American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Hearing Loss and/or Vertigo**

Variant 1: **Conductive hearing loss.**

Radiologic Procedure	Rating	Comments	RRL*
CT temporal bone without contrast	9		☢☢☢
MRI head and internal auditory canal without and with contrast	3		O
CT temporal bone with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	3		☢☢☢
MRI head and internal auditory canal without contrast	2		O
CT temporal bone without and with contrast	1		☢☢☢
CTA head with contrast	1		☢☢☢
MR venography head without contrast	1		O
MRA head without and with contrast	1		O
MRA head without contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Conductive hearing loss secondary to cholesteatoma or neoplasm with suspected intracranial or inner-ear extension; presurgical planning.**

Radiologic Procedure	Rating	Comments	RRL*
CT temporal bone without contrast	9		☢☢☢
MRI head and internal auditory canal without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head and internal auditory canal without contrast	6	For this procedure, contrast use is referred; do not use contrast only if it is contraindicated.	O
CT temporal bone with contrast	6		☢☢☢
CT temporal bone without and with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	3		☢☢☢
MR venography head without contrast	3		O
MRA head without contrast	3		O
CTA head with contrast	2		☢☢☢
MRA head without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Hearing Loss and/or Vertigo**

Variant 3: **Sensorineural hearing loss.**

Radiologic Procedure	Rating	Comments	RRL*
MRI head and internal auditory canal without and with contrast	9	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head and internal auditory canal without contrast	7	If contrast cannot be administered, CISS sequences are needed.	O
CT temporal bone without contrast	6		☢☢☢
CT temporal bone with contrast	4		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	3		☢☢☢
CT temporal bone without and with contrast	1		☢☢☢
CTA head with contrast	1		☢☢☢
MR venography head without contrast	1		O
MRA head without and with contrast	1		O
MRA head without contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 4: **Mixed conductive and sensorineural hearing loss.**

Radiologic Procedure	Rating	Comments	RRL*
MRI head and internal auditory canal without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	O
CT temporal bone without contrast	8	If contrast cannot be administered, CISS sequences are needed.	☢☢☢
MRI head and internal auditory canal without contrast	7		O
CT temporal bone with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	2		☢☢☢
CT head without and with contrast	2		☢☢☢
CT temporal bone without and with contrast	1		☢☢☢
CTA head with contrast	1		☢☢☢
MR venography head without contrast	1		O
MRA head without and with contrast	1		O
MRA head without contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Hearing Loss and/or Vertigo**

Variant 5: **Congenital hearing loss, total deafness, cochlear implant candidate, surgical planning.**

Radiologic Procedure	Rating	Comments	RRL*
CT temporal bone without contrast	9		☢☢☢
MRI head and internal auditory canal without and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head and internal auditory canal without contrast	7		O
CT temporal bone with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	3		☢☢☢
CT temporal bone without and with contrast	1		☢☢☢
CTA head with contrast	1		☢☢☢
MR venography head without contrast	1		O
MRA head without and with contrast	1		O
MRA head without contrast	1		O

Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** ***Relative Radiation Level**

Clinical Condition: **Hearing Loss and/or Vertigo**

Variant 6: **Episodic vertigo with or without associated hearing loss or tinnitus or aural fullness (peripheral vertigo).**

Radiologic Procedure	Rating	Comments	RRL*
MRI head and internal auditory canal without and with contrast	8	Use of this procedure depends on the degree/type of hearing loss. If hearing loss is asymmetric, MRI is appropriate. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head and internal auditory canal without contrast	7		O
CT temporal bone without contrast	7	CT is preferred if symptoms suggest superior semicircular canal dehiscence; Poschl view reconstruction is indicated in that case.	☢☢☢
CT temporal bone with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	2		☢☢☢
CT temporal bone without and with contrast	1		☢☢☢
CTA head with contrast	1		☢☢☢
MR venography head without contrast	1		O
MRA head without and with contrast	1		O
MRA head without contrast	1		O
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Hearing Loss and/or Vertigo**

Variant 7: **Persistent vertigo with or without neurological symptoms (central vertigo).**

Radiologic Procedure	Rating	Comments	RRL*
MRI head and internal auditory canal without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head and internal auditory canal without contrast	7		O
MRA head and neck without and with contrast	6	This procedure is appropriate if there is a concern for dissection/stroke. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRA head and neck without contrast	6	This procedure is appropriate if there is a concern for dissection/stroke.	O
CTA head and neck with contrast	6	This procedure is appropriate if there is a concern for dissection/stroke.	☢☢☢
CT temporal bone without contrast	5		☢☢☢
CT temporal bone with contrast	3		☢☢☢
CT head without contrast	3		☢☢☢
CT head with contrast	3		☢☢☢
CT head without and with contrast	3		☢☢☢
MR venography head without contrast	2		O
CT temporal bone without and with contrast	1		☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

HEARING LOSS AND/OR VERTIGO

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Summary of Literature Review

Hearing Loss

Hearing loss is typically classified as conductive, sensorineural, or mixed. Conductive hearing loss (CHL) results from pathologic changes of either external or middle-ear structures that prevent sound waves from reaching the endolymph of the inner ear. Sensorineural hearing loss (SNHL) results from pathologic changes of inner-ear structures such as the cochlea or the auditory nerve and prevents neural impulses from being transmitted to the auditory cortex of the brain [1].

Conductive Hearing Loss

In CHL, imaging is mainly required to evaluate ear canal or middle-ear pathology. Computed tomography (CT) is the modality of choice in the study of CHL for its excellent ability to demonstrate even small abnormalities of the middle ear's bony structures. Established indications for imaging encompasses conditions such as the complications of acute and chronic otomastoiditis, evaluation of the postoperative ear following chronic otomastoiditis surgery, postoperative localization of middle-ear prosthetic devices, and assessment of congenital or vascular anomalies. In particular, the precise extent of bone erosion associated with cholesteatoma is correctly demonstrated by high-resolution CT. Conversely, although fistulization through the tegmen tympani of the temporal bone is usually detected by CT, the actual involvement of the meninges and veins is better assessed by magnetic resonance imaging (MRI). Although it is not a first-line study, MRI may be indicated when complicated inflammatory lesions are suspected of extending into the inner ear or toward the sigmoid sinus, jugular vein, or intracranial cavity (eg, epidural, subdural, or brain abscess). Neoplasms arising from or extending into the middle ear may require the use of both MRI and CT. The most important data for surgical planning concern the destruction of thin bony structures and the relationships of the lesion to the dura, inner ear/otic capsule, and surrounding vessels. Vascular imaging such as CT angiography (CTA) or MR angiography (MRA) is reserved for cases when initial imaging studies raise suspicion of a paraganglioma extending into the middle ear.

Sensorineural Hearing Loss

SNHL may be sudden, fluctuating, or progressive. Sudden SNHL is a manifestation of viral infections, vascular occlusive diseases, or inner-ear membrane ruptures [2-6]. In rare instances, sudden SNHL can also be a manifestation of a vestibular schwannoma [7,8]. Vertigo may be associated with these conditions and can help define whether the lesion is peripheral or central [9]. To discriminate among idiopathic, viral, and other causes of SNHL, auditory brainstem responses and gadolinium-enhanced MRI are used [2,3,5,10]. Patients with cochleitis or cochlear nerve neuritis typically have abnormal auditory brainstem responses and may be helped by a tapering course of oral corticosteroids [2,5]. Presence or absence of cochlear or cochlear nerve enhancement on gadolinium-enhanced MRI does not reliably guide corticosteroid therapy. However, some authors suggest that MRI-positive sudden deafness is more difficult to cure with steroid therapy than MRI-negative sudden deafness [5]. Nevertheless, all patients suffering sudden SNHL should undergo MR imaging to rule out vestibular schwannoma or other retrocochlear lesion.

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Fluctuating SNHL is difficult to evaluate. The audiometric examination would indicate the level of dysfunction but not the likely cause. Patients who are noted to have large vestibular aqueducts (bony vestibular aqueduct >2 mm at the midpoint) may have a congenital cause for fluctuating hearing loss [11-15]. Such patients with large vestibular aqueducts have high-frequency loss more often than low-frequency loss and can have conductive or mixed hearing loss. Fluctuating SNHL due to an enlarged vestibular aqueduct appears to be more common in children and young adults, an important point in differentiating this disease from Ménière disease, in which most patients are middle-aged or older. Of interest, the vestibular aqueduct of patients with Ménière disease may be small, not large [16,17].

There is speculation on the causes of a sudden drop in hearing in patients with large vestibular aqueducts. Two possible causes are hyperosmolar fluid reflux from the endolymphatic sac into the inner ear and rupture of the membranous labyrinth or a perilymphatic fistula due to transmission of intracranial pressure to the inner ear through the enlarged vestibular aqueduct. It is well recognized that head trauma patients or those subjected to extreme barotrauma, as in SCUBA diving, may aggravate their episodes of hearing loss. In such cases, it may be worthwhile to image the temporal bones to detect enlarged vestibular aqueducts and thus advise the patients/their parents of the dangers of contact sports or activities that entail extreme barometric pressure changes [12,13]. Imaging findings must be correlated with audiometry because the fluctuating SNHL of patients with large vestibular aqueducts does not resemble the low-frequency changes characteristic of Ménière disease, which may also be associated with fluctuating hearing loss [12,13]. The mechanism by which patients with enlarged vestibular aqueduct have conductive or mixed hearing loss is thought to be secondary to a third window effect: transmission of sound to the cochlea is damped or lessened by loss of sound energy through the enlarged aqueduct. Patients with isolated large vestibular aqueducts may have a different pathophysiologic basis than patients whose large aqueducts are associated with other inner-ear malformations. Patients with complex inner-ear malformations may be subject to recurrent episodes of meningitis, the “gusher” syndrome, or both, resulting in a dead ear after surgical intervention such as a stapedectomy [6,12].

Asymmetric SNHL or gradually declining unilateral SNHL is a common symptom that may be ascribed to many different pathologic processes. Initial evaluation is geared toward localizing the lesion site, (ie, cochlear [18] or retrocochlear [19]). Most retrocochlear lesions are associated with an abnormal auditory brainstem response, which is often obtained before an imaging study. Most clinicians will refer patients to MRI after preliminary audiometric, auditory brain response testing, or both [2,3,20,21] show an asymmetric SNHL or asymmetric transmission of the electrical impulse along the auditory nerve and central auditory pathway.

Patients with retrocochlear localization should have a complete MRI study of the head in addition to internal auditory canal and temporal bones studies. The MRI examination should include complete evaluation of the central nuclei in the brainstem as well as the auditory pathways extending upward into the cerebral hemispheres [22]. Whether gadolinium contrast enhancement is routinely used depends on many factors, including coil size, field of view, field strength, and pulse sequences. If gadolinium cannot be used, CISS (constructive interference in steady state) sequences are recommended. CT is sometimes diagnostic in lesions ≥1.5 cm in diameter when dedicated techniques are used, but it does not readily detect small brainstem lesions such as infarctions or demyelination [21-28].

Mixed Conductive and Sensorineural Hearing Loss

The classic cause of mixed hearing loss (MHL) is otospongiosis. Otospongiosis (also known as otosclerosis) is a primary bone dysplasia of the otic capsule in which normal bone is replaced by spongy, irregular bone. The fissula ante fenestram is the cleft of fibrocartilage tissue just anterior to the oval window and is often the initial site affected. The fenestral form demonstrates a large plaque narrowing the oval window. The retrofenestral form or cochlear form shows plaques in the pericochlear bony labyrinth. It is bilateral in up to 85% of cases. In general, most cochlear disorders such as otosclerosis are evaluated by high-resolution CT imaging. On CT, focal lucencies are apparent in the otic capsule. MRI shows punctate enhancement in the otic capsule. Other causes of MHL include extensive cholesteatoma and separate pathologies contributing to CHL and SNHL [15].

Preoperative assessment for cochlear implants is usually best accomplished using thin-section CT with reformatted multiplanar images. In patients with congenital etiologies for hearing loss, recent reports suggest that high-resolution MRI is more useful for surgical planning [29,30]. Cochlear nerve aplasia is rare and can be diagnosed through high-resolution MRI techniques performed in the parasagittal plane to visualize the absence on the nerve within the internal auditory canal.

Trauma

The effects of trauma can be divided into osseous and soft-tissue injuries. CT is used extensively to delineate fractures (typically divided into longitudinal and transverse fractures of the temporal bone and characterized as otic-capsule sparing versus otic-capsule violating), ossicular dislocations, fistulous communications, and facial nerve injury and to evaluate post-traumatic hearing loss [31].

Congenital and Childhood Hearing Loss

The ideal imaging method for children with unilateral or asymmetric sensory neural hearing loss is still controversial. Most reports suggest that children with unilateral or asymmetric SNHL should have a high-resolution temporal bone CT scan and that brain and temporal bone MRI be obtained in select cases. In general, high-resolution CT has been shown to be efficacious for the preoperative workup for congenital hearing loss due to aural dysplasia, congenital ossicular anomalies, large vestibular aqueduct syndrome, congenital absence of cochlear nerve, and labyrinthitis ossificans [32-41].

Vertigo

Dizziness is a common clinical complaint that accounts for 1% of visits to office-based physicians in the United States. Functional balance relies on the complex interaction of vestibular function, vision, and proprioception. A defect in any of these areas results in the sensation of imbalance, disequilibrium, light-headedness, or vertigo [42]. Vertigo is a form of dizziness in which there is an illusion of movement (rotation, tilt, or linear translation). The mechanism for vertigo is an imbalance of tonic vestibular signals. Thus, vertigo is a hallucination of movement and is a symptom of a disturbed vestibular system [1,17,43].

The complete vestibular system comprises the end organs in the temporal bone, the vestibular components of the VIII cranial nerve, and the central connections in the brainstem. The end organs in the temporal bones are the cristae of the 3 semicircular canals, which respond to movement of the head, and the macula of utricle, which records the position of the head. The semicircular canals record angular acceleration, and the macula of utricle records linear acceleration. Vertigo is subdivided into peripheral vertigo (due to failure of the end organs) or central vertigo (due to failure of the vestibular nerves or central connections to the brainstem and cerebellum) [16,17,44]. One should try to differentiate them based on history, examination, and tests such as electronystagmography [42].

Imaging of the Dizzy Patient

Patients with a typical history of peripheral causes of vertigo, such as benign paroxysmal positional vertigo (BPPV) or vestibular neuritis, do not normally need imaging. Patients with asymmetric hearing loss, unclear central causes of dizziness, and other neurologic signs should undergo imaging.

MRI with gadolinium contrast is the most common imaging modality used to evaluate the dizzy patient. Cerebellopontine lesions, such as vestibular schwannomas and meningiomas, are easily diagnosed with gadolinium-enhanced MRI. Multiple sclerosis can present with hyperintense plaques seen on fluid-attenuated inversion recovery and T2-weighted images. Acute or chronic ischemic disease is easily diagnosed with MRI. CT complements MRI because of its superior imaging of the bony labyrinth. If a semicircular canal fistula is suspected as the cause of dizziness (patient has vertigo with loud noise or with Valsalva maneuver), CT can confirm this diagnosis. Temporal bone fractures are best evaluated with CT and can show a fracture extending across the otic capsule and involving the labyrinth [42]. One of the common neurological scenarios seen in the emergent setting is a patient with sudden-onset dizziness. A noncontrast CT of the head may assist both the triage and management. Depending on the CT findings and the patient's clinical condition, the workup may proceed to a postcontrast CT or MRI with diffusion to evaluate for possible mass or infarction; CTA or MRA may be useful in discovering a vertebral artery dissection or other significant vascular pathology.

Benign Paroxysmal Positional Vertigo, Ménière Disease, and Peripheral Vestibular Disorders

Patients with BPPV describe episodic vertigo lasting less than a minute, brought on by movements of the head, and without other associated symptoms. The history is typical and diagnostic; there are no radiological findings in patients with BPPV [16,43].

In Ménière disease, paroxysmal attacks of whirling vertigo are usually accompanied by nausea and are transient, lasting a few hours but not days. Severe episodic vertigo is accompanied by tinnitus, fluctuating hearing loss, and a feeling of fullness in the affected ear(s). Typically, during the attack, hearing decreases and tinnitus increases. Hearing may improve between attacks in early stages of the disease. Generally, hearing loss begins unilaterally

and affects the lower frequencies primarily; mid and high frequencies are affected in later stages of the disease [16,17,43].

Ménière disease is most common in middle age and may become bilateral in up to 50% of affected patients. The etiology of Ménière disease is a failure of the mechanism regulating the production and disposal of endolymph, resulting in recurrent attacks of endolymphatic hydrops. Since the endolymphatic duct and sac are sites of resorption of endolymph, these structures play an important role in the pathogenesis of endolymphatic hydrops. The success of various surgical procedures in relieving Ménière disease symptoms has led to great interest in using CT, MRI, or both to evaluate the vestibular aqueduct, endolymphatic duct, and sac [16,45-48].

Unfortunately, there is no unanimity on the value of imaging in cases of Ménière disease. Some investigators have used CT or MRI to predict results of shunt surgery based on showing patency of the vestibular aqueduct [1,46]. Other investigators, however, report that the size, shape, and patency of the vestibular aqueduct are of no value in predicting surgical results in shunt procedures or in predicting occurrence of bilateral disease [16]. MRI, with its ability to differentiate the endolymphatic duct and sac from the bony vestibular aqueduct, may offer more useful information than CT [46]. The value of CT and MRI rests in their ability to rule out associated infectious or neoplastic disease (eg, vestibular schwannoma in the setting of asymmetric SNHL [16,17,49-51].

Vestibular neuritis is a clinical diagnosis based on an aggregate of symptoms. The disease is characterized by an acute onset of severe vertigo, lasting several days, followed by gradual improvement over several weeks. Hearing is typically unaffected. The history includes onset of vertigo following an illness such as an upper respiratory infection. Most patients become completely symptom free following resolution of the primary disease [16,52]. Vestibular labyrinthitis is similar because the disease presents with the acute symptoms of vertigo but is always associated with hearing loss. Labyrinthitis is usually viral in origin but may result from acute or chronic bacterial middle-ear infections. Unlike viral labyrinthitis, labyrinthitis associated with suppurative ear disease may progress to partial or complete occlusion of the lumen of the affected labyrinth [16,17]. Early on, the obstructed lumen may be detected on MRI due to loss of signal intensity of fluid contents. Later, more complete obliteration and partial ossification of all the labyrinthine structures occur, with an end result of labyrinthitis obliterans, which is readily diagnosed on high-resolution CT [53].

With MRI, there may be gadolinium enhancement of the labyrinthine structures or vestibular nerves during the acute or subacute stages of vestibular neuritis, labyrinthitis, or both [54,55]. Such results must be interpreted with care because sudden labyrinthine dysfunction may be caused by spontaneous hemorrhage or injury, which results in abnormal signal intensities within the labyrinthine structures secondary to the blood products [56].

Superior semicircular canal dehiscence syndrome is a pathologic condition in which sound or pressure transmitted to the inner ear may inappropriately activate the vestibular system. It can be diagnosed by high-resolution coronal CT imaging of the temporal bones [57-59]. A Poschl view, perpendicular to the petrous ridge, is also helpful in diagnosing superior canal dehiscence [60].

Sound-induced vertigo or nystagmus has been reported in superior semicircular canal dehiscence, perilymphatic fistulas, syphilis, Ménière disease, congenital deafness, chronic otitis, and Lyme disease.

Diseases of the internal auditory canal and cerebellopontine angle are generally not characterized by severe attacks of vertigo but rather by mild disequilibrium, intermittent dizziness, and/or periods of exacerbated dizziness [16,43]. A variety of benign or malignant tumors of the petrous temporal bone, such as paragangliomas, carcinomas, or metastatic tumors, may directly involve the labyrinthine structures, causing vertigo. Such processes are readily evaluated with CT and MRI.

Central Vestibular Disorders

Lesions of the brainstem or cerebellum that result in central vertigo can be readily diagnosed by MRI. Vascular insufficiency in the vertebrobasilar circulation is a common cause of vertigo in patients older than 50. Thrombosis of the labyrinthine artery or infarction of the lateral medulla from insufficient vertebral or posterior inferior cerebellar artery can cause severe vertigo. Subclavian steal syndrome can cause a variety of symptoms, including vertigo [17,61,62]. Such conditions can be carefully evaluated with MRA, CTA, or conventional angiography of the posterior fossa vasculature. For a complete discussion of the evaluation of stroke and ischemia and a more directed approach to this condition, see the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease."

A variety of other central nervous diseases may produce vertigo or dizziness. These include seizure disorders, multiple sclerosis, ataxic diseases, head injuries, or any cause of increased intracranial pressure. Vertigo may result as a sequela of stroke, and transient ischemic attacks may present as episodic dizziness [16].

Various metabolic disorders can result in dizziness. These include thyroid disorders, hyperlipidemia, diabetes, and hypoglycemia. Autoimmune diseases or diseases that affect the proprioceptive system can cause dizziness. In many cases, the possibility of functional neurotic symptoms must be considered in patients in whom no disease can be found. Finally, cervical spondylosis is thought to cause vertigo by disc degeneration and disc-space narrowing, which affects nearby nerves, or by osteophyte formation, which compresses the blood vessels. In such cases, CT may be helpful [16,17,53].

Tinnitus

Vertigo and hearing loss are sometimes accompanied by tinnitus. Tinnitus is defined as a sound, such as buzzing or ringing, heard in one or both ears that occurs without an external stimulus. Tinnitus is a common phenomenon, occurring in 10% of the general population, and is prevalent between ages 40–70. Evaluation of patients with tinnitus usually requires a detailed history, a neuro-otologic physical examination, and a comprehensive audiologic evaluation. This evaluation will determine the appropriate imaging study.

Tinnitus may be pulsatile (repetitive sound that may or may not coincide with the patient's heartbeat ["pulse-synchronous"]) or nonpulsatile (continuous or constant noise). Tinnitus is also classified as being subjective (heard only by the patient) or objective (audible to the examining physician). Nonpulsatile tinnitus is almost always subjective and is most common. Pulsatile tinnitus may be subjective or objective.

Nonpulsatile tinnitus is often associated with medication toxicities or exposures to environmental noises. The imaging evaluation of patients with isolated nonpulsatile tinnitus usually does not reveal structural abnormalities. With associated findings of headaches, hearing loss, or dizziness, imaging studies such as a contrast-enhanced MRI study may be warranted [54].

Detailed discussion of pulsatile and nonpulsatile tinnitus without hearing loss or vertigo is beyond the scope of this document and will be addressed in an upcoming ACR Appropriateness Criteria® dedicated to this topic.

Summary

- CT of the temporal bone without contrast is the most appropriate initial imaging study in patients with conductive hearing loss.
- MRI of the brain and internal auditory canal (IAC) without and with contrast is the most appropriate initial imaging study in patients with asymmetric sensorineural hearing loss.
- High-resolution temporal bone CT without contrast is indicated in patients undergoing preoperative evaluation for cochlear implantation. High-resolution temporal bone MRI use is increasing as an adjunctive study for preoperative planning.
- In patients with suspected superior semicircular canal dehiscence, high-resolution temporal bone CT with Poschl view reconstruction is indicated.
- Patients with central vertigo are best evaluated with MRI of the brain and the IAC. If vertebral artery dissection is suspected, further evaluation with MRA or CTA of the head and neck is recommended.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [63].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Documents

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

References

1. Bagai A, Thavendiranathan P, Detsky AS. Does this patient have hearing impairment? *JAMA.* 2006;295(4):416-428.
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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.