Preoperative, Intraoperative, and Postoperative Auditory Evaluation of Patients with Acoustic Neuroma

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- Acoustic neuroma • Preoperative auditory evaluation
- Postoperative auditory evaluation • Intraoperative monitoring for acoustic neuroma
- Audiometry • Neurotology

PREOPERATIVE EVALUATION OF ACOUSTIC NEUROMA

Behavioral Audiometry

Because patients with acoustic neuroma (AN) typically present with unilateral sensorineural (SNHL) hearing loss as their most common presenting symptom, most of them would already have had behavioral audiometry. This test evaluates the entirety of the auditory system, including the tympanic membrane/middle ear, cochlea, cochlear nerve, dorsal and ventral cochlear nuclei, trapezoid body and its nucleus, superior olivary nuclei, lateral lemniscus and its nuclei, inferior colliculus, medial geniculate body, auditory radiations via the posterior limb of the internal capsule, and finally the auditory cortex in the transverse gyri of Heschl. For the purpose of this section, the focus is on tests that may be done as part of the preoperative assessment of a patient with AN. Pure tone auditory thresholds and speech discrimination score (SDS) are the most important factors in preoperative decision making. Even patients with relatively poor pure tone thresholds would remain candidates for attempted hearing-preservation surgery if their SDS were good enough to allow successful amplification. Traditionally the 50/50 rule is used as a guideline in this decision making; that is, a patient with hearing equal to or better than 50 dB pure tone average (PTA) and better than 50% SDS may be considered for hearing-preservation surgery. This also, of course, depends on tumor size because the likelihood of hearing preservation is inversely proportional to increasing tumor size.

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Auditory Brainstem Response

Some investigators advocate the use of auditory brainstem response (ABR) testing as a way to prognosticate chances for hearing preservation.[1] In the absence of a good-quality ABR, some surgeons would advise translabyrinthine surgery because there would be no ABR signal to monitor during attempted hearing-preservation surgery. On the other hand, those surgeons who routinely use direct eighth-nerve monitoring (DENM) during surgery have found that a cochlear nerve action potential (CNAP) is routinely recorded even when preoperative ABR is poor or absent.[2] Therefore, ABR is thought to be of little utility for preoperative assessment by surgeons using DENM because it does not influence their decision to attempt hearing preservation or their ability to monitor hearing intraoperatively.

ABR is a far-field technique for monitoring sound-evoked electrical activity in the auditory system from the cochlea/cochlear nerve through the brainstem. Because signal amplitude is negatively affected by increasing distance from the source of the neuronal activity, ABR has relatively small amplitudes on the order of tenths of a microvolt. In addition, averaging of hundreds to thousands of stimulus/response events is necessary to separate the desired signal from the random background electrical activity of the brain. Given the necessity of averaging many stimulus/response events, obtaining an ABR can take from 2 to 5 minutes. Pure tone thresholds less than 70 dB at 2 kHz and more are usually required to achieve an interpretable ABR. In patients with hearing worse than this, waveforms III through V may be of poor quality or absent. However, poor-quality or absent ABR waveforms do not preclude attempted hearing preservation during surgery because DNEM is often useful in this setting. Since the identification of ABR as a reliable tool in the assessment of the auditory system, a significant amount of research has endeavored to identify the location of the neural generators for the waveforms.

Animal studies investigating ABR, primarily in cats, were conducted in the mid- to late 1970s.[3–5] Correlation of ABR waveforms with their neural generators in humans was investigated in the mid-1970s and continued into the 1990s by studies looking at ABR abnormalities related to known lesions of the central nervous system[6–8] and studies using intracranially recorded auditory responses during surgery.[9–11] Based on these investigations, generally accepted neural generators for ABR waves I and II have been established. However, the precise identity of the neural generators for waves III, IV, and V remains unclear because of conflicting reports from various laboratories. **Fig. 1** demonstrates a normal ABR with the waveforms labeled with Roman numerals I through V. **Table 1** indicates the first 5 ABR waveforms, their typical latencies, and their proposed neural generators.[12–14] The most important waveforms regarding preoperative and intraoperative assessment of the auditory system in patients with ANs are I, III, and V. These waveforms correlate with the functional status of anatomic structures from the cochlea to the inferior colliculus. If these waveforms are present preoperatively then reasonable cochlear nerve integrity can be assumed. Likewise, if these waveforms are present at the conclusion of acoustic tumor surgery, the likelihood of hearing preservation is good.

Otoacoustic Emissions

Otoacoustic emissions (OAEs) in their different variations (distortion product OAE and transient-evoked OAE) can differentiate cochlear from noncochlear hearing losses and, thus, may be useful in a retrocochlear screening test battery.[15] Although the expected pattern would be one of poor hearing and intact OAEs, it was somewhat surprising to discover that more than half of ANs had reduced cochlear function as