Evaluation & Management of Vestibular Disorders

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Overview

• **History and Symptoms**

• **Diagnostic Battery**
  – Vestibulo-ocular Reflex (____)
  – Vestibulo-spinal Reflex (____)
  – Vestibulo-collic Reflex (____)

• **Clinical Pathways**

• **Case Studies**
Clinical Pathway: Assessment

Hx

Sx

Dx
Testing

Dx
Results

Positive

Negative

Tests may include:

- Audiometry
- Dynamic Visual Acuity Tests (DVAT)
- Postural Stability Tests (PST)
- Rotational Tests (RT)
- Subjective Measures (DHI)
- Vestibular Evoked Myogenic Potential (cVEMP)
- Videonystagmography (VNG)

- Triage of findings and Rx to physician and/or patient

VRT EVAL & Tx

Measure Outcomes

Medical Tx (VRT Post-Tx if applicable)

Triage of findings and Rx to physician and/or patient
Case History

Acute
- Duration
- Frequency
- Precipitating
- Auditory
- Vertigo
- Dizziness
- Visual
- Headache
- Balance
- Speech
- Nausea

Chronic
- Days
- Weeks
- Months
- Constant or episodic
- Sx
  - Balance
  - Dizziness
  - Auditory
  - Nausea

- Otologic
- Trauma
- Migraine
- Motion Sensitivity
- Vascular
- Metabolic
- Neurologic
- Diabetes
- Stroke
Vestibulo-ocular Reflex (VOR)

Purpose: Maintain _____ on visual target during head motion
VOR

Active head movement

_______ Hz

Normal function

Gain _____

Phase _____ deg
Common Symptoms of Impaired VOR

- Trouble reading or focusing with head motion, i.e.

- May be provoked with specific direction or plane of movement

- Trouble reading signs when walking

- Side to side head turns i.e. sitting at a 4-way stop or shopping at the grocery store

- BVD may be so severe, gum chewing or eating while watching T.V.
Vestibulo-spinal Reflex (VSR)

Sends descending motor control signal to musculoskeletal system for _________ control

A response to sensory information is sent to the musculoskeletal system to maintain our center of gravity.
Common Symptoms of Impaired VSR

- Unsteadiness
- History of Falls
- Visual Preference
- Surface Dependence
  - Difficulty on dynamic or uneven surfaces
Vestibulocollic Reflex (VCR)

Acts on the muscles in the neck to stabilize the head. The head responds to movement sensed by the otolith or SCC organs.

From Halmagyi & Curthoys, In Herdman
The vestibulocollic reflex (VCR) has been well studied in animals and humans.

The benefit of measuring ______ is there are no other vestibular function tests, which provide information about the saccule, inferior branch of the vestibular nerve or lower brainstem.

The ______ is a myogenic recording from the large SCM muscle. It is easy to produce a large response of 200 μV (ABR is only 1 μV).
# cVEMP Responses and Pathology

<table>
<thead>
<tr>
<th>Pathology</th>
<th>VEMP Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Otologic</strong></td>
<td></td>
</tr>
<tr>
<td>Meniere’s Disease</td>
<td>X</td>
</tr>
<tr>
<td>Superior Canal Dehiscence Syndrome</td>
<td></td>
</tr>
<tr>
<td>Neurolabyrinthitis</td>
<td>X</td>
</tr>
<tr>
<td>Vestibular Neuritis</td>
<td>X</td>
</tr>
<tr>
<td><strong>Neurologic</strong></td>
<td></td>
</tr>
<tr>
<td>Migraine</td>
<td>X</td>
</tr>
<tr>
<td>Spinocerebellar Degeneration</td>
<td>X</td>
</tr>
<tr>
<td>Multiple Sclerosis</td>
<td>X</td>
</tr>
<tr>
<td>Brainstem Stroke</td>
<td>X</td>
</tr>
</tbody>
</table>

cVEMP Summary

- It is a fast, simple, non-invasive test
- Reimbursable
- Requires only typical ABR unit
- Provides unique diagnostic information about the saccule, inferior portion of the vestibular nerve, and lower brainstem
- Unaffected by cochlear hearing loss
Selecting Tests and Integrating Results
<table>
<thead>
<tr>
<th>Tests</th>
<th>Sensitivity</th>
<th>Description</th>
<th>Triage</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNG</td>
<td>• Ear • Neuro</td>
<td>• Oculomotor • Status of condition • BPPV • Isolate deficient end organ</td>
<td>• Medical • VRT/Balance • Reposition</td>
</tr>
<tr>
<td>RT (Active)</td>
<td>• Ear • Neuro</td>
<td>• Active rotation “real-life” frequency of head movement</td>
<td>• Medical • VRT/Balance</td>
</tr>
<tr>
<td>RT (Passive)</td>
<td>• Ear • Neuro</td>
<td>• Passive rotation – low frequency • Physiologic stimulus</td>
<td>• Medical • VRT/Balance</td>
</tr>
<tr>
<td>Tests</td>
<td>Sensitivity</td>
<td>Description</td>
<td>Triage</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>DVAT</td>
<td>• Ear (UVD) • Ear (BVD)</td>
<td>• Identify oscillopsia (VOR functional impairment)</td>
<td>• VRT/Balance</td>
</tr>
<tr>
<td>PST</td>
<td>• Ear • Neuro • Multifactorial</td>
<td>• Pattern of performance on Romberg, CTSIB &amp; Fukuda provides a qualitative profile of possible vestibular and non-vestibular dysfunction</td>
<td>• Medical • VRT/Balance</td>
</tr>
<tr>
<td>cVEMP</td>
<td>• Ear • Neuro</td>
<td>• Evaluates portions of peripheral &amp; central vestibular system unavailable with other methods</td>
<td>• Medical • VRT/Balance</td>
</tr>
</tbody>
</table>
Functional Impact & Prognosis

- BPPV
  - High Freq
  - Partial
  - Total
- UVD
  - Partial
  - Total
- BVD
  - Partial
  - Total
- Multifactorial

Prognosis:
- Excellent
- Poor
Non-medical Vestibular Treatment Options

- **BPPV**
  - Repositioning
    - Appiani
    - Canalith
    - Casani
    - Gans
    - Semont

- **UVD/BVD**
  - Vestibular Rehabilitation
    - Adaptation
    - Habituation
    - Substitution

- **Multifactorial**
  - Balance
    - Strengthening
    - Conditioning
    - Fall Prevention
    - ADLs
Clinical Pathway: Treatment

**Treatment Options**

- **BPPV**
  - PC
  - AC
  - HC

- **UVD**
  - Without Dysequilibrium
    - can
    - cup
    - SLM
    - GRM
  - With Dysequilibrium
    - can
    - cup
    - Appiani
    - Casani

- **BVD**
  - Balance Retraining
  - Substitution
  - Fall Prevention
  - Strengthening
  - Activities of Daily Living

**Adaptation**
- Habituation

**CRM**

**BBQ Roll**
Case Studies Utilizing Integrated Clinical Pathways
Clinical Pathway: UVD

**Hx:**
- 60 y.o. Male
- Two attacks of Vertigo, Nausea, & Emesis
- No Auditory Sx
- MRI, CT Scan, & Carotid ultrasound Unremarkable
- BP Normal

**Sx:**
- Oscillopsia
- Balance Problems during ambulation
- Hallucination of Motion with head movement
- DHI = 52

**Dx:**
- 42% Left UVD
  - Abnormal Gain & asymmetry to Left
  - Degradation from 100% to 56% correct in Horizontal
- Fall on 6 (Vestibular)
  - Reduced amplitude on Left
  - Dx: Vestibular Neuritis with total vestibular nerve involvement on left. CDVAT and SOP results suggest patient is uncompensated

- VOR
- VNG
- VAT
- CDVAT

- VSR
- SOP

- VCR
cVEMP

- VRT
  ____________
  ____________
  ____________
SOP Results

CDVAT Results
VEMP Results

Left Ear

Right Ear
Outcome

- **Dynamic Gait Index:** 24 out of 24
- **Dizziness Handicap Inventory** 0 out of 100

Post-treatment CDVAT

![Graph showing outcomes](image)
Clinical Pathway: UVD

**Hx:**
- 40 y.o. Male
- Attack of Vertigo, Nausea, & Emesis
- No Auditory Sx
- MRI, CT Scan, & Carotid ultrasound Unremarkable
- BP Normal

**Sx:**
- Visual provocation
- Exacerbation while driving
- Clear-headed in a.m.
- Difficulty walking
- DHI = 72

**Dx:**
- Sway on 6 (Vestibular)
- VOR
- VNG
- VAT
- CDVAT
- 76% Left UVD
- RBN post-HFHS
- Abnormal Gain, Phase & asymmetry to Left
- Degradation from 100% to 28% correct in Horizontal

**Dx:** Vestibular Neuritis with superior branch involvement on left. CDVAT and SOP results suggest patient is uncompensated

**Self-Directed VRT**
Seated, Horizontal HFHS
## Left Lateral HFHS

### Exam Details

- **Date:** 11/9/04
- **Examiner:** Melanie Kirch

### Nystagmus Direction

<table>
<thead>
<tr>
<th>Direction</th>
<th>avg. SPV</th>
<th>max. SPV</th>
<th>Beats/s</th>
<th>Beats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>35.7°/s</td>
<td>61.4°/s</td>
<td>0.1/s</td>
<td>3</td>
</tr>
<tr>
<td>Right</td>
<td>6.1°/s</td>
<td>18.2°/s</td>
<td>0.3/s</td>
<td>12</td>
</tr>
<tr>
<td>Upwards</td>
<td>20.0°/s</td>
<td>24.3°/s</td>
<td>0.0/s</td>
<td>2</td>
</tr>
<tr>
<td>Downwards</td>
<td>15.5°/s</td>
<td>22.7°/s</td>
<td>0.0/s</td>
<td>2</td>
</tr>
</tbody>
</table>

### Horizontal Eye Position (°)

- **Horizontal SPV:** [Graph]

### Vertical Eye Position (°)

- **Vertical SPV:** [Graph]

### Pupil Diameter (Pixel)

- [Graph]

### Additional Notes

- Random saccades
- Smooth Pursuit
- OKP
- Gaze wo Vision
- High freq head shak
- Positional wo vision
- Caloric
- Spontaneous Nystagmus
- Spontaneous Nystagmus
SOP Results

SUMMARY OF ELECTROPHYSIOLOGICAL STUDIES

Gans Sensory Organization Performance Test ®:

Key:
N = Normal
S = Sway
F = Fall
R = Right
L = Left

CDVAT Results

DVA-GRAM W/O MOVEMENT

# Correct

Vertical # Correct

Horizontal # Correct

Total 96 %   V:Total 90 %   H:Total 80 %
VEMP Results

Normal P13-N23 waveform complexes with stimulation to both ears
Self-Directed Treatment Program

Provides patients with home-based program.

1. Ideal for High Frequency UVDs without acute symptoms or imbalance.
2. Minimizes disruption of work or home lifestyle.
3. Cost effective, no need for third party involvement.
4. Requires motivated patient willing to perform protocols 2-3 times per day for thirty-ninety days.
5. Treatment efficacy as successful as clinician-directed.
Adaptation

Saccades

Focusing While Turning Head

Targets

Circle Sways

Habituation

Horizontal Head Movements

Ball Circles

Head Circles

Gait with Head Turns

Post-therapy SOP

Gans Sensory Organization Performance Test

Key:
N = Normal
S = Sway
F = Fall
R = Right
L = Left

CDVAT

DHI = 0
Clinical Pathway: Posterior Canal BPPV

**Hx:**
- 76 y.o. Male
- Postionally-provoked vertigo

**Sx:**
Vertigo with turning to right in bed
Mild Balance Problems worse in a.m.
DHI = 96

**Dx:**
- PC - BPPV on the Right

- **VOR**
- VNG
- **VSR**
- SOP
- **VCR**
- cVEMP

- GRM
  Clear in single treatment
  DHI = 4
Clinical Pathway: SCDS

**Hx:**
- 41 y.o. Male
- 30 lb weight gain over 10 years
- Outbreaks of fever blisters
- Migraine 2x/mo.
- No Auditory Sx

**Sx:**
- Dizziness & disequilibrium provoked by patient’s voice, loud sounds, sneezing and coughing
- Feels as if eyes move during symptoms

**Dx:**
- Vestibular Pattern
- Bilateral SCDS

**VOR**
- Nystagmus during vocalization
- Nystagmus during Reflex Decay (Stim Right)

**VSR**
- Vestibular Pattern

**VCR**
- cVEMP

**CDVAT**
- Thresholds down to 62 dB nHL, bilaterally

**CT Scan**
- Confirmed bilateral SCDS
- Referred to Neurotology

**Rec:**
- High Resolution CT Scan
Clinical Pathway: Multifactorial Patient

**Hx:**
- 72 y.o. Female
- Right CVA 1995
- Arthritis left knee
- HBP
- Bilateral Peripheral Neuropathy
- Unsteadiness

**Sx:**
- Balance Problems
- Decreased Strength
- Transient Positional Vertigo
- VOR
- VNG
- VAT
- CDVAT
- PC-BPPV on Right

**Dx:**
- VSR
- SOP
- cVEMP
- CNS Pattern
- Normal
- Repositioning Maneuver
- Clinician-directed Balance Therapy

**Strengthening**
- Fall Prevention
- ADLs
AIB Testing

- Berg Balance Test
- Tinetti Fall Risk Assessment
- LE strength – LE weakness (Left worse)
- Sensation – neuropathy B LE
- Gait – using 4 wheeled walker
Treatment

- __________ exercises
- Gait training
- Fall Recovery
- Lower Extremity Strengthening
  – in PT & Home Exercise Program
Outcome

MODIFIED CLINICAL TEST FOR SENSORY INTERACTION ON BALANCE (CTSIB)

1. Firm--Eyes Open (FIRM-EO)
   - Trial 1: 0.2
   - Trial 2: 0.3
   - Trial 3: 0.2

2. Firm--Eyes Closed (FIRM-EC)
   - Trial 1: 0.5
   - Trial 2: 0.5
   - Trial 3: 0.6

3. Foam--Eyes Open (FOAM-EO)
   - Trial 1: 0.6
   - Trial 2: 0.5
   - Trial 3: 0.7

4. Foam--Eyes Closed (FOAM-EC)
   - Trial 1: 1.8
   - Trial 2: 1.1
   - Trial 3: 0.9

deg/sec  | Mean COG Sway Velocity
---|---
0.0  | Firm-EO
0.2  | Firm-EC
0.4  | Foam-EO
0.6  | Foam-EC
1.3  | Comp-
0.6  |

Average COG Position:
- o = Firm-EO
- + = Firm-EC
- * = Foam-EO
- x = Foam-EC

Data Range Note: NeuroCom Data Range: 70–79
Post-Test Comments:
Right, 16% LOS @83.5 degree
Summary

• Integration of patient history and symptoms into a _______________ will provide valuable information useful in the triage of diagnostic and treatment protocols.

• Selection of vestibular function tests correlated to the patient’s subjective complaints, i.e., _____ and/or _____ will provide the greatest sensitivity and specificity.

• Application of “________________” will improve efficiency and efficacy of treatment.

• Use of ______________ will provide validation of treatment efficacy, improved function and ______________.
**Patient Hx & Sx**
- 40 year old female
- Blurred vision with ambulation
- Disequilibrium, worse on dynamic surfaces & darkened environments
- No auditory symptoms
- No vertigo
- IV Antibiotics during recent hospitalization
- MRI Unremarkable

**Dx Testing**
- Audio
- DHI
- DVAT
- PST
- RT
- VNG
- cVEMP

**Dx Results**
- Audio - Normal
- DHI - 72
- DVAT - Degradation with Head Movement
- PST - Vestibular Loss Pattern
- RT - Abnormal
- VNG - Bilaterally Absent Calorics
- cVEMP - Absent Bilaterally

**What is the plan?**
- Activities of Daily Living
- Balance Retraining Therapy
- Canalith Repositioning Maneuver
- Fall Prevention
- Low Sodium diet
- Meclizine
- Strengthening & Conditioning
- Transtympanic Gentamicin
- Vestibular Rehabilitation Therapy
- Adaptation
- Habituation
- Substitution

**What outcome measures?**
- Calorics
- DHI
- DVAT
- PST
- RT
- cVEMP

**What is the likely diagnosis?**
- Acoustic Neuroma
- Autoimmune Inner Ear Disease
- BPPV
- Labyrinthitis
- Meneire’s disease
- Migraine
- Multifactorial Disequilibrium
- Perilymphatic Fistula
- Superior Canal Dehiscence
- Vestibular Neuritis
- Vestibulotoxicity