Arterial Blood Supply & Venous Drainage of the Brain

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Lecture outline

• Introduction
• Sources of Blood supply
• Internal carotid artery
• Vertebral artery
• Circle of Willis
• Blood supply to spinal cord
• Introduction to Venous Drainage
• Clinical Anatomy
Human Brain

• Weight constitute 2 - 2.5% of body weight

• Receives about 15% or $\frac{1}{6}$ of cardiac output (approx. 750 ml of blood/minute)

• Utilizes approx. 20-25% or $\frac{1}{5}$ of total oxygen of whole body
  • High metabolic rate
Sources of supply

- 2 pairs of arterial trunks which form a complex anastomosis (circle of Willis)
- Internal carotid artery
  - Forebrain & occipital lobe of cerebrum
- Vertebral artery
  - Occipital lobe, brainstem & cerebellum, upper spinal cord
Internal Carotid Artery

• **Origin**
  - Bifurcation of common carotid artery

• **Course**
  - *Extracranial part* enters cranial cavity via carotid canal
  - *Intracranial* S-shape curve called carotid siphon
  - *Petrosus* part of temporal bone
  - Side of sphenoid & within *cavernous* sinus in close relation with CN III, IV, V & VI, reaches base of brain lateral to optic chiasm
  - *Cerebral* course pierces dura mater to reach anterior perforated space
Extracerebral Branches of Internal Carotid Artery

• Petrous part
  • Caroticotympanic to tympanic cavity
  • Pterygoid artery to pterygoid canal

• Cavernous part
  • Cavernous brs
  • Meningeal brs
  • Hypophysial brs

• After cavernous course
  • Ophthalmic to contents of orbital cavity
Cerebral branches

- Choroidal
- Anterior cerebral
- Middle cerebral

**Choroidal**
- Choroidal plexus, globus pallidus, posterior limb of internal capsule, optic tract and radiation, hippocampus
Anterior cerebral

• Smaller terminal br. of ICA
• Cortical branches
  • medial surface & marginal area of superolateral surfaces of cerebrum

• Central branches
  • rostrum of corpus callosum, septum pellucidum, putamen, head of nucleus
Middle cerebral artery

- Larger terminal branch of ICA
- Cortical:
  - superolateral surface & temporal pole
- Central: 2 sets
  - Medial striate: caudate nucleus, internal capsule, lentiform nucleus
  - Lateral striate: caudate nucleus
    - Charcot’s artery of cerebral haemorrhage – largest & most frequently ruptured in apoplexy
- Posterior communicating
Vertebral Artery

- **Origin**
  - First part of subclavian artery

- **Course**
  - Prevertebral, vertebral, atlantic, intracranial
  - Transverse foramen of C6 to C1 vertebrae
  - Foramen magnum
  - Ends at lower border of pons by joining opposite vertebral artery to form basilar artery
Branches of vertebral artery

- Posterior spinal
  - Dorsal 1/3rd spinal cord & DRGs
- Anterior spinal
  - Ventral 2/3rd spinal cord
- Posterior inferior cerebellar
  - Largest branch & supplies cerebellum
- Medullary
  - Medulla oblongata
- Basilar
  - Formed by union of vertebral arteries
Branches of Basilar artery

- Anterior inferior cerebellar (AICA)
  - Inferior surface of cerebellum
- *Labyrinthine (internal auditory)
  - Internal ear
- Pontine
  - Pons
- Superior cerebellar (SC)
  - Superior surface of cerebellum and anastomose with AICA
- Posterior cerebral (PC)
Posterior cerebral

• Terminal br. of basilar
• Cortical
  • inferior surface of cerebrum, occipital pole (visual cortex)
• Central
  • thalamus, 3rd ventricle, globus pallidus
• Posterior choriodal
  • choroid plexus of lateral ventricle, thalamus, fornix & tectum of midbrain
Circle of Willis

- Arterial anastomosis connecting vertebrobasilar & internal carotid systems

- Location:
  - Base of interpeduncular fossa

- Branches Involved
  - Anterior communicating
  - Anterior cerebral
  - Internal carotid
  - Posterior communicating
  - Posterior cerebral
Importance of circle of Willis

- Serves to equalise blood flow to various parts of brain
  - maintaining a constant supply of oxygen & glucose even when a contributing artery is narrowed or in head movements

- Furnishes collateral circulation in cases of occlusion of one or more of arteries contributing to circle
Brain angiogram
Blood supply to spinal cord

- At medulla, vertebral arteries give off anterior spinal artery (ASA)
- 10 to 12 segmental (medullary) arteries (brs of aorta) join anterior spinal artery
- Vertebral arteries (or PICA) give rise to paired posterior spinal arteries (PSA) that run along dorsal surface.
Disorder of blood supply to spinal cord

- Most vulnerable in thoracic region & anterior part of spinal cord
- Occlusion of anterior spinal artery leads to acute thoracic cord syndrome with paraplegia & incontinence
Venous Drainage of brain

Characteristic Features

• No valves
• Extremely thin walls
• Lack muscular tissue in tunica media
• Pierce arachnoid mater & inner layer of dura mater
• End in dural venous sinuses
Three sets of veins

- Superficial veins
- Deep veins
- Dural venous sinuses
Superficial & Deep veins

- **Superficial veins** within subarachnoid space
  - Superior cerebral - SSS
  - Superficial middle cerebral – CS
  - Inferior cerebral - empty into SSS, TrS & SS
  - Superior & inferior cerebellar into TrS & SS

- **Deep veins**
  - Thalamostriate + choroidal = internal cerebral (2)+ basal = great cerebral (of Galen) + ISS = straight sinus
Dural Venous Sinus

- Between the 2 layers of dura mater
- Namely
  - Superior sagittal sinus
  - Inferior sagittal sinus
  - Straight sinus
  - Transverse sinus
  - Occipital sinus
  - Cavernous & intercavernous sinus
  - Superior petrosal sinus
  - Inferior petrosal sinus

*Review location, termination and whether single or paired*
Clinical Anatomy

- One of the most common cause of neurological disability is **Stroke** (Ischemic or hemorrhagic)
  - Sudden occlusion of a cerebral artery leading to death of brain tissue (Infarction)

- Cerebral haemorrhage

- **Aneurysm** – abnormal ballon-like swelling of an artery which may rupture & blood enters subarachnoid space (**subarachnoid haemorrhage**) or into brain (**intracerebral haemorrhage**)

www.stroke.org.nz/.../understand_stroke.html
Questions

• Use a well labelled diagram to show the branches of the arterial blood supply to the brain
• Enumerate the branches involve in the ‘Circle of Willis’. Add a note on the clinical significance of the Circle of Willis
• Draw a diagram of the cerebral hemispheres showing the areas supplied by the cerebral arteries
• Describe the blood supply to the spinal cord
• What are the characteristic features of the veins of the brain.
• How is the great cerebral vein (of Galen) formed and where does it terminate
• List the dural venous sinuses