

"Blood Supply of Brain and Spinal Cord (Part 2/2)"

<- Clinicals ->

- Resting Cardiac Output to Brain: 15%
- Arterial Supply to Brain:
- Main Arteries: Two internal carotid and two vertebral arteries
- Primary Blood Source: Internal carotid arteries
- Distributing Arteries: Primary Arteries:
- Anterior, middle, and posterior cerebral arteries
- Path and Anastomosis:
- Arise from circle of Willis
- Pass over brain surface, anastomosing with each other

- Branches penetrate brain at right angles, with no further anastomosis within the brain tissue

- Collateral Circulation:

- Surface anastomoses provide backup circulation if occlusion occurs

» Cerebrovascular Disease

- Impact:

- Accounts for ~50% of adult neurologic hospital admissions

- Recent Improvements:

- Decrease in cases due to management of high blood cholesterol and aggressive hypertension treatment

"Cerebral Ischemia"

» Effects of Blood Flow Interruption:

> Unconsciousness:

- Occurs within 5-10 seconds of complete blood flow cessation
- Neuronal Function: Ceases after ~1 minute without blood flow

> Irreversible Brain Damage:

- Starts after ~4 minutes, possibly delayed by cooling of the body
- Potential for reversal if blood flow is restored within 5 minutes
- Primary Cause: Cardiac arrest from coronary thrombosis

"Cerebral Circulation Interruption"

» Vascular Lesions:

- Common in brain; neurologic outcomes depend on:

- Artery size affected
- Collateral circulation status
- Brain area involved

» Cerebral Artery Syndromes

> Frequent Lesion Sites:

- Common carotid
- Internal carotid
- Vertebral arteries in the neck

» Anterior Cerebral Artery Occlusion

> Effect of Occlusion:

- Proximal to Anterior Communicating Artery:
 - Usually adequate collateral circulation

- Distal to Communicating Artery: leads to the following symptoms:

> Symptoms:

1) Contralateral Hemiparesis & Hemisensory Loss:

- Primarily affects leg and foot (paracentral lobule of cortex)

2) Cognitive Effects:

- Object identification issues, apathy, personality changes (frontal and parietal lobes)

» Middle Cerebral Artery Occlusion

- Symptoms (Variable based on occlusion site and anastomoses):

1) Contralateral Hemiparesis & Hemisensory Loss:

Mainly impacts face and arm (precentral and postcentral gyri)

2) Aphasia:

- If left hemisphere is affected (rare in right hemisphere)

3) Contralateral Homonymous Hemianopia:

- Due to optic radiation damage

4) Anosognosia:

- If right hemisphere is affected (rare in left hemisphere)

"Posterior Cerebral Artery Occlusion"

» Symptoms (vary based on occlusion site and collateral anastomoses):

1) Contralateral Homonymous Hemianopia with Macular Sparing:

- Damage to calcarine cortex; macular sparing due to collateral supply from middle cerebral artery to occipital pole

2) Visual Agnosia:

- Ischemia in left occipital lobe

3) Memory Impairment:

- Potential damage to medial temporal lobe.

"Internal Carotid Artery Occlusion"

» Effects:

- May be asymptomatic or cause severe cerebral ischemia depending on collateral anastomoses

1) Symptoms often mimic Middle Cerebral Artery Occlusion:

- Contralateral hemiparesis and hemianesthesia

2) Vision Loss (ipsilateral):

- Partial or complete; permanent loss is rare
- Emboli from internal carotid artery may reach retina via ophthalmic artery

"Vertebrobasilar Artery Occlusion"

» Supplies:

- Central nervous system in posterior cranial fossa, and visual cortex (through posterior cerebral arteries)

» Symptoms (varied):

- 1) Ipsilateral Face Sensory Loss & Contralateral Body Sensory Loss (pain/temperature)
- 2) Hemianopia or Cortical Blindness
- 3) Ipsilateral Cranial Nerve Damage:
 - Loss of gag reflex, dysphagia, hoarseness (glossopharyngeal and vagus nerve nuclei lesions)
- 4) Vertigo, Nystagmus, Nausea, Vomiting
- 5) Ipsilateral Horner Syndrome
- 6) Ipsilateral Ataxia & Cerebellar Signs

7) Unilateral/Bilateral Hemiparesis

8) Coma

"Cerebral Blood Flow Impairment"

» Causes:

- Diseases Affecting Blood Pressure
 - Arterial Wall Diseases
- Arterial Lumen Blockage Diseases

"Postural Hypotension"

» Causes:

- Rising after bed confinement, prolonged standing (e.g., soldiers), or prolonged kneeling (e.g., worshippers)

» Mechanism:

- Venous blood pools in limbs, reducing venous return and cardiac output, lowering arterial blood pressure
- Significant arterial pressure drop required to affect cerebral blood flow

"Physical and Psychological Shock"

» Effects:

- Severe, prolonged drop in blood pressure post-physical trauma (e.g., car accident, major surgery) can lead to unconsciousness, especially in older adults with narrowed cerebral arteries.
- Hyperventilation in anxiety lowers blood CO_2 , reducing cerebral blood flow.

"Blood Viscosity Changes"

» Polycythemia Vera:

- Increases blood viscosity, significantly reducing cerebral blood flow.

"Carotid Sinus Syndrome"

» Location:

- Proximal internal carotid artery.

» Mechanism:

- Arterial wall distension triggers reflex heart rate slowing and blood pressure drop.

» Cause:

- Increased nervous impulses travel via the sinus nerve (branch of glossopharyngeal nerve) to cardioinhibitory and vasomotor centers.

» Outcome:

- Reflex hypersensitivity or external pressure may suddenly lower blood pressure, leading to cerebral ischemia and possible loss of consciousness.

"Heart Disease"

» Effects:

- Severe cardiac diseases (e.g., coronary thrombosis, atrial fibrillation, heart block) cause a drastic drop in cardiac output, lowering arterial blood pressure and cerebral blood flow.

» Arterial Wall Disease

> Atheroma:

- Primary cause of narrowing in arteries supplying the brain, affecting both neck and intracranial pathways.

> Complications:

- Atheromatous narrowing worsens cerebral circulation during events like coronary thrombosis, surgical shock, severe anemia, or head rotation causing carotid artery pressure.

> Atheromatous Degeneration:

- Common in middle-aged/older adults, often linked with diabetes and hypertension.
- Blockage causes nerve cell degeneration in affected areas, with neuroglial proliferation.
- Generalized artery narrowing without specific blockage leads to diffuse brain atrophy.

> Risk:

- Narrow arteries can fully block with a thrombus, sealing the lumen.

"Diseases Causing Arterial Lumen Blockage"

» Cerebral Artery Embolism:

> Types:

- 1) Thrombus (most common)
- 2) Fat Globules

> Thrombus Formation:

- Originates anywhere from the left heart to cerebral artery sources.

> Common Sites:

- Atheromatous plaque in internal, common carotid, or vertebral arteries.
- Mitral/aortic valve endocarditis, or post-myocardial infarction.

> Fat Embolism:

- Follows severe long bone fractures.

> Process:

- Fat globules from damaged yellow marrow enter veins, pass through pulmonary circulation, and block small cerebral end arteries.

"Cerebral Aneurysms"

» Congenital Aneurysms:

- Commonly form at arterial junctions in the circle of Willis.

> Cause:

- Deficiency in the tunica media layer, often worsened by atheroma, leading to weakened arterial walls and local dilation.

> Symptoms:

- May compress nearby structures like the optic nerve or cranial nerves (III, IV, VI), causing symptoms.
- Sudden rupture can lead to severe headache, mental confusion, and potentially rapid death or delayed fatality.

> Treatment:

- Surgical clipping or ligation of the aneurysm neck is the most effective intervention.

» Other Aneurysms:

- Less common; may result from:
 - Softened arterial walls post-infected embolus.
 - Internal carotid artery damage within the cavernous sinus after skull fractures.
 - Disease of arterial walls, such as atheroma.

"Intracranial Hemorrhage"

» Types:

- 1) Epidural
- 2) Subdural
- 3) Subarachnoid.
- 4) Cerebral.

"Subarachnoid Hemorrhage"

» Causes:

- Often due to rupture or leakage of a congenital aneurysm on the cerebral arterial circle.
- Less commonly caused by angioma, brain contusions, or meningeal lacerations.

» Symptoms:

- Sudden severe headache, neck stiffness, loss of consciousness.

» Diagnosis:

- CT Scan: Detects dense blood areas in the subarachnoid space.
- Lumbar Puncture: Withdrawal of blood-stained cerebrospinal fluid, though now largely replaced by CT.

"Cerebral Hemorrhage"

» Common Cause:

- Rupture of an atheromatous artery, particularly in individuals with hypertension, especially in middle-aged patients.

» Location:

- Often involves rupture of the lenticulostriate artery (a branch of the middle cerebral artery).

» Effects:

- Damages corticonuclear and corticospinal fibers in the internal capsule, leading to hemiplegia on the contralateral side.
- Patient loses consciousness immediately, with paralysis observable upon regaining consciousness.
- Severe cases involve hemorrhage into the lateral ventricle, resulting in:
 - Deeper unconsciousness.
 - Corticospinal lesions on both sides.

» Possible Sites:

- Hemorrhage may also occur in the pons and cerebellum.

"Imaging Techniques for Cerebrovascular Diseases"

» CT, MRI, and PET:

- Essential tools for quick, accurate, and safe diagnosis of cerebrovascular diseases.
- Enable recognition of intracranial blood clots based on density.
- Current Standard: These methods have largely replaced cerebral angiography for diagnosis.

"Cerebral Angiography"

» Purpose:

- Used to detect blood vessel abnormalities, locate space-occupying lesions (tumors, hematomas, abscesses), and study the vascular pattern of tumors to assist in pathology diagnosis.

» Procedure:

- Patient Position: Supine with head centered on a radiographic apparatus.
- Anesthesia: Performed under general anesthesia.

» Technique:

- Radiopaque medium is injected quickly into the common carotid or vertebral artery or indirectly introduced through a catheter via the radial or femoral artery.
- Repeated radiographs are taken at 2-second intervals in anteroposterior and lateral views.

» Result:

- Demonstrates cerebral arteries, capillary flush, and veins.

» Risks:

- Invasiveness: Has a morbidity rate of 0.5%-2.5%.
- Preferred Alternatives: CT, MRI, and PET are less invasive and often preferred.

"Spinal Cord Ischemia"

» Blood Supply to the Spinal Cord:

- Posterior Third: Supplied by posterior spinal arteries.
- Anterior Two-Thirds: Supplied by the anterior spinal artery, which supplies the anterior white column, anterior gray horns, anterior part of the lateral white columns, and the root of the posterior horns.

» Anterior Spinal Artery Occlusion:

> Symptoms

- 1) Paraplegia: Due to bilateral damage to corticospinal tracts.
- 2) Thermoanesthesia and Analgesia: Loss of temperature and pain sensation below the lesion due to spinothalamic tract damage.
- 3) Limb Muscle Weakness: Caused by damage to anterior gray horns in the cervical or lumbar regions.

4) Loss of Bladder and Bowel Control: Due to damage to descending autonomic tracts.

5) Preserved Sensation: Position, vibration, and light touch remain intact as posterior white columns, supplied by posterior spinal arteries, are unaffected.

» Causes of Spinal Cord Ischemia:

- Can result from minor arterial damage due to nerve blocks, aortic surgery, or severe hypotension.
- Vulnerable regions include T4 and L1 spinal cord segments.

"Spinal Cord Ischemia in Specific Conditions"

» Thoracic Aortic Dissection:

- Segmental arteries of the thoracic spinal cord are supplied by posterior intercostal arteries originating from the thoracic aorta.

> Cause of Ischemia:

- Expansion of a blood clot in the aortic wall can obstruct the origins of these arteries, leading to ischemia in the spinal cord.

"Complication of Leaking Abdominal Aortic Aneurysm"

» Lumbar Region Supply:

- Receives segmental arteries from lumbar arteries branching from the abdominal aorta.

» Effect:

- Pressure from a leaking aneurysm can impede blood flow to the lumbar arteries, compromising spinal cord blood supply.