CLINICAL REVIEW

Acoustic Neuroma: Physical Therapy

Indexing Metadata/Description

› **Title/condition:** Acoustic Neuroma: Physical Therapy

› **Synonyms:** Neuroma, acoustic; vestibular schwannoma; acoustic schwannoma; acoustic neurinoma; cerebellopontine angle tumor; neurilemmoma

› **Anatomical location/body part affected:** Schwann cells surrounding the 8th cranial nerve, usually within the auditory canal[1]

› **Area(s) of specialty:** Neurological Rehabilitation

› **Description:** [2,8,30,31]

- An acoustic neuroma is a slow-growing, benign, intracranial, extra-axial tumor composed of Schwann cells that originate in the nerve sheath of the vestibulocochlear nerve, and usually on the superior vestibular portion. It usually arises in the internal auditory canal near the cerebellopontine angle.
- Accounts for 8 to 10% of all intracranial tumors and more than 90% of all cerebellopontine angle tumors
- Patients typically present with hearing loss, tinnitus, and balance dysfunction, and might require physical therapy to address impairments in balance, gaze stabilization, functional mobility, and ability to ambulate, as well as facial weakness

› **ICD-10 codes**

- D33.3 Benign neoplasm of cranial nerves
- R42 Dizziness and giddiness
- R26.2 Difficulty in walking, not elsewhere classified
- R26.81 Unsteadiness on feet
- R26.89 Other abnormalities of gait and mobility

(ICD codes are provided for the readers' reference, not for billing purposes)

› **G-Codes**

- **Mobility G-code set**
  - G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8979, Mobility: walking & moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8980, Mobility: walking & moving around functional limitation, discharge status, at discharge from therapy or to end reporting
- **Changing & Maintaining Body Position G-code set**
  - G8981, Changing & maintaining body position functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8982, Changing & maintaining body position functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8983, Changing & maintaining body position functional limitation, discharge status, at discharge from therapy or to end reporting
- **Carrying, Moving & Handling Objects G-code set**
  - G8984, Carrying, moving & handling objects functional limitation, current status, at therapy episode outset and at reporting intervals

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- G8985, Carrying, moving & handling objects functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8986, Carrying, moving & handling objects functional limitation, discharge status, at discharge from therapy or to end reporting

• **Self-care G-code set**
- G8987, Self-care functional limitation, current status, at therapy episode outset and at reporting intervals
- G8988, Self-care functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8989, Self-care functional limitation, discharge status, at discharge from therapy or to end reporting

• **Other PT/OT Primary G-code set**
- G8990, Other physical or occupational primary functional limitation, current status, at therapy episode outset and at reporting intervals
- G8991, Other physical or occupational primary functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8992, Other physical or occupational primary functional limitation, discharge status, at discharge from therapy or to end reporting

• **Other PT/OT Subsequent G-code set**
- G8993, Other physical or occupational subsequent functional limitation, current status, at therapy episode outset and at reporting intervals
- G8994, Other physical or occupational subsequent functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
- G8995, Other physical or occupational subsequent functional limitation, discharge status, at discharge from therapy or to end reporting

G-code Modifier	Impairment Limitation Restriction
CH	0 percent impaired, limited or restricted
CI	At least 1 percent but less than 20 percent impaired, limited or restricted
CJ	At least 20 percent but less than 40 percent impaired, limited or restricted
CK	At least 40 percent but less than 60 percent impaired, limited or restricted
CL	At least 60 percent but less than 80 percent impaired, limited or restricted
CM	At least 80 percent but less than 100 percent impaired, limited or restricted
CN	100 percent impaired, limited or restricted
Source: https://www.cms.gov/	

› **Reimbursement:** No specific issues or information regarding reimbursement have been identified

› **Presentation/signs and symptoms**
- The majority of acoustic neuromas present unilaterally (95%)[8]
- Bilateral presentation is much less common (5%) and is usually due to neurofibromatosis type 2 (NF2) [2]
- Tumors associated with NF2 typically occur before the age of 30[8]
- Hearing loss is the most common symptom;[44]typically gradual onset of high-frequency sensorineural hearing loss,[1,28,31] with deterioration of speech discrimination exceeding that predicted by the degree of pure tone loss[2,28]

- Tinnitus[28,31]
  - Occurs in approximately 63-75% of patients[38]
  - For detailed information. see Clinical Review…*Tinnitus*; Topic ID Number: T709236
- Dizziness[2,45]
  - Dizziness is the only symptom that seems to decrease as the size of the tumor increases[44]
- Unsteadiness/disequilibrium[2,29,30]
  - Researchers in Uruguay who conducted a randomized controlled trial found patients who were still unsteady one year after surgery to completely remove an acoustic neuroma had alterations in their response to gravitational vertical, as measured by the head tilt response test (a test in which the patient wears goggles and has to tilt his or her head in order to keep a white bar aligned with his or her gravitational vertical)[29]
- Vertigo[2]
- Aural fullness[1]
- Less common symptoms that might occur as tumor progresses
  - Headaches[8]
  - Diplopia[34]
  - Loss of coordination/ataxia[8]
  - Facial weakness[30]
  - Facial numbness[1,31]
  - Trigeminal nerve dysfunction[8]

Causes, Pathogenesis, & Risk Factors

› **Causes**

- Atypical proliferation of Schwann cells
  - Idiopathic – unknown cause, usually unilateral[8]
  - Genetic mutation–manifestation of autosomal dominant disorder NF2. NF2 is caused by a mutation on the NF2 gene on the long arm of chromosome 22, and is often bilateral[8,41,42]
  - Recent studies have also identified increased risk of schwannomatosis, a member of the neurofibromatosis family of neurogenetic disorders, with mutation of the gene LZTR1[41,42]
    - Although schwannomas with this disease tend to be non-vestibular, cases of unilateral acoustic neuromas are observed[41]

› **Pathogenesis**

- Benign, slowly growing encapsulated tumor composed of Schwann cells located around superior or inferior vestibular nerves that might lead to cochlear nerve dysfunction (due to compression or stretching), internal auditory artery occlusion, facial and trigeminal nerve dysfunction, increased intracranial pressure, or brainstem and/or cerebellar compression[3,9]
  - Compression of the facial and vestibulocochlear nerves when located in the internal acoustic canal[8]
  - Compression of the brain stem, 4th ventricle, and trigeminal nerve when located at the cerebellopontine angle[8]
- The NF2 gene produces Merlin, a tumor suppressor, therefore, deficiency in NF2 genes leads to the tumor development[8]

› **Risk factors**

- Environmental exposure to high-dose ionizing radiation[4,37]
- NF2
  - Five percent of cases are due to NF2[2,30,37]
- Exposure to loud noise:[5,6] Results from studies are conflicting[37]
  - Researchers from Sweden who conducted a study in 2014 found no statistically significant association between acoustic neuroma and persistent occupational noise exposure, with or without hearing protection, but they did find a statistically significant association between leisure-timeexposure to loud noise, although they could not rule out a recall bias as an alternative explanation[37]

- Researchers who conducted a nationwide cohort study in Denmark found no evidence that mobile phone use increases the risk of vestibular schwannoma. However, as these tumors tend to grow slowly and there is always the possibility of a delay in diagnosis, it is possible that an observation period of only 10-15 years after the widespread introduction of mobile phones might be too short a period to observe an effect, and further research is indicated[25]
- Researchers who conducted a prospective study in the United Kingdom in 2013 found that there was an increased risk for acoustic neuroma only in middle aged women who used cell phones for 5 years or longer.[32] However, after receiving updated data and repeating analysis, they now report that "there is no longer a significant association between long duration of use of mobile phone and acoustic neuroma risk." They also report that follow-up on their original study is ongoing[33]
- Researchers in Sweden found no increase in likelihood of acoustic neuroma with long-term mobile phone use[36]

Overall Contraindications/Precautions

› Any worsening of symptoms (e.g. impaired balance, gait, mental status, etc.) or appearance of new symptoms (e.g. headache, dizziness, etc.) should be immediately reported to the referring physician
› Examination and treatment should be performed by a trained vestibular therapist
› See specific **Contraindications/precautions** under **Assessment/Plan of Care**

Examination

› **History**
- **History of present illness/injury**
  - **Mechanism of injury or etiology of illness**
    - When did symptoms develop? What were the initial symptoms? What are the primary complaints?
    - When was the patient diagnosed?
    - Does the patient have any of the risk factors?
    - Does the patient have any hearing loss?[31]
      - Researchers who conducted a study in the United States found workers at risk for hearing loss due to their jobs who undergo annual hearing exams as a part of a company-instituted hearing conservation program are more likely to be diagnosed with an acoustic neuroma that otherwise would have gone undetected[31]
    - What treatment did patient receive for the tumor?
    - Were there any postoperative or posttreatment complications?
    - How have patient's symptoms changed postoperatively or posttreatment?
    - Does the patient report anxiety, depression, or problems coping with the disease/treatment?[18]
  - **Course of treatment**
    - **Medical management:** Has the patient had surgery, radiosurgery, or radiotherapy, or is the acoustic neuroma under observation?
      - Observation
        - Generally not advisable in young patients[7]
        - Indicated for patients with small tumors who are not good candidates for surgery[1]
        - Patients with static acoustic neuromas should be advised that although the tumor is not increasing in size, they still may be at increased risk for hearing loss in that ear[40]
      - Microsurgery
        - Involves resection of the tumor; has the lowest rate of recurrence (up to 97.5%have complete tumor removal)[8]
        - 3 standard approaches:[8]
          - Retromastoid/retrosigmoid
          - Middle cranial fossa
          - Translabrynthine
      - Staged Resection[52]
        - Occasionally, during unfavorable cases involving large tumors, surgery has to be suspended to avoid risk to patient life with additional surgeries being necessary

- Stereotactic radiosurgery
  - Uses image guided radiation directed right at the lesion; leads to disruption in cancer cell DNA and ultimately, cell death[47]
  - Delivery methods are: gamma knife, linear accelerators, and proton beam and heavy-chargedparticles[47]
  - Often used in patients with small to medium-sized tumors[7]and in those who are at high risk for complications associated with anesthesia[47]
  - Gamma knife single-dose stereotactic radiosurgery[8]
    - Performed on outpatient basis; indicated for smaller tumors (< 3 cm) or for those with contraindications to microsurgery
    - Better tumor control rates than conservative management and fewer complications than high-doseradiation, but may not be as effective as high-dose
    - Complications include trigeminal or facial nerve damage and hydrocephalus
- Radiotherapy
  - Fractionated stereotactic radiation therapy[7]
    - Typically used when the tumor is of substantial size and resection is not an option
    - Delivers higher dose of radiation to tumor and less to surrounding tissue
    - Requires multiple treatments
  - Hypofractionated stereotactic radiation treatment[35]
    - A more shortened course of therapy[35]
    - Preferable because it is more comfortable for the patient than surgery or convectional regimens but with comparable results, according to researchers in Austria[35]
- Chemotherapy has not been adequately investigated[8]
- Treatment for hearing loss:[53]
  - Nonsurgical
    - Contralateral routing of signal hearing aid
    - Bone conduction devices
  - Surgical
    - Surgically implanted bone conduction devices
      - Can be implanted at the time of tumor removal
- Treatment for facial nerve disruption[55]
  - Facial nerve reconstruction with graft

- **Medications for current illness/injury**
  - Vasoactive medications (e.g., nimodipine [Nimotop] and hetastarch/hydroxyethyl starch [Hespan, Hextend]) might preserve hearing and facial nerve function after surgery for acoustic neuroma[9]
  - Amphetamine and trimethobenzamide might reduce the symptoms of a severed vestibulocochlear nerve following surgical intervention[10]
  - As the molecular mechanisms behind the genesis of these tumors are better understood, novel therapies are emerging that might reduce mortality and morbidity while preserving function[2,8,46]
    - Bevacizumab (vascular endothelial growth factor blocker) has shown promise for treatment of tumors in patients with NF2[2]
    - Researchers in the United States studying salicylates report that they are a promising pharmacotherapy asCOX-2 is a key modulator in acoustic neuroma cell proliferation[46]

- **Diagnostic tests**
  - MRI
    - MRI should typically be the first diagnostic test performed when acoustic neuroma is suspected; using a noncontrast MRI first (rather than an MRI with contrast) is more cost-effective and is generally as useful as an MRI with contrast[2,11]
    - MRI with gadolinium is the gold standard test and has 100% specificity[8]

- Noncontrast T2-weighted fast-spin echo MRI is less expensive and has 98% specificity[8]
- CT scan can have a high false-negative rate (as high as 37%)[8]
- Audiometry[31]
- Stacked auditory brainstem response (ABR)[8]
- ABR is highly sensitive and less expensive than MRI but its sensitivity is lower for smaller tumors[44]
- Electronystagmogram (ENG)
- Calorics reveal a hypofunction to the affected side[56]
- Distortion-product otoacoustic emission tests can determine if the tumor is on the cochlear or vestibular portion of the nerve; retrocochlear hearing loss correlates with cochlear portion[8]

- **Home remedies/alternative therapies:** Document any use of home remedies (e.g., ice or heating pack) or alternative therapies (e.g., acupuncture) and whether or not they help
- Electroacupuncture has been used for years in China for treating diplopia and ptosis. In a case study, researchers discuss its use for abducent palsy after acoustic neuroma surgery[34]
- The patient fully recovered in 4 months, but the authors recommend more case controlled studies
- **Previous therapy:** Document whether patient has had occupational or physical therapy for this or other conditions and what specific treatments were helpful or not helpful

– **Aggravating/easing factors** (and length of time each item is performed before the symptoms come on or are eased): Are symptoms (e.g. tinnitus, dizziness, headache, etc.) associated with any specific activities or with head or body position changes? Does anything relieve or worsen symptoms?
– **Body chart:** Use body chart to document location and nature of symptoms
– **Nature of symptoms:** Document nature of symptoms (e.g., constant vs. intermittent, sharp, dull, aching, burning, numbness, tingling). Are symptoms such as dizziness, vertigo, imbalance, tinnitus, and/or headaches constant or intermittent? Ask patient to further describe (e.g. is tinnitus high pitch or low pitch? Is the patient dizzy or is the room spinning?)
– **Rating of symptoms:** Use a visual analog scale (VAS) or 0-10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much)
- Activities-specific Balance Confidence (ABC) Scale: A 16-item scale utilized in which patients rate confidence to perform specific activities
- Visual Vertigo Analogue Scale (VVAS)

– **Pattern of symptoms:** Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables
– **Sleep disturbance:** Document number of wakings/night
– **Other symptoms:** Document other symptoms patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician (e.g., symptoms of hydrocephalus such as worsening of balance, gait, or mental status)
– **Respiratory status:** Any respiratory complications during surgery? Does the patient require supplemental oxygen?
– **Barriers to learning**
- **Are there any barriers to learning? Yes__ No__**
- **If Yes, describe _____**

• **Medical history**
– **Past medical history**
- **Previous history of same/similar diagnosis**
- Other vestibular disorders
- NF2[1]
- CNS disorders
- Hearing impairment
- Any disease that affects the sensory systems (e.g., diabetes)
- Vision problems (e.g., macular degeneration)
- Migraine/other headache

- **Comorbid diagnoses:** Ask patient about other problems, including diabetes, cancer, cardiovascular disease, psychiatric disorders, orthopedic disorders, complications of pregnancy, etc.

- Pregnancy may increase risk and accelerate growth of the tumor[8]

- **Medications previously prescribed:** Obtain a comprehensive list of medications prescribed and/or being taken (including over-the-counter drugs). Is the patient taking medications that affect the vestibular system, such as vestibular suppressants, sedatives, anticonvulsants, antihistamines, antipsychotics, or antidepressants?
- **Other symptoms:** Ask patient about other symptoms he or she might be experiencing. Specifically ask about symptoms the patient might not realize are associated (e.g., fatigue, facial weakness, eye problems) or what they would like to speak about with a health care provider
  - Researchers in the United Kingdom conducted an online survey (n = 480) to investigate the issues, needs, and concerns of patients undergoing treatment for acoustic neuroma[50]
    - The most frequently selected issues were tinnitus, fatigue, dizziness
    - The most frequently selected fear was the tumor recurring
    - The most frequently selected concerns were facial appearance and head and neck pain

• **Social/occupational history**
  – **Patient's goals:** Document what the patient hopes to accomplish with therapy and in general
  – **Vocation/avocation and associated repetitive behaviors, if any:** Does the patient participate in recreational or competitive sports? Does the patient work? What does his or her job require? Does the patient participate in any other activities?
  – **Functional limitations/assistance with ADLs/adaptive equipment**
    - Does the patient report any pre-existing functional limitations?
    - Does patient have and/or use adaptive equipment?
  – **Living environment:** Inquire about stairs, number of floors in home, and with whom patient lives. Does the patient have a caregiver? Identify if there are barriers to independence in the home. Are any modifications necessary? Does the home seem safe based on the information provided by the patient?

› **Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)**

• **Arousal, attention, cognition (including memory, problem solving):** Assess in all patients and routinely monitor for changes. Consider using the Mini-Mental State Exam (MMSE), and obtain all formal testing results done by other disciplines

• **Assistive and adaptive devices:** Assess need for adaptive equipment for all patients with imbalance or dizziness. Assess proper fit and use for all equipment patient already has

• **Balance:** Assess all patients statically and dynamically. If possible, test with platform posturography (Equitest) or the Clinical Test for Sensory Integration of Balance (CTSIB)(also known as the Foam and Dome test), as well as with Romberg test. Utilize standardized tests such as Berg Balance Scale, Tinetti Balance Assessment, Functional Reach Test, and standing on one leg.
  – Authors of an observational research study conducted in Australia indicate that patients who have had surgical removal of a vestibular neuroma typically have balance deficits as measured by the CTSIB[12]

• **Cardiorespiratory function and endurance:** Assess blood pressure in lying, sitting, and standing. Assess vital signs throughout treatment as indicated and appropriate

• **Cranial/peripheral nerve integrity**
  – Assess for involvement of cranial nerves
    - I – Olfactory (evaluate ability to smell)
    - II – Optic (evaluate visual acuity, visual fields, and ocular fundi)
    - II, III – Optic and oculomotor (evaluate pupillary reactions)
    - III, IV, VI – Oculomotor, trochlear, abducens (evaluate extraocular movements)
    - V – Trigeminal (evaluate corneal reflexes, facial sensation, and jaw movements)
    - VII – Facial (evaluate facial movements, including lifting eyebrows, smiling/frowning, showing teeth, filling cheeks with air, and shutting eyes tight)
    - VIII – Vestibulocochlear (evaluate ability to hear)
    - IX, X – Glossopharyngeal, vagus (evaluate swallowing and rise of the palate, gag reflex)
    - V, VII, X, XII – Trigeminal, facial, vagus, hypoglossal (evaluate voice and speech)
    - XI – Spinal accessory (evaluate neck and shoulder movements)
    - XII – Hypoglossal (evaluate tongue symmetry and position)

  - Cranial nerve VIII is commonly affected by an acoustic neuroma and might be completely severed during surgery[10]
  - Patients who have had surgery to remove an acoustic neuroma might have facial nerve (CN VII) involvement
  - Involvement of other cranial nerves (IV, VI, IX, and X) depends on the size of the tumor[2,13]
- **Functional mobility** (including transfers, etc.): Assess safety with mobility and note any symptoms with position changes. Use objective measurements such as the FIM and the Timed Up & Go (TUG) test
- **Gait/locomotion:** Assess for any imbalance, sway and/or veering
  - Perform thorough gait analysis
  - Utilize standardized tests such as Dynamic Gait Index (DGI) to assess safety with ambulation
    - Results of an observational research study indicate that patients who have had surgical removal of a vestibular neuroma typically have gait deficits as measured by the DGI[12]
  - Vestibular specific gait tests
    - Ambulation with head turns side to side
    - Ambulation with head turns up and down
    - Tandem walking[13]
    - Walking with eyes closed
      - According to a study conducted in Japan, patients with a small vestibular schwannoma might appear to have a normal gait, but the deficit can be detected with proper use of gait analysis, especially analyzing the patient's gait with eyes closed[13]
- **Joint integrity and mobility:** Assess cervical spine. If there is a history of pain or dysfunction, a thorough exam should be performed
- **Muscle strength:** Assessment of upper and lower extremities. If patient has facial weakness, assess strength of facial movements as well
  - For evaluating facial muscle weakness:
    - House-Brackmann Facial Nerve Grading System[23]
    - Sunnybrook Facial Grading System
    - Facial Clinometric Evaluation (FaCE) Scale[49]
- **Oral mechanism exam and related tests:** Perform oral mechanism exam if facial weakness is present
- **Range of motion**: Assess all motions in the cervical spine. Also assess hips and ankles as normal ROM allows for optimal balance reactions
- **Reflex testing:** Assess vestibular ocular reflex (VOR) in horizontal and vertical planes. Have patient focus on an object and turn head side to side (15° to each side) as fast as he or she can, keeping the object perfectly clear. Normal speed is 120 head turns per minute
- **Self-care/activities of daily living** (objective testing): Assess safety in ADLs for patients with dizziness or imbalance, can use the Barthel Index
- **Special tests specific to diagnosis**
  - Gaze stability testing includes the following:
    - Spontaneous nystagmus
    - Gaze evoked nystagmus
    - Rapid head thrust[56]
    - VOR (horizontal [HVOR], vertical [VVOR])
      - Head turns per minute while focused on object
      - 15° to each side
      - Normal is 120 head turns per minute
    - Static vs. dynamic visual acuity
    - Post head shaking-induced nystagmus[56]
    - Vibration-induced nystagmus[56]
    - Hyperventilation test[56]
      - Authors of an observational research study conducted in Australia report that patients who have had surgical removal of a vestibular neuroma typically have impaired gaze stability[12]

- Researchers in Italy studied the hyperventilation test and found that hyperventilating for 60 seconds induced a nystagmus in 40/45 patients with unilateral acoustic neuroma, which is indicative of a unilateral vestibular deficit[56]

– Use the Dix-Hallpike test to assess for benign paroxysmal positional vertigo (BPPV), which causes true vertigo (room spinning) for seconds to a minute when the patient lies down, rolls over, and looks up and/or down. For detailed information. see Clinical Review…*Benign Paroxysmal Positional Vertigo*; Topic ID Number: T708435
  - With patient in long sitting position, rotate head 45° to one side and have patient lie back with head hanging off edge of bed. Wait 45 seconds and sit back up. Repeat on other side. Positive test indicated by patient's subjective report of the room spinning and therapist's objective report of rotary nystagmus. Horizontal nystagmus is possible but less likely positive response, and indicates horizontal canal BPPV
– Motion sensitivity: Assess for 16 specific positions. Patient reports and therapist notes severity and duration of symptoms
– Dizziness Handicap Inventory (DHI): 25-item questionnaire that evaluates how dizziness affects the patient's quality of life, including emotional, functional, and physical domains
– Tinnitus Functional Index (TFI)[49]
– Quality of life[51]
  - Penn Acoustic Neuroma Quality of Life (PANQOL)
    - Minimally Clinically Important Difference(MCID) is 11
  - SF-36
    - MCID for mental health component is 7 and for physical health component is 8

Assessment/Plan of Care

› **Contraindications/precautions**
- When possible, treatment should be provided by a trained vestibular therapist
- **Patients with this diagnosis might be at risk for falls; follow facility protocols for fall prevention and post fall prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall prevention strategies. Discharge criteria should include independence with fall prevention strategies**

› **Diagnosis/need for treatment**
- Patients with acoustic neuroma benefit from physical therapy to treat dizziness, imbalance, gait abnormality, and facial weakness
- Patients who have facial nerve involvement following acoustic neuroma surgery might benefit from early rehabilitation[14]

› **Rule out**
- Labyrinthitis
- Vestibular neuritis
- BPPV
- Migraine-associated dizziness
- Ménière's disease
- Perilymphatic fistula
- Microvascular compression
- Chiari malformation
- Gentamicin toxicity
- Multiple sclerosis
- Hearing loss of different etiology[8]
  – Presbycusis (age-related hearing loss)
  – Middle ear effusion
  – Infection
  – Wax
  – Cholesteatoma
  – Tympanic membrane rupture
- Stroke
- Brain injury
- Other cerebellopontine angle (CPA) tumors (e.g. meningiomas, epidermoid tumors)[45]

› **Prognosis**

- The growth of an acoustic neuroma is typically slow, although there can be exceptions[3]
  - Very slow-growing, generally 1-2.3 mm/year
  - < 30% of tumors grow > 2 mm/year
  - The manner in which the tumor grows during the initial 3 years is generally indicative of the future growth pattern
- Approximately half of acoustic neuromas shrink or do not grow without treatment[8]
- Postoperative mortality is increased among older patients, African American patients, and patients receiving care from low caseload surgeons[15]
- Conservative therapy is more likely to preserve hearing than radiotherapy or surgery[8]
- Researchers in the Czech Republic who analyzed the effect of microsurgery on hearing and tinnitus found the main prognostic indicators of hearing preservation were: grade/size of tumor, preoperative hearing level, intraoperative neuromonitoring, tumor consistency, and adhesion to neurovascular structures. The main prognostic indicators of tinnitus elimination were preservation of useful hearing and neurectomy of the eighth cranial nerve. The main prognostic indicators for persistence and new onset of tinnitus is the preservation of cochlear nerve but loss of preoperative hearing[39]
- Researchers in the United States found 50-70% of patients maintained serviceable hearing after surgery using middle cranial fossa approach and of those, 75% maintained serviceable hearing after 5 years[54]
- Although most patients' balance improves with vestibular rehabilitation, 10% will have residual unsteadiness even after rehabilitation[17]
- Researchers who conducted a study in France of 30 patients with acoustic neuroma, 15 physically active and 15 sedentary, found that those who were physically active before surgery presented with the best compensation of postural control right after surgery. They also found that although the sedentary patients, as a group, did not do as well acutely (at 8 days), they were able to compensate well by middle (90 days) and long-term (180 days) follow-up[26]
- Researchers who conducted a study in the United States found similar quality of life outcomes for patients regardless of management (conservative, gamma knife, or surgery)[27]
  - Main outcome used was PANQOL scores

› **Referral to other disciplines**

- Social work for needs at home
- Psychology for anxiety, depression
- Speech therapy for patients with impaired speech or dysphagia
- Occupational therapy for ADL training
- Physician for red flags, suspicion of hydrocephalus
- Audiologist for hearing testing, vestibular testing, hearing aides

› **Other considerations**

- CN VIII can be severed during surgery, resulting in severe vertigo[10]
  - A patient might be able to compensate for vestibulocochlear nerve dysfunction with vestibular exercises
- Patients might have the following problems in association with acoustic neuroma
  - Hydrocephalus[8]
    - There is an 11% risk of developing hydrocephalus status post stereotactic radiotherapy[16]
    - Symptoms include: headache, ataxia, worsening of balance or gait, blurred or double vision, urinary incontinence, decline of mental status
  - Brainstem compression[8]
  - Cerebellar tonsil herniation[8]
- Surgical complications
  - Researchers who conducted a retrospective case review in the United States found 22.4% of 64 patients who had surgery suffered complications, and those with larger tumors were more likely to have complications[30]
  - Possible complications:
    - Headaches
    - Hearing loss[17]
      - Although rare, can affect contralateral ear as well[38]

- Facial paresis[17,30]
- Disequilibrium[17]
- Cerebral spinal fluid (CSF) leakage[30]
  - Symptoms include otorrhea (drainage from the ear), headache and dizziness and CSF leakage can lead to meningitis and abscess formation in the brain[43]
- Air embolism
- Intracranial hemorrhage[17]
- Infection[30]
- Impaired vestibular compensation[47]
- Meningitis[47]
- Mortality[47]

• A study conducted in Australia found an increased incidence of depression and anxiety in patients with increased amount of symptoms and comorbid conditions, as well as with longer duration of management[18]

› **Treatment summary**

• There is limited research regarding physical therapy for patients with acoustic neuroma
  – Limitations of studies include small sample sizes, lack of randomization, and lack of controls or confounding variables
• Physical therapy for patients who have had surgery to treat acoustic neuroma includes vestibular rehabilitation and proprioceptive neuromuscular facilitation[14]
• In patients ≥ 50 years old who are status post-surgery for acoustic neuroma, researchers found that vestibular rehabilitation might facilitate the recovery of balance[19]
  – Based on a randomized trial conducted in Belgium
  – Fifty three patients participated in the study, all of whom were status post retrosigmoid surgical removal of an acoustic neuroma
  – Participants were grouped by age (< 50 years old and ≥ 50 years old), then randomized to one of two groups
    - Intervention group
      - Customized vestibular rehabilitation for 12 weeks
      - Inpatient rehabilitation began 3-5 days after surgery, lasted ~ 1 week, and was followed by customized home program (~ five activities, 3x/daily) continued through week 12
      - Program was adjusted as indicated at periodic assessment (every 3 weeks)
    - Control group – general instructions alone
  – Results (at 12 weeks) – comparing the control group to patients in the intervention group ≥ 50 years old, the participants in the intervention group achieved significantly better results in the following:
    - Standing balance sum
    - TUG test
    - Tandem gait
    - Dynamic gait
  – Results (at 1 year) – patients > 50 years old in the intervention group also had superior scores on the TUG test and DGI
• Patients who have facial nerve involvement following acoustic neuroma surgery might benefit from early rehabilitation consisting of proprioceptive neuromuscular facilitation (PNF) applied to the facial muscles[14]
  – Based on a research study conducted in Italy of 29 patients who had facial nerve involvement following acoustic neuroma surgery
  – Eleven patients started rehabilitation on postoperative day 3 (study group) and 18 patients did not participate in rehabilitation at all (control group)
    - The patients in the study group participated in a rehabilitation program every day for 15 days and then 3 days a week for 7 to 42 weeks
    - Treatment was terminated when the patient had achieved treatment goals
    - The patients in the study group had a significantly greater improvement in facial muscle strength and facial tone and symmetry than patients in the control group

Problem	Goal	Intervention	Expected Progression	Home Program
Impaired functional mobility due to balance, flexibility, and strength impairments	Improved balance, flexibility and strength resulting in improved functional mobility	**Therapeutic exercise** General strengthening and/or stretching exercises if indicated to maximize strength and flexibility to allow for optimal balance reactions Romberg exercises, static and dynamic balance exercises that vary somatosensory, visual, and vestibular conditions	Strengthening exercises can be progressed with resistive equipment such as weights or from supine to sitting to standing Balance activities can be progressed by narrowing base of support and/or having patient stand on one limb or unstable surfaces. Also can add head movements and cognitive activities	Provide patient/ family with written instructions and diagrams to safely perform exercises at home
Decreased ability to ambulate safely	Improved safety with ambulation	**Gait training** Gait training, with assistive device if necessary	Wean off assistive device. Add head turns, obstacles and cognitive tasks, vary surface, narrow base of support, and have patient close eyes	Provide patient/ family with written instructions and diagrams to perform safely at home
Decreased safety with increased risk for falls while performing ADLs and functional mobility	Improve safety with ADLs performance and functional mobility	**Functional and safety training** Educate patient/ family regarding safe techniques for transfers, gait, and ADLs. Ensure that patient is using assistive devices and adaptive equipment correctly. Home modifications (i.e., remove throw rugs)	Provide less assistance and feedback as patient improves	Provide patient/ family with written instructions and diagrams regarding fall prevention techniques and home modifications

Decreased gaze stability, dizziness	Increased gaze stability, decreased dizziness	**Vestibular exercises** Vestibular ocular reflex (VOR) X1 viewing: instruct patient to view a stationary object while turning his or her head side to side (HVOR) and up and down (VVOR) for 1-2 minutes while the object stays in perfect focus VOR X2 viewing: the patient views a target moving in the opposite direction of head rotation Exercises can begin slowly 2-3 days after acoustic neuroma resection[20] Cohen et al. found that recovery was more affected by tumor size than age or early postoperative vestibular exercises;[21] however, Herdman et al. found that vestibular exercises enhanced recovery,[22] and Enticott et al. found that postoperative gaze stabilization exercises reduced VOR asymmetry and improved balance[9]	As patient improves, he or she should be able to turn head faster with the object still staying perfectly clear. Adaptations to the vestibular exercises should be made as appropriate for each patient; take into consideration the environment patient performs work/leisure or ADL activity Can progress to include different backgrounds (e.g., checkerboard) or perform exercises outdoors Incorporate VOR exercises with balance activities Normal rate is 120 head turns/minute	Perform exercises for 1-2 minutes, 2-3 times per day as tolerated

Weakness of facial muscles	Increase strength of facial muscles	**Therapeutic exercise** Facial muscle strengthening exercises might include exercises based on proprioceptive neuromuscular facilitation (PNF). PNF utilizes traction, contralateral contraction, manual contact, maximal resistance, verbal input, and stretching to increase motor control and strength(14) **Electrical stimulation** A small study conducted in the United States found electrical stimulation for facial muscles might facilitate partial reinnervation in patients with residual paralysis(23)	Facial muscle strengthening can be progressed from passive to active assisted to active to resisted exercise	Provide patient/ family with written instructions and diagrams

Desired Outcomes/Outcome Measures

› Desired outcomes and associated measures

- Improved balance
  - Platform posturography (Equitest)
  - Berg Balance Scale
  - Tinetti Balance Assessment
  - Functional Reach Test
  - Clinical Test for Sensory Integration of Balance
  - Standing on one leg
  - Romberg test
- Improved dizziness and vertigo
  - VVAS
  - UCLA Dizziness Questionnaire
  - Vertigo Symptom Scale(24)
  - Motion sensitivity test
- Improved safety and independence with ADLs and gait
  - DGI
  - TUG test
  - FIM
  - ABC Scale
  - DHI
  - Functional Checklist

- Increased gaze stability
  - VOR speed (head turns per minute)
- Increased strength of facial muscles
  - House-Brackmann Facial Nerve Grading System[23]
  - Sunnybrook Facial Grading System
  - FaCE Scale[48]
- Improved Tinnitus
  - TFI
- Patient satisfaction/quality of life
  - PANQOL
  - SF-36

Maintenance or Prevention

› Patient is advised to follow home program and follow up with physician as indicated
› Implementation of all prevention strategies and home modifications

Patient Education

› Mayo Clinic Web site:
  • http://www.mayoclinic.org/diseases-conditions/acoustic-neuroma/symptoms-causes/syc-20356127
› National Institute on Deafness and Other Communication Disorders Web site:
  • https://www.nidcd.nih.gov/health/vestibular-schwannoma-acoustic-neuroma-and-neurofibromatosis
› American Hearing Research Foundation Web Site:
  • http://american-hearing.org/disorders/acoustic-neuroma/

Note

› Recent review of the literature has found no updated research evidence on this topic since previous publication on January 20, 2017

Coding Matrix

References are rated using the following codes, listed in order of strength:

M	Published meta-analysis	**RV**	Published review of the literature	**PP**	Policies, procedures, protocols
SR	Published systematic or integrative literature review	**RU**	Published research utilization report	**X**	Practice exemplars, stories, opinions
RCT	Published research (randomized controlled trial)	**QI**	Published quality improvement report	**GI**	General or background information/texts/reports
R	Published research (not randomized controlled trial)	**L**	Legislation	**U**	Unpublished research, reviews, poster presentations or other such materials
C	Case histories, case studies	**PGR**	Published government report	**CP**	Conference proceedings, abstracts, presentation
G	Published guidelines	**PFR**	Published funded report		

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