EYE MOVEMENTS IN DEGENERATIVE DISEASES OF THE CEREBELLUM: A VIDEO TUTORIAL

Cerebellar atrophy: SCA6
BEFORE WE START:

- Is CEREBELLAR ANATOMY complex?
  - YES, but it is orderly and manageable.

- Is CEREBELLAR PHYSIOLOGY complex?
  - YES, highly complex, and it can be OVERWHELMING

- But can we extract from the anatomy and physiology easy to use, easy to remember, practical principles for our clinics?
  - YES, WITHOUT A DOUBT!

- Do we need fancy equipment and detailed quantitative analysis to evaluate eye movement disorders?
  - ABSOLUTELY NOT! The focused history and careful, ordered bedside exam usually points us to the diagnosis, and always directs us down the correct path for management. (Testing of course helps to confirm our diagnoses, and provides data for research BUT ....)

- HANG IN THERE! Rather than thinking that eye movements take you to the “Gates of Hell”, you will receive “The Kiss” from your patients at the end of the day.
“Gates of Hell”  “The Kiss”
A Road Map for Today
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• Key cerebellar anatomy

• Flocculus and paraflocculus (tonsil): downbeat, gaze-evoked, rebound nystagmus

• Bedside vestibular testing in cerebellar patients
  • Head impulse
  • Head-shaking
  • Hyperventilation
  • Valsalva

• Nodulus: periodic alternating nystagmus

• Dorsal vermis and fastigial nucleus: Saccade dysmetria

• Strabismus and the cerebellum (ESO and HYPER deviations)
Why do we need eye movements?

Sharp, detailed vision is possible only at the **fovea**, the small area at the center of the retina, and when images are **held steady** there.
KEY ANATOMY: Three basic functional-anatomical cerebellar syndromes

- Syndrome of the nodulus & ventral uvula
- Syndrome of the flocculus and paraflocculus (tonsil)
- Syndrome of the dorsal vermis (OMV) & posterior fastigial nucleus (FOR)

**Sagittal View**

**Inferior View**

**Vestibular** (low-freq, slowly changing)

**Gaze-holding, pursuit, vestibular (high-freq, rapidly changing)**

**Saccade accuracy**
Cerebellar flocculus and paraflocculus (tonsils)
Flocculus/Paraflocculus syndrome: Downbeat, gaze-evoked and rebound nystagmus in cerebellar atrophy

Cerebellar atrophy: SCA6
Flocculus/Parafloucculus syndrome
Impaired pursuit and vestibuloocular reflex cancellation (fixation suppression)
Testing of the VOR: Head impulse sign in a unilateral peripheral labyrinthine lesions

Catch-up saccade during brief, high-acceleration, head rotation (left-sided loss)

Head-impulse sign in unilateral labyrinthine loss
Abnormal VOR in cerebellar disease: Abnormal direction
Head-shaking nystagmus (HSN) in cerebellar disease

PEARL: Think central if HSN is

- Directed DIFFERENTLY than head motion (cross-coupled), e.g., vertical nystagmus with horizontal head-shaking.
- Directed OPPOSITE to spontaneous nystagmus
- If there is an EARLY and STRONG REVERSAL of the direction of HSN
Hyperventilation-induced (HVN) downbeat nystagmus

**PEARL: HVN**

- Cranial-cervical junction anomalies
- Cerebellar degenerations
- Compressive lesions on VIII CN (microvascular compression, tumors)
- Demyelinating diseases (e.g., MS)
- Labyrinthine fistula and SCC dehiscence
Valsalva-induced vertigo
Valsalva-induced nystagmus

Cranial-cervical junction: Chiari

Cerebellar atrophy: SCA6

Superior Semicircular Canal dehiscence

PEARL: Remember Valsalva-induced vertigo with cranial-cervical junction anomalies and with labyrinthine fistula and SCC dehiscence
Ocular motor disorders with nodulus lesions: Periodic Alternating Nystagmus and Central Positional Nystagmus
PAN: Pathogenesis and Treatment

• In PAN, instability in velocity storage is produced by **loss of (gaba-mediated) inhibition** from the Purkinje cells of the nodulus onto the vestibular nuclei.

• Short-term adaptation (which is working normally) causes reversals of nystagmus leading to sustained oscillation.

• **Baclofen (GABA-b)** provides the missing inhibition and stops the nystagmus.
  – Usually need only 10 mg PO TID.
  – Avoid precipitous discontinuation.
  – Does not work as well in congenital PAN.

  – **Memantine** may be of help.
REMEMBER:
1) The vermis contains Purkinje cells and they INHIBIT their target neurons in the deep nuclei (FOR)

2) Each FOR normally stops ipsilateral saccades
Cerebellar fastigial nucleus lesions produce saccade hypermetria
Hemangiopericytoma

Involving dorsal vermis

Cerebellar dorsal vermis lesions produce saccade *hypometria*
Dysmetria of saccades: *Overshoot* to one side, *undershoot* toward the other, called *lateropulsion* of saccades.

Wallenberg’s Syndrome – Posterior Inferior Cerebellar Artery distribution infarct involving the dorsolateral medulla.
MRI in Progressive Supranuclear Palsy (PSP)  
Steele-Richardson-Olszewski syndrome

**PSP** small midbrain, ‘humming bird’ or ‘emperor penguin’ sign  

**SCA2** small pons
THE ALIGNMENT CHANGES IN PATIENTS WITH CEREBELLAR DISEASE

• **Esodeviation** (eyes turn in with distance viewing, mimics a divergence paralysis)

• ‘**Skew**’ (vertical misalignment (alternating hyperdeviation, usually abducting eye is higher))
WHY this pattern? We ALL have a lateral-eyed rabbit inside our ‘human’ brains.

This is reflected in the Ocular Tilt Reaction (OTR) – in which (the rabbit) emerges when there is imbalance in otolith (utricular) responses.
A FEW TAKE HOME POINTS:

- LOOK FOR DOWNBEAT NYSTAGMUS: WORSE ON LATERAL GAZE AND CONVERGENCE
- LOOK FOR HORIZONTAL GAZE-EVOKED NYSTAGMUS
- IF YOU SEE PENDULAR NYSTAGMUS, LOOK AT THE PALATE
- TEST SACCADE ACCURACY (CEREBELLUM) AND SPEED (BRAINSTEM)
- CEREBELLAR SACCADE DYSMETRIA (HYPERMETRIA (DEEP NUCLEI) OR HYPOMETRIA (VERMIS))
- CEREBELLAR STRABISMUS
  
  ESO AT DISTANCE
  ALTERNATING HYPERDEVIATION ON CHANGING LATERAL GAZE DIRECTION, (ABDUCTING EYE USUALLY HIGHER)

TREAT WITH BACLOFEN, MEMANTINE, 4 AMINO PYRIDINE