Lecture 25 – Cerebellum -- Martin

Lecture Plan

1) functional anatomy (mediolateral zones)
2) pathophysiology (movement onset delays, ataxia, learning)
3) Imaging studies (motor cognition)

Functional anatomy of the cerebellum

- Motor hierarchy
  - • influences motor behavior not by driving motoneurons directly, but rather by its influence on the motor pathways
  - •Cerebellum-neither high nor low, but all levels
- Anatomy of the cerebellum
  - Cortex—folia, many many neurons
    - *Anterior lobe (limbs and trunk)*
    - *Posterior lobe (limbs and trunk)*
    - *Flocculonodular lobe*
  - 3 pairs of deep nuclei (fastigial, interposed, dentate)
  - Peduncles—Inputs and outputs—superior, middle, and inferior
- Cerebellar inputs
  - Climbing fibers, from inferior olivary nucleus
    - *Mossy fibers, from various sources (spinal cord, vestibular nuclei, pontine nuclei, etc.)*
  - Input-output organization
    - *Inputs directed both to deep nuclei and cortex*
    - *Cortical output from Purkinje cells only; INHIBITORY*
    - *Purkinje cells project to deep nuclei (and vestibular nuclei)*
    - *Deep nuclei (EXCITATORY) project to motor systems*
- Medio-lateral cerebellar zones and their connections
  1. Spinocerebellum
     - *Vermis and fastigial nucleus*
     - *Intermediate hemisphere and interposed nucle*i
  2. Cerebro-cerebellum
     - *Lateral hemisphere and dentate nucleus*
  3. Vestibulocerebellum
     - *Flocculonodular lobe and vestibular nuclei*

Pathophysiology of clinical signs

- Delayed movement initiation & hypotonia
  - Dysfacilitation of motor pathways (e.g., corticospinal tract)
- Ataxia
  - Substitution of ANTICIPATORY (PREDICTIVE) CONTROL with FEEDBACK control
- Motor learning deficits
  - Defects in adapting movements—controlling movements in a flexible way to better suit the task

Role of cerebellum in motor cognitive functions

- Complex motor strategies
- Active tactile explorations

Overall Conclusions

- Unlike pyramidal lesions, which produce weakness/paralysis, cerebellar lesions produce disorders of coordination, learning, and motor cognition
- Role in automating movements, adapting movements to task demands
- Purely mental processes
  - Cerebellum watches and waits, optimizing and fine-tuning movements by adjusting anticipatory control signals

Cerebellar Cortex Circuitry Addendum

Inputs—Excitatory

Climbing fibers

Mossy fibers

Cerebellar cortex excitatory circuits

Inferior olivary nucleus □**+Climbing fiber**□+Purkinje cells

various nuclei□**+Mossy fibers**□+Granule cells (Parallel fibers) □+Purkinje cells

Key Points:

Cerebellar circuitry—cortical and deep nuclei—**same for different anatomical divisions**

Functional distinctions based on **different inputs and outputs** rather than different circuitry

Purkinje cell is the **output neuron** of the cerebellar cortex; also is **inhibitory**

One cerebellar excitatory neuron (granule cell), rest are inhibitory

Neurons of the cerebellar cortex:

Purkinje	Inhibitory	**OUTPUT**	projects to deep nuclei
Granule	**Excitatory**	Interneuron	projects to Purkinje neuron
Basket	Inhibitory	Interneuron	inhibits Purkinje neuron cell body
Golgi	Inhibitory	Interneuron	granule cell dendrite
Stellate	Inhibitory	Interneuron	inhibits Purkinje neuron cell distal dendrite

Cerebellar cortex inhibitory interneuronal circuits

Parallel fiber □**+Basket cell** □-Purkinje cell body

Parallel fiber □**+Stellate cell** □-Purkinje cell distal dendrite

Parallel fiber □**+Golgi cell** □-Granule cells

Relevant reading: chapter 42 in "Principles"