CEREBELLAR OCULAR MOTOR AND VESTIBULAR DISORDERS

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Disclosure

• None related to the teaching course
Learning objectives

• Revisit the main cerebellar functional areas
• Understand the role of the different cerebellar areas in control of eye movements and vestibular system
• Examine and recognize the cerebellar ocular motor disorders that can be observed at bedside
Key messages

- Cerebellar oculomotor deficits are numerous and can affect ocular stability during fixation, metrics of slow eye movements and saccades, and ocular alignment.
- Recognizing them is important since some oculomotor deficits are anatomically specific and thus greatly aid a subtle or a topographical diagnosis of cerebellar syndrome.
Plan

• Main cerebellar functional areas
• Role of the different cerebellar areas in eye movements
• Cerebellar disorders of eye movements
Purpose of eye movements

• Optimize vision by promptly bringing images to the fovea:
  • Saccades
  • Vergence

• Stabilizing images on the retina/fovea even when the target or body are displaced
  • Fixation
  • Smooth pursuit (SP)
  • Vestibulo-ocular reflex (VOR).

• Cerebellum
  • Best calibration
  • Reduce eye instability
  • Maintain ocular alignment
Main cerebellar functional areas

Dorsal oculomotor vermis
- Vermis VI
- Vermis VII
- Vermis VIII
- Vermis IX
- Vermis X

Nodulus / Ventral uvula

Flocculus / Paraflocculus
Role of the different cerebellar areas in eye movements

- **Flocculus, paraflocculus**
  - Gaze holding
  - Smooth pursuit and VOR cancellation
  - VOR
    - Amplitude
    - Direction of rotation

- **Nodulus, uvula:**
  - Downward smooth pursuit
  - VOR
    - Duration
    - Direction relative to gravity

Kheradmand A, Zee DS Frontiers Neurol. 2011
Role of the different cerebellar areas in eye movements

• Vermal lobules VI and VII and fastigial nucleus
  • Saccade amplitude and direction
  • Pursuit initiation
  • Horizontal eye alignment

Kheradmand A, Zee DS Frontiers Neurol. 2011
Cerebellar disorders of eye movements

• Ocular instability: nystagmus and saccadic intrusions
• Deficits in slow eye movements: impaired smooth pursuit and VOR
• Deficits in saccades: dysmetria and lateropulsion
• Ocular misalignment: skew deviation and esotropia
Cerebellar disorders of eye movements

1. Ocular instability
   1. Downbeat nystagmus
      • The most frequent
      • Cerebellar-specific
      • Increase or observed when looking to the side
      • Flocculus / Paraflocculus global dysfunction
Cerebellar disorders of eye movements

1. Ocular instability
   2. Gaze evoked nystagmus
      • The most frequent
      • Not cerebellar-specific
      • Change direction according to gaze position
      • May be associated
         • To downbeat nystagmus (oblique)
         • To rebound nystagmus
      • Flocculus / Paraflocculus global dysfunction
Cerebellar disorders of eye movements

1. Ocular instability
   3. Periodic alternating nystagmus

• Very rare
• Cerebellar-specific
• Horizontal-jerk nystagmus
  which changes direction every 2 minutes
• Nodulus / Uvula
Cerebellar disorders of eye movements

1. Ocular instability
   4. Central positioning nystagmus
      • Nodulus / Uvula
      • Not cerebellar-specific
      • Mainly
         • downbeat, upbeat
         • apo/geotropic horizontal nystagmus
      • In different hanging positions
      • With or without vertigo
      • To be differentiated with BPPV
Cerebellar disorders of eye movements

1. Ocular instability
   5. Saccadic intrusions and oscillations

   • Frequent
   • Fastigial nucleus
     • Square wave jerks and macro-square wave jerks
       • Not cerebellar-specific
     • Macrosaccadic oscillations
       • Cerebellar-specific
     • Flutter / Opsoclonus
       • Cerebellar-specific
Cerebellar disorders of eye movements

2. Deficits in slow eye movements
   1. Impaired smooth pursuit and visual suppression of vestibulo-ocular reflex
      • Very frequent
      • Not cerebellar-specific
      • Flocculus or oculomotor vermis
      • Catch up saccades
Cerebellar disorders of eye movements

2. Deficits in slow eye movements
   2. Impaired VOR
      • Flocculus
      • Head impulse test
         • Normal
         • Impaired gain (not specific)
         • Impaired direction
Cerebellar disorders of eye movements

3. Deficits in saccades
   1. Saccadic dysmetria
     • Very frequent
     • Hypometria
       • Oculomotor vermis: not cerebellar-specific
     • Hypermetria
       • Fastigial nucleus: cerebellar-specific
     • Saccadic lateropulsion
       • Saccadic hypermetria on one side; hypermetria on the other side; horizontal deviation of pure vertical saccades
       • Fastigial nucleus: not cerebellar-specific
       • More frequent in Wallenberg syndrome
Cerebellar disorders of eye movements

4. Ocular misalignment
   1. Skew deviation
      • Non-paralytic vertical ocular misalignment (not cerebellar-specific)
      • Mostly alternating in cerebellar syndrome (and cerebellar-specific): changing direction with changes in horizontal eye position, the abducting eye being the higher
   2. Esotropia
      • Inward non-paralytic strabismus
References


• Kheradmand A, Zee DS. Cerebellum and ocular motor control. Front Neurol. 2011 Sep 1;2:53