

Tinnitus
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. National Institutes of Health. National Institute on Deafness and Other Communication Disorders (NIDCD). Quick Statistics. Available at: http://www.nidcd.nih.gov/health/statistics/Pages/quick.aspx .	Review/Other-Dx	N/A	To present statistics regarding deafness and other communication disorders.	No results stated in abstract.	4
2. Fife TD. Neuro-otology of Systemic Disease. In: Lewis SL, ed. <i>Neurological Disorders due to Systemic Disease</i> . 1st ed. Oxford, UK: Wiley-Blackwell Health Sciences; 2013:145-154.	Review/Other-Dx	N/A	Book chapter.	N/A	4
3. Tunkel DE, Bauer CA, Sun GH, et al. Clinical practice guideline: tinnitus. <i>Otolaryngol Head Neck Surg</i> . 2014;151(2 Suppl):S1-S40.	Review/Other-Dx	N/A	To provide evidence-based recommendations for clinicians managing patients with tinnitus.	No results stated in abstract.	4
4. American College of Radiology. ACR Appropriateness Criteria®: Hearing Loss and/or Vertigo . Available at: https://acsearch.acr.org/docs/69488/Narrative/ .	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for Hearing Loss and/or Vertigo.	N/A	4
5. American College of Radiology. ACR Appropriateness Criteria®: Head Trauma. Available at: https://acsearch.acr.org/docs/69481/Narrative/ .	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.	N/A	4
6. American College of Radiology. ACR Appropriateness Criteria®: Cerebrovascular Disease. Available at: https://acsearch.acr.org/docs/69478/Narrative/ .	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.	N/A	4
7. Sonmez G, Basekim CC, Ozturk E, Gungor A, Kizilkaya E. Imaging of pulsatile tinnitus: a review of 74 patients. <i>Clin Imaging</i> . 2007;31(2):102-108.	Review/Other-Dx	74 patients	To assess the effectiveness of imaging modalities in detecting the underlying pathologies in patients with PT.	The underlying pathology of tinnitus was detected in 50 patients (67.6%), and 24 patients were normal with radiologic studies. The most common cause was high jugular bulb (21%) followed by atherosclerosis, dehiscent jugular bulb, aneurysm of internal carotid artery, dural arteriovenous fistula, aberrant internal carotid artery, jugular diverticulum, and glomus tumor.	4

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8. Alaani A, Chavda SV, Irving RM. The crucial role of imaging in determining the approach to glomus tympanicum tumours. <i>Eur Arch Otorhinolaryngol.</i> 2009;266(6):827-831.	Review/Other-Dx	9 patients	To present our management approach for tinnitus based on a series of 9 cases.	No results stated in abstract.	4
9. Bierry G, Riehm S, Marcellin L, Stierle JL, Veillon F. Middle ear adenomatous tumor: a not so rare glomus tympanicum-mimicking lesion. <i>J Neuroradiol.</i> 2010;37(2):116-121.	Review/Other-Dx	N/A	To present several radiologic and clinical findings that will help the radiologist to discriminate middle ear adenomatous tumor from glomus tympanicum.	Middle ear adenomatous tumor and glomus tympanicum appeared as tissular lesion with significant enhancement on CT and MR. A vascular blush was present on angiography in all cases of glomus tympanicum and absent from all cases of middle ear adenomatous tumor. A close relationship between the tumor and the Jacobson's nerve or its branches was identified in all cases of glomus tympanicum. PT was present in all patients with glomus tympanicum and absent in all patients with middle ear adenomatous tumor.	4
10. Sismanis A. Pulsatile tinnitus. <i>Otolaryngol Clin North Am.</i> 2003;36(2):389-402, viii.	Review/Other-Dx	N/A	To describe the different classifications of tinnitus and the approaches used to diagnose them.	No results stated in abstract.	4
11. Zhao P, Wang Z, Xian J, Yan F, Liu Z. Persistent petrosquamosal sinus in adults: qualitative imaging evaluation on high-resolution CT venography. <i>Acta Radiol.</i> 2014;55(2):225-230.	Observational-Dx	532 patients	To analyze the characteristics of PSS on high-resolution CT venography in order to improve imaging diagnostic accuracy as well as to assist clinical management.	The average diameter of the PSS was 1.4 mm. 29 temporal bones (74%) had PSS origin from the dorsolateral surface of the transverse sinus before its junction with the superior petrosal sinus (Position A); 3 temporal bones (8%) had PSS origin from the ventroinferior surface of the transverse sinus after or before the junction (Position B or C); 7 temporal bones (18%) had PSS without definite origin (Position D). 18 temporal bones (46%) had PSS course in a lateral bony canal/groove (lateral canal type); 15 temporal bones (38%) had PSS course in petrosquamosal fissure; 6 temporal bones (15%) had PSS course in both (lateral canal/ petrosquamosal fissure type). For other imaging findings, a branch entering the cranial part of PSS was identified in 10 temporal bones (26%); a vascular mass was formed in 5 temporal bones (13%); focal defect of bony wall was observed in 7 temporal bones (18%). A postglenoid foramen was detected in 25 temporal bones (64%).	3

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12. Narvid J, Do HM, Blevins NH, Fischbein NJ. CT angiography as a screening tool for dural arteriovenous fistula in patients with pulsatile tinnitus: feasibility and test characteristics. <i>AJNR Am J Neuroradiol.</i> 2011;32(3):446-453.	Observational-Dx	7 patients	To determine the sensitivity and specificity of CTA compared with cerebral angiography for dural arteriovenous fistulas in patients presenting with PT.	The presence of arterial feeders showed good test characteristics for screening, with a sensitivity of 86% (95% CI, 42–99) and a specificity of 100% (95% CI, 52–100). A shaggy sinus or tentorium was highly specific: sensitivity of 42% (95% CI, 11–79) and specificity of 100% (95% CI, 56–100). The presence of transcalvarial venous channels demonstrated a poor sensitivity of 29% (95% CI, 5–70) but a high specificity 86% (95% CI, 42–99). CT attenuation of the jugular veins showed statistically significant asymmetry in the dural arteriovenous fistulas group vs the control group ($P<.05$).	2
13. Spittau B, Millan DS, El-Sherifi S, et al. Dural arteriovenous fistulas of the hypoglossal canal: systematic review on imaging anatomy, clinical findings, and endovascular management. <i>J Neurosurg.</i> 2015;122(4):883-903.	Review/Other-Tx	120 cases	To describe clinical and imaging findings of hypoglossal canal dural arteriovenous fistulas, as well as treatment strategies and subsequent outcomes, based on a systematic literature review supplemented by the authors' own cases.	3 major types of venous drainage are associated with distinct clinical patterns: Type 1, with anterograde drainage (62.5%), mostly presents with PT; Type 2, with retrograde drainage to the cavernous sinus and/or orbital veins (23.3%), is associated with ocular symptoms and may mimic cavernous sinus dural arteriovenous fistulas; and Type 3, with cortical and/or perimedullary drainage (14.2%), presents with either hemorrhage or cervical myelopathy. For Types 1 and 2 hypoglossal canal dural arteriovenous fistulas, transvenous embolization demonstrates high safety and efficacy (2.9% morbidity, 92.7% total occlusion).	4

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14. Grewal AK, Kim HY, Comstock RH, 3rd, Berkowitz F, Kim HJ, Jay AK. Clinical presentation and imaging findings in patients with pulsatile tinnitus and sigmoid sinus diverticulum/dehiscence. <i>Otol Neurotol.</i> 2014;35(1):16-21.	Review/Other-Dx	261 patients	To understand the clinical and imaging features of patients with PT due to sigmoid sinus diverticulum/dehiscence.	Cohort 1: 35 cases of sigmoid sinus diverticulum/dehiscence were identified (18%); 10 (29%) true diverticula; and 25 (71%) dehiscence. 66% were right sided. 12 patients had PT (34%). Patients with sigmoid sinus diverticulum/dehiscence are more likely to have PT ($P=0.003$). A significant association between right sigmoid sinus diverticulum/dehiscence and PT was found ($P=0.001$). Cohort 2: 15 out of 61 patients had PT and CT-confirmed sigmoid sinus diverticulum/dehiscence. All were female subjects; average age was 45 years (26–73 years). Radiologic evaluation revealed 10 sigmoid sinus diverticulum/dehiscence cases on the right (66.7%), 2 on the left (13.3%) and 3 bilateral (20%). Sensorineural hearing loss was seen in 8 (53%), aural fullness in 12 (80%). Average BMI was 32.2 (21.0-59.82), and 4 (26%) had audible mastoid bruits.	4
15. Harvey RS, Hertzano R, Kelman SE, Eisenman DJ. Pulse-synchronous tinnitus and sigmoid sinus wall anomalies: descriptive epidemiology and the idiopathic intracranial hypertension patient population. <i>Otol Neurotol.</i> 2014;35(1):7-15.	Review/Other-Dx	13 patients	To describe the clinical features of a population of patients with sinus wall anomalies and pulse-synchronous tinnitus.	13 patients presented with sigmoid sinus diverticulum (39.4%) and 20 (60.6%) with sinus wall dehiscence. 30 ears were successfully treated with surgery (responders), and 3 were not (nonresponders). Responders' mean age was 38 years, with 26 female patients (92.9%) and 2 male (7.1%). BMI of responders compared with nonresponders did not differ significantly (35.5 vs 33.4 kg/m ² , $P=0.08$). BMI of responders was elevated compared with an asymptomatic control group (35.5 vs 27.4 kg/m ² , $P<0.0001$). BMI of responders did not differ significantly compared with a cohort of patients with spontaneous cerebrospinal fluid otorrhea and temporal bone encephaloceles (35.5 vs 40.7 kg/m ² , $P=0.17$).	4

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16. Schoeff S, Nicholas B, Mukherjee S, Kesser BW. Imaging prevalence of sigmoid sinus dehiscence among patients with and without pulsatile tinnitus. <i>Otolaryngol Head Neck Surg.</i> 2014;150(5):841-846.	Review/Other-Dx	194 patients	To define the radiographic prevalence of sigmoid sinus diverticulum or dehiscence in patients with and without PT.	Within the PT group, sigmoid sinus diverticulum or dehiscence was identified in 24% of ears (9/37) and 23% of patients (7/30); all sigmoid sinus diverticulum or dehiscence patients were female ($P=.024$). Patients with sigmoid sinus diverticulum or dehiscence were significantly younger ($P=.037$). Sigmoid sinus diverticulum or dehiscence more frequently caused objective tinnitus ($P=.016$). There was no difference in average BMI between those with and those without sigmoid sinus diverticulum or dehiscence. In the nonPT group, sigmoid sinus diverticulum or dehiscence was identified in 2 (both female) of 164 patients (1.2%; 0.6% of ears). The difference in sigmoid sinus diverticulum or dehiscence prevalence between groups was significant ($P<.0001$).	4
17. Ellenstein A, Yusuf N, Hallett M. Middle ear myoclonus: two informative cases and a systematic discussion of myogenic tinnitus. <i>Tremor Other Hyperkinet Mov (N Y)</i> . 2013;3.	Review/Other-Dx	N/A	To systematically evaluate the different mechanisms and movement disorder phenomena that could lead to a diagnosis of MEM.	From a functional neuroanatomic perspective, we explain how tensor tympani MEM is best explained as a form of peritubal myogenic tinnitus, similar to the related disorder of essential palatal tremor. From a pathogenic perspective, we discuss how MEM symptomatology may reflect different mechanical and neurologic processes. We emphasize the diagnostic imperative to recognize when myogenic tinnitus is consistent with a psychogenic origin.	4
18. Fox GN, Baer MT. Palatal myoclonus and tinnitus in children. <i>West J Med.</i> 1991;154(1):98-102.	Review/Other-Dx	1 patient	To review palatal myoclonus and tinnitus in children.	No results stated in abstract.	4

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19. Park SN, Bae SC, Lee GH, et al. Clinical characteristics and therapeutic response of objective tinnitus due to middle ear myoclonus: a large case series. <i>Laryngoscope</i> . 2013;123(10):2516-2520.	Observational-Tx	58 patients	To evaluate the clinical characteristics and therapeutic response of tinnitus due to MEM and to suggest appropriate diagnostic methods.	Patients had a mean age of 29.8 years (range, 6-70 years), 20.7% (n = 12) were <10 years old, 39.7% (n = 23) were <20 years old, 74.1% (n = 43) were <40 years old, and 5.2% (n = 3) were ≥60 years old. Remembered stressful events or noise exposure were associated with the onset of MEM in 51.8% (n = 30) and 27.6% (n = 16) of patients, respectively. The most frequent nature of the tinnitus was a crackling sound. MEM associated with forceful eyelid closure was observed in 15% of patients. Impedance audiogram and otoendoscopic examinations of the tympanic membrane were helpful tools for diagnosing MEM. With medical therapy, more than 75% of patients exhibited complete or partial remission of their tinnitus. Patients with intractable MEM who underwent sectioning of the middle ear tendons had very good outcomes.	2
20. Sinclair CF, Gurey LE, Blitzer A. Palatal myoclonus: algorithm for management with botulinum toxin based on clinical disease characteristics. <i>Laryngoscope</i> . 2014;124(5):1164-1169.	Observational-Dx	15 patients	To review the clinical characteristics and management of patients with palatal myoclonus and devise an algorithm for treatment with botulinum toxin based on presenting symptoms, clinical examination findings, and involved muscle groups.	Patients were more commonly female (60.0% vs 40.0%) with average age at onset of 35.6 years. In 40.0% of patients, the myoclonus began after a viral upper respiratory tract infection. Two-thirds of patients had been previously treated unsuccessfully with oral medications. Predominant presenting symptoms included clicking tinnitus (46.7%), nonaudible awareness of palatal movements +/- rhinolalia (20.0%), or both (33.3%). Clinical examination revealed co-incident involvement of pharyngeal musculature in 53.3%. Palatal site for initial botulinum toxin injection depended on the predominant presenting symptom: for tinnitus, 2.5 U were injected transorally into the tensor veli palatini muscle at the level of the pterygoid hamulus/lateral soft palate; for palatal movements, the injection was placed medially on either side of the uvula. Dose and location of subsequent injections were tailored depending on response to the toxin and location of subsequent observed maximal muscular contractions.	4

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21. Remley KB, Coit WE, Harnsberger HR, Smoker WR, Jacobs JM, McIff EB. Pulsatile tinnitus and the vascular tympanic membrane: CT, MR, and angiographic findings. <i>Radiology</i> . 1990;174(2):383-389.	Review/Other-Dx	107 patients	To identify the frequency and types of lesions, to construct an imaging algorithm utilizing basic historical and physical examination information, and to define the role of MRI in the diagnostic evaluation.	Of the 100 patients with PT, 25 had objective tinnitus. A vascular tympanic membrane was present in 37 cases (35%). Normal vascular variants were present in 23 patients (21%). 27 patients (25%) had acquired vascular lesions. Temporal bone tumors were found in 33 patients (31%). No abnormality was identified in 21 cases (20%).	4
22. Willinsky RA. Tinnitus: imaging algorithms. <i>Can Assoc Radiol J</i> . 1992;43(2):93-99.	Review/Other-Dx	N/A	To review imaging algorithms based on symptoms and signs.	For patients with nonpulsatile tinnitus and a normal drum, MRI is preferred if a retrocochlear lesion is suspected, whereas high-resolution CT is recommended if a cochlear abnormality is likely. If a chronic inflammation in the middle ear is suspected, high-resolution CT is the study of choice to differentiate cholesteatoma from chronic otitis media. If the bruit is objective and the tympanic membrane normal, selective cerebral angiography should be the initial investigation, because most such patients have an acquired vascular abnormality, usually a dural arteriovenous fistula. If there is PT and a retrotympanic mass, high-resolution CT should be the first examination because this technique allows differentiation of a vascular variation, such as an aberrant carotid artery or jugular dehiscence, from a paraganglioma.	4

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23. Hillman TA, Kertesz TR, Hadley K, Shelton C. Reversible peripheral vestibulopathy: the treatment of superior canal dehiscence. <i>Otolaryngol Head Neck Surg.</i> 2006;134(3):431-436.	Observational-Tx	30 patients	To review cases of superior canal dehiscence found at our institution and report their presentation, workup, and response to therapy.	30 patients were identified with superior canal dehiscence. Patients presented with chronic disequilibrium (63%), Tullio's phenomenon (41%), pressure evoked vertigo (44%), hearing loss (30%), and PT (7%). Electronystagmography performed early in our series revealed abnormal nystagmus with sound presentation, Valsalva, or tympanogram; however, history and CT examination alone was used to identify this condition in most of our patients. 27 of the 30 patients had some symptoms related to superior canal dehiscence; the other 3 were found to have incidental superior canal dehiscence on CT examination. Of these patients, 14 had severe enough symptoms to warrant operative intervention. All, but 1 had resolution of their symptoms after completion of intervention.	3
24. Ceylan N, Bayraktaroglu S, Alper H, et al. CT imaging of superior semicircular canal dehiscence: added value of reformatted images. <i>Acta Otolaryngol.</i> 2010;130(9):996-1001.	Review/Other-Dx	93 patients	To investigate prevalence of superior semicircular canal dehiscence, its length and its correlation with symptoms in patients who had previously undergone temporal bone CT examination that was reported normal and to demonstrate the importance of reformatted images in the diagnosis of superior semicircular canal dehiscence.	93 patients were included in the study. 19 patients with semicircular canal dehiscence were detected. The mean age of the study group was 45 years. Radiologic evidence of superior semicircular canal dehiscence occurred in 23 of 186 temporal bones with a radiologic prevalence of 12%. The most common symptoms in dehiscent patients were vertigo, hearing loss and tinnitus. Defect lengths varied between 1 mm and 6.5 mm.	4
25. Cho IK, Jung JY, Yoo DS, Suh MW. 3-Dimensional reconstruction of the venous system in patients suffering from pulsatile tinnitus. <i>Acta Otolaryngol.</i> 2012;132(3):285-289.	Observational-Dx	11 patients and 12 normal control ears	To compare, through 3D-reformatted images of the intracranial venous system, the volume, cross-sectional area, and caliber changes in patients with PT and normal controls.	The largest area/smallest area ratio was significantly increased in the PT group (5.01), compared with the control group (3.42). When the threshold value of the largest area/smallest area ratio was assessed by the receiver operator characteristic method, 4.75 seemed to be the significant dissecting point. The sensitivity of this method was 0.64 and the specificity was 0.83.	3

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26. Liu Z, Chen C, Wang Z, et al. Sigmoid sinus diverticulum and pulsatile tinnitus: analysis of CT scans from 15 cases. <i>Acta Radiol.</i> 2013;54(7):812-816.	Observational-Dx	15 patients	To examine the CT characteristics of sigmoid sinus diverticulum accompanied with PT.	Sigmoid sinus diverticulum was located on the same side of PT in 15 patients. Diverticula originated at the superior curve of the sigmoid sinus in 11 patients and the descending segment of the sigmoid sinus in 4 patients. Sigmoid sinus diverticula focally eroded into the adjacent mastoid air cells in 12 patients and mastoid cortex in 3 patients. Among 8 patients with unilateral dominant brain venous systems, the diverticula were seen on the dominant side in 7 patients and nondominant side in 1 patient. In contrast, the other 7 patients showed co-dominant brain venous systems, with 3 presenting diverticula on the right side and 4 on the left. More notably, dehiscent sigmoid plate on the PT side was demonstrated in all patients. In addition, temporal bone hyper-pneumatization was found in 9 patients, good and moderate pneumatization in 3 patients, respectively.	4
27. Mattox DE, Hudgins P. Algorithm for evaluation of pulsatile tinnitus. <i>Acta Otolaryngol.</i> 2008;128(4):427-431.	Review/Other-Dx	54 patients	To evaluate the incidence of identifiable anomalies in patients with PT.	54 patients were seen between January 2002 and June 2007 with the chief complaint of constant PT, excluding those with chemodectomas. On the basis of physical examination and imaging, 14 were considered arterial, 23 venous, and 15 were indeterminate in origin. Among patients with venous tinnitus, sigmoid sinus diverticulum was the most common finding. Among patients with arterial tinnitus, carotid atherosclerotic disease was the most common. One patient had erosion of the cochlea by the carotid artery. Nonvascular entities identified include superior semicircular canal dehiscence and benign intracranial hypertension.	4
28. Krishnan A, Mattox DE, Fountain AJ, Hudgins PA. CT arteriography and venography in pulsatile tinnitus: preliminary results. <i>AJNR Am J Neuroradiol.</i> 2006;27(8):1635-1638.	Observational-Dx	16 patients	To evaluate the utility of CTA/CT venography in the imaging workup of PT.	7 of the 16 patients had lesions on CTA/CT venography that could account for their PT. Examples of pathologic conditions in the series included a significantly dominant venous system, a venous diverticulum with stricture, and a transverse sinus stenosis.	4

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29. Pelkonen O, Tikkakoski T, Luotonen J, Sotaniemi K. Pulsatile tinnitus as a symptom of cervicocephalic arterial dissection. <i>J Laryngol Otol.</i> 2004;118(3):193-198.	Review/Other-Dx	136 consecutive patients	To investigate PT as a presenting symptom in cervicocephalic arterial dissection.	Of the 136 consecutive patients with confirmed cervicocephalic arterial dissection, 16 presented with PT. On admission 10 patients presented with subjective tinnitus and 5 with objective tinnitus, tinnitus being the only presenting symptom in 1 case. In 1 further case with bilateral internal carotid artery dissection subjective tinnitus appeared 3 months after the initial symptoms of arterial dissection, despite a contralateral cervical bruit being evident on admission. 13 patients presented with headache or neck pain. Ischemic symptoms were detected in 6 and Horner’s syndrome in 4 patients. Vertigo and dysgeusia were reported in 2 patients each. Arterial dissection involved unilateral internal carotid artery in 11, bilateral internal carotid artery in 2, unilateral vertebral artery in 2 and bilateral internal carotid artery and bilateral vertebral artery in 1 patient. In angiography the most common finding was irregular stenosis, and the majority of these abnormalities normalized during follow-up. To avoid delay in diagnosis a high index of suspicion and early angiography (DSA or MRA) are warranted.	4

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30. von Babo M, De Marchis GM, Sarikaya H, et al. Differences and similarities between spontaneous dissections of the internal carotid artery and the vertebral artery. <i>Stroke</i> . 2013;44(6):1537-1542.	Observational-Dx	970 patients	To compare potential risk factors, clinical symptoms, diagnostic delay, and 3-month outcome between spontaneous internal carotid artery dissection and spontaneous vertebral artery dissection (sVAD).	Patients with spontaneous internal carotid artery dissection were older (46.3 +/- 9.6 vs 42.0 +/- 10.2 years; $P<0.001$), more often men (62.7% vs 53.0%; $P=0.004$), and presented more frequently with tinnitus (10.9% vs 3.4%; $P<0.001$) and more severe ischemic strokes (median National Institutes of Health Stroke Scale, 10 +/- 7.1 vs 5 +/- 5.9; $P<0.001$). Patients with spontaneous vertebral artery dissection had more often bilateral dissections (15.2% vs 7.6%; $P<0.001$) and were more often smokers (36.0% vs 28.7%; $P=0.007$). Thunderclap headache (9.2% vs 3.6%; $P=0.001$) and neck pain were more common (65.8% vs 33.5%; $P<0.001$) in spontaneous vertebral artery dissection. Subarachnoid hemorrhage (6.0% vs 0.6%; $P<0.001$) and ischemic stroke (69.5% vs 52.2%; $P<0.001$) were more frequent in spontaneous vertebral artery dissection. After multivariate analysis, sex difference lost its significance ($P=0.21$), and all other variables remained significant. Time to diagnosis was similar in spontaneous internal carotid artery dissection and spontaneous vertebral artery dissection and improved between 2001 and 2012 compared with the previous 10-year period (8.0 +/- 10.5 days vs 10.7 +/- 13.2 days; $P=0.004$). In spontaneous vertebral artery dissection, favorable outcome 3 months after ischemic stroke (modified Rankin Scale, 0-2: 88.8% vs 58.4%; $P<0.001$), recurrent transient ischemic attack (4.8% vs 1.1%; $P=0.001$), and recurrent ischemic stroke (2.8% vs 0.7%; $P=0.02$) within 3 months were more frequent.	3
31. Deuschl C, Goricke S, Gramsch C, et al. Value of DSA in the diagnostic workup of pulsatile tinnitus. <i>PLoS One</i> . 2015;10(2):e0117814.	Observational-Dx	54 patients	To evaluate the diagnostic impact of DSA in the diagnostic workup of patients with PT in comparison to MRI alone.	37 of the 54 patients revealed a pathology explaining PT on MRI, which was detected by the readers in 100% and proved by means of DSA. 24 dural arteriovenous fistula, 4 paraganglioma, 2 AVM and 7 more pathologies were described. All patients without pathology on MRI did also not show any pathology in DSA.	3

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<p>32. Noguchi K, Melhem ER, Kanazawa T, Kubo M, Kuwayama N, Seto H. Intracranial dural arteriovenous fistulas: evaluation with combined 3D time-of-flight MR angiography and MR digital subtraction angiography. <i>AJR Am J Roentgenol.</i> 2004;182(1):183-190.</p>	<p>Observational-Dx</p>	<p>17 MR angiograms in 15 patients and 35 MR angiograms in 35 controls</p>	<p>To compare the diagnostic utility of 3D time-of-flight MRA and MR DSA in patients with angiographically proven moderate- to high-flow intracranial dural arteriovenous fistula.</p>	<p>In patients with dural arteriovenous fistula, source images of 3D time-of-flight MRA showed 2 abnormal findings: multiple high-intensity curvilinear or nodular structures adjacent to the sinus wall and high-intensity areas in the venous sinus. Findings of multiple high-intensity structures adjacent to the sinus wall were observed in all cases of dural arteriovenous fistula. Findings of high-intensity areas in the venous sinus were observed in 13 of 17 cases of dural arteriovenous fistula. Findings of multiple high-intensity structures adjacent to the sinus wall were not observed in any control subjects. Findings of high-intensity areas within the venous sinus were observed in 5 of 35 control subjects. Findings of MR DSA showed early filling of the venous sinus, suggestive of dural arteriovenous fistula, in 13 of 15 patients with dural arteriovenous fistula. Sensitivity and specificity of multiple high-intensity structures adjacent to the sinus wall, high-intensity areas in the venous sinus, and early filling of the venous sinus were 100% and 100%, 76% and 86%, and 87% and 100%, respectively. Although 3D time-of-flight MRA failed to show the findings of retrograde cortical venous drainage and venous sinus occlusion, MR DSA clearly showed both findings in all 5 subjects.</p>	<p>2</p>

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<p>33. Guevara N, Deveze A, Buza V, Laffont B, Magnan J. Microvascular decompression of cochlear nerve for tinnitus incapacity: pre-surgical data, surgical analyses and long-term follow-up of 15 patients. <i>Eur Arch Otorhinolaryngol.</i> 2008;265(4):397-401.</p>	<p>Review/Other-Dx</p>	<p>15 patients</p>	<p>To select a homogeneous group of patients suffering from incapacitating tinnitus who underwent endoscopy-assisted microvascular decompression through a retrosigmoid keyhole approach.</p>	<p>During the surgery, a vascular compression was found on every patient. In a long-term follow-up, 53.3% (8 cases) of our tinnitus cases improved and 20% (3 cases) of them were completely cured. The auditory brainstem response returned to normal in all patients who had good clinical results (diminished or disappeared tinnitus). When a vertebral artery loop (5 cases) was concerned we obtained 80% of good clinical results. No one showed amelioration or sudden aggravation of their hearing. 3 cases required surgical correction of cerebrospinal fluid leak and 1 case developed spontaneously regressive swallowing problems. Such microvascular decompression surgery of the cochlear nerve appears to be successful in treating incapacitating tinnitus in particular when a vertebral artery loop is observed. Therefore, in such a case, one might recommend neurovascular decompression surgery, keeping in mind that the complications of this surgery should be minimized by a careful closure of the retrosigmoid approach. In order to ensure a better selection of patient more accurate cochlear nerve monitoring and fMRI should be a promising assessment.</p>	<p>4</p>

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34. Nowe V, De Ridder D, Van de Heyning PH, et al. Does the location of a vascular loop in the cerebellopontine angle explain pulsatile and non-pulsatile tinnitus? <i>Eur Radiol.</i> 2004;14(12):2282-2289.	Observational-Dx	47 patients	To investigate patients with unexplained PT and non-PT by means of MRI of the CPA and to correlate the clinical subtype of tinnitus with the location of a blood vessel (in the IAC or at the cisternal part of the VIIIth cranial nerve).	High-resolution T2-weighted constructive interference in steady state images of the CPA demonstrate a significantly higher number of vascular loops in the IAC in patients with PT. Virtual endoscopy of the CPA provides a noninvasive view of the anatomical relationships between nerves and blood vessels and can be of use to demonstrate vascular contacts with the cisternal part of the VIIIth cranial nerve in patients with non-PT. Our findings indicate that in some patients with non-PT, the location of the blood vessel impinging on the cisternal segment of the VIIIth cranial nerve can be correlated with the clinical subtype of tinnitus (high pitch and low pitch). Furthermore, we found a correlation between the clinical presentation of tinnitus (high pitch and low pitch) and the perceptive hearing loss in patients with non-PT.	3
35. Chadha NK, Weiner GM. Vascular loops causing otological symptoms: a systematic review and meta-analysis. <i>Clin Otolaryngol.</i> 2008;33(1):5-11.	Meta-analysis	5 studies	To determine evidence for a relationship between vascular loops in contact with the vestibulocochlear nerve (CN VIII) and otological symptoms.	5 case-control studies included. A statistically significant association was demonstrated for the prevalence of vascular loops in contact with CN VIII, with unilateral sensorineural hearing loss: pooled OR 2.0 [95% CI: 1.5-2.6]. No association was demonstrated for nonpulsatile tinnitus. A highly significant association with vascular loops was shown in subjects having PT, with pooled OR: 78.8 (95% CI: 10.9-821.8).	M
36. Yeh SJ, Tsai LK, Jeng JS. Clinical and carotid ultrasonographic features of intracranial dural arteriovenous fistulas in patients with and without Pulsatile Tinnitus. <i>J Neuroimaging.</i> 2010;20(4):354-358.	Observational-Dx	67 patients	To characterize the clinical and ultrasonographic features of dural arteriovenous fistulas in patients with PT.	PT was highly associated with the location and feeding arteries of dural arteriovenous fistulas ($P < .001$). The sensitivity of resistive index (Norm, $>.72$) and end diastolic velocity (Norm, <21 cm/sec) of external carotid artery in carotid duplex sonography study for diagnosing dural arteriovenous fistulas in patients with PT was 95% and 92%, respectively. Changes of RI and end diastolic velocity of external carotid artery also correlated with the changes of tinnitus status.	3

Tinnitus
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Gimsing S. Vestibular schwannoma: when to look for it? <i>J Laryngol Otol.</i> 2010;124(3):258-264.	Observational-Dx	199 vestibular schwannoma patients and 225 nontumor patients	To compare audiometric parameters in patients with vestibular schwannoma and in those with asymmetric hearing loss from other causes; and to assess proposed screening criteria by comparing published protocols.	Vestibular schwannoma and nontumor patients with little or no hearing loss in the unaffected ear were inseparable; however, vestibular schwannoma patients with hearing loss in the unaffected ear had greater audiometric asymmetry, compared with nontumor patients with the same pattern of hearing loss. The sensitivity of screening protocols varied from 73% to 100%; parallelism was observed between sensitivity and screening rate.	3
38. Jiang ZY, Kutz JW, Jr., Roland PS, Isaacson B. Intracochlear schwannomas confined to the otic capsule. <i>Otol Neurotol.</i> 2011;32(7):1175-1179.	Review/Other-Dx	10 cases	To determine the natural history and management for patients with intracochlear schwannomas.	Hearing loss was present in all 10 patients at their initial presentation. Tinnitus was present in 50% of patients, and vertigo was present in 30% of patients. No patient presented with aural fullness or facial weakness. The pattern of hearing loss seemed to correlate with the location of the lesion within the cochlea. Of the 9 patients that had follow-up MRIs, 3 patients showed tumor growth. 2 of the 10 patients underwent surgical excision for intractable vertigo that resulted in resolution of symptoms	4
39. Springborg JB, Poulsen L, Thomsen J. Nonvestibular schwannoma tumors in the cerebellopontine angle: a structured approach and management guidelines. <i>Skull Base.</i> 2008;18(4):217-227.	Review/Other-Dx	N/A	To provide a structured approach to the diagnosis of nonvestibular schwannoma CPA lesions and also management guidelines.	No results stated in abstract.	4
40. van de Langenberg R, de Bondt BJ, Nelemans PJ, Dohmen AJ, Baumert BG, Stokroos RJ. Predictors of volumetric growth and auditory deterioration in vestibular schwannomas followed in a wait and scan policy. <i>Otol Neurotol.</i> 2011;32(2):338-344.	Observational-Dx	63 patients	To identify factors predicting growth and audiologic deterioration during follow-up in a wait and scan policy of vestibular schwannomas using a novel volumetric measuring tool.	Labyrinthine hypointensity on T2-weighted MRI and complaints of hearing loss at presentation are predictive of a faster deterioration of hearing ($P<0.05$). Growth during the first follow-up year predicts further growth. Vestibular schwannoma volume does not correlate with audiologic deterioration significantly.	4
41. Chole RA, Parker WS. Tinnitus and vertigo in patients with temporomandibular disorder. <i>Arch Otolaryngol Head Neck Surg.</i> 1992;118(8):817-821.	Review/Other-Dx	1032 patients	To observe tinnitus and vertigo in patients with temporomandibular disorder	No results stated in abstract.	4

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Lee CF, Lin MC, Lin HT, Lin CL, Wang TC, Kao CH. Increased risk of tinnitus in patients with temporomandibular disorder: a retrospective population-based cohort study. <i>Eur Arch Otorhinolaryngol.</i> 2016;273(1):203-208.	Review/Other-Dx	37,925 patients	To determine whether there is an increased risk of tinnitus in patients with temporomandibular joint.	A higher proportion of temporomandibular joint disorder patients suffered from hearing loss (5.30 vs 2.11%), and degenerative and vascular ear disorders (0.20 vs 0.08%) compared with the control patients. The crude hazard ratio of tinnitus in the temporomandibular joint disorder cohort was 2.73-fold higher than that in the control patients, with an adjusted hazard ratio of 2.62 (95% CI = 2.29-3.00). The comorbidity-specific temporomandibular joint disorder cohort to the control patients' adjusted hazard ratio of tinnitus was higher for patients without comorbidity (adjusted hazard ratio = 2.75, 95% CI = 2.39-3.17). We also observed a 3.22-fold significantly higher relative risk of developing tinnitus within the 3-year follow-up period (95% CI = 2.67-3.89).	4
43. Park RJ, Moon JD. Prevalence and risk factors of tinnitus: the Korean National Health and Nutrition Examination Survey 2010-2011, a cross-sectional study. <i>Clin Otolaryngol.</i> 2014;39(2):89-94.	Review/Other-Dx	10,061 individuals	To examine the association between tinnitus and several potential risk factors in Korean population.	Of the 10,061 participants ranging from 20 to 97 years old, the overall prevalence of any tinnitus was 21.4% and annoying tinnitus was 7.3%. In a multivariable logistic regression model, the following factors were associated with having tinnitus: occupational noise exposure [any tinnitus, OR = 1.34; annoying tinnitus, OR = 1.47], nonoccupational noise exposure (any tinnitus, OR = 1.48; annoying tinnitus, OR = 2.02), hearing impairment (any tinnitus, OR = 2.27; annoying tinnitus, OR = 3.61), chronic otitis media (any tinnitus, OR = 1.53; annoying tinnitus, OR = 1.36), chronic rhinosinusitis (any tinnitus, OR = 1.38; annoying tinnitus, OR = 1.38), temporomandibular disorder (any tinnitus, OR = 1.69; annoying tinnitus, OR = 1.90), depression (any tinnitus, OR = 1.44; annoying tinnitus, OR = 1.70), and higher stress level (any tinnitus, OR = 1.28; annoying tinnitus, OR = 1.76).	4
44. Vernon J, Griest S, Press L. Attributes of tinnitus that may predict temporomandibular joint dysfunction. <i>Cranio.</i> 1992;10(4):282-287; discussion 287-288.	Review/Other-Dx	1002 patients	To describe attributes of tinnitus that may predict temporomandibular joint dysfunction.	No results stated in abstract.	4

* See Last Page for Key

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>45. Pyykko I, Zou J, Poe D, Nakashima T, Naganawa S. Magnetic resonance imaging of the inner ear in Meniere's disease. <i>Otolaryngol Clin North Am.</i> 2010;43(5):1059-1080.</p>	<p>Review/Other-Dx</p>	<p>N/A</p>	<p>A critical review of the recent advancements in the inner ear MRI technology, contrast agent application and the correlated ototoxicity study, and the uptake dynamics of gadolinium-chelate in the inner ear.</p>	<p>Gadolinium-chelate causes inflammation of the mucosa of the middle ear, but there are no reports or evidence of toxicity-related changes in vivo either in animals or in humans. Intravenously administered gadolinium-chelate reached the guinea pig cochlea about 10 minutes after administration and loaded the scala tympani and scala vestibuli with the peak at 60 minutes. However, the perilymphatic loading peak was 80 to 100 minutes in mice after intravenous administration of gadolinium-chelate. In healthy animals the scala media did not load gadolinium-chelate. In mice in which gadolinium-chelate was administered topically onto the round window, loading of the cochlea peaked at 4 hours, at which time it reached the apex. The initial portions of the organ to be filled were the basal turn of the cochlea and vestibule. In animal models with EH, bulging of the Reissner's membrane was observed as deficit of gadolinium-chelate in the scala vestibuli. Histologically the degree of bulging correlated with the MRI. In animals with immune reaction-induced EH, MRI showed that EH could be limited to restricted regions of the inner ear, and in the same inner ear both EH and leakage of gadolinium-chelate into the scala media were visualized. More than 100 inner ear MRI scans have been performed to date in humans. Loading of gadolinium-chelate followed the pattern seen in animals, but the time frame was different. In intravenous delivery of double-dose gadolinium-chelate, the inner ear compartments were visualized after 4 hours. The uptake pattern of gadolinium-chelate in the perilymph of humans between 2 hours and 7 hours after local delivery needs to be clarified. In almost all patients with probable or suspected MD, EH was verified. Specific algorithms with a 12-pole coil using FLAIR sequences are recommended for initial imaging in humans.</p>	<p>4</p>

* See Last Page for Key

**Tinnitus
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. 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. <i>Laryngoscope</i> . 2016;126(4):974-979.	Observational-Dx	54 patients	To investigate the correlation between a battery of diagnostic symptoms of definite MD and the degree of 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 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
47. Han L, Zhaohui L, Fei Y, et al. Disrupted neural activity in unilateral vascular pulsatile tinnitus patients in the early stage of disease: evidence from resting-state fMRI. <i>Prog Neuropsychopharmacol Biol Psychiatry</i> . 2015;59:91-99.	Observational-Dx	34 patients and 34 controls	To investigate changes in spontaneous brain activity among patients with unilateral PT in the early stage of disease (<48 months) and determine the relationship of these changes with clinical data.	Compared with normal controls, the patients with PT had significantly increased regional homogeneity and amplitude of low-frequency fluctuation in the posterior cingulate cortex, right inferior parietal lobule and right cerebellum posterior lobe. The PT group showed increased regional homogeneity in the posterior cingulate cortex, precuneus, right inferior parietal lobule, right superior frontal gyrus, some occipital areas and part of the right cerebellum posterior lobe. For amplitude of low-frequency fluctuation, the increased clusters were in the posterior cingulate cortex and precuneus and in some areas of the cerebellum posterior lobe, bilateral inferior parietal lobule and inferior frontal gyrus. Increased PT duration was correlated with increased amplitude of low-frequency fluctuation in the bilateral inferior frontal gyrus and precuneus. An increased THI score was correlated with regional homogeneity and amplitude of low-frequency fluctuation values in the precuneus.	3
48. Zobay O, Palmer AR, Hall DA, Sereda M, Adjamian P. Source space estimation of oscillatory power and brain connectivity in tinnitus. <i>PLoS One</i> . 2015;10(3):e0120123.	Observational-Dx	28 patients and 19 controls	To compare resting-state oscillatory activity of tinnitus participants and normal-hearing controls to examine effects on spectral power as well as functional and effective connectivity.	We find increased functional connectivity within the auditory cortices in the alpha band. A significant increase is also found for the effective connectivity from a global brain network to the auditory cortices in the alpha and beta bands.	3

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
49. Chen YC, Xia W, Feng Y, et al. Altered interhemispheric functional coordination in chronic tinnitus patients. <i>Biomed Res Int.</i> 2015;2015:345647.	Review/Other-Dx	28 patients and 30 controls	To investigate interhemispheric functional coordination in tinnitus patients and to study the relationships between altered interhemispheric functional connectivity and other tinnitus characteristics.	Compared to the controls, tinnitus patients showed significantly increased voxel-mirrored homotopic connectivity in the middle temporal gyrus, middle frontal gyrus, and superior occipital gyrus. In tinnitus patients, a positive correlation was found between tinnitus duration and voxel-mirrored homotopic connectivity of the uncus. Moreover, correlations between voxel-mirrored homotopic connectivity changes and tinnitus distress were observed in the transverse temporal gyrus, superior temporal pole, precentral gyrus, and calcarine cortex.	4
50. Chen YC, Zhang J, Li XW, et al. Altered intra- and interregional synchronization in resting-state cerebral networks associated with chronic tinnitus. <i>Neural Plast.</i> 2015;2015:475382.	Review/Other-Dx	29 patients and 30 controls	To compare the resting-state fMRI patterns of tinnitus patients and healthy controls and identify aberrant neural networks involved in chronic tinnitus.	Relative to healthy controls, tinnitus patients had significant greater regional homogeneity values in several brain regions including the bilateral anterior insula, left inferior frontal gyrus, and right supramarginal gyrus. Furthermore, the left anterior insula showed enhanced functional connectivity with the left middle frontal gyrus, while the right anterior insula had enhanced functional connectivity with the right middle frontal gyrus; these measures were positively correlated with Tinnitus Handicap Questionnaires ($r = 0.459$, $P=0.012$ and $r = 0.479$, $P=0.009$, respectively).	4
51. de Aguiar PH, Zicarelli CA, Isolan G, et al. Brainstem cavernomas: a surgical challenge. <i>Einstein (Sao Paulo).</i> 2012;10(1):67-73.	Review/Other-Tx	13 patients	To present the authors' experience in brainstem cavernomas surgery, and compare it with literature data.	The mean age was 42.4 years (ranging from 19 to 70). No predominant gender: male-to-female ratio, 6:7. Pontine cases were more frequent. MRI was used as the imaging method to diagnose cavernomas in all cases. The mean follow-up was 71.3 months (range of 1 to 138 months). Clinical presentation was a single cranial nerve deficit, VIII paresis, tinnitus and hearing loss (69.2%). All 13 patients underwent resection of the symptomatic brainstem cavernoma. Complete removal was accomplished in 11 patients. Morbidity and mortality were 15.3 and 7.6%, respectively.	4

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
52. Saito N, Watanabe M, Liao J, et al. Clinical and radiologic findings of inner ear involvement in sickle cell disease. <i>AJNR Am J Neuroradiol.</i> 2011;32(11):2160-2164.	Review/Other-Dx	89 patients	To examine the prevalence of inner ear involvement and to assess the relationship between clinical and imaging findings in patients with sickle cell disease.	Among 89 patients with sickle cell disease identified (41 males, 48 females), 17 patients (14 males, 3 females; 10–48 years old) underwent imaging evaluation for inner ear complaints, including sensorineural hearing loss, dizziness, vertigo, and tinnitus. Labyrinthine hemorrhage was identified in 3 patients (3 males) and labyrinthitis ossificans was identified in another 3 patients (2 males, 1 female). All patients with labyrinthine hemorrhage had sickle-hemoglobin C disease, whereas those with labyrinthitis ossificans consisted of 2 patients homozygous for HbS (2) and 1 with HbS/beta-thalassemia. Patients with labyrinthine hemorrhage presented with vestibular symptoms (2 vertigo, 1 dizziness), whereas patients with labyrinthitis ossificans presented with sensorineural hearing loss. Labyrinthine hemorrhage was seen in the basal turn of cochlea and vestibule, whereas labyrinthitis ossificans involved the lateral semicircular canal.	4

**Tinnitus
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>53. Shulman A, Goldstein B, Strashun AM. Central nervous system neurodegeneration and tinnitus: a clinical experience. Part I: Diagnosis. <i>Int Tinnitus J.</i> 2007;13(2):118-131.</p>	<p>Review/Other-Dx</p>	<p>96 patients</p>	<p>A retrospective review and analysis of consecutive tinnitus patients.</p>	<p>Of these 96 patients, 54 had severe disabling type of the predominantly central type and of these, 18 (ages 39–75 years) were recommended for nuclear medicine imaging (SPECT FDG-PET/CT). Patient selection for nuclear medicine imaging fulfilled the criteria of a medical-audiological neurodegeneration tinnitus profile: completion of a patient protocol that diagnosed a predominantly central-type, severe, disabling, subjective, idiopathic tinnitus lasting in excess of 1 year, and failure of existing modalities of treatment attempting tinnitus relief. In 16 of the 18 patients, objective evidence of neurodegeneration was reported in multiple neural substrates of brain obtained with SPECT or FDG-PET/CT of brain. Classification of central nervous system neurodegeneration and tinnitus differentiated between (1) neurodegeneration of nonspecific or unknown etiology; (2) neurodegeneration manifested by perfusion asymmetries in brain associated with ischemia (n = 11/18); and (3) neurodegenerative central nervous system disease consistent with nuclear medicine criteria for senile dementia of the Alzheimer’s type (n = 5/18). The diagnosis has been associated with cerebrovascular disease (n = 16/18). The identification of neurodegenerative central nervous system disease in a selected cohort of patients with subjective idiopathic tinnitus as a soft sign of such central nervous system disease has implications for diagnosis and treatment.</p>	<p>4</p>

**Tinnitus
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
54. Arai M, Takada T, Nozue M. Orthostatic tinnitus: an otological presentation of spontaneous intracranial hypotension. <i>Auris Nasus Larynx</i> . 2003;30(1):85-87.	Observational-Dx	1 patient	To report a case of spontaneous intracranial hypotension with orthostatic tinnitus.	Cranial MRI with gadolinium infusion showed diffuse enhancement of the dura mater. Radionuclide cisternography demonstrated cerebrospinal fluid leaks at the upper and lower thoracic levels. Epidural blood patches at these leak sites alleviated the orthostatic headache, however, orthostatic tinnitus and muffled hearing persisted. Initial audiometry was unremarkable; repeat audiometry performed 6 weeks later demonstrated low-frequency hearing loss in the right ear. Continuous epidural saline infusion for 3 consecutive days was performed; auditory symptoms disappeared 4 weeks thereafter.	4
55. Ferrante E, Savino A, Sances G, Nappi G. Spontaneous intracranial hypotension syndrome: report of twelve cases. <i>Headache</i> . 2004;44(6):615-622.	Review/Other-Dx	12 patients	To investigate clinical, MRI, and radioisotope findings and therapeutic outcome of the syndrome of spontaneous intracranial hypotension.	11 patients presented orthostatic headache, 1 patient had continuous nonpostural headache. Additional clinical symptoms included nausea, vomiting, tinnitus, diplopia, and back pain. All the patients had low cerebrospinal fluid opening pressure, 7 had increased cerebrospinal fluid albumin, and 4 had pleocytosis. Brain MRI showed diffuse pachymeningeal gadolinium enhancement. Other features included subdural fluid collections (hematoma/hygroma) in 4 patients, downward displacement of the brain in 4 patients, and enlargement of the pituitary gland in 1 patient. Radioisotope cisternography results indicated, in 2 patients, a cerebrospinal fluid leakage site in the cervico-thoracic region, and in 1 patient showed limited ascent of the tracer to the cerebral convexity and early appearance of radioisotope in the bladder. All the patients had complete resolution of headache with conservative treatment.	4

**Tinnitus
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
56. Isildak H, Albayram S. Spontaneous intracranial hypotension syndrome accompanied by bilateral hearing loss and venous engorgement in the internal acoustic canal and positional change of audiography. <i>J Craniofac Surg.</i> 2010;21(1):165-167.	Review/Other-Dx	1 patient	To describe spontaneous intracranial hypotension as a curable reason of hearing loss, tinnitus, and vertigo.	Spontaneous intracranial hypotension, which may cause Meniere syndrome-like symptoms, is a curable reason of hearing loss, tinnitus, and vertigo. In addition, the fluctuation of the hearing loss with positional changes supports the use of positional audiometry when evaluating hearing loss-related spontaneous intracranial hypotension. Venous engorgement in the internal acoustic canal may be related to the symptoms.	4
57. Falcioni M, Taibah A, Rohit. Pulsatile tinnitus as a rare presenting symptom of residual cholesteatoma. <i>J Laryngol Otol.</i> 2004;118(2):165-166.	Review/Other-Dx	1 patient	To present a case of residual cholesteatoma with PT, 9 years after the first surgery.	No results stated in abstract.	4
58. Lao Z, Sha Y, Chen B, Dai CF, Huang WH, Cheng YS. Labyrinthine sequestrum: four case studies. <i>Otolaryngol Head Neck Surg.</i> 2012;147(3):535-537.	Review/Other-Tx	4 patients	To present 4 case studies of patients with labyrinthine sequestrum.	Imaging studies showed an osteolytic soft mass with calcified debris in the inner ear, and the bony labyrinth was eroded partly or completely by granulation mass, with loss of bony morphology. Further pathological examination was coincident with inflammatory granulation tissue with some calcification or osseous tissue. The disease process is attributed to chronic osteomyelitis due to the presence of osteonecrosis. Prompt CT and MRI examinations and optimal therapeutic management facilitate definitive diagnosis and protect against fatal complications.	4

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
59. Yamashita K, Yoshiura T, Hiwatashi A, et al. The radiological diagnosis of fenestral otosclerosis: the utility of histogram analysis using multidetector row CT. <i>Eur Arch Otorhinolaryngol.</i> 2014;271(12):3277-3282.	Observational-Dx	38 patients and 30 controls	To evaluate the utility of CT histogram analysis in diagnosing fenestral otosclerosis.	The number of pixels below mean minus SD in the control (%Lowcont) and total subjects (%Lowtotal) were also compared. In addition, the area under the receiver operating characteristic curves value for the discrimination between otosclerosis patients and normal controls was calculated. 51 temporal bones of 38 patients with otosclerosis and 30 temporal bones of 30 control subjects were included. The mean CT value was significantly lower in otosclerosis cases than in normal controls (P<0.01). In addition, variance, entropy, %Lowcont and %Lowtotal were significantly higher in otosclerosis cases than in normal controls (P<0.01, respectively). The area under the receiver operating characteristic curves values for the mean CT value, %Lowcont and %Lowtotal were 0.751, 0.760 and 0.765, respectively.	3
60. Samii M, Nakamura M, Mirzai S, Vorkapic P, Cervio A. Cavernous angiomas within the internal auditory canal. <i>J Neurosurg.</i> 2006;105(4):581-587.	Review/Other-Dx	7 patients	To describe the symptomatology, radiological features, and surgical treatment of patients with cavernous angiomas within the IAC.	Cavernous angiomas of the IAC are very uncommon lesions that can imitate the symptoms of vestibular schwannomas. Although it is the most sensitive study available, MRI does not show sufficiently specific findings to differentiate the 2 lesion types. Thus, the preoperative diagnosis must be based on patient symptoms plus the CT and MRI features.	4
61. Nowe V, Van de Heyning P, Parizel PM. MRI in patients with otovestibular complaints of unknown origin. <i>B-ENT.</i> 2007;3 Suppl 7:27-35.	Observational-Dx	430 patients	To investigate the role of MRI in patients with otovestibular and cranial nerve complaints of unknown etiology.	The detection rate for essential lesions was 4.9%. 2 groups of retrocochlear lesions were frequently observed: central white matter lesions/atrophy and neurovascular conflict affecting a cranial nerve.	4
62. Kang HM, Kim MG, Hong SM, Lee HY, Kim TH, Yeo SG. Comparison of temporal bone fractures in children and adults. <i>Acta Otolaryngol.</i> 2013;133(5):469-474.	Observational-Dx	32 children and 186 adults	To investigate differences in temporal bone fractures in adults and children by examining the manifestations and clinical symptoms of temporal bone fractures in pediatric patients.	Causes of fracture, gender distribution, manifestations of temporal bone fracture, and clinical symptoms were similar in adults and children (P>0.05 each). Petrous fracture, ear fullness, dizziness, and tinnitus were significantly more frequent in adults than in children (P<0.05 each).	4

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
63. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: http://www.acr.org/~media/ACR/Documents/AppCriteria/RadiationDoseAssessmentIntro.pdf	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	N/A	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.
- M = Meta-analysis

Dx = Diagnostic

Tx = Treatment