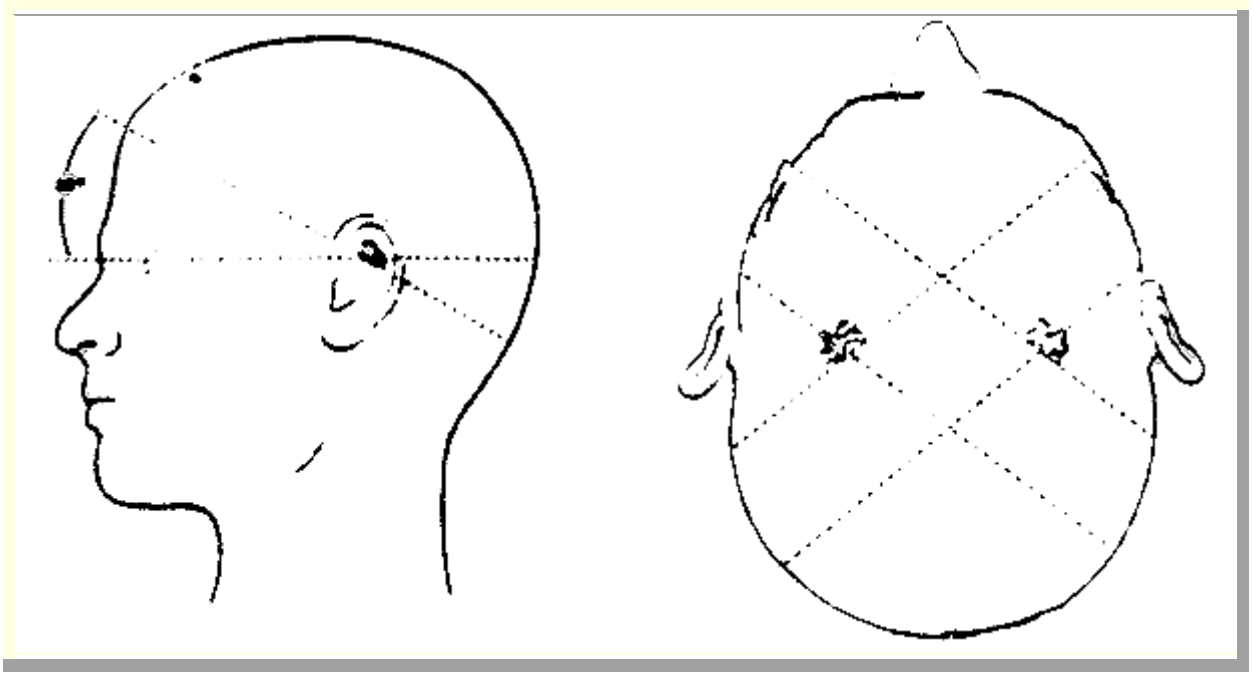
INNER EAR DISEASE

VERTIGO

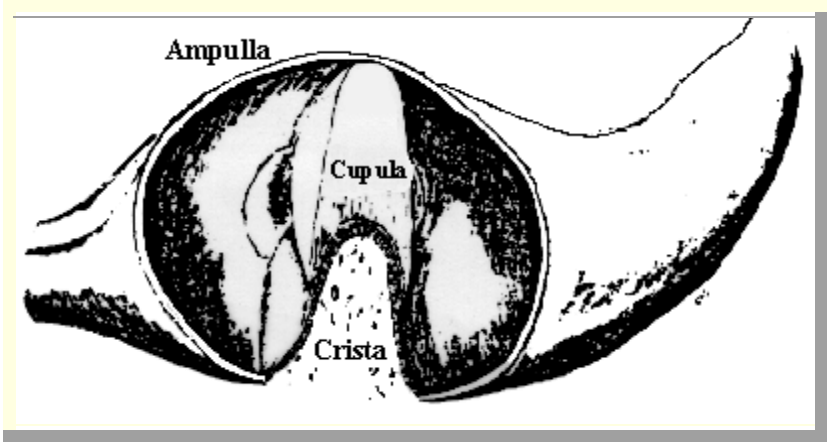
Dizziness is a common complaint and too often the symptom is attributed to an "inner ear problem." Numerous cochleovestibular, neurologic, cardiovascular, metabolic, ocular, and systemic diseases are capable of eliciting the sensation of dizziness; the ear, however, is responsible for only 50-60 percent of the known causes of dizziness. I. **ANATOMY AND PHYSIOLOGY OF THE LABYRINTH**

- The semicircular canals
    - Anatomy: the semicircular canals (lateral, posterior, and superior) lie at right angles to one another and are encased within the otic capsule of the temporal bone.

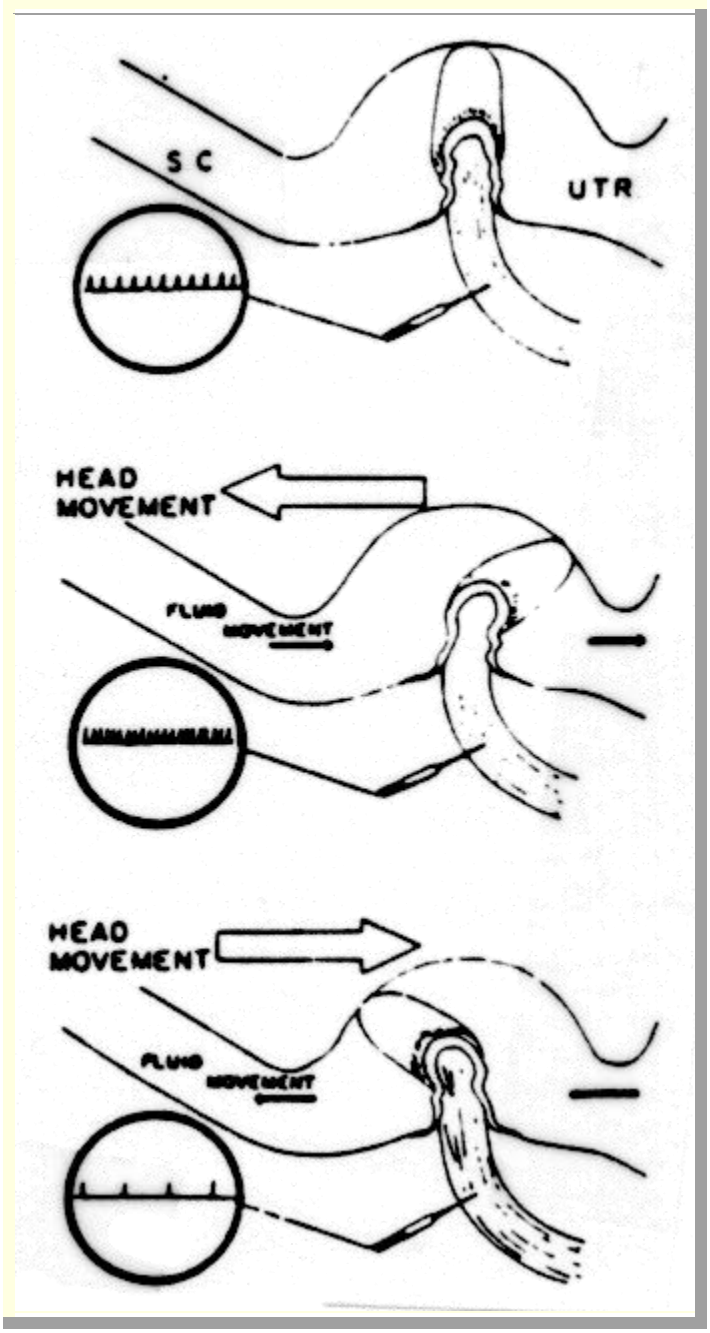


Each canal contains perilymph which bathes the membranous ducts within the canal. Each canal has an ampulla or a widening of the

canal at the point it communicates with the vestibula. The crista ampullaris is located in each respective ampulla. The crista contains specialized neuroepithelium with hair cells imbedded in a gelatinous material to form the cupula.



- Physiology: the cupula extends into the ampulla to detect rotational movement of the endolymph.



- The maculae of the utricle and saccule
    - Anatomy: the utricle and saccule are located in the bony vestibula. The endolymph contained within the utricle and saccule is continuous with the cochlear duct and the membranous duct of the semicircular canals. Both the saccule and utricle have maculae which contain hair cells embedded in a gelatinous material covered with calcium carbonate crystals (otoconia).
    - Physiology: the maculae are responsive to the effect of

gravity and linear movement.

- Posture and movement

    - The labyrinth acts as a bilateral frequency modulator. Acceleration,deceleration, or rotational movement of the head leads to excitation of one system and inhibition of the opposite. Sensory output is relayed to the vestibular nuclei and pathways for central interpretation.
    - The manifestation of disease: in order to maintain posture and move through the environment in an orderly and safe fashion,appropriate information from three sensory modalities is important: the visual axis, proprioception in the joints and muscles, and the labyrinths. This input is integrated in the brain stem and cerebellum to adjust posture and motor activity and to maintain orientation. A failure in sensory input, poor integration in the central nervous system, or diseased support systems (cardiovascular and metabolic), can provoke the feeling of disorientation or dizziness. The interdependence of so many organ systems accounts for the large differential diagnosis of dizziness.

II. **DIFFERENTIAL DIAGNOSIS OF DIZZINESS**

- The cochleovestibular system
    - Infection
        - Acute otitis media
        - Chronic otitis media
        - Serous otitis media
        - Bacterial labyrinthitis
        - Viral labyrinthitis
        - Vestibular neuronitis
        - Syphilis
        - Herpes zoster oticus
    - Trauma
        - Perilymph fistula
        - Temporal bone fracture
        - Labyrinthine concussion
        - Iatrogenic injury
        - Barotrauma
        - Cervical vertigo
    - Tumor
        - Cholesteatoma
        - Acoustic neurinoma
        - Glomus tumors
        - Primary or metastatic carcinoma

    - Vascular
        - Infarction of labyrinthine artery
        - Intralabyrinthine hemorrhage
    - Degenerative
        - Benign positional vertigo (cupulolithiasis)
        - Aging
    - Developmental
        - Congenital anomalies of the inner ear
    - Idiopathic
        - Meniere's disease (Endolymphatic hydrops)
        - Bell's palsy
    - Disorders of bone metabolism
        - Otospongiosis
        - Osteopetrosis
    - Ototoxins
        - Aminoglycosides
        - Salicylates
        - Alcohol
        - Loop diuretics: ethacrynic acid and furosemide
        - Heavy metals: mercury, gold, lead, arsenic drugs
        - Antineoplastics: nitrogen mustard, bleomycin, cis-platinum
- Nervous system
    - Infection
        - Meningitis
        - Encephalitis
        - Brain abscess
    - Demyelinating disorders
        - Multiple sclerosis
        - Other demyelinating processes
    - Tumor
        - Cerebellopontine angle tumors
        - Benign and malignant neoplasia
        - Metastatic carcinoma
    - Developmental
        - Malformations of the base of skull
    - Peripheral neuropathy
        - Diabetes mellitus
        - Ethanol
        - Pellagra
        - Tabes dorsalis
    - Vascular
        - Hyperventilation
        - Vertebrobasilar insufficiency

        - Migraine variants
        - Brain stem infarction or hemorrhage
        - Cerebellar infarction or hemorrhage
        - Vascular loop syndrome
    - Seizure disorders
        - Temporal lobe
        - Petit mal
- Cardiovascular system
    - Circulatory
        - Hypovolemia
        - Anemia
        - Polycythemia
        - Orthostatic hypotension
        - Hypotension
    - Cardiac
        - Arrhythmias
        - Valvular disease: AS/AI
        - Stokes-Adams attacks
    - Great vessels
        - Subclavian steal
        - Hypersensitive carotid sinus reflex
- Other Systems
    - Ocular/Oculomotor
        - Changes in refraction
        - Cataracts
        - Glaucoma
        - EOM neuropathy
        - Muscle imbalance
    - Endocrine or metabolic
        - Diabetes mellitus
        - Hyperlipidemia
        - Hyperthyroidism
        - Carcinoid syndrome
        - Menstruation-pregnancy-menopause
        - Pheochromocytoma
    - Allergy/autoimmune
        - Inhalant
        - Food
        - Drug
        - Collagen vascular disorders
    - Psychiatric
        - Chronic anxiety
        - Hysteria
    - "Old age syndrome"
        - Multisensory deficit

III. **THE EVALUATION OF DIZZINESS**

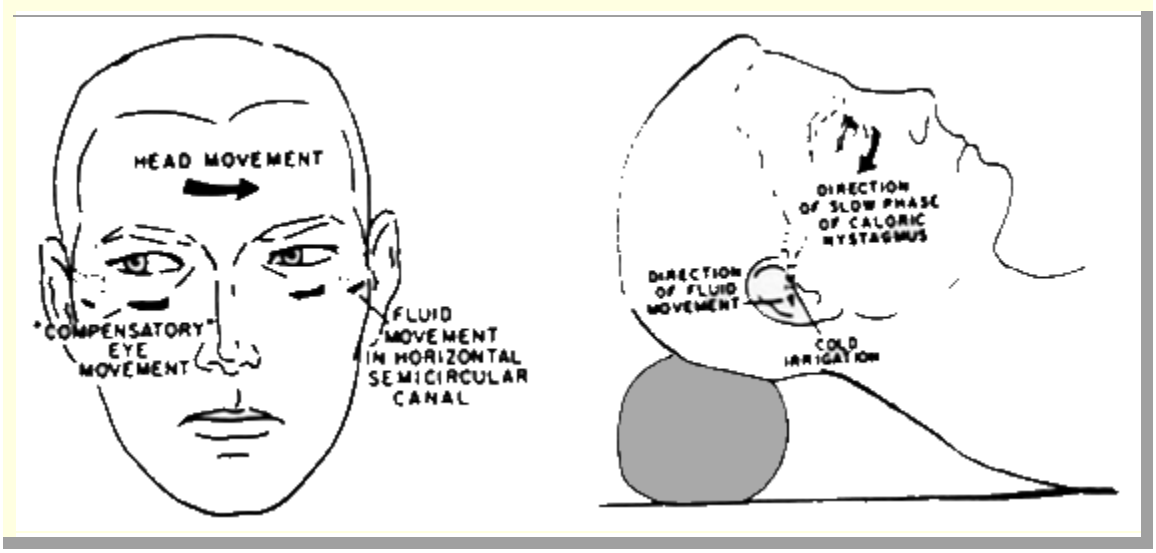
- History
  - Characterizing exactly what the patient means by "**dizzy**"is the most important step in the evaluation.
  - **Vertigo** is an illusion of movement and is specific for a lesion in the inner ear, vestibular nuclei, or vestibular pathways. Momentary vertigo associated with rapid head movements typifies benign paroxysmal positional vertigo. Vertigo lasting for several hours tends to occur with inner ear disorders. Persistent vertigo of greater than three weeks' duration is due to a problem within the central nervous system!
  - **Imbalance or incoordination** connotes disease in the cerebellum, brain stem, or vestibulospinal tracts.
  - **Light-headedness** or the feeling of faintness, although often benign, can implicate a problem in any of the systems listed in the differential diagnosis.
  - Peripheral vestibular disorders do not produce a loss of consciousness! Loss of consciousness associated with dizziness is most frequently due to vertebrobasilar insufficiency, cardiac arrhythmias, or seizures.
- Examination
  - Resting pulse and blood pressure should be measured in the supine and standing positions to document presence or absence of orthostatic hypotension.
  - Complete head and neck exam
    - **Otologic inspection** is necessary to rule out disease of the external and middle ear.
    - The Weber and Rinne test are used to document sensorineural or conductive hearing losses.
    - A fistula test is performed with a pneumatic otoscope in order to ascertain the presence or absence of a perilymph fistula.
    - The patient is examined for the presence of spontaneous gaze and positional nystagmus.
    - Nasopharyngoscopy and indirect laryngoscopy are considered a part of the neurotologic examination.
    - Cranial nerve assessment is essential.
    - Vestibular and cerebellar assessment is made through rapid repetitive motion, past pointing, Romberg, tandem walk, and cold water

caloric testing.

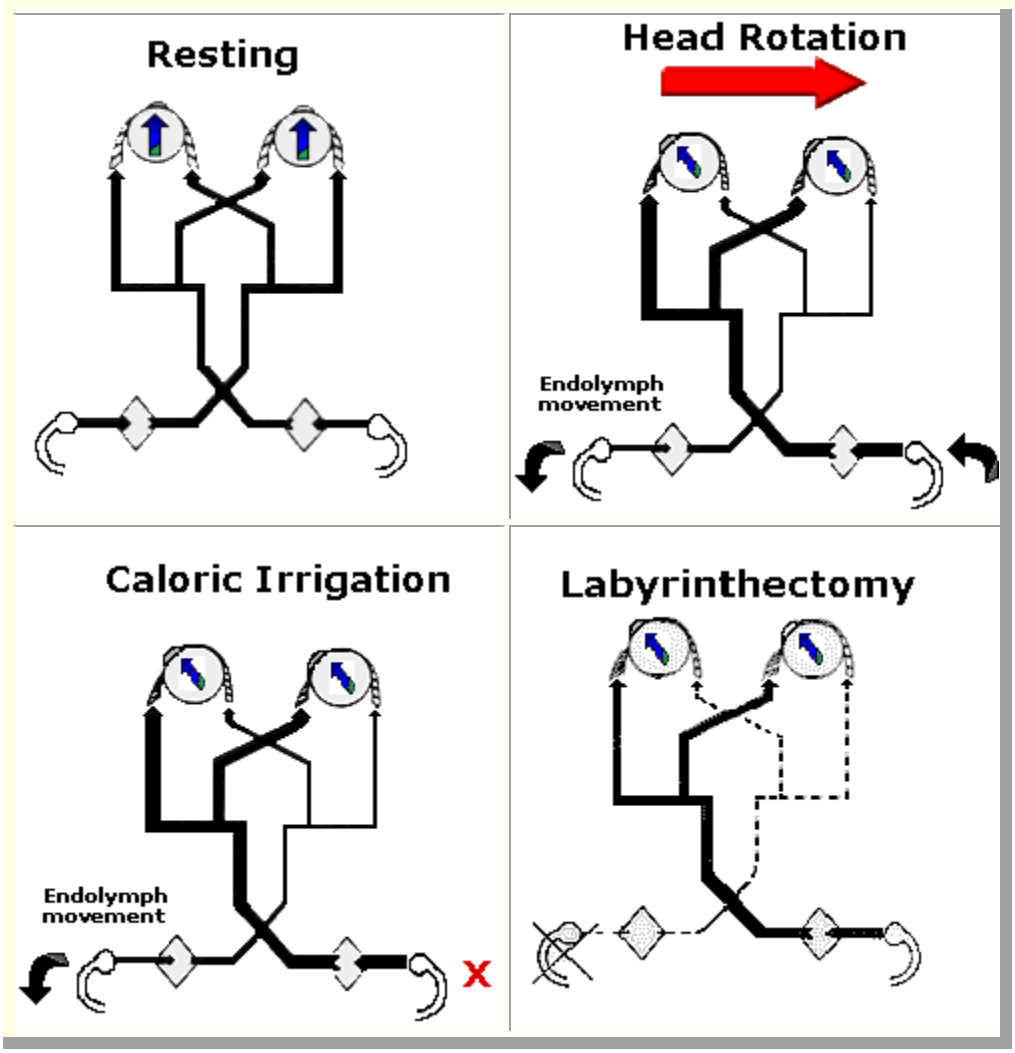
- Auscultation of the precordium and the neck is necessary to detect carotid bruits, AV malformations, and valvular heart disease.

IV. **LABORATORY STUDIES**

- Cochleovestibular
  - Standard audiometry
    - Pure tone studies
    - Speech studies
    - Recruitment
    - Tone decay
  - Impedance audiometry
    - Tympanometry
    - Acoustic reflex
  - Auditory brainstem evoked response
  - Electronystagmography
    - Oculomotor testing
    - Bithermal calorics



- Positional tests
- Rotary testing



Generation of the vestibular **(slow)** phase of different kinds of nystagmus. The thickness of the lines connecting the semicircular canal to the eye muscles is proportional to the intensity of nervous discharge along the nerve pathways.

- Roentgenographic views of the internal auditory canal: plain or polytomography
- CT scanning
    - Contrast
    - High resolution
    - Air-contrast
- Arteriography
- Nervous system
    - Lumbar puncture/CSF studies
    - EEG

- CT scanning with contrast
- NMR scanning
- Arteriography

- Cardiovascular system

  - CXR
  - EKG
  - Holtor monitor
  - Stress testing
  - Carotid doppler
  - Echocardiogram
  - Arteriography

- Other systems

  - CBC with differential
  - Fasting blood glucose
  - Five-hour glucose tolerance test
  - Lipid profile
  - Thyroid function studies
  - Rheumatoid factor and antinuclear antibody
  - RPR, VDRL, or FTA-ABS
  - Psychiatric testing

V. **COMMON CAUSES OF DIZZINESS**

- Cochleovestibular system
  - Benign paroxysmal positional vertigo.
    - Symptoms: a 15-30 second episode of vertigo induced byposition chang
    - Signs: the positional nystagmus may be observed by purposefullyinducing the position change and observing the eyes. Nystagmustends to be toward the involved ear and exhibits latency and fatiguability.
    - Laboratory: ENG documents the presence of positional nystagmus.
    - Treatment: reassurance and vestibular exercises. Singular nerve section for the recalcitrant and disabled patient.
  - Meniere's disease (See previous section on Hearing Loss).
  - Viral labyrinthitis
    - Symptoms: acute onset of vertigo usually associated with nausea and vomiting

        - Hearing loss may or may not be present.
        - Signs: unilateral hearing loss, spontaneous nystagmus with the slow component toward the involved ear. Pass pointing and falling to the side of the lesion in the acute stages.
        - Laboratory: audiograms may show sensorineural hearing loss. ENG reveals nystagmus and often a caloric weakness.
        - Treatment: the condition is self-limited and the most effectivetherapy includes rest and sedation. Meclizine or diazepam often beneficial.
    - Vestibular neuritis
        - Symptoms and signs: presentation and physical findings can be identical to those of viral labyrinthitis except that hearing loss is not present.
        - Laboratory: ENG will show a unilateral weakness in theinvolved ear.
        - Treatment: same as for viral labyrinthitis. Vestibular neuronitis can be recurrent. A vestibular nerve section willcure the vertigo and preserve hearing.
    - Acoustic neurinoma. Patients rarely present with true vertigo secondary to acoustic neurinoma but more frequently complain ofunsteadiness, tinnitus, or hearing loss. See previous sectionon Hearing Loss.
    - Labyrinthine concussion
        - Symptoms: vertigo or dizziness with or without hearing loss following severe head injury.
        - Signs: spontaneous nystagmus with the slow component toward the involved ear may be present along with a sensorineural hearing loss.
        - Laboratory: a basic audiogram will document the presenc eof sensorineural hearing loss. The ENG may document the presenceof a caloric weakness or a positional nystagmus. Polytomography of the skull base or CT scanning is indicated when skull fractures are suspected.
        - Treatment includes the use of antivertiginous medications in the initial stages. Labyrinthectomy or vestibular nerve sectionare indicated for a patient with

symptoms persistent beyond six months.
    - Otosyphilis. See section on Hearing Loss.
- Cardiovascular
    - Orthostatic hypotension.
        - Symptoms: the patient complains of light-headedness or thesensation of faintness upon sitting upright or standing.
        - Signs include an increased pulse rate or a fall of systolicpressure with the change in position.
        - Laboratory: none.
        - Treatment: reassurance and a change in medication whenindicate
    - Hyperventilation
        - Symptoms: light-headedness, fullness in the throat, perioral paresthesias, chest tightness, anxiety.
        - Physical examination: normal.
        - Laboratory: if the patient is symptomatic, an arterial blood gas may reveal the presence of hypocarbia.
        - Treatment: reassurance along with methods to increase the pCO2 (paper bag).
- Neurological systems
    - Vertebrobasilar insufficiency.
        - Symptoms: these patients can experience true vertigo but this is usually associated with visual disturbances, dysarthria, disorientation, and ataxia.
        - Signs: physical examination may be normal between attacks.
        - Laboratory: CT scan is usually normal. Findings on arteriography can be variable
        - Treatment: ASA, Persantine, anticoagulation in severe cases.
    - "Old age syndrome"
        - Symptoms: complaints of dizziness and disequilibrium withfrequent falls in the elderly population.
        - Signs: include orthostatic hypotension, diminished visual acuity, presbycusis, etc.
        - Laboratory: findings tend to be nonspecific.
        - Treatment: ambulation with assistance and adjustment of any medications implicated in the production of orthostatic hypotension.