Imaging of the Temporal Bone

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KEYWORDS

• Temporal bone • Computed tomography • Magnetic resonance imaging • Acquired • Congenital

KEY POINTS

- Knowledge of normal temporal bone anatomy and space-specific differential diagnoses is key to interpretation of temporal bone imaging.
- Correlation with clinical history and physical examination is vital to making the correct diagnosis or providing an appropriate differential.
- Computed tomography and magnetic resonance imaging are complementary imaging modalities in the evaluation of temporal bone abnormalities.

INTRODUCTION

Interpretation of temporal bone can be a challenging task for the general radiologist and neuroradiologist alike. An understanding of temporal bone anatomy and common abnormalities affecting the individual spaces of the temporal bone facilitates an expert interpretation. Although grouping temporal bone disease into types such as congenital, infectious, neoplastic, traumatic, or vascular can be a helpful memory tool, a space-specific approach is more valuable to the interpreting radiologist who rarely knows the pathologic category beforehand. Like all head and neck radiology, critical diagnostic information is derived from the clinical assessment and otoscopic examination. This article reviews common temporal bone abnormalities in a space-specific fashion with attention to key observations that the referring clinician will wish to know.

IMAGING TECHNIQUES

Computed tomography (CT) is the mainstay imaging modality for evaluation of the temporal bone (**Box 1**). The authors' institutional temporal bone CT protocol acquires noncontrast volumetric CT data of the bilateral temporal bones, and reconstructs the data into 0.6-mm thick axial and coronal planes and 0.6-mm thick planes parallel (Poschl) and perpendicular (Stenver) to the superior semicircular canals. Each plane is reconstructed in a bone algorithm with a field of view centered over each individual temporal bone. Axial 2-mm thick soft-tissue algorithm CT images are also reconstructed with a field of view including both temporal bones to evaluate the soft tissues. Intravenous contrast is only administered if there is clinical concern for abscess in the soft tissues of the external ear, or in cases when magnetic resonance (MR) imaging is not possible.

For MR imaging the authors use both a noncontrast protocol and a contrast-enhanced protocol for imaging of the temporal bone. The noncontrast protocol is a screening study comprising an axial 3-dimensional (3D) T2-weighted Sampling Perfection with Application optimized Contrast using different flip angle Evolutions (SPACE) sequence and a 1.25-mm thick 3D coronal T2 sequence, used to evaluate patients with clinical suspicion

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Box 1
Imaging techniques

Computed Tomography

- 0.6-mm thick axial and coronal bone algorithm (each temporal bone)
- 0.6-mm thick Poschl and Stenvers bone algorithm (each temporal bone)
- 2-mm thick axial soft-tissue algorithm (both temporal bones)
- Intravenous contrast administered if concern for soft-tissue abscess

Magnetic Resonance Imaging

Noncontrast protocol

- Axial 3-dimensional (3D) Sampling Perfection with Application optimized Contrast using different flip angle Evolutions (SPACE)
- 1.25-mm thick 3D coronal T2

Contrast-Enhanced Protocol

- Axial 3D SPACE
- 3-mm thick axial and coronal T1 precontrast
- 3-mm thick axial and coronal T1 fat-suppressed postcontrast

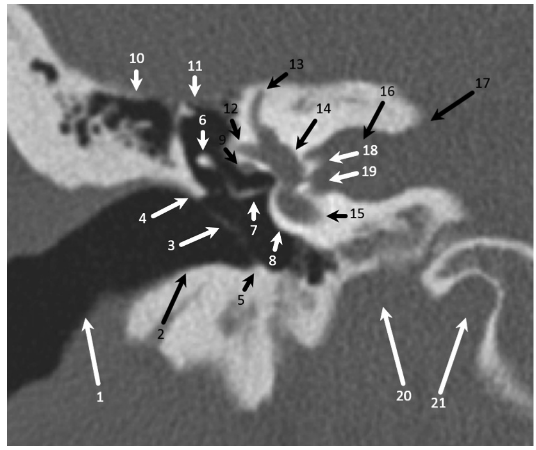

Fig. 1. Anatomy of the temporal bone. Coronal bone algorithm computed tomography (CT) image shows important structures of the external auditory canal (EAC), middle ear, and inner ear. (1) Cartilaginous EAC, (2) osseous EAC, (3) tympanic membrane, (4) scutum, (5) tympanic annulus, (6) incus, (7) stapes, (8) cochlear promontory, (9) tympanic segment of the facial nerve, (10) tegmen mastoideum, (11) tegmen tympani, (12) lateral semicircular canal, (13) superior semicircular canal, (14) vestibule, (15) basal turn of the cochlea, (16) internal auditory canal (IAC), (17) porus acusticus, (18) crista falciformis, (19) cochlear nerve canal, (20) jugular foramen, (21) hypoglossal canal.

for vestibular schwannoma. The T2 SPACE sequence was added to the screening MR imaging protocol to evaluate its utility as a cisternographic fluid-sensitive sequence, similar to constructive interference in steady-state (CISS) but without banding artifact.

For the contrast-enhanced protocol, the authors obtain 3-mm thick axial and coronal T1-weighted precontrast and T1-weighted fat-suppressed postcontrast sequences in addition to the 3D SPACE sequence. This protocol is typically used when there is clinical suspicion for disorder other than vestibular schwannoma.

NORMAL ANATOMY

Temporal bone anatomy can be conceptualized into the following key spaces: external auditory canal (EAC), middle ear and mastoid, inner ear, petrous apex, and facial nerve course. Accurate localization of temporal bone abnormality into one of these spaces is crucial to making the correct diagnosis or providing an appropriate differential.

The EAC (**Fig. 1**) is bordered laterally by the external ear and medially by the tympanic membrane. It is composed of 2 parts: the fibrocartilaginous EAC laterally and osseous EAC medially. The fibrocartilaginous EAC contains inferior fissures (of Santorini), which allow for abnormality in the EAC to pass into the adjacent parotid space inferiorly. The parotid lymph nodes are the first-order lymphatic drainage for the EAC and external ear.

The tympanic membrane (TM) is a 3-layered sound-transducing partition between the EAC and middle ear. Its superior attachment is the scutum, which should always have a sharp medial margin, and the inferior attachment is the tympanic annulus. The TM is divided into the pars flaccida (superior one-third) and the pars tensa (inferior two-thirds), which are demarcated by the attachment of the umbo of the medial malleolus to the TM.

The middle ear (see **Fig. 1**; **Fig. 2**) comprises the hypotympanum, mesotympanum, and epitympanum. An artificial plane between the tympanic annulus and cochlear promontory in the axial plane divides the hypotympanum and mesotympanum. The mesotympanum and epitympanum are divided by an artificial plane extending between the scutum and tympanic segment of the facial nerve. The hypotympanum contains air and no vital structures.

The mesotympanum (see **Fig. 2**) contains all parts of the ossicles with the exception of the head of the malleus and the short process of the