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# Computed tomography imaging technique and normal computed tomography anatomy of the temporal bone

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Computed tomography (CT) of the temporal bone is an important diagnostic imaging tool. Good CT acquisition and postprocessing technique are critical for depicting pathology and normal anatomy. In this article, we discuss CT acquisition and reformatting technique, as well as normal anatomy on temporal bone CT.
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## Computed tomography imaging technique

Computed tomography (CT) of the temporal bone has 2 major acquisition techniques: a dual acquisition, including separate direct coronal and direct axial scans or a single axially acquired volume, with coronal and optionally sagittal reformats from the axial source data. In most patients, a single axially acquired volume from a multidetector row CT (MDCT) scanner reformatted in multiple planes will provide adequate diagnostic information while minimizing radiation dose–related and patient-related motion artifact. There are cases, however, in which both direct coronal as well as axial acquisitions may provide superior diagnostic image quality.

Intravenous contrast may be helpful for specific indications, such as evaluating for complications of otomastoiditis, vascular tumors, and vascular abnormalities, but is not typically necessary for routine evaluation of coalescence or destruction of mastoid air cells or hearing loss.

### Multidetector row CT

MDCT scanners with 16, 32, 64, 128, 256, and 320 rows have become increasingly common compared with the early single-slice CT scanners. MDCT, with many scanners acquiring isotropic voxels, allows high-resolution imaging and enables high-quality image reconstruction for displaying in different 2-dimensional (2D) planes than the original acquisition. In addition, these data sets may allow various 3D reconstructions, which may aid comprehension of anatomy in complex cases.[1] This communication will concentrate on standard CT acquisition parameters and 2D reconstructions; the various 3D reconstruction and volume surface–shaded display techniques are numerous and outside the scope of this communication.

There are radiation considerations in MDCT with 4 or more slices, which include overbeaming and overranging.[2] Overbeaming is the difference between the area of the imaged body region and the total area irradiated by the scanner beam penumbra. Overranging is related to additional scanner rotations required at the beginning and end of a scan to reconstruct the first and last slices of the imaged body region. Each CT scanner may vary in its manufacturer-specific strategies for addressing radiation dose related to overranging and overbeaming. Please refer to their specific documentation for scanner specific recommendations.

### Acquisition technique

There are many possible temporal bone CT acquisition protocols, which can vary by manufacturer, specific scanner,

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and patient's age with different trade-offs in image quality and total radiation dose. These variations are beyond the scope of this article; however, we do describe our imaging protocol.

We prefer our 64 detector scanner (Lightspeed VCT; GE Medical Systems) for temporal bone imaging. We perform a helical acquisition and routinely use a collimation of 0.6 mm. Our pitch is set to 0.531:1 and rotation time of 0.5. Speed is 21.24 mm/s. Scan field of view is set to head. Kilovolt peak and tube current is adjusted according to both size of head and patient's age to balance image quality and total radiation dose. For neonates to 5-year-old children, our recommended low-dose protocol is 80 kV and 90-110 effective mAs. For children between the ages of 5 and 10 years, our protocol suggests 120 kV and 180 effective mAs. For adolescents, our protocol suggests 120 kV and 330 effective mAs. For adults, our protocol suggests 140 kV and 335 effective mAs. Lower radiation doses are possible, but need to balance diagnostic image quality with greater image noise typical in lower dose images.[3,4] On scanners that support iterative reconstruction techniques in addition to standard filtered back-projection, lower effective mAs may be used resulting in lower radiation doses without compromising image quality.[5]

For the axial technique, the patient is placed supine and positioned to minimize radiation to the lens. The scan is then planned for acquisition from the lateral scout topogram from the arcuate eminence through the mastoid tip. To limit distortion of reformatted images, axial CT source images may be obtained with a 0° gantry tilt and scan plane parallel to the inferior orbitomeatal line. For best quality of reformatted images in the coronal or sagittal planes, reconstruction of the raw data with submillimeter overlapping sections should be performed.[6]

For direct coronal imaging, the patient is placed in the prone position and the gantry angled perpendicular to the infraorbital-meatal line. The scan is planned for acquisition from the lateral scout from the level of the posterior temporomandibular joint anterior to the bony portion of the external auditory canal through the entire mastoid air cells.

In patients with implanted metallic hardware within the typical scan planes, it may be possible to improve diagnostic image quality with various techniques. Metal in the scan field can result in severe streak artifact directed in the plane of scanning, which can obscure anatomical areas of interest. By performing both direct coronal and axial acquisitions, each acquisition "throws" the artifact into a different plane, and the 2 acquisitions in total may result in a diagnostic scan. On an MDCT, acquiring an axial volume in an obliquity that avoids the metal and then reformatting into standard planes for imaging review, it may be possible to avoid scanning the metal altogether. There are other techniques to reduce the effect of metallic artifact on the postprocessing or reconstruction side, such as using of iterative reconstruction techniques[7] when available. To reduce metal artifact on the acquisition side, for temporal bone imaging, collimation and slice thickness are typically already at their minimum, but one can still increase kilovolt peak and increase effective mAs to reduce metal artifact at the expense of additional radiation dose. Another acquisition technique that may reduce metal artifact is acquisition on dual-energy energy scanners with reconstructed virtual monochromatic images,[8] though dual-energy scanners are still relatively rare in most clinical practices.

All images should be reconstructed in bone algorithm. Separate left and right sides may be reconstructed with a magnified smaller field of view in standard axial and coronal planes. For evaluating for superior semicircular canal dehiscence, additional reformats in the Poschl and Stenver planes may be performed. Some practices also choose to reconstruct an additional set of images using soft-tissue algorithm.

At our institution, we reconstruct each side into 0.625-mm thick axial images and effectively magnify them by using a display field of view of 100 mm. The raw data are then reformatted at the CT console or a separate workstation to create standard axial and coronal reformats.

## Standard axial and coronal reformats

To create standard axial reformats that will display the anterior and posterior limbs of the lateral semicircular canal in a single section, the raw data of the scan are loaded into the CT console or a workstation and then displayed in 3 orthogonal planes (axial, coronal, and sagittal). The sagittal images are used to identify an image in which the anterior and posterior limbs of the lateral semicircular canals are displayed in cross-section. The axial dataset created by selecting a plane parallel to the lateral semicircular canal in which a reference slice connects the anterior limb to the posterior limb of the lateral semicircular canal (Figure 1). The coronal reformats are then created by selecting a plane perpendicular to the axial images. At our institution, for these reformats, we generate 0.625-mm thick images at 0.5-mm intervals.

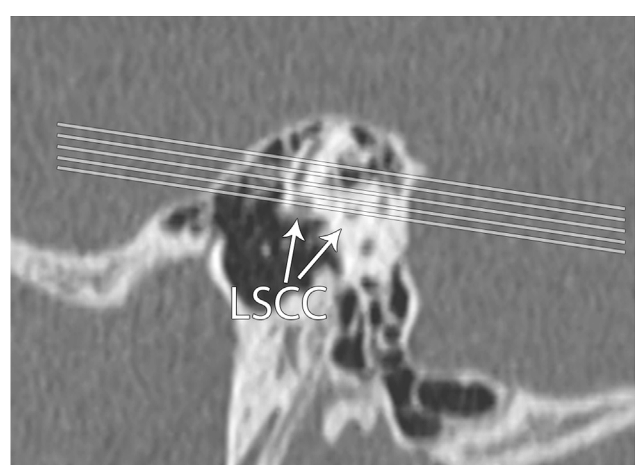


**Figure 1** Sagittal CT image with axial reformatting plane (lines) parallel to the line created by connecting the anterior and posterior limbs (arrows) of the lateral semicircular canal (LSCC).

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