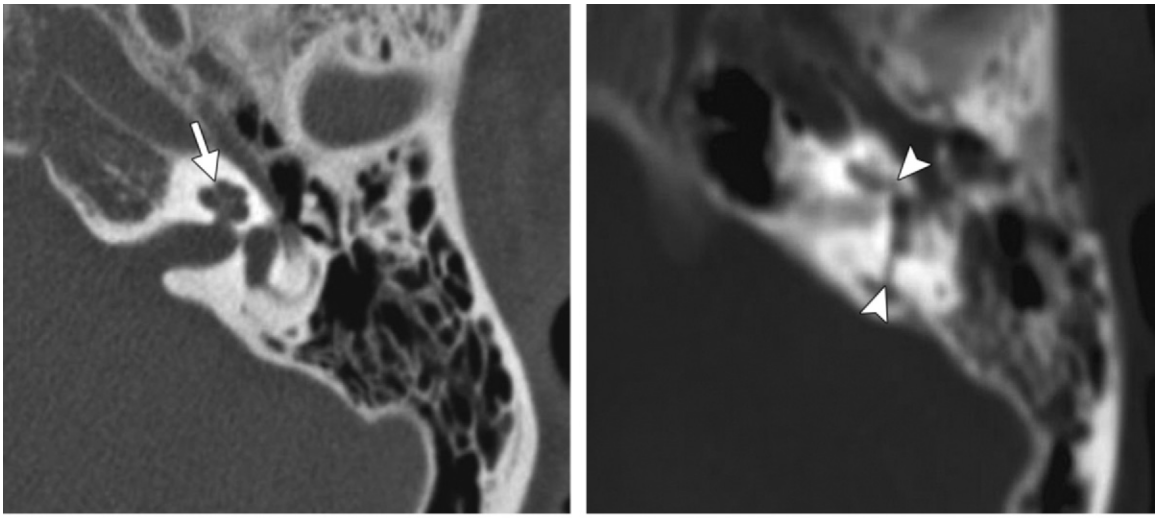
Carotid Canal

The petrous part of the temporal bone contains the petrous segment of the internal carotid artery, which enters the skull through the carotid canal, medial to the styloid process and anterior to the jugular fossa (Fig 12a). The carotid canal should be evaluated along its length in the axial plane, with sagittal and coronal MPR used to evaluate the more horizontal portion of the canal. Patients with fractures that extend to the carotid canal are at an increased risk for carotid artery injury (Fig 12b). Resnick and colleagues (32) examined 230 patients with basicranial fractures and found that 55 (24%) had fractures involving the carotid canal, six (11%) of whom had vascular complications directly related to the intracranial carotid injury. Complications associated with carotid artery injury may be devastating and include arterial dissection, pseudoaneurysm, complete transection, occlusion, and arteriovenous fistulas (Fig 12). CT angiography should be performed when fractures involving the carotid canal are identified.

Facial Nerve

The path of the facial nerve is divided into six segments. The intracranial segment extends from the pons to the internal auditory canal. The intracanalicular segment runs in the internal auditory canal. The labyrinthine segment extends from the entrance of the fallopian canal to the geniculate ganglion. The tympanic segment extends from the geniculate ganglion to the posterior genu, anterior and caudal to the lateral semicircular canal. The mastoid segment begins at the posterior genu and extends vertically down the anterior wall of the mastoid process to the stylomastoid foramen. Finally, the nerve emerges from the stylomastoid foramen, forming the extracranial segment. The facial nerve should be evaluated along its length in the axial plane. Sagittal oblique MPR imaging also may be used to evaluate the integrity and continuity of the tympanic and mastoid segments on a single image. The facial nerve is injured in 7% of patients with a temporal bone fracture (Fig 13) (2). Most injuries occur in the labyrinthine segment, in the region of the geniculate ganglion, and they manifest as contusion of the nerve, edema and hematoma of the nerve sheath, and partial or complete nerve transection (7,13,14,33,34).

◀ **Figure 12.** Internal carotid canal. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows the petrous portion of the intact carotid canal (arrow). **(b)** In a different patient, axial multidetector CT image of the head shows a transverse fracture (arrow) that extends into the petrous portion of the carotid canal (arrowhead). **(c–f)** In a third patient, coronal multidetector CT angiogram of the neck **(c)** shows dissection (arrow) of the distal cervical left internal carotid artery. Anteroposterior digital subtraction angiographic image **(d)** shows dissection of the distal cervical left internal carotid artery (arrow) as it enters the base of the skull. Axial multidetector CT angiography maximum intensity projection **(e)** and lateral digital subtraction angiographic **(f)** images show a cavernous arteriovenous fistula in the left internal carotid artery (arrow) and bilateral dilatation of the ophthalmic veins (arrowheads).



a. b.

Figure 14. The cochlea. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows a normal cochlea (arrow). **(b)** In a different patient, axial multidetector CT image of the cervical spine shows a transverse fracture (arrowheads) that extends into the cochlea.

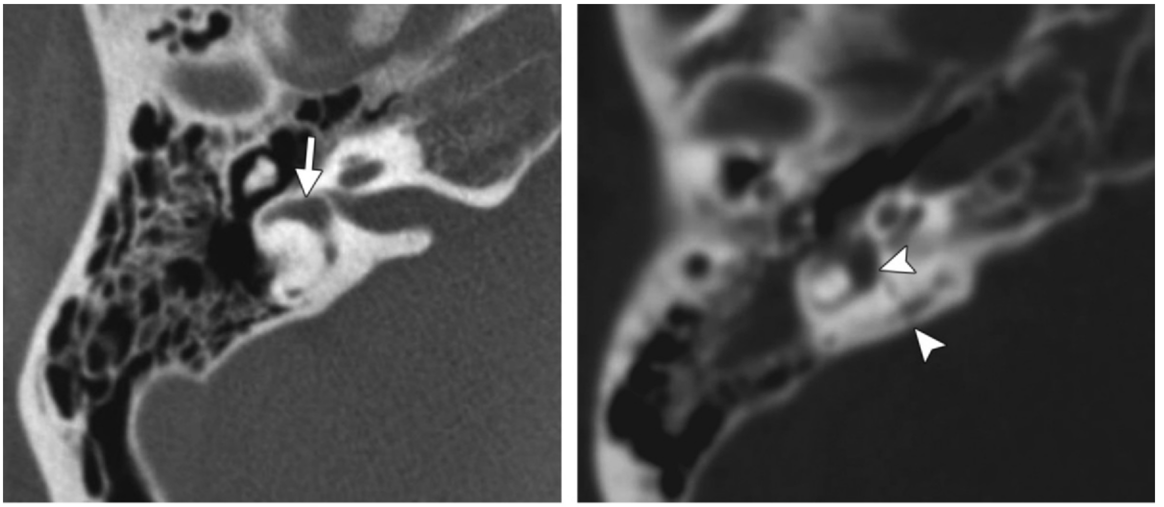
Immediate posttraumatic paralysis frequently is indicative of transection of the nerve or compression by an osseous fragment, whereas delayed onset of paralysis may be explained by development of edema, swelling, or an expanding hematoma causing neural compression with an intact nerve (21). Care must be taken when evaluating the path of the facial nerve to identify osseous fragments or hematomas that may compress the facial nerve because the nerve itself is not readily visualized at multidetector CT.

Cochlea

The cochlea is an osseous spiral of two and one-half turns that consists of three fluid-filled ducts or scalae: the scala tympani, scala vestibuli, and scala media (Fig 14a). The scala vestibuli and scala tympani communicate with one another and contain perilymph, whereas the scala media contains endolymph. The Corti organ resides within the cochlear duct and contains the hair cell receptors. In addition to axial images, MPR images in planes that parallel the long and short axes of the petrous portion of the temporal bone may be used to evaluate the integrity of the cochlea in its short and long axes, respectively. Injury to the cochlea, cochlear nerve, or cochlear nuclei is associated with sensorineural hearing loss (Fig 14b). Sensorineural hearing loss also may occur when no definitive temporal bone fracture is present, an occurrence known as cochlear concussion.

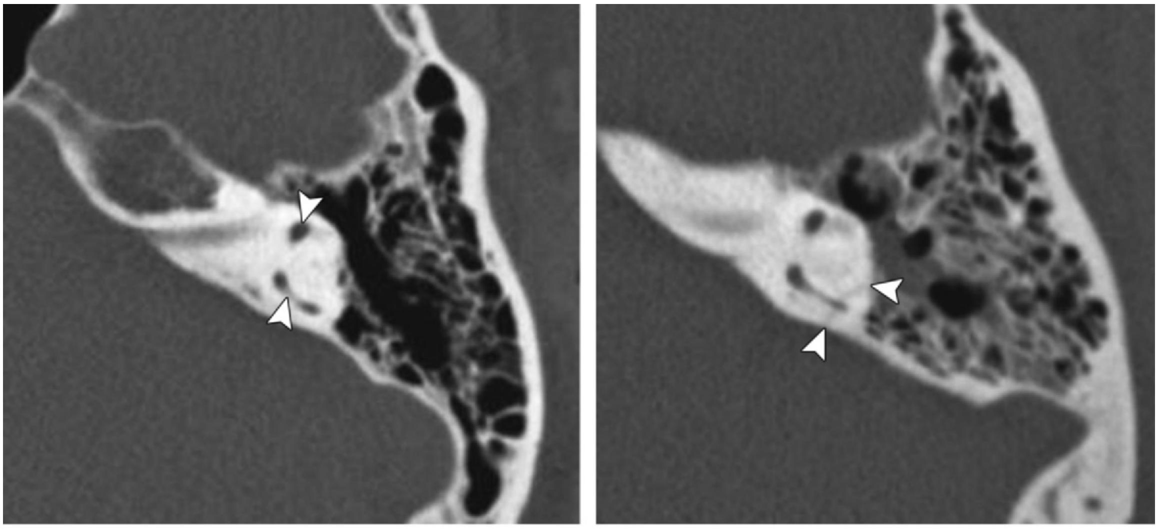
Vestibule

The vestibule is the central chamber of the osseous labyrinth (Fig 15a). It is continuous with the cochlea anteriorly and the semicircular canals posteriorly and contains the utricle and saccule, which are part of the membranous labyrinth and are involved in balance. Axial and coronal oblique MPR images are useful in identifying the relationship of the vestibule with the cochlea and semicircular canals. Vertigo frequently occurs after temporal bone trauma and may be secondary to injury to the vestibular apparatus, the vestibular nerve, or the vestibular aqueduct. Vertigo may result from vestibular concussions in the setting of otic capsule–sparing fractures or vestibular destruction in the setting of otic capsule–violating fractures (Fig 15b). Benign paroxysmal positional vertigo is the most common form of disequilibrium after head injury (23,24). It is usually self-limiting and resolves within 6–12 months. Perilymphatic fistulas also may cause vertigo and may occur with injury to the otic capsule. In patients with posttraumatic vertigo and no fracture identified, other causes such as perilymphatic fistulas, labyrinthine concussions, or otolith detachment (cupulolithiasis) may be considered.



a. b.

Figure 15. The vestibule. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows normal vestibule anatomy (arrow). **(b)** In a different patient, axial maxillofacial multidetector CT image shows a transverse fracture (arrowheads) that extends into the vestibule.



a. b.

Figure 16. The semicircular canals. **(a)** Axial high-resolution multidetector CT image of the temporal bone shows an intact semicircular canal (arrowheads). **(b)** In a different patient, axial high-resolution multidetector CT image of the temporal bone shows a subtle fracture line (arrowheads) that extends into the posterior semicircular canal.

Semicircular Canals

There are three semicircular canals that are related to one another orthogonally: the lateral, posterior, and superior semicircular canals, which open into the vestibule (Fig 16a). Each semicircular canal should be evaluated individually in the orthogonal coronal, axial, and sagittal planes. The osseous semicircular canals contain the corresponding membranous semicircular ducts, which are part of the membranous labyrinth and communicate with the utricle. Collectively, the semicircular ducts contain the sensory organs that respond to angular acceleration (25,26). As with vestibular injuries, trauma to the semicircular canals results in vertigo (Fig 16b).

Unseen Temporal Bone Fractures

Teaching Point

Temporal bone fractures may not be seen at initial imaging studies. Multidetector CT findings that are suggestive of an unseen temporal bone fracture include opacification of mastoid air cells, the external ear canal, or the middle ear; air-fluid level in the sphenoid sinus; pneumocephalus adjacent to the temporal bone; an extraaxial fluid collection or brain injury; and air in the glenoid fossa of the temporomandibular joint (Fig 17). If a temporal bone fracture is clinically suspected, additional imaging studies (ie, temporal bone multidetector CT) may depict the fracture. In trauma patients with opacified mastoid air cells on head CT images, it should be assumed that a temporal bone fracture is present until proved otherwise. In these cases, clinicians should verify whether CT images of the cervical spine were obtained, because often the mastoid air cells are visible at cervical spine CT, which has significantly better spatial resolution than that of head CT.

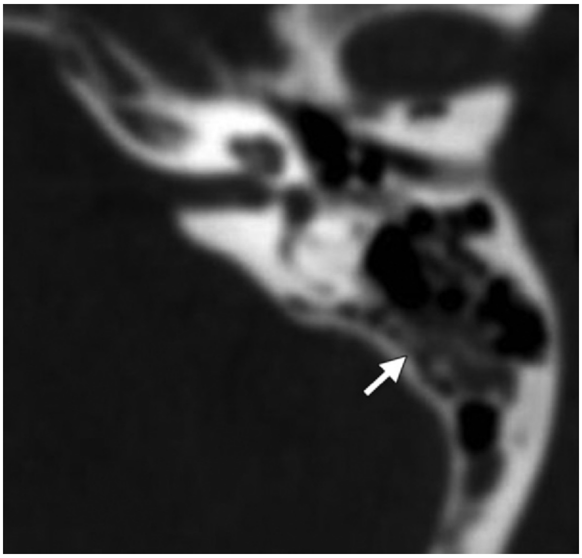


Figure 17. Unseen temporal bone fracture. Axial multidetector CT image of the head shows opacification of the mastoid air cells (arrow). No temporal bone fracture is seen.

Clinical Relevance

Teaching Point

Routine maxillofacial, head, and cervical multidetector CT performed in the emergency department depicts most temporal bone fractures and their associated complications. Dedicated temporal bone multidetector CT should be considered when there is a high degree of suspicion for temporal bone fractures and no fractures are identified at head, cervical, or maxillofacial CT. In addition, many temporal bone complications in patients with polytrauma may be readily identified and characterized at routine cervical and maxillofacial multidetector CT without performing dedicated temporal bone multidetector CT.

Summary

Teaching Point

A diagnosis of temporal bone fracture may be reached by using multidetector CT with MPR. Classification schemes often lack the detail and precision needed to tailor the treatment of an individual patient. Designating fractures as otic capsule–sparing or otic capsule–violating seems to be the most clinically relavant classification system thus far. Identification of injury to critical structures is more important to guide further management and predict prognosis than to simply classify temporal bone fractures as a general category. The use of multidetector CT allows accurate prediction of clinical outcome and complications, and it helps guide medical treatment of patients with polytrauma in the emergency department.

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Temporal Bone Trauma and the Role of Multidetector CT in the Emergency Department[1]

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Multidetector CT may be used to identify injury to important structures that may have devastating complications, such as sensorineural hearing loss, conductive hearing loss, dizziness and balance dysfunction, perilymphatic fistulas, cerebrospinal fluid leaks, facial nerve paralysis, and vascular injury.

Page 1749
Identifying injury to critical structures is more important to guiding case management and establishing a prognosis than is simply classifying temporal bone fractures as a general category.

Page 1754 (Figure on page 1754)
Multidetector CT findings that are suggestive of an unseen temporal bone fracture include opacification of mastoid air cells, the external ear canal, or the middle ear; air-fluid level in the sphenoid sinus; pneumocephalus adjacent to the temporal bone; an extraaxial fluid collection or brain injury; and air in the glenoid fossa of the temporomandibular joint (Fig 17).

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