Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Curtin HD.. Imaging of Conductive Hearing Loss With a Normal Tympanic Membrane. AJR Am J Roentgenol. 206(1):49-56, 2016 Jan.	Review/Other-Dx	N/A	To present an approach to imaging conductive hearing loss in patients with normal tympanic membranes and discusses entities that should be checked as the radiologist evaluates this potentially complicated issue.	No results stated in abstract.	4
2. Shah LM, Wiggins RH, 3rd. Imaging of hearing loss. Neuroimaging Clin N Am. 2009; 19(3):287-306.	Review/Other-Dx	N/A	Review of the common entities causing hearing loss and divide these pathologies into conductive hearing loss, SNHL, and mixed hearing loss.	Reviewed the common pathologies and the imaging findings affecting the hearing pathways from outside to inside, starting at the external auditory canal and moving inward toward the midbrain.	4
3. Connor SE, Sriskandan N. Imaging of dizziness. [Review]. Clin Radiol. 69(2):111-22, 2014 Feb.	Review/Other-Dx	N/A	To review the key anatomy, relevant imaging methods, and the diagnostic considerations with their imaging findings.	No results stated in abstract.	4
4. Macleod D, McAuley D. Vertigo: clinical assessment and diagnosis. Br J Hosp Med (Lond). 2008; 69(6):330-334.	Review/Other-Dx	N/A	To review the diagnosis and assessment of vertigo.	Outline of current workup and treatment algorithms.	4
5. Newman-Toker DE, Della Santina CC, Blitz AM. Vertigo and hearing loss. [Review]. Handb. clin. neurol.. 136:905-21, 2016.	Review/Other-Dx	N/A	To describe recommended strategies for audiovestibular imaging based on patient symptoms and signs.	No results stated in abstract.	4
6. Bakhit M, Heidarian A, Ehsani S, Delphi M, Latifi SM. Clinical assessment of dizzy patients: the necessity and role of diagnostic tests. Glob J Health Sci. 6(3):194-9, 2014 Mar 24.	Observational-Dx	270 patients.	To investigate the performing rate of Brain Magnetic Resonance Imaging (MRI), Laboratory tests, Pure Tone Audiometry (PTA), and Electrocardiography (ECG) diagnostic tests, and to evaluate their necessity and medical indications.	These findings revealed that many unnecessary and time-consuming diagnostic tests were performed, which had minor contribution to the final diagnosis and treatment of the patients.	3
7. Kutz JW, Jr. The dizzy patient. Med Clin North Am. 2010; 94(5):989-1002.	Review/Other-Dx	N/A	To discuss causes and treatment of dizziness in patients.	Central causes include migraine-associated dizziness, postconcussion syndromes, cerebrovascular disease, and multiple sclerosis. Treatment depends on the cause of the dizziness and may include dietary modifications, diuretics, vestibular suppressants, vestibular rehabilitation, or surgical intervention.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
8. Belden CJ, Weg N, Minor LB, Zinreich SJ. CT evaluation of bone dehiscence of the superior semicircular canal as a cause of sound- and/or pressure-induced vertigo. Radiology. 2003; 226(2):337-343.	Observational-Dx	50 patients, 50 controls having CT at 1.0-mm and 57 controls having CT at 0.5-mm	To describe the CT findings at different collimation widths associated with superior SSC dehiscence syndrome and to determine the frequency of these findings in a control population.	The PPV of CT in identification of SSC dehiscence syndrome improves with 0.5-mm-collimated helical CT (93%) and reformation in the SSC plane.	2
9. Branstetter BF 4th, Harrigal C, Escott EJ, Hirsch BE. Superior semicircular canal dehiscence: oblique reformatted CT images for diagnosis. Radiology. 2006; 238(3):938-942.	Observational-Dx	27 patients; 27 control patients; 108 total temporal bones	To retrospectively determine, by using thin-section MDCT, whether additional reformations in the planes of Stenver and Poschl change the diagnostic interpretation for SSC dehiscence when compared with the diagnostic interpretation of standard coronal reformations for SSC dehiscence.	Observer 1 diagnosed SSC dehiscence in 25/108 (23%) temporal bones and had no discordances between the two reviews. Observer 2 diagnosed SSC dehiscence in 21/108 (19%) temporal bones and had one intraobserver discordance. After a post hoc consensus review of this one discordance, the radiologic diagnosis remained equivocal. The discordance involved the right temporal bone of a patient suspected of having SSC dehiscence in the left temporal bone, so no clinical follow-up was available.	2
10. Lee YH, Rivas-Rodriguez F, Song JJ, Yang KS, Mukherji SK. The prevalence of superior semicircular canal dehiscence in conductive and mixed hearing loss in the absence of other pathology using submillimetric temporal bone computed tomography. J Comput Assist Tomogr. 38(2):190-5, 2014 Mar-Apr.	Observational-Dx	404 patients	To assess the relationship between superior semicircular canal dehiscence (SSCD) and hearing impairment.	From the patients with conductive hearing loss (CHL) (n = 127) and mixed hearing loss (MHL)(n = 45), the overall prevalence of SSCD in the ears classified as CHL, MHL, and normal hearing status were 6.6%, 7.2%, and 3.0%, respectively. Furthermore, the odds ratio for SSCD in the absence of any cause of hearing loss (eg, dysfunction of the tympanic membrane or middle ear, temporal bone computed tomographic (TBCT)abnormalities, otosclerosis, trauma, surgery) was 5.35 in MHL (4/27; P = 0.037, 95% confidence interval, 1.1-25.81) and 3.31 in CHL (5/61; P = 0.115, 95% confidence interval, 0.75-14.63), compared with normal hearing status.	2

Hearing Loss and/or Vertigo
EVIDENCE TABLE

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11. Saliba I, Maniakas A, Benamira LZ, Nehme J, Benoit M, Montreuil-Jacques V. Superior canal dehiscence syndrome: clinical manifestations and radiologic correlations. Eur Arch Otorhinolaryngol. 271(11):2905-14, 2014 Nov.	Observational-Dx	187 patients.	To describe the superior canal dehiscence syndrome (SCDS) and its vestibule-cochlear manifestations, while analyzing dehiscence size, audiogram and vestibular-evoked myogenic potential (VEMP) changes following dehiscence obliteration. We conducted a prospective study in a tertiary referral center.	At 2 months postoperatively, low-frequency air-bone gaps showed a statistically significant improvement ($p < 0.001$). SDS and PTA did not show any statistically significant changes 2 months postoperatively ($p = 0.282$ and $p = 0.295$, respectively). VEMP threshold differences between operated and contralateral ears were statistically significant preoperatively ($p < 0.001$) and non-significant 2 months postoperatively ($p = 0.173$). Dehiscence size only showed a statistically significant correlation with preoperative total cochlear symptoms, while remaining insignificant with all other variables measured.	2
12. Stimmer H, Hamann KF, Zeiter S, Naumann A, Rummeny EJ. Semicircular canal dehiscence in HR multislice computed tomography: distribution, frequency, and clinical relevance. Eur Arch Otorhinolaryngol. 269(2):475-80, 2012 Feb.	Review/Other-Dx	350 patients	To evaluate the frequency of semicircular dehiscence using high-resolution CT technology in the newest state of development in a large and unselected group of (mostly nonvestibular) patients.	An unselected group of ENT patients with different clinical symptoms and variable age was chosen. Semicircular canal dehiscence were found in 9.6% of temporal bones, superior semicircular canal was affected mostly (8%), less common posterior semicircular canal (1.2%); only in 3 cases (0.4%), lateral semicircular canal showed dehiscence. In 60% of SSC dehiscence, we registered bilateral manifestation. The so-called "third mobile window" in semicircular canal dehiscence causes a great variety of clinical symptoms like vertigo, nystagmus, oscillopsies, hearing loss, tinnitus and autophonia. Comparison with anatomic studies shows that CT examination implies the risk of considerable overestimation; this fact emphasizes the important role of clinical and neurophysiological testing.	4
13. Eshetu T, Aygun N. Imaging of the temporal bone: a symptom-based approach. [Review]. Semin Roentgenol. 48(1):52-64, 2013 Jan.	Review/Other-Dx	N/A	To discuss the common diseases associated with the temporal bone in a symptom-based approach.	No results stated in abstract.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
14. Meyer A, Bouchetemble P, Costentin B, Dehesdin D, Lerosey Y, Marie JP. Lateral semicircular canal fistula in cholesteatoma: diagnosis and management. Eur Arch Otorhinolaryngol. 273(8):2055-63, 2016 Aug.	Observational-Dx	42 patients.	To present the authors' experience on the management of labyrinthine fistula secondary to cholesteatoma.	However, preoperative high-resolution computed tomography predicted fistula in 88 %. Using the Dornhoffer and Milewski classification, 16 cases (38 %) were identified as stage 1, 22 (52 %) as stage II, and 4 (10 %) as stage III. The choice between open or closed surgical procedure was independent of the type of fistulae. The cholesteatoma matrix was completely removed from the fistula and immediately covered by autogenous material. In eight patients (19 %), the canal was drilled with a diamond burr before sealing with autologous tissue. After surgery, hearing was preserved or improved in 76 % of the patients. There was no statistically significant relationship between the extent of the labyrinthine fistula and the hearing outcome.	2
15. Mohan S, Hoeffner E, Bigelow DC, Loevner LA. Applications of magnetic resonance imaging in adult temporal bone disorders. [Review]. Magn Reson Imaging Clin N Am. 20(3):545-72, 2012 Aug.	Review/Other-Dx	N/A	To summarize the current MR imaging applications in evaluating adult temporal bone lesions according to their location, beginning from the most common indication, vestibular schwannoma.	No results stated in abstract.	4
16. Braun T, Dirr F, Berghaus A, et al. Prevalence of labyrinthine ossification in CT and MR imaging of patients with acute deafness to severe sensorineural hearing loss. Int J Audiol. 52(7):495-9, 2013 Jul.	Observational-Dx	64 patients.	To evaluate the prevalence of labyrinthine ossification, and especially cochlear ossification, in a cohort of patients with unilateral sudden deafness or severe sensorineural hearing loss.	Radiologic signs of cochlear ossification were present in 14 patients (12 CT and 2 MRI). Eight patients showed unilateral and six patients bilateral signs of cochlear ossification. In all except one of the unilateral cases, the deafened ear was affected.	3

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
17. Kulkarni BSN, Bajwa H, Chandrashekhar M, et al. CT- and MRI-based gross target volume comparison in vestibular schwannomas. Rep. Pract. Oncol. Radiother.. 22(3):201-208, 2017 May-Jun.	Observational-Dx	43 patients.	To represent an enumeration and comparison of gross target volumes (GTV) as delineated independently on contrast-enhanced computed tomography (CT) and T1 and T2 weighted magnetic resonance imaging (MRI) in vestibular schwannomas (VS).	The male to female ratio for VS was found to be 1:1.3. The tumor was right sided in 34.9% and left sided in 65.1%. Tumor volumes (TV) on CT image sets were ranging from 0.251 cc to 27.27 cc. The TV for CT, MRI T1 and T2 weighted were 5.15 +/- 5.2 cc, 5.8 +/- 6.23 cc, and 5.9 +/- 6.13 cc, respectively. Compared to MRI, CT underestimated the volumes. The mean dice coefficient between CT versus T1 and CT versus T2 was estimated to be 68.85 +/- 18.3 and 66.68 +/- 20.3, respectively. The percentage of volume difference between CT and MRI (%VD: mean +/- SD for T1; 28.84 +/- 15.0, T2; 35.74 +/- 16.3) and volume error (%VE: T1; 18.77 +/- 10.1, T2; 23.17 +/- 13.93) were found to be significant, taking the CT volumes as the baseline	3
18. Berrettini S, Seccia V, Fortunato S, et al. Analysis of the 3-dimensional fluid-attenuated inversion-recovery (3D-FLAIR) sequence in idiopathic sudden sensorineural hearing loss. JAMA Otolaryngol Head Neck Surg. 139(5):456-64, 2013 May.	Observational-Dx	23 patients.	To confirm the diagnostic, clinical, and prognostic role of 3-dimensional fluid-attenuated inversion-recovery (3D-FLAIR) magnetic resonance imaging (MRI) in patients with idiopathic sudden sensorineural hearing loss (ISSNHL).	Thirteen patients showed high-intensity signals in the affected inner ear on precontrast and postcontrast 3D-FLAIR MRI (57%). From the analysis of different MRI sequences, we posited 3 radiologic patterns likely correlated with mild hemorrhage, acute inflammation, and presence or absence of blood-labyrinth or nerve barrier (BLB) breakdown. Hypersignal on 3D-FLAIR MRI was positively associated with pretreatment hearing loss (P = .04) and presence of vertigo (P = .04). A strict correlation also existed between distribution of the signal (vestibule, semicircular canals) and clinical features (vertigo) (P = .04).	3
19. Chau JK, Cho JJ, Fritz DK. Evidence-based practice: management of adult sensorineural hearing loss. [Review]. Otolaryngol Clin North Am. 45(5):941-58, 2012 Oct.	Review/Other-Dx	N/A	To review our current knowledge regarding the causes of sensorineural hearing loss and reviews the more challenging clinical presentations of sensorineural hearing loss.	No results stated in abstract.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
20. Cueva RA. Auditory brainstem response versus magnetic resonance imaging for the evaluation of asymmetric sensorineural hearing loss. Laryngoscope. 2004; 114(10):1686-1692.	Observational-Dx	312 patients	Multicenter, prospective, nonrandomized comparison of ABR and MRI for the evaluation of patients with asymmetric SNHL. ABR and MRI were interpreted independently in a blinded fashion.	31 (9.94%) of 312 were found on MRI to have lesions causing their SNHL. Sensitivity of ABR as a screening test was 71%, and specificity was 74%. Study recommends abandoning ABR as a screening test for asymmetric SNHL and adoption of a focused MRI protocol as the screening test of choice (within certain guidelines).	1
21. Davidson HC, Harnsberger HR, Lemmerling MM, et al. MR evaluation of vestibulocochlear anomalies associated with large endolymphatic duct and sac. AJNR Am J Neuroradiol. 1999; 20(8):1435-1441.	Observational-Dx	63 patients with large endolymph-atic duct and sac, 60 controls	Retrospective review. Use high-resolution T2-weighted FSE MRI to describe the features and prevalence of specific anomalies that occur in association with large endolymphatic duct and sac.	High-resolution FSE MRI provides a means of exquisite characterization of large endolymphatic duct and sac and a more sensitive detection of associated vestibulocochlear anomalies.	3
22. Kwan TL, Tang KW, Pak KK, Cheung JY. Screening for vestibular schwannoma by magnetic resonance imaging: analysis of 1821 patients. Hong Kong Med J .2004; 10(1):38-43.	Observational-Dx	1,821 consecutive patients	Retrospective study to examine diseases that can be detected by MRI in patients suspected of having vestibular schwannoma (acoustic neuroma) and to assess the extent of the problem of hearing loss in a screened population.	MRI is an effective tool to screen for vestibular schwannoma in patients with sensorineural or mixed hearing loss.	3
23. Mafee MF. Congenital sensorineural hearing loss and enlarged endolymphatic sac and duct: role of magnetic resonance imaging and computed tomography. Top Magn Reson Imaging 2000; 11(1):10-24.	Review/Other-Dx	N/A	To review the anatomy and embryology of the inner ear, the pathological changes associated with congenital SNHL, the spectrum of imaging findings in patients with SNHL.	MRI and CT are useful for preoperative evaluation of cochlear implant patients. CT is the study of choice for evaluating anomalies of otic labyrinth including large vestibular aqueduct. MRI is recommended to confirm the presence or absence of cochlear nerve when a cochlear implant is indicated. Both MRI and CT cannot provide any information on physiological condition and electrical excitability of the cochlear sensory end organ and cochlear nerve.	4
24. Valvassori GE, Clemis JD. The large vestibular aqueduct syndrome. Laryngoscope. 1978; 88(5):723-728.	Review/Other-Dx	50 patients	Analysis of the radiographic observation of patients, each having an enlarged (>1.5 mm diameter) vestibular aqueduct.	Large vestibular aqueduct may be associated with other inner abnormalities in 60% of cases.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
25. Weissman JL, Curtin HD, Hirsch BE, Hirsch WL, Jr. High signal from the otic labyrinth on unenhanced magnetic resonance imaging. AJNR Am J Neuroradiol. 1992; 13(4):1183-1187.	Review/Other-Dx	2 patients	Case report in which high signal from the otic labyrinth was observed on precontrast MRI of patients who presented with sudden hearing loss and vertigo.	High signal may be due to hemorrhage. Further studies recommended.	4
26. Gebarski SS, Tucci DL, Telian SA. The cochlear nuclear complex: MR location and abnormalities. AJNR Am J Neuroradiol. 1993; 14(6):1311-1318.	Observational-Dx	175 patients	Retrospective study to determine the value of MRI in detecting central cochlear nuclei and their diseases.	175 patients provided 350 cochlear nuclear complex for study. 13/175 patients (7.4%) had focal cochlear nuclear complex MR abnormalities; 136 of these 175 patients had been referred for MR evaluation of unilateral SNHL. In 10 of these 136 patients (7.4%), the cochlear nuclear complex abnormalities shown on MR proved to be the cause of the SNHL. MRI delineates central cochlear nuclei and focal abnormalities reliably.	3
27. Sharma A, Viets R, Parsons MS, Reis M, Chrisinger J, Wippold FJ 2nd. A two-tiered approach to MRI for hearing loss: incremental cost of a comprehensive MRI over high-resolution T2-weighted imaging. AJR Am J Roentgenol. 202(1):136-44, 2014 Jan.	Review/Other-Dx	256 patients	To compare the cost-effectiveness of two approaches to using Magnetic Resonance Imaging (MRI) for the evaluation of patients with hearing loss.	The conventional approach was less cost-effective, with a baseline incremental cost-effectiveness ratio (ICER) of 27,299 minutes of scanner utilization per unit increase in effectiveness. Assuming a 50% reduction in the reimbursement of the technical component from the current level by the Centers for Medicare & Medicaid Services, this result reflected an ICER of $258,664 per unit increase in effectiveness. The results of a sensitivity analysis showed the robustness of the cost-effectiveness of the two-tiered imaging approach in a variety of scenarios that reflect differences in scanning practices and possible differences in recall rates. The conventional imaging approach was absolutely dominated by the two-tiered approach in the scenarios created to reflect the expected range of prevalence of disease.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

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28. Daniels RL, Swallow C, Shelton C, Davidson HC, Krejci CS, Harnsberger HR. Causes of unilateral sensorineural hearing loss screened by high-resolution fast spin echo magnetic resonance imaging: review of 1,070 consecutive cases. Am J Otol. 2000; 21(2):173-180.	Review/Other-Dx	1,070 consecutive cases	Retrospective review to evaluate ability of screening high-resolution, nonenhanced, FSE T2-weighted MRI of the IAC and CPA to detect nonacoustic schwannoma causes of unilateral SNHL.	High-resolution FSE screening technique, used in conjunction with appropriate clinical prescreening and referral, can provide an equally sensitive method of evaluating unilateral SNHL compared to gadolinium-enhanced T1 MRI while reducing costs and providing distinct advantages in evaluating nonacoustic schwannoma causes of SNHL.	4
29. Held P, Fellner C, Fellner F, et al. MRI of inner ear and facial nerve pathology using 3D MP-RAGE and 3D CISS sequences. Br J Radiol. 70(834):558-66, 1997 Jun.	Observational-Dx	38 patients	To evaluate three dimentional (3D) constructive interference in steady state (CISS), unenhanced 3D magnetization prepared rapid gradient echo (MP-RAGE) and contrast enhanced 3D MP-RAGE for the diagnosis of neoplastic, vascular and inflammatory lesions of the cerebellopontine angle, the inner auditory canal, the labyrinth and the facial nerve.	Results of contrast enhanced 3D MP-RAGE-pathological enhancement was found in the following lesions: schwannomas of the cerebellopontine angle (CPA) and the internal auditory canal (IAC), 4; schwannomas of the IAC, 7 and labyrinthine tumours, 3; posterior fossa lymphoma, 1; meatal meningioma, 1; acute labyrinthitis, 15 and neuritis of the seventh cranial nerve, 10. Results of 3D CISS-filling defects were found with the following lesions: schwannomas of the CPA, the IAC or labyrinth, 14; lymphoma, 1; meningioma, 1; labyrinthine fibrosis, 13 and scar in the IAC.	3
30. Zealley IA, Cooper RC, Clifford KM, et al. MRI screening for acoustic neuroma: a comparison of fast spin echo and contrast enhanced imaging in 1233 patients. Br J Radiol. 2000; 73(867):242-247.	Observational-Dx	1,233 consecutive patients	Prospectively study patients with suspected acoustic neuroma referred for MRI and compare the diagnosis based on thin section FSE with that of gadolinium enhanced MRI.	Screening examination should continue to include a gadolinium enhanced sequence in order to optimize the detection of small acoustic neuromas.	2

Hearing Loss and/or Vertigo
EVIDENCE TABLE

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31. Dudau C, Salim F, Jiang D, Connor SE. Diagnostic efficacy and therapeutic impact of computed tomography in the evaluation of clinically suspected otosclerosis. Eur Radiol. 27(3):1195-1201, 2017 Mar.	Observational-Dx	259 patients	To assess the diagnostic efficacy and therapeutic impact of computed tomography (CT) in evaluating patients with clinically suspected otosclerosis.	Of 259 CT studies, 46 % of patients were positive, 49 % negative and 5 % equivocal for otosclerosis. A relevant alternative CT diagnosis was evident in 33 % of the negative studies. One targeted surgery was performed for every four CT studies. CT outcome influenced the decision to perform stapedectomy in 41 % CT-positive versus 4 % CT-negative patients. CT-positive ears for otosclerosis could not be predicted from baseline clinical or audiometric criteria. Those with endosteal extension demonstrated lower bone conduction thresholds presurgically. The positive predictive value of CT diagnosis of otosclerosis was 100 %.	3
32. Quesnel AM, Moonis G, Appel J, et al. Correlation of computed tomography with histopathology in otosclerosis. Otol Neurotol. 34(1):22-8, 2013 Jan.	Review/Other-Dx	47 specimens	To compare computed tomography (CT) findings in otosclerosis to histopathology.	In a randomized blinded evaluation, radiologists identified 8 of 10 bones with otosclerosis and made 3 false-positive diagnoses from the 36 control bones. Radiologic examination correctly identified otosclerosis anterior to the oval window, in the pericochlear area, and in the round window niche in 17 of 17, 9 of 11, and 3 of 6 bones, respectively. CT correctly determined involvement of the endosteal layer, oval window (OW) obliteration, and round window (RW) obliteration in 5 of 8, 2 of 2, and 2 of 2 temporal bones.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

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33. Jeong SW, Kim LS. A new classification of cochleovestibular malformations and implications for predicting speech perception ability after cochlear implantation. Audiol Neurootol. 20(2):90-101, 2015.	Observational-Dx	59 children.	To introduce a new classification of cochleovestibular malformation (CVM) and to investigate how well this classification can predict speech perception ability after cochlear implantation in children with CVM.	The speech perception test scores after implantation were significantly better in children with CVM type A or type B than in children with CVM type C or type D. The test scores did not differ significantly between the implanted children with CVM type A or type B and those without CVM. In univariate regression analysis, the type of CVM was a significant predictor of the speech perception test scores in implanted children with CVM. Multivariate regression analysis revealed that the age at cochlear implantation, cochlear nerve size and preimplantation speech perception test scores were significant predictors of the postimplantation speech perception test scores. The chance of cochlear nerve deficiency increased progressively from CVM type A to type D.	3
34. Young JY, Ryan ME, Young NM. Preoperative imaging of sensorineural hearing loss in pediatric candidates for cochlear implantation. [Review]. Radiographics. 34(5):E133-49, 2014 Sep-Oct.	Review/Other-Dx	N/A	To review the relevant imaging methods and normal anatomic findings, briefly describe the cochlear implantation device and implantation procedure, and review the major imaging findings associated with congenital and acquired childhood Sensorineural hearing loss (SNHL).	No results stated in abstract.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
35. El-Badry MM, Osman NM, Mohamed HM, Rafaat FM. Evaluation of the radiological criteria to diagnose large vestibular aqueduct syndrome. Int J Pediatr Otorhinolaryngol. 81:84-91, 2016 Feb.	Observational-Dx	61 children	To increase the sensitivity of the radiological diagnosis of the large vestibular aqueduct syndrome (LVAS).	Only 81% of ears of children with LVAS (99 ears) fit Valvassori criterion (i.e., larger than 1.5mm at midpoint), while 19% (23 ears) of them were missed. There were statistically significant correlations among the diameters of the VA in the axial view (both in the midpoint and operculum) and their counterparts in the 45 degrees oblique reformate. Values equal to or greater than 1.2mm in the midpoint and 1.3mm in the operculum are proposed to be the criteria to diagnose LVA in the 45 degrees oblique reformate. Finally, no significant correlations were found between the degree of hearing loss and VA diameters at the axial or 45 degrees oblique reformate.	3
36. Kim BG, Sim NS, Kim SH, Kim UK, Kim S, Choi JY. Enlarged cochlear aqueducts: a potential route for CSF gushers in patients with enlarged vestibular aqueducts. Otol Neurotol. 34(9):1660-5, 2013 Dec.	Observational-Dx	71 patients; 142 ears	To investigate whether the size of the cochlear aqueduct (CA) is increased in patients with enlarged vestibular aqueducts (EVAs) compared with individuals with normal inner ear anatomy. Furthermore, to assess whether the size of the CA is related to the cerebrospinal fluid (CSF) gusher during cochlear implantation (CI) surgery.	The CA was larger in patients with EVA (2.39 +/- 0.99 mm) as compared with controls (1.76 +/- 0.87 mm; $p < 0.001$). The types that could be most easily visualized from the subarachnoid space to the cochlea were more common in patients with EVA. Furthermore, mean CA size was significantly larger in EVA patients with CSF gushers (3.65 +/- 1.12 mm) as compared with those without CSF gushers (2.03 +/- 0.66 mm; $p < 0.001$).	3
37. Glastonbury CM, Davidson HC, Harnsberger HR, Butler J, Kertesz TR, Shelton C. Imaging findings of cochlear nerve deficiency. AJNR Am J Neuroradiol. 2002; 23(4):635-643.	Review/Other-Dx	22 patients	Retrospectively review high-resolution T2-weighted FSE MRI of patients examined for SNHL who had deficiency of the cochlear nerve.	Deficiency of the cochlear nerve was seen in 12 patients with congenital SNHL and in 10 patients with acquired SNHL. Deficiency of the cochlear nerve can be shown by high-resolution T2-weighted FSE MRI.	4
38. Parry DA, Booth T, Roland PS. Advantages of magnetic resonance imaging over computed tomography in preoperative evaluation of pediatric cochlear implant candidates. Otol Neurotol. 2005; 26(5):976-982.	Observational-Dx	56 patients	Retrospective study to compare MRI to HRCT in the preoperative evaluation of pediatric cochlear implant candidates.	MRI is more sensitive and specific in diagnosing soft tissue abnormalities in the inner ear than HRCT in cochlear implant candidates and the abnormalities detected with MRI are more likely to influence the implantation process.	3

Hearing Loss and/or Vertigo
EVIDENCE TABLE

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39. Jiang ZY, Odiase E, Isaacson B, Roland PS, Kutz JW Jr. Utility of MRIs in adult cochlear implant evaluations. Otol Neurotol. 35(9):1533-5, 2014 Oct.	Review/Other-Dx	188 patients.	To determine the prevalence of Magnetic Resonance Imaging (MRI) abnormalities in adults undergoing cochlear implantation and to correlate abnormalities to audiology data.	The study included 188 patients. Seventeen (9%) patients had significant otic capsule or vestibulocochlear nerve pathologies: 5 vestibular schwannomas, 4 enlarged vestibular aqueducts, 2 hypoplastic cochlear nerves, 2 labyrinthitis ossificans, 1 cochlear aplasia, 1 posterior semicircular canal malformation, 1 calcified meningioma, and 1 cholesterol granuloma. MRI results were normal (65%) or with findings not directly related to hearing loss (incidental findings, 25%) in the remaining patients. Mean pure tone average (PTA) differences (between the implanted and contralateral ear) did not significantly vary between normal-incidental and abnormal MRI scans (-6.6 dB versus -6.7 dB, p = 0.99) nor did speech discrimination scores (SDS) scores (8.5% versus 8.4%, p = 0.99). No significant difference was found in HINT scores for patients with a normal versus an abnormal MRI (19% versus 16,%, p = 0.62).	4
40. Lawhn-Heath C, Buckle C, Christoforidis G, Straus C. Utility of head CT in the evaluation of vertigo/dizziness in the emergency department. EMERG. RADIOL.. 20(1):45-9, 2013 Jan.	Review/Other-Dx	448 patients	To determine diagnostic yield for the patients with dizziness and for the patients undergoing head computed tomography (CT).	The diagnostic yield for head CT ordered in the ER for acute dizziness is low (2.2 %; 1.6 % for emergent findings), but MRI changes the diagnosis up to 16 % of the time, acutely in 8 % of cases.	4
41. Pasaoglu L.. Vertebrobasilar system computed tomographic angiography in central vertigo. Medicine (Baltimore). 96(12):e6297, 2017 Mar.	Observational-Dx	249 patients	To evaluate computed tomography angiography (CTA) findings of the vertebrobasilar system in central vertigo without stroke.	Vertebral artery hypoplasia and >/=50% stenosis were seen more often in the vertigo group (P = 0.000, <0.001). Overall 78 (60.5%) vertigo patients had >/=50% stenosis, 54 (69.2%) had stenosis at V1 segment, 9 (11.5%) at V2 segment, 2 (2.5%) at V3 segment, and 13 (16.6%) at V4 segment. Both vertigo and control groups had similar basilar artery hypoplasia and >/=50% stenosis rates (P = 0.800, >0.05).	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Fukuoka H, Takumi Y, Tsukada K, et al. Comparison of the diagnostic value of 3 T MRI after intratympanic injection of GBCA, electrocochleography, and the glycerol test in patients with Meniere's disease. Acta Otolaryngol (Stockh). 132(2):141-5, 2012 Feb.	Observational-Dx	20 patients.	To investigate the relationship between 3 Tesla (3T) Magnetic Resonance Imaging (MRI) after intratympanic injection of gadolinium-based contrast agent (GBCA), the glycerol test, and electrocochleography (ECoG) in patients with Meniere's disease (MD).	A positive result was observed in 11 patients (55%) in the glycerol test and in 12 patients (60%) by ECoG. The incidence of positive findings when evaluating the same patients with both the glycerol test and ECoG increased to 75%. Nineteen of 20 (95%) patients showed positive results for 3 T MRI.	3
43. Grieve SM, Obholzer R, Malitz N, Gibson WP, Parker GD. Imaging of endolymphatic hydrops in Meniere's disease at 1.5 T using phase-sensitive inversion recovery: (1) demonstration of feasibility and (2) overcoming the limitations of variable gadolinium absorption. Eur J Radiol. 81(2):331-8, 2012 Feb.	Experimental-Tx	15 patients.	To demonstrate the feasibility of imaging endolymphatic hydrops at 1.5 T using phase-sensitive inversion recovery (PS-IR) Magnetic Resonance Images (MRI) following intratympanic injection of gadolinium (Gd).	In 11 out of 13 patients, dilated endolymphatic structures were clearly identified as filling defects within the opacified perilymph allowing identification of endolymphatic hydrops. There was a large range in the degree of perilymphatic signal enhancement due to variability in absorption of Gd from the middle ear into the perilymph. The use of multiple TI values allowed confident identification of endolymphatic hydrops in Meniere’s patients even when perilymph opacification was suboptimal at one TI value.	2
44. Hagiwara M, Roland JT Jr, Wu X, et al. Identification of endolymphatic hydrops in Meniere's disease utilizing delayed postcontrast 3D FLAIR and fused 3D FLAIR and CISS color maps. Otol Neurotol. 35(10):e337-42, 2014 Dec.	Observational-Dx	15 patients	To evaluate the diagnostic utility of delayed postcontrast 3 dimentional (3D) Fluid- attenuated inversion recovery (FLAIR) images and a color map of fused postcontrast FLAIR and constructive interference steady state (CISS) images in the identification of endolymphatic hydrops in patients with clinically diagnosed Meniere's disease.	The gray-scale 3D FLAIR images demonstrated 68.2% sensitivity and 97.4% specificity, and the fused color map images demonstrated 85.0% sensitivity and 88.9% specificity in the identification of endolymphatic hydrops in Meniere's disease. There was significant correlation between the gray-scale 3D FLAIR images and fused color map images with the categorization of involvement ($p = 0.002$). Inter-evaluator reliability was excellent (kappa = 0.83 for gray-scale images, kappa = 0.81 for fused color map).	2

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
45. Hornibrook J, Flook E, Greig S, et al. MRI Inner Ear Imaging and Tone Burst Electrocochleography in the Diagnosis of Meniere's Disease. Otol Neurotol. 36(6):1109-14, 2015 Jul.	Experimental-Dx	102 patients	To compare the sensitivity of gadolinium Magnetic Resonance Imaging (MRI) inner imaging with tone burst electrocochleography (EcochG) for diagnosing endolymphatic hydrops.	In 30 patients with symptom-based Definite Meniere's Disease, tone burst EcochG was positive in 25 (83%) and the click EcochG was positive in 9/30 (30%), and gadolinium MRI imaging diagnosed hydrops in 14 (47%). A positive result for either MRI imaging or tone burst EcochG was seen in 26 patients (87%). In 14 subjects with symptom-based Probable Meniere's Disease, 10 (71%) had either a positive EcochG or MRI. In 13 with Possible Meniere's Disease, four (31%) had a positive EcochG or MRI.	2
46. Karatas A, Kocak A, Cebi IT, Salviz M. Comparison of Endolymphatic Duct Dimensions and Jugular Bulb Abnormalities Between Meniere Disease and a Normal Population. J Craniofac Surg. 27(5):e424-6, 2016 Jul.	Observational-Dx	35 patients	To determine the length and width of the endolymphatic duct (ED) along with jugular bulb (JB) abnormalities in Meniere disease (MD) patients and normal controls using high-resolution computed tomography, and to discuss the results supporting and opposing endolymphatic hydrops based on the data obtained.	The ED was found to be significantly shorter and narrower in the affected ears of the MD patients than in the healthy control group. In addition, more JB abnormalities were detected in the affected ears of the MD patients than in the healthy control group. However, there was no difference between the affected and unaffected ears of the MD patients.	3
47. Le CH, Truong AQ, Diaz RC. Novel techniques for the diagnosis of Meniere's disease. [Review]. CURR. OPIN. OTOLARYNGOL. HEAD NECK SURG.. 21(5):492-6, 2013 Oct.	Review/Other-Dx	N/A	To review the newly developed and emerging diagnostic techniques with real or potential clinical application to the diagnosis of Meniere's disease.	No results stated in abstract.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
48. Liu F, Huang W, Meng X, Wang Z, Liu X, Chen Q. Comparison of noninvasive evaluation of endolymphatic hydrops in Meniere's disease and endolymphatic space in healthy volunteers using magnetic resonance imaging. Acta Otolaryngol (Stockh). 132(3):234-40, 2012 Mar.	Experimental-Dx	26 patients	To compare the standard evaluation of endolymphatic hydrops in Meniere's disease and the endolymphatic space in healthy volunteers in the cochlea and the vestibule in the same age group by applying noninvasive intratympanic gadolinium (Gd) perfusion through the eustachian tube and three-dimensional fluid-attenuated inversion recovery magnetic resonance imaging (3D-FLAIR MRI).	Gd was present in the perilymph of the inner ear, which clearly displayed the endolymphatic space on 3D-FLAIR MRI with a visible borderline between the perilymph and the endolymph. In 45-55-year-old healthy volunteers, the normal value for the endolymphatic space in the cochlea ranged between 8% and 26%, and that in the vestibule was between 20% and 41%. According to the normal value for the endolymphatic space, four of six patients had a ratio of more than 26% in the cochlea; moreover, four of six patients had a ratio of more than 41% in the vestibule. All the patients had a ratio of more than the normal value in the cochlea and/or the vestibule. No significant changes in pure tone test and tympanometry were noted.	3
49. Liu Y, Jia H, Shi J, et al. Endolymphatic hydrops detected by 3-dimensional fluid-attenuated inversion recovery MRI following intratympanic injection of gadolinium in the asymptomatic contralateral ears of patients with unilateral Meniere's disease. Med Sci Monit. 21:701-7, 2015 Mar 06.	Experimental-Dx	30 patients	To identify the incidence of endolymphatic hydrops using 3-dimensional fluid-attenuated inversion recovery (3D-FLAIR) magnetic resonance imaging (MRI) in the contralateral ear in patients with unilateral Meniere's disease (MD).	Endolymphatic hydrops was observed in 7 of the 30 (23.3%) asymptomatic ears. The mean PTA of the asymptomatic ears in the contralateral hydrops patients (33.0+/-6.1 dB) was significantly higher compared with the non-hydrops patients (17.8+/-5.7 dB). The patients with observed contralateral hydrops exhibited a significantly longer duration of the disease compared with the non-hydrops patients (6.7+/-6.3 vs. 2.9+/-3.1 years, respectively). Furthermore, the patients with contralateral hydrops had a worse hearing level in the affected ears compared with the non-hydrops patients (70.3+/-7.4 vs. 52.5+/-3.8 dB, respectively).	2

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
50. Naganawa S, Yamazaki M, Kawai H, Bokura K, Sone M, Nakashima T. Imaging of Meniere's disease after intravenous administration of single-dose gadodiamide: utility of multiplication of MR cisternography and HYDROPS image. Magn. reson. med. sci.. 12(1):63-8, 2013 Mar 25.	Observational-Dx	10 patients	To compare CNR values between the endo- and perilymph on HYDROPS images and those on HYDROPS-Mi2 images obtained 4 hours after IV administration of single-dose GBCM. Further clinical study is warranted to justify the routine use of HYDROPS-Mi2 images.	The average CNR of generated images increased to more than 200 times that of HYDROP images.	3
51. Naganawa S, Yamazaki M, Kawai H, et al. MR imaging of Meniere's disease after combined intratympanic and intravenous injection of gadolinium using HYDROPS2. Magn. reson. med. sci.. 13(2):133-7, 2014.	Experimental-Dx	10 patients	To evaluate whether the use of HYDROPS2 images can obviate the need to use 3-dimensional inversion recovery with real reconstruction (3D-real IR) images for intratympanic (IT) and intravenous (IV) administration (IT + IV) study.	Enhancement of cochlear and vestibular perilymph was recognized in all ears in HYDROPS2 images but only in the IT + IV side in 3D-real IR images, and enhancement of only 22 of 30 semicircular canals could be recognized in the IT + IV side in the 3D-real IR images. In all IV-side ears, 3D-real IR failed to detect the enhancement of the perilymph in the cochlea, vestibule, and 3 semicircular canals. HYDROPS2 detected perilymph enhancement in all cochleas and vestibules and 58 of 60 semicircular canals but did not demonstrate enhancement in the superior and posterior semicircular canal of the IV side in one patient. Grades of EH in the IT + IV side agreed completely between HYDROPS2 and 3D-real IR images (Figs.1, 2). No case showed significant motion between scans.	3
52. Sepahdari AR, Ishiyama G, Vorasubin N, Peng KA, Linetsky M, Ishiyama A. Delayed intravenous contrast-enhanced 3D FLAIR MRI in Meniere's disease: correlation of quantitative measures of endolymphatic hydrops with hearing. Clin Imaging. 39(1):26-31, 2015 Jan-Feb.	Observational-Dx	22 subjects; 41 ears	To correlate quantifiable measures of endolymphatic hydrops (EH) with auditory function in the setting of Meniere's disease (MD).	EH was better evaluated on 3D maximum intensity projections (MIPs) than on two-dimensional (2D) images. Using MIPs, quantitative assessments EH correlated with severity of hearing impairment.	2

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
53. Wu Q, Dai C, Zhao M, Sha Y. The correlation between symptoms of definite Meniere's disease and endolymphatic hydrops visualized by magnetic resonance imaging. Laryngoscope. 126(4):974-9, 2016 Apr.	Observational-Dx	54 patients	To investigate the correlation between a battery of diagnostic symptoms of definite Meniere's disease (MD) and the degree of endolymphatic hydrops (EH) in the inner ear.	Various degrees of EH were observed in the vestibule and/or each turn of the cochlea in the affected ears of all patients. The duration of MD disease and low-tone and middle-tone hearing thresholds were proportional to the extent of EH in the vestibule and cochlear. However, no significant correlation was demonstrated between EH and other aspects of symptoms such as high-tone hearing loss, tinnitus, and aural fullness. Of all subjects, 16.7% exhibited bilateral EH on MRI exam who were diagnosed with unilateral MD based on diagnostic criteria.	3
54. Kabra R, Robbie H, Connor SE. Diagnostic yield and impact of MRI for acute ischaemic stroke in patients presenting with dizziness and vertigo. Clin Radiol. 70(7):736-42, 2015 Jul.	Observational-Dx	188 patients	To identify predictors of acute ischaemic stroke (AIS) and evaluate the diagnostic yield and impact of magnetic resonance imaging (MRI) in patients imaged for dizziness and vertigo.	One hundred and eighty-eight patients were included: 39 with vertebrobasilar AIS (20.7%), 32 (17%) with a significant but non-ischaemic abnormality, and 117 (62.2%) with a normal or non-related abnormality. The sensitivity of CT in diagnosing AIS was 9.52% (95% CI: 1.67-31.8%). Posterior inferior cerebellar artery (PICA) territory infarcts were the most common (38.5%). Patients with AIS were significantly more likely to be older than 50 years ($p = 0.04$), have a greater number of cardiovascular risk factors ($p < 0.01$), shorter duration of symptoms ($p = 0.03$), and at least one neurological sign ($p = 0.02$). DWI MRI had a diagnostic impact on 21.6% patients with stroke.	3

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55. Arai M, Higuchi A, Umekawa J, Mochimatsu Y, Itoh K. [The efficiency of magnetic resonance angiography (MRA) in the diagnosis and vertigo--prediction of vertebrobasilar insufficiency (VBI) and atherosclerosis]. [Japanese]. Nippon Jibiinkoka Gakkai Kaiho. 102(7):925-31, 1999 Jul.	Observational-Dx	185 patients	To see whether Magnetic Resonance Angiography (MRA) findings can distinguish vertebrobasilar insufficiency (VBI) from peripheral vestibular disorders (PVD) to evaluate the efficiency of MRA in the diagnosis of vertigo.	In 185 vertigo patients, 139 patients were clinically diagnosed as having PVD, 41 patients as having VBI, and 5 patients as having cerebellar and brainstem infarctions. The numbers of patients in MRA patterns I, II-R, II-L, III and IV were 140, 17, 12, 8, and 8 cases, respectively. The total number of VBI patients who demonstrated type III or IV patterns in MRA was significantly higher than that of type I, II-R and II-L ($P < 0.005$). All of the 8 cases with cerebellar and brainstem infarction belonged to type IV. Cerebral angiography was performed in nine cases with type II-R, II-L, III or IV-1, and the number of patients in each group was 3, 3, 1 and 2 cases, respectively. All of the type II-R and II-L cases revealed hypoform of the vertebral artery. The appearance of type III was restricted to type III's view was only meandering and type IV-1 showed severe stenotic changes in the union area.	3
56. Doijiri R, Uno H, Miyashita K, Ihara M, Nagatsuka K. How Commonly Is Stroke Found in Patients with Isolated Vertigo or Dizziness Attack?. J STROKE CEREBROVASC DIS. 25(10):2549-52, 2016 Oct.	Observational-Dx	221 patients	To elucidate the frequency of strokes in patients with isolated vertigo or dizziness attack.	One hundred eighteen patients had vertigo whereas the other 103 had dizziness. Brain computed tomography or magnetic resonance imaging revealed recent stroke lesions in 25 patients (11.3%) (ischemic, 21; hemorrhagic, 4).The lesions were generally small and localized in the cerebellum (n = 21), pons (n = 1), medulla oblongata (n = 1), or corona radiata (n = 1). Of the 25 patients, 19 (76%) had dizzy-type spells; none had neurological dysfunction at the time of discharge. In the remaining 196 patients, no stroke was detected on computed tomography or magnetic resonance imaging.	3

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
57. Leker RR, Hur TB, Gomori JM, Paniri R, Eichel R, Cohen JE. Incidence of DWI-positive stroke in patients with vertigo of unclear etiology, preliminary results. Neurol Res. 35(2):123-6, 2013 Mar.	Observational-Dx	28 patients	To determine the incidence of Diffusion weighted Magnetic Resonance Imaging (MRI) (DWI)-positive stroke in patients with vertigo of unclear etiology, preliminary results.	Between June 2010 and August 2011, 28 patients fulfilling the entry criteria were identified with a mean age of 62.2+/-12.8 (60% male). The final diagnosis was stroke in 11 patients (39%). Patients with stroke did not differ from those without stroke in their risk factor profile. However, patients with stroke more often tended to present with vertigo accompanied by other neurological symptoms (73% versus 12% respectively, P = 0.001). After adjusting for age and the presence of diabetes, the presence of multiple symptoms remained the only variable that was associated with a positive DWI scan (odds ratio: 30: 95% confidence interval: 2.6-349). Most patients with stroke had very mild strokes with a median admission NIHSS score of 3 and DWI lesion volumes >2 cm were found in only three patients. Most stroke patients made a good recovery (modified Rankin score </=2 in seven of nine patients with 90 day data). The most common diagnosis in patients without stroke was of vertigo of peripheral origin (14/17).	3
58. Schick B, Brors D, Koch O, Schafers M, Kahle G. Magnetic resonance imaging in patients with sudden hearing loss, tinnitus and vertigo. Otol Neurotol. 2001; 22(6):808-812.	Observational-Dx	354 patients	Retrospective study to evaluate the value of MRI in analysis of the complete audiovestibular pathway.	MRI abnormalities seen in 122/354 patients (34.5%). Contrast-enhanced MRI can be used to assess a significant number of different pathologic conditions in patients with audiovestibular disorders.	4

Hearing Loss and/or Vertigo
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
59. Saber Tehrani AS, Kattah JC, Mantokoudis G, et al. Small strokes causing severe vertigo: frequency of false-negative MRIs and nonlacunar mechanisms. Neurology. 83(2):169-73, 2014 Jul 08.	Observational-Dx	15 patients	To describe characteristics of small strokes causing acute vestibular syndrome (AVS).	Of 190 high-risk AVS presentations (105 strokes), we found small strokes in 15 patients (median age 64 years, range 41-85). The most common vestibular structure infarcted was the inferior cerebellar peduncle (73%); the most common stroke location was the lateral medulla (60%). Focal neurologic signs were present in only 27%. The HINTS "plus" battery identified small strokes with greater sensitivity than early MRI-DWI (100% vs 47%, $p < 0.001$). False-negative initial MRIs (6-48 hours) were more common with small strokes than large strokes (53% [n = 8/15] vs 7.8% [n = 7/90], $p < 0.001$). Nonlacunar stroke mechanisms were responsible in 47%, including 6 vertebral artery occlusions or dissections.	2
60. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf.	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	No results stated in abstract.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  a. The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b. The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c. The study is an expert opinion or consensus document.
- Meta-analysis
  a. *Good quality* – the study design, methods, analysis, and results are valid and the conclusion is supported.
  b. *Inadequate quality* – the study design, analysis, and results lack the methodological rigor to be considered a good meta-analysis study.

Abbreviations Key

Dx = Diagnostic

Tx = Treatment