Imaging Evaluation for Cochlear Implantation

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Learning Objectives:
- Understand the components and function of a cochlear implant.
- Have a basic understanding of the MRI anatomy relevant to cochlear implantation.
- Understand the hardware and pulse sequences that can optimize temporal bone MRI for cochlear implantation.
- Be able to recognize the contraindications to cochlear implantation.
- Be able to recognize the conditions that can impact or complicate cochlear implant surgery.

Cochlear Implant Function
1) Microphone receives sound
2) Sound is digitized by the speech processor
3) Coded signal is sent to the transmitter and then to the implant
4) Implant converts the code to electrical signals
5) Implant electrodes stimulate the cochlear nerve spiral ganglia
6) Stimulus travels through the auditory pathway
Imaging Evaluation for Cochlear Implantation

The imaging evaluation for cochlear implantation is focused on identifying those conditions that contraindicate implantation, or could potentially complicate or alter surgery.

- Cochlea or cochlear nerve aplasia are contraindications to cochlear implantation.
- Conditions that can impact the placement of the implant and electrode array include the degree of mastoid aeration, aberrant facial nerve anatomy, aberrant carotid artery, dehiscent jugular bulb, cochlear dysplasia, and labyrinthitis.
- An enlarged endolymphatic duct/sac can result in a “gusher” during the cochleostomy, and perilymphatic leaking around the electrode.
- Otosclerosis is not a contraindication to cochlear implantation, but extensive retrofenestral disease can result in facial nerve stimulation when the electrode array is activated.
- Imaging of the brain and brainstem needs to be performed to evaluate for other etiologies of SNHL.

CT Imaging

CT has unique advantages when evaluating patients with SNHL for cochlear implantation. Its sensitivity to bone detail is useful for evaluating cochlear morphology, the presence of ossifying labyrinthitis, and retrofenestral otosclerosis. Facial nerve anatomy is also easily discerned. We currently use a 64-slice helical acquisition and reconstruct in the planes of the semicircular canals. Disadvantages include radiation exposure and the inability to directly identify the cochlear nerve. The fast acquisition can be performed without anesthesia, and we have found this to be advantageous in infants and toddlers.

MR Imaging

Hardware. Temporal bone imaging has demonstrated significant recent evolution. While the technique is system dependant, high quality exams can be performed at 1.5T and 3T. At 1.5T we prefer to image with surface coils
or a 32-channel head coil. At 3T we have found contemporary multi-channel head coils provide acceptable SNR to image the small labyrinthine structures.

**Pulse sequences.** MR cisternography using heavily T2-weighted sequences is essential to evaluate the cochlear nerve and cochlea morphology. The scalar chambers and modiolus are easily discerned. Both 3D CISS (constructive interference in steady state) and FSE VFA (fast spin echo variable flip-angle) provide excellent detail. FSE VFA sequences avoid potential banding (or residual “ghosts”) sometimes seen in the gradient echo CISS sequences. Our current cochlear implant protocol utilizes an axial FSE VFA sequence at 16cm to include both inner ears. This is supplemented with a direct sagittal VFA acquisition perpendicular to the IAC to evaluate the cochlear nerve. Pre- and post-gadolinium sequences are obtained to evaluate for inflammation and tumor.

**References**


