Interpretation of Video Electronystagmography (VNG)

Elliot Michel, M.D.
Neurology
Background

VENG provides an objective assessment of the oculomotor and vestibular systems.

VENG test battery consists of 4 parts:

- **Oculomotor** evaluation:
  - Tracking, Saccades, Optokinetic, **Active Head Rotation**, Spontaneous Gaze, Torsion Swing.

- **Positional testing**:
  - Dix-Hallpike, Supine Head (Center, Left, Right)
  - Supine Body (Left, Right)

- **Caloric stimulation**
The comparison of results obtained from various subtests of VENG assists in determining whether a disorder is **central** or **peripheral**.

**Central** findings should be correlated with neuroimaging.

**Peripheral** findings can be treated with canalith repositional maneuvers (CRM), and/or vestibular rehabilitation therapy (VRT).

In peripheral vestibular disorders, the side of lesion can be inferred from the results of caloric stimulation and, to some degree, from positional findings.
**Medications**
- Many medications can affect test results.
- Patients should discontinue medications, unless contraindicated, for 48 hours prior to testing.
  - sleeping pills, tranquilizers, barbiturates, antihistamines, anti-dizzy medications, anti-depressants, ETOH
- Any medications taken should be clearly noted on the test results.
- Alcohol ingestion can affect ENG test results for 72 hours post ingestion (agonist or antagonist).
Patient Instructions-Practical Considerations

• Why stop medications?
• What about long-term users?
• Why stop alcohol?
• Why 48 hours for medications and alcohol?
• What about tobacco and caffeine?
• What if the patient does not comply?
Patient Interview

• Develop rapport with the patient
• Explain the test in an honest and reassuring manor without using misleading or threatening language
• Ask about recent medication and alcohol use
• Obtain clinical information
  - Heart/circulation problems?
  - Seizures?
  - Severe hearing impairment?
  - Ear surgery?
  - Severe visual problems?
  - Positional vertigo?
  - Child/mentally retarded?
  - Head trauma?
VNG vs. ENG: *Resolution*

**VNG**
- Resolution of about $0.1^\circ$
- In laboratory conditions, can detect movements as small as $0.5^\circ$

**ENG**
- Resolution of about $1^\circ$
- In laboratory conditions, cannot detect movements of less than $2-3^\circ$

**Practical Implication**
- VNG can measure smaller amplitude of eye movements.
VNG vs. ENG: Type of Eye Movements

- **VNG**
  - Measures horizontal and vertical positions and displays (but currently does not measure) torsional eye movements
  - No major difference in the accuracy of horizontal and vertical eye movements

- **ENG**
  - Measures horizontal and vertical positions but cannot measure or display torsional eye movements
  - Vertical eye movements are usually noisy and contaminated by eye blinks

- **Practical Implications**
  - VNG can visualize torsional nystagmus.
  - Vertical tracings are cleaner and more accurate in VNG.
VNG vs. ENG: Limitations

- **VNG**
  - Cannot test patients with ptosis and similar eye abnormalities
  - Some patients do not tolerate wearing goggles

- **ENG**
  - Cannot test patients with absent corneo-retinal potential
  - Some patients develop skin reaction to electrodes

- **Practical Implication**
  - Have both ENG and VNG!
  - ENG is needed in less than 5% of patients
VNG vs. ENG: *Most Important Difference*

**VNG**
- Allows direct visualization of eye movements, uses digital image processing to measure movements of the center of the pupil electrode-free

**ENG**
- Indirectly measures eye movements, uses changes in corneo-retinal potentials from surface electrodes to measure eye position

**Practical Implications**
- VNG tracings are verifiable by direct visual inspection. They are also cleaner and drift-free whereas ENG tracings can be noisier.
VNG vs. ENG Terminology

• **VNG**
  - With fixation (with vision)
  - Without fixation (without vision)

• **ENG**
  - Eyes open (in light)
  - Eyes closed (in dark)
VENG provides an objective assessment of the oculomotor and vestibular systems.

VENG test battery consists of 4 parts:

- **Oculomotor** evaluation
  - Tracking, Saccades, Optokinetic, **Active Head Rotation**, Spontaneous Gaze, Torsion Swing.

- **Positional testing**
  - Dix-Hallpike, Supine Head (Center, Left, Right)
  - Supine Body (Left, Right)

- **Caloric stimulation**
Oculomotor evaluation

- Tracking
- Saccades
- Optokinetic
- Active Head Rotation
- Spontaneous Gaze
- Torsion Swing
The smooth pursuit system is responsible for following targets within the visual field. Tracking can be evaluated horizontally and vertically. As a rule, vertical tracking is not as smooth as horizontal, even in healthy subjects. Tracking test results should resemble a smooth sinusoid. Breakup of movement may indicate CNS pathology. Nystagmus may be seen in tracking test results when also observed in spontaneous (center gaze) recordings. ***Test results are influenced by patient attention & cooperation, visual acuity (presbyopia), Drugs, Age.
OCULOMOTOR EVALUATION
Interpretation - Smooth Pursuit Tracking

- Gain
  - normal, increased, decreased
- Phase
  - increased
- Accuracy
  - intrusions
• Normal Gain, normal phase
Tracking/Pursuits

- Increased Gain
  - Consistent with central dysfunction

![Tracking/Pursuits](image)
Tracking/Pursuits

- Decreased Gain
  - Consistent with central dysfunction, low vision, or oculomotor dysfunction
Tracking/Pursuits

- Increased Phase Shift
  - Consistent with central dysfunction
• **Saccadic intrusions**

![Graphs showing tracking/pursuit results](image)
Tracking/Pursuits

- Abnormal findings: refer for balance therapy
- Tracking exercises
OCULOMOTOR EVALUATION

Oculomotor evaluation

- Tracking
- Saccades
- Optokinetic
- Active Head Rotation
- Spontaneous Gaze
- Torsion Swing
**OCULOMOTOR EVALUATION**

Interpretation Saccades

- **Normal** latency and velocity
- Slowed velocity saccades
- Prolonged Latency = Delayed saccades
- Accuracy…
Alerting/Mental Tasking

- Should patients be alerted during tests with fixation?
- Why should patients be alerted during tests without fixation?
- What are the best alerting tasks?
OCULOMOTOR EVALUATION

Interpretation – Saccades Velocity

- Saccadic slowing:
  - first rule out drowsiness or drug effects.
  - In the absence of these, saccadic slowing is consistent with various CNS disorders, and oculomotor weakness.
    - degenerative conditions, basal ganglia pathology, and cerebellar disorders.

- Abnormally fast saccades:
  - As with saccades that evidence an abnormally short latency, abnormally fast saccades are usually an artifact and may be due to technical difficulties.
  - However, in some cases, abnormally fast saccades may suggest CNS or ocular pathology (i.e., ocular flutter).
OCULOMOTOR EVALUATION
Interpretation – Saccades Velocity

- Asymmetrical velocity:
  - Asymmetry in saccadic velocity can be observed as an asymmetry between the eyes or between directions.
  - Ocular nerve or muscle pathology (i.e., lesions, palsy). CNS pathology may also be suspected.
  - A lesion in the medial longitudinal fasciculus causing internuclear ophthalmoplegia may evidence as asymmetrical saccadic velocity.
OCULOMOTOR EVALUATION
Interpretation Saccades

- Normal latency and velocity
- Slowed velocity saccades
- Prolonged Latency = Delayed saccades
- Accuracy…
OCULOMOTOR EVALUATION
Interpretation: Saccades Delay – Latency

- Short latency are usually because of an artifact or the patient anticipating the position of the target.
- If prolongation of saccades is evident, the examiner should rule out inattention or uncooperative behavior.
- Prolongations of more than 400 ms in attentive and cooperative patients may be suggestive of CNS pathology.
- Asymmetrical latencies
  - in one direction may be normal with a prolongation of saccades in the opposite direction.
  - can occur in patients with lesions in the occipital or parietal cortex.
Saccades

- Delayed saccades
  - lesion of the frontal or frontoparietal cortex or basal ganglia.
  - These must be interpreted with caution; consider drugs and inattention.
OCULOMOTOR EVALUATION

Interpretation Saccades

- Normal latency and velocity
- Slowed velocity saccades
- Prolonged Latency = Delayed saccades
- Accuracy…
OCULOMOTOR EVALUATION

Interpretation Saccades

• Accuracy
  – Hypermetric saccades
  – Hypometric saccades
  – Flutter
  – Multistep saccades
  – Glissade
  – Pulsion
**Hypermetric**: AKA calibration *overshoot*.

- patient has difficulty measuring the distance required for the muscular act necessary for following the target.
- You see an overshoot of the target followed by a correction.
- Pts. that *consistently* exhibit hypermetric saccades may have *ocular dysmetria*, which is suggestive of a CNS lesion at the level of the *cerebellum*.
**Hypometric:**
- The patient **undershoots** the target.
- Occasionally undershooting a target is normal.
- The undershoot must be reproducible and must occur frequently to be considered abnormal.
- If extreme, hypometric saccades are suggestive of **basal ganglia** pathology.

**Ocular flutter:**
- This is evidenced as a type of **spiky overshoot**;
- The patient overshoots the target several times with a short duration between overshoots.
- This is also suggestive of CNS pathology.
- **Multistep** saccades:
  - This occurs when a patient *undershoots* the target and then attempts to correct with *multiple small saccades*.
  - This pattern is suggestive of CNS pathology.
- **Postsaccadic drift**: Also called glissade
  - This is seen as a drifting of eye movement after the saccade.
  - This is consistent with cerebellar pathology.
- **Pulsion**:
  - The pattern includes a *pulling to the left or right* of the eyes when completing *vertical* saccades.
  - Posterior inferior or superior cerebellar artery syndrome.
Saccades

- Abnormal findings: refer for balance therapy
- Saccade exercises (progressive)
- May need evaluation for specific neurologic disorders (e.g. MRI)
Saccade Test Summary

• Normal Variations
  - Fast, precise eye movements
  - Occasional small overshoots or undershoots

• Artifacts
  - Inattention
  - Head movements
  - High or low gain (faulty calibrations)
  - Too few saccades for analysis
Oculomotor evaluation

- Tracking
- Saccades
- Optokinetic
- Active Head Rotation
- Spontaneous Gaze
- Torsion Swing
**OCULOMOTOR EVALUATION**

Interpretation - Optokinetic Testing (OPKN)

- Eye movements that are generated by moving fields resemble nystagmus.
- Evaluate symmetry of the response.
- If responses are not symmetrical, CNS pathology may be suspected.
- Some patients are unable to appropriately complete this task in either direction.
Optokinetic Test - Procedure

- Record eye movements as the patient watches a series of visual targets moving first to the right and then to the left in the horizontal plane on the light bar.
- Stimulus – Constant velocity target movements as 20°/sec or 40°/sec.
- Record until you have at least 5 good nystagmus beats for each direction.
- Ask the patient to avoid head movements.
- Look for the patient’s best performance.
Optokinetic Nystagmus

- Normal bilaterally
Optokinetic Nystagmus

Asymmetric
Optokinetic Nystagmus

Reduced bilaterally
Optokinetic Nystagmus

- Artifact due to prolonged fixation on a single moving target
Tracking/Optokineti c Test Summary

- Normal variations
  - Smooth, precise eye movements in tracking/ nystagmus intensities matching target velocity in optokineti c
  - Occasional interspersed saccades in tracking/ large or small amplitude nystagmus beats in optokineti c

- Artifacts
  - Inattention
  - Head movements
  - High or low gain (faulty calibrations)
  - Mismatch between tracking and optokineti c results
  - Superimposed nystagmus
OCULOMOTOR EVALUATION

Oculomotor evaluation
  Tracking
  Saccades
  Optokinetic
  Active Head Rotation
  Spontaneous Gaze
  Torsion Swing.
Active Head Rotation (AHR) Autorotation

- AHR for assessing the VOR
- Pts. Move their head horizontally then vertically from 0.3 to 4 Hz.
- We get gain & phase from the frequency analysis.
  - Inc. Gain = CNS
  - Dec. Gain = PVS
- We compare horizontal vs. vertical
  - Asymmetric unilateral PVS.
Active Head Rotation

- Asymmetry (horizontal) dominant side is the side of the central lesion, i.e. if asymmetric to right, the lesion is on the right
- Asymmetry (vertical) is less clear but implies CNS or oculomotor dysfunction
Active Head Rotation

- Normal gain horizontally
- Normal gain vertically
Active Head Rotation

- Increased gain
  - Horizontally
  - Vertically
Active Head Rotation

**HORIZONTAL**
- Velocity gain 80-120%
- Asymmetry +10 to -10%
- Velocity phase 160-210 degrees

**VERTICAL**
- Velocity gain 70-130%
- Asymmetry +10 to -10%
- Velocity phase 160-210 degrees
Oculomotor evaluation

- Tracking
- Saccades
- Optokinetic
- Active Head Rotation
- Spontaneous Gaze
- Torsion Swing.
Gaze Test - Procedure

- Purpose – to examine the patient’s ability to reach and maintain different gaze positions
- Record eye movements as the patient fixates on targets at center, 30° rightward, 30° leftward, 30° upward, and 30° downward
- In each gaze position, record for at least 20 seconds or as long as necessary to make a definite decision
- Results must match visual exam results

Include testing with and without fixation?
Gaze testing is conducted to evaluate for the presence of nystagmus in the absence of vestibular stimulation.

In the ENG test battery, essentially 4 types of information are obtained:

1. presence or absence of spontaneous nystagmus (no task or center gaze);
2. presence, absence, or exacerbation of nystagmus with addition of off-center gaze tasks to stress the system.
3. fixation suppression of spontaneous nystagmus.
4. Head shaking nystagmus
OCULOMOTOR EVALUATION

Interpretation – Spontaneous Gaze

Spontaneous nystagmus:
- This may indicate either central or peripheral pathology.
- The presence of nystagmus with eyes open is always diagnostically significant.
- Peripheral indicators include
  - horizontal or horizontal rotary nystagmus
  - nystagmus suppressed by visual fixation
  - non-direction-changing nystagmus
  - nystagmus exacerbated by gazing in the direction of the fast phase.
Spontaneous nystagmus:
- Central indicators include
  - vertical nystagmus
  - nystagmus not suppressed by fixation
  - direction-changing nystagmus.
- Alexander's law:
  - Nystagmus evident with eyes open always beats in the same direction and increases when the patient gazes in the direction of the fast phase.
  - Nystagmus decreases or disappears when the patient gazes in the direction opposite to the fast phase.
  - This pattern is often seen in peripheral vestibular disorders and occasionally in central disorders.
Spontaneous nystagmus: Square-wave jerks:

- This is the most common abnormality found with eyes closed.
- **Caution**: many healthy patients exhibit this pattern with their eyes closed.
- The frequency of square-wave jerks increases with age.
- In *young patients*, square-wave jerks may be considered *atypical* if they occur more frequently than 1 per second or with eyes open.
- In such cases, square-wave jerks are suggestive of a *cerebellar* disorder.
Square Wave Jerks

• Square wave jerks (SWJ):
  – sporadic horizontal conjugate saccades away from
    the intended position of fixation
  – followed some 200 ms later by saccadic return to
    the fixation position.

• Macro square-wave jerks (MSWJ):
  – large amplitude square-wave jerks which are
    fixation dependent with a frequency of
    approximately two Hz.
  – Both eyes suddenly and conjugately move off the
    target with a saccade. After approx. 80 ms the
    eyes return to primary position.
Square Wave Jerks

- Seen in cerebellar disease
Abnormal Gaze - *Square Wave Jerks*

- **Localization**
  - *Square Wave Jerks* denote a **central lesion** in the cerebellum or basal ganglia.

- **Etiologies**
  - Olivopontocerebellar atrophy
  - Spinocerebellar degeneration
  - Multiple Sclerosis
OCULOMOTOR EVALUATION
Interpretation - Spontaneous Gaze

Spontaneous nystagmus:

- **Unilateral gaze-paretic nystagmus:**
  - This nystagmus only occurs with eccentric gaze in one direction.
  - Elicited nystagmus beats in the direction of the gaze. This is consistent with CNS pathology.

- **Bilateral gaze-paretic nystagmus:**
  - When the patient gazes to the right, nystagmus is elicited that beats to the right;
  - when the patient gazes to the left, left-beating nystagmus occurs.
  - This pattern suggests CNS pathology
Abnormal Gaze - *Brun’s Nystagmus*

- *Brun’s nystagmus* denotes a central lesion involving an extra-axial mass in the posterior fossa on the side of the gaze-evoked nystagmus
OCULOMOTOR EVALUATION

Interpretation - Spontaneous Gaze

Spontaneous nystagmus:
- **Bruns nystagmus:**
  - This is a combination of unilateral gaze-paretic nystagmus and vestibular nystagmus,
  - which is evidenced as nystagmus in both directions of a gaze that is asymmetrical.
  - Bruns nystagmus is associated with extra-axial mass lesions on the side of the gaze-paretic nystagmus.
- **Congenital nystagmus:**
  - This often has a spiky appearance and increases with lateral gaze.
  - Congenital nystagmus may decrease in velocity or completely disappear with eyes closed.
Spontaneous nystagmus:
- **Rebound nystagmus** –
  - characterized by a burst of nystagmus lasting approximately 5 seconds that begins when the eyes are returned to center gaze.
  - When this is present, the clinician may suspect brainstem or cerebellar lesions.

Physiologic **end-point nystagmus** seen at extreme gaze is always weak and symmetric, usually transient and a common finding in the elderly.
Abnormal Gaze - *Periodic Alternating Nystagmus*

- Reverses direction about every 2-4 minutes
- Conjugate
- Horizontal
- Present in both with and without fixation
- Can be congenital or acquired
- Denotes a central lesion
- Etiologies
  - Cranio-cervical junction abnormalities
  - MS
  - Blind Patients
  - Complication of anticonvulsants
  - If acquired, Baclofen abolishes nystagmus
OCULOMOTOR EVALUATION

Interpretation - Spontaneous Gaze

- Direction-changing nystagmus
- Periodic alternating nystagmus is horizontal and conjugate, present in light and darkness, and reverses direction about every 2 minutes.
OCULOMOTOR EVALUATION

Interpretation - Spontaneous Gaze

• Upbeat nystagmus
  – Denotes a lesion in the medulla or anterior vermis of the cerebellum.
  – Etiologies include cerebellar degeneration, multiple sclerosis, infarction of medulla or cerebellum, and tumor of medulla or cerebellum.
Abnormal Gaze – *Upbeat Nystagmus*

- **Localization**
  - *Upbeat nystagmus* denotes a central lesion in the medulla or anterior vermis of cerebellum

- **Etiologies**
  - Side effect of nicotine
  - Alcohol intoxication
  - Side effect of medications
  - Infarction of medulla or cerebellum
  - Tumor of medulla or cerebellum
  - Multiple sclerosis
  - Cerebellar degeneration
Interpretation - Spontaneous Gaze

- **Downbeat nystagmus**
  - Denotes a lesion in the posterior midline cerebellum and underlying medulla.
  - Etiologies include Arnold-Chiari malformation, cerebellar degeneration, infarction of brainstem or cerebellum, multiple sclerosis, cerebellar tumor, and drug intoxication (notably lithium).
Abnormal Gaze - *Downbeat Nystagmus*

**Localization**

- *Downbeat nystagmus* denotes a **central lesion** in the posterior midline cerebellum and underlying medulla.

**Etiologies**

- Arnold-Chiari malformation
- Cerebellar degeneration (commonly, paraneoplastic type)
- Infarction of brain stem or cerebellum
- Multiple sclerosis
- Vertebrobasilar ischemia
- Cerebellar tumor
- Drug intoxication
OCULOMOTOR EVALUATION
Interpretation - Spontaneous Gaze

• Fixation suppression:
  – For peripheral lesions, nystagmus that is evident with eyes closed or in the dark should be suppressed by visual fixation.
  – If visual fixation does not suppress nystagmus, CNS pathology is possible.
Abnormal Gaze – *Congenital Nystagmus*

- Noted at birth or shortly after
- Pendular or jerk (increasing velocity slow phase)
- Conjugate
- Horizontal or torsional
- Exacerbate by visual fixation
- Attenuated by convergence
- Has a null point (usually not at center gaze)
Gaze Test Summary

• Normal variations
  - No nystagmus with fixation in any gaze position
  - Mild nystagmus in extreme gaze positions (end-point nystagmus)

• Artifacts
  - Inattention
  - Eye blinks
HEAD-SHAKING TEST
Test Procedure

- Perform if requested (suspected vestibular asymmetry)
- Place patient in sitting position
- Eliminate fixation (eyes closed)
- Start recording eye movements
- Ask patient to shake the head back and forth vigorously about 40 times in 20 seconds
- After head-shake stops, continue recording eye movements for at least 20 seconds
Head-Shake Nystagmus Test

The head-shake nystagmus (HSN) test is most useful in the assessment of vestibular disorders that produce asymmetries in vestibular function.

The patient is placed in an upright sitting position with his or her head tilted forward 30°. The examiner rotates the head back and forth (45° to either side), completing 30 full cycles at a frequency of about 2 cycles per second. If nystagmus is observed following head rotation, eye movements should be recorded for at least one minute.

Nystagmus produced following the head rotation is considered significant if at least 5 consecutive beats of at least 2° per second are observed.
Head-Shake Nystagmus Test classifications:

- **Monophasic**: Nystagmus produced does not change directions.
- **Biphasic**: Nystagmus produced initially beats in one direction and then fatigues and reverses directions.
- **Paretic**: Initial nystagmus observed beats away from the side of lesion.
- **Reversed**: Initial nystagmus observed beats toward the side of lesion.
- **Cross-coupled**: Strong vertical nystagmus produced by head shaking on the horizontal axis.

**Cross-coupled** HSN is suggestive of **CNS pathology**.
Head-Shake Nystagmus Test

A positive finding of HSN is highly suggestive of an underlying vestibular pathology.

A negative HSN test result does not rule out a vestibular pathology.

HSN usually beats away from the side of a peripheral lesion

However, since this is not the rule, HSN should be used in conjunction with other vestibular tests in determining the side of the lesion.
Oculomotor evaluation

- Tracking
- Saccades
- Optokinetic
- Active Head Rotation
- Spontaneous Gaze
- Torsion Swing.
Torsion Swing

- Normal with suppression
Torsion Swing

- Inadequate fixation suppression
Dynamic Position Test Summary

• Normal variations
  - No nystagmus after head movement

• Artifacts
  - Differentiating transient from non-transient nystagmus
  - Differentiating torsional from other types of horizontal/vertical nystagmus
  - Extraneous eye movements due to severe dizziness
The Rest

Positional Test:
  Dix-Hallpikes
  Positional
    Supine Head Center
    Supine Head Left
    Supine Head Right
    Supine Body Left
    Supine Body Right

Bithermal Calorics
Dynamic Position Test - *Practical Issues*

- Possible contraindications – Check with the referring physician
  - Severe neck or back problems
  - Severe carotid stenosis
  - Active heart disease
  - Orthopedic and mobility restrictions for some maneuvers
Dix-Hallpike
Vertebrobasilar Insufficiency Screen

Screen for vertebrobasilar insufficiency, (prior to head hanging or Dix-Hallpike maneuvers).

- Have the patient engage in mental tasking (e.g., counting, reciting multiplication tables) while gradually tilting the head back and then holding it.
- Change in cognitive status or reports of lightheadedness may be significant.
- This screening method is especially important for older patients.

Patients must have adequate vision to follow targets for the oculomotor portion.
Dynamic Position Test - *Dix-Hallpike Maneuver*

- Instruct the patient about the procedure
- Begin from the sitting position with head turned 45° right or left, move rapidly to supine head hanging
- Observe eye movements (IR or Frenzel goggles are recommended, recording is optional)
- After nystagmus subsides, proceed to treatment or bring the patient back to sitting position and repeat to determine fatigability
Dynamic Position Test - *Practical Issues*

- Indications for the test
- When to do the test in the ENG battery
  - First/middle/last
- Recording eye movements
  - VNG/ENG/Frenzel’s goggles
  - With or without fixation
- How fast to move from the sitting to supine position
- How far to have the head in the supine position
- The best position for the examiner to perform the test
- How long to wait before sitting the patient back up
- Is it necessary to establish fatigability
Positional Testing
Dix-Hallpike Maneuver

- Specifically to assess the presence or absence of nystagmus associated with BPPV.
- If positive, canalith repositioning maneuvers (CRM) and vestibular rehabilitation therapy (VRT) may be indicated.
- If nystagmus is observed, the test is repeated to evaluate fatigability of the response.
- Because of fatigability, the Dix-Hallpike maneuver should be completed before any other positional testing.
- Patients with BPPV present with a geotropic rotary nystagmus.
- Suppressed with visual fixation.
Positional Testing

Dix-Hallpike Maneuver

- If rotary nystagmus is observed, the results must have the following 4 characteristics to be considered classically positive:
  - Delayed onset - After 20 seconds of observation
  - Transient burst of nystagmus - Lasts approximately 10-15 seconds
  - Subjective report of vertigo
  - Fatigability
- When BPPV occurs, a peripheral lesion on the side that is down when the nystagmus occurs may be indicated.
Dix-Hallpike

- Torsional Nystagmus
Dix-Hallpike

HALLPIKE LEFT

RESULTS

SCV
Horizontal 13R
Vertical 0
Marked 'R' at 34 Sec.

- Horizontal

- Vertical
Dix-Hallpike

- Ageotropic torsional or Downbeating
The otolith (red, in the insert) has located to the top of a hair cell in the cupula. Exercise therapy is used to move it and eliminate the condition (see treatment section).

(2) Canalithiasis: Otoliths or "dense bodies" become located in the canal itself near the cupula, again in a position to cause symptoms with change in head position. Canalithiasis is depicted in the following diagram:

The dense bodies (violet) or otoliths (blue squares [depending on your viewer]) are lodged near the cupula. A series of head position changes can move the material to a non-sensitive portion of the inner ear (see treatment section).
Figure 4 In benign paroxysmal positional nystagmus (BPPN), the nystagmus fast phase is horizontal-rotary directed toward the undermost ear when gaze is directed toward the undermost ear (upper panel). The nystagmus fast phase is upward toward the forehead when gaze is directed to the uppermost ear (middle panel). With the eyes in the central orbital position, the nystagmus fast phase is vertical upward and rotary toward the down ear (bottom panel).
Dix-Hallpike

Cupulolithiasis vs. Canalithiasis

- Cupulolithiasis comes on immediately after no delay and persists with maintenance of the position.
- Canalithiasis comes on after a delay of at least 4 seconds and up to even 40 seconds; it will ultimately stop.
VNG vs. ENG: Dix-Hallpike

- **VNG**
  - Goggles can move during Dix-Hallpike

- **ENG**
  - Recording is of limited value during Dix-Hallpike

**Practical Implication**
- While VNG can visualize torsional nystagmus, precautions must be taken to avoid moving the goggles. Otherwise, nystagmus may be missed.
The Rest

Positional Test:
  Dix-Hallpikes
  Positional
    Supine Head Center
    Supine Head Left
    Supine Head Right
    Supine Body Left
    Supine Body Right

Bithermal Calorics
Positional Testing

SHC, SHL, SHR, LL, RL

- If no nystagmus is observed in any position, results are considered normal.
- For results to be considered abnormal, the nystagmus observed in positional testing should
  - exceed 6° per second
  - change direction in any 1 position
  - persist in at least 3 different positions
  - or be intermittent in all positions.
- Lesser degrees of nystagmus are of questionable pathologic significance.
- If spontaneous nystagmus is observed, the nystagmus observed during positional testing must show an increase in velocity to be considered a significant positional finding.
Positional Testing
SHC, SHL, SHR, LL, RL

- Peripheral indicators include
  - direction-fixed nystagmus
  - direction of nystagmus changing in different positions, following a geotropic pattern (also consider a horizontal canal variant of BPPV in this case); latency of onset; and fatigability.

- Central indicators include
  - direction of nystagmus changing in different positions
  - following an ageotropic pattern
  - direction of nystagmus changing in a single position, which is a strong indicator for CNS pathology
  - immediate onset of nystagmus
  - non fatigability.
Positional Testing

- Geotropic nystagmus
Positional Testing

- Ageotropic nystagmus

### RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Left Eye</th>
<th>Right Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>N.A.</td>
<td>15R</td>
</tr>
<tr>
<td>Vertical</td>
<td>N.A.</td>
<td>0</td>
</tr>
<tr>
<td>Marked 'R' at 41 Sec.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing positional testing results]
Inspect the tracings for the evidence of nystagmus. When present, determine the following characteristics for each gaze position:

- Direction of movement (specify fast or slow phase)
  - Horizontal/vertical/oblique/torsional
- Effect of fixation (if tested with fixation)
  - Suppressed/enhanced/no effect
- Intensity – slow phase velocity (SPV)
- Latency and duration (for transient nystagmus only)
  - Provoked by head movements (dynamic position test)
Abnormal Position Test

• Nystagmus without fixation must exceed 6°/sec in at least one head position to be considered abnormal.

• Localization
  – *Spontaneous and positional (including geoptropic and ageotropic) nystagmus* denote a non-localizing lesion in the peripheral or central vestibular pathways.
Position Test – *Criteria for Abnormality*

- Greater than $6^\circ/\text{sec}$ in any one head position
- Persistent in at least 4 head positions
- Persistent in at least 3 head positions
- Intermittent in at least 4 head positions
Static Position Test Summary

• Normal variations
  - No nystagmus with or without fixation in any head position
  - Mild nystagmus without fixation

• Artifacts
  - Lack of alertness
  - Eye blinks
  - Squarewave jerk nystagmus without fixation
Static vs. Dynamic Position Testing

• **Static position test**
  - Look for nystagmus that is present as long as head remains in critical position

• **Dynamic position test**
  - Look for transient nystagmus that is provoked by head moving to critical position
CALORIC TESTING
Status of the outer and middle ear

- **Drainage** in the outer ear canal may affect air caloric stimulation
  - Because moisture will change the calibrated temperature, thus limiting interpretation.
- **Perforations** limit interpretation of air caloric
  - can increase stimulation with cool air above calibrated expectation
  - can exhibit a cooling effect for warm air because moisture of the middle ear mucosa is evaporated.
- **Excessive earwax** must be removed prior to any vestibular stimulation.
Caloric Test Assumptions

- Most common method of bithermal calorics (each ear is irrigated twice to elicit both excitatory and inhibitory responses)

- Basic assumption of caloric testing is that right and left ears receive equal stimulation
  - Controllable – temperature, volume, duration, alerting, cerumen
  - Uncontrollable – ear anatomy, body, temperature, perforations
Caloric Stimulation
Interpretation

- Assessment of the lateral semicircular canal.
- Valuable tool because it allows for the objective measurement of function from each labyrinth individually.
- Vestibular stimulators include water, air.
  - We use air.
  - Water calorics provide a strong stimulus but cannot be used with patients with pressure equalization tubes or perforation of the tympanic membrane.
Caloric Test Procedure

- Describe the procedure and expected responses
- Perform the first irrigation as follows:
  - Eliminate fixation (ask the patient to close eyes in ENG or cover goggles in VNG).
  - Start recording eye movements
  - Start the irrigation
  - When the irrigation ends, ask the patient to perform alerting tasks
  - Ask the patient to fixate on a small target approximately 40-45 seconds after the end of the caloric irrigation. Mark the tracing.
  - Eliminate fixation after 10-15 seconds. Mark the tracing.
  - Continue recording eye movements until the response subsides (usually about 2 minutes)
- Perform three remaining irrigations the same way
Caloric Stimulation
Interpretation - COWS

- In patients with responsive vestibular systems.
- Cool irrigations - The fast phase of nystagmus beats in the direction opposite to the stimulated ear (i.e., cool irrigation in the right ear causes left-beating nystagmus).
- Warm irrigations - Nystagmus beats in the direction of the stimulated ear (i.e., warm stimulation of the right ear produces right-beating nystagmus).
- Alternating binaural bithermal
  - Right ear cool (RC)
  - Left ear cool (LC)
  - Left ear warm (LW)
  - Right ear warm (RW)
After the stimulus is removed, record while the patient is mentally tasked.

The patient is given a break of 3-5 minutes between the RC and LC calorics and between the LW and RW.

A break of 8-10 minutes is given between the LC and LW conditions.

If there is hypofunction consider correlating with cold water.

When adequate data have been recorded, fixation suppression testing is conducted.
Caloric Test Procedure - *Practical Issues*

- **Recalibrate before each irrigation?**
  - Not a good idea in computerized ENG or VNG (instead, verify the calibration and recalibrate only if necessary)

- **Test in total darkness with eyes open?**
  - Not necessary unless caloric responses are contaminated

- **What order to do the irrigations?**
  - Start with one temperature and irrigate the ears in the same order for each temperature

- **How long to wait between irrigations?**
  - Wait 3-5 minutes after the caloric nystagmus ends. Use this time to analyze the previous caloric test
Caloric Test Procedure – Practical Issues

• How many Fixations tests are needed
  - One for each nystagmus directed but do four and choose two irrigations where nystagmus intensities just before fixation are approximately equal

• Are two irrigations (cool & warm) enough?
  - Significantly increases chance of identifying caloric results as abnormal when they are not (false positive)

• What to do if the patient gets sick?

• Is there an age limit for caloric testing?
Caloric Test Data Analysis

- Three different time intervals must be carefully analyzed
  - First 10-15 seconds after the onset of irrigation (to detect spontaneous nystagmus, must match results from supine position in static position testing)
  - After 60-90 seconds of irrigation (to detect the peak of caloric response)
  - Immediately before and after fixation (to detect fixation suppression)
Caloric Stimulation
Interpretation

- Slow phase velocity is determined for each recording for use in the following calculations:
- Unilateral weakness (UW) is used to evaluate symmetry.
  - In many clinics, a UW greater than 25% is significant. 
    \[
    \%\text{UW} = \left[ \frac{((RC + RW) - (LC + LW))}{(RC + RW + LC + LW)} \right] \times 100.
    \]
  - A negative number indicates a right unilateral weakness
  - A positive number indicates a left unilateral weakness.
- Unilateral weakness is indicative of a peripheral vestibular lesion involving the nerve or end-organ on the side of the weakness.
Caloric Stimulation
Interpretation

- Bilateral weakness:
  - Average caloric responses of 6° per second or less are consistent with a bilateral weakness.
  - Borderline bilateral weakness is noted when the average responses are between 7-9° per second.
  - Abnormally weak bilateral responses may be due to:
    - bilateral peripheral vestibular pathology or central interruption of VOR.
    - When a borderline bilateral weakness or bilateral weakness is observed, drug effects should be excluded.
Caloric Testing

- Normal
- Unilateral weakness=15%L
- Directional Preponderance=13%R
Caloric Testing

A normal caloric response does not rule out a vestibular pathology, since this test only measures a response from part of the labyrinth at a very low frequency of stimulation.

- Does not check high frequency vestibulopathy.
Caloric Test Analysis - *Abnormal Values*

- BW – responses from both right and left ear <12°/sec  
  (Total R<12°/sec and Total L<12°/sec)
- UW %>25% (range 20% - 30%)
- DP %>30% (range 25% - 50%)
- F.I. >60% (range 50% - 60%)
- Hyperactive – Total R>140°/sec or Total L>140°/sec
Caloric Stimulation
Interpretation

- Directional preponderance (DP):
  - If the patient has spontaneous nystagmus, directional preponderance is evident.
  - In general, a directional preponderance greater than 20-30% is considered significant.
  - \[%DP = \frac{((LC + RW) - (RC + LW))/(RC + RW + LC + LW)}{X 100}.\]
Caloric Testing

• Unilateral weakness
  \[(3+2)-(57+8) = (3+2+57+8)\]
  
  - 86% Left

• Directional Preponderance
  \[(3+8)-(57+2) = (3+8+57+8)\]
  
  - 69% Left
Abnormal Calorics - *Directional Preponderance (DP)*

- **Criterion for abnormality**
  - DP%>30% (range 25%-50%)

- **Localization**
  - *Directional Preponderance* denotes a non-localizing lesion in the peripheral or central vestibular pathways
Caloric Stimulation

Interpretation

- **Fixation Suppression**
  - After each caloric stimulus, the patient is instructed to fixate on a light or other object.
  - Caloric responses should suppress >50% with light fixation.
  - If visual fixation does not inhibit nystagmus, central pathology at the level of the brain stem is indicated.
- Compute the fixation index (FI):
  - An FI of 0.60 or greater is considered significant
  - \( \text{FI} = \frac{\text{EO}}{\text{EC}} \), where EO = nystagmus with eyes open and EC = closed).
Caloric Test Data Analysis - *Fixation Index & Temp Effect*

- Fixation Index (FI) is a measure of nystagmus intensity during fixation expressed as a percentage of nystagmus intensity just before fixation
  \[
  \text{FI\%} = \frac{\text{SPV Fix}}{\text{SPV NoFix}} \times 100
  \]

- Temperature Effect (TE) shows relative difference of warm vs. cool responses *not a clinical parameter*
  \[
  \text{TE\%} = \frac{(\text{LW} - \text{RW}) - (\text{RC} - \text{LC})}{(\text{LW} - \text{RW}) + (\text{RC} - \text{LC})} \times 100
  \]
Caloric Test Summary

• Normal variations
  - Approximately equal and symmetrical caloric responses
• Artifacts
  - One irrigation dominating the results
  - Alerting
  - Superimposed nystagmus
  - Tympanic membrane perforation
Caloric Test Data Analysis - Bilateral Weakness

- Determine total response from each ear
  - Total R=RC - RW; Total L=LW – LC
- When total responses from both ears are less than normal limits (Total R<12° and Total L<12°)
  - Bilateral caloric weakness
  - Stop calculations – UW & DP values are not valid!
Caloric Testing

- Bilateral weakness
- Needs verification with ice water bilaterally
ICE WATER CALORIC TEST
Ice Water Caloric Test Procedure

• Perform if standard caloric irrigations fail to provoke a response
• Perform the ice water test as follows:
  - Place patient in caloric test position
  - Turn patient’s head so ear to be irrigated is uppermost
  - Ask the patient to close eyes (eliminate fixation)
  - Start recording eye movements
  - Fill ear with 2 cc of ice water, wait 20 seconds
  - Turn patient’s head to opposite side to drain out water
  - Turn patient’s head nose upward, alert patient, and record eye movements for at least a minute
Test Procedure - Prone Position Ice Water Test

- Perform when standard ice water response is not distinguishable from spontaneous nystagmus
- Irrigate ear with 2 cc of ice water as before and record nystagmus in supine position for 30-40 sec
- Turn patient to prone position, record nystagmus for 30-40 sec
- Return patient to supine position, record nystagmus
- Positive if nystagmus disappears or reverses direction
Caloric Testing

Hyperresponsiveness
SPV > 50 deg/sec cool
SPV > 80 deg/sec warm

CNS pathology
Artifacts

- Eye blink
Artifacts

- Square wave nystagmus
PRESSURE TEST
Pressure Test Procedure

- Perform if specifically requested or fistula is suspected
- Ask patient to close eyes (eliminate fixation)
- Start recording eye movements
- Apply pressure in external ear canal
  - Can use an impedance bridge to alternate pressure in external ear canal between +200 and -400 mm H2O
  - Also can use tragal pressure, pneumatic otoscopy, valsalva maneuver, or sound
- Maintain pressure for 15-20 seconds, repeat the test
- Positive if nystagmus is *synchronized* with pressure change
- *Nystagmus in the plane of superior semicircular canal* denotes superior canal dehiscence
Benign Paroxysmal Positional Vertigo (BPPV)

- Transient episode of vertigo lasting several seconds when head moves to critical positions
- Vertigo may be severe but usually no other symptoms
- Prevalence: high (20%-25% of dizzy patients)
  - Higher in older individuals
  - High recurrence rate
- Causes: idiopathic, trauma, inner ear disease
- Lab findings: abnormal dynamic position test
  - Dix-Hallpike, sidelying, or roll maneuver
Abnormal Dix-Hallpike - *Mechanism of BPPV*

- **Original view**
  - Particles, most likely otoconia, *adhering* to the cupula of *posterior* semicircular canal (Schuknecht 1969)

- **Current view**
  - Floating particles in the canal (canalithiasis) and particles adhering to the cupula (cupulolithiasis)
  - Canal involvement – posterior, horizontal, or anterior semicircular canal
Modified Epley

• Instructions for the patient: (A) Start by sitting on a bed and turn your head 45 degrees to the left. Place a pillow behind you so that on lying back it will be under your shoulders. (B) Lie back quickly with shoulders on the pillow, neck extended, and head resting on the bed. In this position the affected (left) ear is underneath. Wait for 30 seconds. (C) Turn your head 90 degrees to the right without raising it and wait again for 30 seconds. (D) Turn your body and head another 90 degrees to the right and wait for another 30 seconds. (E) Sit up on the right side. This maneuver should be performed 3 times per day. Repeat this daily until you are free from positional vertigo for 24 hours.
L Semicircular Canals

Figure 9. Positioning sequence for left posterior semicircular canal (in red) shows orientation of left labyrinth and gravitating canalis (in violet).
1. The patient is seated with operator behind. An ultrasonic oscillator may be used and is started at this point.

2. Head is placed over end of table, 45 degrees to left, with head extended. (Canalis gravitate to center of posterior semicircular canal, the "cleared" portion now shown in green.)
3. Head is rotated 45 degrees to right; head is kept well extended in process of coming from position 1. (Canaliths reach common crus.)

4. Head (and body) are rotated until facing downward 135 degrees from supine. (Canaliths traverse common crus.)
5. Patient is brought to sitting position; head is kept turned to right in process of coming from position 3. (Canaliths enter utricle.)

6. Head is turned forward with chin down about 20 degrees.
1. The patient is moved quickly from a seated position back over the end of the examination table with the head extended and turned approximately 45 degrees with the left ear down. In each position, there may be nystagmus induced as a result of change from the prior head position. The patient is kept in the position until the nystagmus or symptoms subside, typically ten to fifteen seconds.

2. The head is slowly rotated so that the right ear is now turned 45 degrees down, keeping the head extended.

3. The head and body are rotated to the right until the patient is facing downward. This position is maintained for approximately fifteen seconds.

4. The patient is then brought gradually up to a seated position with the head turned to the right.

5. The head is turned forward with the chin slightly depressed.
<table>
<thead>
<tr>
<th>Involved Canal</th>
<th>Sitting to Supine</th>
<th>Supine to Sitting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Right Dix-Hallpike</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Posterior Canal</td>
<td>Upbeat &amp; Right Torsion</td>
<td>Downbeat &amp; Left Torsion</td>
</tr>
<tr>
<td>Left Anterior Canal</td>
<td>Downbeat &amp; Left Torsion</td>
<td>Upbeat &amp; Right Torsion</td>
</tr>
<tr>
<td><strong>Left Dix-Hallpike</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Posterior Canal</td>
<td>Upbeat &amp; Left Torsion</td>
<td>Downbeat &amp; Right Torsion</td>
</tr>
<tr>
<td>Right Anterior Canal</td>
<td>Downbeat &amp; Right Torsion</td>
<td>Upbeat &amp; Left Torsion</td>
</tr>
</tbody>
</table>
• **Maneuver for treatment of right horizontal canal BPPV**
  - The supine patient is rotated 270 degrees in rapid steps of 90 degrees in the plane of the horizontal semicircular canal towards the healthy side. The time interval between each step is 30 seconds or until nystagmus has subsided.

• **Rolling to the opposite direction is done for the left horizontal semicircular canal.**
Lateral Canal BPPV
## Abnormal Dix-Hallpike – *Canal Involvement*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior</td>
<td>63.6%</td>
<td>90%</td>
<td>93%</td>
<td>90%</td>
</tr>
<tr>
<td>Anterior</td>
<td>11.7%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Horizontal</td>
<td>1.3%</td>
<td>6%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Mixed</td>
<td>23.4%</td>
<td>-</td>
<td>(2.4%)</td>
<td>-</td>
</tr>
</tbody>
</table>
# Treatment Options for BPPV

<table>
<thead>
<tr>
<th>Involved Canal</th>
<th>Canalithiasis</th>
<th>Cupulothiasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CRT</td>
<td>CRT (with oscillator)</td>
</tr>
<tr>
<td><strong>Posterior Canal</strong></td>
<td>2</td>
<td>Liberatory</td>
</tr>
<tr>
<td>3</td>
<td>Brandt-Daroff</td>
<td>Brandt-Daroff</td>
</tr>
<tr>
<td>1</td>
<td>CRT</td>
<td>CRT (with oscillator)</td>
</tr>
<tr>
<td><strong>Anterior Canal</strong></td>
<td>2</td>
<td>Liberatory (head turn)</td>
</tr>
<tr>
<td>3</td>
<td>Brandt-Daroff</td>
<td>Brandt-Daroff</td>
</tr>
<tr>
<td>1</td>
<td>Modified CRT</td>
<td>Modified CRT</td>
</tr>
<tr>
<td><strong>Lateral Canal</strong></td>
<td>2</td>
<td>Brandt-Daroff</td>
</tr>
<tr>
<td>2</td>
<td>Brandt-Daroff</td>
<td>Brandt-Daroff</td>
</tr>
</tbody>
</table>
Management

- Advise pt of benign prognosis
- Beyond placebo effect, meclizine (Antivert) is generally not helpful for treatment of vertigo
- If recurrence, treat w/ positioning maneuvers, e.g., Brandt-Daroff exercises
## Incidence of ENG Abnormalities

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1571</td>
<td>(61%)</td>
</tr>
<tr>
<td>Peripheral</td>
<td>601</td>
<td>(23%)</td>
</tr>
<tr>
<td>Unilateral caloric weakness</td>
<td>383</td>
<td></td>
</tr>
<tr>
<td>BPPV</td>
<td>181</td>
<td></td>
</tr>
<tr>
<td>Combination</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Nonlocalizing</td>
<td>264</td>
<td>(10%)</td>
</tr>
<tr>
<td>Spontaneous positional nystagmus</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>Bilateral caloric weakness</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>112</td>
<td>(4%)</td>
</tr>
<tr>
<td>Peripheral and central</td>
<td>36</td>
<td>(1%)</td>
</tr>
<tr>
<td>Total</td>
<td>2584</td>
<td></td>
</tr>
</tbody>
</table>
ENG Interpretation – Report Writing

- Characteristics of a good report
  - Accurate (comply with the current knowledge base)
  - Informative (commit to one interpretation)
  - Concise (avoid extraneous information)

- Emphasize hard findings

- Emphasize localizing findings

- Report on anything that may affect test results (medications, surgeries, etc.)
ENG Interpretation - Sample Report Format

• Demographics

• Normal/Abnormal ENG
  - List of tests and descriptions of abnormal findings starting with hard localizing findings
  - List of tests and description of normal findings

• Overall Impressions
  - Localization/etiology/supportive findings
  - Other items affecting the test (medications, ect.)
ILLUSTRATIVE CASES
• Reasons for referral:
  - The patient is a 52 year old female with a history of unsteadiness and lightheadedness for approximately two years. These spells are intermittent in nature, lasting a few hours.

• ENG findings:
  - All normal
    ◦ 19% UW in the caloric test
    ◦ Leftbeating nystagmus without fixation in the head right position < 6°/sec
VNG REPORT

Procedure: Bithermal caloric test, saccade test, gaze test, position test, tracking test and optokinetic test. The Dix-Hallpike was not performed due to the patient’s back problems.

Results: Caloric responses showed 19% caloric weakness on the right, which was still within the normal limit of less than 25%. There was leftbeating positional nystagmus without fixation on the head right position only. Nystagmus was not strong enough to be considered abnormal. Peak velocities, accuracies and latencies of horizontal saccades were normal. There was no gaze-evoked nystagmus with fixation Horizontal optokinetic nystagmus was normal in both directions.

Caloric, saccade, gaze, position, tracking and optokinetic test dates are attached.

Impression: The tests showed no abnormality.

What does normal mean?

N.G. Examiner, M.A., CCC-A
Case 2 - *Posterior Canal Benign Positional Vertigo*

- **Reasons for referral:**
  - The patient is a 55 year old female who has had episodic vertigo for many years. In 1989, she was hospitalized for four days for acute vertigo, accompanied by nausea and vomiting and was told she had episodic vertigo off and on. She says the vertigo occurs most often when she lies down in bed at night and in the morning.

- **ENG findings:**
  - BPPV-type nystagmus for right Dix-Hallpike
  - 35% UW in the right ear
VNG REPORT

Procedure: Bithermal caloric test, saccade test, gaze test, position test, tracking test, optokinetic test and Dix-Hallpike maneuver.

Results: The Dix-Hallpike maneuver provoked paroxysmal positional nystagmus with the right ear undermost. Caloric responses of the right ear were 35 percent weaker than those of the left ear.

There were no other abnormalities. Peak velocities, accuracies, and latencies of horizontal saccades were normal. The patient did have left-beating spontaneous nystagmus with eyes closed, but it was not strong enough to be significant. There was no gaze-evoked nystagmus. Horizontal tracking was normal in both directions. Horizontal optokinetic nystagmus was normal in both directions.

Impression: Results of the Dix-Hallpike maneuver indicate benign positional vertigo involving the right lateral semicircular canal or its afferent pathways.
CASE 2

• Localization?
  - Right peripheral vestibular

• Etiologies?
  - BPPV+?
CASE 3 – Nonlocalizing Vestibular Dysfunction

• Reasons for referral:
  - The patient is a 63 year old female who has hypertension, borderline diabetes, thrombophlebitis, a bad back, and chronic headaches. Two years ago, she had the flu and has been dizzy ever since. She has visited many physicians for this problem without satisfaction.

• ENG findings:
  - Significant left-beating spontaneous nystagmus
  - All else normal
Patient: Case 3
ID Number: 111-22-3333
Age/Gender: 63/F
Examiner: N.G. Examiner, M.A., CCC-A
Referring Physician: John Smith, M.D.
Date of test: 25-Jun-02

VNG REPORT

Procedures: Bithermal caloric test, saccade test, gaze test, tracking test, optokinetic test, and Dix-Hallpike maneuver.

Results: The patient had left-beating nystagmus without fixation.

There was no other abnormalities. Caloric responses were approximately equal and symmetrical bilaterally. Peak velocities, accuracies, and latencies of horizontal saccades were normal. There was no gaze-evoked nystagmus with fixation. The Dix-Hallpike maneuver provoked no response, either with the right ear undermost or with the left ear undermost. I was unable to induce the patient to follow a moving target, but optokinetic nystagmus was normal in both directions, indicating normal horizontal pursuit.

Caloric, saccade, gaze, position, tracking and optokinetic test data are attached.

Impression: These results indicate either peripheral or central vestibular dysfunction.

N.G. Examiner, M.A., CCC-A
Case 4 - Central Non-vestibular Lesion

• Reasons for referral:
  - The patient is a 67 year old female with frequent headaches and almost constant dizziness, which she describes as “swimmy-headedness.”

• ENG findings:
  - Bilateral saccadic slowing
  - All else normal
ENG REPORT

Procedures: Bithermal caloric test, saccade test, gaze test, position test, tracking test, optokinetic test, and Dix-Hallpike maneuver.

Results: Bithermal saccades were abnormally slow in both directions.

There were no other abnormalities. Accuracies and latencies of horizontal saccades were normal. There was no significant spontaneous, positional, or gaze-evoked nystagmus. The Dix-Hallpike maneuver provoked no response, either with the right ear undermost of the left ear undermost. Horizontal tracking was normal in both directions.

Impression: Saccadic slowing indicates a central lesion.

NOTE: This patient is actively on CNS-acting medications, which can cause saccadic slowing.

N.G. Examiner, M.A., CCC-A
The End