CEREBELLAR OCULAR MOTOR AND VESTIBULAR DISORDERS

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Hôpitaux de Lyon

Lyon 1

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.

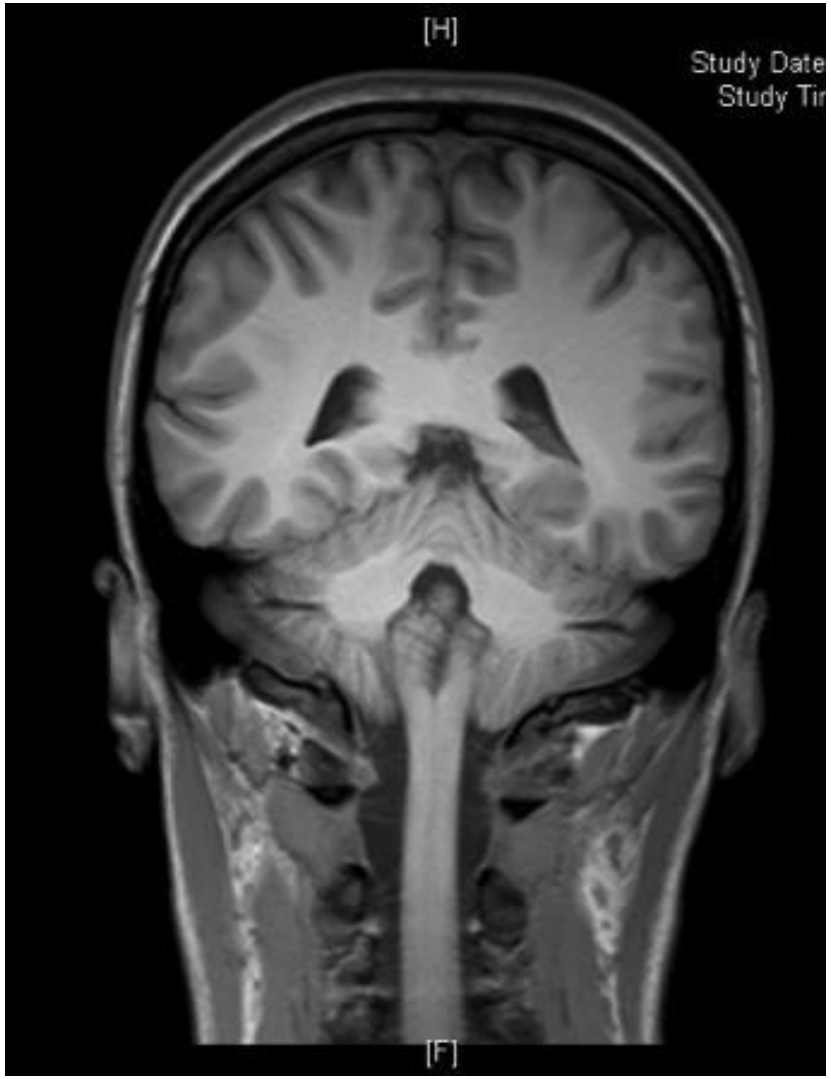
Plan

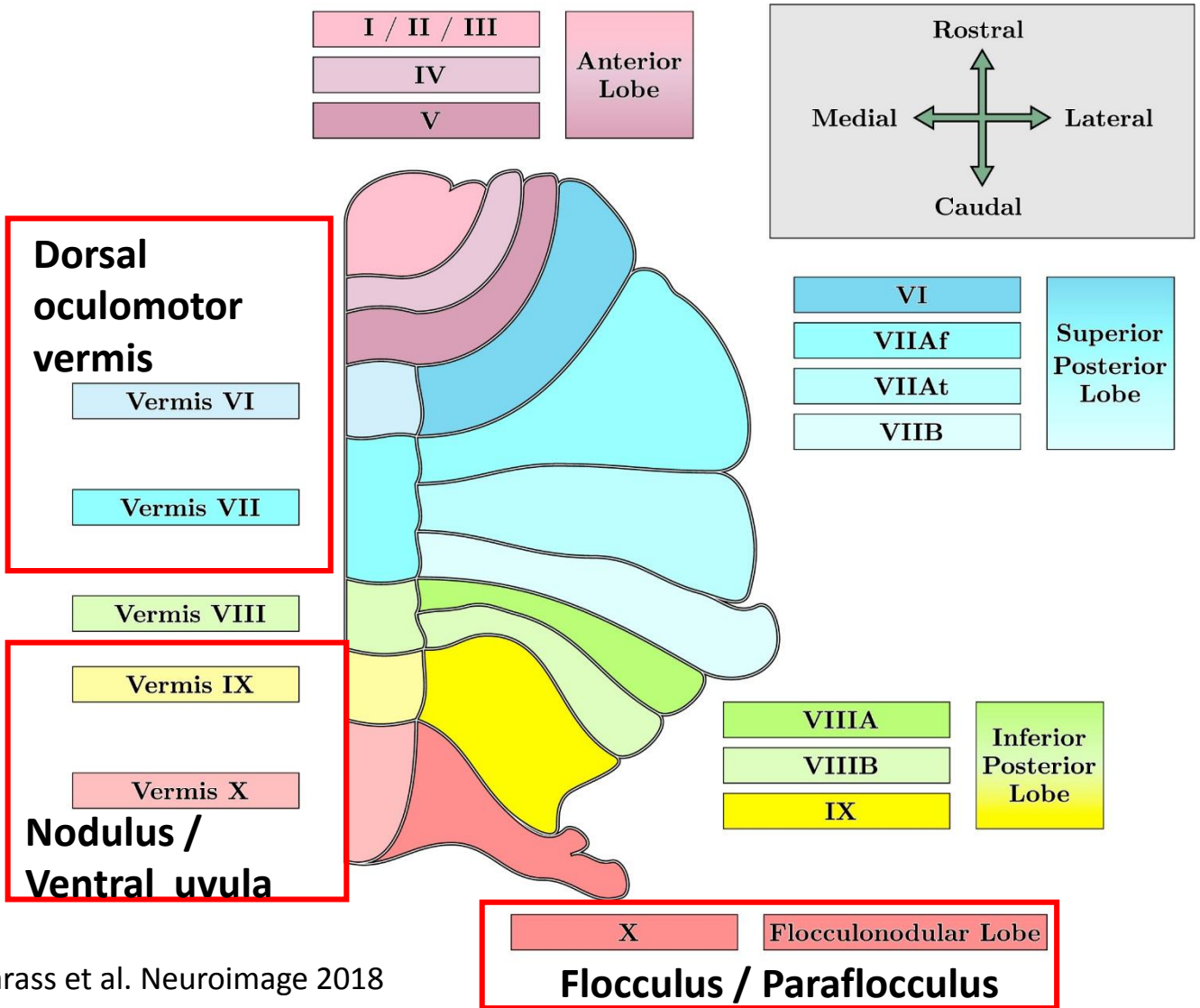
- Main cerebellar functional areas
- Role of the different cerebellar areas in eye movements
- Cerebellar disorders of eye movements

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

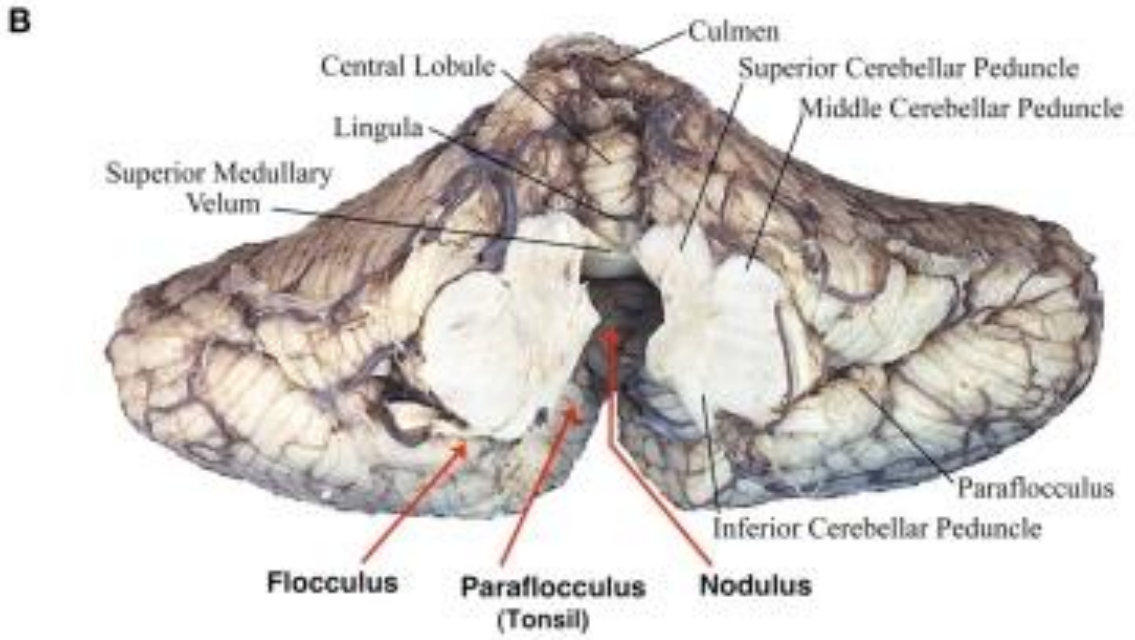




Carass et al. Neuroimage 2018

Role of the different cerebellar areas in eye movements

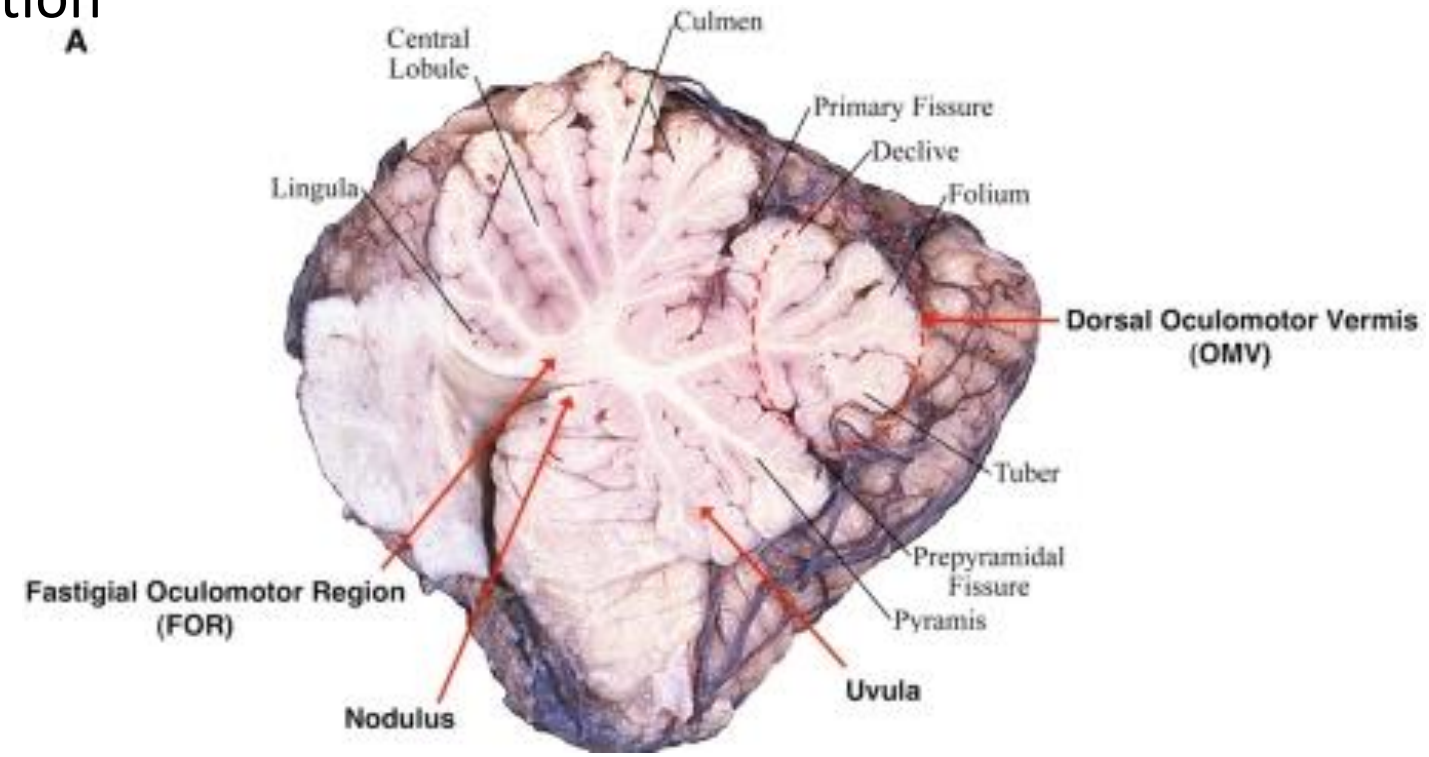
- Flocculus, paraflocculus
  - Gaze holding
  - Smooth pursuit and VOR cancellation
  - VOR
    - Amplitude
    - Direction of rotation
- Nodulus, uvula:
  - Downward smooth pursuit
  - VOR
    - Duration
    - Direction relative to gravity



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



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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
    - apogeotropic 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

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