Neuroanatomy Corner

The Cerebellum – neuroscience aspects

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- ✓ The cerebellum lies in the posterior cranial fossa.
- ✓ It weighs around 150gms in an adult. It lies behind the pons and medulla.
- ✓ It has superficial grey matter forming the cerebellar cortex. It is a thin layer covering the central core of white matter.
- ✓ The cerebellum consists of two lateral hemispheres and a part along the midline called vermis.
- ✓ The important fissures are the primary fissure and the posterolateral fissure which divide the Cerebellum into anterior, posterior (middle) and flocculonodular lobe.
- ✓ Some of the fissures on the surface of the cerebellum are deeper than others, which further divides the lobes into lobules.

Within the central core of white matter are masses of grey matter, which constitute the cerebellar nuclei.

1. The dentate nucleus : it lies in the centre of the each cerebellar hemisphere.
2. The emboliform nuclei : it lies on the medial side of the dentate nucleus
3. The globose nucleus : It lies medial to the emboliform nucleus
4. The fastigial nucleus : it lies close to the midline in the anterior part of the vermis.

The cerebellar cortex is uniformly divided into three layers, namely

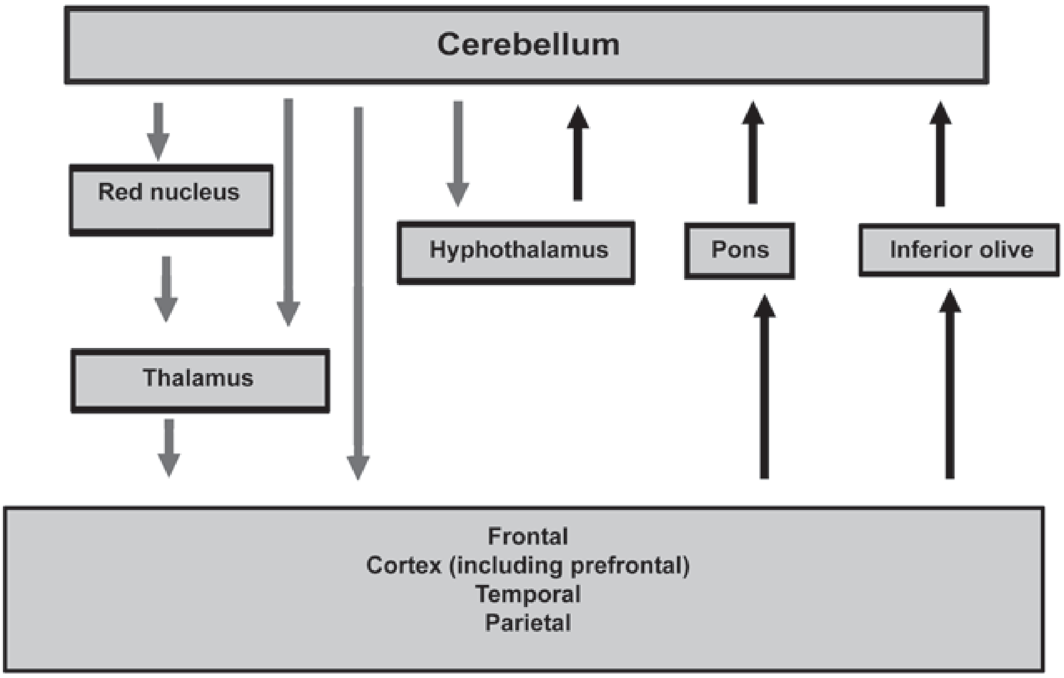
1. molecular layer,
2. purkinje cell layer and
3. granular cell layer.

The cerebellum consists of five main types of cells –

1. purkinjee cells,
2. granule cells,
3. outer stellate cells,
4. basket cells,
5. golgi cells and the brush cells.

The neurons in the molecular layer are supported by large neuroglial cells called cells of Bergmann.

Neurotransmitters in the cerebellum include glutamate, aspartate, GABA, serotonin, noradrenaline and acetylcholine. The cerebellar nerve fibers also show the presence of encephalin, somatostatin, aspartate and corticotrophin releasing factor. The main neurotransmitter is glutamate.



Grey arrows: efferent connections. Black arrows: efferent connections.

Figure 1 - Cerebellar connections

Connections of the cerebellum-

AFFERENT CONNECTIONS

The cerebellum receives direct afferents from the spinal cord and various other centres in the brainstem. The major afferent connections include:

1. Spinocerebellar: They terminate predominantly on the paleocerebellum
2. Pontocerebellar : They are a part of the cortico-ponto-cerebellar pathway.
3. Olivocerebellar: They are received from the inferior Olivary complex of the contralateral side.
4. Vestibulocerebellar: They arrive from the vestibular nucleus as well as directly from the vestibular nerve.
5. Reticulocerebellar: They are the fibres from the reticular formation of the pons and the medulla.

EFFERENT CONNECTIONS

The main efferents of the cerebellum are

1. Cerebello-rubral: to the contralateral red nucleus.
2. Cerebello-thalamic: to the contralateral thalamus.
3. Cerebello-vestibular: to the vestibular nucleus.
4. Cerebello-reticular: to the reticular formation.
5. Some fibres also reach the Olivary nucleus, the nucleus of the occulomotor nerve and the tectum.

CEREBELLAR PEDUNCLES

The fibres leaving or entering the cerebellum pass through thick bundles called cerebellar peduncles. They are the superior, middle and the inferior cerebellar peduncles. These connect the cerebellum to the midbrain, pons and medulla respectively.

CEREBELLUM AND PSYCHIATRIC DISORDERS

1. **Schizophrenia -** Soft neurological signs suggestive of cerebellar dysfunction, suchas subtle ataxia, difficulties in coordination, dysdiadochokinesia, intentional tremor, dysmetria of the ocular saccadic movements are frequent in patients with schizophrenia. Additionally, emergence of positive symptomatology (especially delusions), aswell as cognitive deficits (e.g., difficulties in synthesis and logical sequencing and verbal fluency) and negative symptomatology including flattened affect, thought disorder, avolition, socialization, and poor speech, have frequently been reported in individuals with cerebellar lesions. Neurostructural studies have revealed smaller total cerebellar volume, smaller vermis volume, reduction of hemispheric asymmetry, while functional neuroimaging studies using cognitive paradigms have demonstrated frontal-thalamic-cerebellar hypoactivity in schizophrenia.

2. **Bipolar disorder** – a greater rate of cerebellar atrophy in manic patients and in patients with bipolar disorder who were over 50 years old, but not in younger bipolar patients compared with healthy volunteers. Cerebellar hypermetabolism is a finding restricted to treatment resistant bipolar subjects.

3. **Unipolar depression -** reduced cerebellar volume and patients with depression displayed lower cerebellar regional cerebral blood flow (rCBF) in the cerebellum and thalamus.

4. **Anxiety disorders -** Cerebellum might play a role in anxiety manifestations like hyper arousal symptoms, which are present in different disorderssuch as posttraumatic stress disorder (PTSD) and generalized anxiety disorder (GAD). Cerebellum seems to be reduced in its volume but activated in some tasks in patients with anxiety disorders.

5. **Neurodegenerative dementias -** -cerebellar atrophy is due to vascular factors, molecular factors (dementia pathophysiological mechanisms directly affecting cerebellum) or by toxins (e.g., alcoholic dementia). Cerebellum appears to be affected in later stagesof dementia, probably due to the atrophy of superior structures and spreading of disease.

6. **Attention deficit hyperactivity disorder -** Smaller cerebellar volume in ADHD patients in comparison with normal controls.

RECOMMENDED REFERENCES

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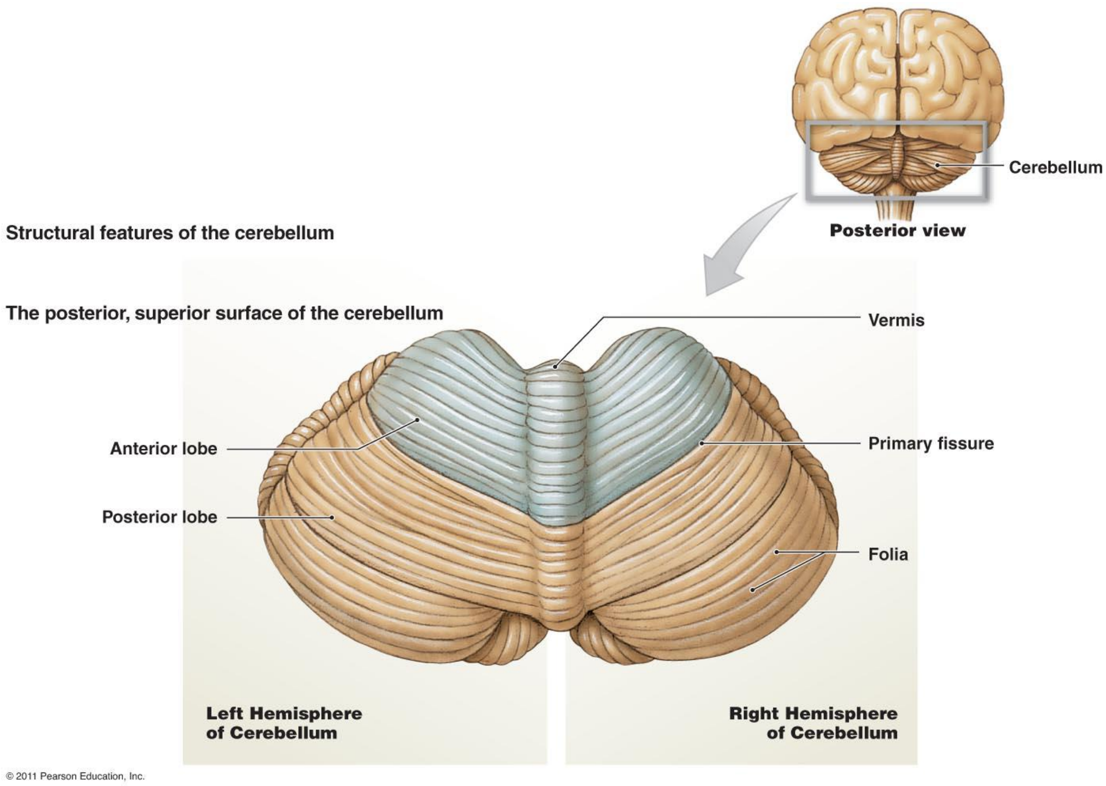

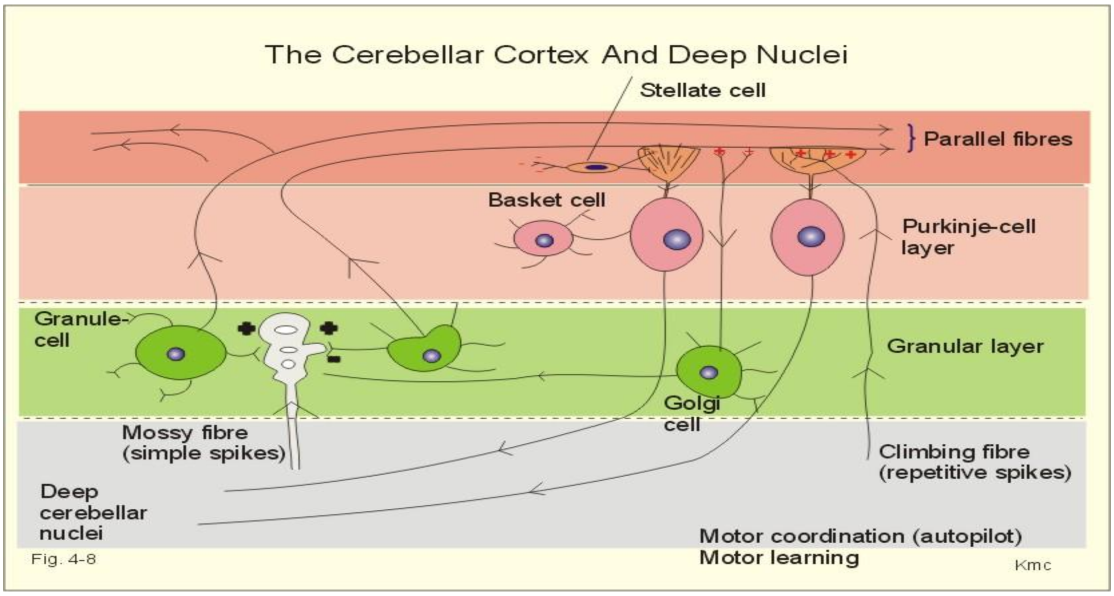

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