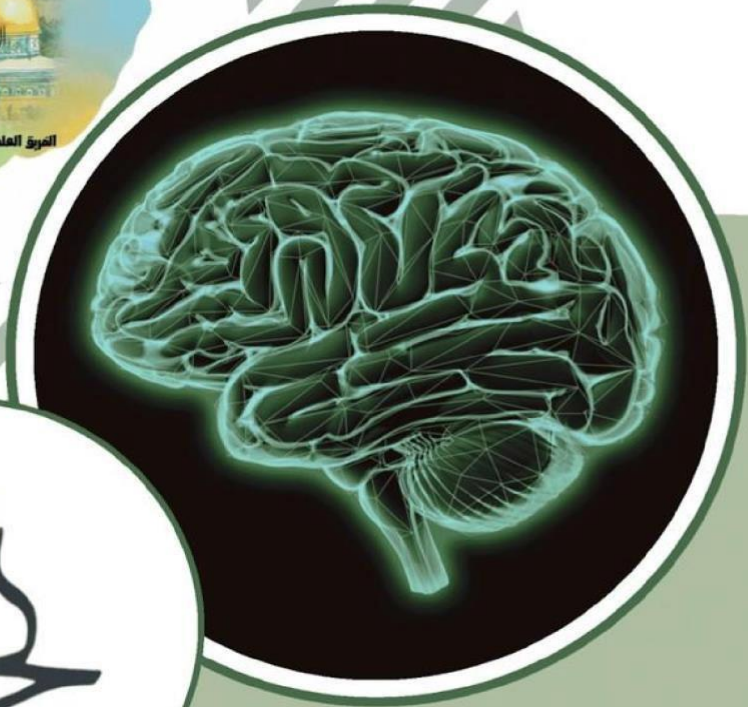


CNS ANATOMY

DOCTOR NOTES



LECTURE NO. 8

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Firstly let's talk about the percentage of blood that supplies the brain, by assuming that the cardiac output percentage is 100% **the brain blood supply will be around 15-20%** from the total cardiac output, this percent is not small at all so it's important to know each area blood supply since many disorders or diseases happen due to problems in the blood supply of the brain (e.g: if the artery that supplies the internal capsule is affected hemorrhage and hemiplegia will happen immediately). Once a stroke take place in the brain, the tissues take a minutes to hours and it can reach 4 days to die and cause infraction ,then it established and we start with the patient's treatment.

8.1 Blood Supply area of the Brain:

We have 2 systems: the **vertebral basilar system** (posterior circulation) and the **internal carotid system** (anterior circulation).

Circle of Willis is an arterial ring that is located inside the interpeduncular fossa that is located between the cerebral peduncles which are the ventral surface of the midbrain, it holds the brainstem in the inferior surface and the whole pathway that passes from the cerebral cortex to the brainstem.

What is the physiological significant of circle of willis?
The connection between posterior and anterior circulation can help when one of them was occluded, the other one will make perfusion of blood for brain.

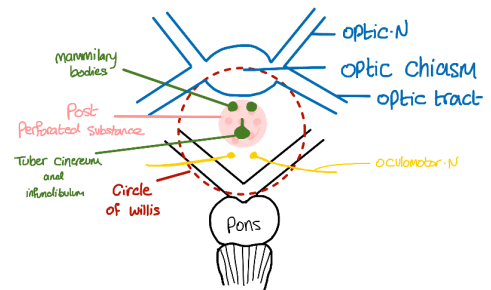


Figure (1)

The **optic tract** connects between the beginning of the **optic chiasm** till the lateral geniculate body. Anteriorly it is bounded by the optic chiasm and posteriorly crus cerebri and upper back of pons.

The interpeduncular fossa floor anatomically contains **mammillary bodies** (the two nuclei of the hypothalamus) and **perforated area** by branches from the posterior cerebral artery so it is called posterior perforated substance, **oculomotor nerve** comes out from this area too (remember the other nerve that comes out from the brain is called trochlear specifically from the posterior part of the brainstem), **pituitary gland** is hanged here too (**tuber cinereum** and **infundibulum**).

Around there is the subarachnoid cisterna (enlargement of the subarachnoid space in specific areas to provide protection for certain structures mainly blood vessels), it is called interpeduncular cisterna.

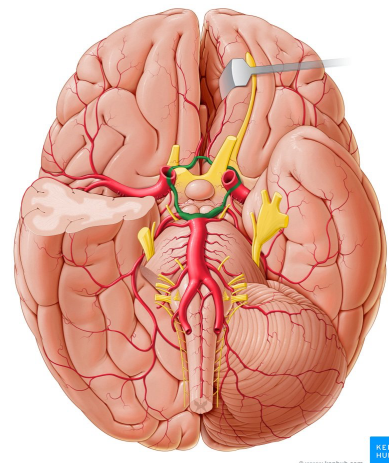


Figure (2): Extra

8.2 Origin of circle of Willis:

Around the medulla there is an artery runs on the right and left sides, it comes from the **1st part of the subclavian artery** which is the **vertebral artery**, the 2 vertebral arteries unite in the upper portion of the medulla making an artery in the middle called the **basilar artery**, it walks alone in the basilar cisterna that protects the artery located in the basilar groove of pons, then it goes to the upper border of pons and makes bifurcation making the **posterior cerebral artery**.

This circulation is called the **vertebral basilar circulation (posterior circulation)**.

Anterior we have the **anterior circulation** that comes from the **internal carotid artery**, it runs inside to supply the brain from the inside through the carotid foramen that is located on the base of the skull in the petrous part of the temporal bone then to the carotid canal then it walks inside the cavernous sinus that is located on the anterior border of the foramen lacerum besides sella turcica, it crosses the cavernous sinus from posterior to anterior then separated into 2 branches: **anterior and middle cerebral artery**. (4 courses).

-The anterior cerebral artery runs superior to the cc in the callosal sulcus.

-The **anterior communicating artery** connects between the 2 anterior cerebral artery, it is a branch of the anterior cerebral artery.

Posterior communicating artery also closes the ring but posteriorly, but this artery arises from the internal carotid itself.

-The only artery that is not part of the circle of Willis: the middle cerebral artery.

-Thrombosis or embolism here will block the anterior or the posterior circulation the blood then will run inside the communicating artery.

-70% of the blood comes from the carotid circulation, 30% from the vertebrobasilar circulation

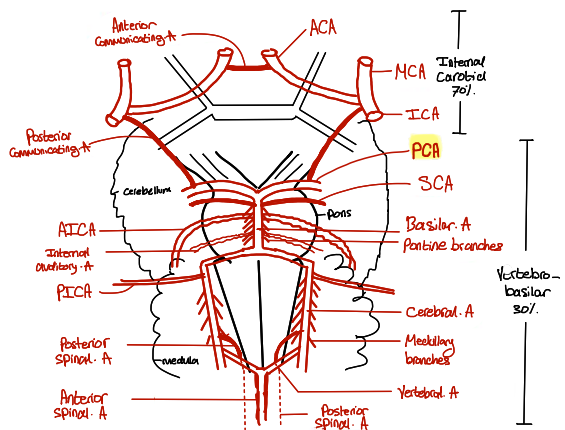


Figure (3)

8.3 Main Branches:

Vertebral artery: (1) **medullary branches** since it runs there, an artery that is resulted from the union of these 2 vertebral arteries in the anterior median fissure then it supplies the anterior surface of the medulla and the anterior spinal cord which is called the (2) **anterior spinal artery**, in the posterolateral sulci we have (3) **two posterior spinal arteries**. (2/3 is supplied by the anterior spinal artery and 1/3 by the posterior spinal arteries), (4) **PICA** which supplies the cerebellum and the lateral side of the medulla.

-Embolism in the PICA will lead to lateral medullary syndrome (Wallenberg syndrome), since it supplies the lateral side of the medulla.

-Anterior spinal artery lesion will lead to medial medullary syndrome (Dejerine syndrome).

Basilar artery: since it runs in pons it will give rise to (1) **pontine branches**, two branches supply the cerebellum (2) **AICA**, (3) **two superior cerebellar arteries(SCA)** run on the upper surface of the pons bodies, long artery supplies the inner ear labyrinth called (4) **internal auditory artery** or artery of the inner ear or labyrinthine artery.

-Since 2 branches from the basilar artery supply the cerebellum, it is considered more important than the vertebral artery that gives one branch only.

Internal carotid: (1) **Anterior cerebral artery**, (2) **middle cerebral artery**, (3) **anterior choroidal artery** (branches of the internal capsule will be discussed later) it gives rise to the choroid plexus of the lateral and 3rd ventricles, (4) **ophthalmic artery** that supplies the eye, (5) **artery of the pituitary gland**.

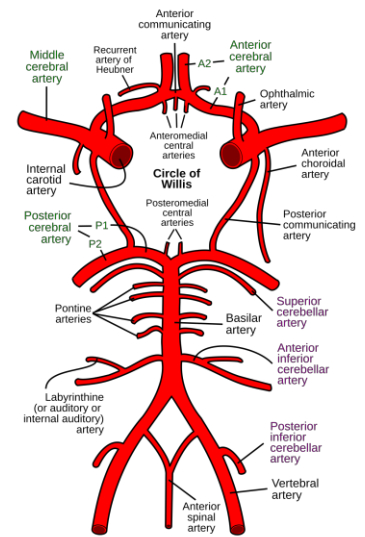


Figure (4): Extra

8.4 Blood Supply area of the Cerebral Cortex:

The blood supply to the cerebral cortex can be divided into three surfaces: the medial, lateral, and inferior surfaces.

- **Lateral Surface:** The lateral surface is identified by the posterior rami of the lateral fissure. The blood supply to this surface comes from the internal carotid artery, which gives rise to the middle cerebral artery.
- **Medial Surface:** The medial surface is defined by the corpus callosum and fornix, with the septum and thalamus located inferior to these structures. The internal carotid artery supplies this surface through the anterior cerebral artery, which runs along the callosal sulcus. Additionally, the posterior cerebral artery originates from the basilar artery and travels along the basal surface, running through the calcarine fissure of the medial surface.
- **Inferior Surface:** The inferior surface is defined by the stem of the lateral fissure, which divides it into the tentorial and orbital surfaces.

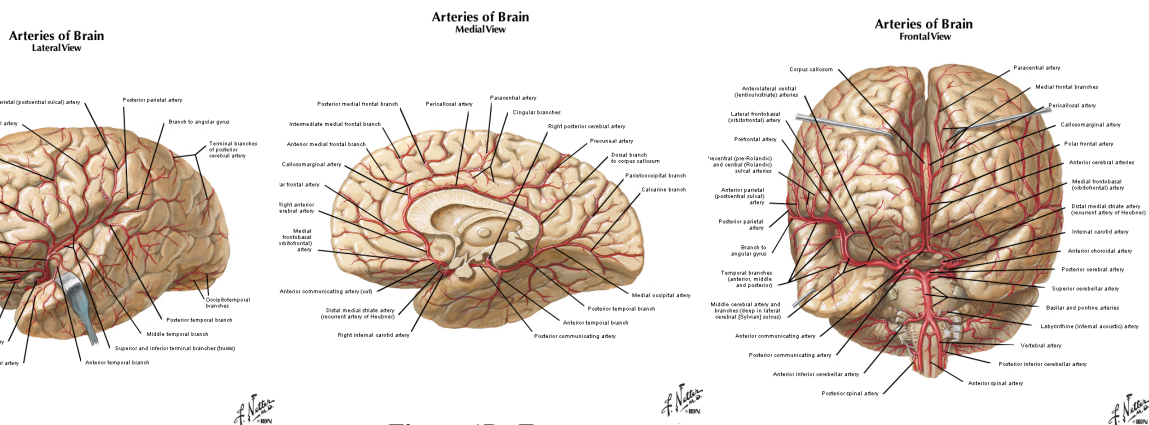


Figure (5): Extra

Both the Middle Cerebral Artery (MCA) and the Anterior Cerebral Artery (ACA) originate from the internal carotid artery. Let's look at the areas supplied by each artery, with each color represents the region: blue for MCA, green for ACA, and orange for PCA.

- **Lateral Surface:** The MCA supplies the entire lateral surface of the brain, except for the upper and lower 1 inch. The upper 1 inch is supplied by the ACA, extending to the parieto-occipital fissure, while the entire occipital lobe and the lower 1 inch are supplied by the PCA.
- **Medial Surface:** The ACA supplies most of the medial surface, including the fornix, septum pellucidum, and most of the corpus callosum, up to the parieto-occipital fissure. The PCA supplies the **occipital lobe, tentorial surface**, thalamus, and the splenium of the corpus callosum.
 - Additionally, the temporal pole is supplied by the **MCA**, while
 - **PCA** also supplies the midbrain, Thalamus, and Splenium of the corpus callosum

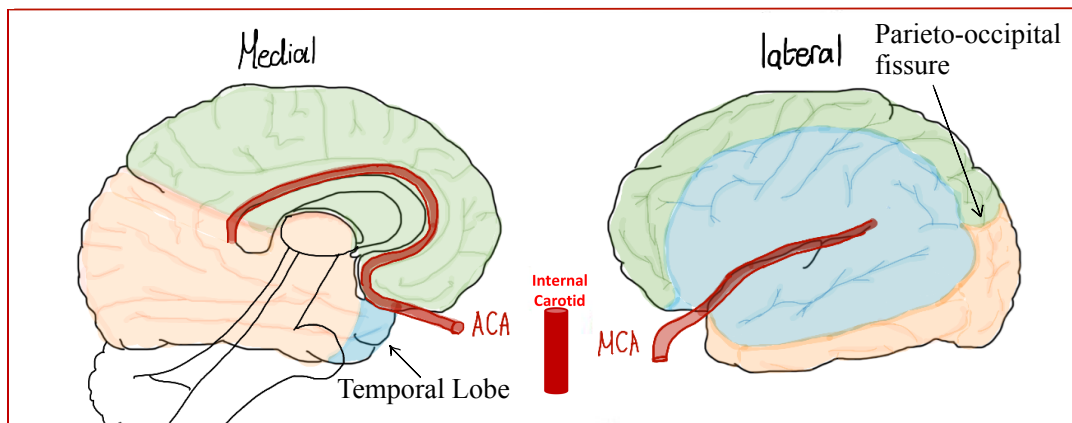


Figure (6)

- The inferior Surface is divided into :
 1. orbital surface is supplied by two arteries: the **anterior cerebral artery (ACA)** on the medial half and the **middle cerebral artery (MCA)** on the lateral half. The temporal pole is supplied by the MCA.
 2. the **tentorial surface** is supplied by the posterior cerebral artery (PCA).

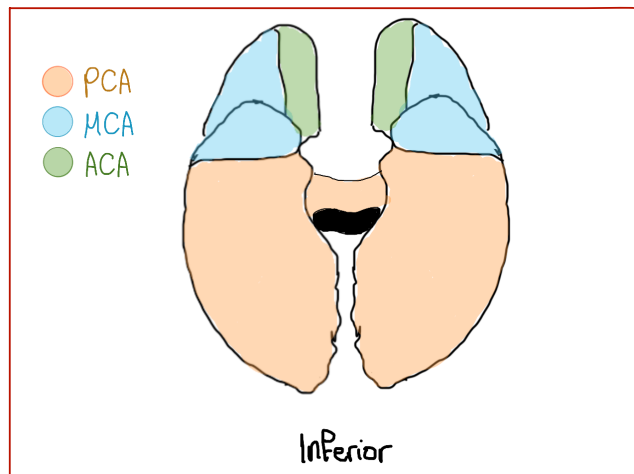


Figure (7)

8.5 Clinical Applications:

1. A lesion in the **paracentral** lobule affects the motor and sensory functions of the lower limb below the knee and the sphincters. The anterior part is responsible for motor function, while the posterior part is responsible for sensory function. Therefore, a lesion in the **anterior cerebral artery (ACA)** can lead to specific deficits.
2. A lesion of the middle cerebral artery (**MCA**) can result in hemiplegia, except affecting the lower limb.
3. A lesion in the MCA, particularly in the Wernicke's area, can cause fluent aphasia and potentially non-fluent aphasia as well. This lesion would typically be located in the left dominant hemisphere, rather than the right.
4. Loss of conjugate eye movement is typically due to a lesion in the MCA. Recall that area 8, located in the middle frontal gyrus, is responsible for eye tracking; therefore, a lesion here will cause ipsilateral consequences. This means a lesion on the right side will cause both eyes to deviate toward the right side.
5. A lesion in the ACA on the inferior surface can affect the rectus gyrus.
6. The precuneus is supplied by the ACA. A lesion in the precuneus can cause problems with episodic memory, which is responsible for remembering specific events, as opposed to semantic memory.
7. The prefrontal gyrus, which is responsible for personality, is supplied by the ACA and is located on the medial surface. Consequently, a lesion in the ACA can affect most of the limbic loop, except for the hippocampus, which is supplied by the posterior cerebral artery (PCA).
8. The uncus, located at the anterior part of the temporal pole, is supplied by the MCA.
9. The midbrain, thalamus and the splenium corpus callosum is supplied by PCA, the corpus callosum except the splenium is supplied by ACA.

In clinical scenarios, the doctor may ask which artery supplies a specific area or vice versa.

8.6 Blood Supply area of the Internal Capsule:

The **corpus striatum (putamen+caudate)** can be divided into two halves: the anterior part, which is supplied by the **anterior cerebral artery (ACA)**, and the posterior part, supplied by the **middle cerebral artery (MCA)**.

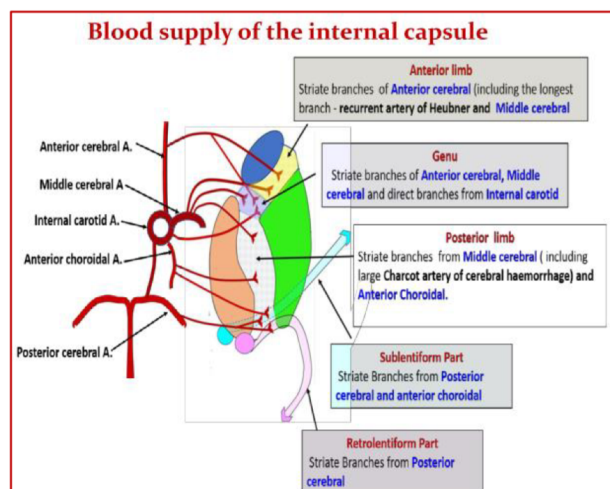


Figure (8)

- The ACA supplies the following regions:
 1. Anterior part of the caudate nucleus
 2. Anterior part of the anterior limb of the internal capsule
 3. Anterior part of the lentiform nucleus
- The MCA supplies:
 1. Posterior part of the caudate nucleus
 2. Posterior part of the lentiform nucleus.
 3. Parts of the internal capsule, including:
 - a. Posterior part of the anterior limb of the internal capsule
 - b. Genu
 - c. Most of the posterior limb of the internal capsule, with the exception of a small part
- PCA provides blood supply to the thalamus and the posterior part of the posterior limb of the internal capsule. The metathalamus consists of the medial geniculate body (MGB) and the lateral geniculate body (LGB).

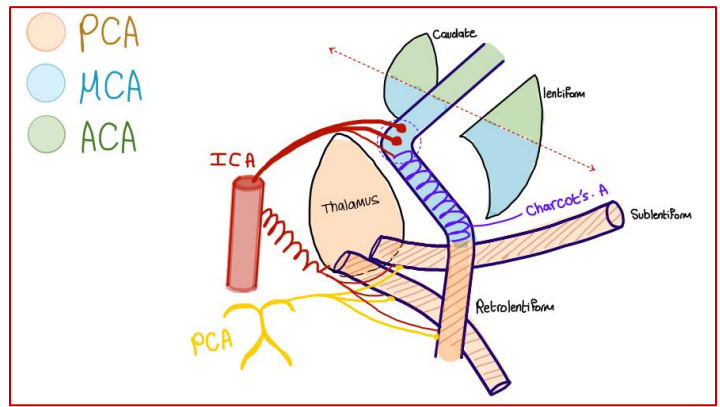


Figure (9)

- PCA supplies these parts but notice anterior choroidal artery that also give supply also, is branch of internal carotid, that supplies posterior part of posterior limb ,sublentiform and retrolentiform parts of internal capsule.
- The **internal carotid artery** gives rise to direct branches that supply the **genu of the internal capsule**, which is clinically significant.
- If there is a lesion in the **middle cerebral artery (MCA)**, the part of the internal capsule that would be most affected is the posterior limb.

Charcot's artery is a branch from the MCA and runs in the posterior limb of the IC. **Charachot** artery has a thin wall, so when it ruptures, the blood accumulates in the posterior limb and affects the fibers running in them, which are both motor and sensory.

- Recall that the **posterior limb** has **sensory** fibers from the **medial lemniscus** and **motor** fibers from the **lateral corticospinal tract**; therefore, any injury in the posterior limb causes contralateral **hemiplegia** and **hemianesthesia**.
- Will this lesion affect his face and neck with hemianesthesia and hemiplegia? No, the part that carries fibers of the corticobulbar tract (neck and face) is the genu of the IC, and it is supplied by the **MCA and the anterior choroidal artery**.

-Note that venous drainage is not exam material; slides 30 to 37 cover this subject. The doctor said us to focus only on cortical supply and the lesions associated with each blood supply, as well as the blood supply to the corpus callosum and the striated branches, along with the blood supply in the internal capsule (as found in our notes).

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