Neuro-otology Testing

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Neuro-otology testing

• Diagnostic.
  • Assess the function of the inner ear and central signs.
    - Hearing, balance and CN8.
    - Localise.
    - Oculomotor function.
    - Diagnose specific conditions.
Neuro-otology testing

- Rehabilitation.
  - Confirm/localise a vestibular cause.
  - Measure changes in function over time.
What do we do?

- Detailed History
- Neuro-otological function testing
- Particle repositioning maneuvers (as indicated)
- Feedback, Counseling, Report
Balance function test

• Most tests measure the output of the vestibular system
  • VOR & VSR
• Recorded at rest
• Recorded in response to vestibular stimulation.
Semi-circular canal (SCC)

- Horizontal SCC assessed by
  - Caloric
  - vHIT
  - Rotational chair.
- Recording the VOR.

- Anterior and Posterior SCC assessed by
  - vHIT LARPs and RAPLs
Caloric

- Bi-thermal stimulus
- Convection current in HSCC
- VOR
Caloric analysis

Unilateral Weakness (UW)
- Compares left and right \textbf{EAR} responses.
- UW greater than 25\% abnormal.

Directional Preponderance (DP)
- Compares left and right \textbf{BEATING nystagmus}
- DP greater than 30\% abnormal.

Localizing finding H SCC function/superior vestibular nerve

May indicate central compensation status. Non localizing finding in isolation.
Normal caloric results

- UW = 10%
- DP = 1%

Normal HSCC function bilaterally.
Abnormal caloric results

Unilateral right HSCC dysfunction.

- UW = 60%
- DP = 28%
Abnormal caloric results

Bilateral HSCC dysfunction.
Advantages & disadvantages of calorics

- Localizing information about HSCC function
- Compensation
- Peripheral and central indicators

- Variable results
- Subject to problems with temperature transference (e.g., ME pathology) & non-physiologic response
- Impacted by poor response state
- Spontaneous nystagmus
- Impacted by some medications.
Video head impulse test (vHIT)

High velocity head movements

Activation of unilateral SCC

VOR
Normal vHIT bilaterally

Blue trace = left head movement.
Red trace = red head movement.
Grey traces = eye movements in response to head movement.
Abnormal vHIT

Unilateral left HSCC dysfunction.

Catch up saccades
Bilateral abnormal vHIT

Bilateral HSCC dysfunction.
Advantages & disadvantages of vHIT

- Localising information about SCC function
- High frequency
- Able to assess all 6 SCCs.
- Can assess visual vestibular interaction
- Monitor a patient’s vestibular function over time
- Not impacted by response state

- No measure of central compensation
- Unable to performed with cervical restrictions
Rotational chair - SHA

Sinusoidal motion

HSCC activation

VOR

The Royal Victorian Eye and Ear Hospital
Gain
• Ratio of head to eye movement. A peripheral HSCC vestibulopathy causes a reduction in gain.

Phase
• Timing between head and eye movement.

Symmetry
• Comparison between the eye velocities with rotation to the right compared to the left. An asymmetry suggests an uncompensated peripheral lesion.
Normal SHA

VOR Summary

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<tr>
<th>Gain</th>
<th>Asymmetry</th>
<th>Phase</th>
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The Royal Victorian Eye and Ear Hospital
Abnormal SHA

HSCC hypofunction with evidence of compensation.
Abnormal SHA

HSCC hypofunction with the lesion is not fully compensated.
Abnormal SHA

Consistent with a bilateral vestibulopathy.
Rotational chair – Step Velocity

1. Acceleration and deceleration
2. HSCC activation
3. VOR

The Royal Victorian Eye and Ear Hospital
**Time constants**

- The rotational chair accelerated (100 degrees/second) in a clockwise direction and then the movement stops (decelerates) simulating anticlockwise head movement. This is then reversed with an anticlockwise rotation and deceleration.
- The resultant VOR is measured and provides information about the horizontal semicircular canal function.
- The vestibular-ocular reflex is initiated by the initial acceleration and then decays over time. The amount of decay is measured and called a “time constant.”
  - Time constants less than 10 secs consistent with HSCC hypofunction.
  - Time constants greater than 30 secs consistent with a possible central pathology.
Normal step velocity

CW 17

CW Step 19

CCW 21

CCW stop 23
Abnormal step velocity

CW 11

CW Step 5

CCW 5

CCW stop 13
Advantages & disadvantages of rotational chair testing

- Measure of central/peripheral vestibular dys/function
  - Mid frequency (0.01 - 0.64Hz) HSCC function
  - May provide a measure of central compensation (for UW).
  - May confirm bilateral HSCC dysfunction
  - Can assess visual vestibular interaction
  - Monitor a patient’s vestibular function over time

- Does not provide localising (side specific) information
  - Small unilateral HSCC dysfunction may not be detected
  - Affected by response state and some medications
  - Similar results may be seen in central and peripheral pathologies
Otolith function

- Saccular function/inferior vestibular nerve
  - cVEMPs
- Utricle function/superior vestibular nerve
  - oVEMPs
cVEMPs

- Air conduction stimuli
- Vestibulo-cervical reflex
- Ipsilateral relaxation of SCM
Normal cVEMP bilaterally

Consistent with normal saccular function bilaterally.

Left interamplitude 135.22
Right interamplitude 147.89
Abnormal cVEMP

Consistent with a right saccular impairment.

Left interamplitude 135.22
Right interamplitude 33.43
Bilateral abnormal cVEMP

Consistent with a bilateral saccular pathology.
Advantages & disadvantages of cVEMP

- Information about saccule/inferior vestibular nerve function (localising information)
- Indication of SSCD
- Assist with the diagnosis of vestibular neuronitis.

- Requires adequate SCM contraction (difficult for the elderly and those with neck problems)
- Inconclusive with conductive hearing losses
- Does not provide a measure of central compensation
oVEMPs

- Vibratory stimuli
- Vestibular-ocular reflex
- Contralateral inferior oblique muscles
Bilateral normal oVEMPs

Consistent with normal utricle function bilaterally.

Left interamplitude: 5.75
Right interamplitude: 4.88
Unilateral abnormal oVEMP

Consistent with a right utricle impairment.

Left interamplitude: 6.99
Right interamplitude: 0
Inconclusive oVEMPs
## Advantages & disadvantages of oVEMP

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Information about otoliths/superior vestibular nerve function (localising)</td>
<td>Absent oVEMP in isolation are inconclusive</td>
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<td>Does not provide a measure of central compensation</td>
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<td>Contraindicated in recent retinal detachments and skull fractures</td>
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Summary

• Balance and hearing testing is used for diagnostic purposes.
• The battery of tests is interpreted in combination to provide diagnostic information.
• Balance function testing records the ‘output’ of the vestibular reflexes in response to vestibular stimulation
  – Localizing information
  – May find signs of central disorders
  – Objective measure of central compensation.
Referring for audiological care

• N.O. tests at RVEEH are Medicare funded and therefore referrals accepted from any medical source, except an ED.

• Provide sufficient referral information to allow for triage. The Hospital’s referral guidelines can be found at https://www.eyeandear.org.au/page/Health_Professionals/Referring_to_the_Eye_and_Ear/Referrals/

• List of Audiology providers in community: http://audiology.asn.au/index.cfm/consumers/audiology-services-directories/
  • Note: fees vary.
  • There is no list of Neuro-otology centres.