"White Matter of Cerebrum (Part 1/1)"

》 Composition:

- Myelinated nerve fibers of different diameters
- Supported by neuroglia

》 Classification of Nerve Fibers:

- Commissural fibers
- Association fibers
- Projection fibers

》 Commissural Fibers

> Function

- Connect corresponding regions of the two hemispheres

> Types:

i) Corpus Callosum:

- Largest commissure of the brain
- Connects the two cerebral hemispheres
- Located at the bottom of the longitudinal fissure

-> Divided into:

- Rostrum: Thin part of the anterior end, continuous with the upper end of the lamina terminalis

- Genu: Curved anterior end, bends inferiorly in front of the septum pellucidum

- Body: Arches posteriorly and ends as the splenium

- Splenium: Thickened posterior portion

-> Fiber Pathways:

- Genu fibers: Curve forward into the frontal lobes, forming the forceps minor

- Body fibers: Extend laterally as the radiation of the corpus callosum
  - Intersect with association and projection fibers
  - Form the roof and lateral wall of the posterior horn of the lateral ventricle
  - Form the lateral wall of the inferior horn of the lateral ventricle (tapetum)

- Splenium fibers: Arch backward into the occipital lobe, forming the forceps major

ii) Anterior Commissure:

- Small bundle of nerve fibers crossing the midline in the lamina terminalis

-> Fiber Pathways:

• Smaller anterior bundle: Curves forward toward the anterior perforated substance and the olfactory tract

• Larger bundle: Curves posteriorly, grooves the inferior surface of the lentiform nucleus to reach the temporal lobes

iii) Posterior Commissure

> Location:

- Crosses the midline immediately above the opening of the cerebral aqueduct into the third ventricle
- Related to the inferior part of the stalk of the pineal gland

> Components:

- Various collections of nerve cells along its length

> Function:

- Unknown for many fibers
- Fibers from the pretectal nuclei involved in the pupillary light reflex cross in this commissure on their way to the parasympathetic part of the oculomotor nuclei

iv) Fornix

> Composition:

- Myelinated nerve fibers

> Function:

- Efferent system of the hippocampus to the mammillary bodies of the hypothalamus

> Structure:

- Alveus: Thin layer of white matter covering the ventricular surface of the hippocampus

- Fimbria: Formed by converging nerve fibers from the alveus

- Posterior Columns: Formed by fimbriae arching forward above the thalamus and below the corpus callosum

- Body of the Fornix: Formed by the two columns coming together in the midline

- Commissure of the Fornix: Transverse fibers that cross the midline and connect one posterior column to another just before forming the body of the fornix

> Function of the Commissure of the Fornix:

- Connects the hippocampal formations of the two sides

v) Habenular Commissure

> Location:

- Crosses the midline in the superior part of the root of the pineal stalk

> Components:

- Associated with the habenular nuclei situated on either side of the midline
- Habenular nuclei receive many afferents from the amygdaloid nuclei and the hippocampus

> Function:

- Unknown in humans

> Fiber Pathways:

- Afferent fibers pass to the habenular nuclei in the stria medullaris thalami

- Some fibers cross the midline to reach the contralateral nucleus through the habenular commissure

》 Association Fibers

> Function: Connect various cortical regions within the same hemisphere

> Types:

-1) Short Association Fibers:

- Location: Immediately beneath the cortex
- Function: Connect adjacent gyri
- Path: Run transversely to the long axis of the sulci

2) Long Association Fibers:

- Collected into named bundles that can be dissected in a formalin-hardened brain

• Uncinate Fasciculus:

- Connects the first motor speech area and the gyri on the inferior surface of the frontal lobe with the cortex of the pole of the temporal lobe

• Cingulum:

- Long, curved fasciculus within the white matter of the cingulate gyrus
- Connects the frontal and parietal lobes with parahippocampal and adjacent temporal cortical regions

• Superior Longitudinal Fasciculus:

- Largest bundle of nerve fibers
- Connects the anterior part of the frontal lobe to the occipital and temporal lobes

• Inferior Longitudinal Fasciculus:

- Runs anteriorly from the occipital lobe, passing lateral to the optic radiation
- Distributed to the temporal lobe

• Fronto-occipital Fasciculus:

- Connects the frontal lobe to the occipital and temporal lobes
- Located deep within the cerebral hemisphere
- Related to the lateral border of the caudate nucleus

》 Projection Fibers

> Function: Afferent and efferent nerve fibers passing to and from the brainstem to the entire cerebral cortex

> Pathway:

• Internal Capsule

- Form a compact band known as the internal capsule at the upper part of the brainstem

- Medial boundary: Caudate nucleus and the thalamus

- Lateral boundary: Lentiform nucleus

> Structure:

- Bent to form an anterior limb and a posterior limb, continuous at the genu
- Emerge superiorly from between the nuclear masses, radiating in all directions to the cerebral cortex

• Corona Radiata: Radiating projection fibers

> Location:

- Most projection fibers lie medial to the association fibers but intersect with the commissural fibers of the corpus callosum and the anterior commissure

> Optic Radiation: Nerve fibers in the most posterior part of the posterior limb of the internal capsule radiate toward the calcarine sulcus

》 Septum Pellucidum

> Structure:

- Thin vertical sheet of nervous tissue
- Consists of white and gray matter
- Covered on either side by ependyma
- Double membrane with a closed, slitlike cavity between the membranes

> Location:

- Stretches between the fornix and the corpus callosum
- Anteriorly, occupies the interval between the body of the corpus callosum and the rostrum
- Forms a partition between the anterior horns of the lateral ventricles

》 Tela Choroidea

> Structure:

- Two-layered fold of pia mater
- Covered by ependyma

> Location:

- Situated between the fornix (superiorly) and the roof of the third ventricle and the upper surfaces of the two thalami (inferiorly)
- Anterior end at the interventricular foramina
- Lateral edges project into the body of the lateral ventricles, forming the choroid plexuses of the lateral ventricle

- Posteriorly, lateral edges continue into the inferior horn of the lateral ventricle, projecting through the choroidal fissure
- Projects down through the roof of the third ventricle to form the choroid plexuses of the third ventricle

> Blood Supply:

- Derived from choroidal branches of the internal carotid and basilar arteries
- Venous blood drains into the internal cerebral veins, uniting to form the great cerebral vein
- The great cerebral vein joins the inferior sagittal sinus to form the straight sinus

"Clinical Notes"

》 Thalamic Lesions

> Cause: Thrombosis or hemorrhage of arteries supplying the thalamus.

> Symptoms:

- Major impairment of all forms of sensation on the contralateral side of the body.
- Affected sensations include light touch, tactile localization and discrimination, and joint movements.

1) Subthalamic Lesions

> Role: Part of the extrapyramidal motor nuclei, connected with the globus pallidus.

> Symptoms:

- Sudden, forceful involuntary movements in a contralateral extremity.
- Movements can be jerky (choreiform) or violent (ballistic).

» Pineal Gland

> Structure: Composed of pinealocytes and glial cells, supported by connective tissue.

> Age-related Changes:

- Accumulation of calcareous concretions within glial cells and connective tissue.
- These deposits are useful for radiologists as landmarks.

> Functions: (PPP-AG)

- Mainly inhibitory, influencing the pituitary gland, islets of Langerhans, parathyroids, adrenals, and gonads.
- Pineal tumors or tumors pressing on the pineal gland can severely alter reproductive function.

» Hypothalamus

> Importance: Controls emotional states and regulates fat, carbohydrate, and water metabolism.

> Functions:

- Influences body temperature, genital functions, sleep, and food intake.
- Plays a role in the release of pituitary hormones.

》 Hypothalamic Syndromes:

- Causes: Infection, trauma, vascular disorders, tumors (e.g., craniopharyngioma, chromophobe adenoma of the pituitary, pineal tumors).
- Symptoms: Genital hypoplasia or atrophy, diabetes insipidus, obesity, sleep disturbances, irregular pyrexia, and emaciation.
- Example: Adiposogenital dystrophy syndrome.

》 Cerebral Cortex, Sulci, and Cerebral Hemisphere Lobes

> Structure:

- Composed of gray matter.
- One-third lies on the exposed convexity of the gyri, two-thirds in the walls of the sulci.

> Function:

- Different areas of the cortex have different functions.
- Anatomical division into lobes and gyri by sulci aids in localizing loss of function or brain lesions.

> Lesions:

• Precentral gyrus: Contralateral hemiparesis.

• Postcentral gyrus: Contralateral hemisensory loss.

• Frontal lobe: Symptoms include loss of attention span or change in social behavior.
- Widespread degeneration leads to dementia.

》 Lateral Ventricles

> Contents: Each lateral ventricle contains about 7 to 10 mL of cerebrospinal fluid (CSF).

> CSF Production and Flow:

- Produced in the choroid plexus of the lateral ventricle.
- Drains into the third ventricle through the interventricular foramen (foramen of Monro).
- Blockage of the foramen by a cerebral tumor can cause ventricle distention, resulting in a type of hydrocephalus.

> Choroid Plexus:

- Continuous with the choroid plexus of the third ventricle through the interventricular foramen.
- Largest where the body and posterior and inferior horns join.
- May become calcified with age, visible on radiographs, but should not be confused with calcification of the pineal gland.

> Diagnostic Procedures

i) Past Methods:

- Pneumoencephalography: Small amounts of air introduced into the subarachnoid space by lumbar puncture, used to investigate the size and shape of the lateral ventricle.
  - Risky if the patient had raised intracranial pressure.

- Ventriculography: Air or radiopaque fluid injected directly into the lateral ventricles through a burr hole in the skull.

ii) Current Methods:

- CT and MRI: Replaced previous methods for investigating the lateral ventricles.

》 Basal Nuclei

> Components: Masses of gray matter within the cerebrum, including:

- Caudate nucleus
- Lentiform nucleus
- Amygdaloid nucleus
- Claustrum

> Clinical Significance:

• Tumors:

- Tumors of the caudate or lentiform nuclei may cause severe motor or sensory symptoms on the opposite side of the body due to their proximity to the internal capsule.
- Tumors pressing on the anterior two-thirds of the posterior limb of the internal capsule cause progressive spastic hemiplegia.
- Tumors located more posteriorly impair sensation on the opposite side.

》 Cerebral Commissures

i) Corpus Callosum: Commissural fibers

> Function:

- Major commissure interconnecting symmetrical areas of the cerebral cortex.
- Essential for learned discrimination, sensory experience, and memory by transferring information between hemispheres.

> Developmental Issues:

- Failure to develop can occur without definite signs or symptoms.

> Effects of Damage:

- Destruction later in life isolates hemispheres, causing patients to respond as if they have two separate brains, but general intelligence and behavior remain normal.
- Example: If a pencil is placed in the right hand (eyes closed), the patient can describe it; if in the left hand, the information cannot travel to the speech area, so the patient cannot describe it.

> Surgical Intervention:

- Surgical sectioning attempted to prevent seizure spread between hemispheres.

》 Internal Capsule Lesions: Projection fibers

> Structure

- Compact band of white matter composed of ascending and descending nerve fibers connecting the cerebral cortex to the brainstem and spinal cord.
- Flanked medially by the caudate nucleus and thalamus, and laterally by the lentiform nucleus.

> Clinical Significance

- Frequently involved in vascular disorders.
- Common cause: arterial hemorrhage due to atheromatous degeneration in patients with high blood pressure.
- High concentration of important nerve fibers means even a small hemorrhage can cause widespread effects on the contralateral side.
- Hemorrhage destroys neural tissue and can compress or cause edema in neighboring nerve fibers.

》 Alzheimer Disease

> Overview

• Nature:

- Degenerative brain disease occurring in middle to late life, with an early form now recognized.
- Affects over 4 million people in the U.S., causing over 100,000 deaths annually.
- Risk increases sharply with age.

> Etiology

• Unknown Cause:

- Evidence suggests genetic predisposition.
- Several abnormal genes (e.g., APP, presenilin 1, presenilin 2) linked to familial Alzheimer disease, indicating different pathogenetic mechanisms.

> Clinical Manifestations

• Early Symptoms:

- Memory loss, personality disintegration, complete disorientation, deterioration in speech, restlessness.

• Late Stages:

- Muteness, incontinence, bedridden state, usually leading to death from other diseases.

> Pathology

• Microscopic Changes:

- Early selective involvement of regions like the hippocampus, entorhinal cortex, and associated cerebral cortex areas.
- Presence of senile plaques resulting from protein accumulation around beta-amyloid deposits.
- Neurofibrillary tangles from hyperphosphorylated tau protein.
- Marked loss of choline acetyltransferase in affected cortical areas.
- Neuronal death due to cellular changes.

> Diagnosis

• No Definitive Clinical Test:

- Diagnosis relies on careful history, neurologic and psychiatric examinations.
- Exclusion of other dementia causes.
- Potential alterations in amyloid peptides or tau in serum or CSF.
- Use of CT scans or MRIs to identify abnormalities in the medial temporal lobe and advanced cases show a thin, atrophied cerebral cortex and dilated lateral ventricles.
- Positron emission tomography (PET) for diminished cortical metabolism.

> Treatment

• Cholinesterase Inhibitors:

- Found to be helpful by increasing acetylcholine presence where there is a deficiency.