Temporal bone multidetector computed tomography in the diagnosis of traumatic facial nerve injuries

Poster No.: C-2204
Congress: ECR 2015
Type: Educational Exhibit
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Keywords: Anatomy, Trauma, Head and neck, CT-High Resolution, Computer Applications-Detection, diagnosis
DOI: 10.1594/ecr2015/C-2204

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Learning objectives

- To review temporal bone fracture classification and its practical implications in the management of these patients.
- To illustrate through imaging techniques the complex facial nerve anatomy.
- To discuss the role of multidetector computed tomography (MDCT) with multiplanar reconstruction (MPR) in detection of facial nerve injuries.
**Background**

Temporal bone fractures are common in severe craneoencephalic trauma (up to 20% of skull fractures) and approximately 10% of them are associated with facial nerve injury.

Facial nerve paralysis can result in devastating consequences like deficiency of facial expression, impaired speech and ocular complications; therefore, its early detection has a critical impact in treatment.

MDCT has been a breakthrough in detecting fractures of the temporal bone and their possible complications. Moreover MDCT with multiplanar reconstructive images provides excellent depiction of bony anatomy.
Findings and procedure details

The knowledge of the temporal bone anatomy is crucial to understand and predict trauma-associated complications and guide management and treatment. Then we briefly review the anatomy of the temporal bone and facial nerve.

Temporal Bone Anatomy (Fig. 1 on page 7 and Fig. 2 on page 7)

The temporal bone is composed of five osseous parts: the squama temporalis, the mastoid portion, the petrous portion, the tympanic part and the styloid process. 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. 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.

Middle Ear

The middle ear is located into the petrous portion of the temporal bone and is bounded laterally by the tympanic membrane and the 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, which contains the ossicular chain, the attic and the hypotympanum.

Inner Ear

The inner ear contains the labyrinth, which is located into the petrous portion of the temporal bone. The osseous labyrinth (otic capsule) encloses the membranous labyrinth, which is surrounded by perilymphatic fluid and is divided into three components: the vestibule, the cochlea, and three semicircular canals.

Facial Nerve (Fig. 3 on page 8, Fig. 4 on page 9, Fig. 5 on page 10 and Fig. 6 on page 11)
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 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.

Classification of Temporal Bone Fractures

The classification of temporal bone fractures is of great importance in planning treatment, forecasting prognosis and understanding the associated complications.

Traditional Classification

The traditional classification system indicates the relationship between the fracture line and the long axis of the petrous portion of the temporal bone.

**Longitudinal Fractures (80%)**: The fracture line is parallel to the long axis of the petrous bone. The most common complications of longitudinal fractures are ossicular injury, tympanic membrane rupture, and hemotympanum with conductive hearing loss. Less commonly, the facial nerve and otic capsule also may be injured (Fig. 7 on page 12 and Fig. 8 on page 13).

**Transverse Fractures (20%)**: The fracture line is perpendicular to the long axis of the petrous bone and usually extends into the middle cranial fossa. Sensorineural hearing loss is common and may be secondary to injury of the labyrinthine structures. Facial paralysis is frequent in patients with a transverse fracture and may be immediate and complete (Fig. 9 on page 14 and Fig. 10 on page 15).

**Mixed Fractures**: The traditional bone fracture classification has important limitations as 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 and ossicular injury (Fig. 11 on page 16).

This classification failed to adequately correlate radiologic findings with clinical outcomes and new classifications have been suggested.
The latest two classifications of temporal bone fractures were designed by considering insults to the otic capsule and petrous bone. *Otic capsule-violating fractures* course through the labyrinth and *petrous fractures* extend into the petrous apex or the otic capsule. This kind of fractures are more commonly associated with complications such as sensorineural hearing loss, cerebrospinal fluid otorrhea, and facial nerve injury.

**Facial nerve traumatic lesion (Fig. 12 on page 17)**

The more common sequelae of the temporal bone fracture include injury to the facial nerve with facial paresis or paralysis.

Facial nerve traumatic lesion can be caused by contusion of the nerve, edema or hematoma (particularly at meatal foramen) of the nerve sheath, fixation by fracture fragments and partial or complete transaction of the nerve. Extent of functional loss is determined by the type and level of traumatic lesion. The perigeniculate portion of the facial nerve is most vulnerable due to its anatomical position.

Prognostic factors of traumatic facial palsy are the severity and onset time of facial nerve paralysis. Incomplete and delayed types of facial nerve paralysis present a better prognosis. Immediate paralysis frequently indicate a transaction of the nerve with loss of neural continuity, whereas delayed onset paralysis or paresis usually occurs in the context of an intact nerve and denotes the development of neural edema or expanding hematoma with neural compression inside a nonexpanding bony canal.
Fig. 1: Temporal bone anatomy

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Fig. 2: Temporal bone anatomy

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Fig. 3: Facial nerve anatomy

Facial nerve anatomy

**Fig. 4**: Facial nerve anatomy

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Facial nerve anatomy

A. Axial plane. The tympanic segment (arrow) extends from the geniculate ganglion to the second genu of the facial nerve. It passes posteriorly and laterally along the medial wall of the tympanic cavity.

B. Coronal plane. The facial nerve (arrow) lies above the oval window (arrowhead) and below the bulge of the lateral semicircular canal.

C. Axial plane. At the level of the sinus tympani, the nerve (arrow) changes direction at the second genu.

Fig. 5: Facial nerve anatomy

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**Fig. 6:** Facial nerve anatomy

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Fig. 7: Longitudinal temporal bone fracture

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Fig. 8: Longitudinal temporal bone fracture

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Fig. 9: Transverse temporal bone fracture

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Fig. 10: Transverse temporal bone fracture

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Fig. 11: Mixed temporal bone fracture

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Facial nerve injury

Fig. 12: Facial nerve injury

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Conclusion

Facial nerve lesion must be taken into account in patients with temporal bone fracture. Currently MDCT plays a mayor role in assessing the integrity of the facial nerve. Beyond the simple description of the fracture line, new MDCT allow to accurate the lesion of critical structures, which has important implications for the management and treatment of these patients.
References