Brain ventricles, cerebrospinal fluid, Coverings and blood vessels of the brain

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Cerebrospinal fluid

production – choroid plexus
absorption – arachnoid granulations
Ventricles and subarachnoidal space 140 ml
Daily 500 ml
Mechanic support of the brain ("it floats")
Chemical communication in the CNS (neurons-CSF-wall of ventricles–neurons)
Ventricles

Fig. 305. Cast of the brain ventricles, viewed from the side. Only the left lateral ventricle is represented. (After Rauter-Kopsch.)
CSF comes from ventricles to subarachnoid space through:

A) Median aperture of the IV.ventricle 3 = foramen Magendi

B) Lateral apertures of the IV.ventricle = Foramina Luschkae
Laterally in the tela choroidea ventriculi quarti
Frontal section through the ventricles
Lateral ventricles, interventricular foramen, III. ventricle, aqueductus mesencephali, IV. ventricle, apertura mediana + aperturae laterales
Cirkulace MMM MR
Granulationes arachnoidales
absorbtion to sinus sagittalis superior
Cisternae subarachnoidales

Between pia mater and arachnoid

Other cisterns:
- Cisterna fossae lateralis cerebri
- Cisterna pontis
- Cisterna laminae quadrigeminae
- Cisterna corporis callosi

Cisterna magna = cerebellomedularis
Cisterna ambiens

Between quadrigeminal and interpeduncular cistern

Cisterna fossae lateralis
Cisterna laminae terminalis

1 Cisterna cerebellomedullaris
2 Cisterna pontis
3 Cisterna interpeduncularis
5 Cisterna laminae quadrigeminae = cisterna superior

MRI – T2W
CSF is white
Ventricles and basal ganglia
Cornu frontale ventriculi lateralis
Pars centralis and cornu temporale

Tela choroidea between fornixem and ncl. caudatus

Lamina affixa thalami
Dorsal aspect of ventricles

1- cornu frontale
2- cornu occipitale
3- fornix+ hippocampus
4- plexus choroideus VL
5- septum pellucidum
6- forceps ant
7- temporal lobe
8- cerebellum
9- forceps post
Lateral ventricle – dorsal aspect,
Temporal lobe medial aspect

- Temporal lobe medial aspect
- Parahippocampal gyrus
- Dentate gyrus
- Collateral sulcus
- Subiculum
- Fibria fornicis (hippocampi)
- Collateral sulcus
View of excised hippocampus and its cutout
Lateral ventricle - temporal horn

- amygdala
- commissura fornicis
- hippocampus
- calcar avis
Hippocampus and fornix
Dorsal aspect
Frontal section of the hippocampus

- fimbria fornicis
- cauda ncl caudati
- gyrus dentatus
- subiculum
- area 28
  entorhinální kůra
- gyrus parahippocampalis
- sulcus collateralis
Sagittal section of the brain – silver impregnation
Cornu temporale and 
cornu occipitale 
ventriculi lateralis
Horizontal section through the interventricular foramen

- III. ventricle
III. ventricle - inside of diencephalon
III. ventricle – sagittal fissure, a roof of it is attached to stria medullaris thalami
Tela choroidea ventriculi tertii

Plexus choroideus
Recesses of the III. ventricle
- 1 pineal 2 suprapineal, 3 infundibular, 4 suprachiasmatic
III. ventricle

- chiasma opticum
- lamina terminalis
- corpus mamillare
- sulcus hypothalamicus
Aquaeduct + IV. ventricle
Circumventricular organs

Blood-brain barrier is permeable – fenestrated capillars

chemoreceptors

vascular organ of the lamina terminalis

eminentia mediana

neurohypophysis

Neurons of these organs project to the hypothalamus
Circumventricular organs in the rat brain

chemoreception

area postrema
organum subfornicale
organum subcomissurale
eminentia mediana
neurohypophysis
corpus pineale
organum vasculosum laminae terminalis
Woman with headaches

- CT: Heterogeneous 2 cm mass within the fourth ventricle causing hydrocephalus
Significant dilation of the bilateral lateral ventricles and third ventricles secondary to the tumor filling the distended fourth ventricle and outlet foramina
MRI: Large mixed solid and cystic mass predominantly T1 isointense and T2 hyperintense) centered within the fourth ventricle with indistinct interface along the 4th ventricular floor. The small solid components of the intraventricular mass enhance avidly. A moderate degree of obstructive hydrocephalus is present, with significant dilation of the bilateral lateral ventricles and third ventricles secondary to the tumor filling the distended fourth ventricle and outlet foramina.
Ependymoma:

- Arise from ependymal cells or ependymal cell rests.
- > 60% are located in the fourth ventricle
- More common in children than adults
- "Soft" tumor which accommodates to shape of cisterns or ventricles and often extends into cerebellar pontine angle or cisterna magna.
- Heterogeneous on CT often with calcifications
- On MRI is T1 isointense and T2 hyperintense
- Generally contains enhancing portions, but variable
- Can be associated the NF2 (chromosome 22 defect)
- Most common presentation is child with headache and vomiting.
- Bimodal age distribution: 5 and 30.
- Treatment: surgical resection +/- chemo/radiation therapy
- 5 year survival 60-70%.
60-year woman with worsening cognitive impairment and gait disturbance
Substantial enlargement of the 3rd, 4th, and lateral ventricles. Relative normal appearance of sulci for age. No evidence of substantial vascular pathology.
Normal pressure hydrocephalus

- Classical clinical triad of **dementia, gait disturbance, and urinary incontinence** is seen with normal pressure hydrocephalus.
- Symptoms result from distortion of white matter by distended ventricles.
- Patients commonly have a history of prior SAH or meningeal infection.
- Gradient between ventricular system and subarachnoid space due to incomplete subarachnoid block.
- **Radiographic key:** Diffuse ventriculomegaly out of proportion to sulcal prominence.
- Not a radiographic diagnosis. Diagnosis made by improvement of symptoms after shunting.
- Radioisotope cisternogram shows early entry into the lateral ventricles with persistence at 24-48 hours and delayed ascent to parasagittal regions.
- Flow void can be seen through the aqueduct of Sylvius on MR due to increased flow velocity.
Normal pressure hydrocephalus

From decreased absorption
Trias: Dementia, gait abnormalities, urinary incontinence
From the compression of the white matter by enlarged ventricles
Often after subarachnoid hemorrhage or meningitis

The only treatable dementia

Sameš, Ústí nad Labem
Normal pressure hydrocephalus (NPH)

Upper figures
Typical MRI in NPH coronal plane T1W
Dilatated ventricles (*), flattened gyri and no sulci (oval) and increased Sylvian fissura (arrow).

Lower figures
difuse dilatation of subarachnoid spaces (arrow) and enlarged ventricles
Brain atrophy

Coverings

Dura mater outermost layer
closely attached to the periosteum
Makes a wall of sinuses
Divides the hemispheres
Divides the cerebellum and occipital lobes
Divides subdural and epidural space
ARACHNOID
thin avascular membrane
not reaching the deeper fissures
Divides subdural and subarachnoid space

PIA MATER
Vascular layer closely attached to the brain surface

Cisternae subarachnoidales

Cisterna fossae lateralis cerebri
Cisterna pontis
Cisterna laminae quadrigeminae
Cisterna corporis callosi

Cerebellum
Frontal Lobe
Temporal Lobe
Chiasmatic Cistern
Interpeduncular Cistern
Ambient Cistern
Cisterna cerebellomedularis
Granulationes arachnoidales
Spaces:
Epidural (a.meningea media)
Subdural (overbridging veins)
Subarachnoid CSF+ vessels
Repetition
Dura mater
Arachnoidea
Pia mater
Spinal cord - meninges

Endorhachis
Cavitas epiduralis – žilní pleteně
Dura mater spinalis
Cavum subdurale
Arachnoidea – lig. denticulatum
Cavitas subarachnoidalis
Pia mater spinals
Spinal cord meninges

Denticulate ligament
Sleeves of dura mater = root sleeves
Intracranial hemorrhage

Epidural
From middle meningeal artery.

Subdural
From bridging veins

Subarachnoid
From Willis circuit
Vertebrobasilar system

Blood supplying

**FIGURE 6-2**
Origins of the arterial supply of the brain. a, Artery. (From Osborn AG: Introduction to cerebral angiography, Hagerstown, 1980, Harper & Row.)
Brain arteries
Willis circuit

- Communication between vertebral and a. carotis interna systems
- Anterior and posterior communicating arteries allow blood to flow between both systems (PCA) or between right and left vessels (ACA)
Arteriae centrales (peforatores) - groups:
- Anteromedial
- Anterolateral
- Posteromedial
- Posterolateral
Variets

Obr. 564 a-g  Willisův arteriální okruh, circulus arteriosus cerebri.

a-c variety předního oddílu

b-f variety zadního oddílu

g kaudální spojení vertebrálních arterií
ACA occlusion – contralateral plegia of lower limb

PCA occlusion –
Visual field defect
- Contralateral homonymous hemianopsych

MCA occlusion
Contralateral hemiplegia more expressed on upper limbs and face, can be aphasia
Cerebral arterial territories

- a. cerebri anterior
- a. cerebri media
- a. cerebri posterior
- a. cerebellaris superior
- a. cerebellaris inferior anterior
- a. cerebellaris inferior posterior
- a. choroidea anterior
Blood supplying of basal ganglia

arterie lenticulostriaticae
Blood supplying of basal ganglia, thalamus and capsula interna

- medial lenticulostriate arteries
- lateral lenticulostriate arteries
- Anterior Choroideal artery
- Penetrating branches of posterior cerebral artery (P1-segment)
Circulus arteriosus

Diagram showing the Circle of Willis with labels for:
- Anterior communicating artery
- Anterior cerebral artery
- Ophthalmic artery
- Internal carotid artery
- Middle cerebral artery
- Posterior communicating artery
- Posterior cerebral artery
- Superior cerebellar artery
- Basilar artery
Most common diseases of brain vessels
Circulus arteriosus Willisi – aneurysma

1 A. CEREBRI ANT. 30 % distálne 5 %
2 a. communicans ant. 25 %
3 A. CAROTIS INT. 30 %
a. aphetamica 4 %
a. communicans post 18 %
bifurkácia 4 %
a. choroidea ant. 4 %
5 A. CEREBRI MEDIA 25 %
6 A. CEREBRI POST. 2 %
a. communicans post. 2 %
7 A. cerebelli sup.
8 A. BASILARIS 10 %
bifurkácia 7 %
kmen artérie 3 %
A. CEREBELLI INF. POST. 3 %
9 A. cerebelli inf. ant.
Aneurysma lokalization
Aneurysma - treatment

Clip

Endovascular occlusion
Aneurysma – stent, recoiling
Intravascular coiling
A-V malformation
Cranial nerve origins and arteries on the ventral part of the brainstem
NMR – angioigraphy

1 - a.carotis interna
2 - a.vertebralis
3 - sinus cavernosus
4 - canalis caroticus
5 - a.cerebri anterior
6 - a.cerebri posterior
Thomas Willis
(1621–1675)
The home of Thomas Willis from 1657 to 1667

Oxford, Beam Hall
Thomas Willis

- **Neuroanatomical terms coined by Willis**
  - Anterior commissure | Cerebellar peduncles | Claustrum | Corpus striatum | Inferior olives (corpora teretia) | Internal capsule | Medullary pyramids | Nervus ophthalmicus | The word 'neurology' | Optic thalamus | Spinal accessory nerve | Stria terminalis (taenia cornua) | Striatum | Vagus nerve

- **Pathologies recognized by Willis**
  - Achalasia of the cardia (achalasia of the oesophagus) | Akathisia (restless legs syndrome, Ekbom's syndrome) | Symptoms of myasthenia gravis | Paracusis Willisii. Occurs in deaf patients whose hearing improves in the presence of noise, indicating osteosclerosis | Diabetes mellitus | Abnormalities of the brains of patients with congenital mental retardation | Unilateral degeneration of the cerebral peduncle in a case of long-standing unilateral paralysis | Symptoms of malaria | Distinctions between typhoid and puerperal fevers
5 Vena anastomotica sup. (Trolard)
6 Vena anastomotica post. (Labbé)
Brain veins - % of thrombosis

- Cortical veins: 17%
- Superior sagittal sinus: 62%
- Straight sinus: 18%
- Vein of Galen and internal cerebral veins: 11%
- Transverse sinuses: 86%
- Jugular veins: 12%
Trombosis sinus sagittalis superior
Tromboses vv. cerebri superiores
Deep cerebral veins

Figure 8-17. Veins draining internal areas of the hemisphere and the tributaries of the great cerebral vein and straight sinus, hippocampus.
Cerebral Venous territories
„rough guide“

- Superior sagittal sinus
- Internal cerebral veins
- Sphenoparietal sinus
- Vein of Labbé
1. Epidural hemorrhage

2. Subdural hemorrhage

3. Subarachnoidal hemorrhage
Spinal cord arteries

Artery of Adamkiewicz (a. radicularis magna) from the a. intercostalis post. at the level Th9–L1

vertebral art.

lumbal artereries

aa. sacralis lateralis

a. iliolumbalis

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Longitudinal system

Segmental (radicular) system

Basilar artery
Posterior inferior cerebellar artery
Anterior spinal artery
Vertebral artery

Posterior inferior cerebellar artery
Posterior spinal artery

Radicular arteries
Spinal cord - arteries

5 longitudinal trunks
vasocoronae

a. spinalis anterior

r. spinalis

aa. spinales posteriores
Vertebral veins
basivertebral veins

Posterior external vertebral venous plexus

basivertebral vein

Internal vertebral venous plexus

Anterior external vertebral venous plexus
Vertebral veins

no valves
anastomoses
spreading of
infection and
cancer
Illustration of intradural-extradural venous anastomosis. \textit{Daniels after Netter.}
Common Sources of Infection

- Bloodstream infection associated with a central venous catheter
- Intravenous drug use
- Catheter-related urinary tract infection
- Vertebral osteomyelitis
- Spinal catheter for analgesia or stimulation
- Infected pressure sore

Infectious Complications of Spinal Abscess

- Endocarditis
- Vertebral osteomyelitis
- Psoas muscle abscess

Spinal Epidural Abscess

- Abscess
Vertebral venous plexuses

- no valves, a lot of anastomoses
- **anastamoses with venous plexus around sacrum and pelvis**
- 1) in the vertebral canal in the epidural space (**plexus venosi vertebrales interni**)
- 2) outside the spine (**plexus venosi vertebrales externi**)
- 3) in the bodies of vertebrae (**venae basivertebrales**)

