Vestibular Function Tests

Tomoko Makishima, MD, PhD
Associate Professor
Department of Otolaryngology
The University of Texas Medical Branch
Grand Rounds
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Tests for the dizzy patient

- Electro/video-nystagmography
- Rotary chair
- Computerized dynamic posturography
- Vestibular evoked myogenic potentials
- Head impulse test
- Audiogram
- MRI
- Questionnaire (Dizziness Handicap Inventory)
ENG/VNG

- Electronystagmography: records electrical charges between cornea and retina
- Videonystagmography: obtain pupil position by video recording
ENG/VNG

- Vestibular tests (＝ peripheral)
  (spontaneous nystagmus, gaze nystagmus, positional nystagmus, positioning nystagmus, fistula test, bithermal caloric test)

- Oculomotor tests (＝ central)
  (pursuit system, saccadic system, optokinetic system, fixation system)
VNG

• Spontaneous nystagmus
• Gaze nystagmus (right, left, up, down)
• Positional nystagmus (supine, left side, right side, head hanging, etc)
• Dix-Hallpike
• Random saccade (chase random dots)
• Sinusoidal pursuit
• Optokinetic nystagmus (rotary drum)
• Caloric test (cold, warm)
**VNG**

**Micromedical Technologies**

**VisualEyes 4 Channel**

<table>
<thead>
<tr>
<th>Name</th>
<th>Philpot, Suzanne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age:</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td></td>
</tr>
</tbody>
</table>

**ID:** 273076n  
**Visit Date:** 01/07/2015  
**Tester:**  
**Doctor:**

<table>
<thead>
<tr>
<th>OT</th>
<th>Name</th>
<th>Test Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Summaries:**

<table>
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<tr>
<th>Caloric Summary</th>
</tr>
</thead>
</table>

**Nystagmus Tests:**

- Gaze-Horizontal
- Gaze-Vertical
- Spontaneous Nystagmus
- Positional Head-Sitting
- Dix-Hallpike Right
- Dix-Hallpike Left
- Positional Head-Supine
- Positional Body
- Positional Head-30deg

**Oculomotor Tests:**

- Saccade-Random
- Pursuit
- OPK-Fixed
Caloric test

- Tests horizontal semicircular canal
- Equivalent to slow frequency (0.002 – 0.004Hz)
- Slow phase nystagmus is observed
- Cold water (30°C) = away from ear
- Warm water (44°C) = towards ear
- Ice water (0°C) if no response
- Fixation suppression (R/O central)
- 20° difference significant
- <10deg/sec@30°C = hyporeflexia
Gaze nystagmus

- Horizontal gaze (30 degrees, right and left)
- Vertical gaze (30 degrees, up and down)
Spontaneous nystagmus

With/without fixation
Dix-Hallpike test

Right

Left
Positional nystagmus

Positional Sitting
Head right, left
Positional nystagmus

Supine
Head right, left
Positional nystagmus
Positional nystagmus

Head hanging
Random saccade
Pursuit
Optokinetic nystagmus
Interpretation

Central disorders
- Spontaneous or positional nystagmus with normal caloric test
- Direction changing nystagmus independent of stimulus
- Failure of fixation suppression
- Bilateral caloric response abnormality without cause
- Abnormal saccade, pursuit
- Hyperactive caloric

Peripheral disorders
- Unilateral caloric weakness
- Fatiguing positional nystagmus
- Direction fixed nystagmus
Rotary chair

- Horizontal semicircular function
- Slow phase velocity (0.0125 – 0.8Hz)
- Gain
- Phase
- Light suppression (central vestibular function)
- Bilateral function
- Supplements caloric tests
  (rotary chair with higher velocity)
Rotary chair

- Slow harmonic acceleration
- Vestibular ocular reflex (in darkness)
- Vestibular ocular reflex fixation suppression
- Visuo-vestibular ocular reflex (in light)
- Optokinetic nystagmus
Rotary chair

Mirror ball
Creates stripes
For OKN

Earth-vertical axis rotation
Bidirectional

Reflective lenses
Infrared video cameras
Rotary chair

Vertical eye movement
Horizontal eye movement
Head position
Rotary chair

Several rounds of Matlab analysis
Rotary chair

- Gain
- Phase
- Bias
- Symmetry
Rotary chair: Horizontal VOR
Interpretation

- Low gain: bilateral vestibular dysfunction
- High gain: central vestibular dysfunction
- Phase lead: central or peripheral vestibular dysfunction
- Phase lead: older age
- Bias: marker for central vestibular function
- No light suppression: central dysfunction
- VVOR enhanced gain: anxiety? migraine?
Computerized dynamic posturography

- Vestibular
- Visual
- Somatosensory
- Useful for diagnosis of malingering
- Useful for follow up, progress of physical therapy
Posturography

- Mobile platform
- Mobile surround

Safety harness, just in case
Posturography: SOT

Sensory Organization Test

1. Eyes open, fixed surface and visual surround.
2. Eyes closed, fixed surface.
3. Eyes open, fixed surface, sway referenced visual surround.
4. Eyes open, sway referenced surface, fixed visual surround.
5. Eyes closed, sway referenced surface.
6. Eyes open, sway referenced surface and visual surround.

http://resourcesonbalance.com/program/role/cdp/protocols.aspx
## Interpretation

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Abnormal SOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibular dysfunction</td>
<td>5, 6</td>
</tr>
<tr>
<td>Visual vestibular dysfunction</td>
<td>4, 5, 6</td>
</tr>
<tr>
<td>Visual preference</td>
<td>3, 6</td>
</tr>
<tr>
<td>Visual preference and vestibular dysfunction</td>
<td>3, 5, 6</td>
</tr>
<tr>
<td>Somatosensory and vestibular dysfunction</td>
<td>2, 3, 5, 6</td>
</tr>
<tr>
<td>Severe dysfunction</td>
<td>Abnormal in four or more SOT conditions</td>
</tr>
<tr>
<td>Aphysiologic or functional dysfunction</td>
<td>Normal 5 or 6 combined with abnormal 1, 2, 3, or 4</td>
</tr>
</tbody>
</table>
SOT: normal

Name: makishima, tomoko
ID: AT1000005
Date of Birth: 4/27/1967
Height: 5'4"

Diagnosis: Norms
Operator: makishima, tomoko
Referral Source: Not Specified

File: FD5.DRX
Date: 2/4/2013
Time: 9:43:05

Sensory Organization Test
(Sway Referenced Gain: 1.0)

Equilibrium Score

Sensory Analysis

Strategy Analysis

Center of gravity
SOT: bad balance

Data Range Note: NeuroCom Data Range: 20-59
Post Test Comment: needed support for sot3-6
SOT: anxiety
SOT: malingering?
VEMP

- Electromyogenic response from sternocleidomastoid muscle in response to sound
- Saccular response
- Tulio’s phenomenon
- Lower threshold with superior semicircular canal dehiscence syndrome or third window
cVEMP

Sound → Vestibular nerve → Vestibular nuclear complex → Nucleus ambiguus → Spinal accessory nerve

Vestibulo-colic reflex pathway

Ipsilateral
Contra-lateral
VEMP

- Short-latency myogenic response which is evoked by brief pulses of air-conducted (AC) sound, bone-conducted (BC) vibration or electrical stimulation and recorded using surface electrodes placed over muscles.
VEMP

• Have become a (ALMOST) standard clinical test of **otolith organ function**.
• Can be recorded from other muscles such as, masseter and extraocular muscles.
• Cervical VEMP (cVEMP) and ocular VEMP (oVEMP) are used the most.
Third window? Superior SCCD?

Female in 60s
Dizziness for 2 years
Fistula test positive in right ear

Threshold
Right : 80dB
Left: 95dB
Dizziness Handicap Inventory

- Self-assessment to evaluate self perceived handicap imposed by dizziness
- 25 items
- Functional (9 questions, 36 points), Emotional (9 questions, 36 points), Physical (7 questions, 28 points)
- Maximum score of 100, higher the score, the greater the handicap by dizziness (mild: 0-30, moderate: 31-60, severe: 61-100)
- Answers are graded 0 (no), 2 (sometimes), 4 (yes)
- Most used questionnaire on dizziness
- Translated into >10 languages

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1. Does looking up increase your problem?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>P2. Because of your problem, do you feel frustrated?</td>
<td></td>
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<tr>
<td>F3. Because of your problem, do you restrict your travel for business or recreation?</td>
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<tr>
<td>P4. Does walking down the aisle of a supermarket increase your problems?</td>
<td></td>
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<tr>
<td>P5. Because of your problem, do you have difficulty getting into or out of bed?</td>
<td></td>
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<tr>
<td>F6. Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties?</td>
<td></td>
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</tr>
<tr>
<td>P7. Because of your problem, do you have difficulty reading?</td>
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<tr>
<td>P8. Does performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase your problems?</td>
<td></td>
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<tr>
<td>E9. Because of your problem, are you afraid to leave your home without having someone accompany you?</td>
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<tr>
<td>E10. Because of your problem have you been embarrassed in front of others?</td>
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<tr>
<td>P11. Do quick movements of your head increase your problem?</td>
<td></td>
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<tr>
<td>F12. Because of your problem, do you avoid heights?</td>
<td></td>
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<tr>
<td>P13. Does turning over in bed increase your problem?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Options</td>
<td></td>
<td></td>
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<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F14. Because of your problem, is it difficult for you to do strenuous homework or yard work?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E15. Because of your problem, are you afraid people may think you are intoxicated?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F16. Because of your problem, is it difficult for you to go for a walk by yourself?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P17. Does walking down a sidewalk increase your problem?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E18. Because of your problem, is it difficult for you to concentrate</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F19. Because of your problem, is it difficult for you to walk around your house in the dark?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E20. Because of your problem, are you afraid to stay home alone?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E21. Because of your problem, do you feel handicapped?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E22. Has the problem placed stress on your relationships with members of your family or friends?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E23. Because of your problem, are you depressed?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F24. Does your problem interfere with your job or household responsibilities?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P25. Does bending over increase your problem?</td>
<td>Yes, Sometimes, No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Testing precautions

- Avoid drugs which affect test performance: tranquilizers, sedatives, vestibular suppressants, alcohol, caffeine
- No food intake 4 hrs before test
- Have driver for patient (in case pt becomes sick)
Limitations

- Patient able to follow commands
- Cerumen impaction, middle ear disease, TM perforation
- Drugs
- Blindness, severe hearing loss
- Old age
- Neck pain, back pain
- Overweight
CPT code, etc

**Billing?**

- Interpretation
- Procedure
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>92540</td>
<td>Basic vestibular evaluation, includes spontaneous nystagmus test with eccentric gaze fixation nystagmus, with recording, positional nystagmus test, minimum of 4 positions, with recording, optokinetic nystagmus test, bidirectional foveal and peripheral stimulation, with recording, and oscillating tracking test, with recording</td>
<td>This bundled code is used to bill for codes 92545, 92542, 92544, and 92545 when they are performed on the same patient on the same date of service. 92543 is not included in this bundle and should still be billed separately with the appropriate number of units to reflect the number of irrigations performed.</td>
</tr>
<tr>
<td>92541</td>
<td>Spontaneous nystagmus test, including gaze and fixation nystagmus, with recording</td>
<td>Spontaneous nystagmus portion of the common ENG/VNG test protocol; if billed with either 92542, 92544 and/or 92545 (two or three of the 92540 codes) add -59 modifier</td>
</tr>
<tr>
<td>92542</td>
<td>Positional nystagmus test, minimum of 4 positions, with recording</td>
<td>Positional portion of the common ENG/VNG test protocol, including all positions and the Hallpike maneuver; If billed with either 92541, 92544 and/or 92545 (two or three of the 92540 codes) add -59 modifier</td>
</tr>
<tr>
<td>92543</td>
<td>Caloric vestibular test, each irrigation (binaural, bilateral stimulation constitutes four tests), with recording</td>
<td>Caloric portion of the common ENG/VNG test protocol, including warm, cool, and ice water irrigations; can submit this code for multiple units (1-6)</td>
</tr>
<tr>
<td>92544</td>
<td>Optokinetic nystagmus test, bidirectional, foveal or peripheral stimulation, with recording</td>
<td>Optokinetic portion of the common ENG/VNG test protocol; if billed with either 92541, 92542 and/or 92545 (two or three of the 92540 codes) add -59 modifier</td>
</tr>
<tr>
<td>92545</td>
<td>Oscillating tracking test, with recording</td>
<td>Tracking portion of the common ENG/VNG test protocol; if billed with either 92541, 92542 and/or 92544 (two or three of the 92540 codes) add -59 modifier</td>
</tr>
<tr>
<td>92546</td>
<td>Sinusoidal vertical axis rotational testing</td>
<td>Rotation chair testing; requires special equipment; commonly used to verify bilateral caloric weaknesses; supply documentation supporting medical necessity if claim denied</td>
</tr>
<tr>
<td>92547</td>
<td>Use of vertical electrodes (List separately in addition to code for primary procedure) (Use 92547 in conjunction with codes 92541-92546) (For unlisted vestibular tests, use 92700)</td>
<td>This is an add-on code; it can be added to codes 92540, 92541, 92542, 92543, 92544, 92454, and 92546 if vertical electrodes are used and add diagnostic value to the procedure. This code is inappropriate for use as part of a VNG test battery when billing Medicare (except in Florida)</td>
</tr>
<tr>
<td>92548</td>
<td>Computerized dynamic posturography</td>
<td>Requires special equipment; commonly used for malingerers or as part of a vestibular rehabilitation program; supply documentation supporting medical necessity if claim denied</td>
</tr>
</tbody>
</table>

VEMP: 92700 unlisted otorhinolaryngological service or procedure
Billing example (not UTMB)

<table>
<thead>
<tr>
<th>Diagnostic Testing Procedures</th>
<th>Physical Therapy Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>92541 Spontaneous nystagmus test</td>
<td>PT Evaluation Only: $80</td>
</tr>
<tr>
<td>92542 Positional nystagmus test</td>
<td>Epley Maneuver – Omniax Chair: $250</td>
</tr>
<tr>
<td>92543 Caloric vestibular test</td>
<td>Epley Maneuver – Manual Epley: $45</td>
</tr>
<tr>
<td>92544 Optokinetic nystagmus test</td>
<td>PT Re-Evaluation: $45</td>
</tr>
<tr>
<td>92545 Oscillating tracking test</td>
<td>PT Re-Evaluation with Computerized Dynamic Pos</td>
</tr>
<tr>
<td>92546 Sinusoidal vertical axis rotational testing</td>
<td>Therapy Exercises (Balance or Orthopaedic): $66 p</td>
</tr>
<tr>
<td>92547 Vertical electrodes</td>
<td>Each Near Infrared (NIR) treatment is $13.50/hr</td>
</tr>
<tr>
<td>92548 Computerized Dynamic Posturography</td>
<td></td>
</tr>
<tr>
<td>92557 Comprehensive hearing evaluation</td>
<td></td>
</tr>
<tr>
<td>92567 Tympanometry (impedance testing)</td>
<td></td>
</tr>
<tr>
<td>VEMP Vestibular evoked myogenic potential</td>
<td></td>
</tr>
<tr>
<td>97750 Dynamic Visual Acuity Test (DVA)</td>
<td>CDP Testing: $110</td>
</tr>
<tr>
<td>97750 Gaze Stability Test (GST)</td>
<td>VNG &amp; CDP testing: $215</td>
</tr>
<tr>
<td>97750 Limits of Stability Test (LOS)</td>
<td>VNG or Calorics, CDP: $280</td>
</tr>
<tr>
<td>97750 Rhythmic Weight Shifting Test (RWS)</td>
<td>VNG or Calorics, CDP, Epley: $325</td>
</tr>
<tr>
<td></td>
<td>Caloric Testing only: $70</td>
</tr>
</tbody>
</table>
Tests by anatomic area

- Lateral SCC: caloric test, rotary chair
- Saccule: VEMP

**Vestibule**
- Semicircular canals, crista ampullaris – Angular acceleration
- Otolith organs (saccule, utricle) – Linear acceleration
In clinic

- Frenzel goggles
- Gaze, position, positioning
- Dix-Hallpike
- Fukuda test
- Romberg test (eye closed, 6 seconds)
- Gait (tandem, regular gait)
- Orthostatic hypotension
- Finger to nose test
<table>
<thead>
<tr>
<th>Disorder</th>
<th>VNG</th>
<th>Rotary chair</th>
<th>posturography</th>
<th>VEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meniere’s disease</td>
<td>Reduced/absent caloric response</td>
<td>Decreased gain/phase</td>
<td>normal</td>
<td>Variable</td>
</tr>
<tr>
<td>BPPV</td>
<td>Dix-Hallpike positive</td>
<td>normal</td>
<td>normal</td>
<td>normal</td>
</tr>
<tr>
<td>Central cause</td>
<td>Normal caloric Fixation suppression, saccades, pursuit abnormal, increased gain</td>
<td>Symmetric phase lead</td>
<td>variable</td>
<td>Prolonged latency</td>
</tr>
<tr>
<td>Bilateral ototoxicity</td>
<td>Absent caloric response</td>
<td>Reduced gain</td>
<td>Vestibular defect pattern (fail5,6)</td>
<td>variable</td>
</tr>
</tbody>
</table>