Emerging Vestibular Function Tests

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There a lot to dizziness beyond the ear

- Inputs – ears, eyes, somatosensation, internal models
- Integration – CNS
  - Sensory gain and timing
  - Integration of sensory input
  - Cognitive contribution
- Output – eyes, posture, spatial orientation

Technology driving the current advances

- Response triggered averaging (cheap computers)
  - VEMPs (otoliths and central)
    - Limb VEMPs
  - Also (not covered today)
    - Ocular and various other muscle VEMP’s
    - Sound induced vestibular responses (response triggered Tullio’s).
    - Etc.

Limb VEMP’s

- If saccule activation produces an evoked myogenic potential in neck, shouldn’t it also produce one in the limbs?
- Reasons for looking into limb VEMP’s
  - Sometimes SCM VEMP’s can’t be done (neck pain, weak neck).
  - Pathways to the limbs must traverse cervical and lumbar spinal cords – potential for diagnosis of cord lesions

VEMP reflex arc including limbs
Leg VEMP

- Using a similar methodology to SCM, we have obtained VEMP’s in gastrocnemius.
- Main differences:
  - Longer latency
  - Weaker response (about 1/3 of SCM)
  - Crossed and uncrossed components very different


Leg VEMP method

- Electrodes on Gastroc
- Stand on toes to activate muscle
- Head forward (not turned to L or R)
- 500 clicks (more than 128 used for SCM)

Gastroc VEMP

- Amplitudes are smaller (roughly 50 compared to 150)

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<th>Ipsilateral P1 (μV)</th>
<th>Ipsilateral P2 (μV)</th>
<th>Ipsilateral P3 (μV)</th>
<th>Ipsilateral Median (μV)</th>
<th>Ipsilateral Std. Error of Mean (μV)</th>
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<td>50.58 – 70.38</td>
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Latencies are Longer

- Ipsilateral and Contralateral Mean Latencies

Somewhat erratic presence
P2 best - - about 80%

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Leg VEMPs - overall

- Not a good choice as a clinical test
  - They take too long (100 sec)
  - Have to stand on tiptoes
  - Small (only 50 uv)
  - Not reliable – only 80% of normals
- Needs more work
  - Galvanic responses ipsi vs contra depend strongly on head position on neck. Not sure what happens with sound responses

Triceps VEMP method

- Electrodes on Triceps
- Activate Triceps
- Head forward (not turned to L or R)
- 500 clicks (more than 128 used for SCM)

Triceps VEMP when supporting body weight

Have to support ones weight (nothing here where not supporting ones own weight)

Triceps VEMPs scale with force (10, 15, 20 lbs)

Latency about 35 msec
Amplitude about 80-90 uv
Both ipsi and contra
Limb VEMP -- Overall

- Emerging vestibular test
- Saccule input, limbs output
- Certainly relevant to spinal cord function
- Possibly relevant to cervical vertigo (more coming later)

Technology driving advances

- Video Frenzel goggles (tiny cameras on top of eyes)
  - Neck Vibration
  - Cervical vertigo tests
- Other emerging or improved tests – (not covered today)
  - Rebound nystagmus (without fixation)
  - Head-shaking nystagmus
  - Hyperventilation induced nystagmus
  - Valsalva Testing (for SCD)

Video Frenzels

- Simple but effective new technology
- Allows one rapidly to elicit nystagmus without fixation
- Examiner can judge whether nystagmus is significant, and easily see torsion – often better than ENG

Vibration test

- Method: Apply 60-120 hz vibration to SCM, first one side, then the other. Shower massagers work well for this and are inexpensive.
- Video frenzel goggles – optical frenzels don’t work very well
- Compare nystagmus before and during

Vibration Induced Nystagmus

- Neck Vibration
- Menier's Disease
- Gentamicin to R Side
Vibration Induced Nystagmus

- Unidirectional horizontal nystagmus strongly suggests contralateral vestibular lesion.


Mechanisms of VIN

- Direct generation by the neck (“cervical nystagmus”), perhaps through proprioceptors
- Generation from the inner ear itself
- Interaction between the neck and central vestibular processing (“neck fixation”).

Cervical Vertigo

- Vertigo caused or influenced by NECK movement, rather than inner ear movement
- Classic explanations
  - Vertebrobasilar compression
  - Neck afferents
  - New – Vestibulo-spinal tract impingement in neck?

Classic tests for Cervical Vertigo

- Torsion test –
  - Upright move body under still head
    • Assesses COR
    • Implausible test and no data that it works
  - Supine - dissociate body from head
    • On bloc vs. head turned on neck
    • Difficult to interpret because combines supine position with neck torsion, and history effects.

Newer tests for Cervical Vertigo made possible by video-frenzel

- Compare prone to supine positional
- Simply observe for nystagmus with head turned (upright) – also called “VAT”.

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Method of testing for cervical vertigo with video-Frenzel goggles

Using this methodology, weak cervical nystagmus is common – especially so in people with herniated cervical disks.

Mechanisms for Cervical Nystagmus?
- Neck afferents
- Vascular compression of vertebrae
- Spinal cord – spino-vestibular pathways in cervical cord

Exciting times for Vestibular Testing
- Inexpensive computers allow response triggered averaging of nearly anything
- Inexpensive devices allow highly sensitive recordings of nystagmus
- Nevertheless, we have a long way to go! The inner ears are just a little piece of the puzzle.