Unit VIII – Problem 5 – Neuroanatomy: Crebellum and Basal Nuclei

CEREBELLUM

- **The collection/rule of 3's of the cerebellum:**
  - **It has 3 layers:**
    - ✓ Molecular layer.
    - ✓ Parkinje layer.
    - ✓ Granular layer.
  - **It has 3 nuclei:**
    - ✓ Fastigial nucleus → which is concerned with Archicerebellum (vestibulocerebellum system).
    - ✓ Interposed nucleus → which is formed by globose + emboliform and concerned with Paleocerebellum (spinocerebellum).
    - ✓ Dentate nucleus → which is concerned with Neocerebellum (cerebrocerebellum).
  - **It has 3 peduncles connecting it with different parts of the brainstem:**
    - ✓ Superior cerebellar peduncle: connecting the cerebellum with the midbrain.
    - ✓ Middle cerebellar peduncle: connecting the cerebellum with the pons.
    - ✓ Inferior cerebellar peduncle: connecting the cerebellum with the medulla.
  - **It has 3 inputs (from: cerebrum, vestibular nuclei and spinal cord) and 3 outputs (which are coming from the 3 cerebellar nuclei).**
- **The cerebellum is composed of 2 hemispheres (which are not clearly demarcated when compared to cerebral hemispheres). These 2 hemispheres are connected at the middle by the vermis (the lower part of the vermis is the nodule).**
- **The cerebellum has 2 tonsils which are located near foramen magnum (foramen magnum is the largest foramen in the skull which is located in the posterior cranial fossa).**
  - **If there is a tumor or hemorrhage in infratentorial compartment → this can press on the tonsils of the cerebellum and foramen magnum leading to herniation (compression on the medulla: cardiac and respiratory arrest).**
- **The fluculo-nodular lobe of the cerebellum is composed of**: floculus + nodule.
- **Histologic structure of the cerebellum: it is composed of:**
  - **A cortex (grey matter).**
  - **White matter (tree of life).**
  - **Deep cerebellar nuclei**
- **Internal circuit of the cerebellum:**
  - Most of the fibers which will enter the cerebellum are known as Mossy fibers. They will give branches which will stimulate the deep cerebellar nuclei and then continue their way through the 3 layers of the cerebellum.
  - They will terminate in granular cells (which are present in the granular layer) and then axons from granular cells will reach the cerebellar cortex, bifurcating and making connection with thousands of purkinje cells (purkinje cells inhibit the deep GABAergic cerebellar nuclei).
  - Note that axons from granular cells will also make connection with satellite and basket cells. These cells inhibit surrounding purkinje cells when you want only to stimulate specific purkinje cells.
- **Terms:**
  - **Archicerebellum** → vestibulo-cerebellum.
  - **Paleocerebellum** → spino-cerebellum.
  - **Neocerebellum** → cerebro-cerebellum.
    Note: these regions are distinguished from each other based on the connections which they make.

- **Vestibulo-cerebellum = Archicerbellum = fluculo-nodular lobe:**
  - **Input**: from vestibular nuclei.
  - **Output**: to vestibular nuclei which will send fibers up and down:
    - ✓ Ascending fibers: known as the medial longitudinal fasciculus which functions in internal connection between the nuclei of 3rd, 4th and 6th cranial nerves in the brainstem.
    - ✓ Descending fibers: known as vestibulospinal tract which functions in stimulation of anti-gravity muscles (extensors).
  - **Functions:**
    - ✓ Balance.
    - ✓ Tone of extensor muscles.
    - ✓ Movement of eyes with movement of head.
- **Spino-cerebellum:**
  - **Inputs**: fibers are coming from:
    - ✓ Dorsal spino-cerebellar tract: unconscious proprioception from lower limbs. It is passing to the cerebellum through inferior cerebellar peduncle.
    - ✓ Ventral spinocerebellar tract: unconscious proprioception from lower limbs. It is passing to the cerebellum through superior cerebellar peduncle.
    - ✓ Cuneocerebellar tract: unconscious proprioception from upper limbs.
  - **Output**: from vermal and paravermal areas to interposed nuclei and then fibers will either go up or down:
    - ✓ Ascending fibers: cerebello-rubro-thalamic pathway which functions in modifying movement and correcting it.
    - ✓ Descending fibers: rubrospinal tract (enhancing contraction of flexor muscles).
- **Cerebro-cerebellum:**
  - **Input**: cortico-pontine fibers reaching the cerebellar cortex through the middle cerebellar peduncle.
  - **Output**: from cerebellar cortex to dentate nuclei to red nuclei and eventually to thalami (dento-rubro-thalamic pathway).
- **The cerebellum is therefore divided into 3 zones:**
  - **Median zone** → vestibulocerebellum → fastigial nucleus.
  - **Paramedian zone** → spinocerebellum → interposed nucleus.
  - **Lateral zone** → cerebrocerebellum → dentate nucleus.

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BASAL NUCLEI

- **Definition**: they are collection of cell bodies located inside the CNS and surrounded by white mater. They are composed of:
  - **Caudate nucleus**: the tip of this nucleus is the amygdala.
  - **Lentiform nucleus**: which is further composed of:
    - ✓ Putamen.
    - ✓ Globus pallidus: there is globus pallidus externus located laterally and globus pallidus internus located medially.
  - **Internal capsule.**
  - **Subthalamic nucleus.**
  - **Substantia nigra**: which is divided into pars compacta (with dense nuclei) and pars reticulata with scattered nuclei.
- **The internal capsule has 2 limbs:**
  - **Anterior limb:** which is mainly sensory.
  - **Posterior limb**: which is concerned with passage of corticospinal tract, hearing and vision.
  - **Genu**: the angle between the anterior and posterior limbs.

- **Why does termor at rest occur in patients with Parkinson's disease?**
  - Because there is decreased dopamine release → thus cholinergic fibers will be active (because they remain unchecked) → resulting in the formation of reverberating circuits → leading to alternative contractions of agonists and antagonists (at resting conditions).

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COMPARISON BETWEEN CLINICAL SIGNS OF CEREBELLAR AND EXTRAPYRAMIDAL LESIONS

Cerebellar lesion	Extrapyramidal lesion
Hypotonia	Rigidity
Ataxia	Festinant gait
Dysarthria/ dysmetria	Dyskinesias (inertia)
Intentional tremor	Tremor at rest
Titubation	Athetosis
Dydiadochokinesia	Chorea
Nystagmus	Hemiballismus
Visceral disturbances	