Benign Paroxysmal Positional Vertigo: Diagnosis and Management

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Program Faculty Disclosures

I have no relevant financial relationships to disclose

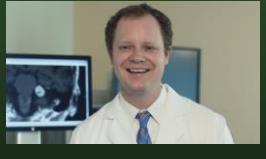
and

I will not discuss products in my presentation

2

Thanks

- CCSU Faculty
- Dr. Dan Roberts
  - Neurotologist
  - UConn/CT ENT/HH
  - Slides and images



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Overview

- Dizziness vs. Vertigo
- Vertigo: Central vs. Peripheral
- Case Studies
- Anatomy (Inner Ear)
- Workup for BPPV
- Treatment for BPPV
- Prognosis/Return to function

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Balance Disorders in the Elderly: Epidemiology and Functional Impact

Harrison W. Lin, MD; Neil Bhattacharyya, MD, FACS

> 65 yo, 19.6% reported a problem with dizziness or balance in the preceding 12 months.

Balance problems:
- unsteadiness (68.0%),
- walking on uneven surfaces (54.8%),
- vertigo (30.1%)
- faintness (29.6%).

50.0% of elderly persons with balance problems who sought care, 85.6%, 30.3%, 23.9%, and 16.8% saw a general practitioner, internist, neurologist, or otolaryngologist, respectively.

Lin and Bhattacharyya, 2012

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Dizziness

- CC: "Dizzy"
- Describe the feeling without using the word "dizzy"
  - Imbalance/unsteady
  - Lightheaded/faint
  - Foggy
  - Wavy
  - Spinning (!)

health.clevelandclinic.org

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Dizziness

- General Categories (percentages = "all comers")
  - Vertigo (50%)
    - False sense of motion, SPINNING
  - Dysequilibrium (15%)
    - Imbalance, unsteady, wobbly while standing/walking
  - Presyncope (15%)
    - Transient, sensing passing/blacking out coming
  - Lightheadedness (10%)
    - Vague, disconnected with environment
  - Other/Combined (10%)

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Dizziness vs. Vertigo

- Vertigo
  - Involves a hallucinatory sense of motion
  - Spinning
  - Maybe nausea/vomiting
  - "Tilt-a-Whirl"

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Vertigo

- Central
  - Migraines
  - Multiple Sclerosis
  - Mal de Debarquement
  - Cerebellar Hemorrhage /Infarct
  - Vertebrobasilar Insufficiency
  - Neoplasms
  - Systemic
  - OTHER!
- Peripheral
  - Benign Paroxysmal Positional Vertigo (BPPV)
  - Ménière's Disease
  - Labyrinthitis
  - Ototoxicity
  - Superior Canal Dehiscence Syndrome
  - EARS!!

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Peripheral Vertigo

- DURATION of spinning (not aftermath)
  - Seconds/Minutes (BPPV, Perilymphatic fistula)
  - Hours (Vestibular Migraines, Hydrops)
  - Days (Labyrinthitis, Neuronitis)
  - Months (Trauma, Neoplasm, Ototoxicity)
- Associated Symptoms
  - Hearing loss, Tinnitus, Pressure, Drainage, Sinusitis
- Motion/Fixation
  - Effects of head position change and eye fixation

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Case #1

- 55 yo Athletic Trainer/ Nurse/Physician/Coach
  - Wakes abruptly at 4:30am
  - Hits "snooze" – world goes rotational for 90sec, then "dizzy" for days
  - NO HL, tinnitus, pain
  - Resolves if head still
  - Afraid to leave the bed/house or drive

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Case #2

- 19 yo Swimmer
- Returns from training trip, c/o vertigo
- Feels like "still on the boat."
- Some "popping" in ears
- Hearing muffled

www.triradar.com

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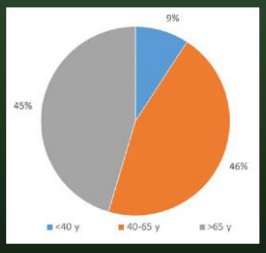
Cases

- BPPV
  - Lasts seconds to minutes
  - NO hearing loss
  - NO tinnitus
  - NO drainage
  - NO pain
  - Stops with fixation
  - Worse with head position changes
  - Comes in waves (weakens)



www.researchgate.net

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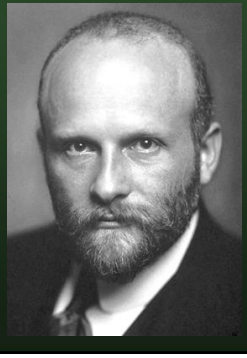
Robert Bárány (1876-1936)



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Evaluation/Testing

- Vestibular Anatomy & Physiology
- Clinical Exam
- VNG
- Rotatory Chair
- Posturography
- VEMP

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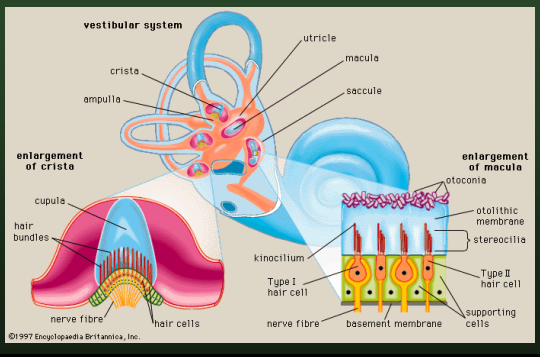
Anatomy



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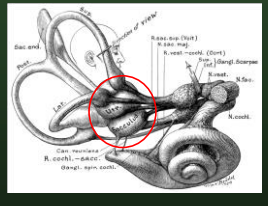
Otolith Organs



Utricle:

- Detects motion in the horizontal plane (forward-backward, left-right)

Saccule:

- Senses motion in the sagittal plane (up-down)

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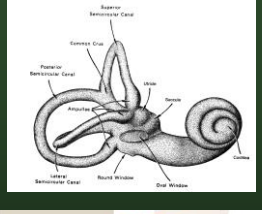
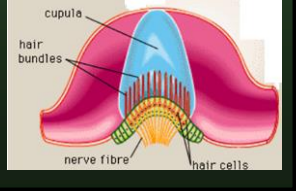
Semicircular Canals

- Detect angular acceleration.
- Anatomy:
  1. Coplanar pairs
  2. Ampulla
  3. Cupula
  4. Ampullopetal vs ampullofugal endolymph flow





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Vestibulo-ocular reflex (VOR)

- 3 neuron arc designed to stabilize images on the retina during head movements
- Works by generating slow-phase eye movements that are equal & opposite to head movements.

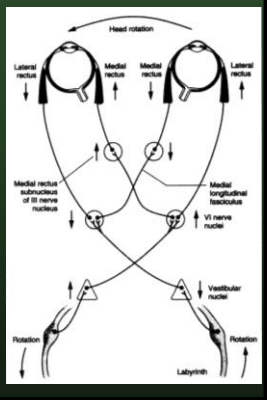

Figure source: Furman JM, Cass SP. *Vestibular Disorders: A Case Study Approach*, 2nd ed., © 2003.

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CLINICAL EXAM

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Peripheral vs. Central Nystagmus

Peripheral	Central
Direction fixed horizontal or torsional nystagmus	Vertical nystagmus (upbeating or downbeating)
Suppression of nystagmus with fixation	No suppression of nystagmus with fixation
Follows Alexander's law	Direction changing nystagmus in neutral position including: (1) congenital nystagmus (2) periodic alternating nystagmus
Fast phase toward intact ear except: (1) Irritative nystagmus (2) Recovery nystagmus	May be present as a result: (1) Pharmacy (2) Alcohol (3) Tobacco

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Spontaneous Nystagmus

- Observe for nystagmus, repeat with Frenzel lenses.

Interpretation

- Normal: no nystagmus
- Peripheral: spontaneous, direction-fixed, horizontal-rotary jerk nystagmus with fast phase away from affected ear and enhanced with gaze in direction of fast phase or when wearing Frenzel lenses
- Central: direction changing horizontal, purely vertical or torsional, or pendular nystagmus that is diminished under Frenzel lenses (loss of visual fixation)

thefreedictionary.com/nystagmus

Graboyes and Goebel, 2015

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Gaze Evoked Nystagmus

- Finger 30 deg from nose, pt fixates on examiner finger
- If nystagmus observed with fast phase in direction of gaze, hold for 30 seconds then refixate on finger in center position

Graboyes and Goebel, 2015

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Gaze Evoked Nystagmus

Interpretation

- Normal: transient gaze-evoked nystagmus at 30 degrees
- Peripheral : direction-fixed most obvious with gaze in direction of fast phase (Alexander's law)
- Central: direction-changing
- Brun nystagmus: gaze-dependent, direction changing nystagmus that is combination central and peripheral due to CPA mass compressing flocculus

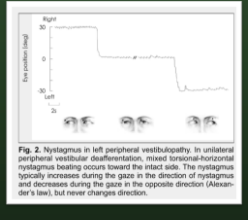

Fig. 2. Nystagmus in left peripheral vestibulopathy. In unilateral peripheral vestibular deafferentation, mixed torsional-horizontal nystagmus beating occurs toward the intact side. The nystagmus typically increases during the gaze in the direction of nystagmus and decreases during the gaze in the opposite direction (Alexander's law), but never changes direction.

Graboyes and Goebel, 2015

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Saccades

Head stationary, examiner holds fingertip 15 degrees off midline in horizontal plane; patient looks back and forth between examiner's nose and fingertip

Interpretation
- Normal: conjugate, accurate, fast.
- Peripheral: normal
- Central lesion:
  - Disconjugate: medial longitudinal fasiculus lesion or MS.
  - Inaccurate: midline cerebellum lesion
  - Decreased velocity: cortical and brainstem disease
    - Progressive supranuclear palsy, olivopontocerebellar atrophy/spinocerebellar ataxia

Graboyes and Goebel, 2015

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Smooth Pursuits

- Head stationary, examiner positions finger in front of patient and moves target at 30-40 degrees/second in horizontal plane
- repeat for vertical plane
- restrict testing to 60 degrees of visual field (30 degrees left and right, up and down) to avoid GEN

Graboyes and Goebel, 2015

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Smooth Pursuits

Interpretation
- Normal: accurate tracking without corrective saccades
- Peripheral: normal
- Central lesion: impaired or absent tracking with catch-up saccades
  - medications: anticonvulsants, sedatives, EtOH
  - Parkinson's disease, Alzheimer's disease, supranuclear degeneration, **cerebellar degeneration**

Graboyes and Goebel, 2015

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Headshake test

- Head tilted 30 degrees forward (plane of horizontal SCC) +/- Frenzel lenses
- Examiner rotates patient's head frequency (>2Hz), low amplitude (20-30 degrees) movement x 20 seconds
- Examiner brings head to abrupt stop

Graboyes and Goebel, 2015

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Headshake test

Interpretation:

- Normal: no post-headshake nystagmus
- Unilateral vestibular hypofunction: horizontal, direction-fixed, post-headshake nystagmus with **fast-phase away from affected ear**
- Bilateral symmetric vestibular hypofunction: no post-headshake nystagmus
- Central lesion: normal, cross coupled nystagmus (vertical nystagmus after horizontal headshake), direction-reversing nystagmus.

Graboyes and Goebel, 2015

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Dynamic Visual Acuity Test

- Visual acuity (VA) measured (Snellen chart)
- Examiner rotates patient's chair (or head) in horizontal plane continuously, without pausing, at 2 Hz oscillations while visual acuity is assessed (by patient reading Snellen eye chart)

Interpretation:

- Normal: decrease in VA < 2 lines on Snellen chart
- Unilateral vestibular hypofunction: normal or decrease in VA > 3 lines on Snellen chart
- Bilateral vestibular hypofunction: decrease in VA > 3 lines on Snellen chart
- Central lesion: variable

Graboyes and Goebel, 2015

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Vestibuloocular Reflex (Head Impulse Test - "Head Thrust"

- Head tilted 30 degrees forward
- Head turned while patient fixates on examiner's nose
- Examiner thrusts head rapidly towards midline while patient maintains fixation
- Repeat x 5-10 times per side to document repeatable fixation failure and refixation saccades

Graboyes and Goebel, 2015

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Vestibuloocular Reflex (Head Impulse Test) - "Head Thrust"

Interpretation:

- Normal: eyes remain fixated on visual target with no corrective saccades
- Unilateral vestibular hypofunction: corrective saccade with angular head movement towards affected ear

Graboyes and Goebel, 2015

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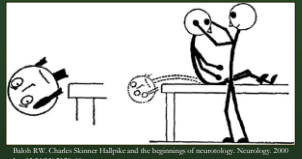
Position Tests



Baloh RW. Charles Skanner Hallpike and the beginnings of neurotology. Neurology. 2000 Jun 13;54(11):2138-46.

•Place head in left/right Hall pike, left/right lateral, supine
- Normal: no nystagmus
- Abnormal: torsional geotropic nystagmus (BPPV), horizontal sustained nystagmus (central or peripheral)

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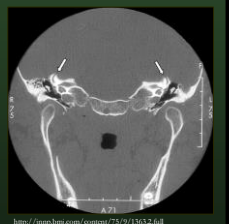
Aural Pressure/Sound Test

- Stimulate ear with positive pressure, loud sound, mastoid vibration
  - Normal: no nystagmus
  - Abnormal: upward deviation or downbeating nystagmus (SSCD), Horizontal nystagmus (perilymphatic fistula)



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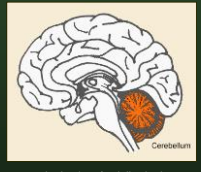
Cerebellar Limb Tests



www.mult-sclerosis.org/cerebellum.html

- Finger to nose
- Heel-shin
- Rapid alternating motion
  - Normal: accurate movements
  - Abnormal: dysmetria, dysdiadochokinesia (central)

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Posture Tests

www.kon.org/urc/v5/fowler.html

- Romberg
- Tandem Romberg
- Foam
  - Normal: minimal sway
  - Abnormal: sway/falls

Graboyes and Goebel, 2015

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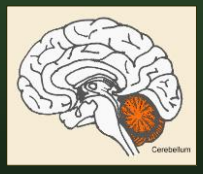
Cerebellar Limb Tests



www.mult-sclerosis.org/cerebellum.html

- Finger to nose
- Heel-shin
- Rapid alternating motion
  - Normal: accurate movements
  - Abnormal: dysmetria, dysdiadochokinesia (central)

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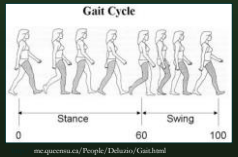
Gait Tests

- Observation
- Fukuda Step Test
  - Normal: <45° rotation on Fukuda
  - Abnormal: wide based gait/ataxic/Parkinsonian; >45° rotation on Fukuda



mcqueensu.ca/People/Deluzio/Gait.html

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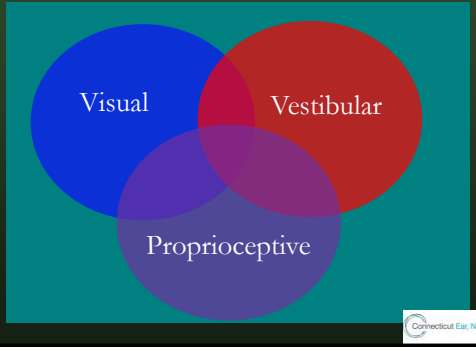
Testing



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VESTIBULAR FUNCTION TESTS

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Why order formal vestibular lab tests?

1. To assist diagnosis.
   - Confirm certain provisional diagnoses
   - When diagnosis is uncertain after a thorough history and exam.
2. To quantify degree of peripheral vestibular loss.
3. To provide information regarding degree of compensation.
4. Prior to ablative procedures to ensure normal function on the contralateral side.

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Limitations of Vestibular Testing

- It does not measure degree of disability. Patients with similar results can have different functional capacities.
- The standard test battery does not assess function of the vertical canals or otolith organs.

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What are we testing?

- VOR (VNG, Rotatory chair)
- VCR (VEMP)
- Central tracking & visual acuity (pursuit, saccade test, OKN test)
- Sensorimotor integration (Posturography)

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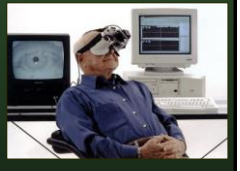
ENG/VNG

1. Spontaneous nystagmus (with and without fixation)
2. Gaze-evoked
3. Headshaking nystagmus
4. Saccade, smooth pursuit
5. Positional testing (Hallpike)
6. Calorics (with test of fixation)



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ENG/VNG-Techniques for Recording Eye Movements

Variable	EOG / ENG	VOG / VNG
Spatial resolution	1 degree	0.5 degree
Temporal resolution	40 Hz	60 Hz
Vertical recording	Possible but confounded by eyeblink	Good (can view video of torsional eye movements)
Setup	Slow	Fast
Cost	Low	Moderate

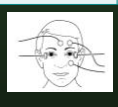

Table adapted from: Jacobson GP, Shepard NT, eds. *Balance Function Assessment & Management*. San Diego, CA; Plural Publishing, Inc. © 2008

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VNG: Caloric Testing

Involves irrigation of the EAC with a medium of significantly different temperature compared with core body temperature.



Open-loop water
44°C / 30°C for 40 seconds†

Closed-loop water
44°C / 27°C for 40 seconds†

Open-loop air
50°C¶ / 24°C for 60 seconds ¶

Pros:
1. Each labyrinth can be evaluated independently
2. Inexpensive equipment

Cons:
1. Caloric stimuli are not calibrated.
2. Tests only lateral semicircular canal function
3. low-frequency stimulation of vestibular system (~ 0.003 Hz)

† American National Standards Institute recommendations (ANSI, 1999) ¶British Society of Audiology (BSA. 1999)

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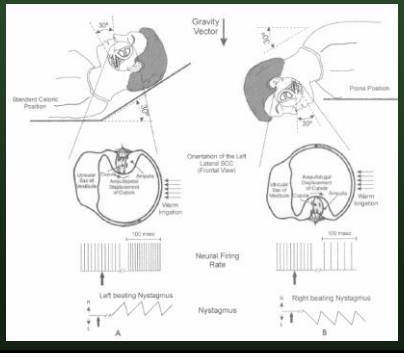
Caloric Testing



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Caloric Data: Key Formulas

Jongkee's formula:
- Compares caloric responses from the right ear to left ear.
- Remember to look at slow component velocity values too.

$$RVR = UW\% = \frac{(RW+RC) - (LW+LC)}{RW+RC+LW+LC} \times 100$$

> 25% is abnormal

Directional Preponderance:
- Compares the amount of RB nystagmus vs. LB nystagmus generated during caloric testing.

$$DP\% = \frac{\text{tot RB} - \text{tot LB}}{\text{tot RB} + \text{tot LB}} = \frac{(RW+LC) - (LW+RC)}{(RW+LC) + (LW+RC)} \times 100$$

> 30% is abnormal

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Rotary Chair Testing

Figure source: www.NDIC.com

Rotary Chair

Pros:

1. Rotation is a natural stimulus
2. Well-tolerated
3. Precisely controlled
4. Can be used for serial evaluations

Cons:

1. Tests only lateral SCCs
2. Expensive equipment
3. Non-lateralizing

Goebels, 2008

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Indications for Rotary Chair Testing

- Test of choice for bilateral peripheral vestibular hypofunction.
  - Calorics suggesting b/l paresis
- When the degree of compensation is desired
  - Establish baseline to follow
- When caloric information alone is inconclusive or inconsistent
  - Well compensated lesion on VNG but + clinical sx
  - Calorics may be normal
  - Rotational testing higher sensitivity for peripheral disorders, higher specificity than calorics

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Rotational Chair

Measure SLOW component eye velocity (SCEV) in response to angular acceleration

- Gain = ratio of peak eye velocity/peak chair velocity
  - Significant gain reduction in bilateral vestibular disorders
- **Phase** = temporal shift in eye velocity relative to head velocity.
  - Increased phase lead suggest vestibular disorder
- Asymmetry = Compares slow phase eye movement between right and left rotation.

Goebels et al., 2008

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Computerized Dynamic Posturography (CDP)

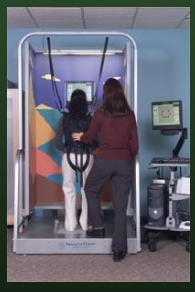

Figure source: www.NBCD.com

- Is a technique used to quantify and differentiate among the variety of sensory, motor, and central adaptive impairments to balance control.
- It does not provide site-of-lesion info.
- Three protocols:
  1. Sensory Organization Test
  2. Motor Control Test
  3. Adaptation Test

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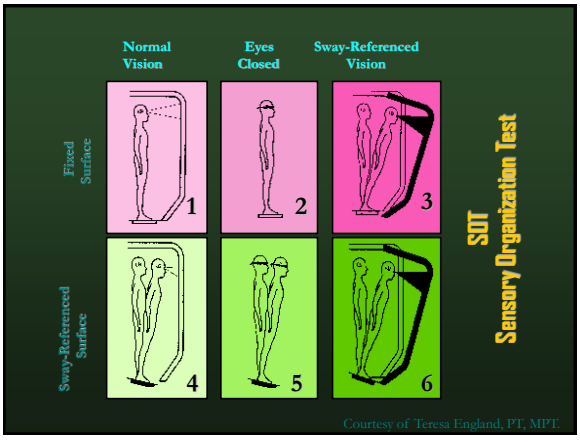

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Vestibular Evoked Myogenic Potentials (VEMP)

- The vestibular system generates muscle potentials in response to auditory and vibration stimuli
- Loud noise presented
- Record EMG from SCM (c-VEMP) or infraorbital muscles (o-VEMP)

Agrawal, 2015

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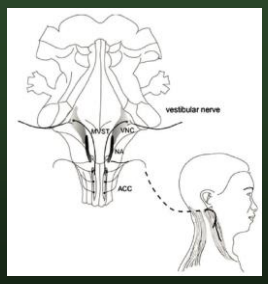
c-VEMP



Sound stimulates the saccule, which activates the inferior vestibular nerve, lateral vestibular nucleus, medial vestibulospinal tract ipsilaterally, and then the sternocleidomastoid muscle in the neck

cVEMP Reflex Arc:
- Outer/middle ear (if AC)
- Saccule
- Inferior Vestibular Nerve
- Vestibular nuclei
- Vestibulospinal Tract
- CN XI Spinal Accessory
- Sternocleidomastoid M.

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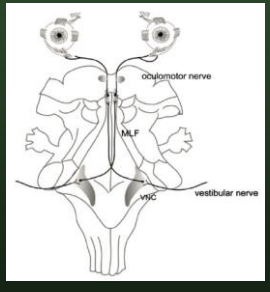
o-VEMP Pathway



oVEMP Reflex Arc:
- Outer/middle ear (if AC)
- Utricle
- Superior Vestibular Nerve
- Vestibular nuclei
- Medial Longitudinal Fasciculus
- CN III- Oculomotor
- Inferior Oblique M.

Can also record oVEMP in response to tap vibration, e.g. with a reflex hammer

oVEMPs better to assess for dehiscence in the setting of conductive hearing loss, because stimulus bypasses middle ear

Agrawal, 2015

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Ocular vs. Cervical VEMPs in the Diagnosis of Superior Semicircular Canal Dehiscence Syndrome

M. Geraldine Zuniga, MD[1], Kristen L. Janky, AuD, PhD[2], Kimanh D. Nguyen, MD[3], Miriam S. Welgampola, MD, PhD[4], and John P. Carey, MD[1]

	Sensitivity	Specificity
Click cVEMP	86%	90%
Tone-burst oVEMP	100%	100%
Click oVEMP	94%	100%

oVEMP amplitudes in response to ACS are superior to cVEMP thresholds in the diagnosis of SCDS. OVEMPs in response to ACS offer an excellent one-step screening for SCDS before CT imaging.

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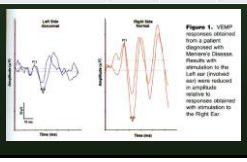
Clinical Utility

Vestibular Disorder	Total n	Absent	↑ Amp	↓ Threshold	Abnormal n	Normal n
Meniere's Dz	320	63	13	39	158	162
Vestibular Schwannoma	306	155	61	0	238	68
SSCD	64	0	0	64	64	0
Tullio	13	13	0	12	12	1
VN/Labyrinthitis	99	44	5	0	49	50
SNHL	46	1	2	0	4	42

Adapted from Akin & Murnane, 2008.



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Testing Summary

Clinical exam mainstay of vestibular evaluation

Clinical exam supported by vestibular tests
- Assist diagnosis
- Quantify degree of peripheral vestibular loss
- Prior to ablative procedures to ensure normal function on the contralateral side

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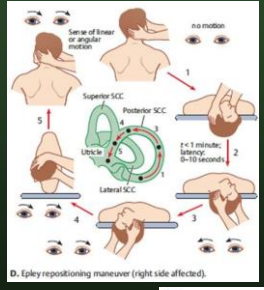
Treatment

- Short Term (Crisis)
  - Meclizine/Antivert
  - Antihistamines
  - Valium
- Ideal – Epley Maneuvers
- Observation (1-2 Mos.)
- Vestibular Rehabilitation
  - Habituation
  - Gaze Stabilization
  - Balance Training



D. Epley repositioning maneuver (right side affected).

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Treatment

- Aftercare (Epley)
  - Head over heart (no bend) – 24 hours
  - Do NOT sleep on trigger side – several days/week
  - May return w/in few weeks, requiring re-Rx
  - 50% recur later in life
  - Move SLOWLY, fix eyes during attacks
  - Avoid bright lights, driving, heights, etc…

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