BLOOD SUPPLY OF THE BRAIN

Learning Objective:

At the end of lecture students should be able to know:
- Arterial supply of the brain
- Division of the arterial system into Carotid & Vertebral Systems
- Branches of Internal carotid & Vertebral arteries.
- Different areas of brain supplied by different branches of these arterial systems & blood supply of areas other than cerebral cortex
- Applied aspects related to the blockage & Hemorrhage of blood vessels supplying brain

The brain is one of the most metabolically active organs in the body, receives 17% of the total cardiac output and about 20% of the oxygen available in the body.

Two pairs of arteries
- Carotid (70%)
- Vertebral (30%)

ARTERIES OF THE BRAIN
- Brain receives it’s arterial supply from two pairs of vessels
- Vertebral arteries
- Internal carotid arteries
- which are interconnected in the cranial cavity to produce an arterial circle (of Willis)
- Circle of Willis
Each artery gives rise to two sets of branches:
- Cortical branches
  - Ramify on surface of hemisphere, supply cortex
- Central or perforating branches
  - Pass deep into the substance of hemisphere to supply structure within it.

**INTERNAL CAROTID ARTERY**
- Begins at bifurcation of the common carotid artery
- Carotid sinus
- The two internal carotid arteries enter the cranial cavity through the carotid canals on either side.
- Petrous temporal bone
- Subarachnoid space
- Anterior clinoid process
- Terminal branches are the anterior and middle cerebral arteries
BRANCHES OF THE INTERNAL CAROTID ARTERY

- **The ophthalmic artery**
  - Enters the orbit through the optic canal
  - Supplies the eye and other orbital structures, frontal area of the scalp, the ethmoidal and frontal air sinuses, and the dorsum of the nose
- **The posterior communicating artery**
  - Joins the posterior cerebral artery, thus participating in the formation of the circle of Willis
- **The anterior choroidal artery**
  - Enters the inferior horn of the lateral ventricle and ends in the choroid plexus
  - Also supplies the crus cerebri, the lateral geniculate body, the optic tract and the internal capsule
- **Anterior cerebral artery**
  - Joined to the anterior cerebral artery of the opposite side by the anterior communicating artery
  - Anastomoses with the posterior cerebral artery
  - Cortical branches supply all the medial surface of the cerebral cortex (basal ganglia, corpus callosum) as far back as the parieto-occipital sulcus.
  - Key functional areas
    - Primary motor cortex for leg and foot
    - Motor planning in medial frontal lobe
    - Middle and anterior corpus callosum
- **Middle cerebral artery**
  - Largest branch
  - Runs in the lateral sulcus
  - Divides into superior and inferior branch
  - Superior MCA – lateral and inferior frontal, anterior part of parietal
  - Inferior MCA – lateral temporal, posterior parietal, lateral occipital.
  - Central perforating branches supply the lentiform and the caudate nuclei and the internal capsule

- **Key functional areas**
  - Primary motor cortex for face, arm, leg
  - Primary sensory cortex for face, arm, leg
  - Broca’s language area (superior MCA)
  - Wernicke’s area (inferior MCA)
  - Parts of lateral, frontal and parietal lobes used in 3D visual perception of own body, outside world and ability to express emotions

**Area of supply of cerebral arteries**
VERTEBROBASILAR SYSTEM

- Vertebral arteries originate from the subclavian artery, and ascend through the transverse foramen of the upper six cervical vertebra.
- Enter the cranial cavity through the foramen magnum.
- Just inferior to the pons fuse to form the basilar artery.
- Key functional areas
  - Spinal cord tracts – pyramidal and spinothalamic
  - Cranial nerves 3 - 12

Vertebral artery branches

- The meningeal branches
- The posterior spinal artery
  - May arise from the posterior inferior cerebellar artery
  - Reinforced by the radicular arteries
- The anterior spinal artery
  - Formed by contribution from the both vertebral arteries
  - Embedded in the pia mater in the anterior median fissure
  - Reinforced by the radicular arteries
- Posterior inferior cerebellar artery
  - The largest branch of the vertebral artery
• Supplies the inferior surface of the vermis, the central nuclei of the cerebellum, the undersurface of the cerebellum, the medulla oblongata and the choroid plexus of the forth ventricle

• **Small medullary arteries**

**BASILAR ARTERY BRANCHES**

• **Pontine arteries**

• **Labyrinthine artery**
  • May arise as a branch of the anterior inferior cerebellar artery
  • Supplies the internal ear

• **Anterior inferior cerebellar artery**
  • Supplies the anterior and inferior parts of the cerebellum
  • Few branches supply the pons and the upper part of the medulla

• **Superior cerebellar artery**
  • Winds around the cerebral peduncle and supplies the superior surface of the cerebellum
  • Also supplies the pons, the pineal gland and the superior medullary velum

• **Anterior spinal artery**

• **Posterior spinal artery**

• **Posterior cerebral artery**
  • Joined by the posterior communicating branch of the internal carotid artery to complete the circle of Willis
  • Blood supply for midbrain, thalamus, hypothalamus, posterior medial parietal lobe, corpus callosum, inferior and medial temporal lobe, inferior occipital lobe

• **Key functional areas**
- Primary visual cortex
- 3rd nerve in midbrain
- Sensory control – temperature, pain, sleep
- Communication between hemispheres.

**Collateral circulation**
- Common sites
  - External and internal carotid via ophthalmic artery
  - Intracranial vessels of circle of willis
  - Small cortical branches of MCA, ACA, PCA and cerebellar arteries.
- Effectiveness depends on
  - Vessel size
  - Speed of occlusion

**CIRCLE OF WILLIS**
- Named after Thomas Willis
- Lies in the interpeduncular fossa at the base of the brain around sella turcica
- Formed by anastomosis between two internal carotid and two vertebral arteries
- The contributing arteries are
  - The anterior communicating
  - The anterior cerebral
  - The internal carotid
  - The posterior communicating
  - The posterior cerebral
  - The basilar
ARTERIES TO SPECIFIC BRAIN AREAS

- The corpus striatum and the internal capsule
  - Mainly the medial and lateral striate central branches of the middle cerebral artery
  - Central branches of the anterior cerebral arteries
- The thalamus
  - Branches of the posterior communicating, basilar and the posterior cerebral arteries
- The midbrain
  - Posterior cerebral, superior cerebellar and the basilar arteries
- The medulla oblongata
  - Vertebral, anterior and posterior spinal, posterior inferior cerebellar and basilar arteries
- The cerebellum
  - Superior cerebellar, anterior inferior cerebellar and posterior inferior cerebellar arteries

CEREBROVASCULAR DISORDERS

- Occlusive cerebrovascular disorders: These result from arterial or venous thrombosis, or embolism, and can lead to infarction of well-defined parts of the brain.
- Transient cerebral ischemia: Transient ischemia, can occur without infarction. Episodes of this type are termed transient ischemic attacks (TIAs). As with occlusive cerebrovascular disease, the neurologic abnormalities often permit the clinician to predict the vessel that is involved.
- Hemorrhage: The rupture of a blood vessel is often associated with hypertension or vascular malformations or with trauma.
CEREBROVASCULAR DISORDERS

- Vascular malformations and developmental abnormalities:
  - aneurysms or arteriovenous malformations (AVMs), which can lead to hemorrhage.
  - Hypoplasia or absence of vessels occurs in some brains.

- Degenerative diseases of the arteries: These can lead to occlusion or to hemorrhage.

- Inflammatory diseases of the arteries: Inflammatory diseases, including systemic lupus erythematosus, giant cell arteritis, and syphilitic arteritis, can result in occlusion of cerebral vessels, which, in turn, can produce infarction.

OCCLUSIVE CEREBROVASCULAR DISEASE

- Insufficient blood supply to portions of the brain leads to infarction and swelling with necrosis of brain tissue.

- Most infarcts are caused by atherosclerosis of the vessels, leading to narrowing, occlusion, or thrombosis; a cerebral embolism, that is, occlusion caused by an embolus (a plug of tissue or a foreign substance) from outside the brain;

- Other conditions, such as prolonged hypotension, drug action, spasm, or inflammation of the vessels. Venous infarction may occur when a venous channel becomes occluded.
Middle cerebral artery infarct
- Contralateral weakness
  - Face, arm, and hand
- Contralateral sensory loss
  - Face, arm and hand
  - Visual field cut
- Aphasia mostly with left hemisphere damage