CEREBRAL BLOOD CIRCULATION

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Resources

Essential of Human Anatomy & Physiology
By Elaine Marieb and Suzanne Keller

The Human Brain
By John Nolte

Atlas of Human Anatomy
By Frank Netter

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Objectives

- List the cerebral arteries.
- Describe the cerebral arterial supply regarding the origin, distribution and branches.
- Describe the arterial Circle of Willis.
- Describe the cerebral venous drainage and its termination.
- Describe arterial & venous vascular disorders and their clinical manifestations.
The cerebral blood circulation is the movement of blood through the network of blood vessels to supply the brain.

- The arteries carry oxygenated blood and other nutrients to the brain.
- The veins carry deoxygenated blood back to the heart removing carbon dioxide and other metabolic products.
- The movement of blood in the cerebral circulation is called cerebral blood flow.
Blood vessels are the part of the circulatory system that transports blood throughout the human body.

There are three major types of blood vessels:

- Arteries, which carry the blood away from the heart.
- Capillaries, which enable the actual exchange of water and chemicals between the blood and the tissues.
- Veins, which carry blood from the capillaries back toward the heart.

The word vascular, meaning relating to the blood vessels, is derived from the Latin vas, meaning vessel.

- Avascular refers to being without (blood) vessels.
The arteries and veins have three layers, but the middle layer is thicker in the arteries than it is in the veins:

- **Tunica Intima** (the thinnest layer): a single layer of simple squamous endothelial cells.
- **Tunica Media** (the thickest layer in arteries): is made up of smooth muscle cells and elastic tissue.
- **Tunica Adventitia** (the thickest layer in veins) entirely made of connective tissue.

Capillaries consist of little more than a layer of endothelium and occasional connective tissue.
Blood

- Blood is the actual carrier of the oxygen and nutrients into arteries.
- Blood is made mostly of plasma, which is a yellowish liquid that is 90% water.
- Plasma contains also salts, glucose and other substances.
- Most important, plasma contains proteins that carry important nutrients to the body’s cells and strengthen the body’s immune system.
- Blood has main 3 types of blood cells that circulate with the plasma.
The arterial cerebral circulation is divided into anterior and posterior cerebral circulations.

The anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries.

- Posterior communicating arteries are part of Circle of Willis.
  - Located on the base of the brain.
  - It Encircles:
    - Optic chiasma
    - Hypothalamus
    - Midbrain

The cerebral arterial supply is provided by two systems:

- Carotid System
  - Supply anterior portion of the brain.
- Vertebral-Basilar System
  - Supply posterior portion of the brain.
Circle of Willis

- Named after Thomas Willis (1621–1675), an English physician.
- Formed by:
  - Two Anterior cerebral arteries
  - Two Internal carotid arteries
  - Two Posterior cerebral arteries
  - Two Posterior communicating arteries
  - One Anterior communicating artery
- It gives numerous small vessels that penetrate the surface of the brain.
  - Perforating arteries
- They are divided into:
  - Anterior perforating arteries
  - Posterior perforating arteries
Anterior Perforating Arteries

- Arise from:
  - Anterior cerebral artery
  - Anterior communicating artery
  - Middle cerebral artery

- Enter brain through:
  - Anterior perforated substance
    - irregularly quadrilateral area in front of the optic tract and behind the olfactory trigone.

- Supply:
  - Large part of basal ganglia
  - Optic chiasma
  - Internal capsule
  - Hypothalamus
Posterior Perforating Arteries

- Arise from:
  - Posterior cerebral artery
  - Posterior communicating artery

- Enter brain through:
  - Posterior Perforated substance

- Supply:
  - Ventral portion of Midbrain
  - Parts of Subthalamus and Hypothalamus
Anterior Cerebral Arteries

- Supplies: Orbital and medial surfaces of frontal and parietal lobes.
Supplies:

- Anterior and inferior temporal lobes.
- Uncus.
  - Located on the tip end of the medial surface of the parahippocampal gyrus.
  - Part of the olfactory cortex that processes information from the sense of smell.
- Inferior temporal gyri.
- Inferior and Medial Occipital lobe.
Middle Cerebral Arteries

- Supplies: Entire Superolateral surface:
  - Somatosensory Cortex
  - Motor Cortex
  - Broca’s Area
    - linked to speech production.
  - Heschl’s Gyrus
    - to process incoming auditory information
  - Wernicke’s Area
    - It is involved in the understanding of written and spoken language
Distribution of Cerebral Arteries
Basilar Artery

- **Supplies:** Midbrain and Cerebellum.
- **Branches:**
  - Anterior inferior cerebellar artery.
  - Pontine branches.
  - Superior cerebellar artery.
Vertebral Arteries

- It originates from the subclavian arteries.
- Supplies: Spinal Cord and Cerebellum.
- Branches:
  - Anterior and posterior spinal arteries.
  - Posterior inferior cerebellar artery.
Arterial Disorder

- **Stroke**
  - Sudden occlusion
  - Hemorrhage

- **Aneurysm**
  - It localized, blood-filled balloon-like bulge in the wall of a blood vessel.

- **Angioma**
  - It is benign tumors derived from cells of the vascular or lymphatic vessel walls (epithelium) or derived from cells of the tissues surrounding these vessels.
Arterial Occlusion

- **Occlusion of ACA**
  - Motor disturbance in contralateral distal leg
  - Difficulty in Prefrontal lobe Functions:
    - Cognitive thinking
    - Judgment
    - Motor initiation
    - Self monitoring

- **Occlusion of PCA**
  - Visual disturbances
    - Contralateral homonymous hemianopsia
    - Bilateral lesions: cortical blindness
  - Memory impairment
    - If temporal lobe is affected

- **Occlusion of MCA**
  - Contralateral weakness of:
    - Face, arm, and hand more than legs
  - Contralateral sensory loss of:
    - Visual field cut (damage to optic radiation)
  - Aphasia: language disturbances
    - Broca’s production
    - Wernicke’s comprehension
It involves:

- **Superficial (cortical) veins:**
  - Drain the cortical surface

- **Deep veins:**
  - Drain the deep structures

These veins ultimately drain into:

- **Dural Venous Sinuses**

The Veins are thin walled and are devoid of valves.
Superficial Cortical Veins

- Lie on the brain surface, in the subarachnoid space.
- They are divided into:
  - Superior cerebral veins
  - Inferior cerebral veins
  - Superficial middle cerebral vein
Superior Cerebral Veins

- 6 to 12 veins.
- Drain lateral surface of brain above the lateral sulcus.
- Terminate mainly into the Superior Sagittal sinus, and partly into superficial middle cerebral vein.
Inferior Cerebral Veins

- Run below the lateral sulcus.
- Drain the lateral surface of the temporal lobe.
- Terminate partly into superficial middle cerebral vein & partly into Transverse sinus.
Superficial Middle Cerebral Veins

- Runs along the lateral sulcus.
- Terminates into the Cavernous sinus.
- Connected posteriorly by Superior & Inferior anastomotic veins to Superior Sagittal & Transverse sinuses, respectively.
They drain the internal structures:
- Basal ganglia
- Internal capsule
- Thalamus

They merge to form the **Internal Cerebral Veins**.

The two veins unite in the midline to form the **Great Cerebral vein**.

This short vessel is continuous with the **Straight Sinus**.
Cerebral Sinuses

- **The Superior Sagittal Sinus**
  - Lies along the superior border of the falx cerebri and empties into the confluence of sinuses.

- **The Inferior Sagittal Sinus**
  - Lies in the inferior border of the falx cerebri.
  - The great cerebral vein of Galen joins the inferior sagittal sinus to form the straight sinus.

- **The Transverse Sinuses**
  - Originate on each side of the confluence of sinuses.
  - Each transverse sinus travels laterally, and curves downward to form the sigmoid sinus that empties into the internal jugular vein on the same side.

- **The Confluence of Sinuses**
  - At the confluence of sinuses, the superior sagittal, straight, transverse, and occipital sinuses join.

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Cerebral Sinuses

- **The Cavernous Sinuses**
  - Located on each side of the sphenoid bone.
  - Ophthalmic and superficial middle cerebral veins drain into these sinuses.

- **The Sphenoparietal Sinuses**
  - Located below the sphenoid bone and drain into the cavernous sinus.

- **The Sigmoid Sinuses**
  - Receive blood from posterior dural venous sinus veins.
Cerebral venous sinus thrombosis is the presence of a thrombus within one of the dural venous sinuses.

- The thrombus block venous return through sinuses and causes accumulation of deoxygenated blood within the brain.
- This may lead to venous infarction (tissue death, necrosis) that is caused by a local lack of oxygen.
- The situation is complicated by the accumulation of cerebrospinal fluid, which can no longer drain through the venous sinus with thrombosis.
- Common clinical symptoms include headache, nausea, vomiting, and neurological defects.
- The diagnosis can be made by CT or MRI scan with contrast.
- Treatment by anticoagulation.
Questions?

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