Video Analysis of Eye Movements in Individuals With Peripheral and Central Vestibular Disorders

Susan J. Herdman, PT, PhD, FAPTA
Michael C. Schubert, PT, PhD
Susan L. Whitney, DPT, PhD, NCS, FAPTA

Objectives of the Program

- Recognize the typical forms of benign paroxysmal positional vertigo (posterior, horizontal, and anterior canal)
- Describe central signs and symptoms demonstrated on the video that suggest brain pathology
- Identify atypical eye movements via video analysis that are not vestibular in origin

Format

- A short case will be presented
- A video of eye movements will be shown
- You will “vote” on what you see in the video from choices on the screen with the clicker technology

Let’s Practice- Here are the Rules

- After each question is on the screen, push the corresponding letter or number on the clicker for your response
- You can change your mind up until the time that the polling has closed
- Please do not discuss your response with others as pandemonium will result!
Now it’s time to try to clicker

- We will ask a simple question and it is your job to “respond” with your clicker
- You will get immediate “feedback” about whether you agree with the instructor
- The instructors will spend more or less time on each eye movement depending on the number of incorrect responses
- If there is a large % of incorrect responses, we will replay the video and review the key characteristics of the eye movements

Case

- 55 year old woman became ill on Thursday night with vomiting and vertigo- too sick to come in to work
- Monday- patient presents to the PT
- On antivert from her primary care physician
- Is able to drive now
- Patient can walk
- Any head movement increases her symptoms

What does this sound like?

A. A peripheral problem
B. A central problem

50% 50% 50%

Is a Dix Hallpike indicated during the examination of this patient?

A. Yes
B. No

50% 50%
Head Impulse Test (HIT)

What is the result of the HIT?

A. Positive to the right
B. Positive to the left
C. Bilaterally positive

33% 33% 33%

Case sh2

49 year old female self-referred to XXXX Neurology clinic complaining of a 3 year history of progressive walking difficulty, balance problems, and frequent falls. Also complained of having persistent, daily vertigo and bilateral tinnitus.

Coordination

Severe heel-knee-shin dysmetria
Moderate finger-nose-finger dysmetria
Defective check responses
Dysarthria
No tremor, No dysdiadochokinesia
Gait – ataxia, slow, wide-based

acknowledge: Saba Bejanishvili, MD
What other tests should be performed?

- Gait speed
- Fall risk assessment
- Balance confidence questionnaire
- All of the above

Motor: normal bulk and strength, mild hypertonia in legs

Sensory:
- Diminished stocking distribution pin-prick
- Slightly diminished joint-position sense
- Slightly diminished vibration below ankles
- Romberg's test: positive

Reflexes: slightly brisk

Babinski: negative

• Mental status - normal
• Cranial nerves
  - Retinas clear
  - Visual fields and visual acuity normal
  - Pupils normal, no ptosis
  - Face symmetric
  - Hearing and tuning fork exam normal
  - Eye movements ......

What did you see?

- Hypermetric saccades
- Gaze-evoked nystagmus
- Macro-saccadic oscillations
- None of the above
What is a macro-saccadic oscillation?

A form of saccadic dysmetria: Saccades that are made back and forth around a target.

Usually a cerebellar disorder

Disturbance of fixation; inhibition or dysfunction of omnipause cells in PPRF

**Treatment**

- Supportive
  - No specific therapy
  - No dietary factors to help
  - Tremor controlling drugs do not work
  - PT/OT – but can not delay progression
- Recommendations
  - Vitamin supplements
  - Assisting devices, weight control
  - Speech therapy

Would you consider getting VFT on this patient?

a) Yes  
b) No
Remember, she complained of daily vertigo!!!

Sinusoidal rotary chair test results

What do you think her head impulse test will look like?

a) Normal  
b) Corrective saccade for HT bilaterally  
c) Abnormal but no corrective saccades because she cannot make saccadic eye movements  
d) Saccadic oscillations with head thrust

This is a person with spinocerebellar atrophy with bilateral vestibular hypofunction

Received physical therapy; can walk safely but is still wide based and slow, ataxic
MCS Case
- 68 y.o woman with complaints of imbalance and dizziness
- Has fallen 3 times in last 5 years
- Normal VOR exam

What did you see?
A. Left eye moves down when left eye is uncovered
B. Right eye moves up when uncovered
C. Left eye moves up when uncovered
D. Right eye moves down when left eye is uncovered
What is this named?

A. Hyperphoric right eye
B. Hypophoric left eye
C. Exotropic left eye
D. Esophoric right eye

Cover Cross-Cover Test

What did you see?

A. Right eye moves up and left eye moves down
B. Left eye moves up and right eye moves up when uncovered
C. Right eye moves down and left eye moves up

What is the cause?

A. Right utricular defect
B. Left utricular defect
C. Central lesion in the vestibular cortex
D. Central lesion at the level of brainstem or higher
E. Left saccular defect
F. Left saccular defect
G. Can’t tell
Case

- 45 year old presents with new onset on dizziness
- Patient reports vertigo with a change of head position
- On exam with IR goggles, you see the following:

Please observe the nystagmus and what happens with fixation on the light

What happened to the nystagmus with fixation?

A. Stayed the same 33% 33% 33%
B. Got more intense
C. Got worse

How would you classify this nystagmus?

A. Horizontal canal BPPV
B. Right vestibular neuritis
C. Congenital nystagmus
Congenital nystagmus

- Increased by fixation and reduced in the dark
- With the Dix–Hallpike, the patient had symptoms consistent with BPPV
- Patient was treated with the modified Epley and the vertigo symptoms completely resolved

Case SH1

- 27 year old woman, 3 weeks post-partum.
- Recently diagnosed with MS, which had its first presentation during her recent pregnancy.
- Her primary problems are imbalance, dysequilibrium and double vision when looks laterally

Case sh1 Examination

- Subjective complaints:
  - Dysequilibrium intensity: 3.2/10
  - Oscillopsia intensity: 4.1/10
  - Balance Confidence (ABC): 56%
- Gait and Balance:
  - Gait speed: 2.3 m/s (nl > 2.9 m/s)
  - Fall risk (DGI): 17/24
- Oculomotor: no spontaneous or gaze holding nystagmus, normal vergence
What did you see? 
pick the one best answer
a. Saccadic pursuit to the left
b. III CN palsy
c. internuclear ophthalmoparesis
d. None of the above

Internuclear Ophthalmoparesis (INO)
To look left:
• left PPRF signals the left CN VI Nu to turn the left eye outwards (abduction).
• At the same time, the PPRF must signal the right CN III Nu, via the right MLF, to simultaneously turn the right eye inwards (adduction).
• A lesion of the right MLF would not allow the neural impulse to reach the right medial rectus. The left eye would abduct, but the right eye would not adduct.

Etiology
- multiple sclerosis (in younger)
- brainstem infarction (in older)
- Tumors (brainstem and fourth ventricle)
- viral infection
- trauma
- syphilis
- Lyme disease
- drug intoxication (phenothiazines)

Case
- 54 year old male seen in the ED
- Complaints- spinning with a change of head position
- Dx- BPPV
- Wife (a nurse practitioner) was told to try the Epley on him at home
- Was give meclazine
Next Day
- Seen in Physical Therapy
- He was much worse
- Dizziness Handicap Inventory-78
- Activities-specific Balance Confidence score- 58%

Please Observe

What did you see?
A. A positive right HTT
B. A positive left HTT
C. Negative HTT bilaterally
D. Positive HTT bilaterally

Video- no sound
What would you call this?

A. First degree nystagmus
B. Second degree nystagmus
C. Third degree nystagmus

Case sh4

57 year old woman with imbalance, tremor, ataxia, dysarthria.
CC: cannot walk, difficulty with self care such as feeding, dressing.
She has been admitted to the hospital and has been referred for PT

PMH: breast CA 4 years ago, hypertension

Case sh4 oculomotor exam

What did you see?

- Macro-saccadic oscillations
- Flutter
- Opsoclonus
- Voluntary nystagmus
- Oscillopsia
Opsoclonus (opsoclonus – myoclonus)

“Dancing eyes”
rapid
involuntary
multivectorial
conjugate
no intersaccadic intervals (no rest
between ‘jerks’)

Rare autoimmune disorder – 1 in
10,000,000 (half the cases - children with
neuroblastoma)

• 2 - 3% of all children with neuroblastoma
• in adults
  - associated with a paraneoplastic syndrome
  breast, ovarian, small-cell lung,
neuroblastoma
  - viral infection e.g. Epstein-Barr, encephalitis

Case sh4
Prognosis:
• no known cure but may improve
• treated with ACTH, corticosteroids, IV
immunoglobulins, surgery or chemotherapy
• Are neurological sequelae in children

In this patient, treat primary CA

MCS Case

49 y.o woman complaining of room spinning
vertigo and imbalance worsens with change
in head position
Sit to Supine and Roll Test

What did you see?
A. Apogeotropic nystagmus in right side lying
B. Geotropic nystagmus in right side lying
C. Left beat nystagmus in right side lying
D. Right beat nystagmus in right side lying
E. A and C
F. B and D

What did you see?
A. Persistent geotropic nystagmus in left side lying
B. Initial geotropic then conversion to apogeotropic nystagmus in left side lying
C. Persistent apogeotropic nystagmus in left side lying
Which ear is affected and what type of BPPV is this?

- Left horizontal canal cupulolithiasis
- Right horizontal canal cupulolithiasis
- Left horizontal canal canalithiasis
- Right horizontal canal canalithiasis

Why did the nystagmus appear to ‘convert’?

A. Patient has both canalithiasis and cupulolithiasis
B. Cupular deflection and velocity storage was still charging from being in right side-lying

How might you attempt to validate the ‘conversion’

A. Repeat the roll test but stop in neutral
B. Perform the Dix Hallpike Test
How will you treat this?

A. Try some maneuver named after an Italian
B. Refer to a colleague that you are not fond of
C. Modified Gufoni
D. Modified Brandt-Daroff for the hSCC

Modified Gufoni - RCT

- Sidelying to affected side for 2 minutes
- Head rotation towards sky, wait 2 minutes
- Sit up

What did you see?

A. Upbeating nystagmus
B. Downbeating nystagmus
C. Torsional nystagmus

33% 33% 33%
SH5

36 year old male with complaints of imbalance, dysequilibrium, episodes of vertigo and a sense the that visual world jumps that began 3 weeks ago

Which of the following is not likely to be the underlying problem?

a. Unilateral vestibular hypofunction
b. Superior Canal Dehiscence
c. BPPV
d. Meniere’s Disease

The vertigo and the world jumping seems to be induced by loud sounds

Now which of the following do you think is the cause of his problem?

a. Unilateral vestibular hypofunction
b. Superior Canal Dehiscence
c. BPPV
d. Meniere’s Disease
Treatment:
Canal ‘plugging’

Residual problems:
Imbalance – recovers with 6 weeks
Positive HIT for that superior SCC

Janky KL et al Arch OHNS 2012