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- Email customerservice@PhysicalTherapy.com

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Physical Therapy Examination of the Vestibular System

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PhysicalTherapy.com

continued[®]

Learning Outcomes

After this course, participants will be able to:

- Correctly perform a Dix-Hallpike test and interpret the results as negative or positive
- Choose and perform the correct repositioning maneuver for both horizontal and posterior canal canalithiasis
- Identify the differences between central and peripheral vestibular dysfunction
- Correctly perform an examination of VOR X 1 and VORc, interpret results and plan appropriate physical therapy treatment for impairments of the VOR

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Vestibular System Sends info to CNS

- ✦ Head angular velocity (Semi-Circular Canals)
- ✦ Linear acceleration of the head (Otoliths)
- ✦ Orientation of the head with respect to gravity (Otoliths)

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CONTINUED

Primary function of the Vestibular System:

- Stabilize gaze: Stabilize visual images on the fovea during head movements
- Control Posture: Keep the body balanced
- Spatial Orientation
- Coordinate head and body movements
- Keep the head aligned with respect to gravity

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continued

Incidence & Prevalence of Dizziness

- Incidence in the US: 5.5% (15 million people)
- 8 million primary care visits annually
- #1 reason for someone over 65 to consult MD
- Second only to HA in prevalence
- Estimated that 85% of dizziness is peripheral
- Appears to be more common in women

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continued

Signs and symptoms of vestibular dysfunction

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Symptoms of Vestibular Pathology

- ✦ Dizziness
- ✦ Gaze Instability
- ✦ Nystagmus
- ✦ Postural Instability
- ✦ Changes in/loss of hearing
- ✦ Autonomic Symptoms
 - ✦ Nausea
 - ✦ Lightheadedness

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CONTINUED

Secondary signs & symptoms

- ✦ Muscle tension
- ✦ Anxiety/depression
- ✦ Fatigue
- ✦ Poor Memory/Concentration
- ✦ Headaches
- ✦ Deconditioning
- ✦ Frequent Falling

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What is the role of Physical Therapy in Vestibular Rehab?

- ✦ Exam signs and symptoms of vestibular dysfunction
- ✦ Identify impairments (Body structures and functions), activity limitations and participation restrictions
- ✦ Develop and implement appropriate treatment activities
- ✦ Educate: Patients and other health care professionals

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Examination

- ✦ History
- ✦ Dizziness
 - ✦ Frequency, intensity, duration
- ✦ Oculomotor Control
- ✦ Visual-Vestibular Interaction
- ✦ VOR Suppression
- ✦ Motor Strategies
- ✦ Sensory Strategies

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continued

History

- Must determine the onset of the problem
- Description of the symptoms
- How do the symptoms affect the individual
- A good history may BEGIN to lead you in the direction of central V. peripheral, but, keep an open mind

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continued

History

- Medications
- Surgery
- Cognition
- Other PMHx
- Dizziness
- Falls History

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continued

Central V. Peripheral Dizziness

- Importance of determination
- As previously noted, 85% of all dizziness is peripheral
- Peripheral dizziness is more amenable to treatment with better overall outcomes
- Some central disorders do not respond to PT

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History: Dizziness

- Def: The term is imprecise and often refers to a variety of symptoms
- Ask patient to be specific: Are you dizzy at rest? (Which may indicate an acute peripheral or central disorder) Does the feeling of dizziness occur only with head movement? Does it cause imbalance in standing, sitting or walking?

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continued

Other problems a patient may describe as “dizziness”

- Disequilibrium: Imbalance or unsteadiness while standing and/or ambulating
- Lightheadedness
- Motion Sickness
- Nausea
- Vertigo
 - The true definition of vertigo is SPINNING → “I am spinning”
 - Some patients feel this, some use the term to mean other things. The PT needs to tease this out.

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continued

History: Dizziness (cont)

- Need to determine if the dizziness is chronic (< 3 days, Herdman & Clendaniel, 2014) or acute (“spells” of dizziness)
- Establish Frequency & Duration
 - Central: Chronic
 - Peripheral: USUALLY acute (there are EXCEPTIONS!!)
- A Visual Analog Scale may be helpful to determine Intensity

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continued

How does the Dizziness Impact the Patient's Life?

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continued

Dizziness Handicap Inventory

- ✦ Jacobsen & Newman (1990)
- ✦ 25-item self assessment inventory
- ✦ Quantifies the impact of dizziness on daily life by measuring self-perception of dizziness
- ✦ 3 domains
 - ✦ Functional (9 questions/36 points)
 - ✦ Emotional (9 questions/36 points)
 - ✦ Physical (7 questions/28 points)
- ✦ The higher the score the greater the perception of the disability

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Dizziness Handicap Inventory

- ✦ Proposed model of interpretation (Whitney et al, 2004)
 - ✦ Mild: 0 - 30
 - ✦ Moderate: 31 - 60
 - ✦ Severe: 61 - 100
 - ✦ Individuals who perceive greater handicap as measured by the DHI demonstrate greater functional impairment
- ✦ High test-re-test
- ✦ Correlates with SF-36
- ✦ Rehabmeasures.org

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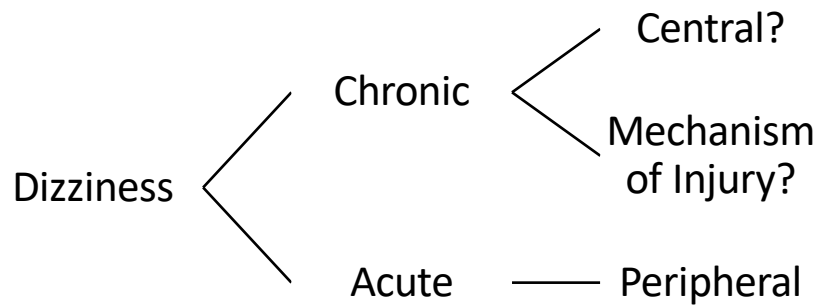
History: Falls

- ✦ Number of Falls
 - ✦ Past week? Month?
- ✦ When was your most recent fall?
- ✦ Did the fall occur inside or outside?
- ✦ How did the fall occur?
- ✦ Injuries?
- ✦ Dizziness during the fall?
- ✦ How often do you lose your balance?
- ✦ Use of ambulatory/safety aids?

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History: Questions/Comments



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Oculomotor Exam

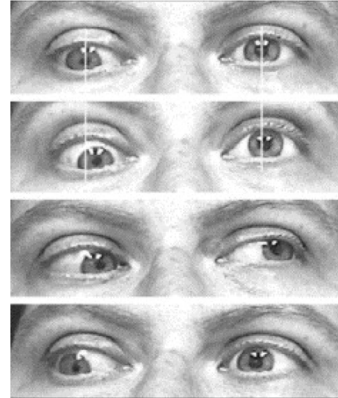
- Ocular Alignment
- Central Oculomotor Control
- Vestibular Function/Vestibular Driven Eye Movements

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continued

Ocular Alignment

- Note the resting eye position
- A “skew” deviation → Malalignment of resting eye position, is a central sign



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Central Oculomotor Control

- Tests of VISUALLY driven eye movement
- Smooth Pursuit (Tracking)
- Saccades (Rapid Eye movement from one target to another)
- Vergence

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Oculomotor Control

- Oculomotor control is primarily a function of the parieto-occipital cortex, pons and cerebellum
- Therefore → Only lesions to the CNS will cause consistent impairments to tracking or saccades
- HOWEVER: Oculomotor control may degrade with inattention, age, sedatives and speed (of eye movement)
- Establish a baseline during the evaluation

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To assess Smooth Pursuits

- Hold an object approximately 12 - 15" from the person's face
- Slowly move the object first horizontally, then vertically
- Do not use the entire ROM of the eye
- Document a deficit as a "corrective saccade" or "saccadic intrusion" not as nystagmus

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continued

To assess saccades

- Hold two objects, several inches apart, approximately 12 - 15" from the person's face
- The person should be able to smoothly move the eyes from one object to another (without moving the head)
- Overshooting or undershooting a target is an indication of a deficit
- Overshooting (hypermetric) is considered a worse sign than undershooting (hypometric)
- (Zoltan, 1996)

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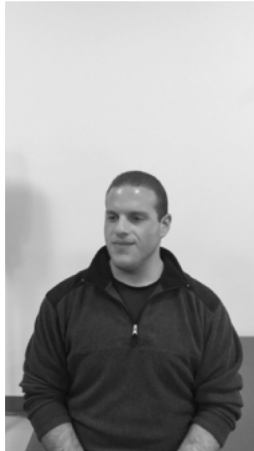
VIDEO: Tracking



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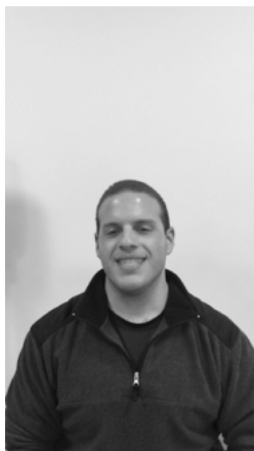
Video: Saccades



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continued

Video: End Point Nystagmus



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continued

Near Point of Convergence (NPC)

- Slowly bring a target in toward the bridge of the nose
- Have patient identify when the object blurs, then doubles
- Measure the distance between the end of the nose and the target at the point where the target was double
- Norm: 5 – 7 cm
- Deficits in NPC interfere with reading and can cause HA
- (Scheiman, 2003)

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continued



Accommodation Near Point Rule

<https://www.good-lite.com/Details.cfm?ProdID=658>

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continued

Scope of practice??

- Neurology Section: Entry-Level Curricular Content
 - Screening of dizziness and vestibular dysfunction including the DHI, CTSIB, CN testing, Smooth pursuits, saccades and head thrust
- Overlap with OT?
- Opinions? Questions? Suggestions?

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Visual-Vestibular Interaction

Vestibular Ocular Reflex (VOR)

- **Head Impulse Test (HIT)**
 - Formerly known as the Head Thrust Test
- **Dynamic Visual Acuity Test (DVAT)**
 - Formerly known as the Clinical Dynamic Visual Acuity Test



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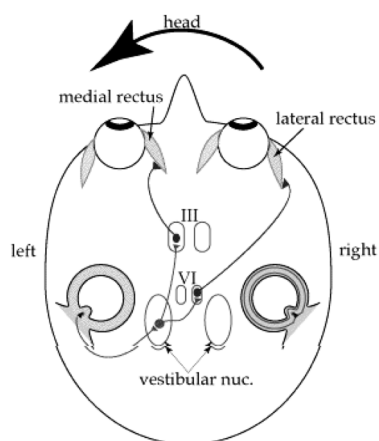
Assessment of the Vestibular Ocular Reflex (VOR)

- The function of the VOR is to keep the eyes steady while the head is moving
- Open Loop Reflex
- Can be suppressed if needed

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Review: VOR



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Head Impulse Test (Head Thrust)

- Used to assess the VOR at High acceleration
- Developed to assess the function of the Semi-CC
- However, both people with unilateral peripheral dysfunction AND people with central dysfunction may not be able to maintain their gaze at high speed
- The HIT is most sensitive to people with complete loss of canal function on one side (Halmagyi & Curthoys, 1998)

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Head Impulse Test

- Have the patient seated, and, if they wear glasses, they should have them on
- Flex the C-spine 30 degrees
- Have the patient fixate their vision on your nose
- Passively rotate the head using small-amplitudes (5 – 15 degrees)
- Moderate velocity (200 deg/sec); High velocity
- Unpredictable
- Move head from lateral to center

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continued

Head Impulse Test

- There is no scoring per se, the therapist notes normal (the eyes stay fixed on the nose) or abnormal (a re-setting saccade is generated)
- There is no normative data available other than to say that a person without vestibular dysfunction should not generate a corrective saccade
- The test appears to have good specificity and marginal sensitivity to detect dysfunction
- (www.rehabmeasures.org; Jorns-Haderli et al, 2007)

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continued

VIDEO: Head Impulse Test

- <https://www.youtube.com/watch?v=BmNCEhN61gM>

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DVAT (Dynamic Visual Acuity Test)

- Performed similarly to the HIT, the therapist passively moves the patient's head laterally with the neck flexed to 30 degrees
- However, the test is designed to measure visual acuity with head still, compared to the head moving, so, an eye chart is used
- The patient stands or sits in front of a standard eye chart and reads the lowest line possible

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CONTINUED

DVAT

- The therapist then moves the patient's head laterally with the spine flexed to 30 degrees
- The speed of head movement is standardized to 2 hz
- A patient without vestibular dysfunction should be able to read the same line or one line above
- If the patient must move the eyes ≥ 3 lines above, the therapist would document a "hypofunctioning VOR"
- (Herdman & Clendaniel, 2014)

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CONTINUED

DVAT

- Good intra-tester & test-re-test reliability (Rine, 2003)
- Subjects with known unilateral peripheral hypofunction have progressively degrading responses on the DVAT as head movement is increased from .5 hz – 1.5 hz (Dannenbaum et al, 2009)

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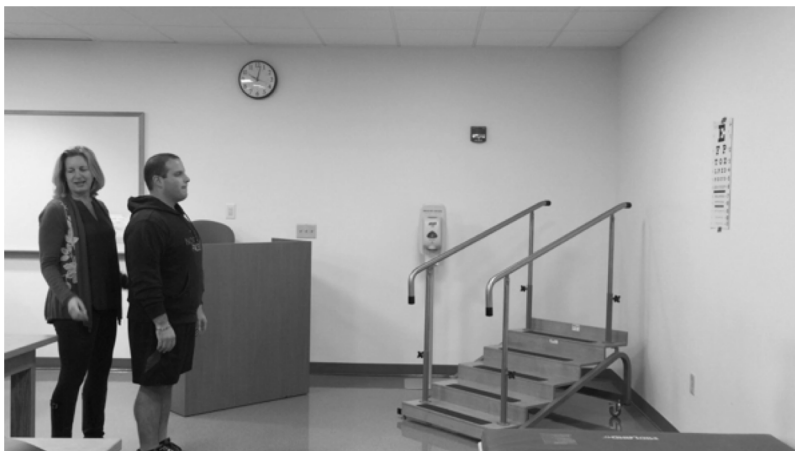
Video: DVAT: 1 HZ



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continued

Video: DVAT: 2 HZ



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continued

VOR Suppression

- Have the patient fixate on a small target, 12 – 15” from the eyes
- Ask the patient to move the head slowly, first horizontally, then vertically
- The target must move in sync with the head movement
- An inability to suppress the VOR is indicative of a central lesion (Herdman & Clendaniel, 2014)
- “Inability” → Catch up saccades or a horizontal saccadic intrusion

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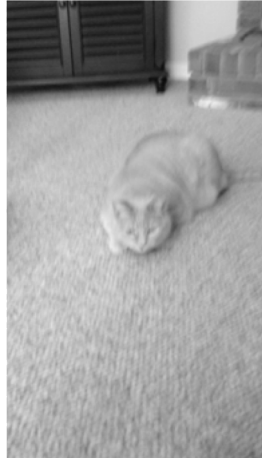
Video: VOR Suppression



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continued

Video: VOR Suppression 2



- The champion of VOR Suppression:
- MURPHY the CAT

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continued

Is it Central or Peripheral?

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CONTINUED

CENTRAL

- Dizziness is often chronic and low grade
- Oculomotor control MAY be impaired
- VOR MAY be impaired
- May be UNABLE to suppress the VOR

PERIPHERAL

- Dizziness of often acute and intense
- Oculomotor function is INTACT
- VOR MAY be impaired
- ABLE to suppress the VOR

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Results of a PT Examination: Unilateral Peripheral Hypofunction secondary to a Viral Infection

- The patient may report a viral infection (head cold, chest cold) 2 – 6 weeks ago
- May report a day or two of chronic dizziness
- NOW: Dizziness with specific activities
- Patient's may be anxious or depressed, may report H/A, may have started to feel deconditioned from self-limiting
- No history of surgery
- Meds are often unremarkable
- Cognition will be intact

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continued

Results of a PT Examination: Unilateral Peripheral Hypofunction secondary to a Viral Infection

- Oculomotor tests: Pursuits and Saccades are intact
- Head Impulse Test: Positive
- DVAT: Positive
- VOR Suppression: Intact

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continued

Questions?

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CONTINUED

History Indicated BPPV

- BPPV: Benign Paroxysmal Positional Vertigo
- The patient complains of occasional dizziness
- This dizziness resolves itself, "If I keep my head still and don't move"
- The onset of the dizziness is often associated with head movements
- NOTE: BPPV is the most common disorder of the peripheral vestibular system (Nedzelski et al, 1986; Balatsouras et al, 2011; Yetiser and Ince, 2015)

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Types of BPPV

- Canalithiasis: Otoconia are detached and free floating in a semi-circular canal. Canalithiasis is more common (Bhattacharyya, et al, 2008; Parnes et al, 2003; Yetiser & Ince, 2015)
- Cupulolithiasis: Otoconia adhere to the cupula

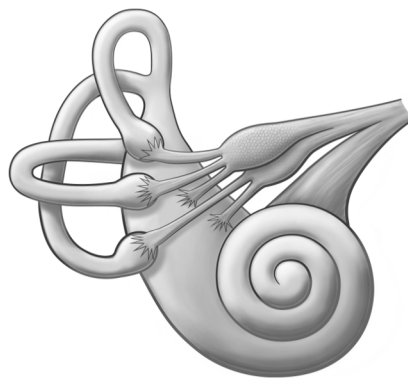
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Prevalence

- **Posterior Canal BPPV:** 85 – 95% of all cases of BPPV (Bhattacharrya et al, 2008; Parnes et al, 2003)
- **Lateral (horizontal) Canal BPPV:** 5 – 15% of all cases (Bhattacharrya et al, 2008; Parnes et al, 2003; Fife et al, 2008)
- **Superior (Anterior) Canal BPPV:** Rare (Parnes et al, 2003)
- **Cupulolithiasis is rare:** Very few studies documenting incidence

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Assessment of BPPV



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continued

Dix-Hallpike Maneuver

- Also known as the “Dix-Hallpike test”
- Begin with the patient long sitting on a plinth
- Have the patient turn their head 45 degrees to the offending side
- QUICKLY lie the patient supine, to assume the head position of 20 – 30 degrees of extension (while maintaining 45 degrees of rotation)

(Herdman, 2014; Bhattacharyya et al, 2008)

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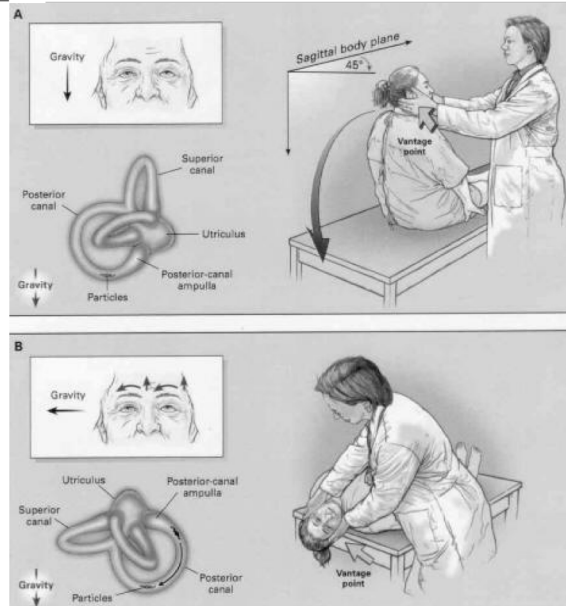
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A positive test results in...

- A brief episode of severe dizziness → 30 seconds to no more than 2 minutes
- The intensity of the dizziness has a characteristic crescendo → decrescendo
- Nystagmus →
 - Up-beat and torsional, with the fast phase toward the test side (Posterior Canal)
 - Down-beat and torsional, with the fast phase toward the test side (Anterior Canal)

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VIDEO: Dix-Hallpike

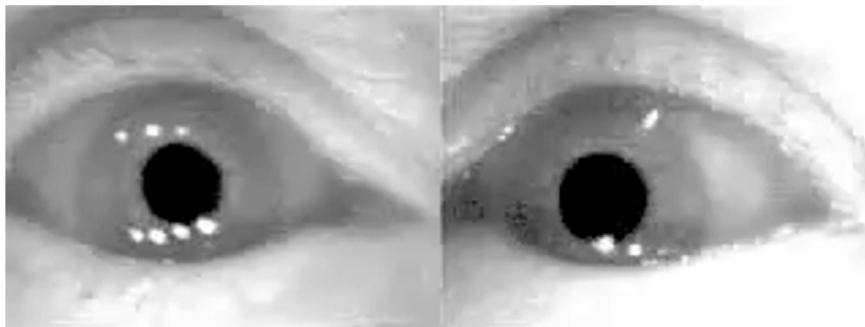


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Positive Dix-Hallpike



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continued

Negative Dix-Hallpike....

- The patient has complaints consistent with Posterior Canal BPPV but the Dix-Hallpike is negative
- Perhaps the patient has Horizontal Canal BPPV
- Perform the Supine Roll Test (Pagnini-McClure Maneuver)

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CONTINUED

Supine Roll Test

- Begin with the patient in sitting
 - The patient lies down in a straight supine position
 - Rapidly turn the patient's head toward the affected side
 - Observe for the characteristic nystagmus
 - Return the head to the face-up position
 - Repeat on the second side
- (Herdman & Clendaniel, 2014)

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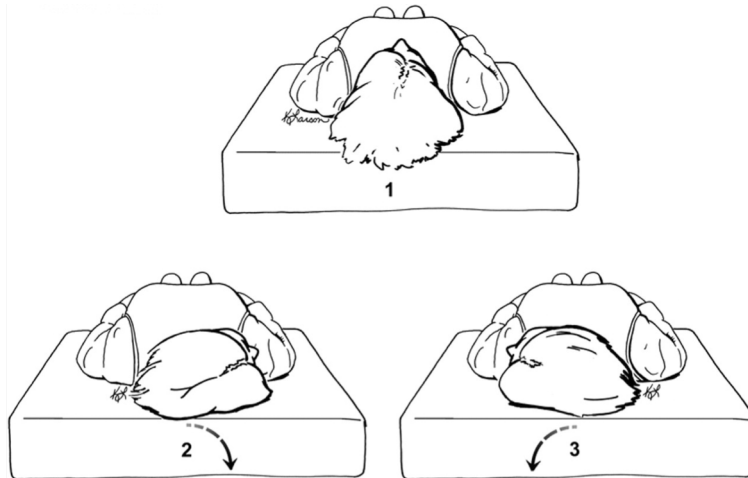
Positive Supine Roll Test

- The outcomes are not as well documented as with posterior canal
 - The patient WILL complain of dizziness that should diminish
 - Nystagmus: Purely horizontal, rotating toward the down (or AFFECTED) side. This is referred to as "geotropic" nystagmus as the fast phase is towards the ground
- (Bhattacharyya et al, 2008; Parnes et al, 2003; Herdman & Clendaniel, 2014)

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Supine Roll Test



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CONTINUED

Video: Supine Roll Test



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Treatment of BPPV

- **Anterior or Posterior Canalolithiasis:** Canal Repositioning Maneuver (CRM)
- **Anterior or Posterior Cupulolithiasis:** Liberatory (Semont)
- **Horizontal Canalolithiasis:** Horizontal Canal Repositioning
- **Horizontal Cupulolithiasis:** Liberatory
- REF: Herdman & Clendaniel, 2014

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CONTINUED

Evaluation Continued

- Rule out BPPV
- The patient presents with Vestibular dysfunction (dizziness, impaired VOR) but also reports other problems (or, you observe these problems)
 - Postural Instability often described as “unsteadiness”
 - Imbalance
 - Falls (?)

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Postural Control

- The vestibular system allows us to be oriented to our own body with respect to both the support surface and gravity
- We integrate somatosensory, visual and vestibular sensory input for accurate postural control
- With vestibular dysfunction, patients often have dysfunctional postural control

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Static Balance

- Romberg test
 - Feet together; standardize arm position
 - EO/EC
 - 30 SEC EO is standard; then test EC
 - No Rel/Val data available
- Sharpened Romberg (Tandem Romberg) test
 - One foot in front of the other (shoes off)
 - Again, 30 sec EO is standard, some normative data available (El Kashlan et al 1998)
 - Good inter-rater reliability
 - Some work on people with vestibular dysfunction (Gill-Body et al 2000), but overall, we are lacking data to support the use of the test

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Static Balance: Unilateral Stance

- SLS (Single Leg Stance)
- SOLEO (Stand on leg eyes open)
- SOLEC (Stand on leg eyes closed)
- Some normative data are available for healthy individuals (El Kashlan et al 1998) and people with vestibular dysfunction (Gill-Body et al 2000)
- Overall, lack of data establishing the validity
- Michikawa et al (2009): Review of 23 studies. Concluded that one-legged stance may be a tool for predicting frailty and times are related to falls.

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Motor Strategies

- Ankle
- Hip
- Stepping
- No standardization of administering; no scoring; difficult to reproduce. How are the strategies related to vestibular dysfunction?

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Balance with Altered Sensory Cues

- mCTSIB: Modified test for sensory interaction in balance
 - Standing with EO/EC then repeat on FOAM (extension of the romberg test)
 - Dome portion no longer used
 - People with uncompensated vestibular hypofunction have difficulty maintaining upright with foam/EC (Nashner, 1992)

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Sub-system Assessment

- ROM: Ankle, neck, pelvis, other?
- MMT
- Sensation: Visual & Somatosensory

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Balance and Gait Assessments

- BERG balance Scale
- Dynamic Gait Index (DGI)
- Functional Gait Assessment (FGA)
- TUG
- Mini – Best Test
- Gait Speed
 - Self-selected
 - Fast

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Summary

- ✦ Vestibular system: Detects gravity and head movement
- ✦ When Dysfunctional: Dizziness, nystagmus, postural instability
- ✦ Accurate examination includes: Dizziness, oculomotor control, VOR, Balance and postural control
- ✦ Treatment is effective!! Especially for peripheral dysfunction

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Questions?

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