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Temporal Fracture

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Introduction

Temporal bone fractures can lead to high morbidity and/or mortality. They are the thickest skull base bones and require a great force to fracture. Temporal bones house numerous nerves, therefore, fracture of the temporal bone carries a risk of concomitant functional deficits.

Temporal bones also house the internal carotid arteries and internal jugular veins, which play a role supplying oxygenated blood and venous drainage to and from the brain.

The temporal bone is a paired component of the skull base. The temporal bones articulate posteriorly with the occipital bone, superiorly with the parietal bones, and anteriorly with the sphenoid bone creating the occipitomastoid, squamous and sphenosquamosal sutures, respectively. The temporal bone has complex anatomy including four geographic parts (squamous, mastoid, petrous, tympanic) and numerous foramen/canals (foramen lacerum, carotid canal, internal acoustic meatus, jugular foramen).

- Foramen lacerum: Great petrosal nerve
- Carotid canal: Internal carotid artery
- Internal acoustic meatus: CN VII, CN VIII
- Jugular foramen: Internal jugular vein, posterior meningeal artery, CN IX, CN X, CN XI

Additionally, there are 3 bony processes (zygomatic, mastoid, styloid).

Etiology

Temporal bone fractures are caused by a lateral force/impact to the cranium.

Epidemiology

Roughly one-third of temporal bone fractures in the general population are as a result of motor vehicle accidents, assaults, and falls. About a quarter of temporal bone fractures are attributed to sports injuries, gunshot wounds, bicycle accidents, and other miscellaneous injuries. Males are at least 3-times more likely as females to suffer temporal bone fractures. Temporal bone fractures are typically unilateral, and more than half of temporal bone fractures are considered “open” fractures.[1]

Pathophysiology

The temporal bones are the thickest skull base components. Dynamic loading studies have yielded a minimum lateral impact force of 6000 to 8000 Newton (N) necessary to cause a fracture.[2] As with all fractures, the fracture force chooses a path of least resistance, which often means disrupting native temporal bone foramina.

History and Physical

Any history of significant trauma to the head, especially that with associated loss of consciousness, should elicit suspicion for cranial bone fractures. On physical examination, patients with temporal bone fractures may present with hemorrhagic otorrhea, hemotympanum, vertigo, nystagmus, facial paralysis, and/or Battle's sign (bruising over the mastoid process).[3] Patients will often present with altered mental status or abnormal Glasgow coma scale (GCS) scores secondary to concomitant, acute, intracranial pathology.

Evaluation

Imaging plays a crucial role in the evaluation and subsequent management of temporal bone fractures. CT has a significantly higher sensitivity for temporal bone fractures than a physical examination.[4] A non-contrast high-resolution CT with less than 1.5-mm slice thickness and coronal/sagittal reconstructions is recommended. Temporal bone fractures have an exceedingly high association with intracranial injury. Along with the careful evaluation of the osseous structures, the brain should be scrutinized for a possible subdural/epidural hematoma, cerebral contusion and/or hemorrhage, subarachnoid hemorrhage and tension pneumocephalus. Trauma to the head necessitates evaluation of the cervical spine. CT angiography should be obtained in the assessment of the intracranial vasculature, specifically the temporal portion of the internal carotid artery. Cisternograms are utilized to diagnose and localize cerebrospinal fluid (CSF) leaks.

Once the patient is stable, an MRI can be obtained for patients who suffer cranial nerve palsy not explained by CT findings, and patients that will require surgical intervention for temporal bone fracture. MRI can help differentiate between a fluid-filled mastoid and a mastoid containing herniated intracranial contents. MRI may also reveal intracranial pathology not previously diagnosed on CT.[4]

The first temporal bone fracture classification system described 2 types of fractures dependent on the plane relative to the long axis of the petrous ridge: Fractures that course parallel are considered longitudinal and fractures that course perpendicular are considered transverse.[5] A more clinically relevant classification describes fractures relative to the otic capsule involvement. Fractures are either otic capsule sparing or otic capsule violating. Temporal bone fractures that violate the otic capsule have a much higher association with CSF leak, sensorineural hearing loss, and certain intracranial pathology.[6]

Electromyography and electroneuronography can be used in cases of immediate facial paralysis.

Treatment / Management

Treatment and management of associated life-threatening, intracranial pathology should be the primary focus. The management of temporal bone fracture complications should be addressed once the patient is stable.

Facial Nerve Paralysis

Immediate paralysis and/or significant degeneration on electroneuronography is more likely to reflect nerve transection which requires surgical repair. Delayed onset paralysis usually indicates the development of neural edema or compression by hematoma which can be treated with 1- to 3-week course of corticosteroids.[7]

CSF Leak

Conservative management including elevation of the head, bedrest, avoidance of straining. Antibiotic use is a controversial prophylactic strategy to avoid the development of meningitis.[8] A small minority of patients will require surgical repair.

Hearing Loss

Early evaluation is recommended to establish a baseline followed by a full audiologic evaluation several weeks post-injury. Persistent conductive hearing loss is an indication for surgical exploration with ossiculoplasty. Persistent sensorineural hearing loss can be treated with hearing aids or cochlear implants.

Vertigo

Vestibular function testing should be performed. In cases of perilymph fistula, surgical repair is warranted. Post-traumatic perilymphatic hydrops should be managed with corticosteroids and diuretics.[1]

Prognosis

Overall the patient prognosis depends on intracranial involvement. The prognoses of common temporal bone fracture complications are as follows:

1. Facial nerve paralysis: Transected nerves can be surgically repaired. Compression of a nerve can be treated with surgery or corticosteroids depending on the situation.
2. CSF leak: The majority of CSF leaks will resolve within two weeks with only conservative measures. Surgical repair of the leak is possible in refractory cases.
3. Hearing loss: Hearing loss may resolve or improve within several months post-injury. Treatment options exist for both persistent conductive and sensorineural hearing loss.
4. Vertigo: Vertigo may improve within several months post-injury. Treatment options exist in refractory cases.

Complications

- Facial paralysis: CN VII damage
- Sensorineural hearing loss: CN VIII damage
- Conductive hearing loss: Ossicle/tympanic membrane disruption, hemotympanum
- Vertigo: CN VIII damage, perilymph fistula, post-traumatic perilymphatic hydrops
- CSF leak
- Cranial nerve palsies: CN IX, X, XI
- Internal carotid artery dissection and/or thrombus
- Meningocele
- Cholesteatoma

Consultations

Successful treatment and management of patients suffering from temporal bone fractures require an interprofessional effort. Trauma surgery, neurosurgery, otolaryngology, and neurotology should be consulted. As in all trauma cases, one must follow the ABCD protocol and consult with the relevant specialists depending on the pathology found on imaging studies. The outcomes for most patients without intracranial injury is good, but those with intracranial pathology have a guarded prognosis. Some patients may have residual neurological deficits that may persist for a long time.

Pearls and Other Issues

- Temporal bones require an immense amount of lateral force to fracture.
- Look for hemorrhagic otorrhea, hemotympanum, nystagmus, facial paralysis, Battle’s sign.
- Fractures should be classified as either otic capsule sparing or violating.
- High-resolution non-contrast CT with slice thickness less than or equal to 1.5 mm is the modality of choice.

- Look for associated intracranial and cervical pathology.
- Once stabilized, temporal bone fracture complications can be treated.
- Common complications include facial nerve paralysis, CSF leak, hearing loss, vertigo.
- Some complications may self-remit, and treatment options exist for those that persist.

Enhancing Healthcare Team Outcomes

Upon presentation, suspicion for intracranial pathology should be high. The patient should be stabilized before undergoing a detailed temporal bone evaluation. Understanding the anatomical relationships of the temporal bone is necessary for anticipating potential complications. Treatment and management of temporal bone fractures are complex and requires a multidisciplinary approach. Radiologists are tasked with timely identification and classification of temporal bone fractures and communication of findings to surgery and medical teams. The surgery teams should decide when and if intervention is necessary. Nursing staff plays a key role in monitoring the status of the patient throughout their hospitalization. The management of complications requires routine follow-up and, sometimes, additional outpatient testing.

Questions

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