# Cranial Nerve VIII: Vestibular Nerve

13

**One sentence:** The vestibular nerve is a special sensory nerve that balances information from the semicircular canals, and its anatomy is best visualized in relation to the temporal bone (Fig. 13.1) and the vestibular organ (Fig. 13.2).

| Genetic testing | NCV/EMG | Laboratory | Imaging | Other | Biopsy |
|---|---|---|---|---|---|
| ? | + | + | + | Impulse test | |

## Symptoms

Dizziness, vertigo ("spinning" and tilting), nausea/vomiting, imbalance, and falling.

## Signs

Lesions result in abnormal eye movements and balance problems with stance, gait, and equilibrium abnormalities.

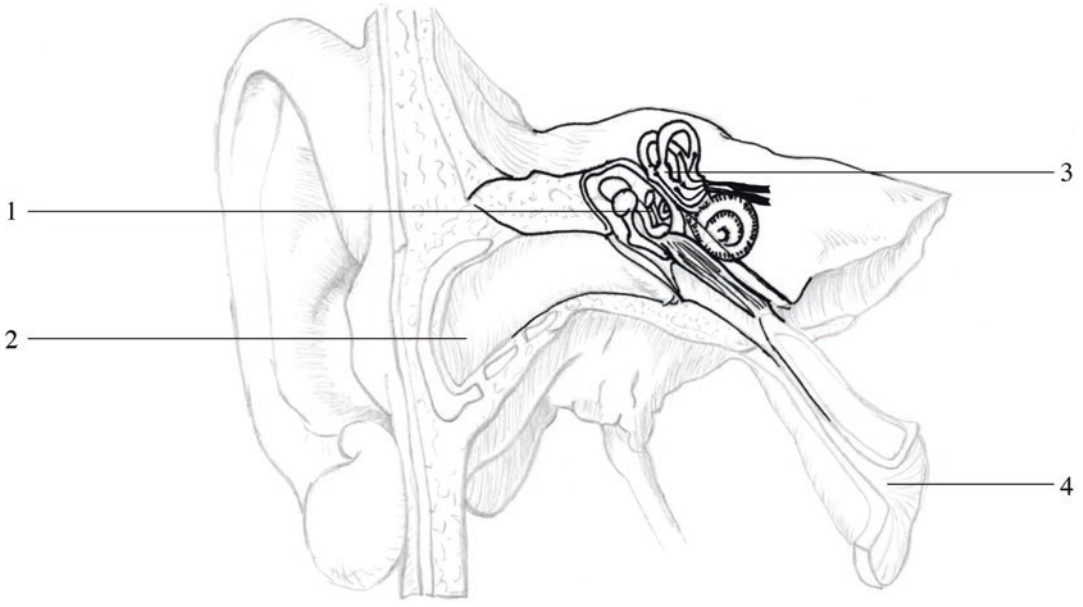


**Fig. 13.1** Temporal bone. (*1*) Tympanic cavity, (*2*) external auditory meatus, (*3*) bony labyrinth, (*4*) eustachian tube


W. Grisold et al., *The Cranial Nerves in Neurology*, https://doi.org/10.1007/978-3-031-43081-7_13

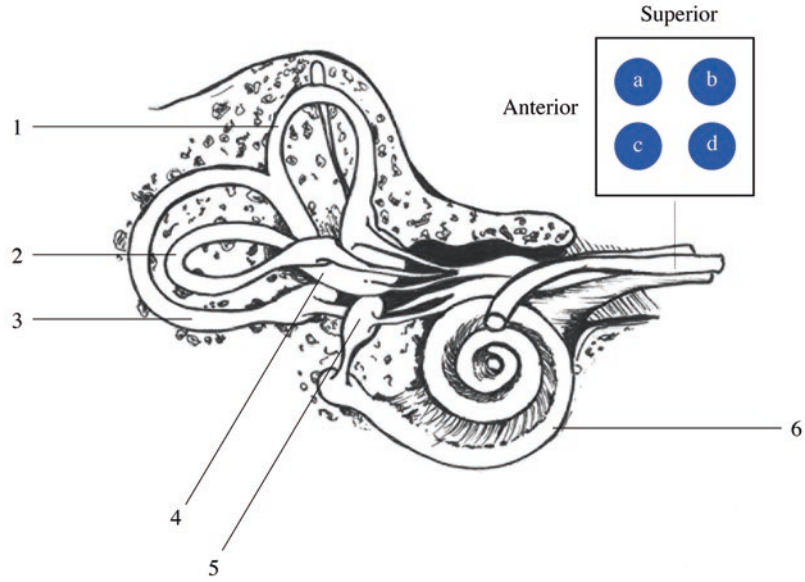


**Fig. 13.2** Vestibular nerve. (*1*) Superior semicircular canal, (*2*) lateral semicircular canal, (*3*) posterior semicircular canal, (*4*) utriculus, (*5*) sacculus, (*6*) spiral ganglia. Positions of nerves in the internal auditory meatus: *a* facial nerve, *b* superior vestibular nerve, *c* cochlear nerve, *d* inferior vestibular nerve

Specific symptoms: Vertigo, nystagmus, oscillopsia, and autonomic involvement.

## Specific Qualities

*Motor*:
*Sensory*:
*Autonomic*:
*Special senses*: +.
*Other*:

## Location of Lesions

*Central*: The distribution of the cortical vestibular areas is complex [1] and is subject to extensive study. A clearly assigned lesion to a cortical area of vestibular symptoms and signs is clinically difficult, but several paradigms of localization of function have been described [1–3].

Brain stem lesion causes include vascular, inflammatory diseases, infections, and tumors.

*Intracranial lesions within the skull:* Examples include cerebellopontine angle tumors (CPA) and other intracranial tumors.

*Exit of the skull*: Temporal bone trauma, fractures. Middle ear damage [4], blast injuries.

*Other*: Other vestibular syndromes include Menier's disease [5], vestibular neuritis [6], peripheral paroxysmal positional nystagmus [7], positional (central) [8], persistent postural-perceptual dizziness (PPPD) [9], bilateral vestibulopathy ("bilateral vestibular weakness"), vestibular paroyxsmia, and the third mobile window syndromes [10]

## Combination with Other CN

In CPA tumors.

## Causes and Frequency

*Age-related*: With increasing age vestibular functions also deteriorate [11]. Presbyastasis is the term coined for aging of sensory systems [12, 13].

*Congenital and hereditary:* Aplasia; Arnold-Chiari syndrome; atrophy of CN VIII; chromosomal aberrations; Cockayne, Hallgren, and Alström syndrome; hereditary motor and sensory

neuropathy (HMSN); Kearns-Sayre; olivopontocerebellar atrophy (OPCA); Refsum's disease; retinitis pigmentosa; sensorineural deafness; SMA; thyroid disease.

*Cupulolithiasis:* Benign paroxysmal positional nystagmus. Several subtypes have been described. Positioning maneuvers: Dix, Hallpike, Semont, or Epley.

*Immunologic disorders:* Demyelinating neuropathies, Hashimoto, leukodystrophies, MS, periarteritis nodosa, sarcoid.

*Infection:* Labyrinthitis, specific and unspecific.

Bacterial: Hemophilus, Lyme disease, petrositis, streptococc pneumoniae, syphilis [14]. Pus reaches the inner ear by either blood or direct invasion (meningoencephalitis).

Viral: AIDS, herpes zoster oticus, Ramsey Hunt syndrome, vestibular neuronitis.

Mycotic: Coccidiomycosis, cryptococcosis, rickettsial infection.

*Metabolic:* Diabetes, uremia.

*Neoplastic:* Acoustic nerve neuroma, metastases, neurofibromatosis [15], schwannoma.

*Neuropathy:* Several associations (polyneuropathy) [16], also several types of CMT.*Perilymphatic fistula*: Communication between the middle ear (air-filled) and inner ear (fluid-filled) following trauma or surgery.

*Radiation therapy*: Usually as late effects [17].

*Toxic:* Alcohol, aminoglycosides, chemotherapy (cisplatin, cyclophosphamide, hydroxyurea, platinum [18], vinblastine); heavy metals (lead, mercury); quinine, salicylate [19].

*Trauma:* Blunt, penetrating, or barotrauma. Transverse fractures are often associated with additional CN VII lesion. The less common transverse fractures damage both facial and vestibulocochlear nerves. These fractures involve the otic capsule, passing through the vestibule of the inner ear, tearing the membranous labyrinth, and lacerating both vestibular and cochlear nerves. Vertigo is the most common neurologic sequel to head injury, and it is a positional vertigo.

*Vascular:* Anterior inferior cerebellar artery aneurysm, arteria posterior communicans aneurysm, labyrinthine hemorrhage or stroke secondary to thrombosis of the labyrinthine (internal auditory) artery, large vascular loops, vascular lesions of the spiral ganglion, vertebrobasilar circulation disorders (history of diabetes, hypertension).

*Vasculitis*: Immune mediated, Cogan syndrome.

*Vestibular epilepsy*: [20].

*Vestibular paroxysms.*

*Others:* Hyperviscosity syndromes (hypergammaglobulinemia, polycythemia vera, Waldenström's macroglobulinemia).

## Main Investigations

Diagnosis is based on clinical and vestibular testing, laboratory testing (including genetics for hereditary causes), and imaging.

Clinical tests: Romberg, vestibular-ocular reflex test (doll's head test), video head impulse test [21].

## Therapy

Depends on the cause of the vestibular nerve damage.

## References

1. Dieterich M, Brandt T. Functional brain imaging of peripheral and central vestibular disorders. Brain. 2008;131(Pt 10):2538–52.
2. Nam HW, Yoo D, Lee SU, Choi JY, Yu S, Kim JS. Pearls & Oy-sters: labyrinthine infarction mimicking vestibular neuritis. Neurology. 2021;97(16):787–90.
3. Gam BU, Cho IH, Yeo SS, Kwon JW, Jang SH, Oh S. Comparative study of vestibular projection pathway connectivity in cerebellar injury patients and healthy adults. BMC Neurosci. 2022;23(1):17.
4. Van Hoecke H, Calus L, Dhooge I. Middle ear damages. B-ENT. 2016;12(Suppl. 26):173–83.
5. Christopher LH, Wilkinson EP. Meniere's disease: medical management, rationale for vestibular preservation and suggested protocol in medical failure. Am J Otolaryngol. 2021;42(1):102817.

6. Le TN, Westerberg BD, Lea J. Vestibular neuritis: recent advances in etiology, diagnostic evaluation, and treatment. Adv Otorhinolaryngol. 2019;82:87–92.
7. Imai T, Inohara H. Benign paroxysmal positional vertigo. Auris Nasus Larynx. 2022;49(5):737–47.
8. Macdonald NK, Kaski D, Saman Y, Al-Shaikh Sulaiman A, Anwer A, Bamiou DE. Central positional nystagmus: a systematic literature review. Front Neurol. 2017;8:141.
9. Waterston J, Chen L, Mahony K, Gencarelli J, Stuart G. Persistent postural-perceptual dizziness: precipitating conditions, co-morbidities and treatment with cognitive behavioral therapy. Front Neurol. 2021;12:795516.
10. Strupp M, Dlugaiczyk J, Ertl-Wagner BB, Rujescu D, Westhofen M, Dieterich M. Vestibular disorders. Dtsch Arztebl Int. 2020;117(17):300–10.
11. Balatsouras DG, Koukoutsis G, Fassolis A, Moukos A, Apris A. Benign paroxysmal positional vertigo in the elderly: current insights. Clin Interv Aging. 2018;13:2251–66.
12. Rogers C. Presbyastasis: a multifactorial cause of balance problems in the elderly. South Afr Family Pract. 2010;52(5):431–4.
13. Belal A Jr, Glorig A. Dysequilibrium of ageing (presbyastasis). J Laryngol Otol. 1986;100(9):1037–41.
14. Casas-Limon J, Ordas-Bandera CM, Matias-Guiu JA, Barahona-Hernando R, Abarrategui-Yague B, Garcia-Ramos R, et al. Otosyphilis as the cause of skew deviation and benign paroxysmal positional vertigo. Rev Neurol. 2012;55(1):62–4.
15. Korf BR. Neurofibromatosis. Handb Clin Neurol. 2013;111:333–40.
16. Buetti B, Luxon LM. Vestibular involvement in peripheral neuropathy: a review. Int J Audiol. 2014;53(6):353–9.
17. Kovar M, Waltner JG. Radiation effect on the middle and inner ear. Pract Otorhinolaryngol (Basel). 1971;33(4):233–42.
18. Prayuenyong P, Taylor JA, Pearson SE, Gomez R, Patel PM, Hall DA, et al. Vestibulotoxicity associated with platinum-based chemotherapy in survivors of cancer: a scoping review. Front Oncol. 2018;8:363.
19. Sheppard A, Hayes SH, Chen GD, Ralli M, Salvi R. Review of salicylate-induced hearing loss, neurotoxicity, tinnitus and neuropathophysiology. Acta Otorhinolaryngol Ital. 2014;34(2):79–93.
20. Hewett R, Bartolomei F. Epilepsy and the cortical vestibular system: tales of dizziness and recent concepts. Front Integr Neurosci. 2013;7:73.
21. Halmagyi GM, Chen L, MacDougall HG, Weber KP, McGarvie LA, Curthoys IS. The video head impulse test. Front Neurol. 2017;8:258.