Balance Function Testing

Shashidhar S. Reddy, MD, MPH
Faculty Advisor: Arun Gadre, MD
The University of Texas Medical Branch
Department of Otolaryngology
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Physiology of Balance

- Humans use three systems:
  - Visual
  - Proprioceptive
  - Vestibular
Visual:

- Orientation and balance are maintained via several visual properties:
  - Saccades
  - Smooth pursuit
  - Optokinetic reflex
    - The optokinetic response can also impart a sense of acceleration in an individual
  - Depth perception
  - Visual cortex centers specially designed to respond to vertical and horizontal stimuli
Proprioceptive:

- Proprioception contributes to balance in the following ways:
  - Myototic reflex (deep tendon reflex)
  - Functional stretch response
  - Cervical proprioception
    - Includes a cervical-ocular reflex arc that can lead to physiologic or pathologic nystagmus
Vestibular:
Semicircular Canals

- Respond to angular acceleration in the plane of the canal.
- Are functionally paired:
Otolith organs:

- Contain calcium carbonate crystals of higher density than endolymph
  - This allows response to gravity (head tilt)
- Respond to linear acceleration
Vestibular Reflexes:

- Vestibulospinal
  - Helps maintain center of gravity
Vestibular Reflexes

- Vestibulo-ocular
  - Helps maintain stability of visual field
  - Leads to physiologic nystagmus
Vestibular Reflexes

- Vestibulo-cervical:
  - Helps to maintain stability of the head during movement of the torso.
Balance Function Testing

- History is the most important tool in evaluation
  - Must obtain a concrete description of symptoms
  - Define vertigo for the patient
  - Ask about onset, duration of symptoms, aggravators, associated symptoms (hearing loss), tinnitus, affect on daily life.
Bedside Evaluation:

- General physical examination
  - Vascular exam for possible posterior circulation problem
  - Cranial nerve exam
  - Cerebellar function (disdiadokinesis)
Bedside Evaluation

- Proprioceptive / Vestibulospinal
  - Romberg
  - Past-pointing
  - Fukuda
  - Deep tendon reflexes
  - Proprioception
Bedside Evaluation

- Vision
  - Visual acuity
  - Saccades
  - Smooth pursuit
  - Optokinetic reflex
Bedside Evaluation

- Static Vestibular Balance – Nystagmus:
  - Check direction
  - Check for torsional component
  - Check for gaze suppression
Bedside Evaluation

- Dynamic Vestibular Function Testing:
  - Head turn
    • Tests the gain of the vestibulo-ocular reflex
  - Head shaking
    • Utilizes a central pathway that “remembers” angular velocity
Bedside Evaluation

- Provocative Measures:
  - Hyperventilation
  - Dix-Hallpike
  - Valsalva
  - Calorics
Electronystagmogram

- Utilizes charge difference between retina and cornea to detect eye movement
Infrared Camera Systems

- Infrared camera directly measures eye movement
Electronystagmography

Saccades

[HORIZTONAL SACCAD]

Eye and Target Position

Peak Velocity

Accuracy

Latency

[VERTICAL SACCAD]

HORIZONTAL SACCAD

EYE ANGLE

TARGET ANGLE

DEGREES

DEGREES/SECOND

PERCENT

MILLISECONDS

[VERTICAL SACCAD]

HORIZONTAL SACCAD

EYE ANGLE

TARGET ANGLE

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[VERTICAL SACCAD]

HORIZONTAL SACCAD

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DEGREES

DEGREES/SECOND

PERCENT

MILLISECONDS

[VERTICAL SACCAD]
Electronystagmography

- Gaze

![Diagram of eye position graphs]
Electronystagmogram

- Optokinetic Nystagmus
- Positional Nystagmus
- Paroxysmal Positional Testing
- Tympanogram
- Tulio Phenomenon
Electronystagmogram

- Caloric Testing
Electronystagmogram

- Caloric Testing
Electronystagmogram

- Caloric Testing
Electronystagmogram

- Rotatory Chair
Dynamic Posturography
Dynamic Posturography

- Conditions Tested:

1. Normal Vision
2. Absent Vision
3. Sway-Referenced Vision
4. Normal Vision
5. Absent Vision
6. Sway-Referenced Vision
Case Study

- 26 y/o woman presents to the emergency room several hours after the sudden onset of severe “dizziness” with nausea and vomiting.
- You call her up to your clinic.
Case Study

- History – reveals no associated symptoms.
- No report of hearing loss
Case Study

- Physical Exam:
Case Study

ENG:
Case Study

ENG:
Case Study

ENG

Bithermal Caloric

Caloric Weakness: 71 percent in the right ear