Brain Meninges, Ventricles and CSF
Lecture Objectives

• Describe the arrangement of the meninges and their relationship to brain and spinal cord.
• Explain the occurrence of epidural, subdural and subarachnoid spaces.
• Locate the principal subarachnoid cisterns, and arachnoid granulations.
• Describe the ventricles of brain and importance of their choroids plexus.
• Summarize the pathway of cerebrospinal fluid (CSF) circulation.
• Locate the safe sites for the lumbar puncture.
• Identify brain ventricles in CT scan, MRI and ventriculograms.
Cerebral Meninges

• Dura mater
  • Endosteal layer
  • Meningeal layer
• Arachnoid mater
• Pia mater
Dura Mater

• Endosteal layer = periosteum
  ➢ Venous sinuses
• Meningeal layer
  ➢ Continuous with spinal dura mater
  • Falx cerebri
    • Shape, Attachments & Sinuses
  • Tentorium cerebelli
    • Shape, Attachments & Sinuses
      • Tentorial notch
  • Falx cerebelli
    • Shape, Attachments & Sinuses
  • Diaphragma sellae
    • Shape, Attachments & Sinuses
Dura Mater

• **Nerve supply**
  • Cranial nerves V & X
    • Referral pain to the head from above the tentorium cerebelli
  • Spinal nerves C1-C3
    • Referral pain to the back of the head and neck from bellow tentorium
• **Sympathetic**

• **Blood supply**
  • Internal carotid, maxillary, ascending pharyngeal, occipital & vertebral aa
  • Middle meningeal a.
Dural Venous Sinuses

- Location
- Drains ..... 
- Fate
  - Superior sagittal sinus
    - Venous lacunae
  - Inferior sagittal sinus
  - Straight sinus
  - Occipital sinus
  - Transverse sinus
  - Sigmoid sinus
  - Cavernous sinuses
  - Superior and inferior petrosal sinuses
Dural Venous Sinuses
Arachnoid Mater

- Subdural space
- Subarachnoid space
  - Cerebral BV & cranial nn.
  - CSF
  - Subarachnoid cisternae
  - Arachnoid villi
    - Arachnoid granulations
- Fuse with epineurium at foramina
  - Except for optic nerve - fuse with sclera
Pia Mater

- Adheres closely to the brain
  - Goes deep into the sulci
  - Fuse with nerves epineurium
  - Covers cerebral arteries entering brain substance
  - Specialized over the roofs of ventricles (tela choroidea)
    - Contribute to formation of choroid plexuses
Ventricular System

- Lateral ventricles
  - Interventricular foramina
- Third ventricle
  - Cerebral aqueduct
- Fourth ventricle
- Central canal
  - Terminal ventricle
Lateral Ventricles

- Location
- Shape
- Parts
  - Body
  - Horns
    - Anterior, posterior, inferior
- Choroid plexus
Lateral Ventriles

• Relations
  • Corpus callosum
  • Septum pellucidum
  • Fornix
  • Thalamus
  • Caudate nucleus
Third Ventricles

- **Shape**
- **Interventricular foramen (foramina of Monro)**
- **Cerebral aqueduct (aqueduct of Sylvius)**
- **Walls**
  - Anterior wall
  - Posterior wall
  - Lateral wall
  - Roof
  - Floor
- **Choroid plexus**
Fourth Ventricle

• Shape
• Relations
• Walls
  • Lateral walls
  • Roof (posterior wall)
    • Superior and inferior medullary velum
    • Median aperture (foramen of Magendie)
  • Lateral apertures (foramina of Luschka)
  • Choroid plexus
  • Floor (rhomboid fossa)
Subarachnoid Cisterns

- Extended area of the subarachnoid space
- Subarachnoid cisterns
  - Cerebellomedullary cistern (cisterna magnum)
    - Median aperture
  - Pontine cistern
    - Lateral apertures
  - Interpeduncular cistern
Subarachnoid Cisterns

Figure 2.14  Sagittal view of choroid plexus and cisterns of ventricular system.

- Subarachnoid space
- Superior sagittal sinus
- Arachnoid villi
- Choroid plexus
- Suprasellar (chiasmatic) cistern
- Interpeduncular cistern
- Pontine cistern
- Central canal
- Quadrigeminal (superior) cistern
- Lateral aperture (foramen of Lusos)

Figure 2.16  Midsagittal MR scan of cisterns.

- QuC
- SuC
- InC
- PoC
- CM
Cerebrospinal Fluid (CSF)

- 80-150 ml (3-5oz)
- Clear liquid containing glucose, proteins, & ions
- Functions
  - mechanical protection
    - floats brain & softens impact with bony walls
  - chemical protection
    - optimal ionic concentrations for action potentials
  - circulation
    - nutrients and waste products to and from bloodstream
Origin of CSF

- Choroid plexus = capillaries covered by ependymal cells
  - 2 lateral ventricles, one within each cerebral hemisphere
  - Roof of 3rd ventricle
  - Roof of fourth ventricle
Drainage of CSF from Ventricles

- One median aperture & two lateral apertures allow CSF to exit from the interior of the brain
Flow of Cerebrospinal Fluid
Reabsorption of CSF

- Reabsorbed through arachnoid villi
  - grapelike clusters of arachnoid penetrate dural venous sinus
- 0.5 ml/min reabsorption rate = same as production rate
Reabsorption of CSF

- When pressure in CSF > venous, Reabsorption occurs.
- When pressure in venous > CSF, arachnoid villi work as valve.
Hydrocephalus

- Blockage of drainage of CSF (tumor, inflammation, developmental malformation, meningitis, hemorrhage or injury)
- Continued production cause an increase in pressure --- hydrocephalus
- In newborn or fetus, the fontanels allow this internal pressure to cause expansion of the skull and damage to the brain tissue
- Neurosurgeon implants a drain shunting the CSF to the veins of the neck or the abdomen
Leptomeningeal Disease

- Cancer metastasis through CSF
- Originate from
  - Primary CNS tumors
  - Secondary distant tumors through blood
- Symptoms may include headache, spine or radicular limb pain or sensory abnormalities, nausea and vomiting
Subarachnoid Hemorrhage

• Nontraumatic (spontaneous)
  • Blood in CSF
  • Mainly from aneurisms
    • Arise at arterial branch points
    • 85% anterior circulation
    • 15% posterior circulation
    • 30% anterior comm., 25% posterior comm., 20% MCA
  • The main symptom is a severe headache that starts suddenly (often called thunderclap headache)

• Traumatic
  • More common
  • Due to contusions and other traumatic injuries
  • Severe headache
Extensions of the Subarachnoid Space
Blood Brain Barrier

• protects cells from some toxins and pathogens
  • proteins & antibiotics can not pass but alcohol & anesthetics do

• Structure
  • tight junctions seal together epithelial cells
  • continuous basement membrane
  • astrocyte processes covering capillaries
Blood Brain Barrier

• Areas without BBB
  • Area postrema in the floor of the fourth ventricle
  • Areas in the hypothalamus

• Structure
  • Endothelial fenestrations
Blood Cerebrospinal Fluid Barrier

• Structure
  • Endothelial cells
  • BM of endothelial cells
  • Pale cells
  • BM of choroidal epithelial cells
  • Tight junctions seal the choroidal epithelial cells