Examination of Visual and Vestibular Function in the Home Health Setting

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Examination of Visual and Vestibular Function in the Home Health Setting

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Objectives

• By the end of this session, the participant will be able to:
  • Discuss the physiology and pathophysiology of vestibular and visual function
  • Perform vestibular and visual assessment tools appropriate for the home
  • Differentiate visual signs and symptoms requiring referral for additional assessment
  • Differentiate vestibular signs and symptoms requiring referral for additional assessment

Anatomy and Physiology Review

Peripheral Vestibular System

Membranous Labyrinth
Orientation of Semicircular Canals

Anatomy of Semicircular Canal

Push – Pull Mechanism

Summary of important concepts

- Semicircular Canals
  - Respond to angular acceleration
  - Have a spontaneous firing rate
  - The canals are excited by movement in their plane
  - Are arranged in a push-pull system

Otoliths

Anatomy of Otoliths
**Otoliths**

- Otoliths respond to linear acceleration and gravity.
- Have a spontaneous firing rate.
- The otoliths are excited by movement within the plane of macula.
- Push-pull relationship within each otolith organ.

**Vascular Supply**

- Peripheral vestibular system supplied by labyrinthine artery (usually branch of anterior inferior cerebellar artery).
- Labyrinth has no collateral anastomotic network.
- At risk for ischemic and embolic events.

**Central and Peripheral Vestibular Pathways**

**Central and Peripheral Vestibular Pathways**

- Ocular Motor Nuclei (VOR Reflex)
- Vestibular Nuclei
- Vestibulospinal Reflexes (MVST and LVST)
- Cervical Proprioceptors
- Thalamus
- Cerebellum
- ANS (parasympathetic) Nausea/Vomiting
- Cerebral Cortex
- Vestibular Ocular Reflex

**Summary of Important Concepts**

- Otoliths respond to linear acceleration and gravity.
- Otoliths have a spontaneous firing rate.
- Otoliths are excited by movement within the plane of macula.
- There is a push-pull relationship within each otolith organ.

**Vestibular Ocular Reflex**

- Vestibular Ocular Reflex (VOR)
Visual and Vestibular Exam in Home Health
Wrisley and Zirges CSM 2016
Eye Movements

• Require information about
  • Head movements (vestibular information)
  • Visual objects (vision)
  • Eye movement and position (proprioceptive information)
  • Selection of a target (brainstem and cortical areas)

• Types of eye movements
  • Conjugate
  • Vergence
  • Gaze stabilization
  • VOR
  • Optokinetic reflex
  • Direction of gaze
    • Saccades and smooth pursuit

Accommodation Reaction:
  • Convergence of the eyes
  • Pupillary constriction
  • Thickening of the lens

Optokinetic Reflex
  • Adjusts eye position during slow head movements
Visual Testing

Visual Acuity

High- and Low-Contrast Visual Acuity

Melbourne Edge Test

Ocular Motor Function
- Smooth pursuit
- Smooth eye movement tracking a slowly moving discrete target
- Mediated by brainstem eye fields, medial longitudinal fasciculus, and cranial nerves III, IV, and VI
- Abnormalities are seen with cerebellar or brain stem lesions
Ocular Motor Function

- **Saccades**
  - A quick eye movement or refixation
  - Mediated by frontal eye fields (voluntary saccades), brainstem reticular formation (voluntary and involuntary saccades) and cranial nerves III, IV, and VI
  - Abnormalities are seen with cortical, brainstem and cerebellar lesions

- **Optokinetic Nystagmus**
  - Involuntary reflexive refixation eye movements
  - Mediated primarily through motion sensitive neurons in retina

- **Convergence**
  - The ability of the eyes to move symmetrically to look at objects at varying distance from the eyes
  - Mediated by medial rectus neurons
  - Abnormalities are seen with brainstem or basal ganglia lesions

- **Skew Deviation (Cover/Uncover test)**
  - Test for ocular torsion and strabismus
  - Ocular torsion is mediated by otolith function
  - Strabismus is mediated by ocular muscles and central nervous system
  - Ocular torsion may be seen with acute vestibular dysfunction
  - Deviation of the eye may be seen with ocular muscle imbalance or central nervous system lesions

- **VOR Cancellation (Fixation Suppression)**
  - Ask the patient to look at their finger or a target that is moving with them while rotating their head or body from side to side. Note any visual vestibular nystagmus or symptoms of dizziness or nausea
  - Abnormalities in the presence of adequate visual acuity implies floccular dysfunction

Visual Testing Lab

- **Visual Acuity**
- **Visual Contrast Sensitivity**
- **Peripheral Visual Fields**
- **Smooth Pursuit**
- **Saccades**
- **Convergence**
- **Cover/Uncover**
- **Optokinetic Nystagmus**
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Vestibular Testing

Clinical Measures of Vestibular Function

• Spontaneous Nystagmus
  • Look for repetitive fast and slow movements of the eyes in room light with
    and without fixation and/or with fixation suppressing goggles
  • Direction fixed, horizontal-rotary nystagmus is indicative of an acute
    asymmetry in the firing of the labyrinth, VIII cranial nerve or vestibular
    nucleus
  • The nystagmus will intensify with gaze in the direction of the fast phase
  • Direction changing horizontal, vertical, torsional or pendular nystagmus is
    indicative of brain stem, cerebellar or cortical lesions

• Active and Passive VOR
  • Mediated by labyrinth, VII cranial nerve, and vestibular nucleus
  • Active VOR
    • While the patient looks at a target have them move their head horizontally and then
      vertically at about 2 cycles/second. Look for refixation saccades, note reports of
      dizziness or nausea
  • Passive VOR
    • Instruct the patient’s head tilted down approximately 30 degrees, move the patient’s head
      horizontally and vertically at about 2 cycles/second while asking them to focus on your
      face. Look for refixation saccades, note reports of dizziness or nausea
  • Abnormalities are indicative of vestibular dysfunction

• Dynamic Visual Acuity Longridge and Mallinson 1984
  • Performed with a Snellen Eye Chart. The patient reads the lowest line
    comfortably with the head still and then with the head moving at 2 Hz
    horizontally and vertically. The number of lines of acuity lost are recorded.
  • Patients with bilateral vestibular dysfunction will have a loss of >5-6 lines;
    patients with acute unilateral vestibular loss will have a loss of >2-3 lines

• Head Thrust (Head Impulse Test) Schubert et al 2004; Halmagyi and Curthoys 1988
  • 95% specificity, 35% sensitivity for detecting vestibular lesion
  • 82% specificity, 71% sensitivity UVL, 86% sensitivity BVL Schubert et al 2004
  • The patient is asked to fixate on a target while the examiner moves the patients head
    rapidly to each side
  • The examiner looks for any movement of the pupil during the head thrust and a
    refixation saccade

• Head Shake (Postheadshake nystagmus) Burgio et al 1991, Fetter 2000, Tseng and
  Chao 1997
  • The head is tilted forward 30 degrees and the head is shaken at 2 Hz for
    20 seconds. Observe for any postheadshake nystagmus either in room
    light or with fixation suppressing goggles. Can be repeated in vertical
    direction
  • Indicative of acute imbalance in vestibular inputs in the plane of rotation

http://library.med.utah.edu/neurologicexam/movies/cranialnerve_n_13_x2.mov
Clinical Vestibular Evaluation

- Positional Testing
  - Provides an objective score of the patient's dizziness
  - The subject moves into positions that involve head and body movement
  - The patient reports a dizziness intensity score and the duration of the symptoms is recorded.
  - The symptom intensity and the duration values are added to get a score. The MSQ is calculated by multiplying the number of provoking positions by the score and dividing by 2048. 0 = no symptoms; 100 = severe dizziness in all positions
  - The positions can also be used for treatment

Unrecognized BPPV in the Elderly

- 100 consecutive patients referred to geriatric clinic
- Age range was 51-95 (mean 74)
- Dizziness was reported by 61% of the older adults although they were not seeking intervention for dizziness
- Balance disorders were noted in 77% of the patients
- 9% of these subjects had unrecognized BPPV

BPPV in the Elderly

- Retrospective study of 404 patients diagnosed with BPPV
  - Patients over 70 took longer to consult for problem
  - Presentation of unsteadiness, or imbalance without vertigo more common in the elderly
  - Effectiveness of CRM less
  - Higher recurrence rate
- Study of 571 75 year olds
  - BPPV found in 13%
  - Dizziness reported by 36%
  - People with BPPV demonstrated impaired balance and walking tests

BPPV in the Elderly

- Dix-Hallpike Maneuver
  - With the patient in long-sitting, their head is turned 45 degrees toward the ear being tested
  - The patient is brought back into supine with the head extended 30° over the edge of the bed.

Posterior Canal Involvement

- Nystagmus is paroxysmal and ipsilateral torsion and upbeating (quick phase is beating upwards toward the involved ear)

Anterior Canal Involvement

- Nystagmus quick phase is ipsilateral torsion and downbeating (quick phase is beating downward towards the involved ear)
What systems need to be checked before testing for BPPV?

• Clear cervical spine
• Ocular motor function
• Vestibular Ocular Reflex
• Vertebral artery test (?)

The Roll Test

Begin with the patient supine and the head in midline. Tilt the head up 30° in midline

The Roll Test

Roll head quickly to one side, observe for nystagmus, ask patient to report symptoms

Horizontal Canal Nystagmus

Horizontal Canal Involvement:

Nystagmus: Horizontal direction-changing nystagmus directed toward the undermost ear on both sides and more intense when turned toward the affected side. Non-fatiguable with repeated testing

Latency: minimal

Duration: < 1 minute

Horizontal Canal Involvement:

Canalithiasis in posterior arm

Nystagmus: Horizontal direction-changing nystagmus directed toward the undermost ear on both sides and more intense when turned toward the affected side. Non-fatiguable with repeated testing

Latency: minimal

Duration: < 1 minute

Horizontal Canal Involvement:

Canalithiasis in anterior arm

Nystagmus: Horizontal direction-changing nystagmus directed toward the uppermost ear on both sides and more intense when turned toward the unaffected side. Non-fatiguable with repeated testing

Latency: minimal

Duration: ~ 1 minute
**Horizontal Canal Involvement: Cupulothiasis**

- **Nystagmus:** Horizontal direction-changing nystagmus directed toward the uppermost ear on both sides and more intense when turned toward the unaffected side. Non-fatigable with repeated testing
- **Latency:** minimal
- **Duration:** non-fatigable

**Vestibular Testing Lab**

- Passive VOR
- Head Thrust
- Head Shaking
- Dynamic Visual Acuity
- Dix-Hallpike
- Roll Test

**Differential Diagnosis**

When to refer out

**Conditions which indicate necessary referral to MD**

- Sudden or unexplained unilateral hearing loss
- Unexplained neurological signs
- Inconsistencies in clinical exam of vestibular function, history, physical exam (gait/stance), dynamic visual acuity, motion sensitivity or positional tests
- Exam does not reveal cause of patient's problems
- No improvement after 30 day treatment period
- Unstable BP, orthostasis, low O2 saturation

*Which do you think would be urgent referrals?*

**Clinical decision flowchart**

GOT DIZZINESS?

- Do you feel that you or the world around you is moving?
- Do you have a painful or discharging ear?
- Do you have a loss of hearing or tinnitus in one ear?

**Auricular or Vestibular**

- Yes: Consider middle ear disorder
- No: Implies inner ear disorder
**CASE STUDY**

<table>
<thead>
<tr>
<th>Past Medical Hx</th>
<th>Complaints</th>
<th>Tests</th>
<th>Recent History</th>
<th>Differential Diagnosis and Plan of Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>78 year old female</td>
<td>Unremarkable</td>
<td>Past Medical History</td>
<td>Neurological and Cardiac workup</td>
<td>Severe cold virus infection, viral polyneuritis, diabetic neuropathy</td>
</tr>
</tbody>
</table>

Questions
References

• Mucha et al. A brief vestibular ocular motor screening assessment to evaluate concussions.