The Ventricular System and Cerebrospinal Fluid (CSF)

Simple Tube Shape of Early CNS with fluid filled canal in middle

In adults there is still a continuous canal running thru all levels of the adult CNS – it is just harder to follow.

Book Fig. 1.19
Side & Frontal Views of Ventricles

Lateral Ventricles in the Hemispheres
Remember – these represent fluid filled cavities in brain

Lateral Ventricles From Above

3rd Ventricle in Diencephalon

These are the canals of the cerebral hemispheres or telencephalon

3rd Ventricle
Interventricular foramen links lateral

You can see the 2 dark lateral ventricles as well as the vertical midline 3rd ventricle

Sagittal Section Thru 3rd Vent. (#2 in figure)

Connects to skinny cerebral aqueduct, the canal of the midbrain (just under the #10)

Ependyma (ventricular lining)

Choroid plexus located in ventricles continuously produces CSF, replacing the ~125-150 ml several times/day

Normal pressure of CSF:
- 100-150 mmH2O lying down
- 200-300 mmH2O sitting up

4th Ventricle in the Hindbrain

3 holes in the roof of the 4th ventricle allow most CSF to leave ventricles and enter the subarachnoid space around brain
Why is CSF pressure measured in mm H2O?

- Larger pressure differences (like BP) are measured by the movement of a column of heavier liquid (Mercury or Hg).
- Smaller pressure differences are measured by the movement of a column of lighter liquid (H2O).
  - CSF moves that column ~150 mm but would only move Hg about 2 mm.

Circulation of CSF in ventricles always moves posteriorly, toward medulla.

Arachnoid Granulations Allow CSF re-absorption into dural sinus blood.

Functions of CSF

- Provide protective cushion around CNS
- Buoyancy – brain floating in a layer of CSF keeps the weight of the brain from crushing ventral brain and blood vessels
- Chemical communication?
- Some “give” in the contents of skull

Clinical Applications Related to CSF
Early on (before birth) the spinal cord and the bony spinal column start out pretty equal in length.

- Spinal Meninges
  - But as we grow the spinal column lengthens more than the cord.
  - Spinal cord ends at the top of the L2 vertebra.
  - Below that we have CSF & the lower spinal nerves known as the cauda equina (horse’s tail)
  - CSF can be safely drawn from here.

Needle Enters Via Intervertebral foramen

- It Goes Thru Dura & Arachnoid to Subarachnoid Space
  - Cerebrospinal fluid

Lumbar puncture or “spinal tap” is done below the L2 level mentioned earlier.

- Spinal or Intrathecal (“inside the coverings”) Anesthesia
  - Anesthetic solution injected into spinal fluid in subarachnoid space
  - Disadvantage: “spinal” headache; puncturing meninges opens CNS to potential infection.
Another procedure which makes reference to the meninges is an “epidural”. The drug is administered outside the dura rather than under the arachnoid. This is less invasive than puncturing the meninges to get to CSF.

Hydrocephalus (“water brain”)
- Reasons for excessive CSF (enlarged ventricles):
  - Noncommunicating hydrocephalus – an obstruction prevents flow of CSF thru ventricles
  - Communicating hydrocephalus – CSF circulates thru ventricles but is not reabsorbed normally
  - Rarely a tumor may cause excess production
- In an infant, the head can expand somewhat, but in adult “intracranial pressure” (ICP) immediately rises if there is too much CSF.
- Pressure damages the brain and impairs neurological functioning

Enlarged Ventricles

Enlarged Skull (macrocephaly)

- Premature babies more at risk of hydrocephalus.

“Setting sun” eyes
Implanted Shunt to Drain CSF

- Shunts work well but mechanical problems almost inevitable, requiring surgery to replace or repair shunt.
- Early treatment can prevent or decrease brain damage.
  - [http://www.learner.org/resources/series142.html](http://www.learner.org/resources/series142.html)

For hydrocephalus due to obstruction a new experimental treatment is opening the bottom of the 3rd ventricle to let CSF escape (3rd ventriculostomy) into the subarachnoid space.

3rd Venticulostomy

http://www.youtube.com/watch?v=ldst0kJpTkw

Normal Pressure Hydrocephalus (NPH)

- Occurs in older (60+) individuals
- Show 3 classic symptoms:
  - Urinary urgency & Incontinence
  - Gait (walking) problems (hesitation, slowness, shuffling walk)
  - Forgetfulness & other signs of dementia
- Mnemonic = 3 W’s (Wet, Wobbly, & Wacky)
- Scan shows enlarged ventricles but CSF pressure is now in normal range
- Even so, symptoms often improve with shunting/removal of some CSF. This should be done diagnostically with a lumbar puncture or catheter before deciding to implant a shunt.
- Important to recognize because this is one of the few potentially reversible causes of dementia
  - [http://video.google.com/videoplay?docid=7891763995469877558&q=hydrocephalus&total=126&start=90&num=10&so=0&type=search&plindex=8](http://video.google.com/videoplay?docid=7891763995469877558&q=hydrocephalus&total=126&start=90&num=10&so=0&type=search&plindex=8)

“Hydrocephalus ex vacuo”

- Not related to an excess of CSF
- Ventricles appear enlarged because of loss of adjacent brain tissue (e.g. in Huntington's, Alzheimer's, schizophrenia)

Ventricles in Huntington's Chorea