

Komorový systém, likvor, obaly a cévy mozku

Veronika Němcová

Mozkomíšňní mok

Tvorba - *plexus choroideus*

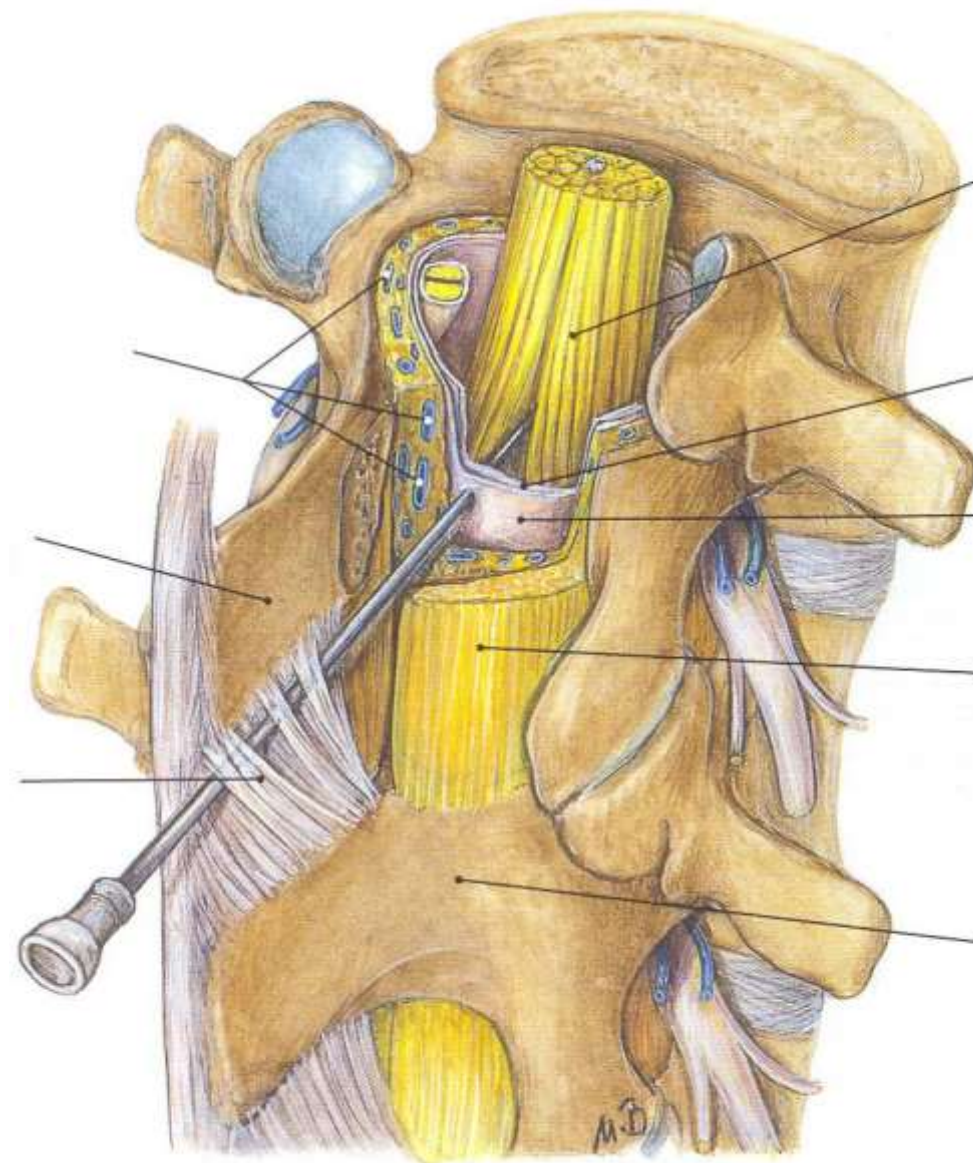
Vstřebávání – *granulationes arachnoidales*

Komory a *spatium subarachnoidale* = 150 ml
objem komor 40 ml

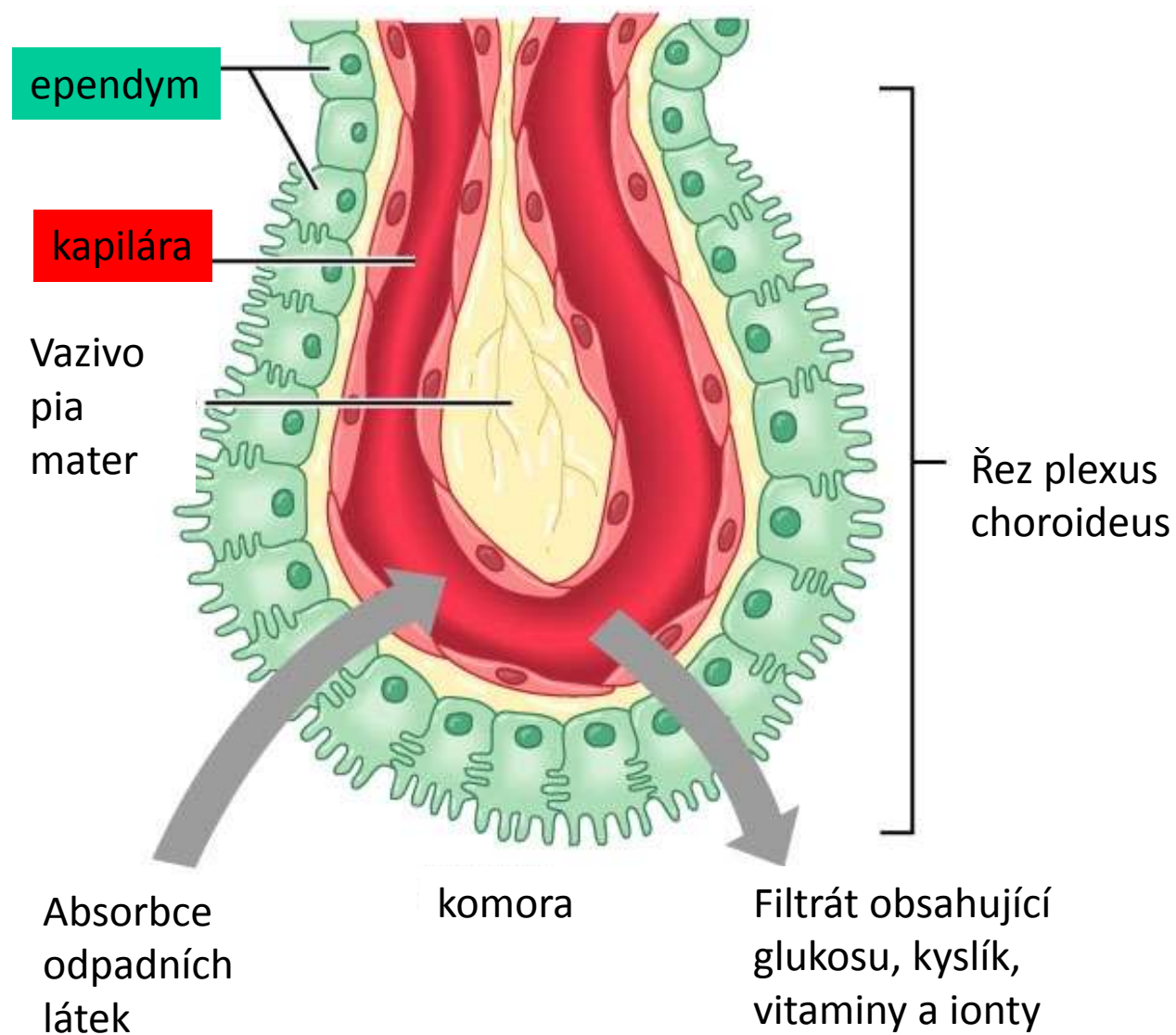
Denně se vytvoří 500 ml

Mechanická opora mozku („plave“)

Chemická komunikace v CNS (neurony- mok-stěna
komor– neurony)

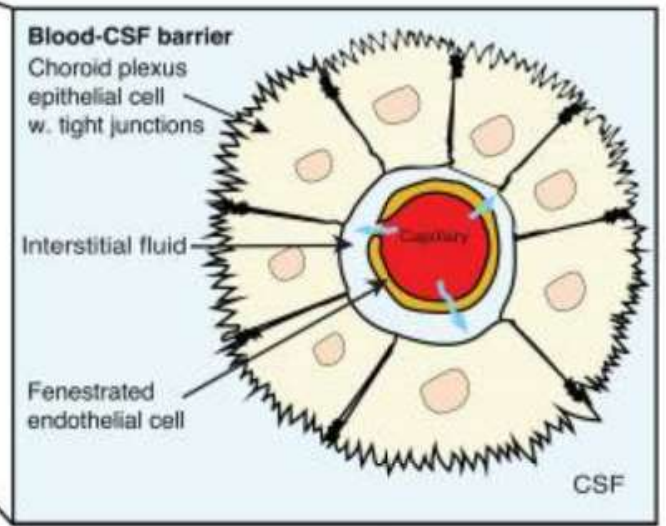
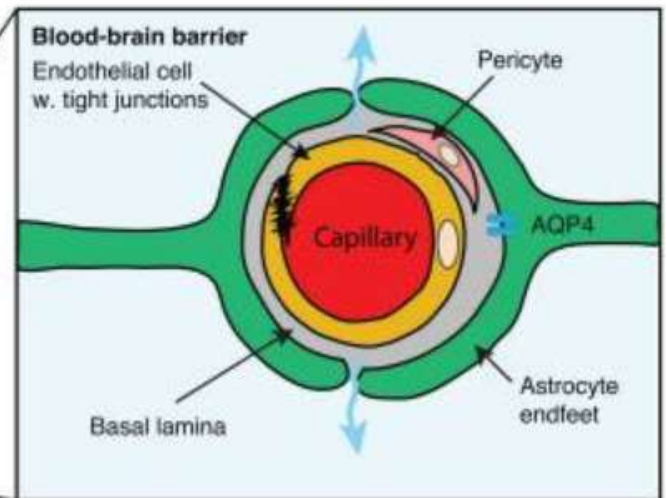
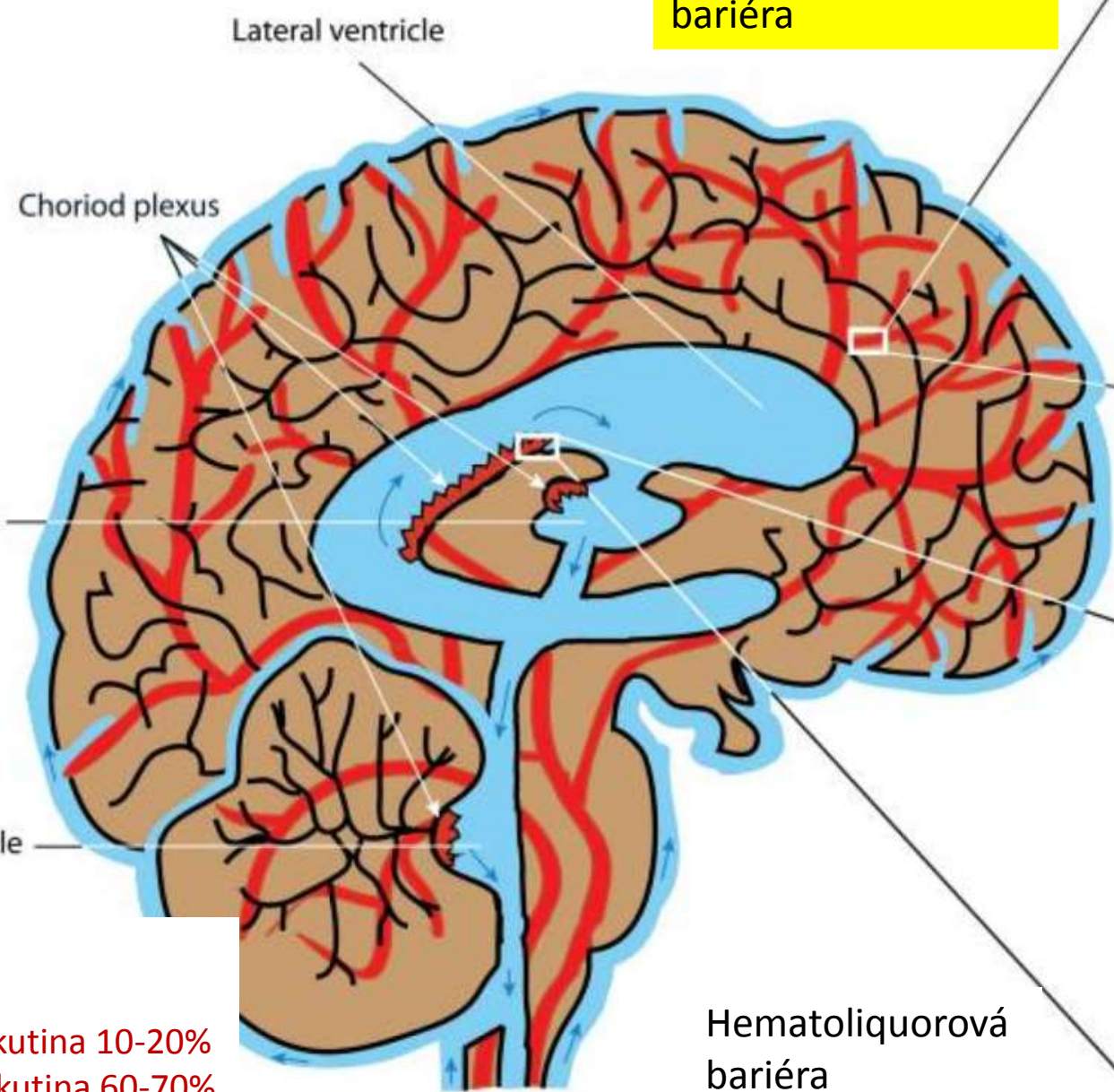


Produkce MMM v plexus choroideus



(a)

Hematoencephalická
bariéra

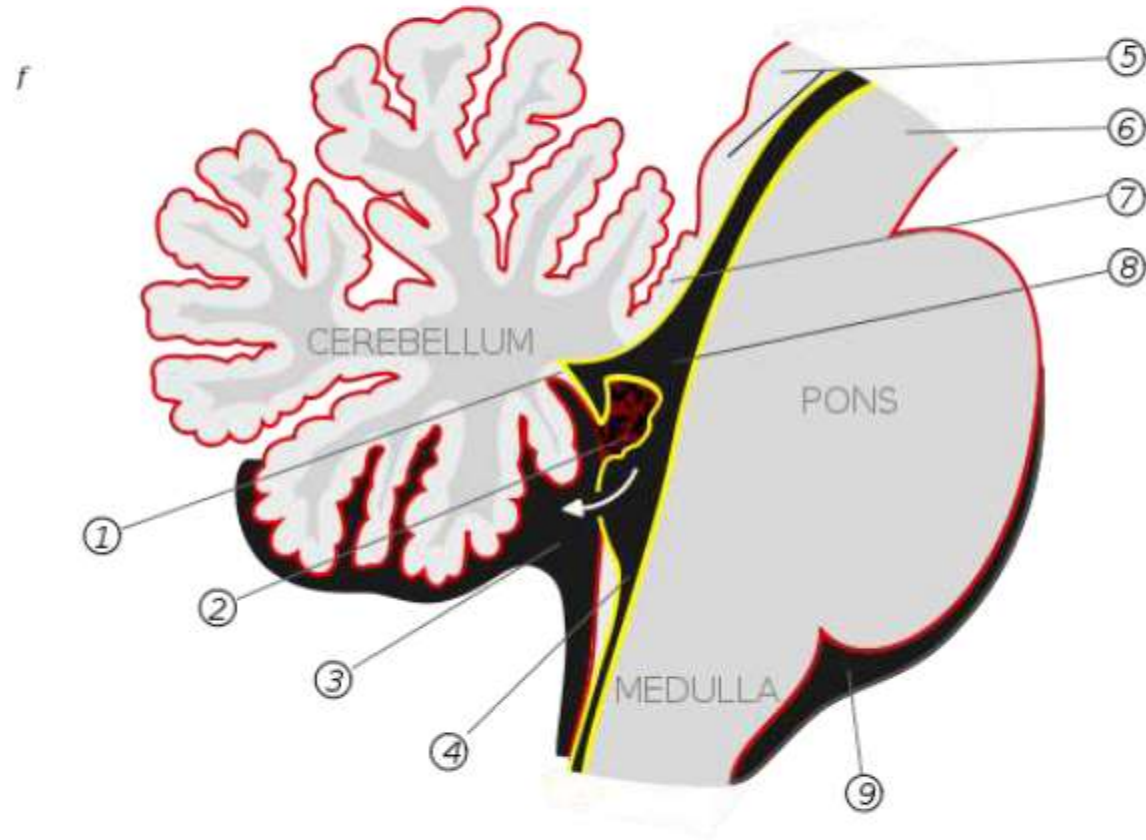


MMM 10%
Krev 10%
Mezibuněčná tekutina 10-20%
Nitrobuněčná tekutina 60-70%

Hematoliquorová
bariéra

Mok se z komor dostává do subarachnoidálního prostoru přes:

A) Apertura mediana ventriculi quarti ③
= **foramen Magendi**



B) Aperturae laterales ventriculi quarti
= **Foramina Luschkae**
Laterálně v tela choroidea ventriculi quarti

Mozkové komory - odlitek

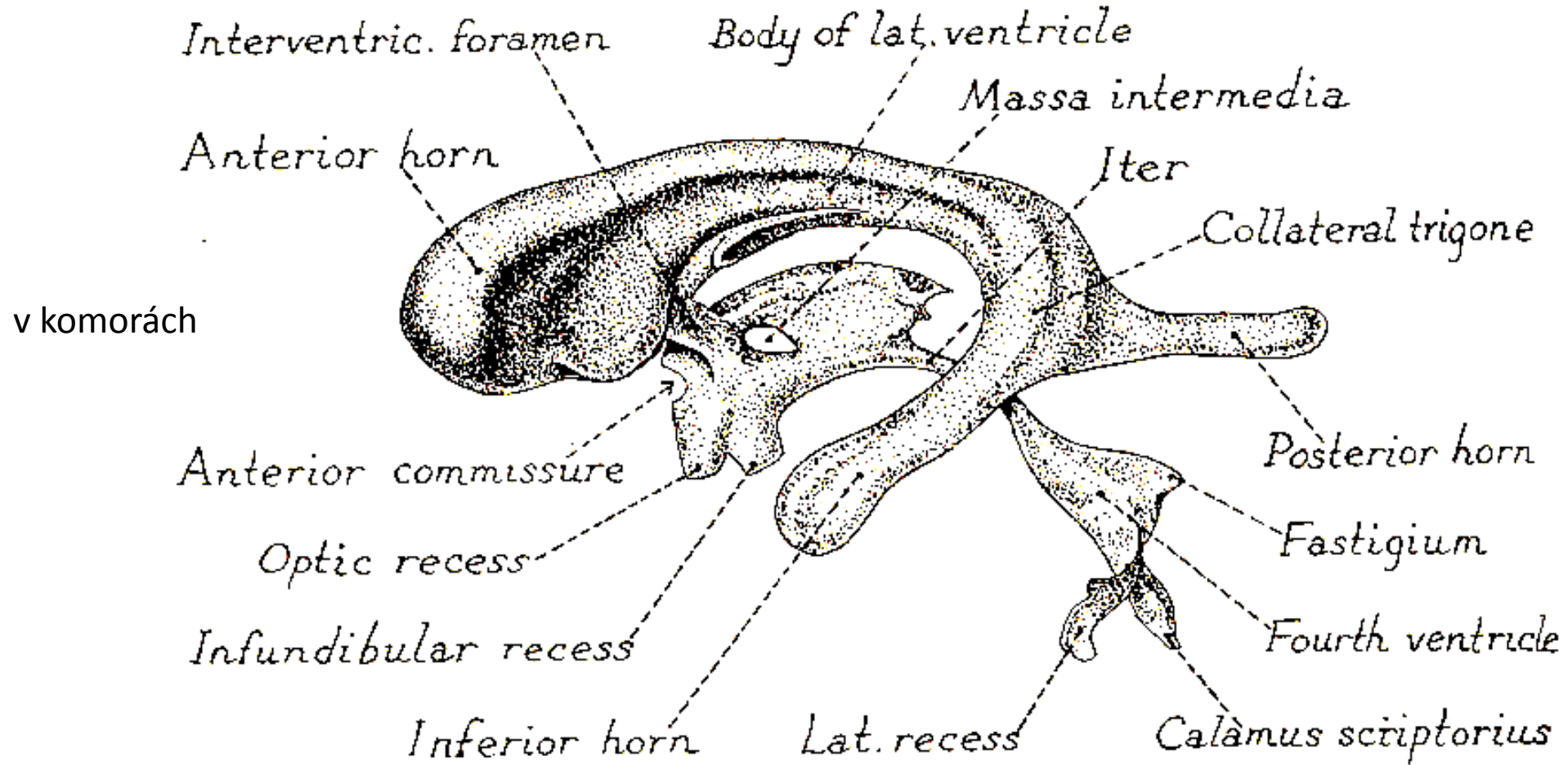
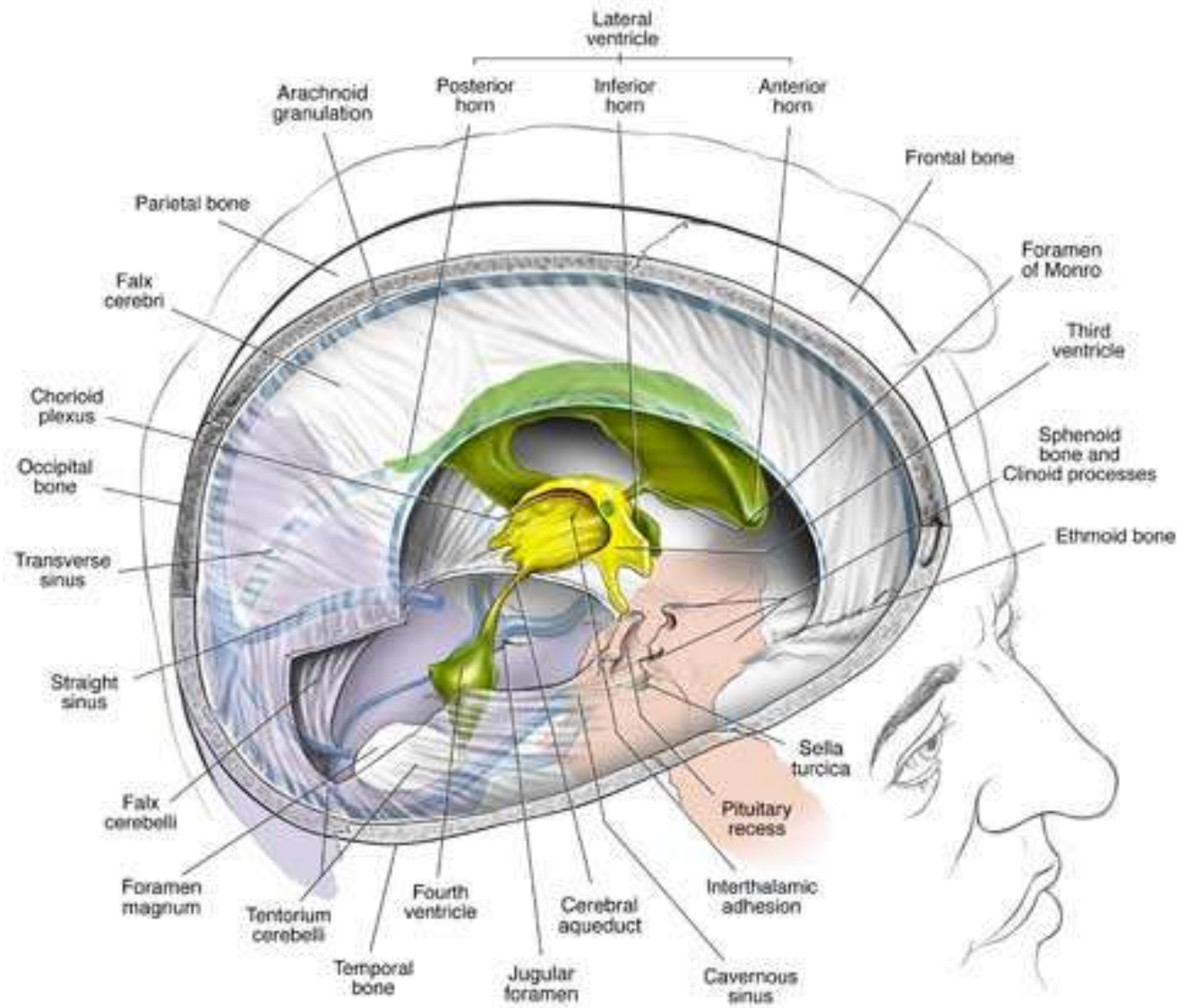
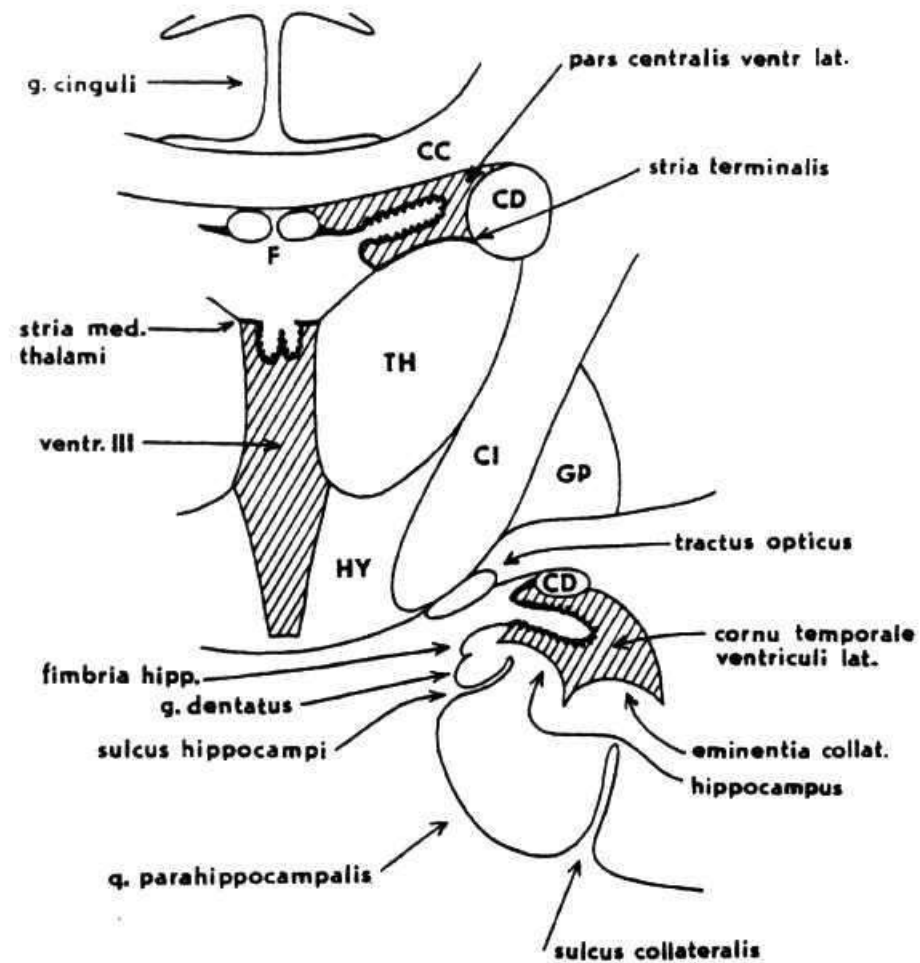


FIG. 305. Cast of the brain ventricles, viewed from the side. Only the left lateral ventricle is represented. (After Rauber-Kopsch.)



Mozkové komory, dura mater a sinusy
 Pravá komora a pravá část III. komory
 odstraněna

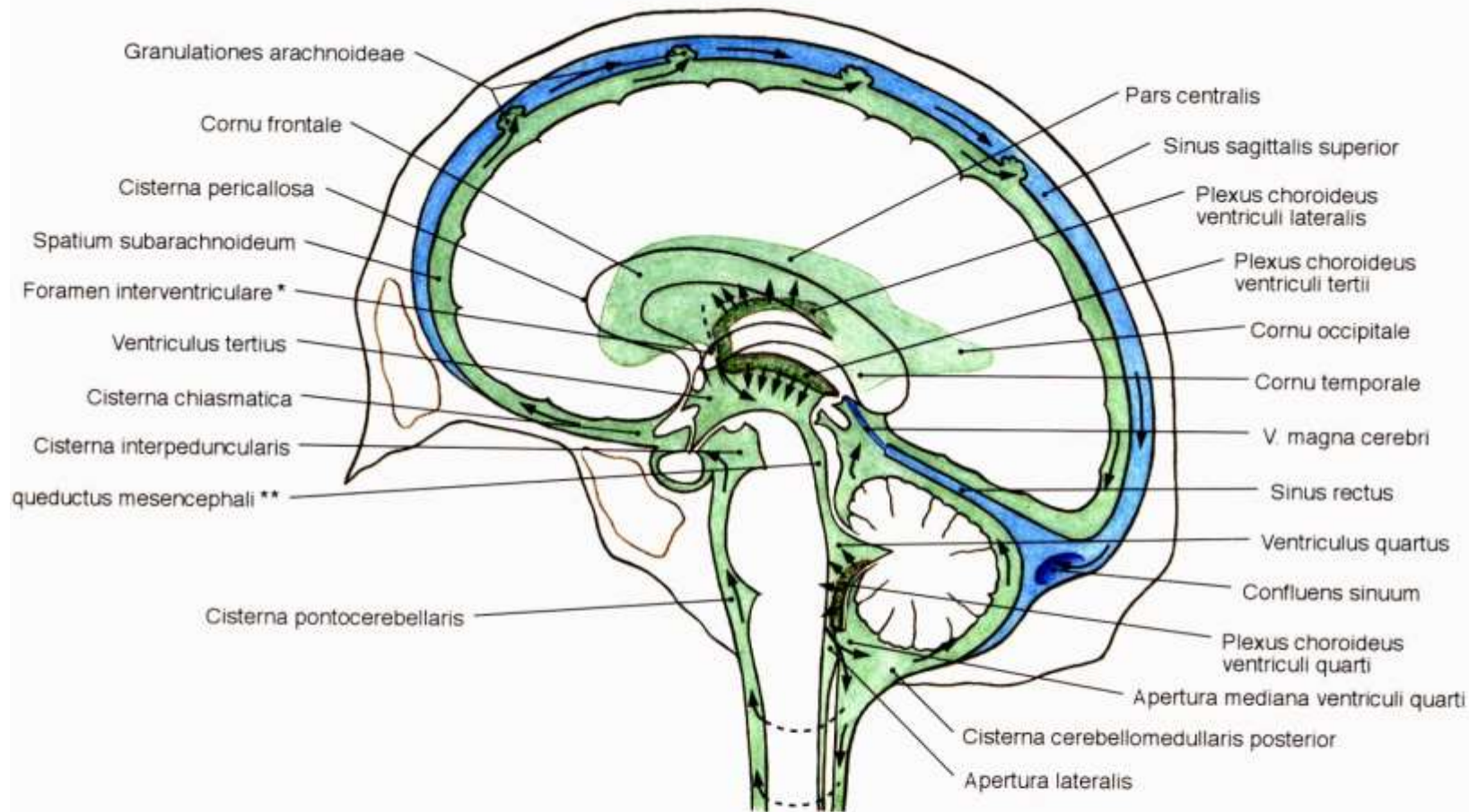


Obr. 58.: Frontální řez mozkem se zachycenou postranní a třetí komorou. Komory šrafovane, tela choroidea silně vlnitě.

CC – corpus callosum,
 CD – caudatum,
 CI – capsula interna,
 F – fornix,

GP – globus pallidus,
 HY – hypothalamus,
 Th – thalamus.

Laterální komory, foramen interventriculare, III. komora, aqueductus mesencephali, IV. komora, apertura mediana Magendi + aperturae laterales Luschkae

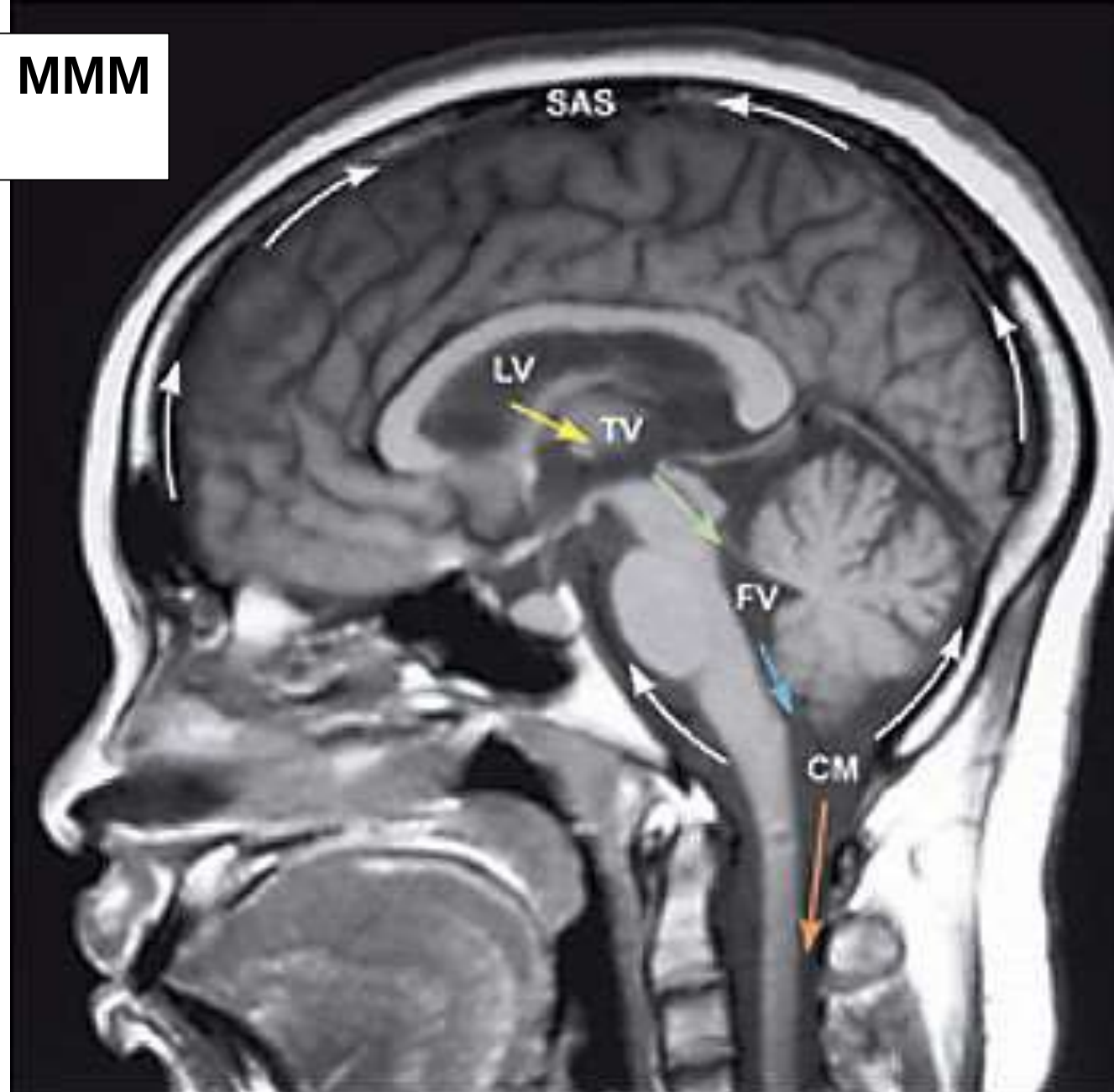


Obr. 551 Mozkové komory, ventriculi encephali a subarachnoideální prostor, spatium subarachnoideum; schéma cirkulace (šipky) mozkomíšního moku, liquor cerebrospinalis z vnitřních do zevních likvorových prostorů.

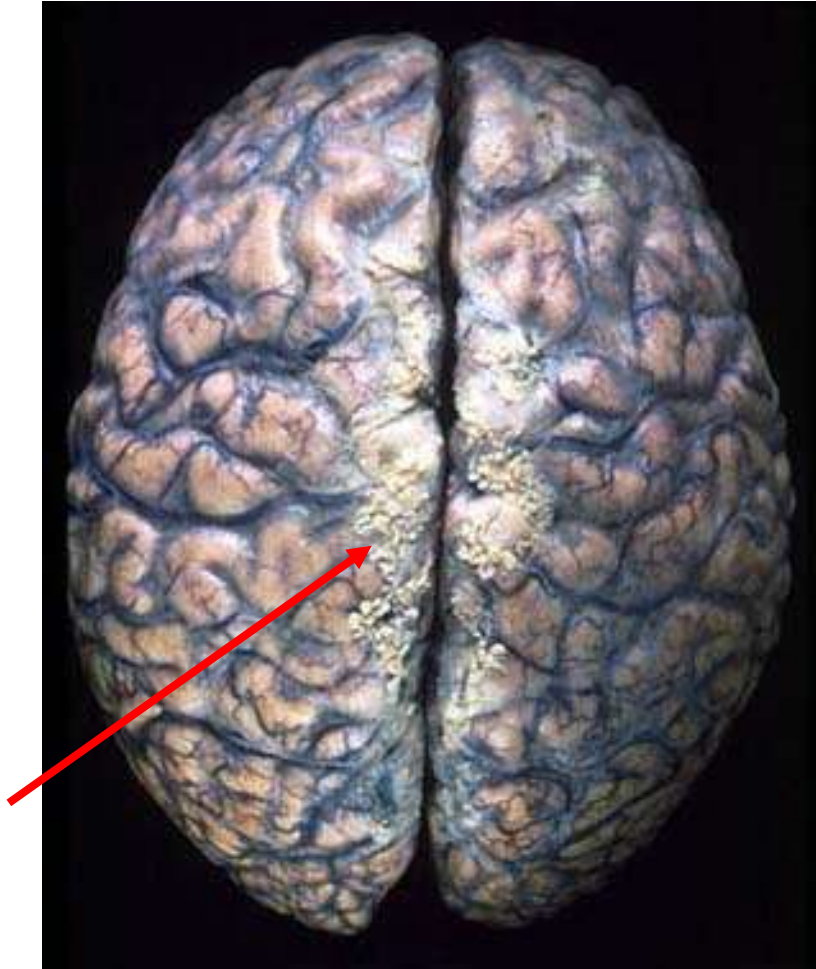
* foramen MONROI

** canalis SYLVII

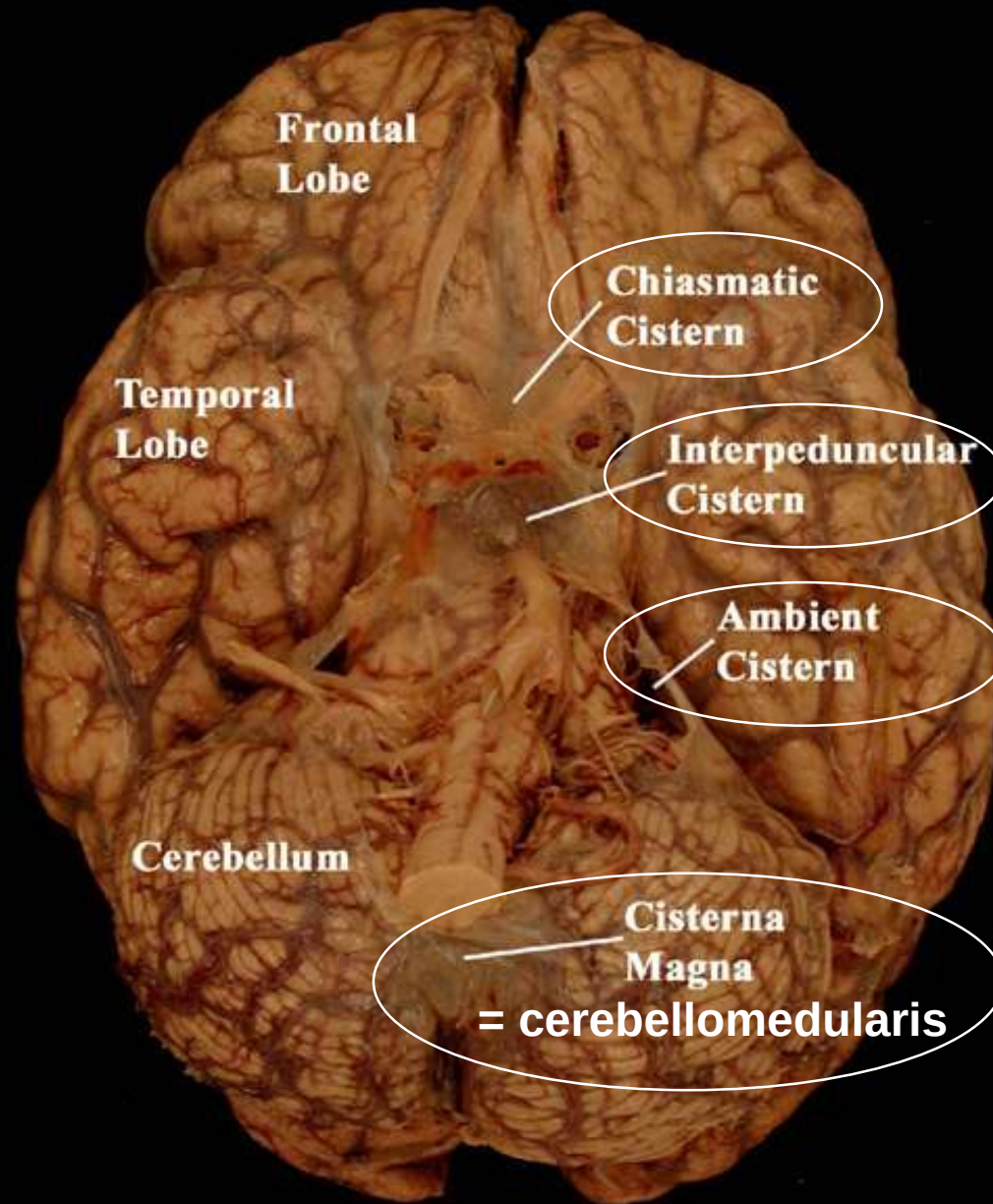
Cirkulace MMM
MR



Granulationes arachnoidales
vstřebávání do žilního splavu (sinus sagittalis superior)



Arachnoid layer covering the Subarachnoid Cisterns



Cisternae
subarachnoidales

Mezi pia mater a
arachnoideou

Další cisterny:

Cisterna fossae lateralis cerebri

Cisterna pontis

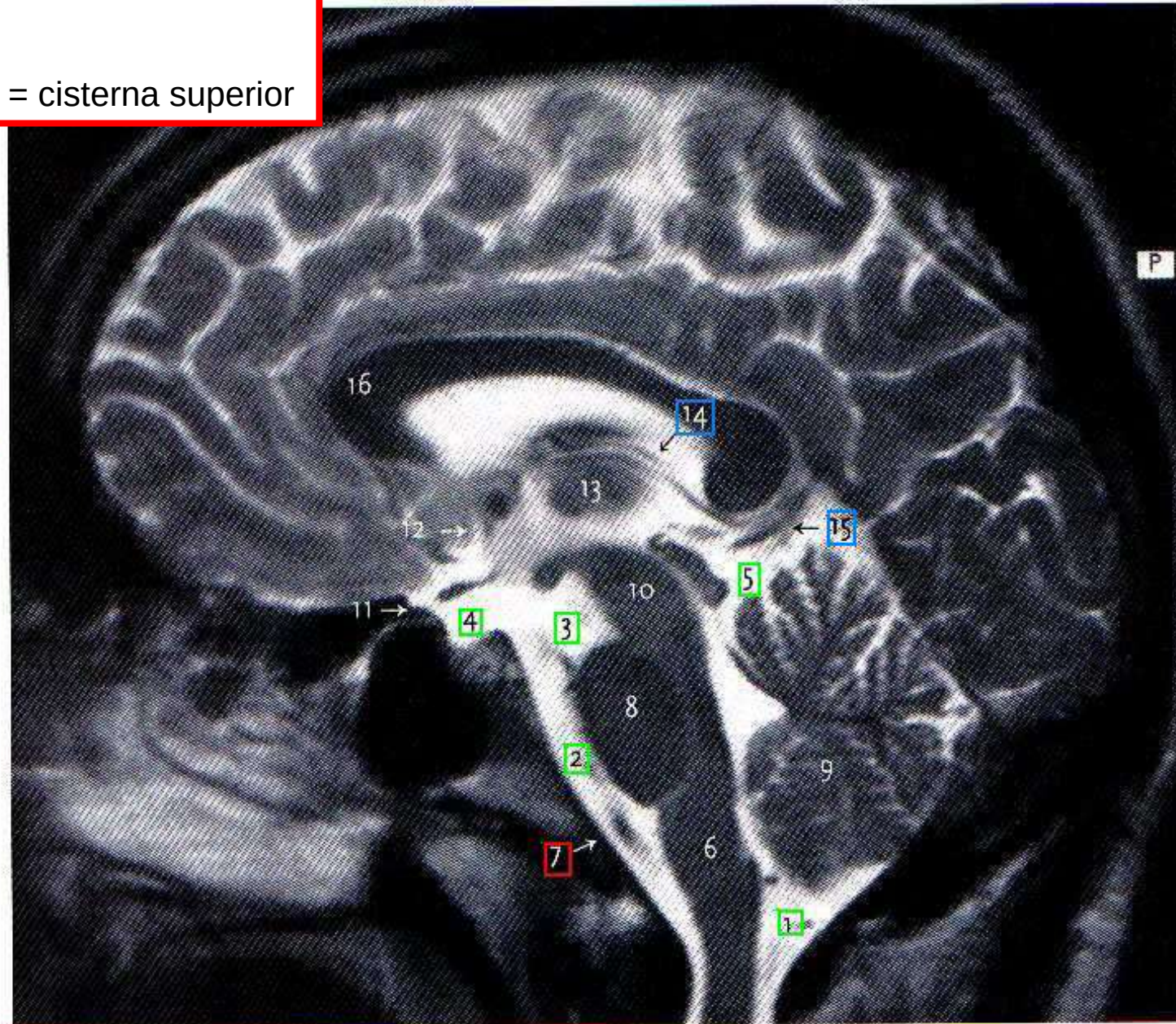
Cisterna laminae quadrigeminae

Cisterna corporis callosi

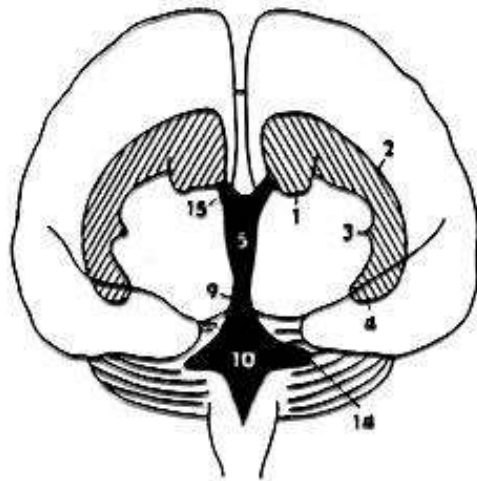
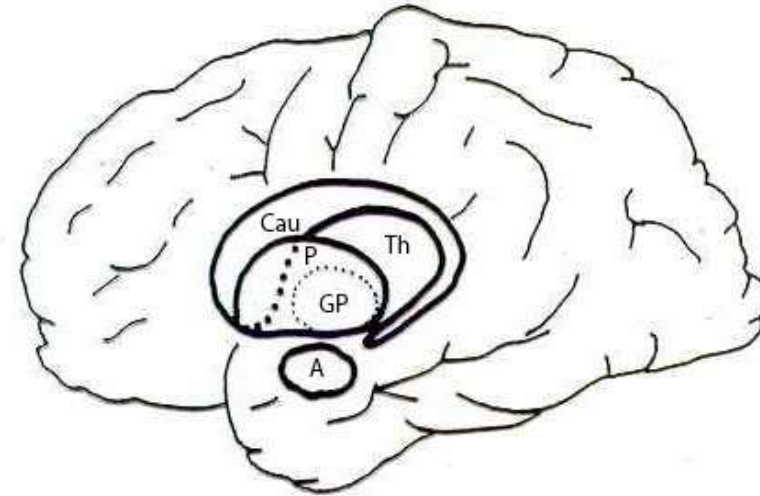
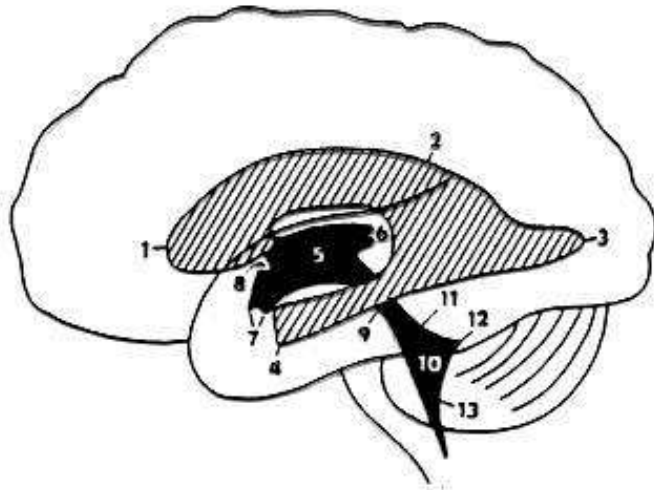
- 1 Cisterna cerebellomedullaris
- 2 Cisterna pontis
- 3 Cisterna interpeduncularis
- 5 Cisterna laminae quadrigeminae = cisterna superior

**Rozšíření
subarachnoidálního
prostoru - cisterny
v MRI :**

1 cisterna
cerebellomedullaris;
2 cisterna pontis;
3 cisterna interpeduncu-
laris; 4 cisterna chias-
matis; 5 cisterna superi-
or; 6 medulla oblongata;
7 a.basilaris; 8 pons;
9 cerebellum; 10 mesen-
cephalon; 11 n.opticus;
12 commissura anterior;
13 thalamus; 14 v.cerebri
interna; 15 v.cerebri
magna; 16 corpus callo-
sum.

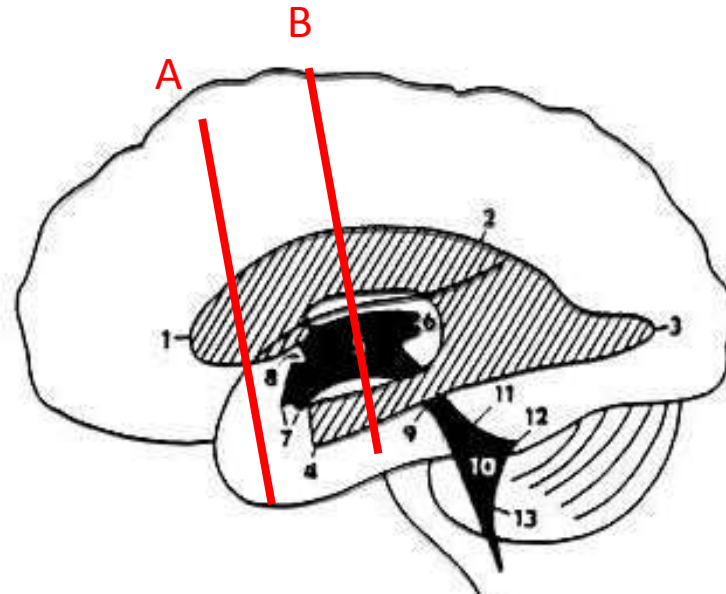
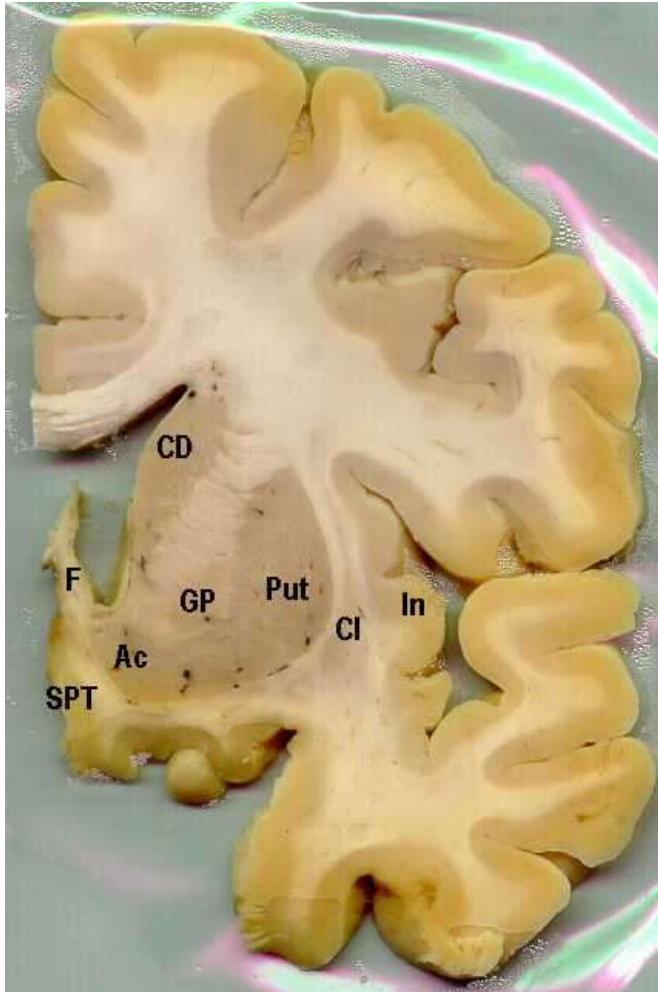


Komory z boku a zepředu a vztah k BG



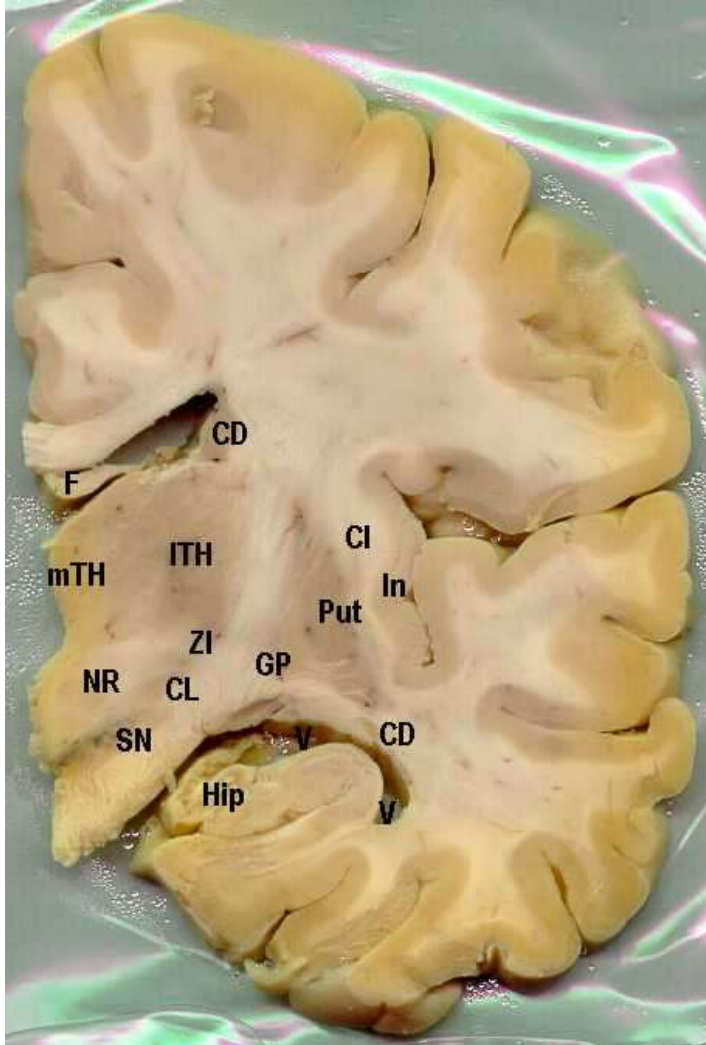
Cornu frontale ventriculi lateralis

A

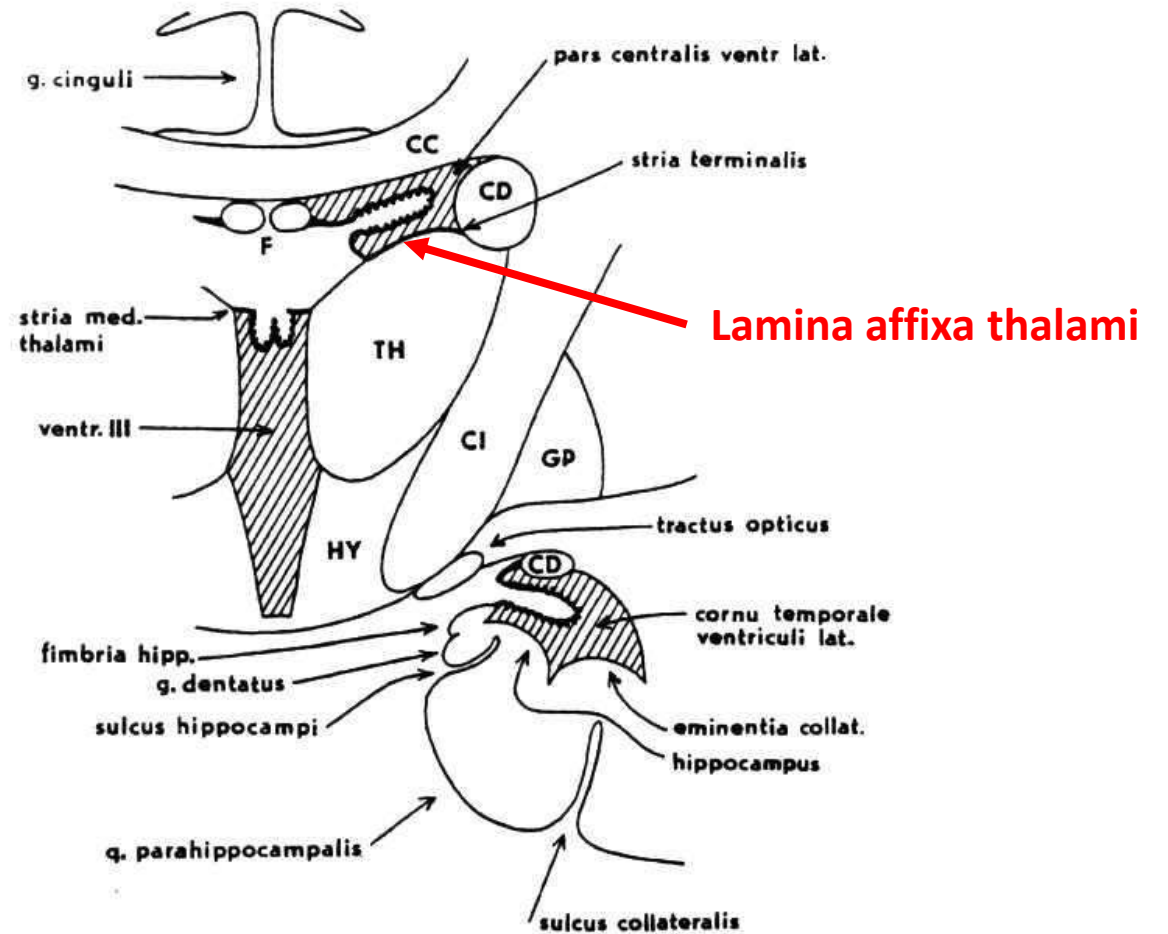


Pars centralis a cornu temporale

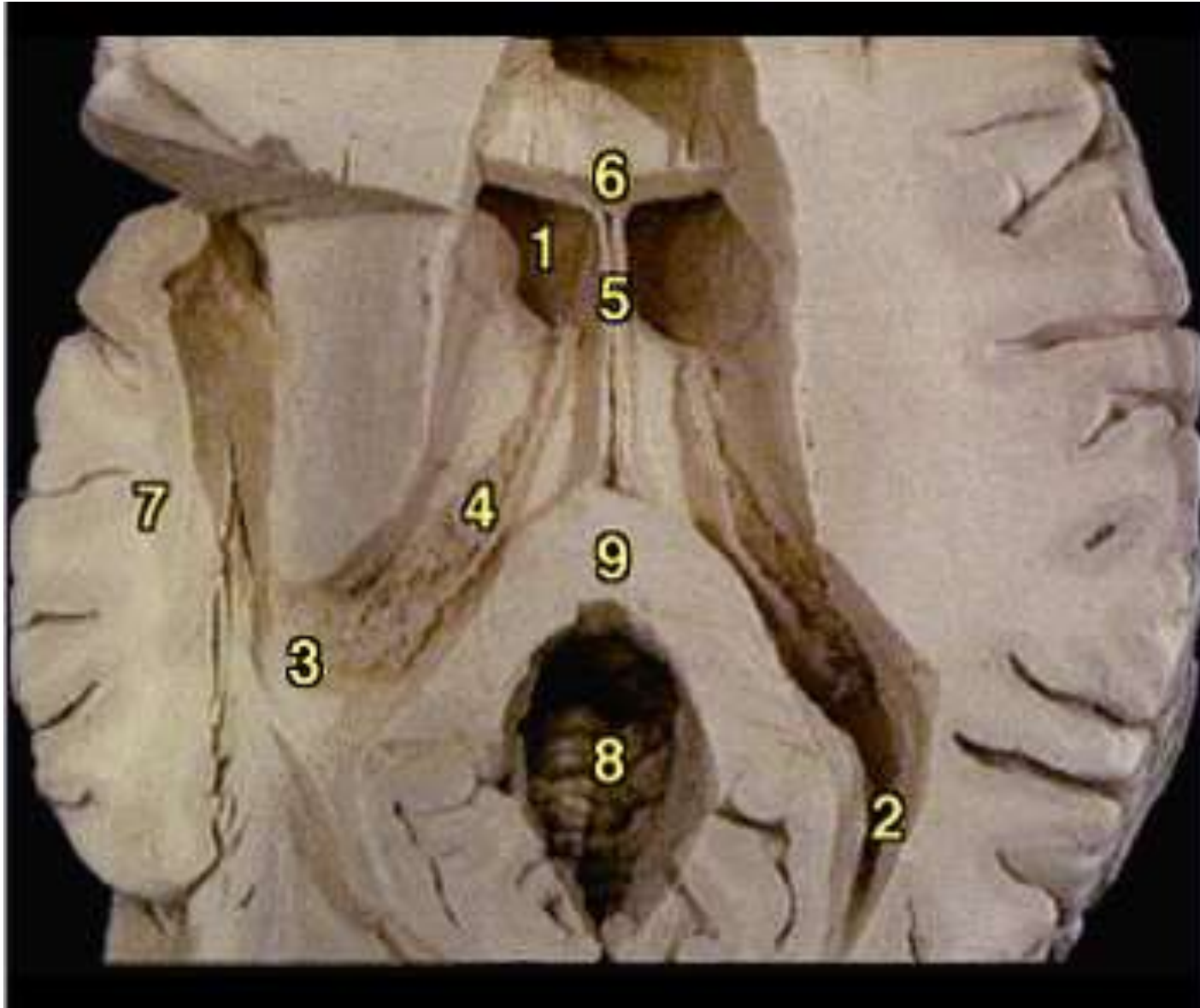
B



Tela choroidea mezi fornixem a ncl. caudatus

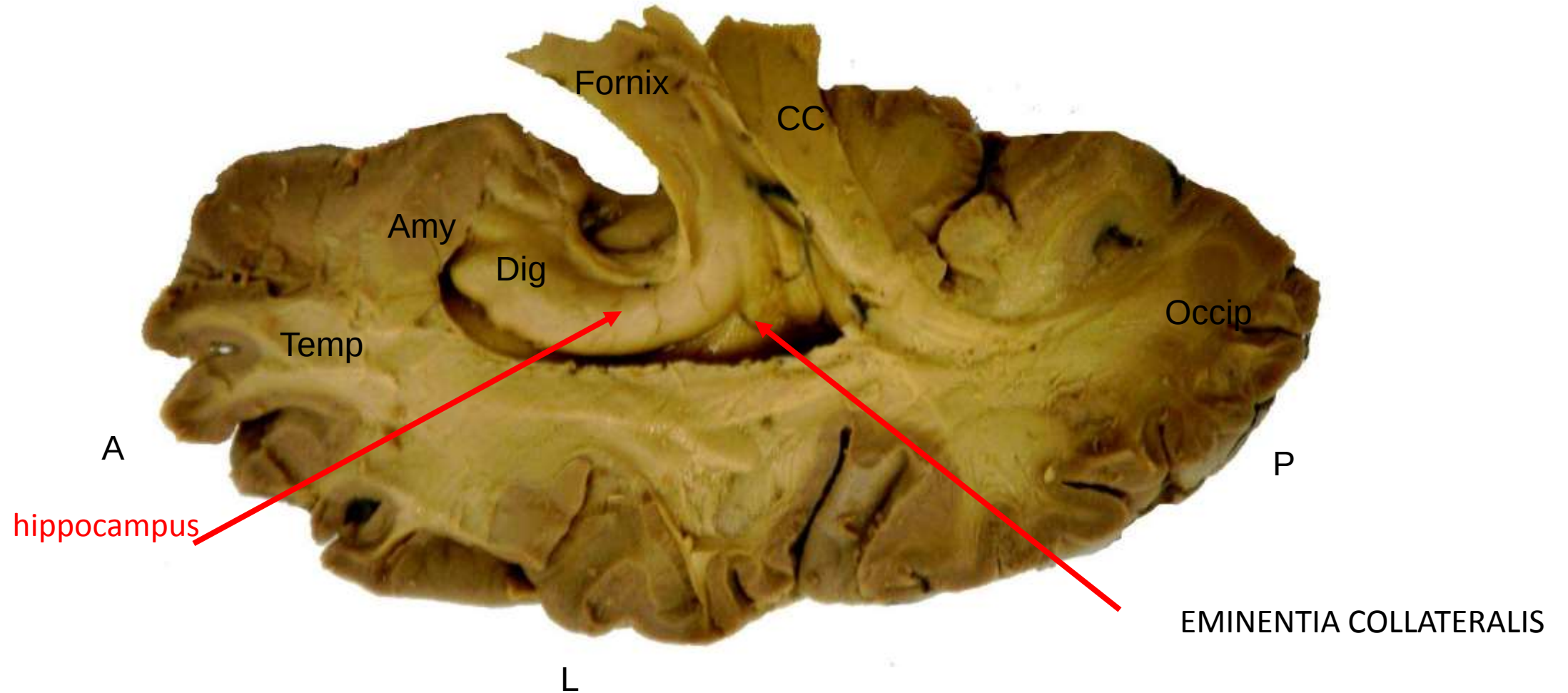


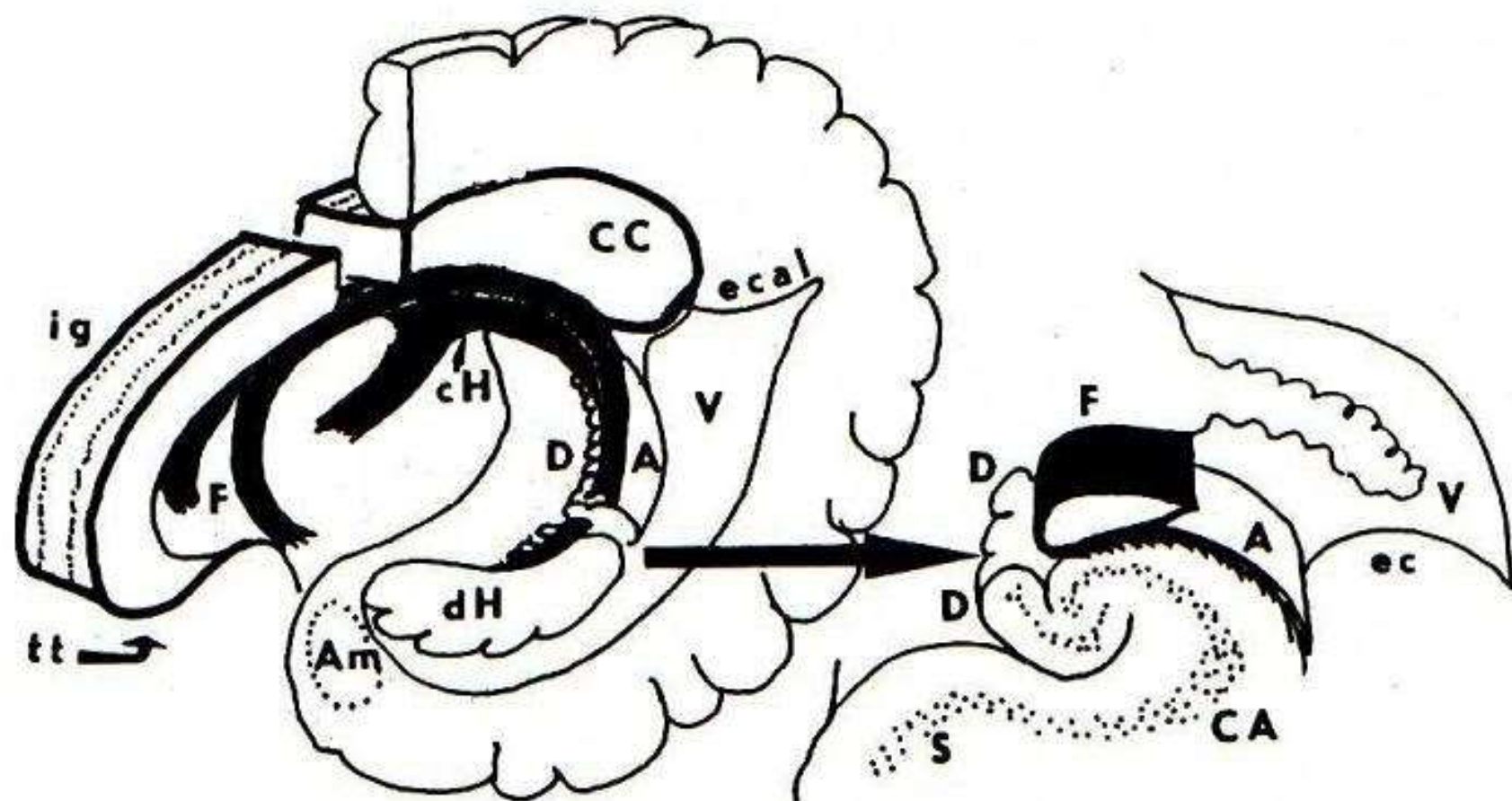
Pohled shora do otevřené laterální komory



- 1- cornu frontale
- 2-cornu occipitale
- 3-fornix+ hippocampus
- 4-plexus choroideus VL
- 5-septum pellucidum
- 6- forceps ant
- 7-temporální lalok
- 8-mozeček
- 9-forceps post

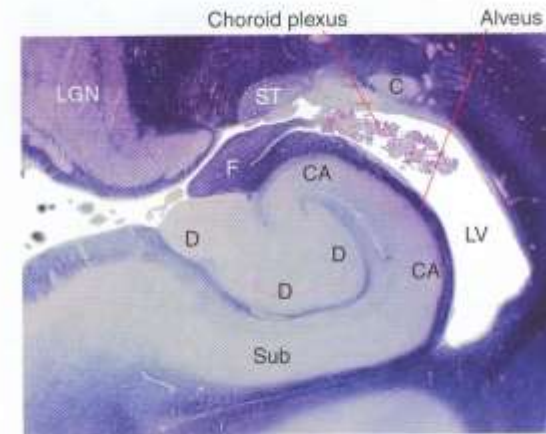
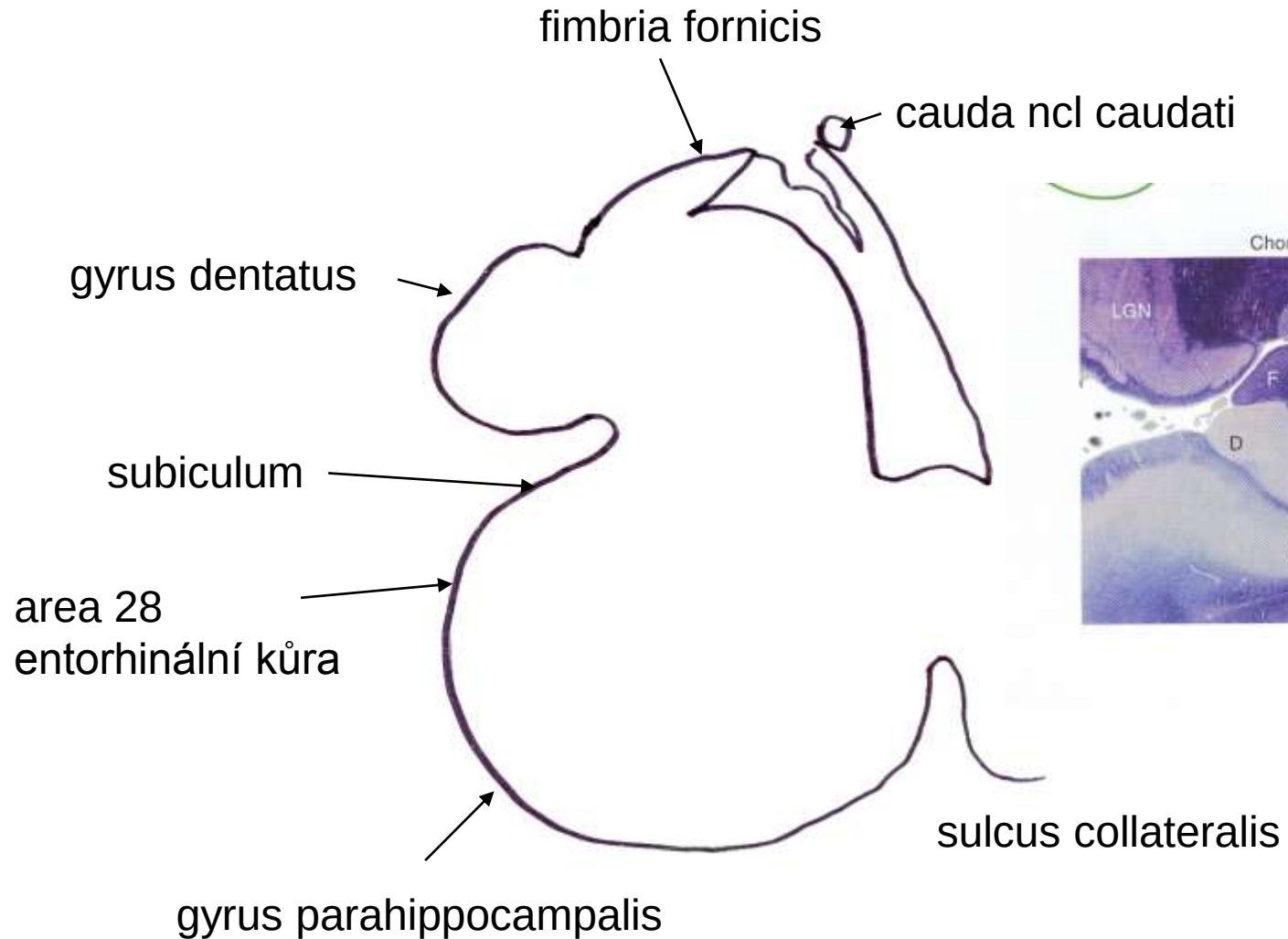
Cornu temporale



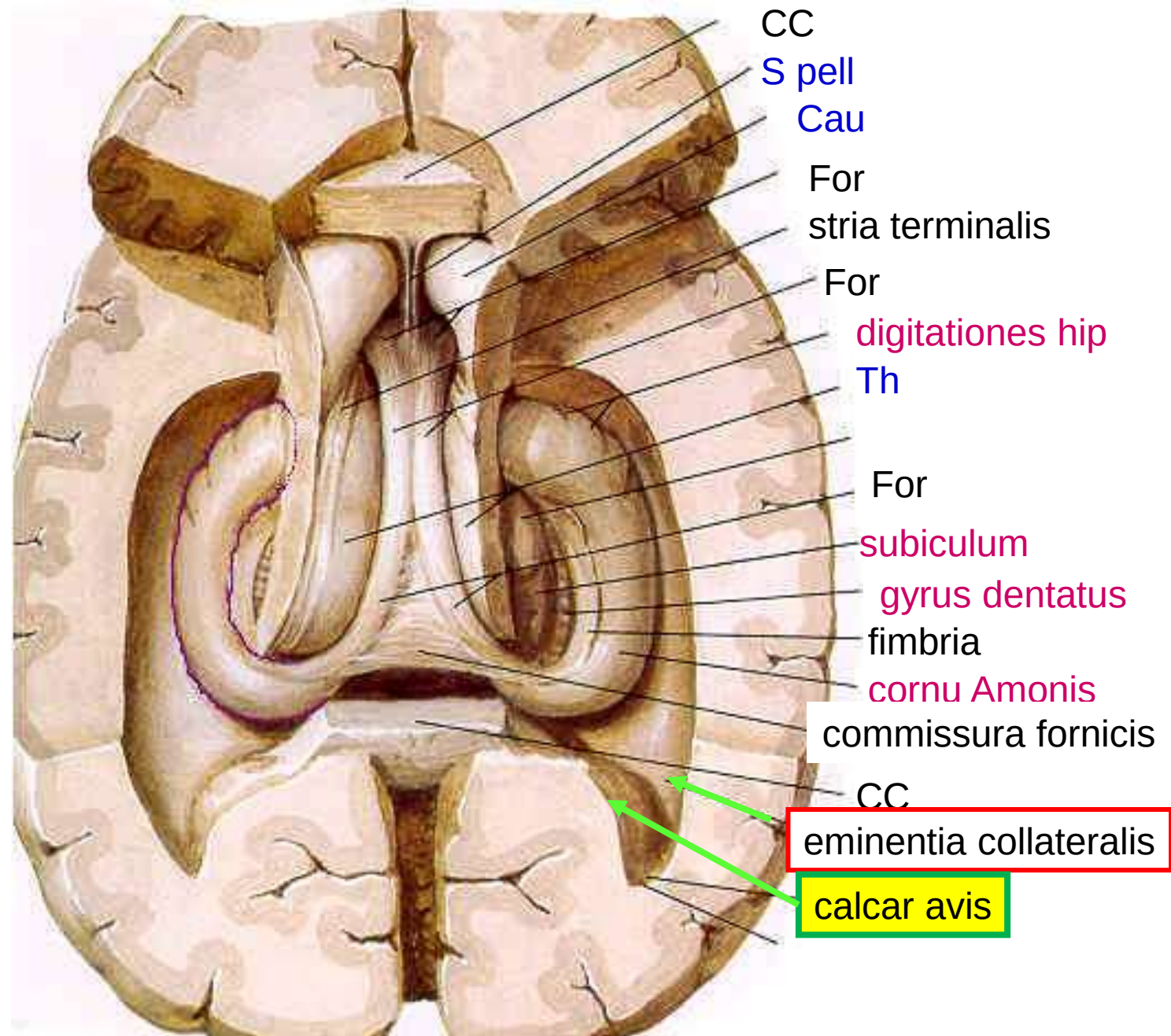


Obr 42.: Pohled na vypreparovaný hippocampus a jeho výřez.
Vysvětlivky u obr. 43.

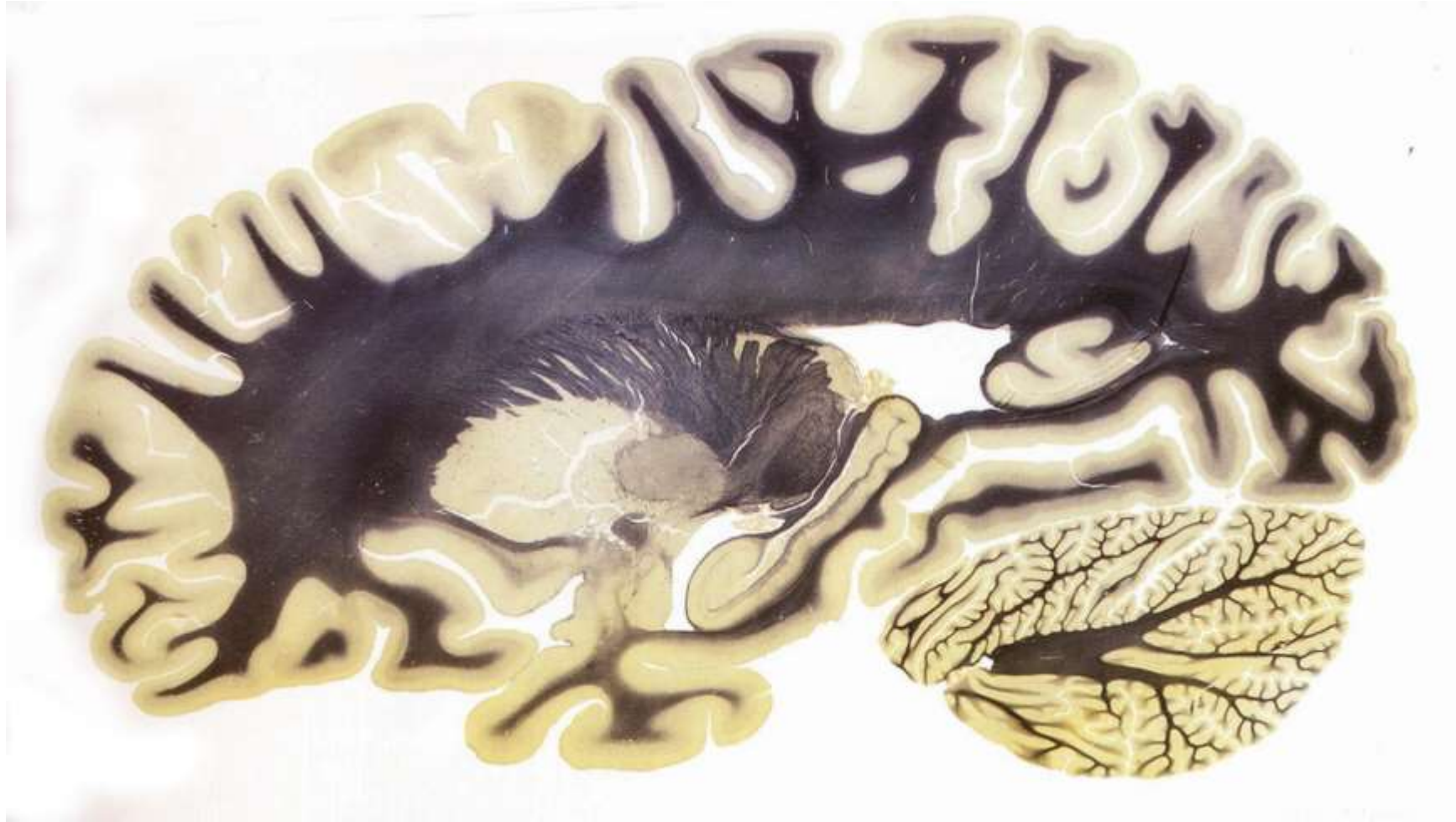
Frontální řez hippocampem



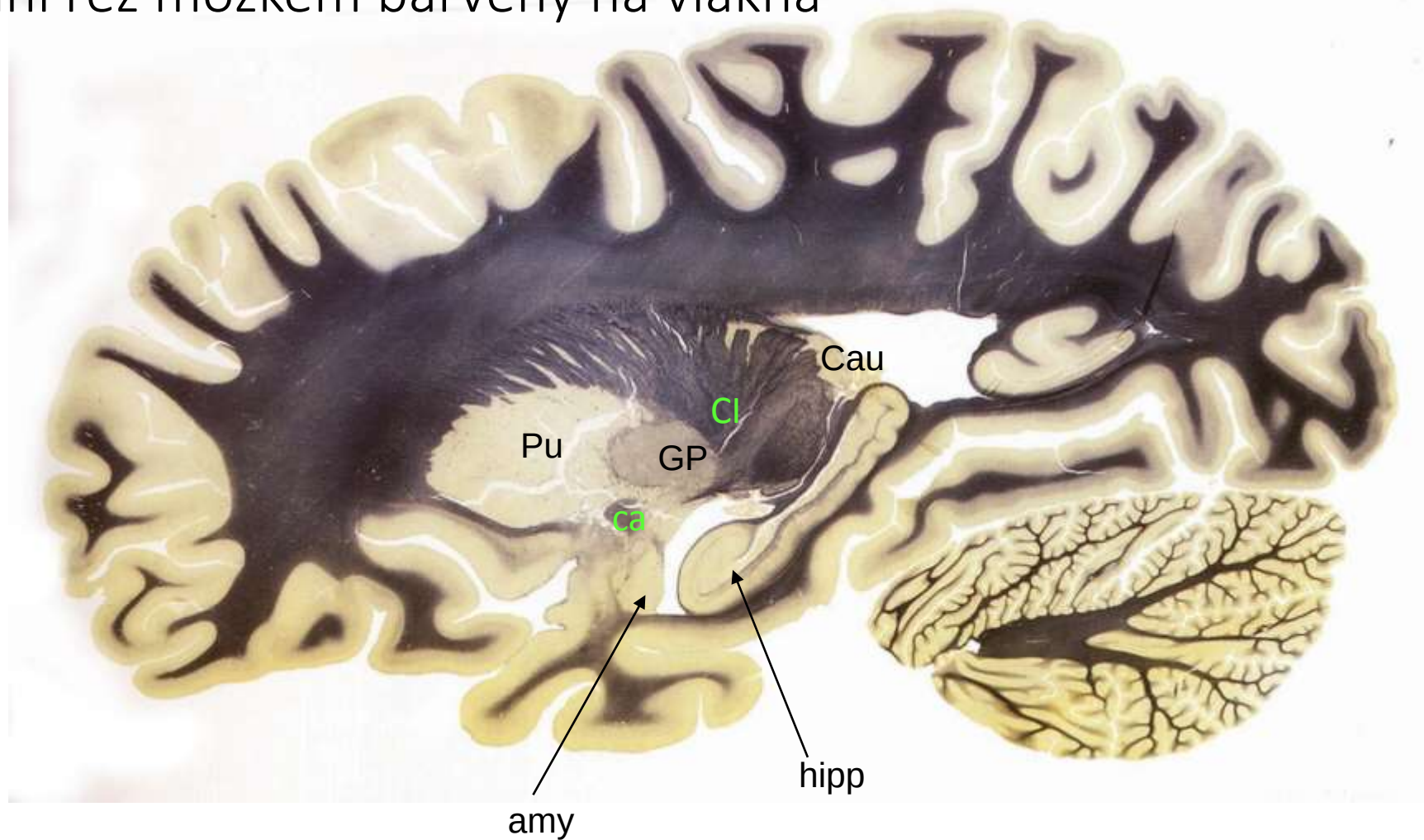
Pohled na cornu temporale a
cornu occipitale ventriculi
lateralis

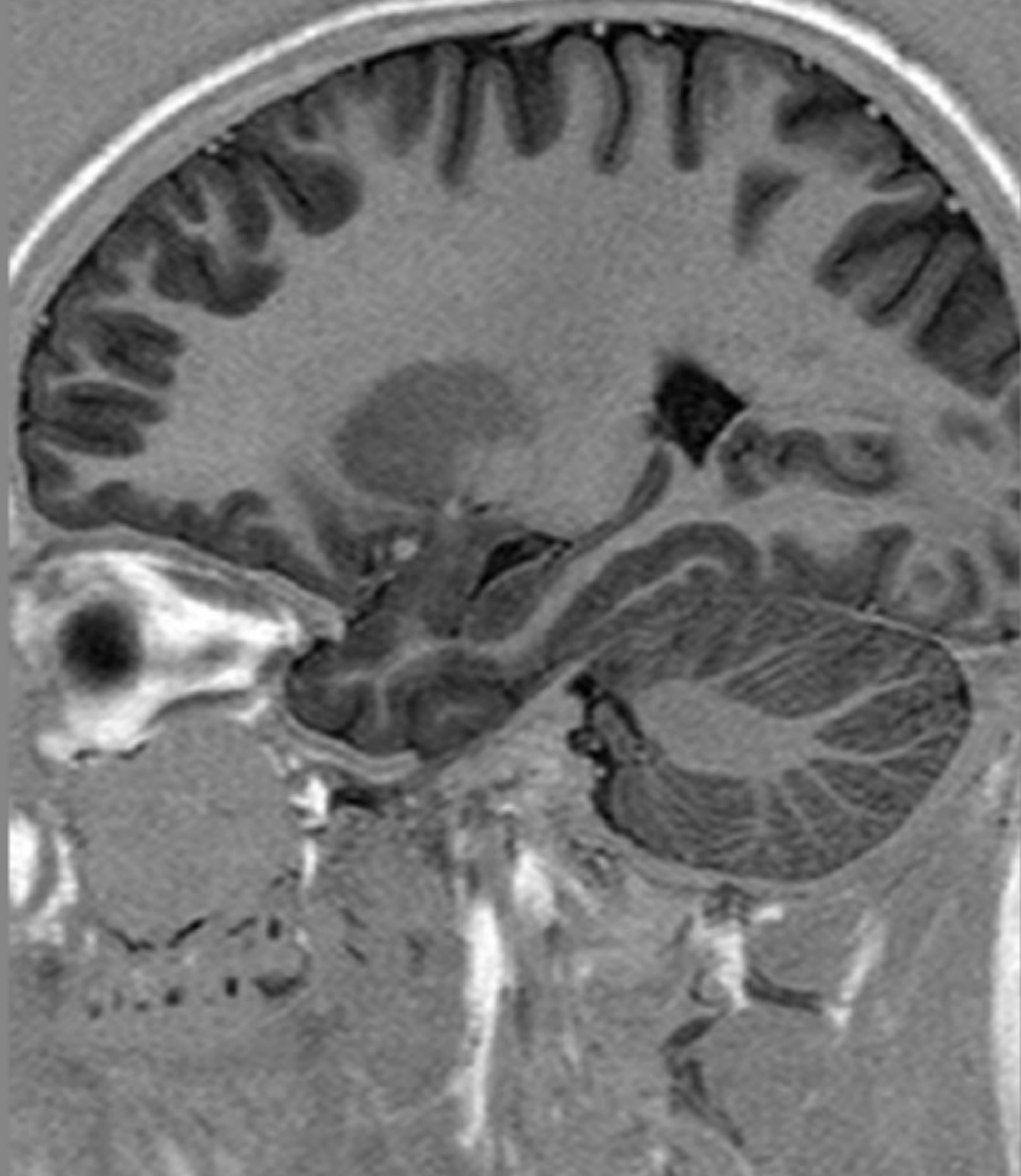


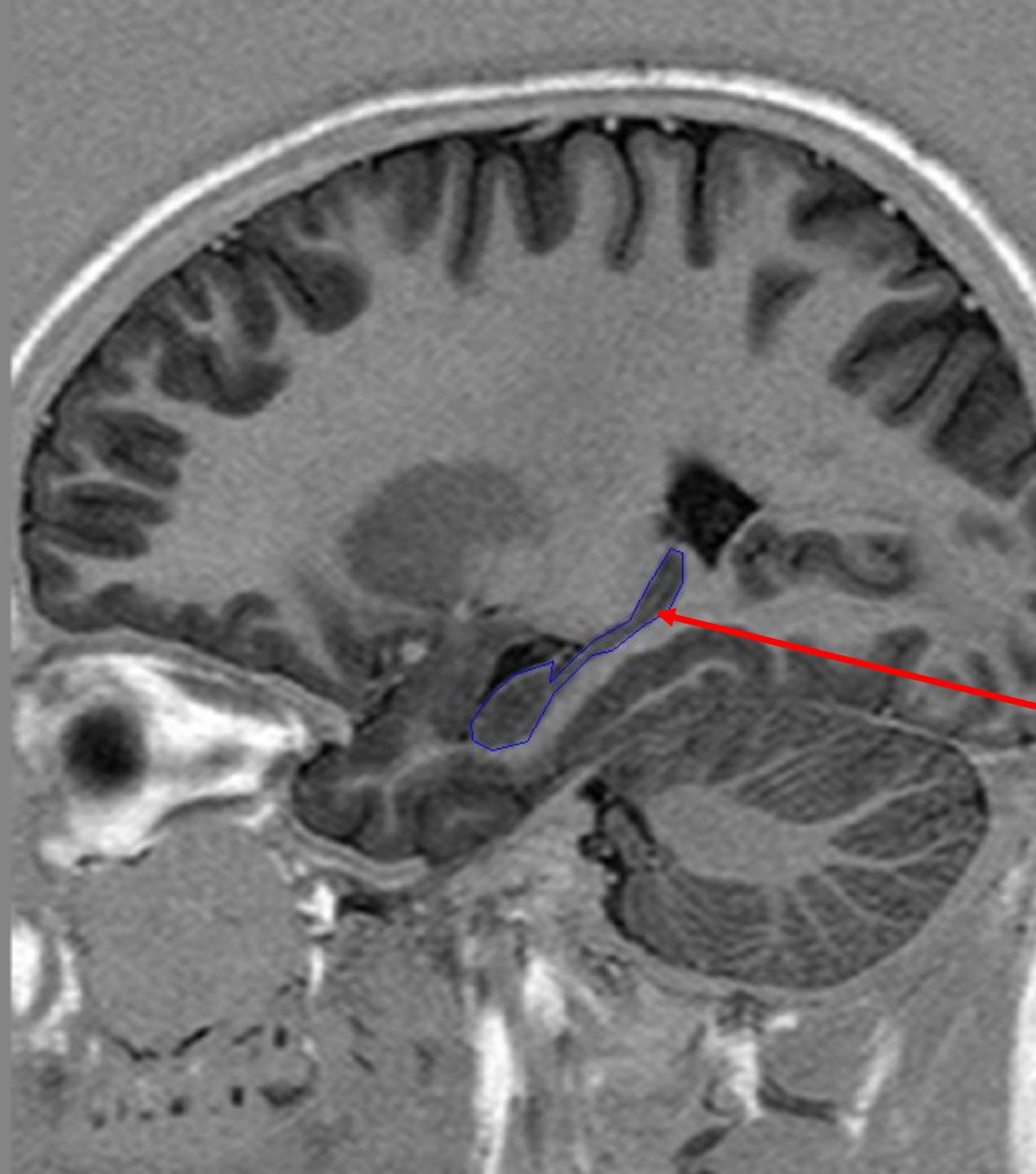
???



Sagittální řez mozkiem barvený na vlákna

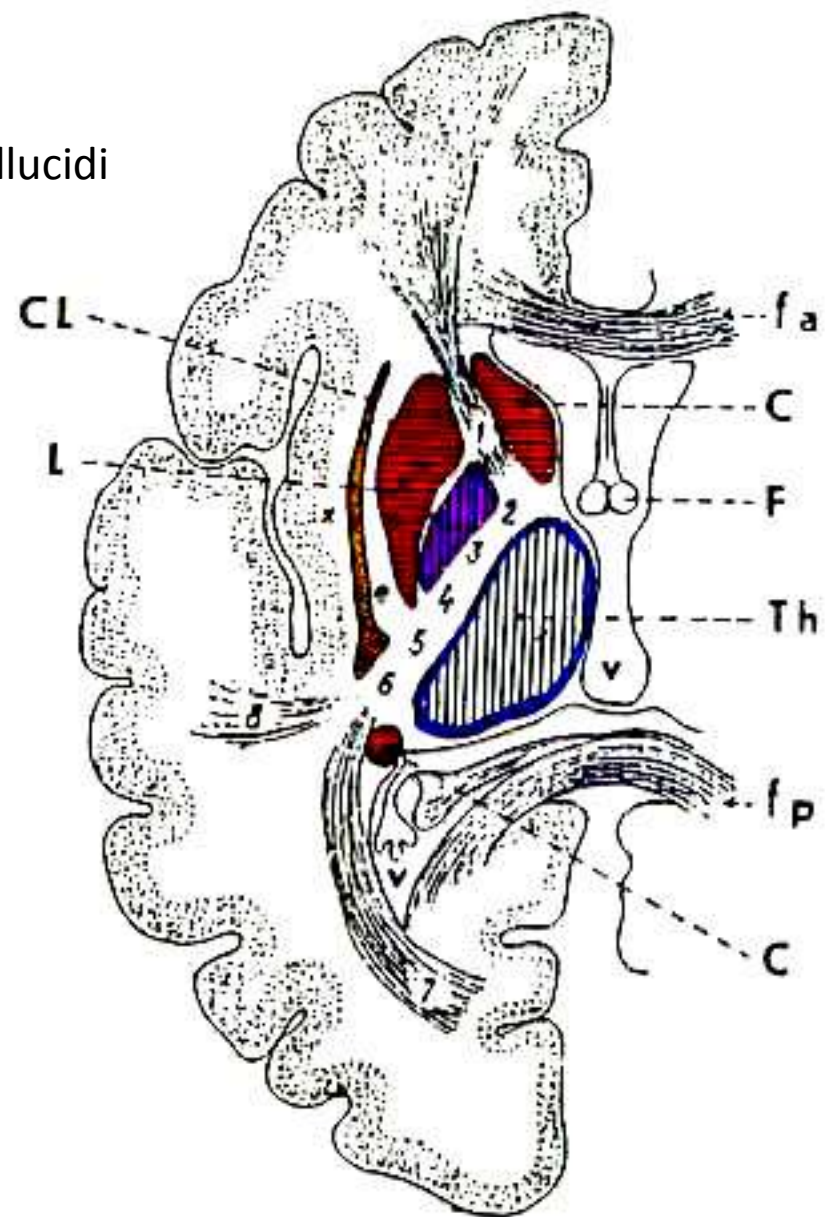
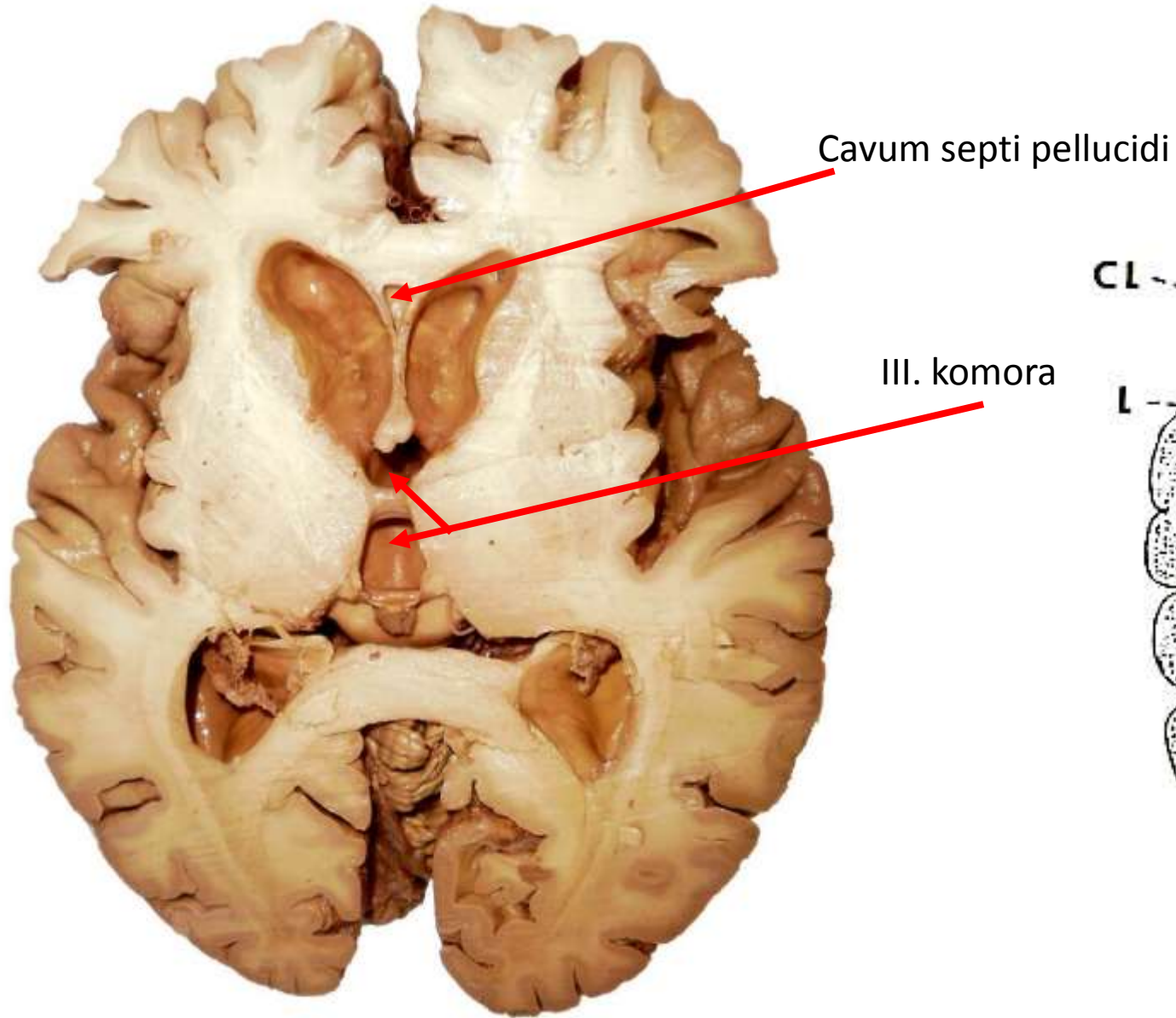




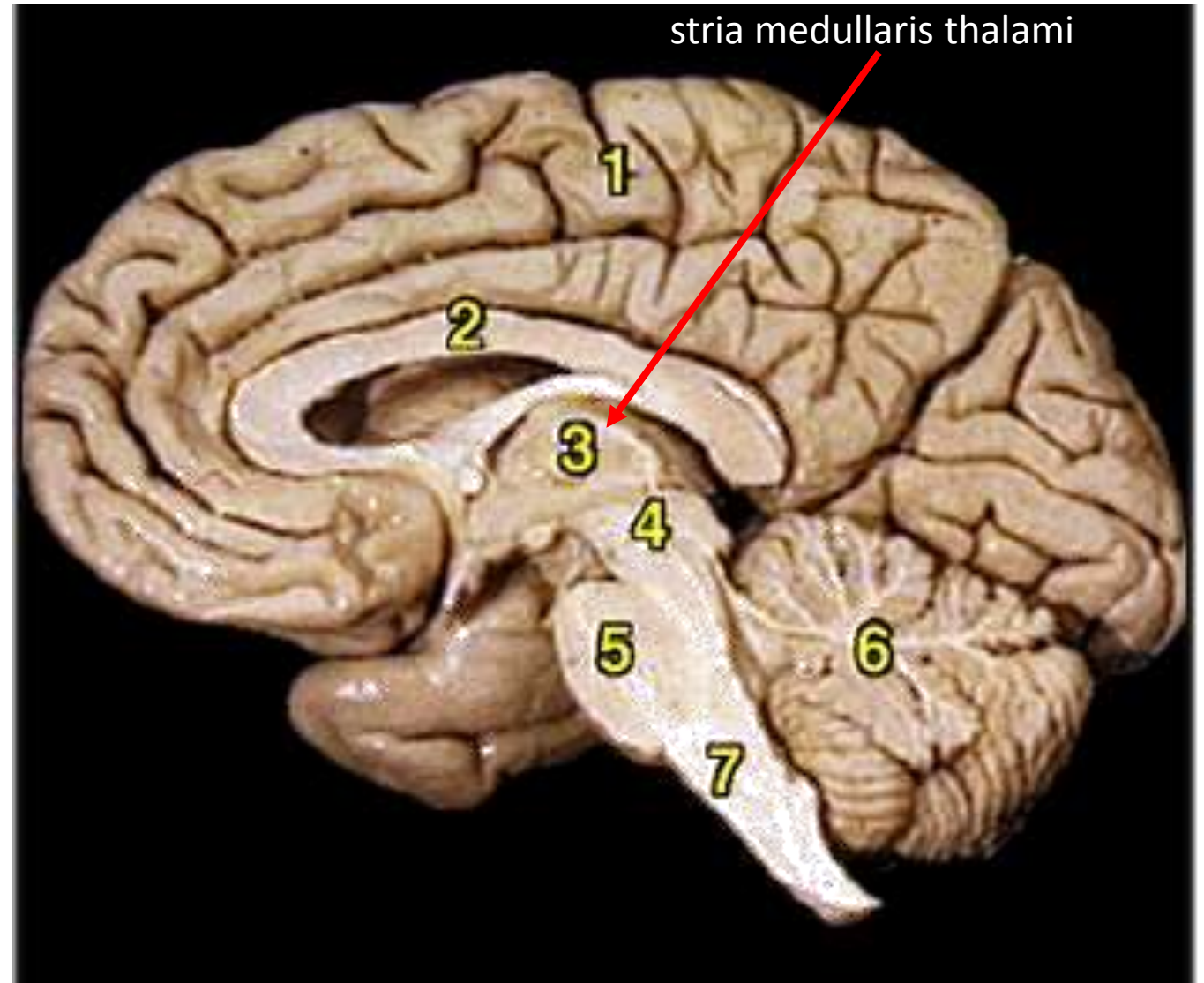
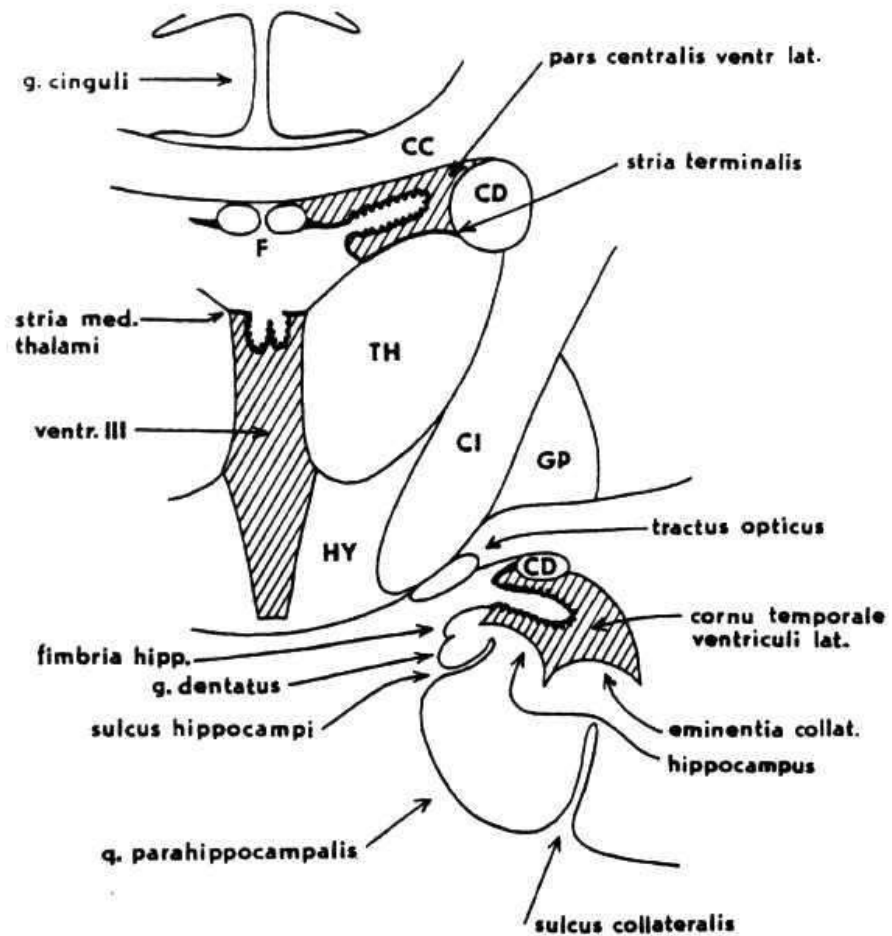


HIPPOCAMPUS

Horizontální řez v úrovni foramen interventriculare



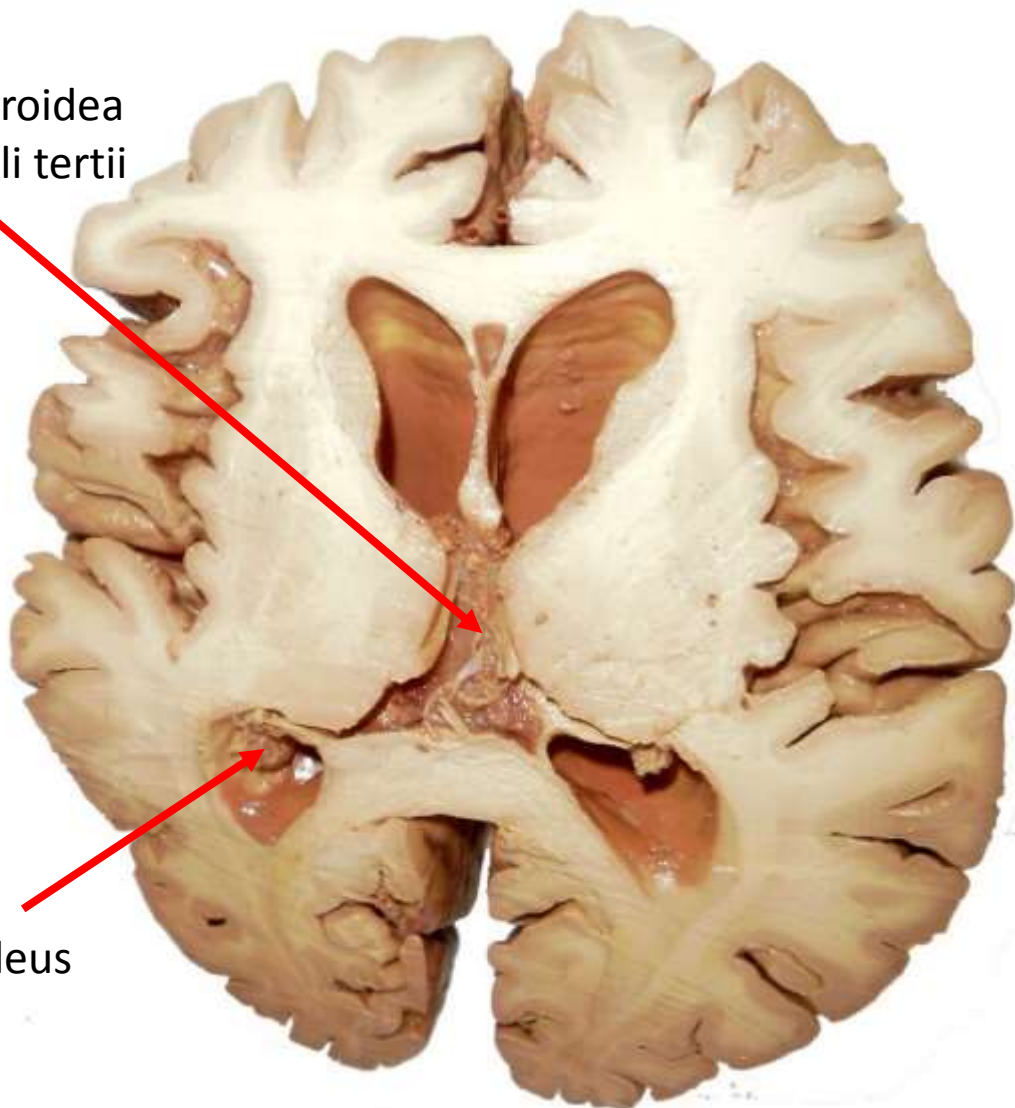
III. komora –
sagitální štěrbina
strop se upíná na stria medullaris thalami



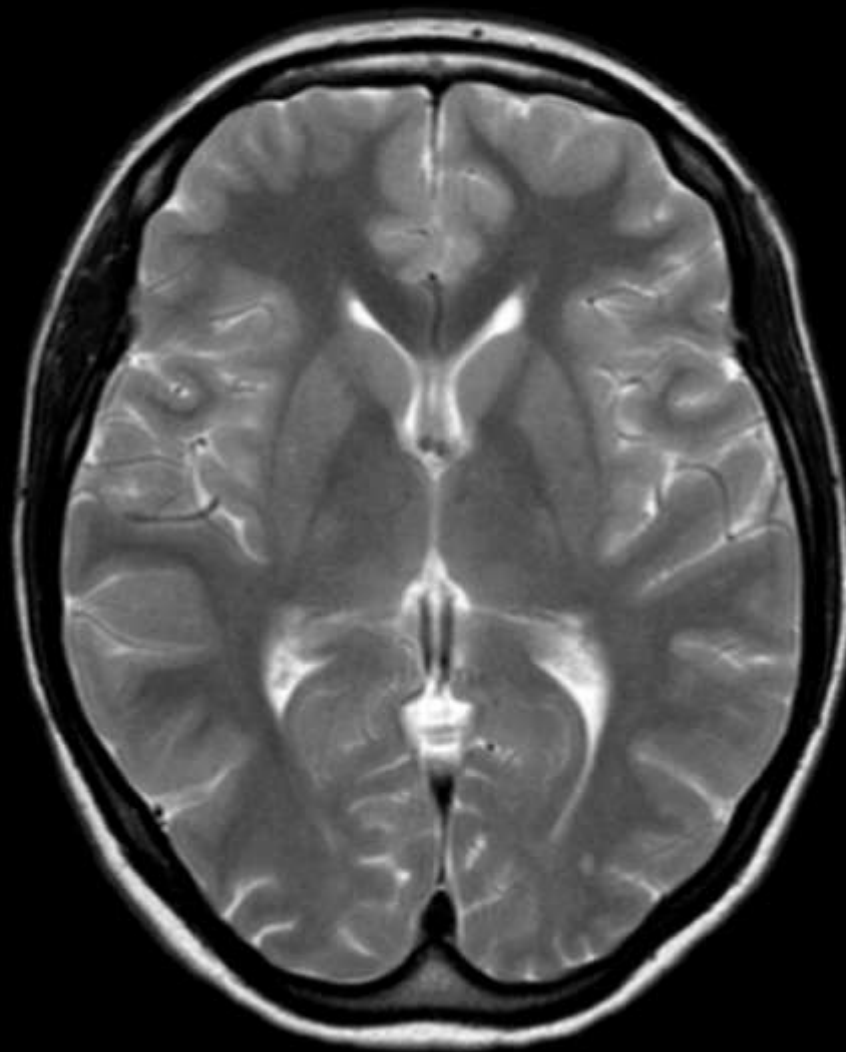
Horizontální řez přes komory

Tela choroidea
ventriculi tertii

Plexus
choroideus

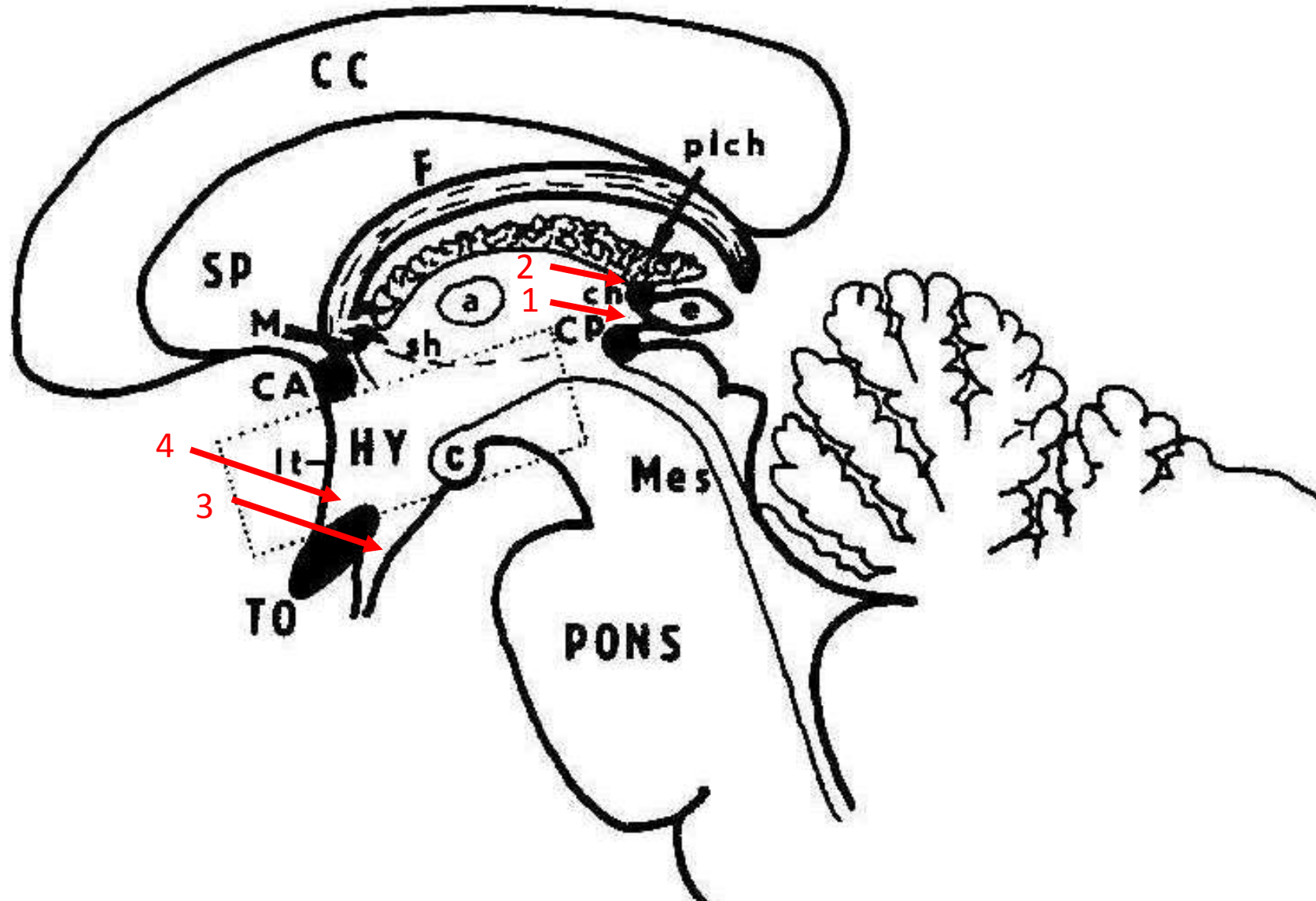


T2W

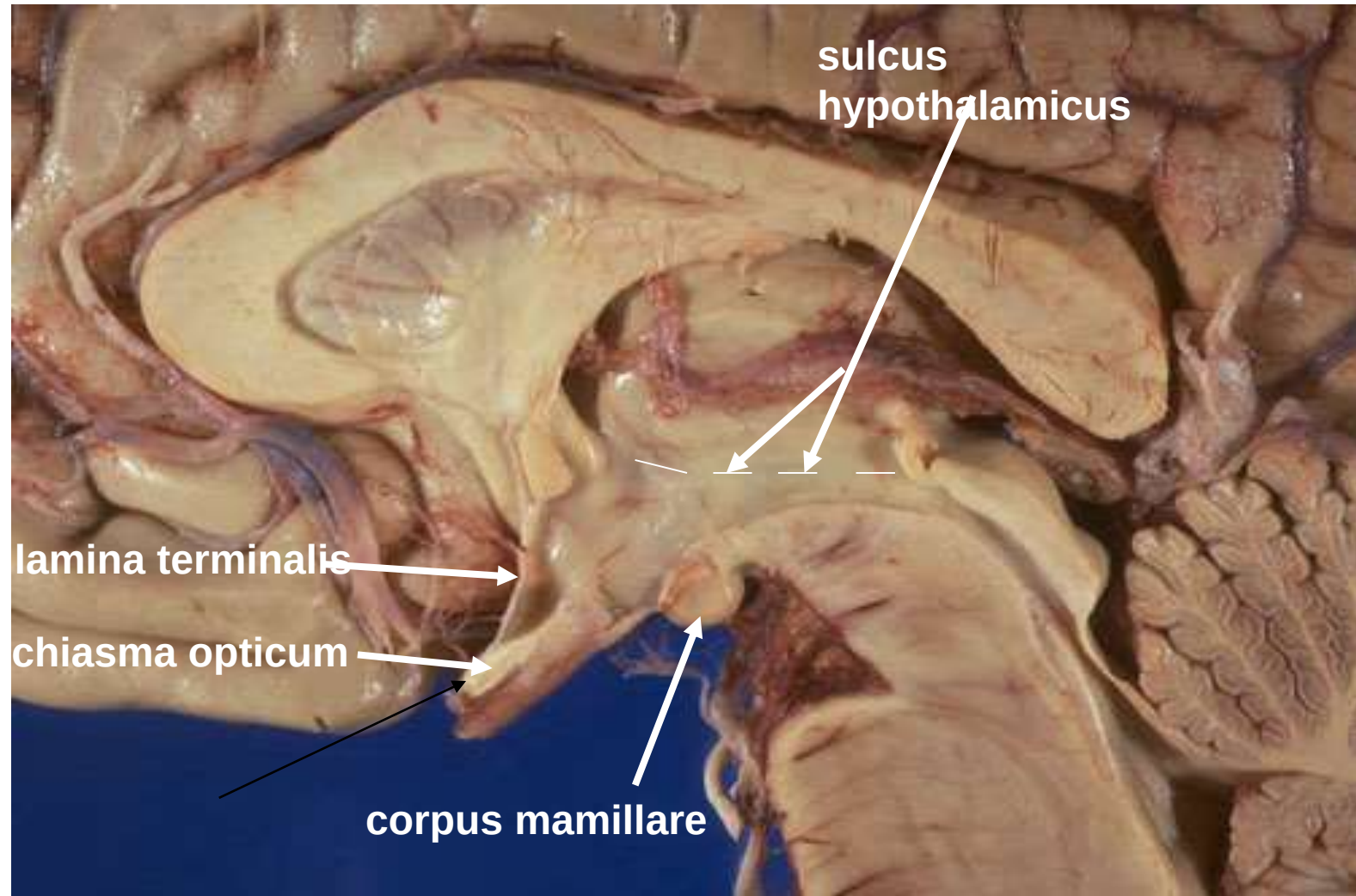


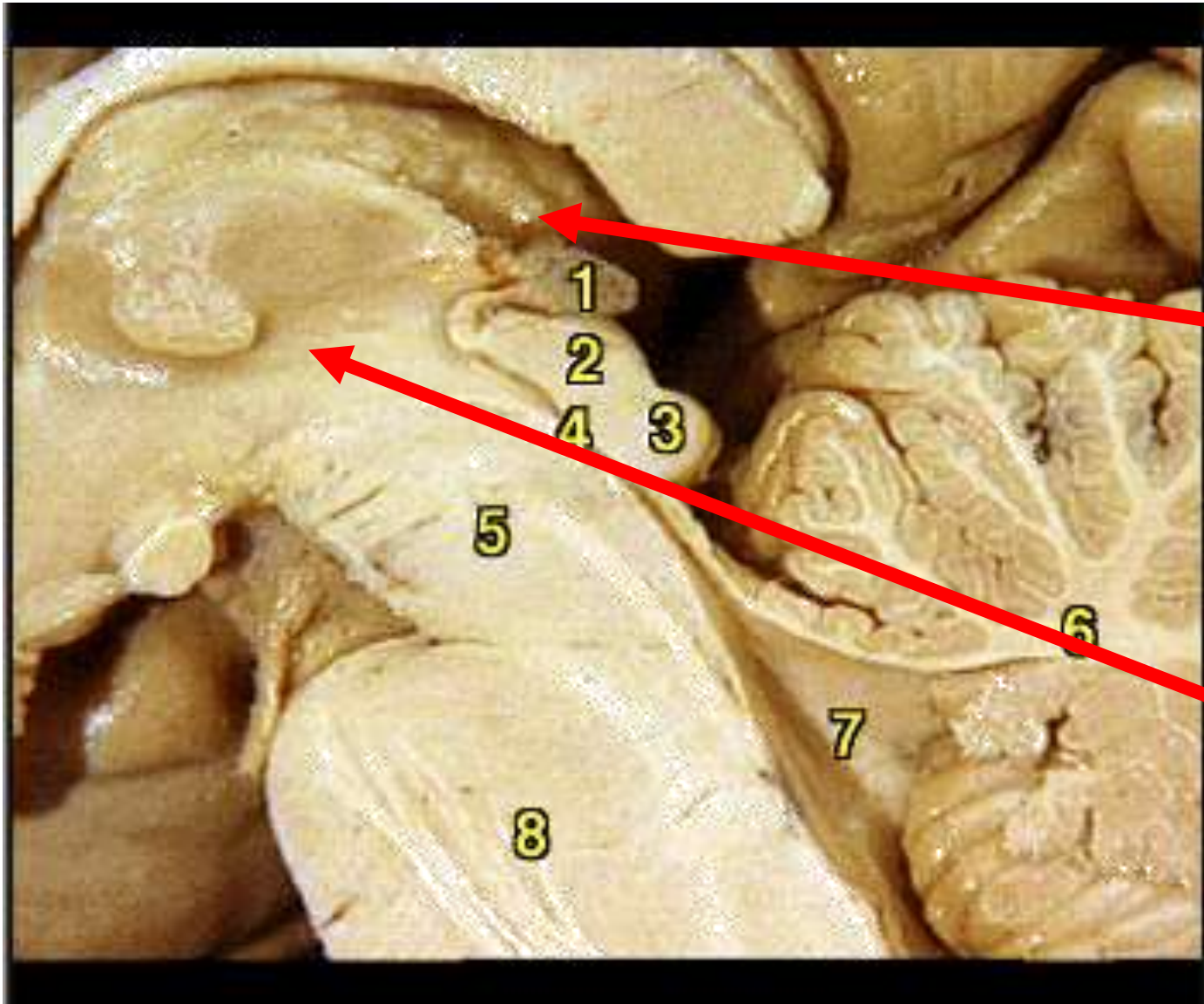
2713/II

Recessy 1 pinealis, 2 suprapinealis, 3 infundibuli, 4 suprachiasmaticus



III. komora





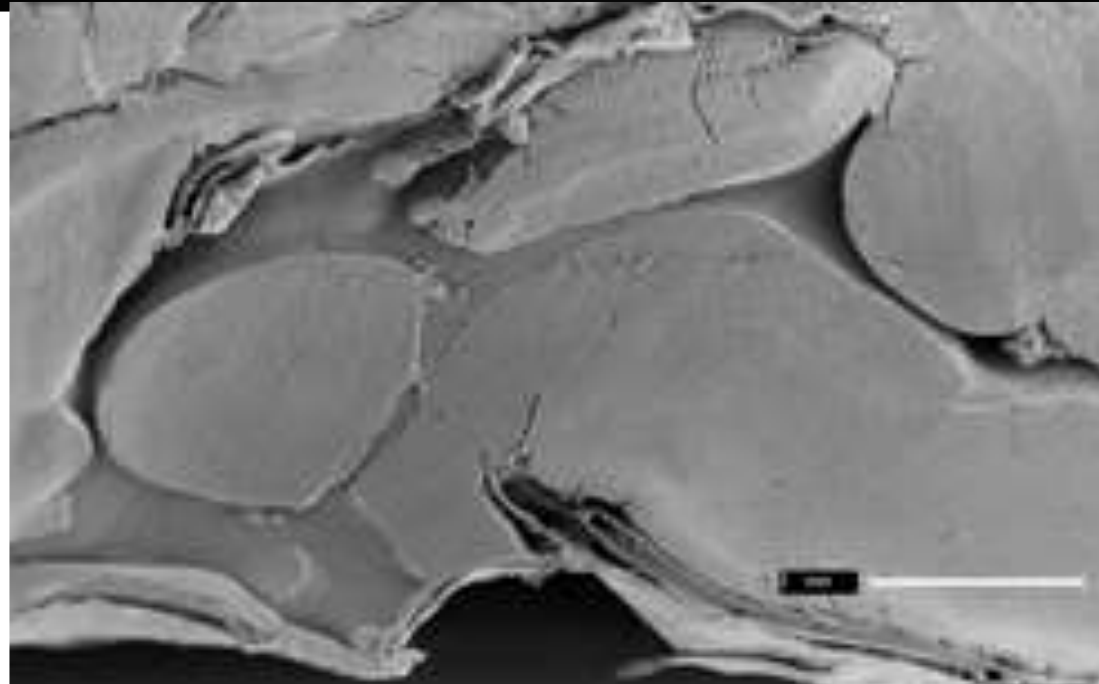
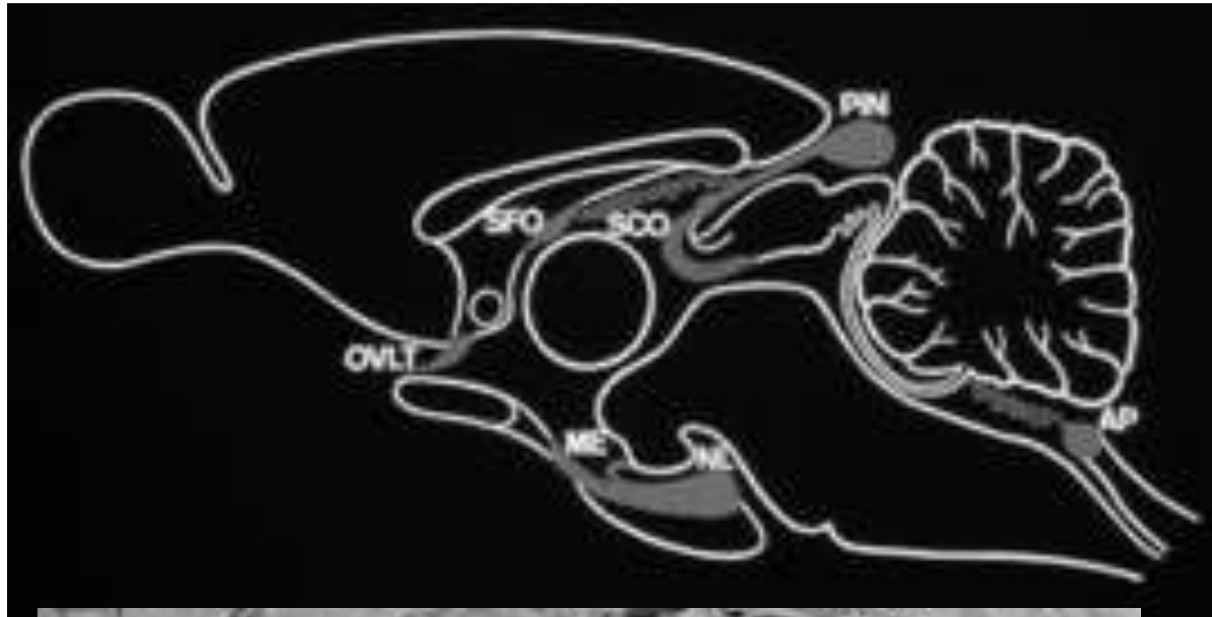
Fissura telodiencephalica

Sulcus hypothalamicus

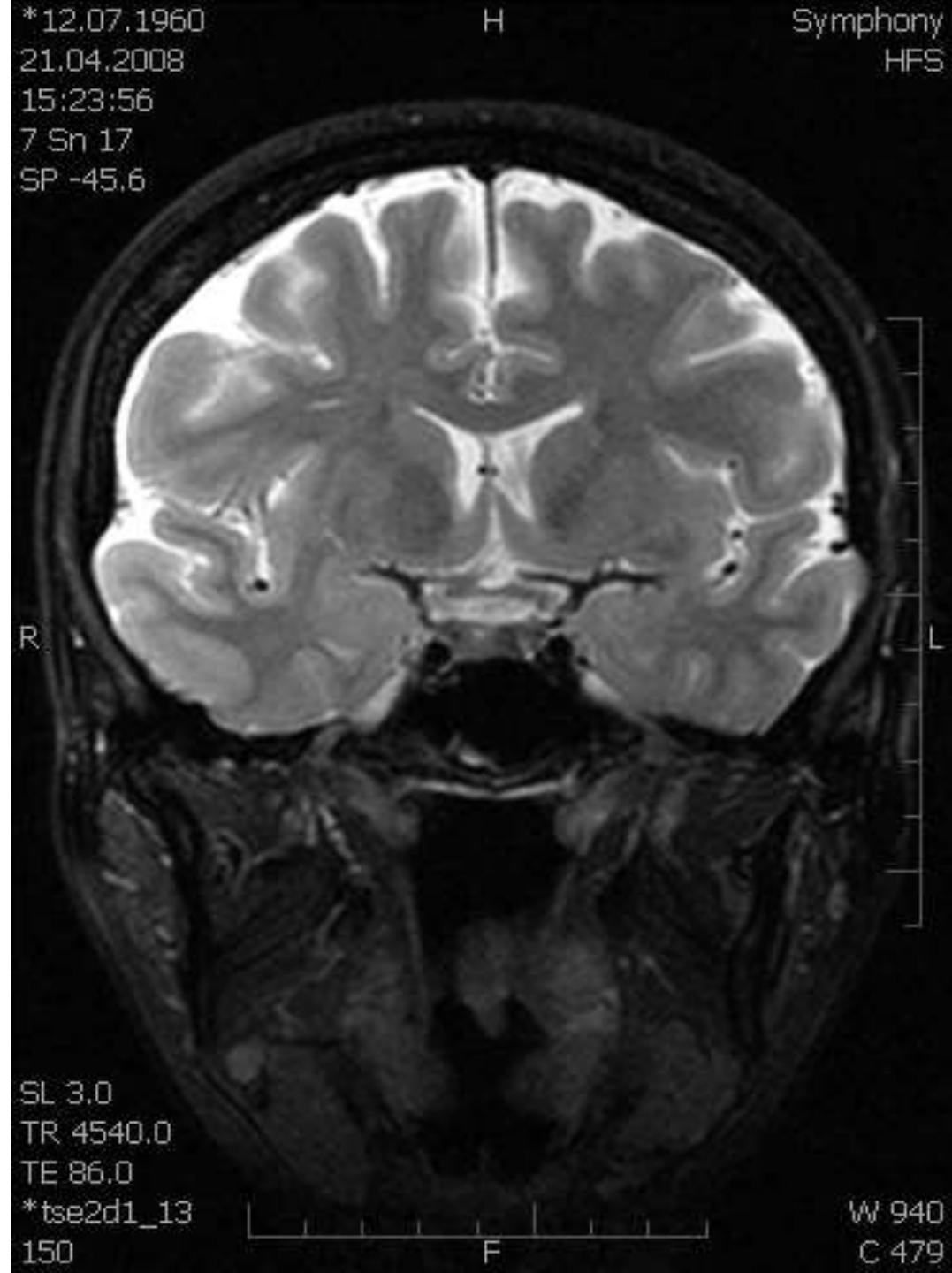
Cirkumventrikulární orgány
chybí hematoencephalická
bariéra – fenestrované kapiláry

chemorecepce

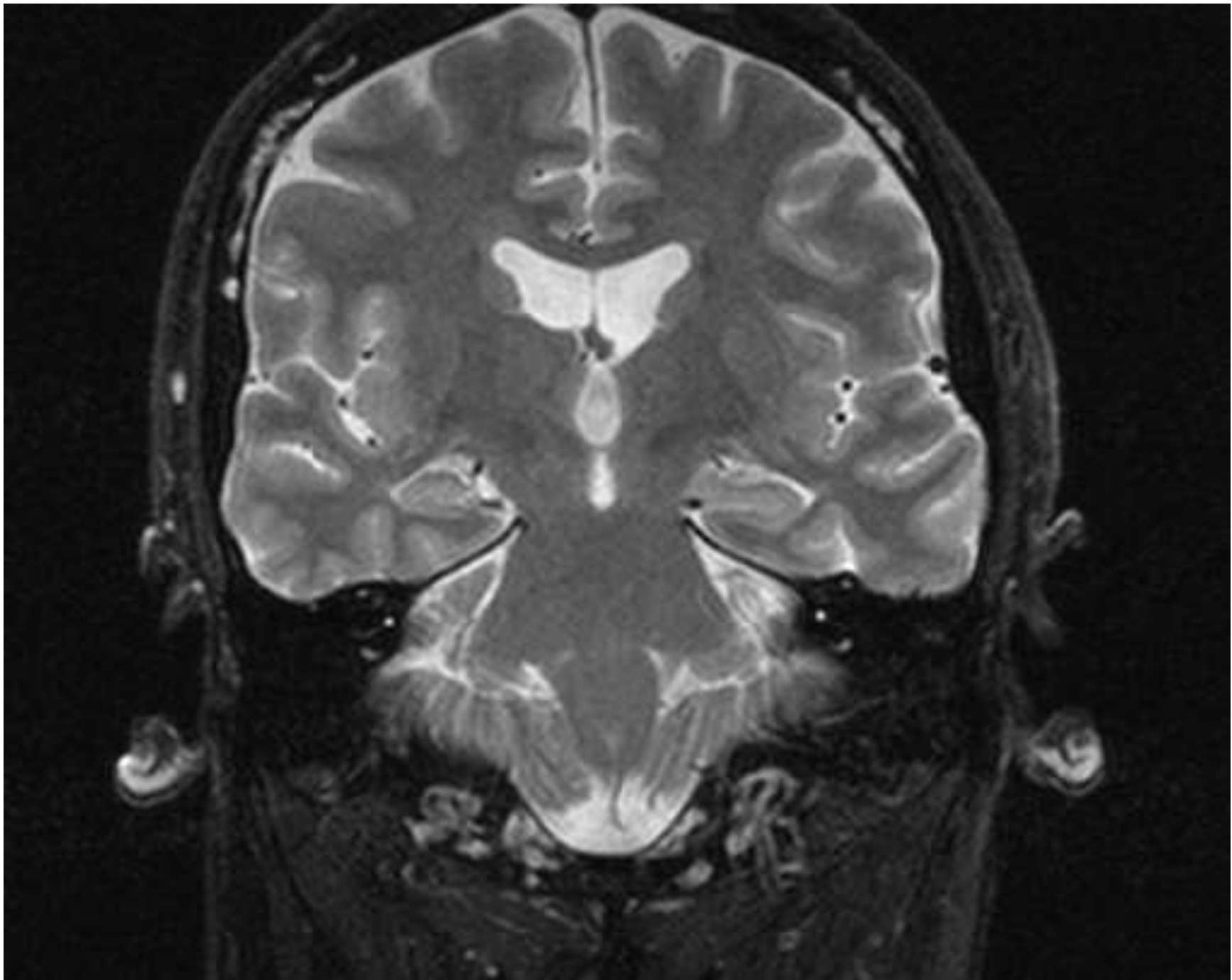
area postrema
organum subfornicale
organum subcomissurale
eminentia mediana
neurohypophysis
corpus pineale
organum vasculosum laminae terminalis



MR – T2



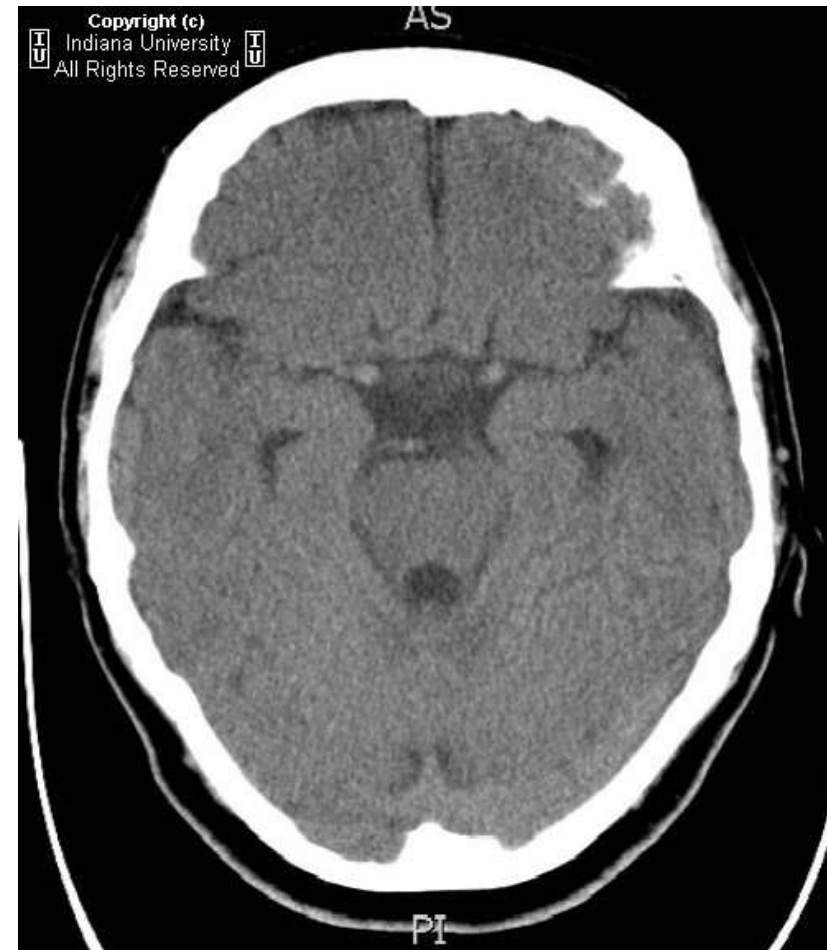
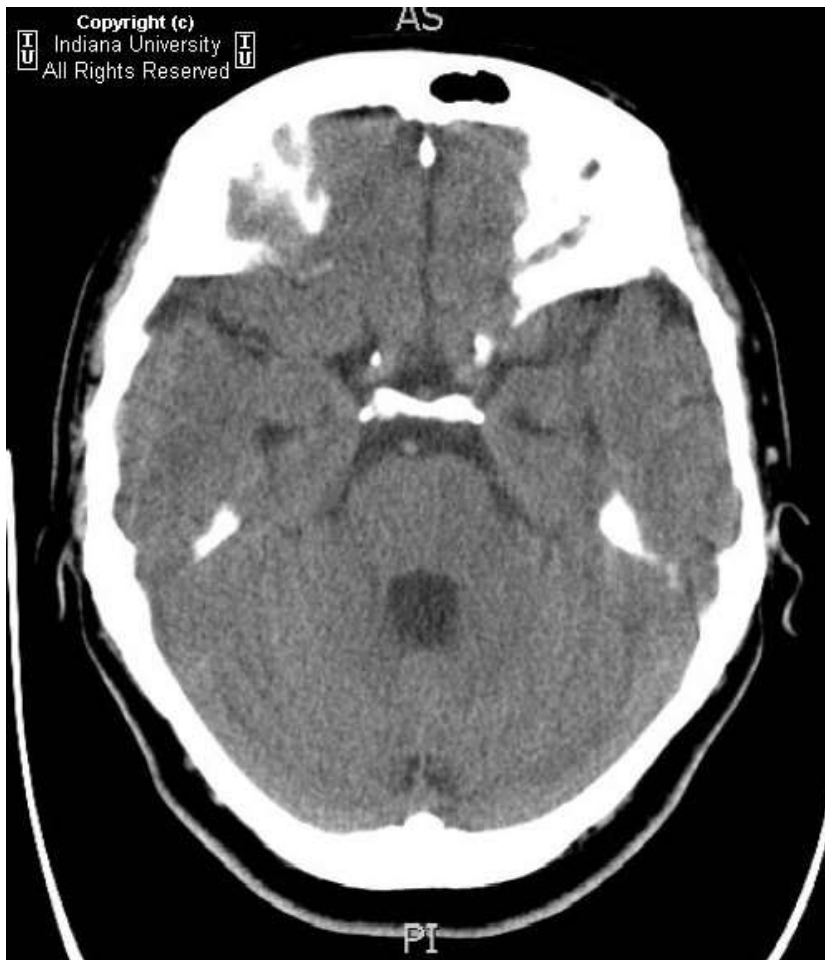
MR – T2

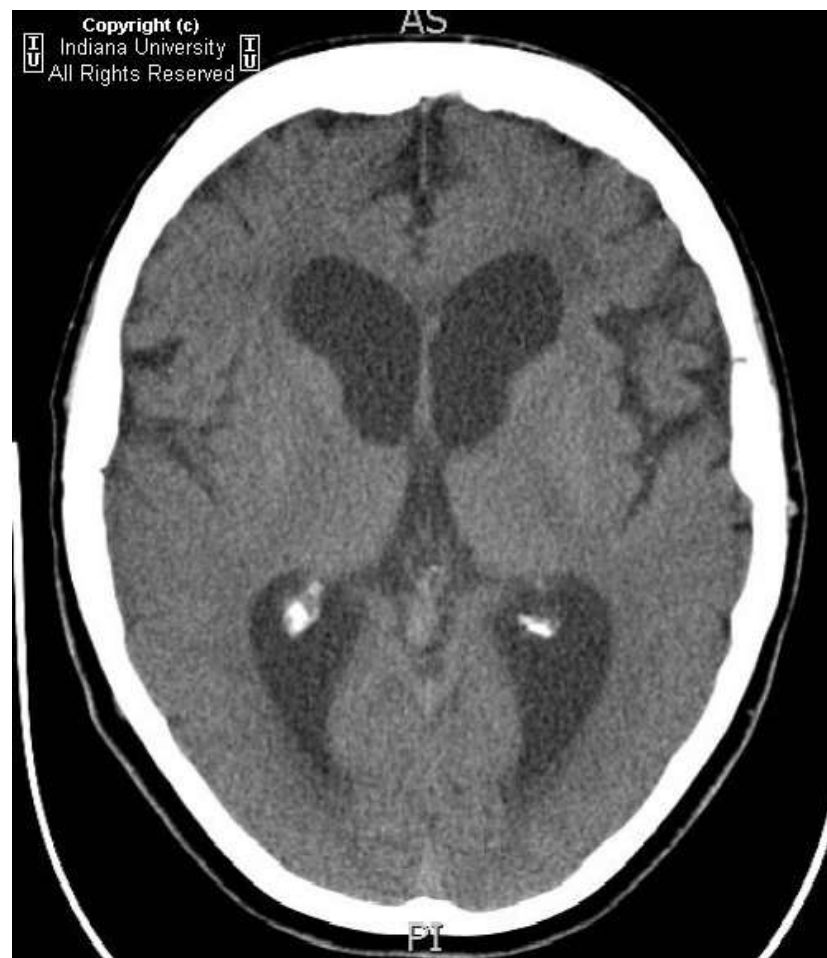


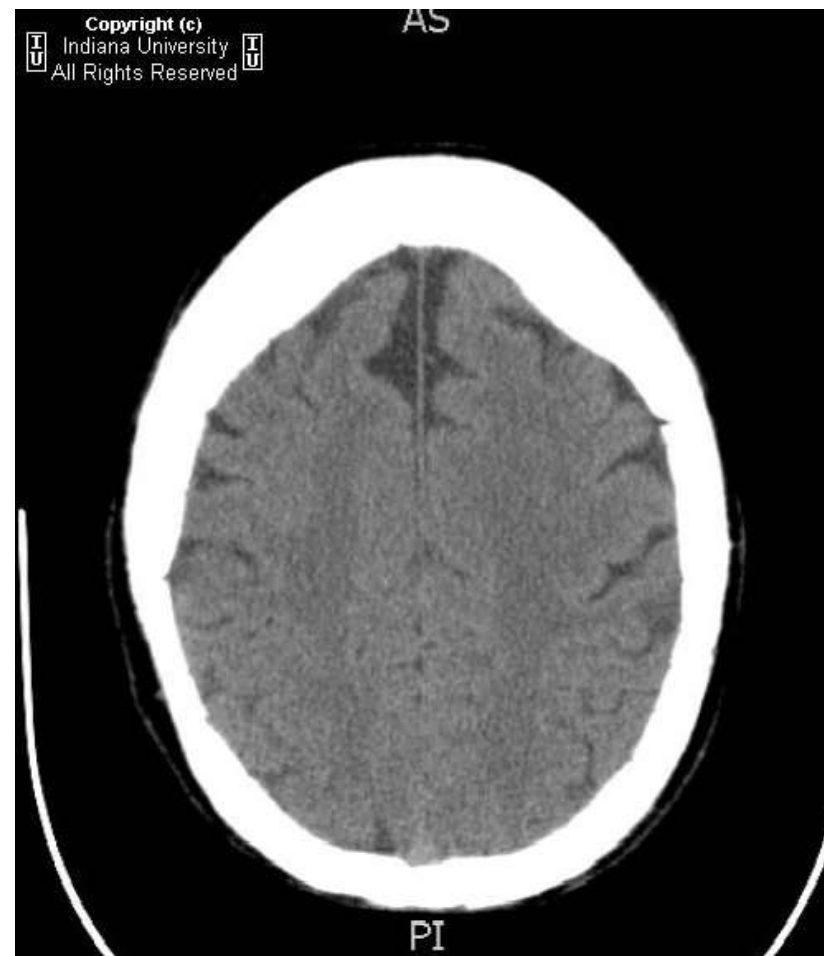
MR – T2



60-letá žena se zhoršujícími se poruchami paměti a poruchami chůze





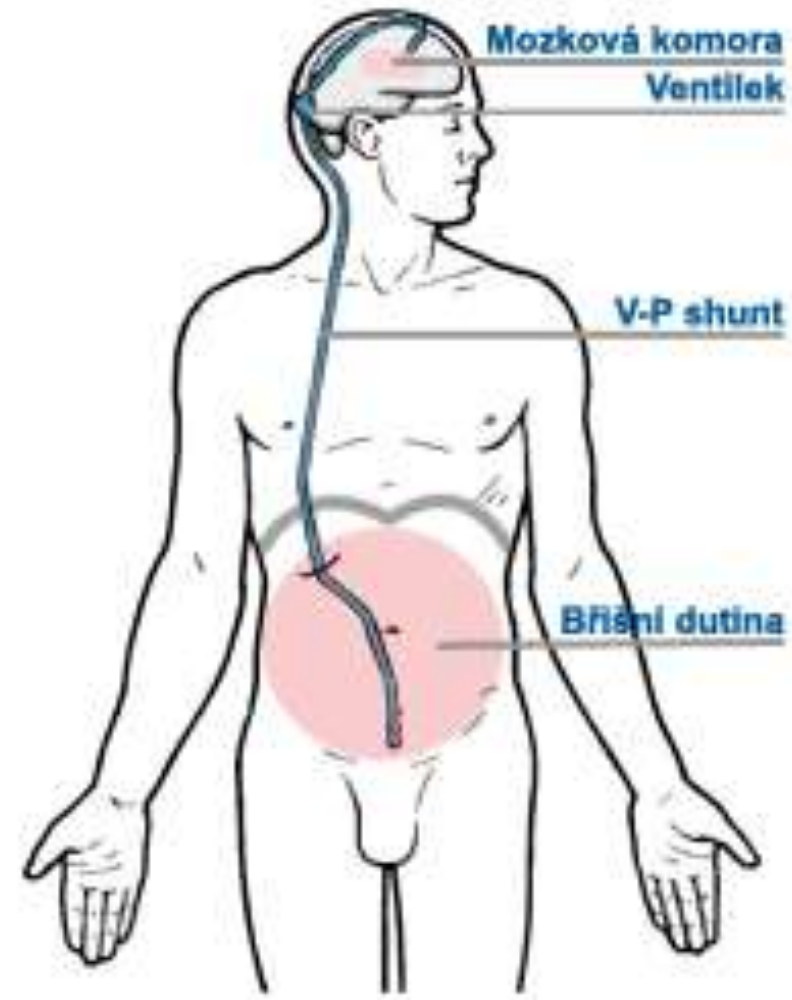


Výrazné zvětšení III., IV., a postranních komor
Relativně normální vzhled sulků vzhledem k věku
Žádné známky cévního postižení.

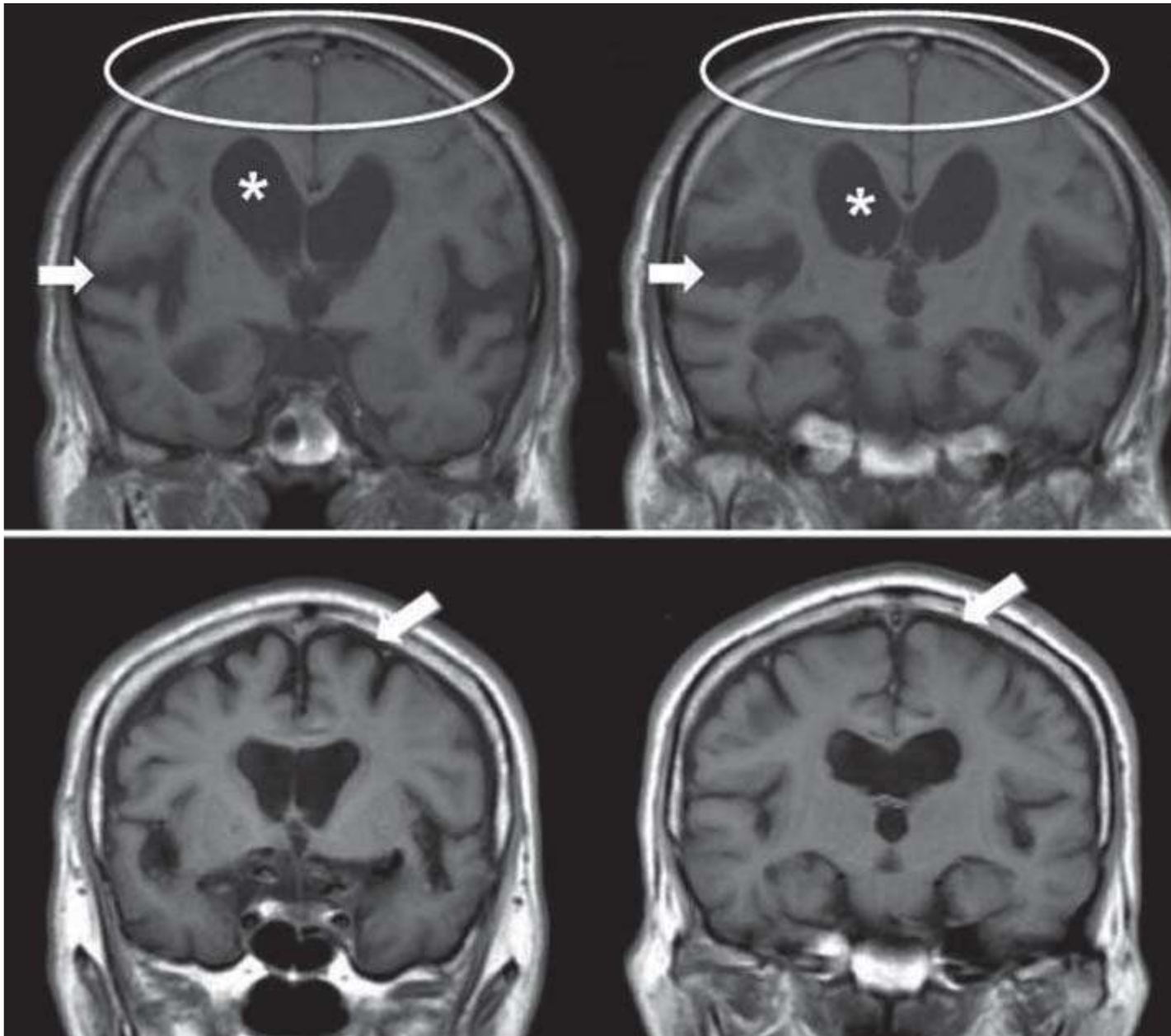
Normotensní hydrocephalus

- Trias: **demence, poruchy chůze, močová inkontinence**
- Příznaky vyplývají z útlaku bílé hmoty rozšiřujícími se komorami.
- Často v anamnéze subarachnoidální krvácení nebo meningitida.
- Tlakový gradient mezi komorovým systémem a subarachnoidálním prostorem
- (nekompletní subarachnoidální blokáda)

- **Likvorodynamické testy**
- Lumbální infuzní test – lumbální punkce a infuze rychlostí 1,5 ml za min
- Tap test lumbální punkce a odpuštění likvoru (50 ml) po 3 hodinách test chůze a kognice
- Lumbální drenáž 2-3 dny 150 ml za den, nutná imobilizace
- **Diagnosu potvrdí zlepšení příznaků po shuntu**
- **Cisternogram s radioizotopy ukazuje časný vstup do laterálních komor s 1-2 denním setrváním v komorách a opožděný vstup do parasagitálních oblastí.**



Sameš, Ústí nad Labem



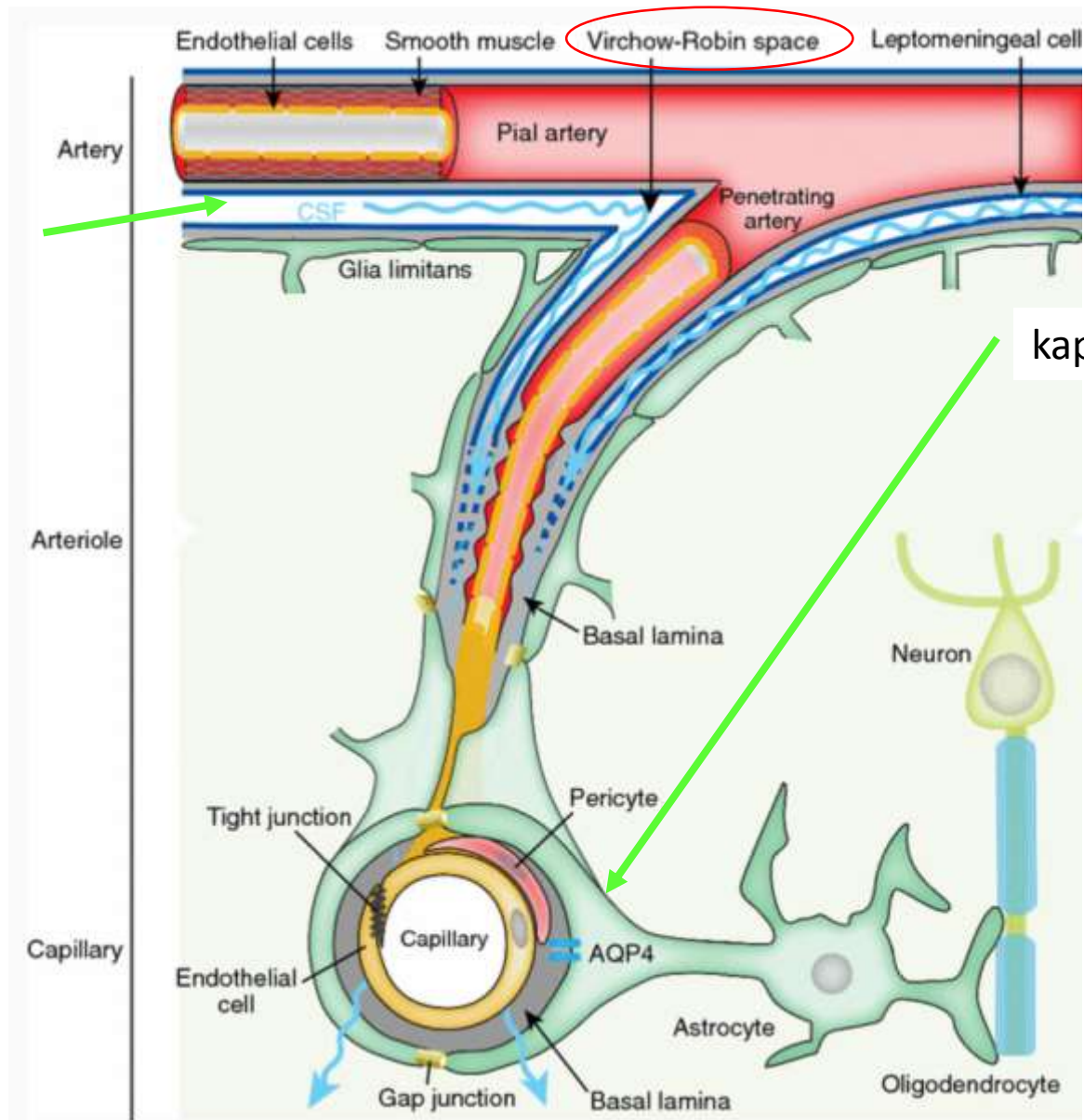
MUDr. Václav Vybíhal

Neurochirurgická klinika, LF MU a FN Brno

Na horním obrazku typicky MR obraz v koronárním řezu v T1-važené sekvenci u pacienta s NPH s nálezem dilatovaného komorového systému (*), oploštělé gyri a vymizele sulky (označeno ovalem) a zvětšena Sylviova ryha (označeno šipkou).

Na dolních snímcích pacient s difúzním rozšířením subarachnoidálních prostor proporcionálně k ventrikulomegalii s otevřenými subarachnoidními prostory na konvexitě (označeno šipkou) **odpovídající atrofii mozku**

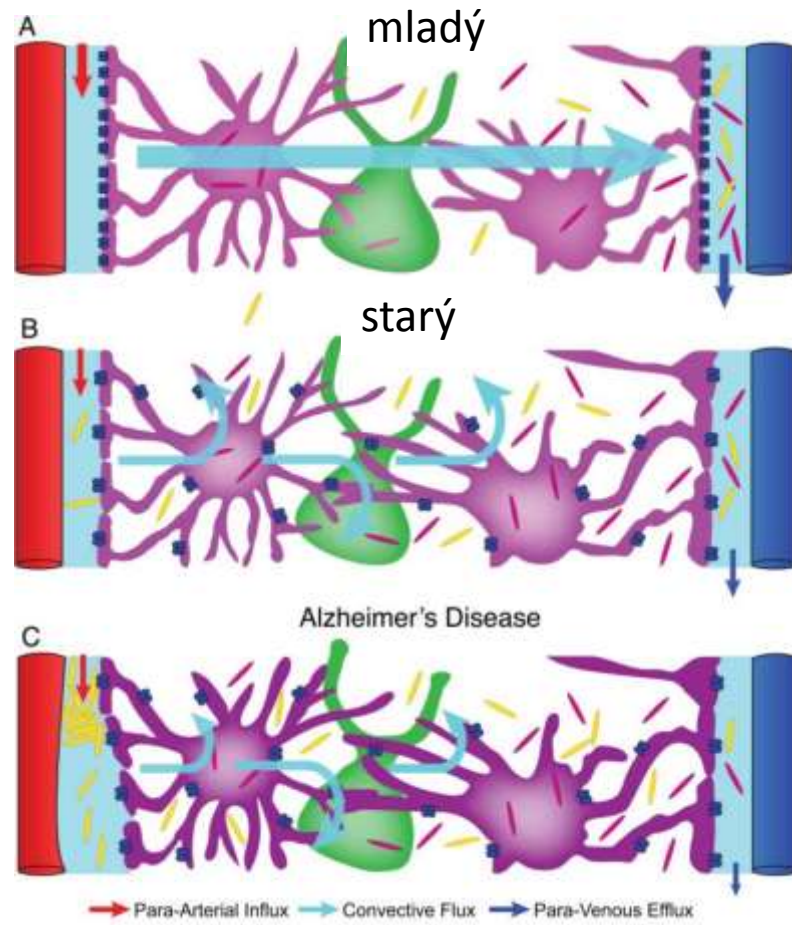
MMM nejen v komorách a cisternách, ale i perivaskulárně
Neurovaskulární jednotka - oboustranná komunikace mezi neurony a kapilárami



Perivaskulární
prostor - mok

kapilární nožka

Glymfatický systém – odvádí odpadní látky z mezibuněčného prostoru do perivaskulárního prostoru (Virchow-Robin), slouží i k rozvozu glukosy a regulaci průtoku krve



Glie
neuron

Aktivní ve spánku

Funkce se ve stáří zhoršuje

Hromadění beta amyloidu v perivaskulárním prostoru u mozkové tkáni u alzheimerovy choroby

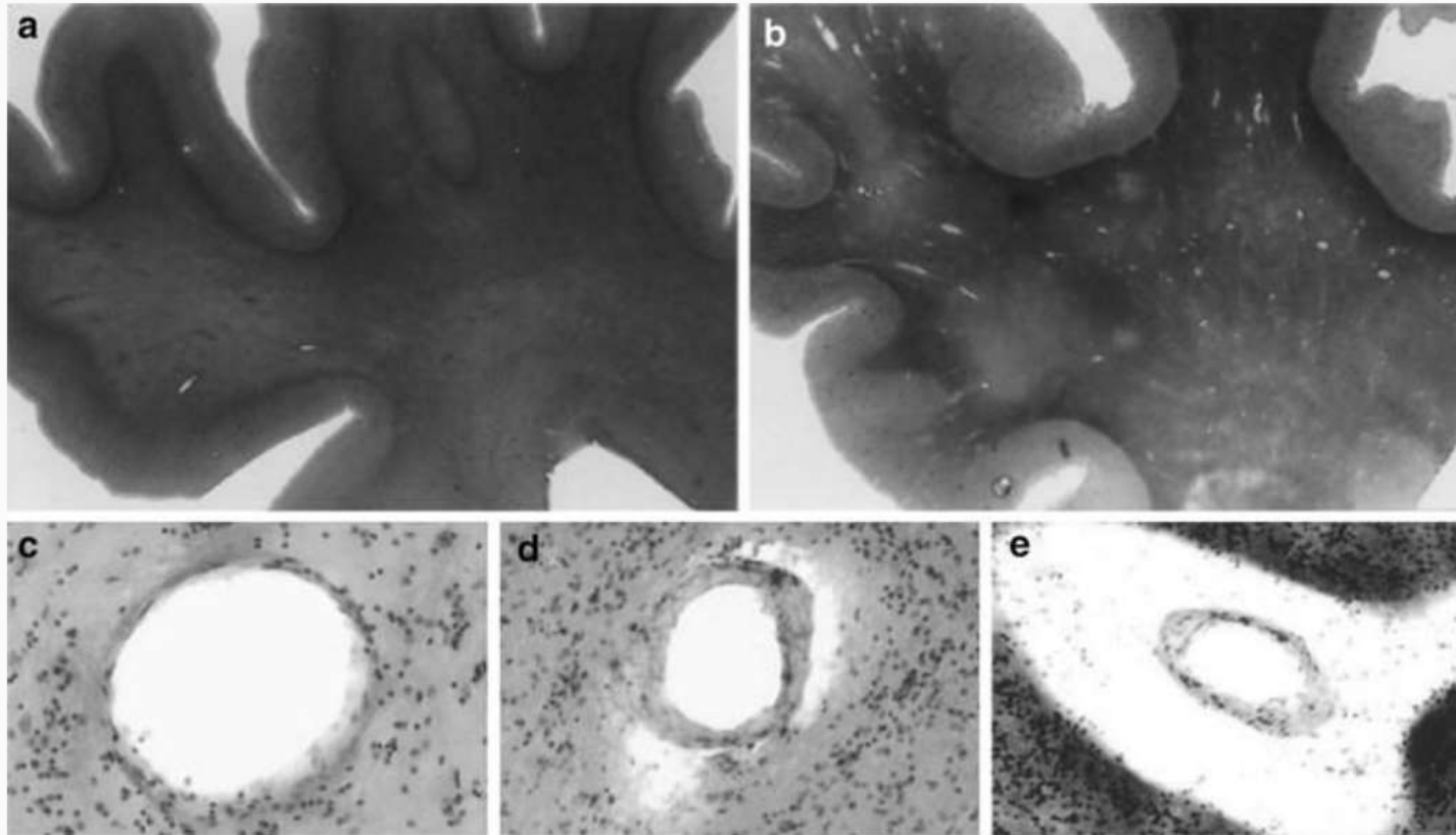
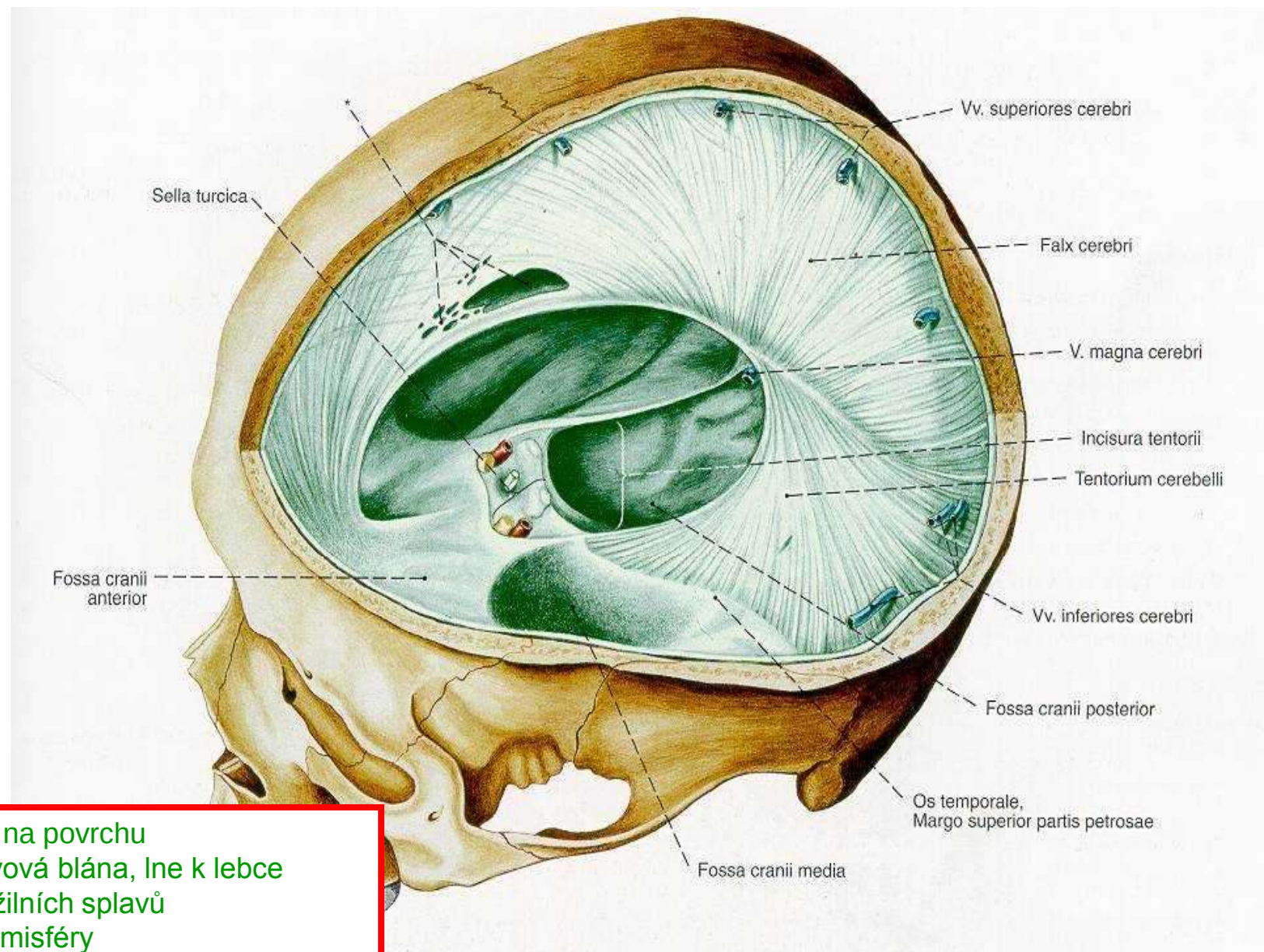


Fig. 6

Abnormal perivascular spaces in Alzheimer's disease. $\times 2.5$ magnification of hematoxylin and eosin staining of superior frontal gyrus and underlying white matter. **a** The white matter of a 74-year old with no CNS diagnosis shows homogenously stained white matter with normal perivascular spaces. **b** The white matter of an 80-year old Alzheimer's disease patient contains patches with paler staining and a large number of abnormally enlarged perivascular spaces. $\times 100$ magnification of normal (**c**), slightly dilated (**d**) and severely dilated (**e**) perivascular spaces in an Alzheimer's disease patient.

- Roher AE, Kuo Y-M, Esh C et al (2003) Cortical and leptomeningeal cerebrovascular amyloid and white matter pathology in Alzheimer's disease. *Mol Med* 9:112–122

Obaly mozku



Dura mater na povrchu
pevná vazivová blána, lne k lebce
tvoří stěny žilních splavů
odděluje hemisféry
odděluje mozeček a týlní laloky
odděluje subdurální a epidurální prostor



falx

tentorium

Obaly mozku

1- dura mater

3-arachnoidea jemná bezcévná, přebíhá záhyby na mozku, tvoří trámce

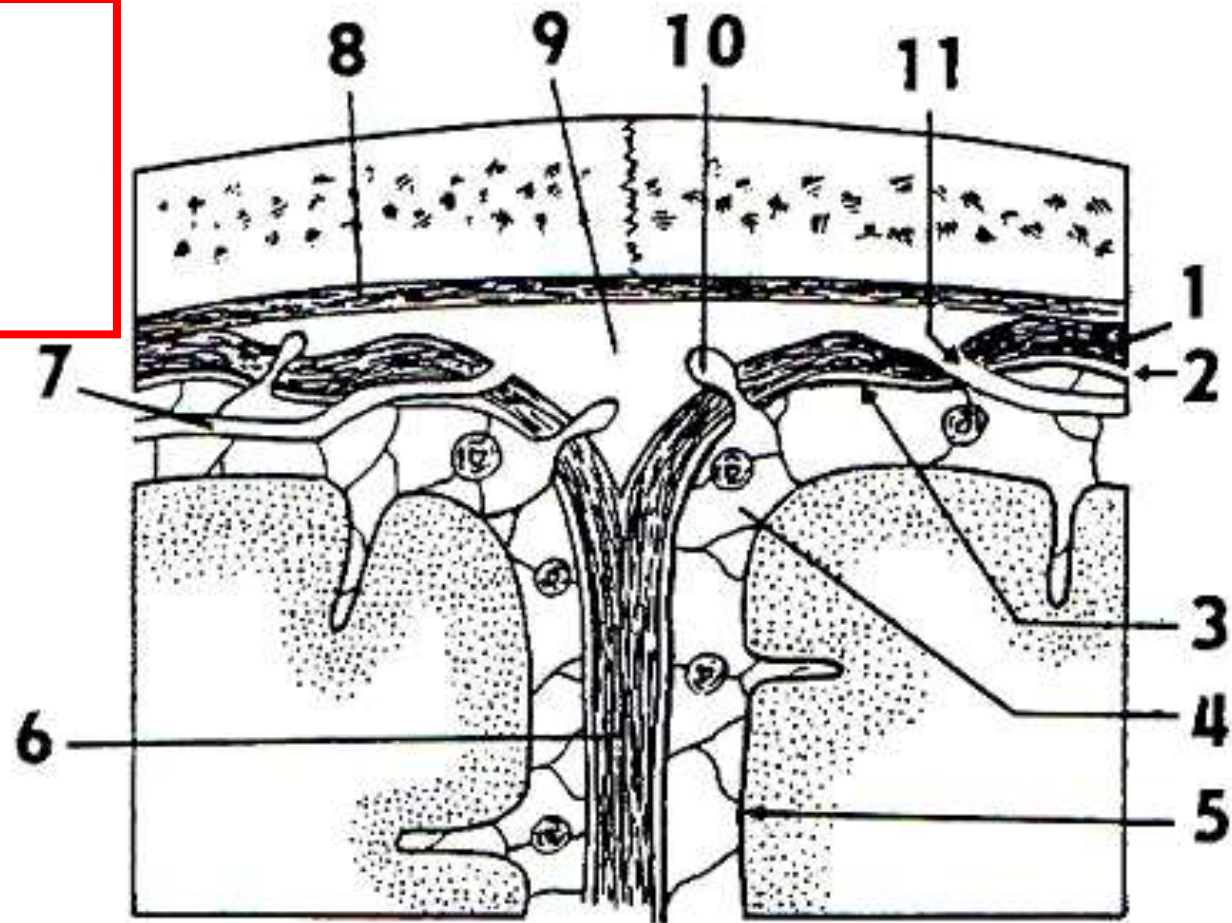
5- pia mater jemná obsahuje cévy zabíhá do všech žlábků na mozku

Prostory

epidurální tepny (a.meningea media)

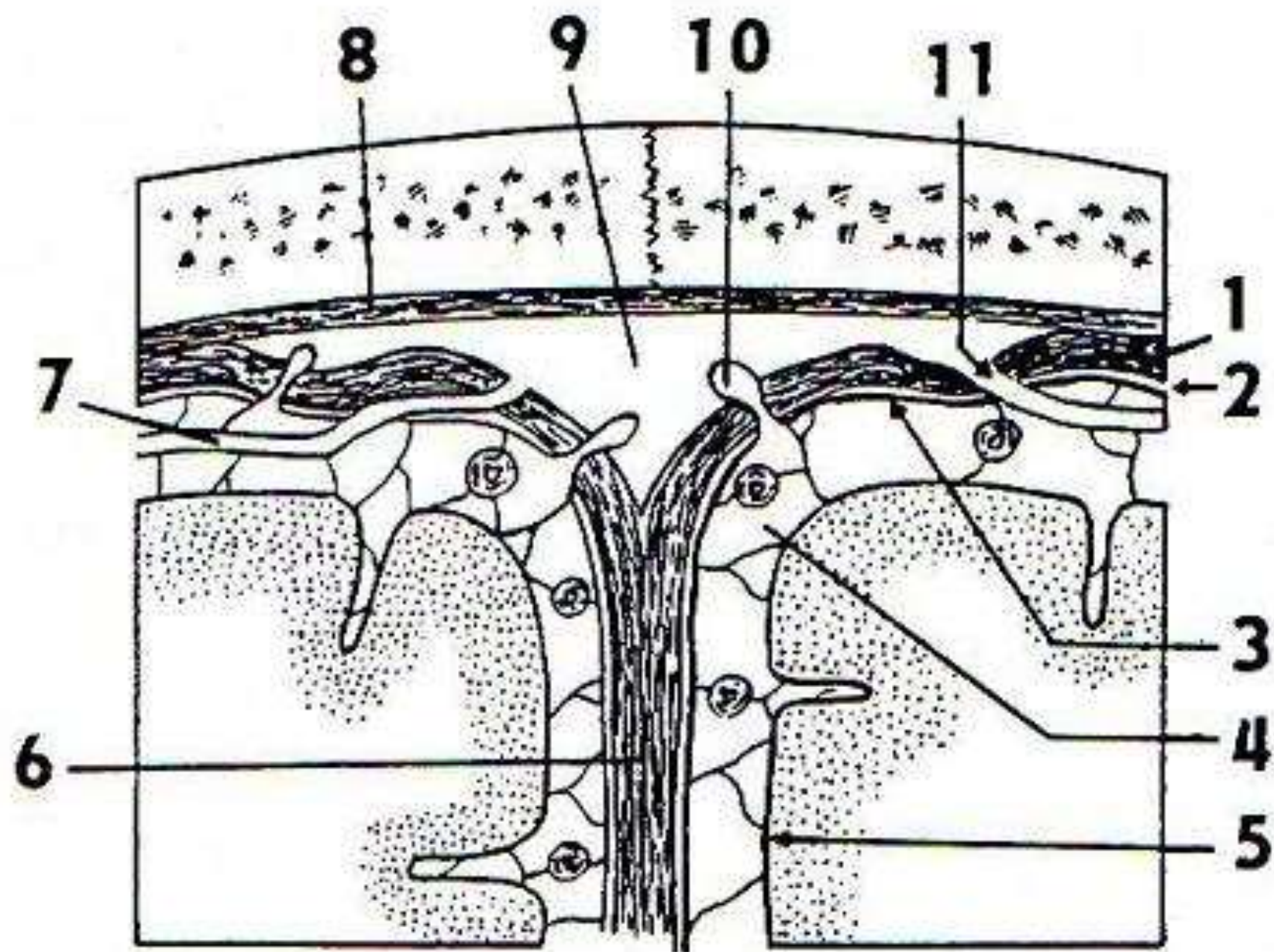
subdurální přemostující žíly

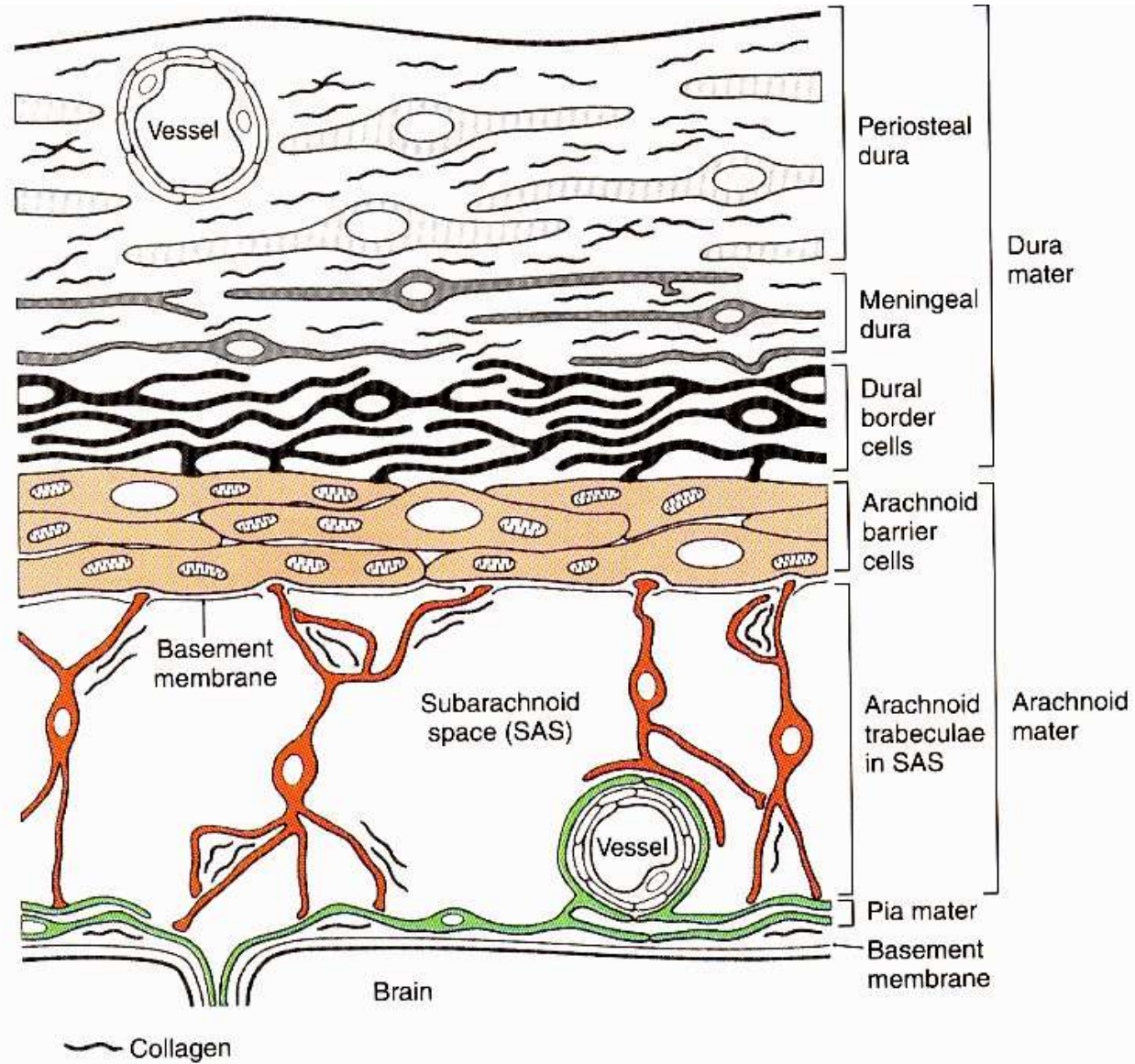
subarachnoidální MMM



Obr. 60.: Frontální řez ve vřichu lebky, zasahující žilou sinus sagittalis superior a odstup falx cerebri.

1 – dura mater, 2 – "spatium" subdurale, 3 – arachnoidea s odstupujícími trámčitými výběžky směrem k pia mater, 4 – cavitas subarachnoidalis, 5 – pia mater, 6 – falx cerebri, 7 – mozková žíla, 8 – periost, 9 – sinus sagittalis superior, 10 – granulationes arachnoidales, 11 – vústění mozkové žíly do sinu.





Dura mater
 Arachnoidea
 Pia mater

Obaly míchy

Endorhachis – periost páteřního kanálu

Epidurální prostor – žilní pleteně

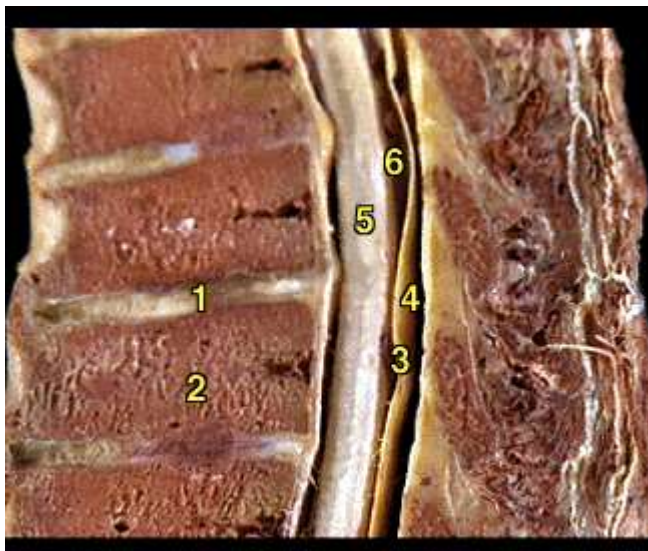
Dura mater spinalis

Cavum subdurale

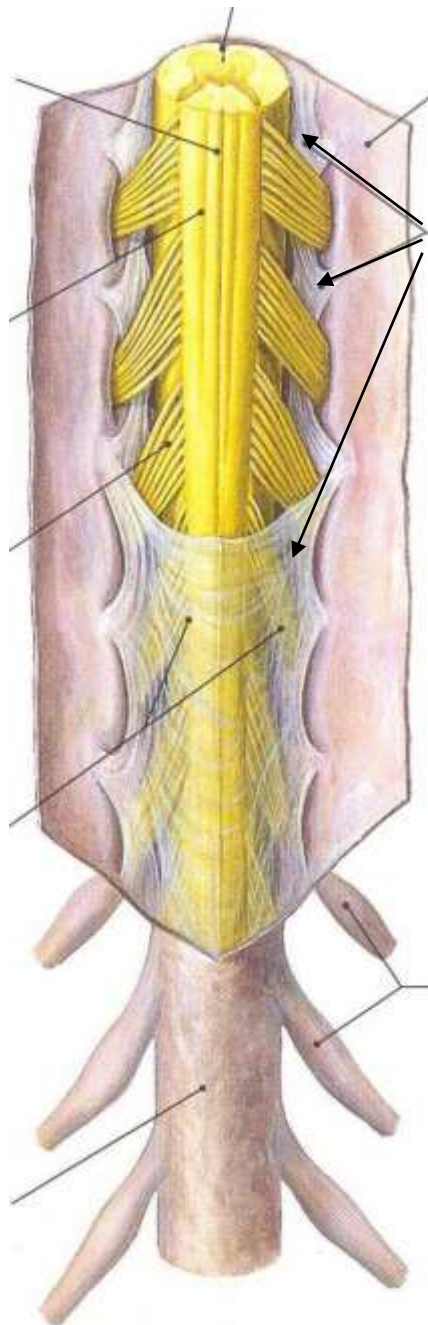
Arachnoidea – lig. denticulatum

Cavitas subarachnoidalis - MMM

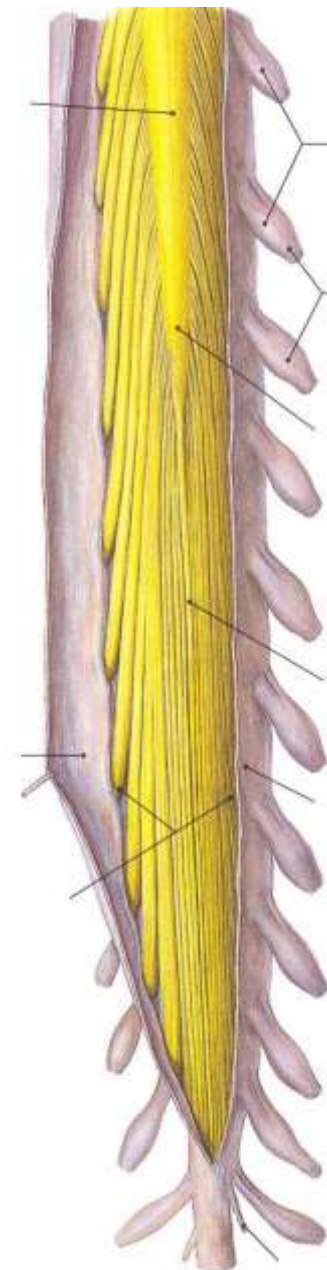
Pia mater spinalis



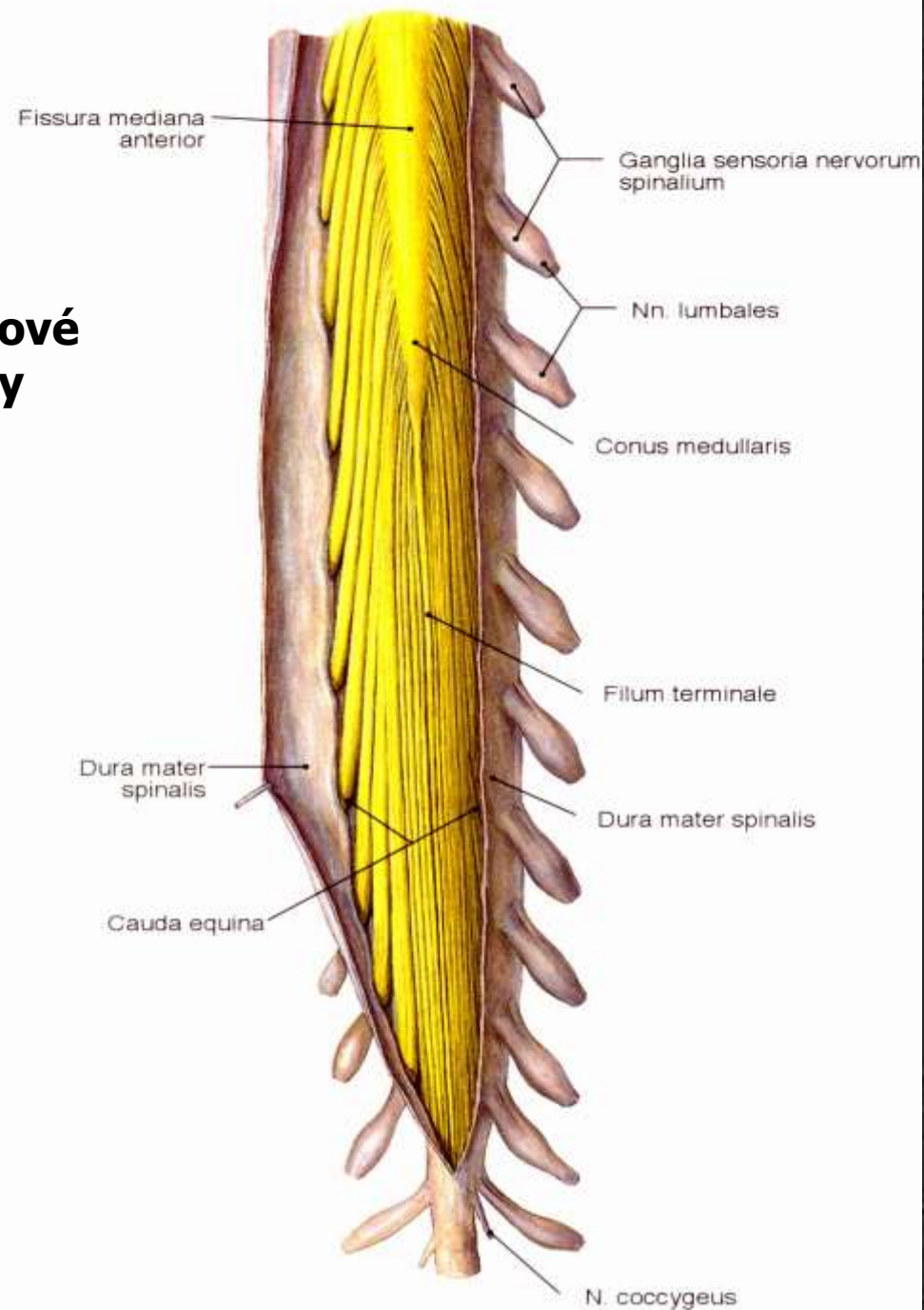
Obaly míchy



Ligamentum
denticulatum



Kořenové pochvy

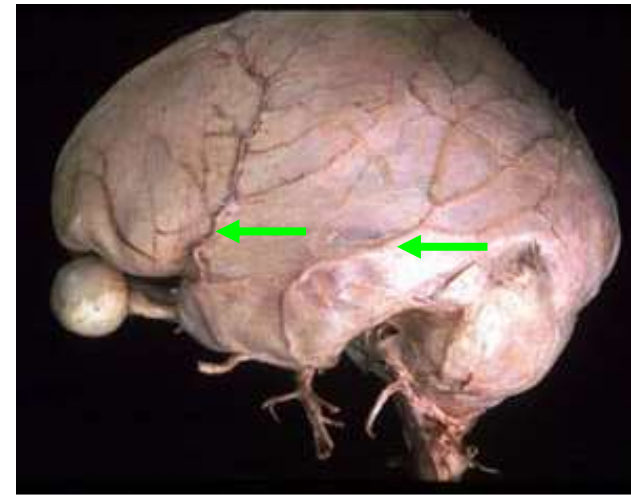
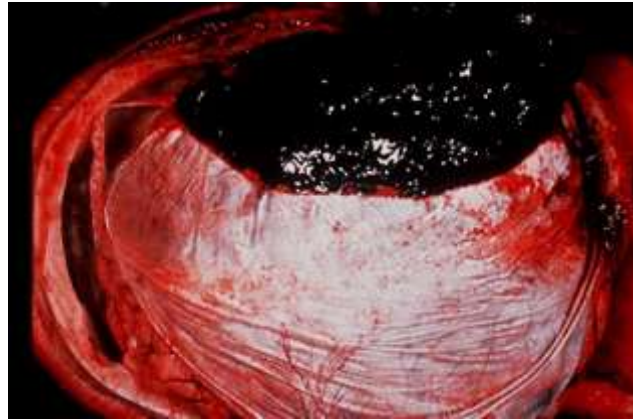


Nitrolební krvácení

Epidurální hematom

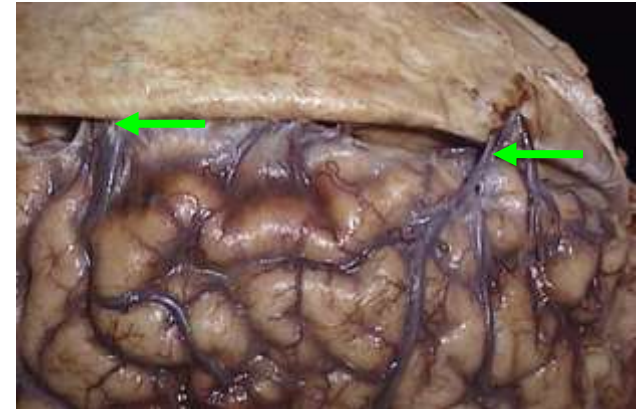
způsobený krvácením
a. meningeae media

(tepna ležící mezi kostí
a tvrdou plenou)

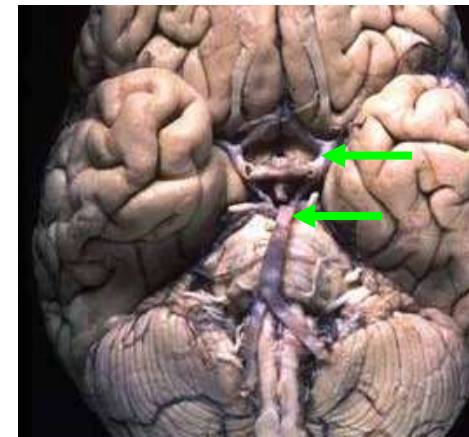
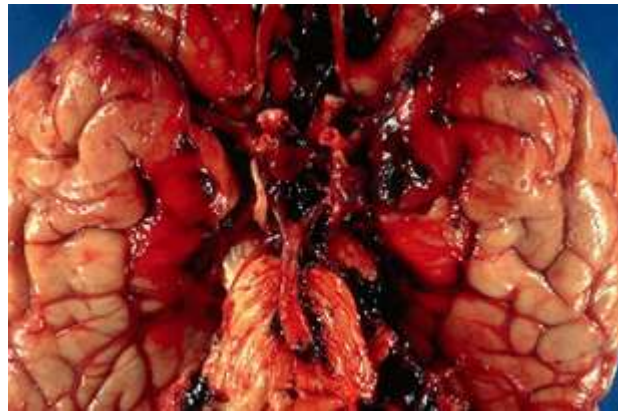


Subdurální hematom

způsobený
krvácením z
přemostujících žil



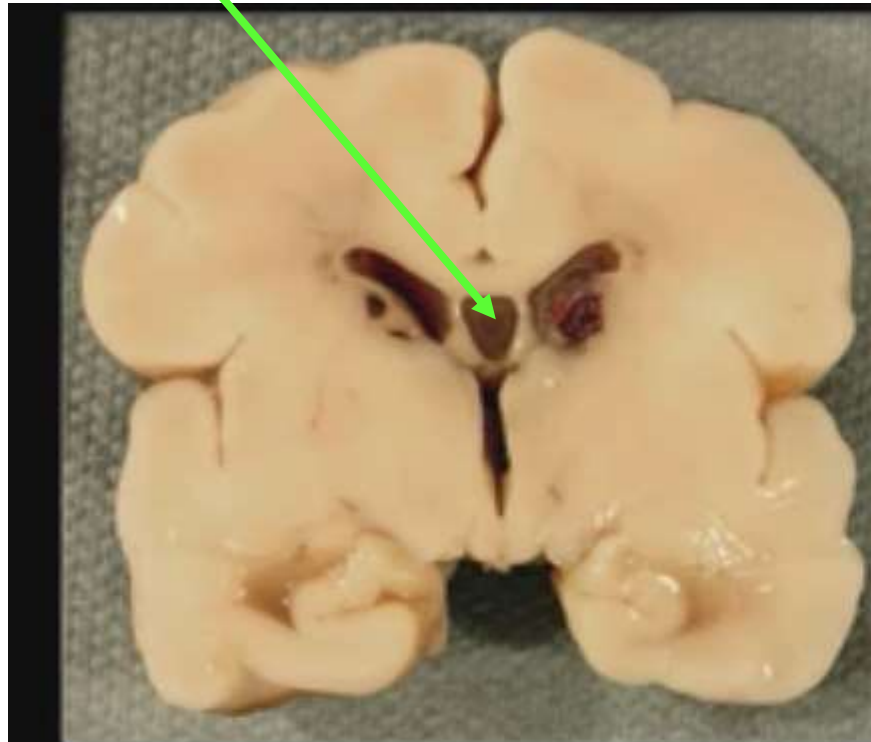
Subarachnoidální
hematom způsobený
krvácením z tepen
Willisova okruhu



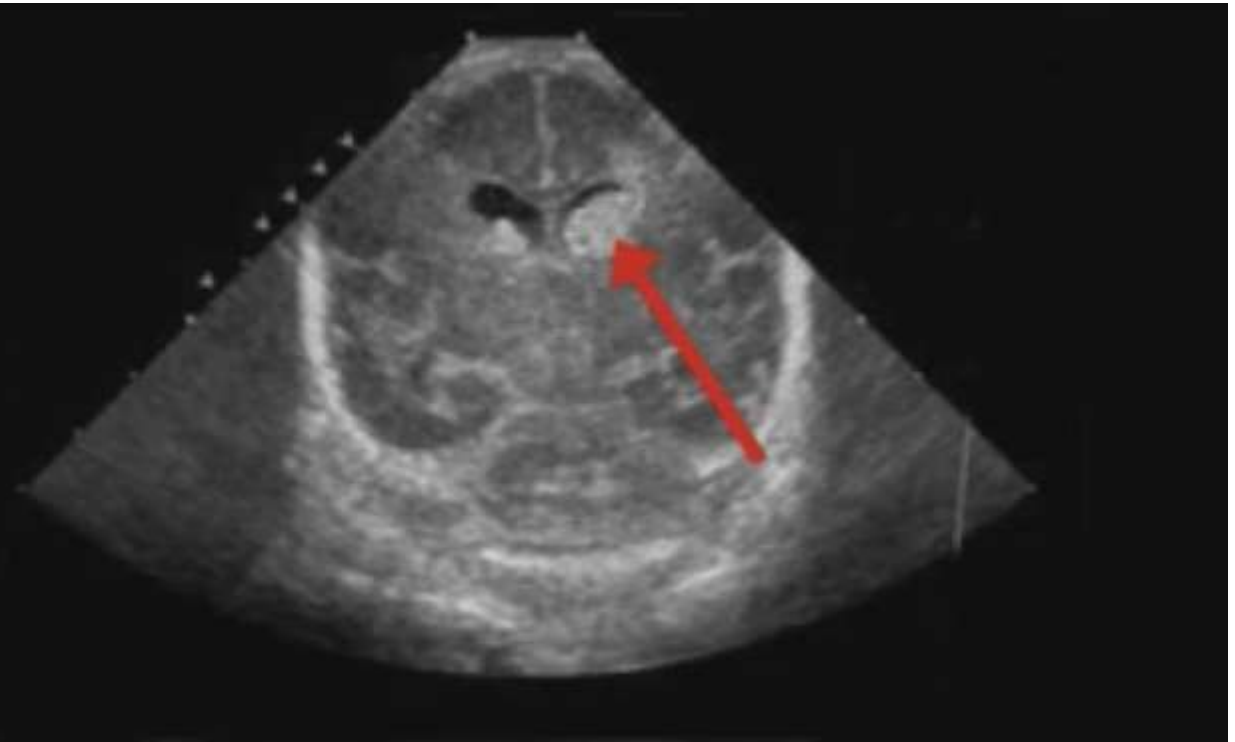
Intraventrikulární krvácení

- I - subependymálně z drobných cév
- II - do komor bez hydrocephalu
- III - s dilatací komor

Cavum septi pellucidi



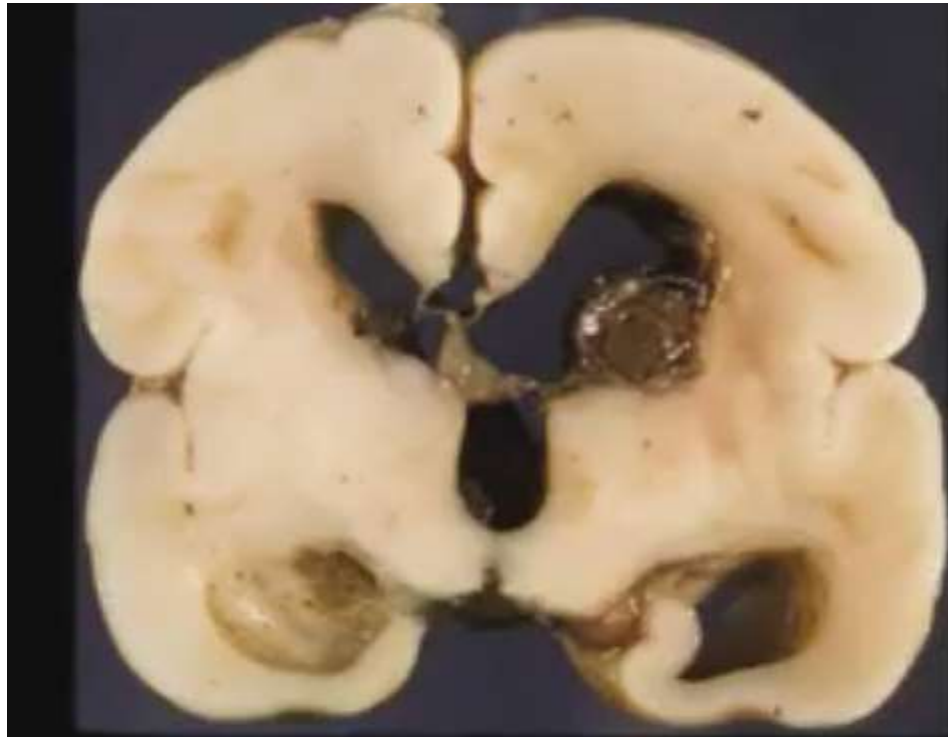
Permission granted for use. "From: D.P. Agamanolis <http://neuropathology-web.org>".



Germinal-matrix-hemorrhage-003.jpg. www.wikidoc.org. [last updated: August 3, 2012; Accessed: August 4, 2014]. <<http://www.wikidoc.org/index.php/File:Germinal-matrix-hemorrhage-003.jpg>>
Open Access Source

67% nedonošených novorozenců pod 32. týden, pod 1500g, hypoxie

Intraventricular Hemorrhage by Anne Hansen, MD, MPH for OPENPediatrics



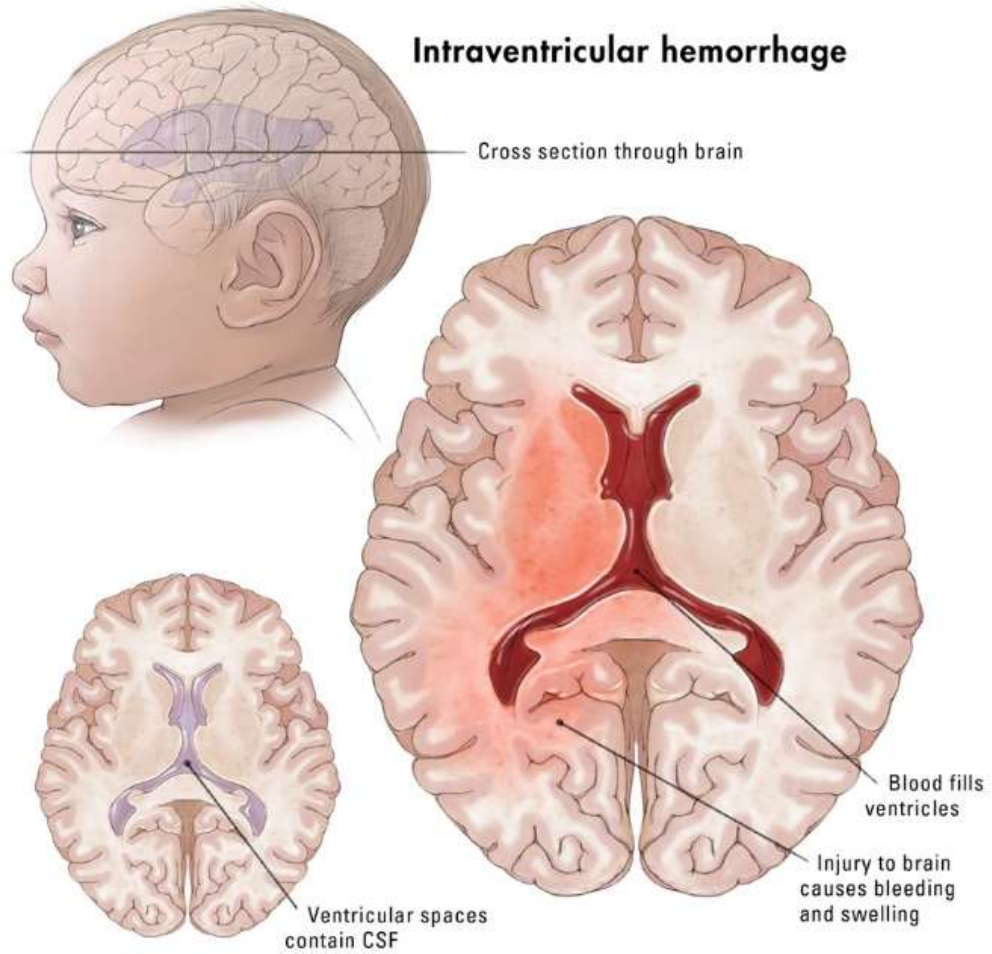
Permission granted for use from D.P. Agamanolis.
<http://neuropathology-web.org>



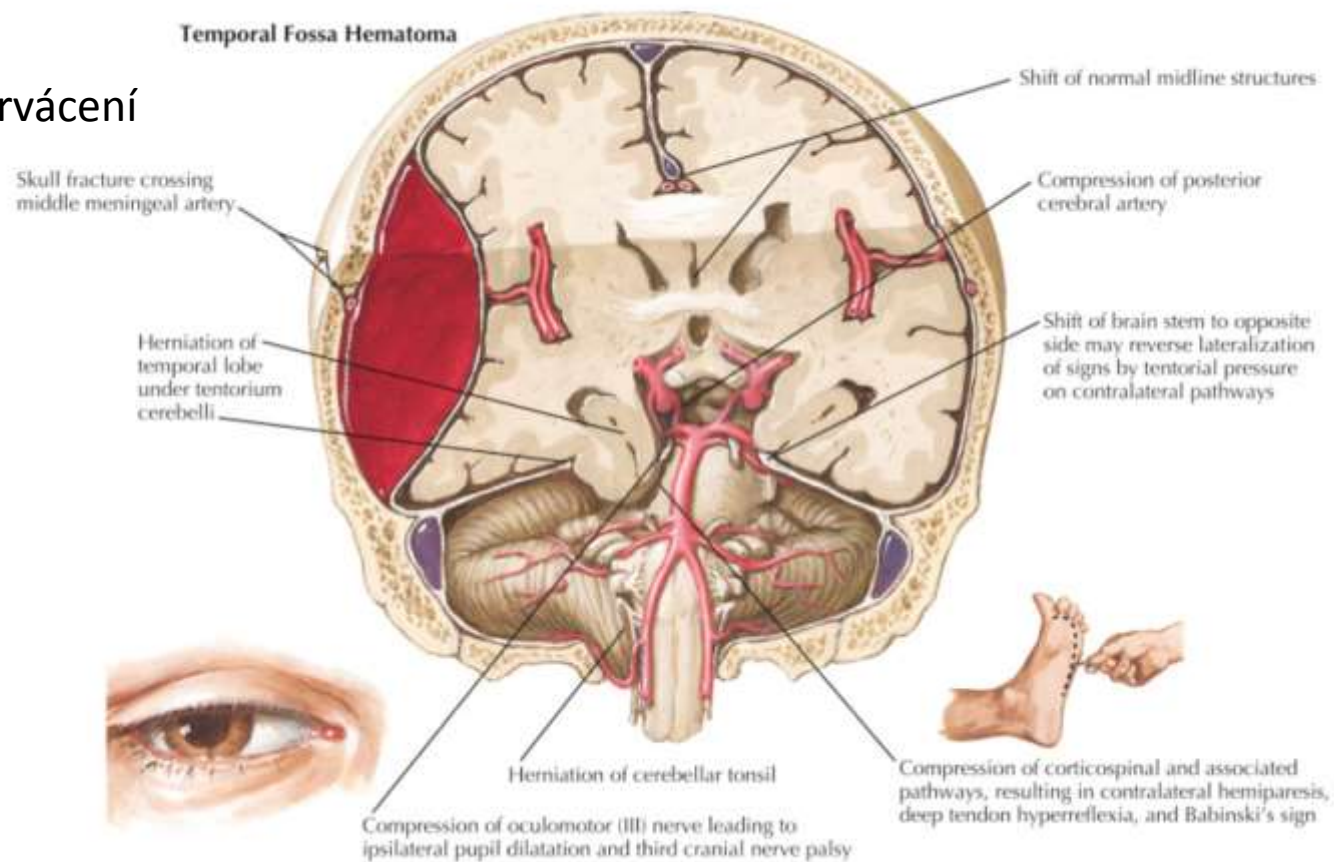
Bilateral Grade 3 GM IVH. www.armobgyn.com. Research of maternal and child health program. [last updated 2014; accessed August 5, 2014] < <http://www.armobgyn.com/en/Neurosonography.htm> > All rights reserved.

Right side of brain:

**Intraventricular Hemorrhage by Anne Hansen, MD, MPH for
 OPENPediatrics**



Příznaky u epidurálního krvácení



Krvácení subfrontálním

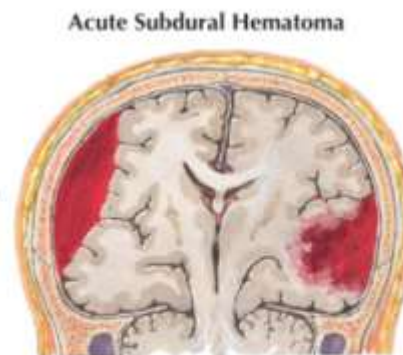
Subfrontal Hematoma

Frontal trauma: headache, poor cerebation, intermittent disorientation, anisocoria



Posterior Fossa Hematoma

Occipital trauma and/or fracture: headache, meningismus, cerebellar and cranial nerve signs, Cushing's triad



Krvácení subdurální

Section showing acute subdural hematoma on right side and subdural hematoma associated with temporal lobe intracerebral hematoma ("burst" temporal lobe) on left

Krvácení do zadní jámy

Cévy mozku

Z ARTERIA CAROTIS INTERNA

Z ARTERIA VERTEBRALIS

Circulus arteriosus Willisi

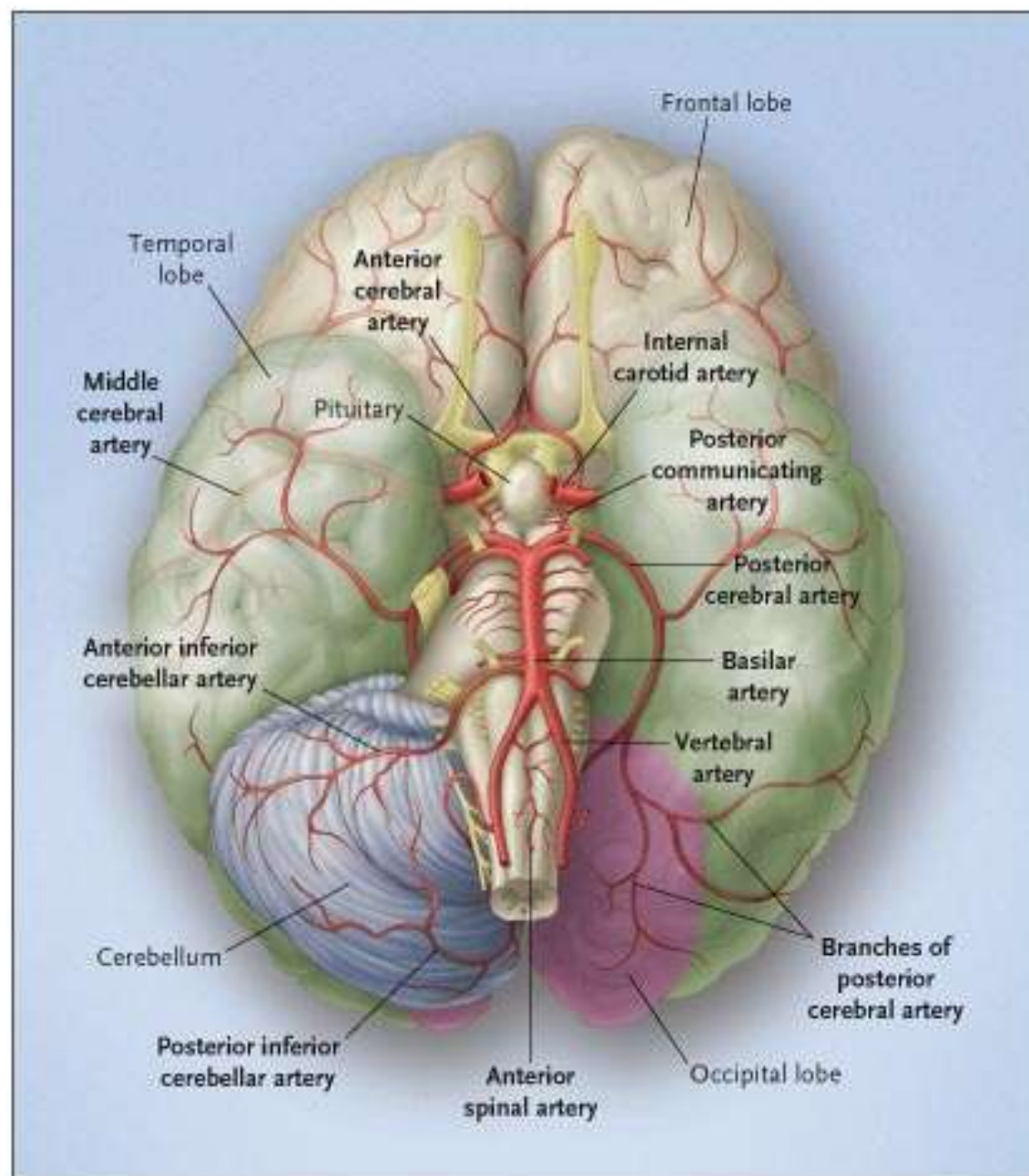
Arteriae centrales- skupiny:

Anteromediální

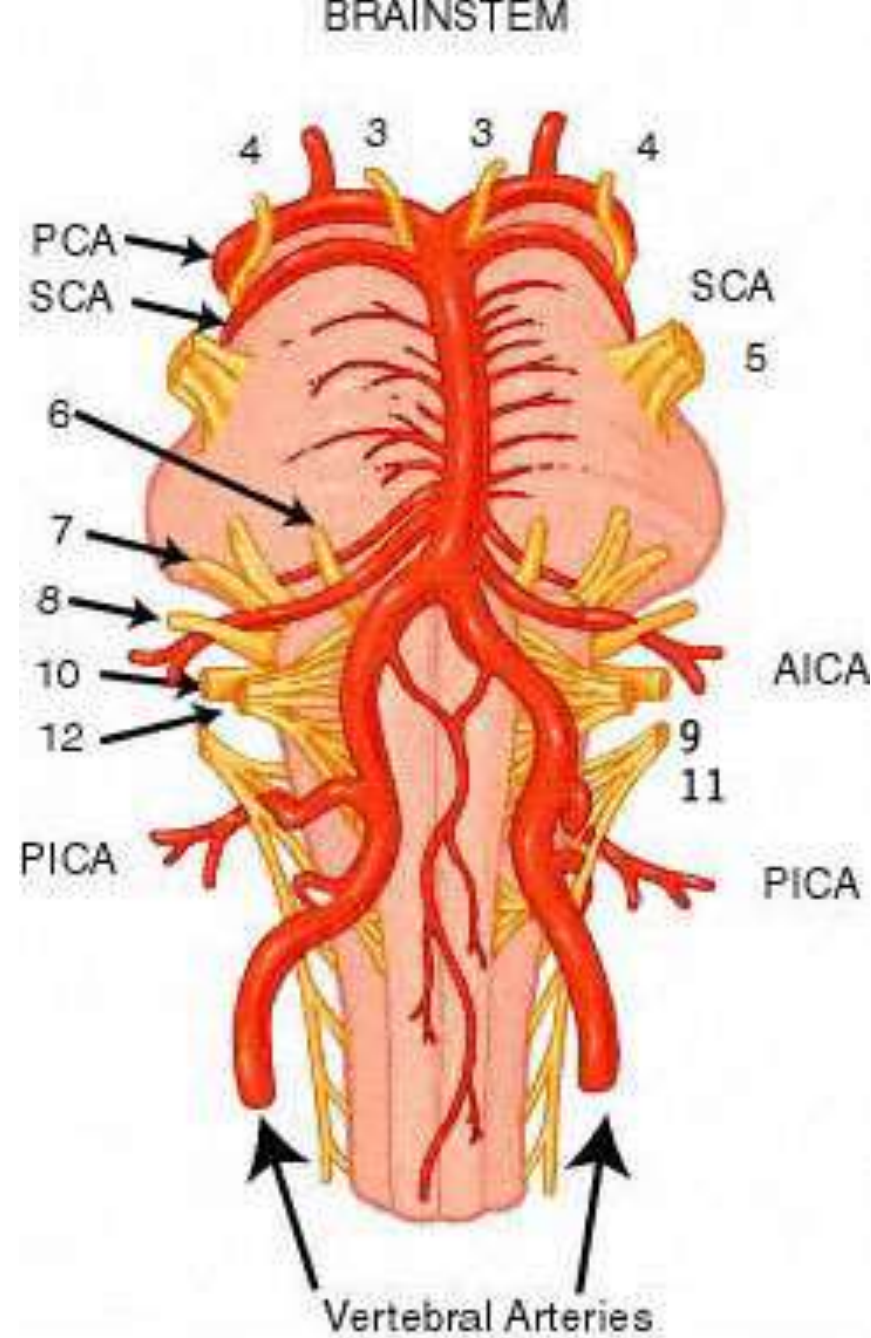
Anterolaterální

Posteromediální

Posterolaterální



Výstupy hlavových nervů a cévy na
ventrální straně mozkového kmene
Cranial nerve origins and arteries on
the ventral part of the brainstem



Vertebrobasilar system

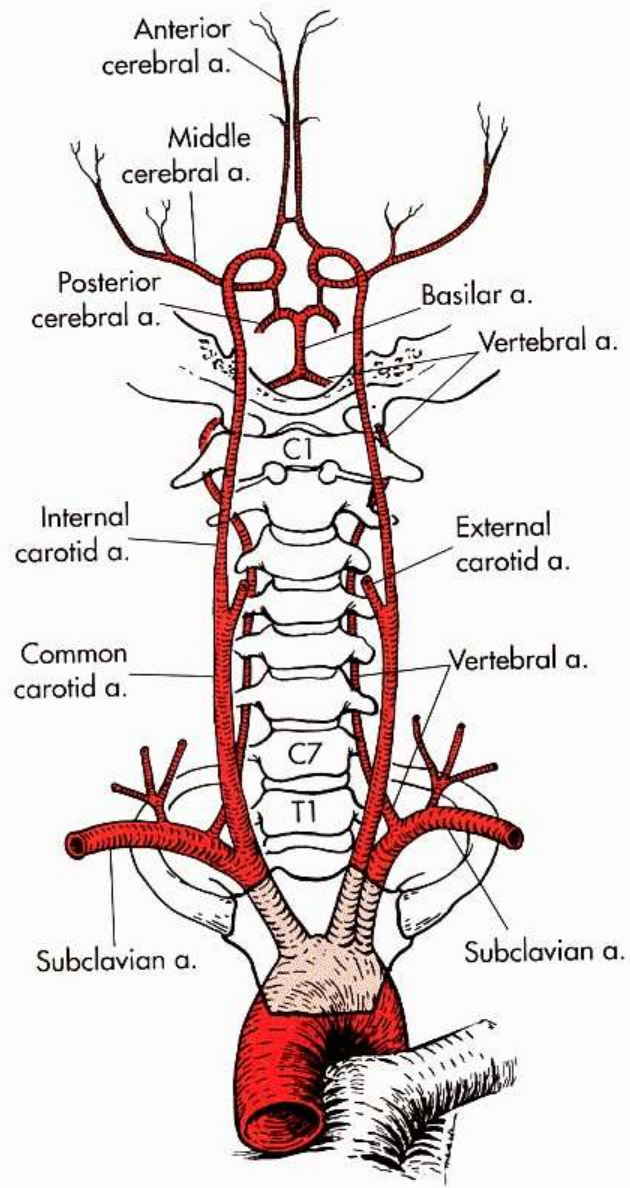
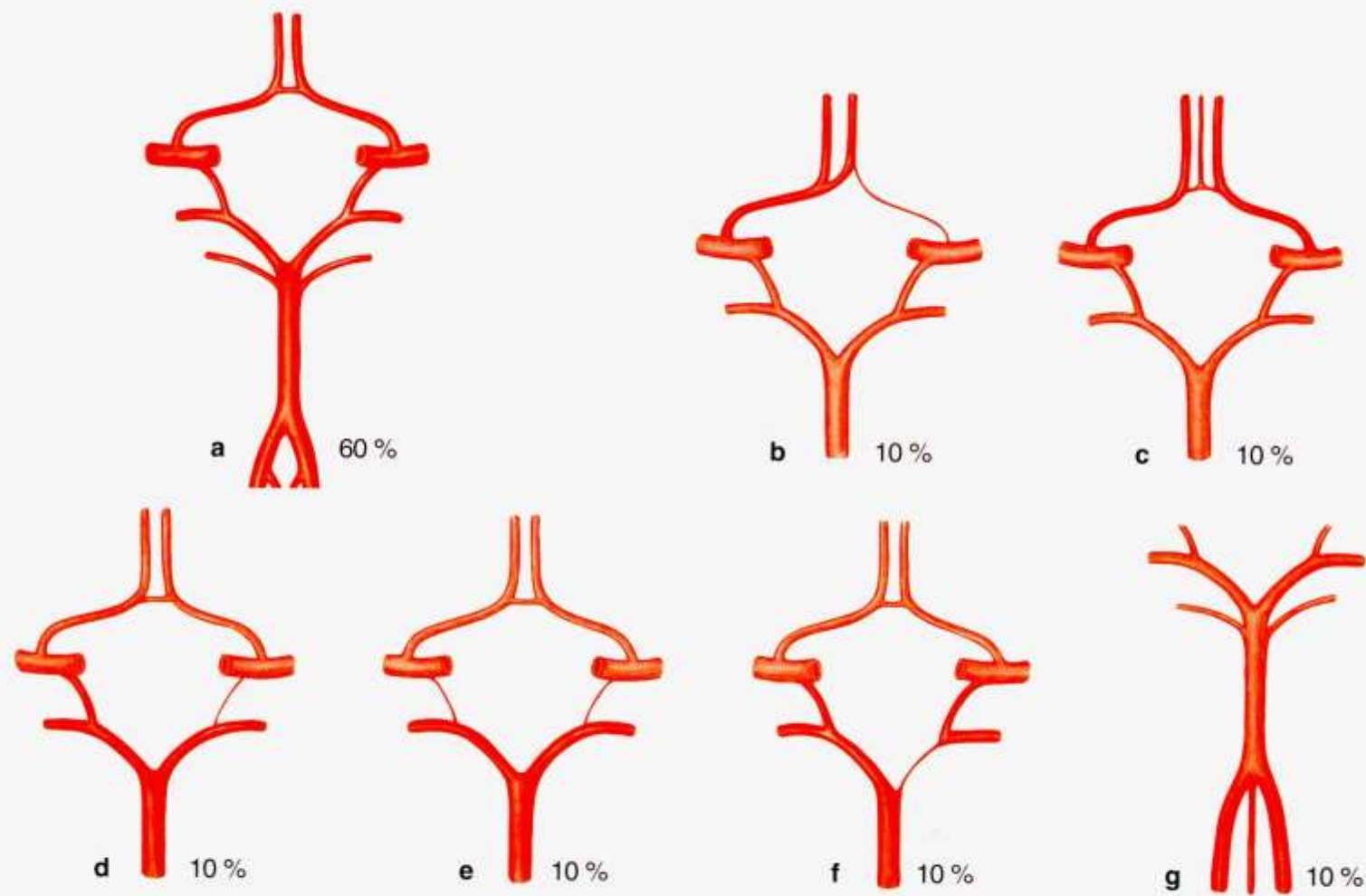
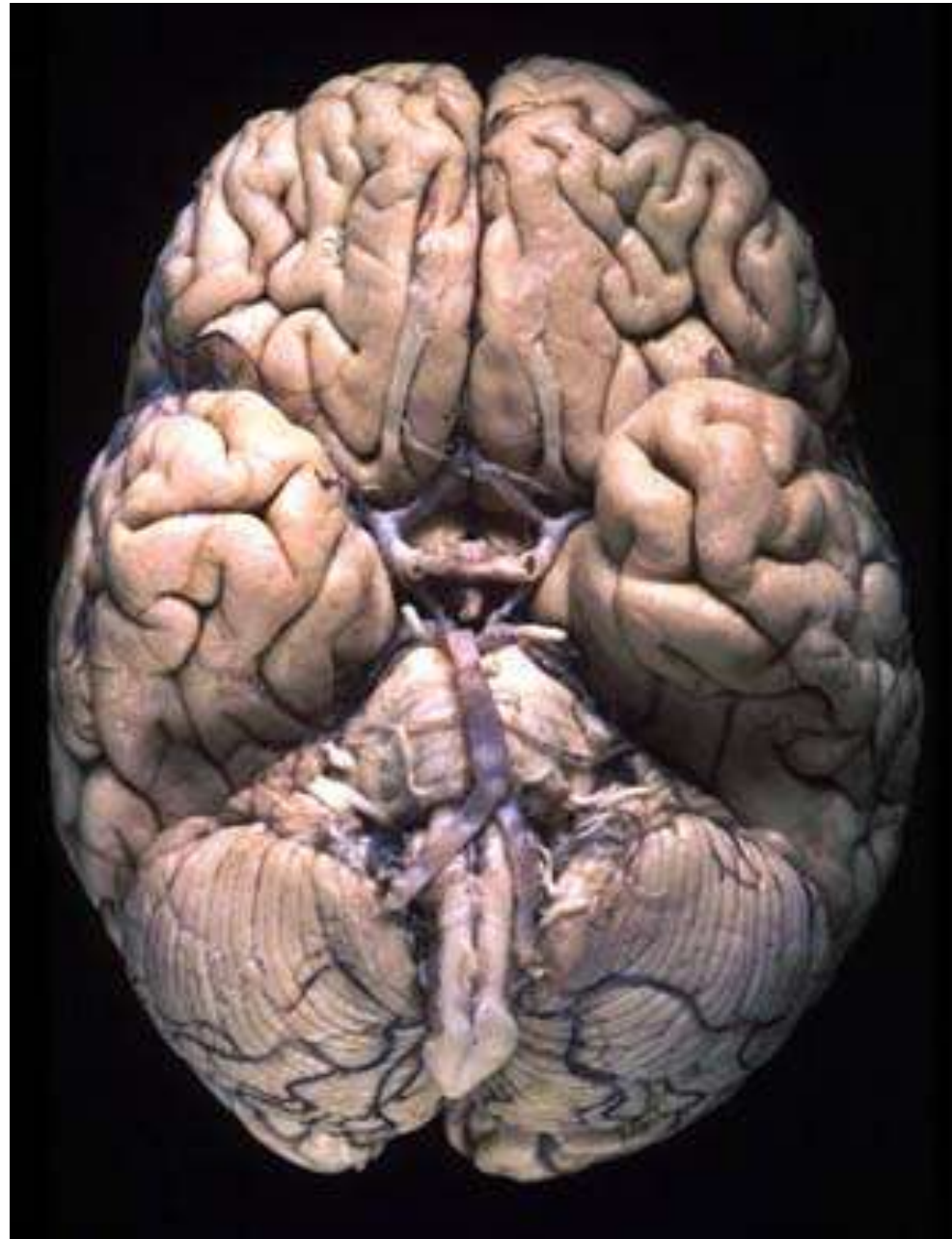
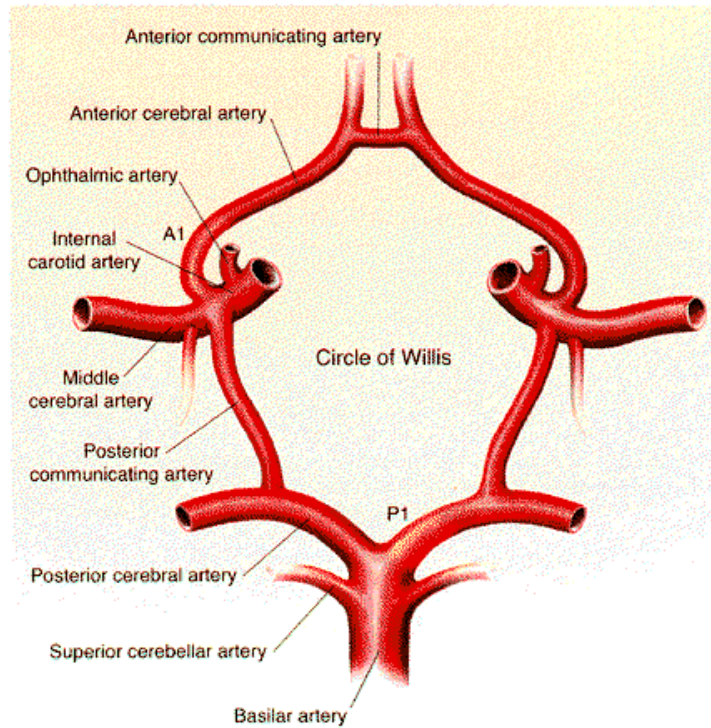


FIGURE 6-2
Origins of the arterial supply of the brain. a, Artery. (From Osborn AG: *Introduction to cerebral angiography*, Hagerstown, 1980, Harper & Row.)

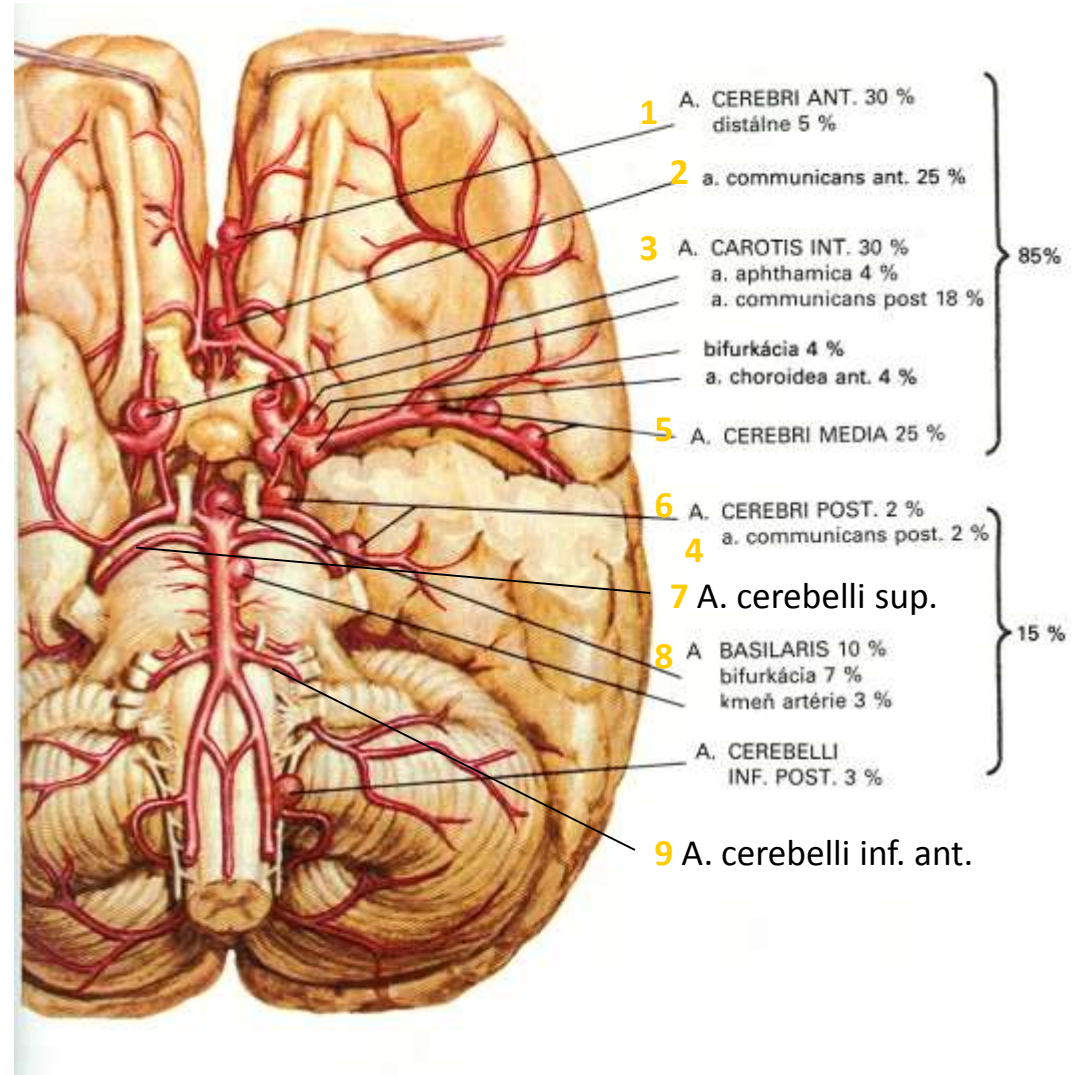
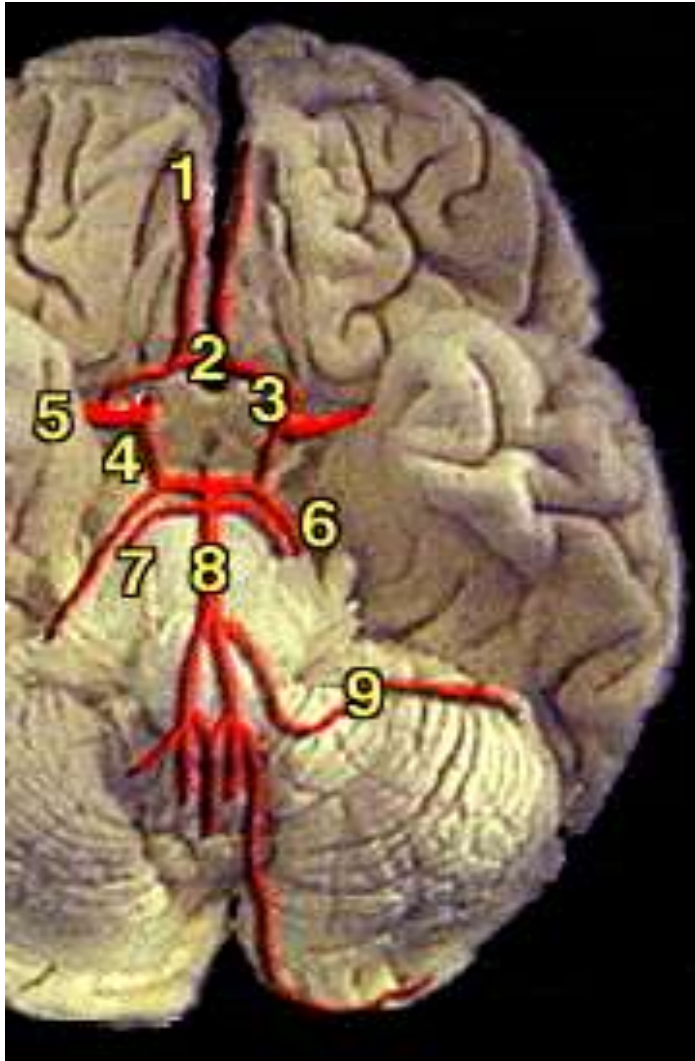


Obr. 564 a-g Willisův arteriální okruh,
 circulus arteriosus cerebri.
a-c variety předního oddílu
d-f variety zadního oddílu
g kaudální spojení vertebrálních arterií

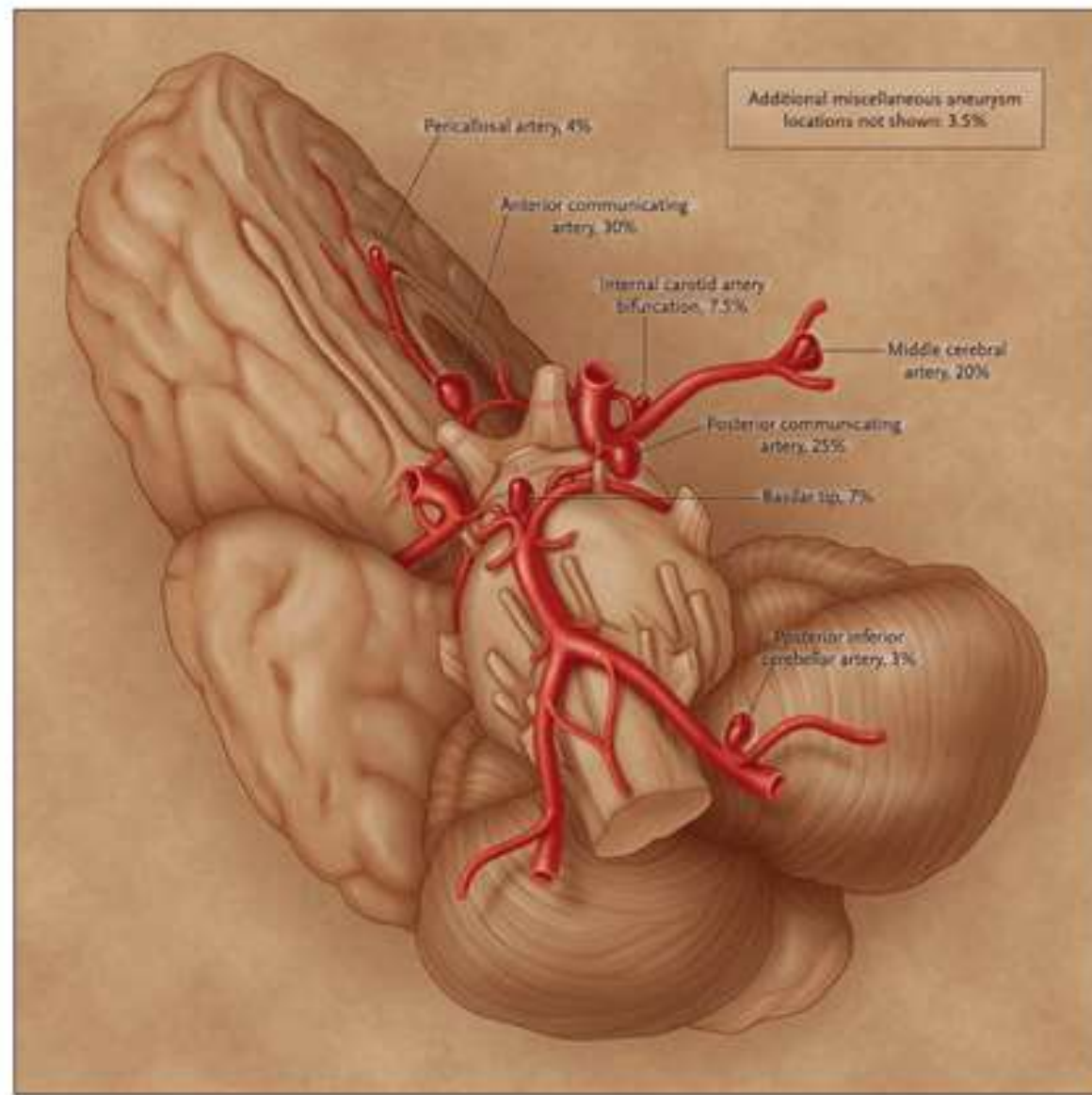
Circulus arteriosus



Circulus arteriosus Willisi – četnost aneurysmat

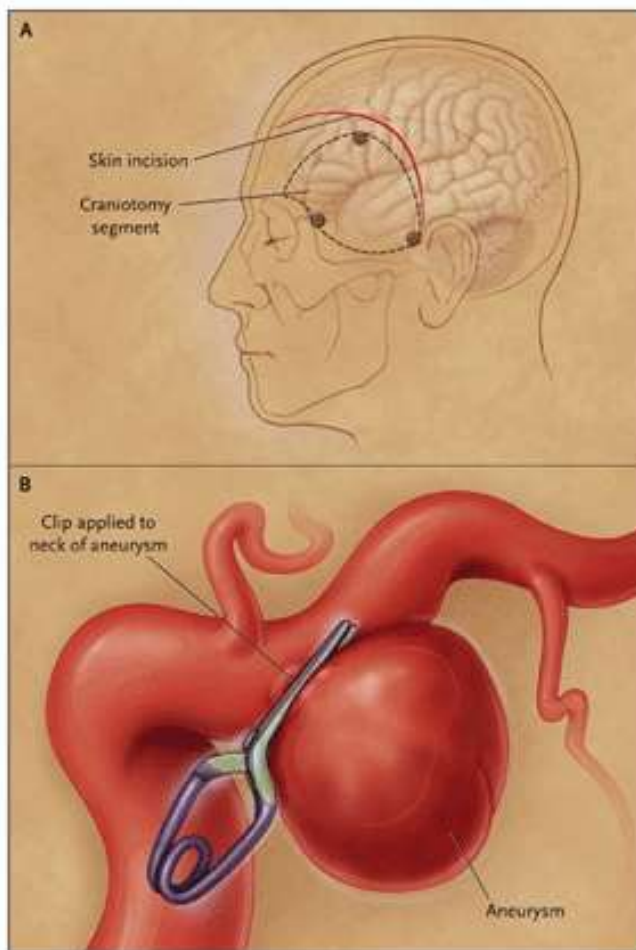


Aneurysmata lokalizace

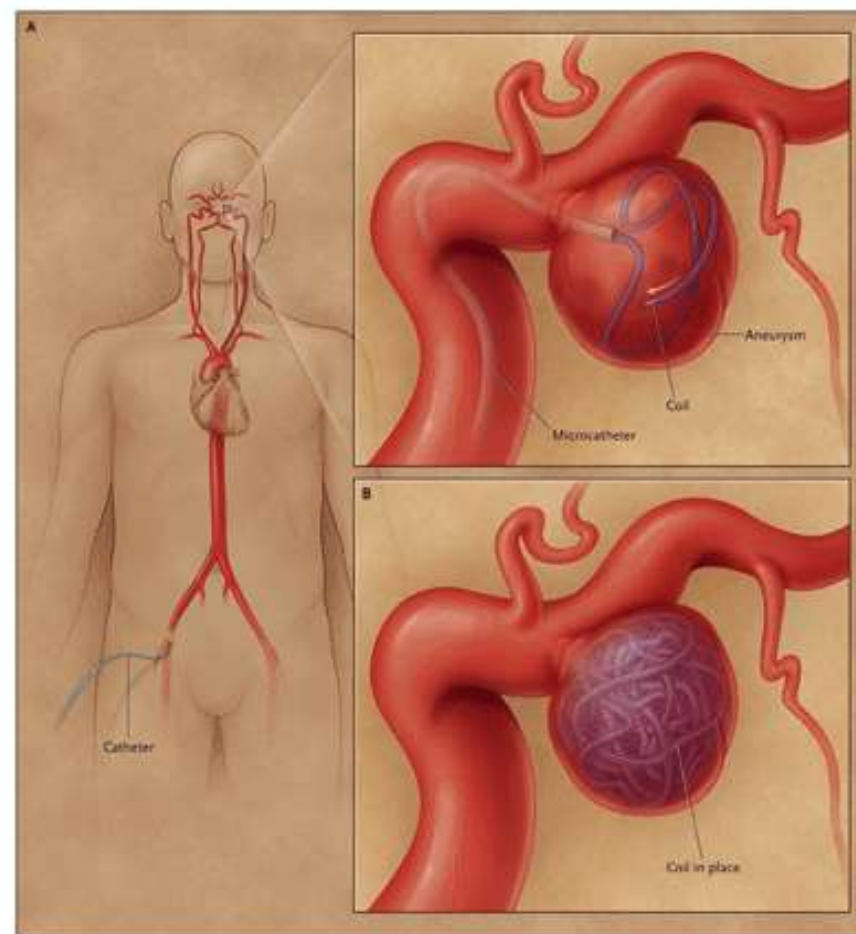


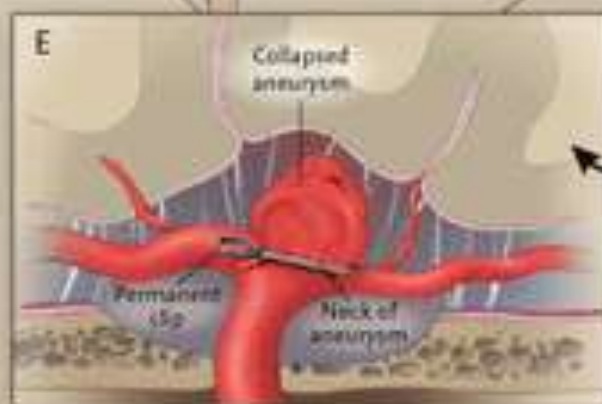
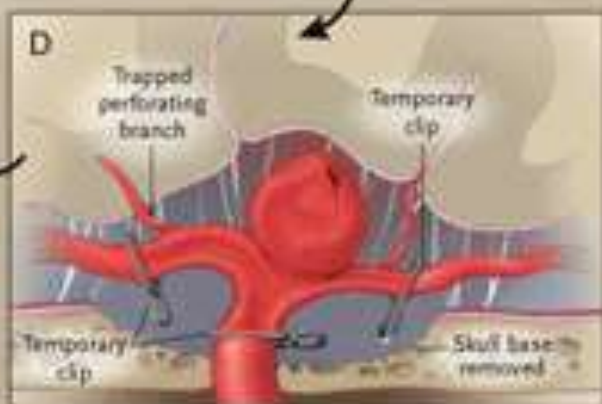
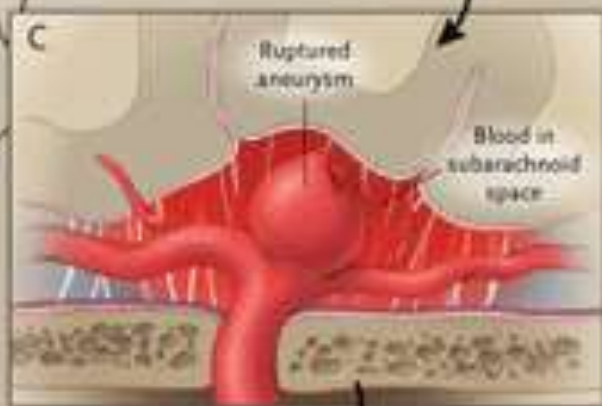
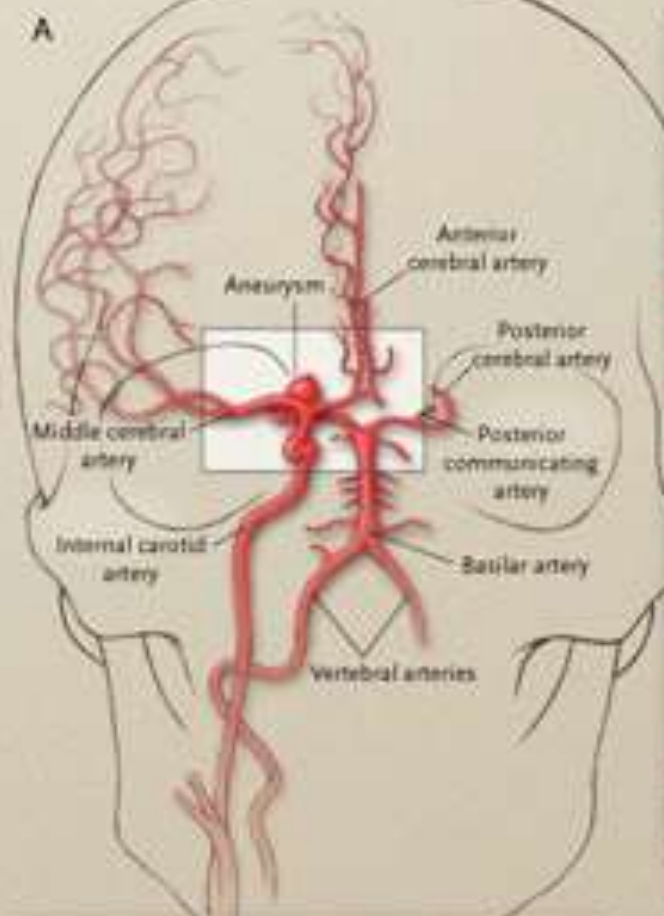
Aneurysma - léčba

Clip

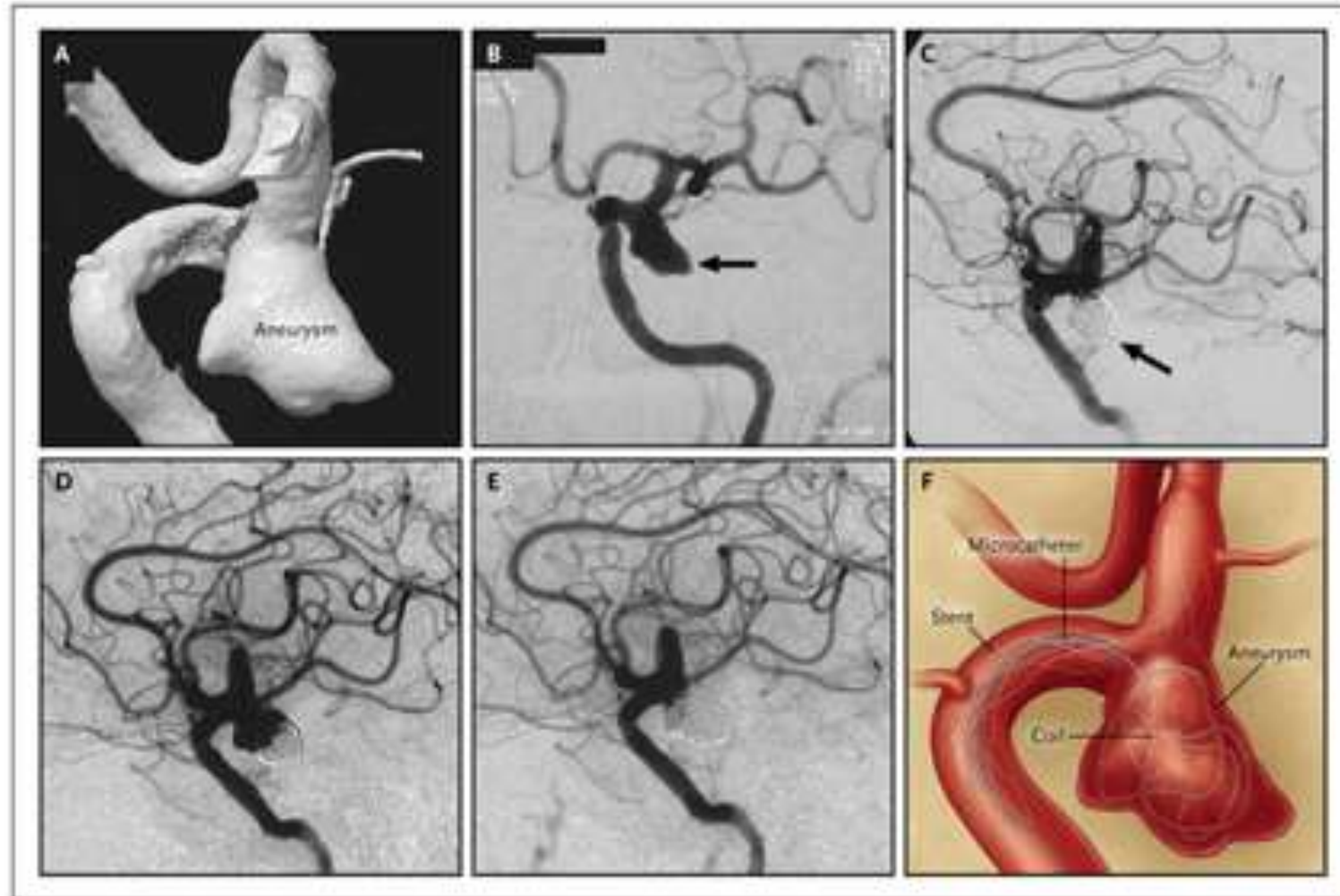


Endovascular occlusion

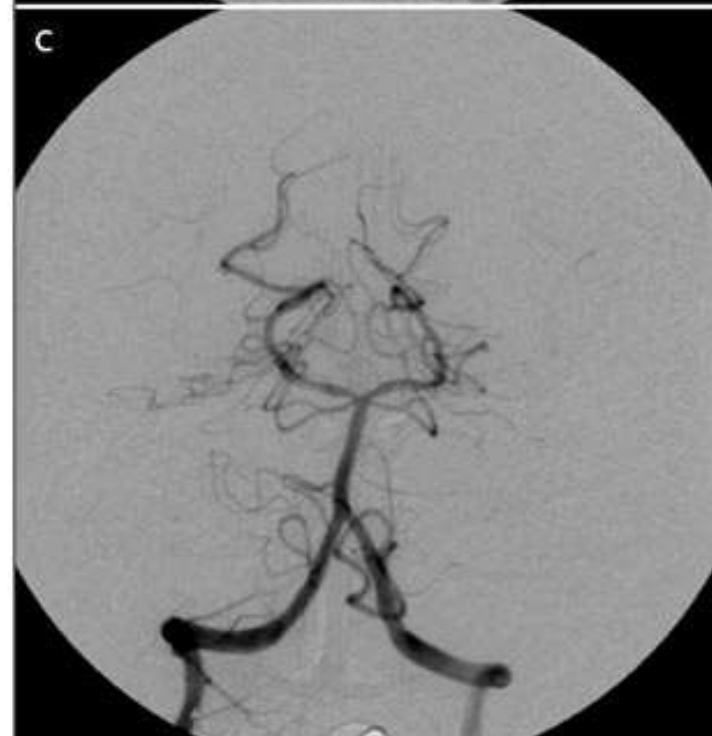
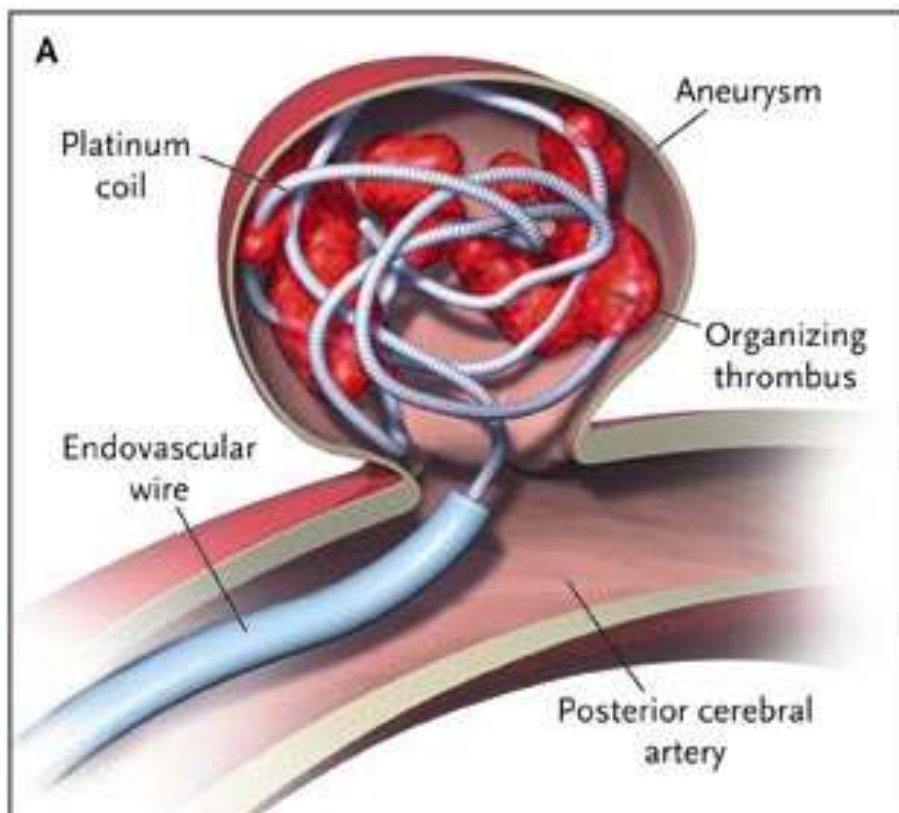




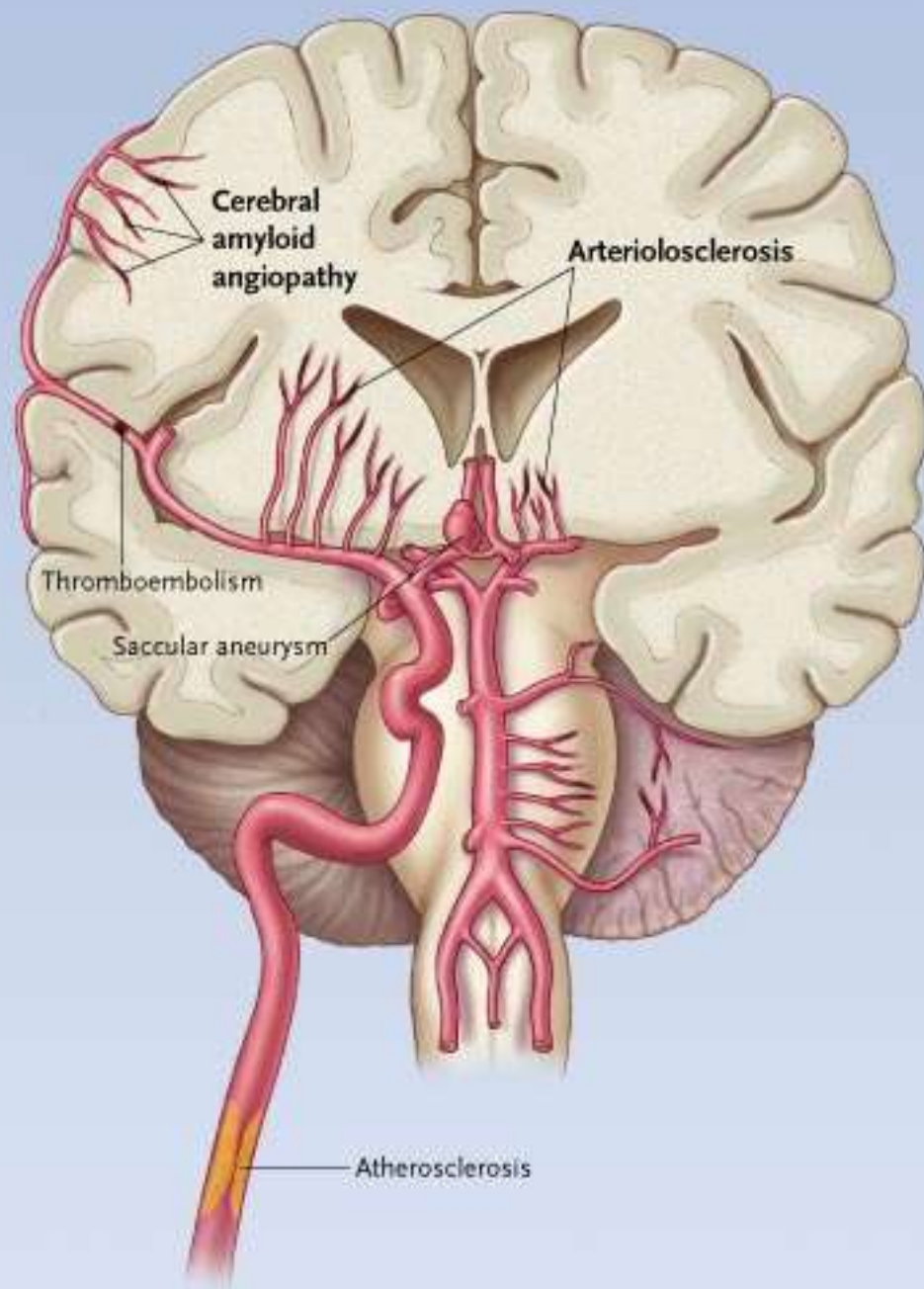
Aneurysma – stent, recoiling



Intravascular coiling



A



Nejčastější příčiny cévních poruch v mozku

aterosklerosa velkých tepen

arteriolosklerosa

aneurysma

uzávěr malých korových tepének

embolizace (např. při fibrilaci síní)

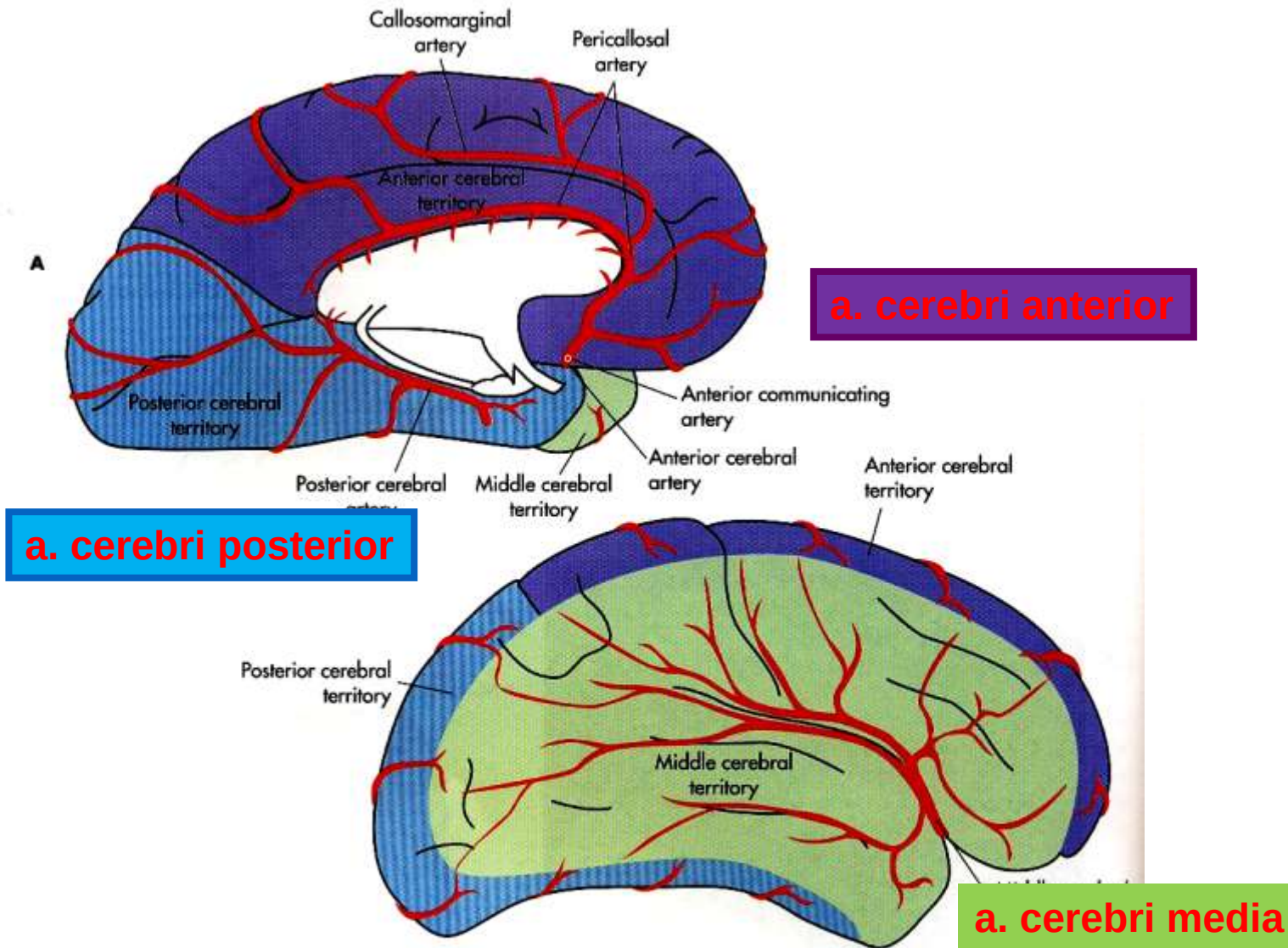


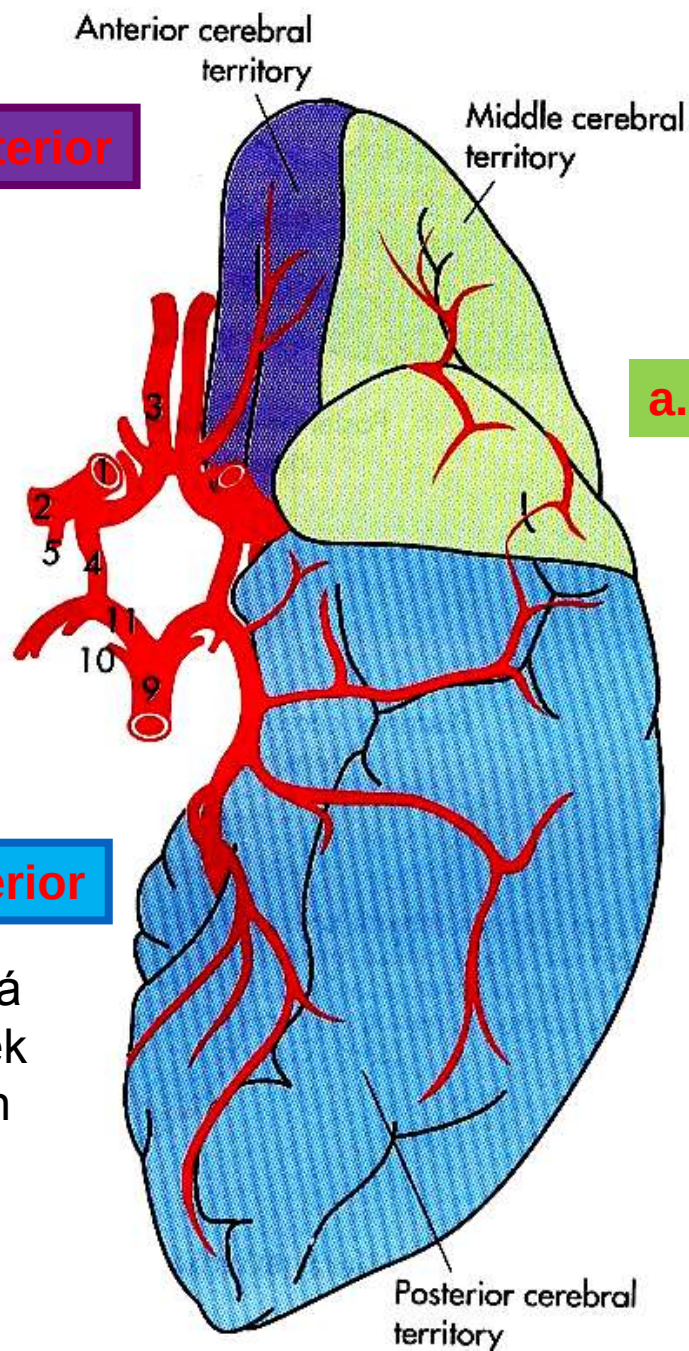
FIGURE 6-4
Arteries on the medial (A) and lateral (B) surfaces of the brain, with their areas of supply indicated. [Modified from Mettler FA: *Neuroanatomy*, ed 2, St. Louis, 1948, Mosby.]

a. cerebri anterior

uzávěr –
hemiplegie
na opačné
DK

a. cerebri posterior

uzávěr – korová
slepota výpadek
druhostranných
zorných polí



a. cerebri media

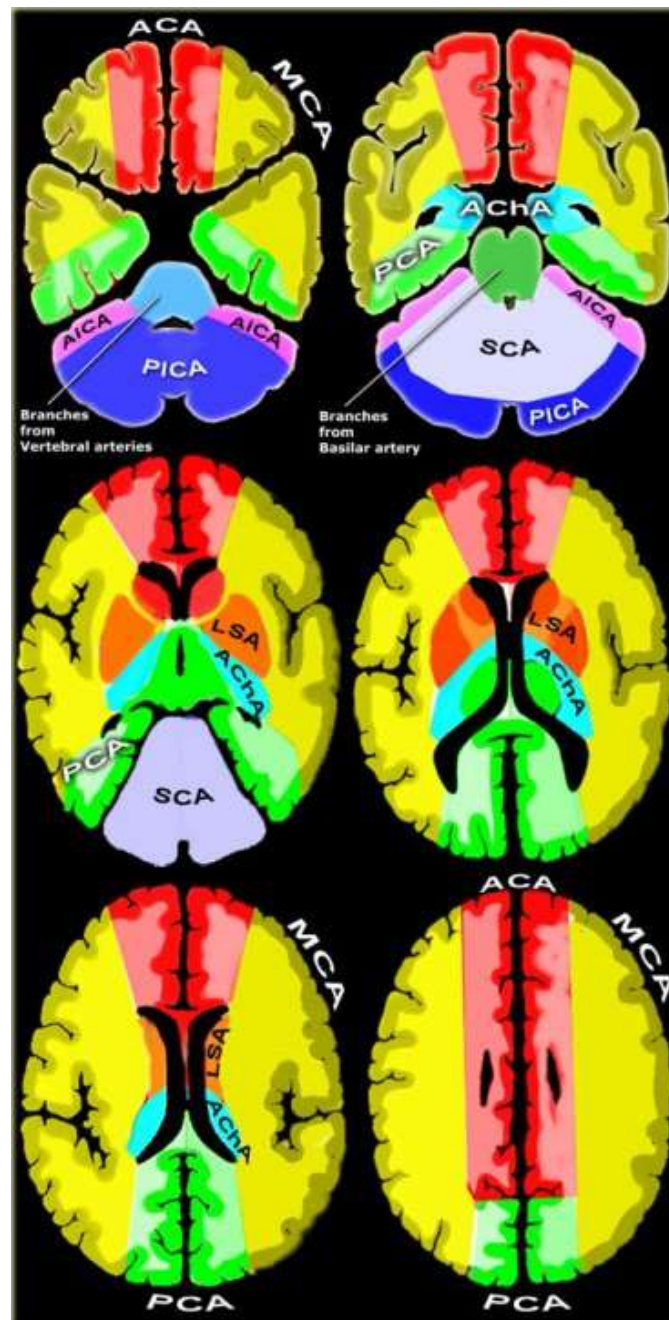
uzávěr –
hemiplegie na opačné HK,
obrna lícního nervu,
afázie (porucha řeči) při
poškození vlevo

Povodí jednotlivých tepen

a.cerebri anterior

a.cerebri media

a. cerebri posterior



a.cerebellaris inferior anterior

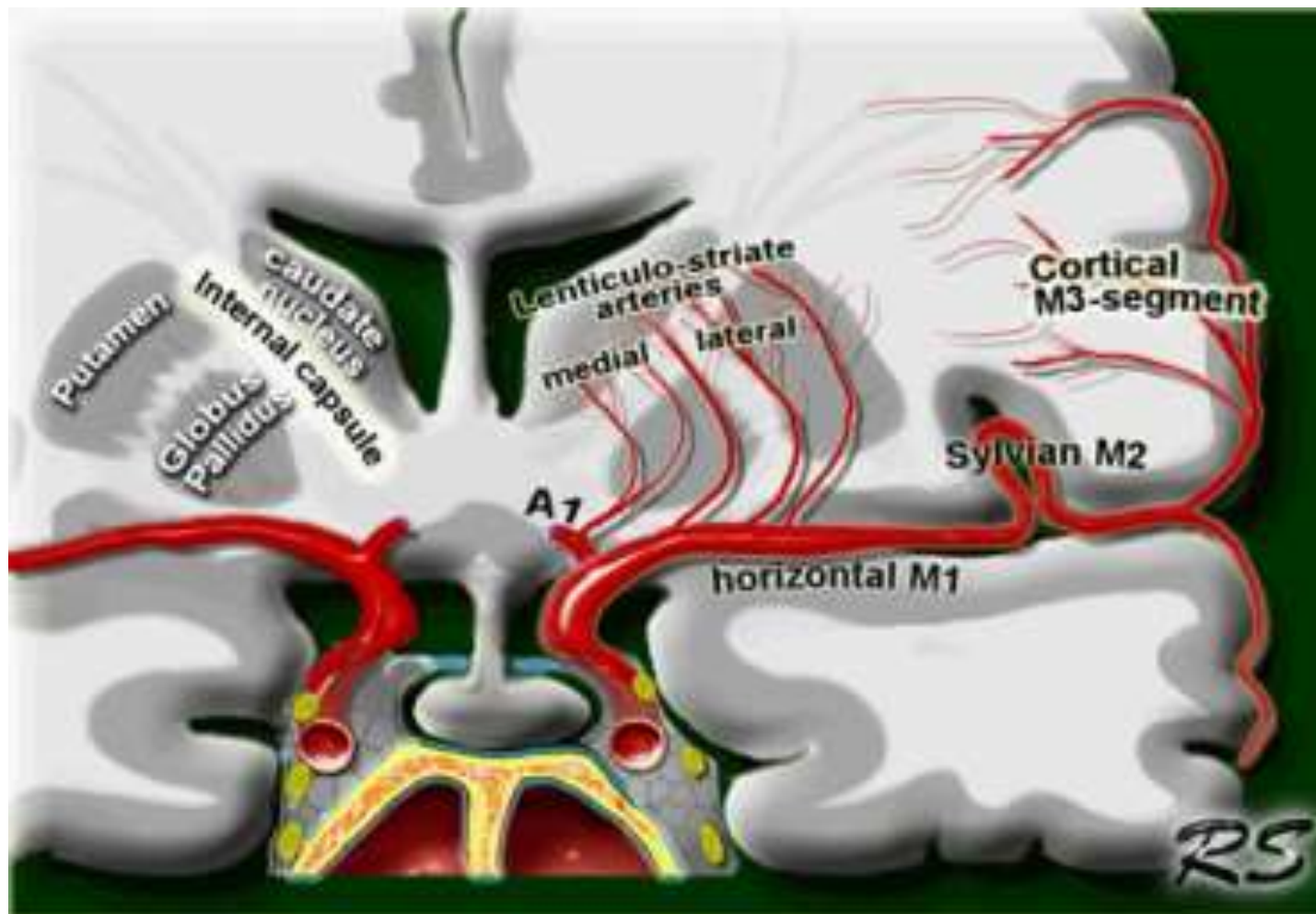
a.cerebellaris inferior posterior

a.cerebellaris superior

a. choroidea anterior

Cévní zásobení basálních ganglií

arterie lenticulostriaticae



A. Reccurens Heubneri –živí přední raménko CI a caput ncl caudati

RCA

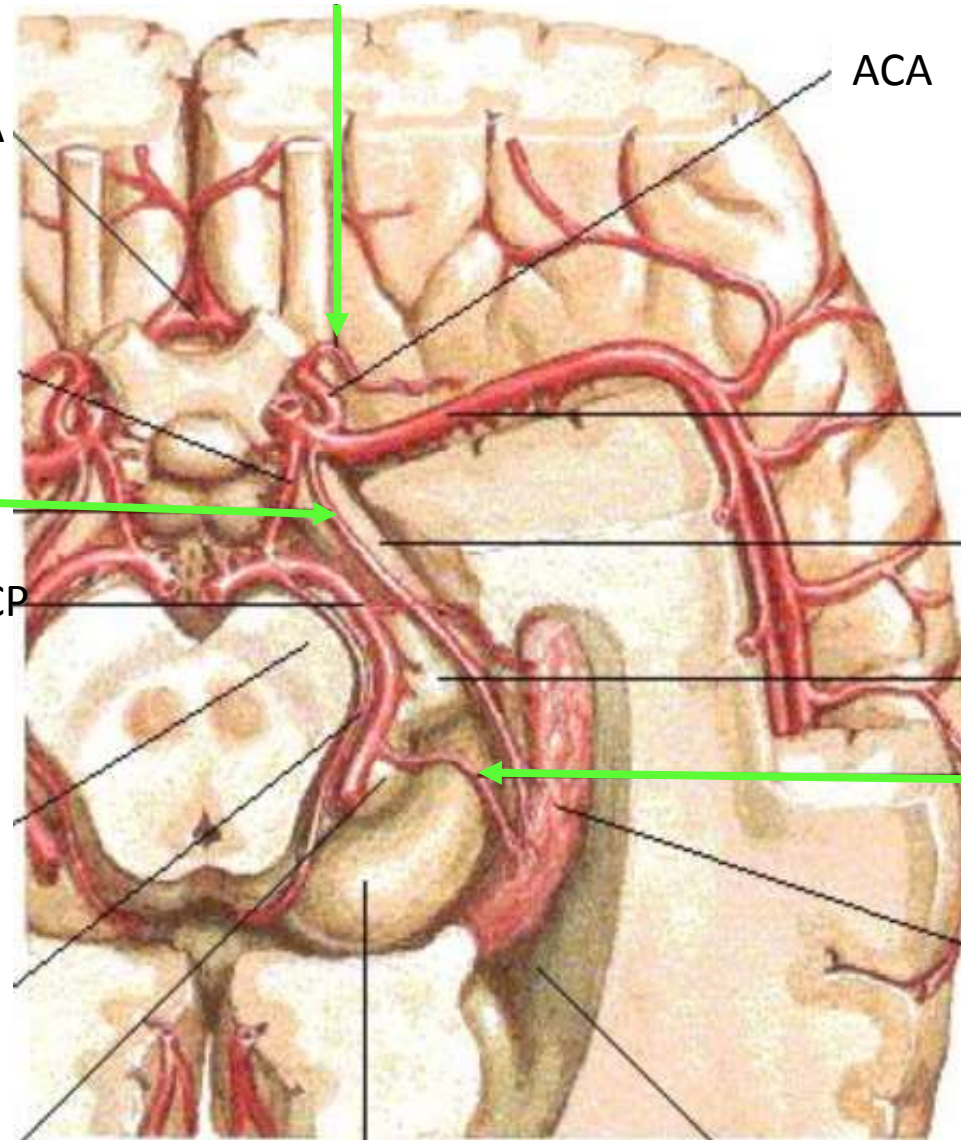
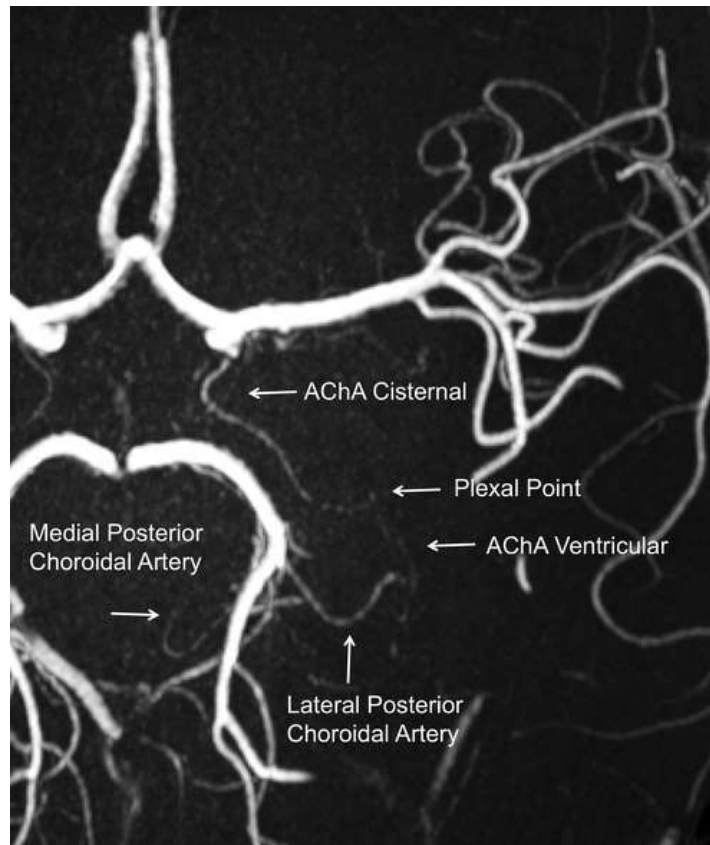
ACA

A. choroidea anterior RCP
živí zadní raménko CI

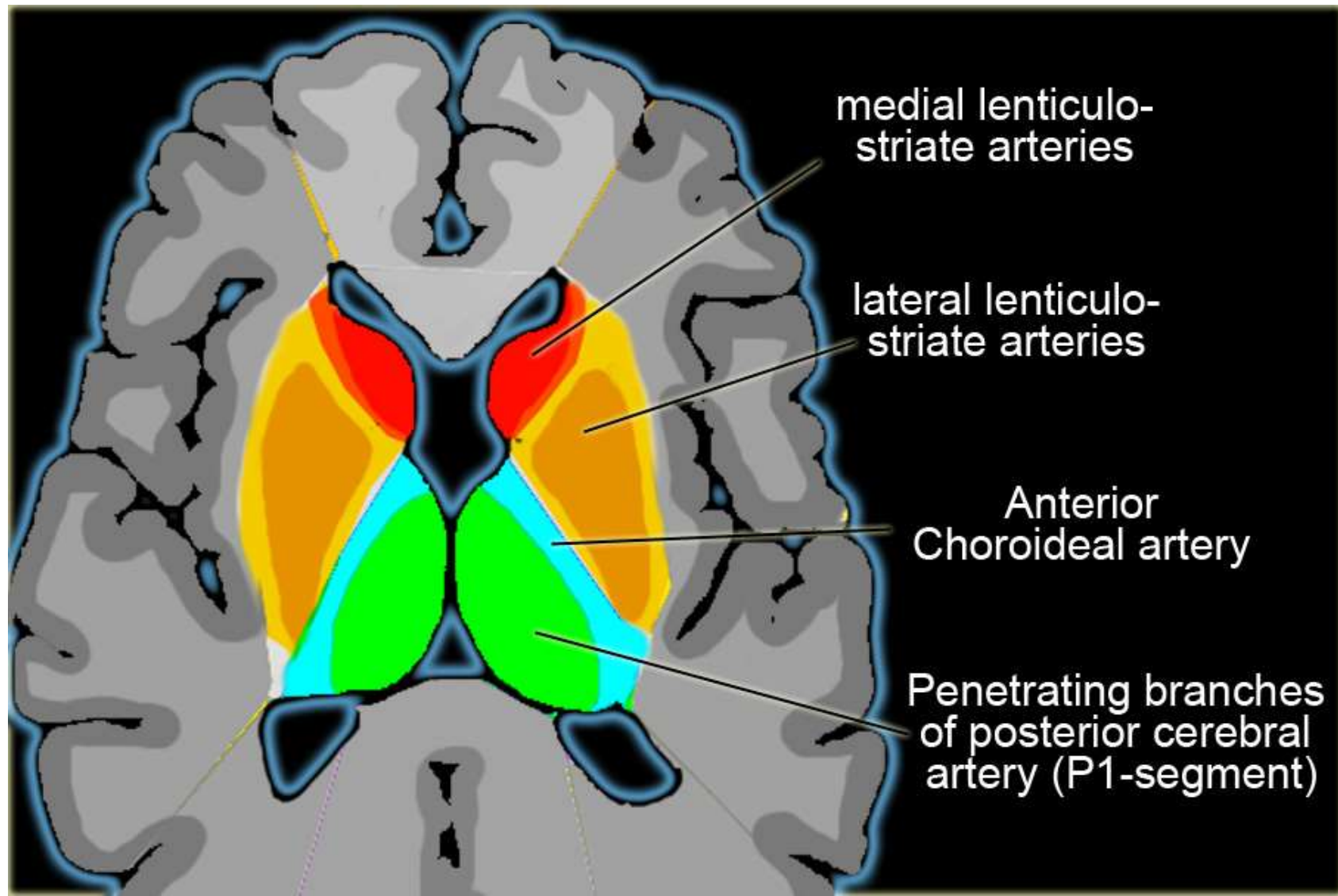
ACM

ACP

A choroidea posterior



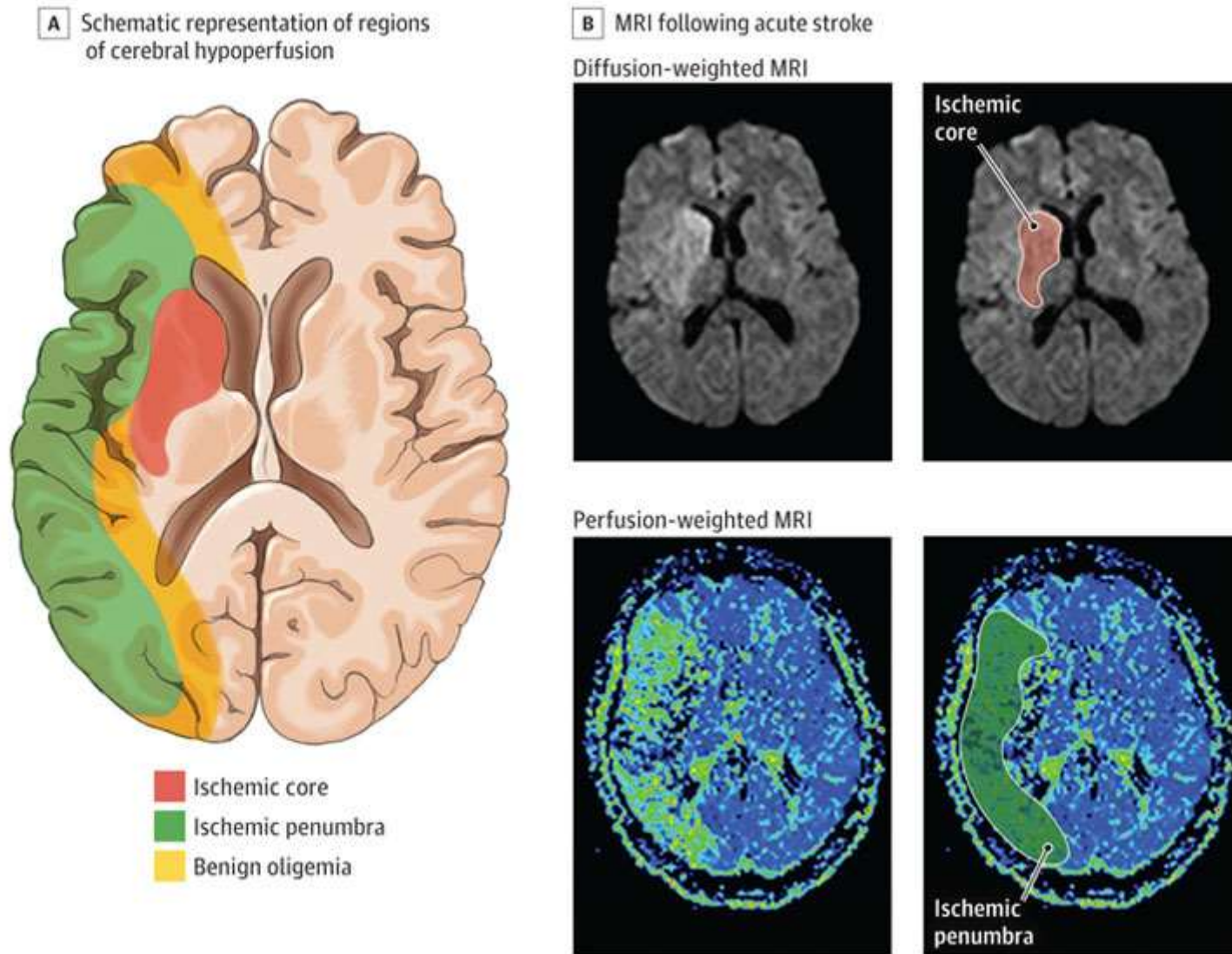
Cévní zásobení basálních ganglií, thalamu a capsula interna



CT 3D ANGIOGRAFIE



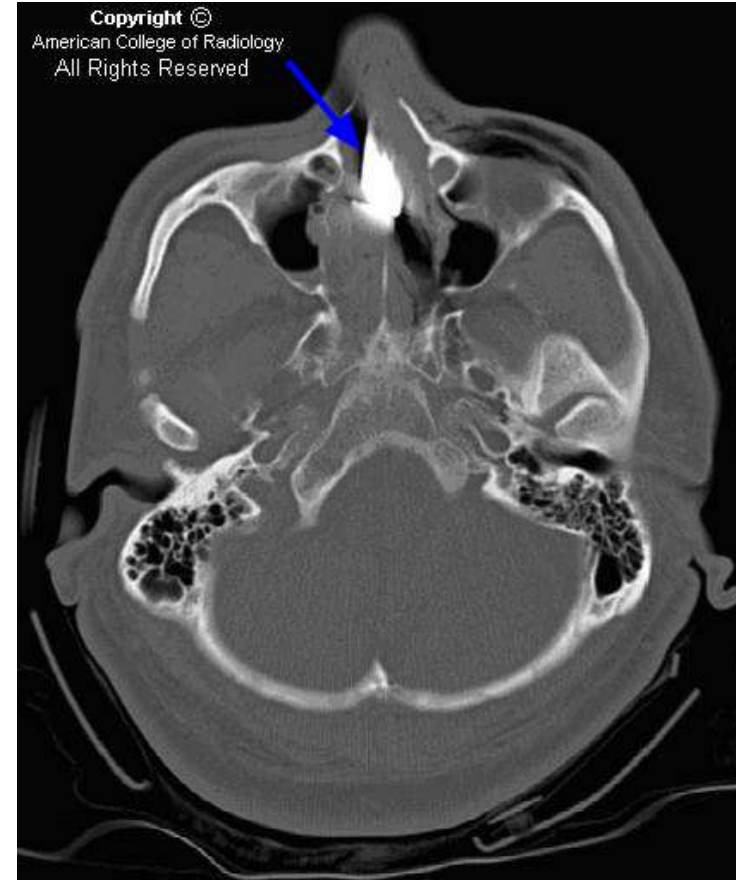
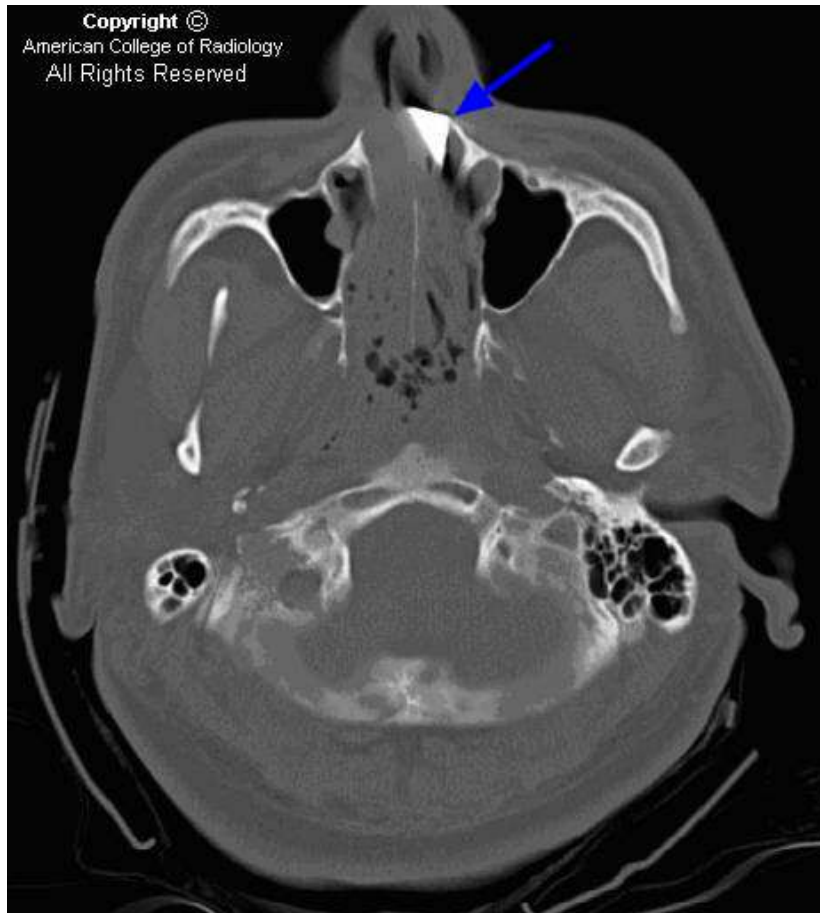
Hypoperfuze po akutní mozkové ischemické příhodě v oblasti a. cerebri media



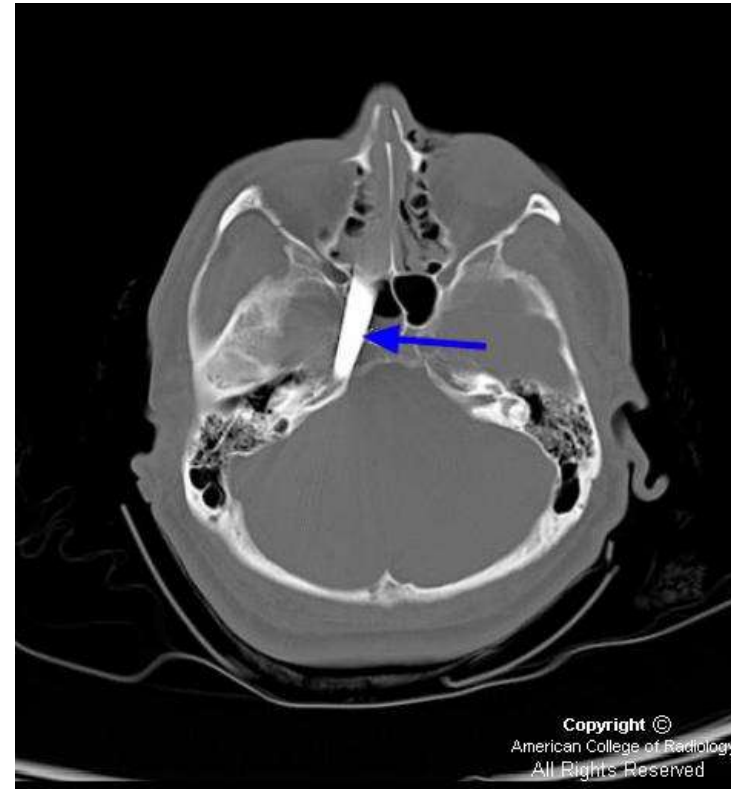
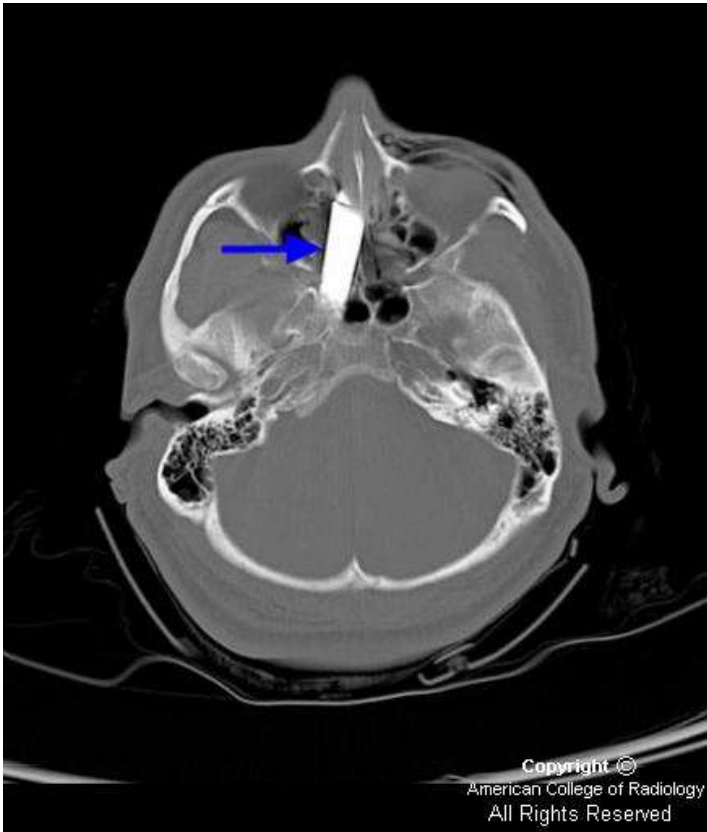
49-letý pacient s náhle vzniklou dysarthrií a levostrannou hemiparesou

Penumbra – oblast se sníženým průtokem krve, kterou lze včasným obnovením průtoku zachránit

45-year-old patient walking around the ER complaining of a
headache



- : Transaxial CT scan of the brain. Knife entering the superolateral aspect of the left nasal cavity (blue arrow).

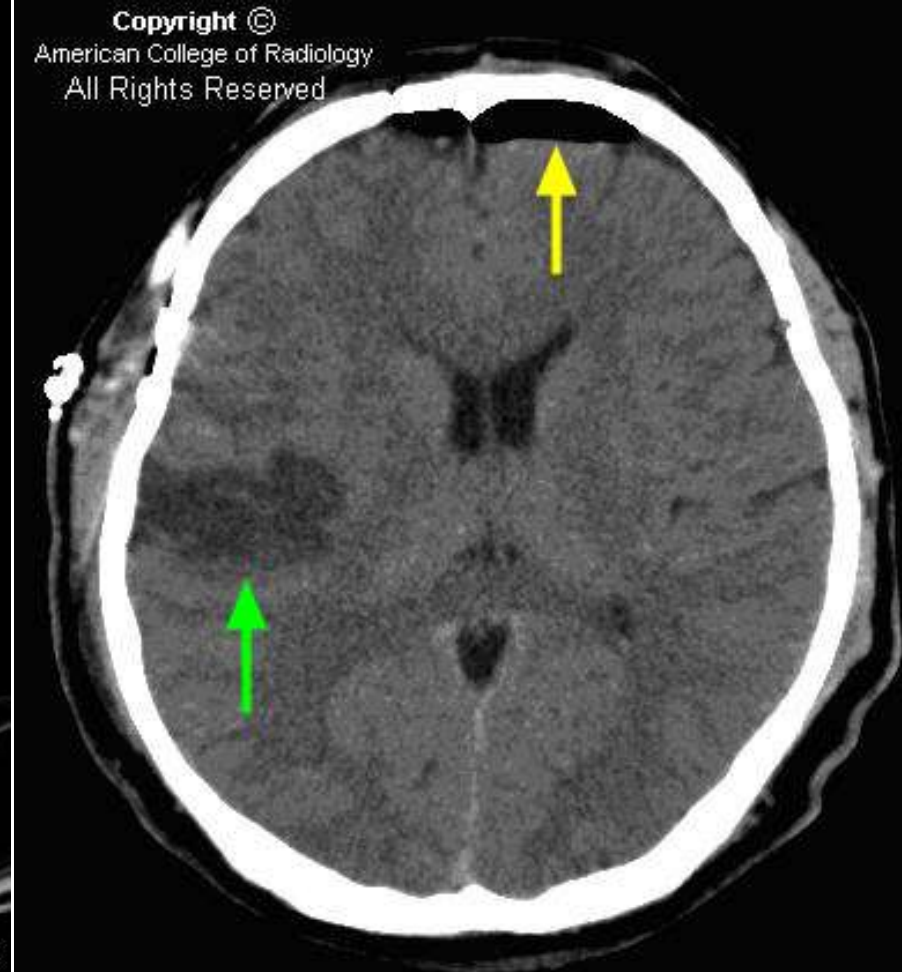


- Transaxial CT scan of the brain. Knife traversing the midline (blue arrow)

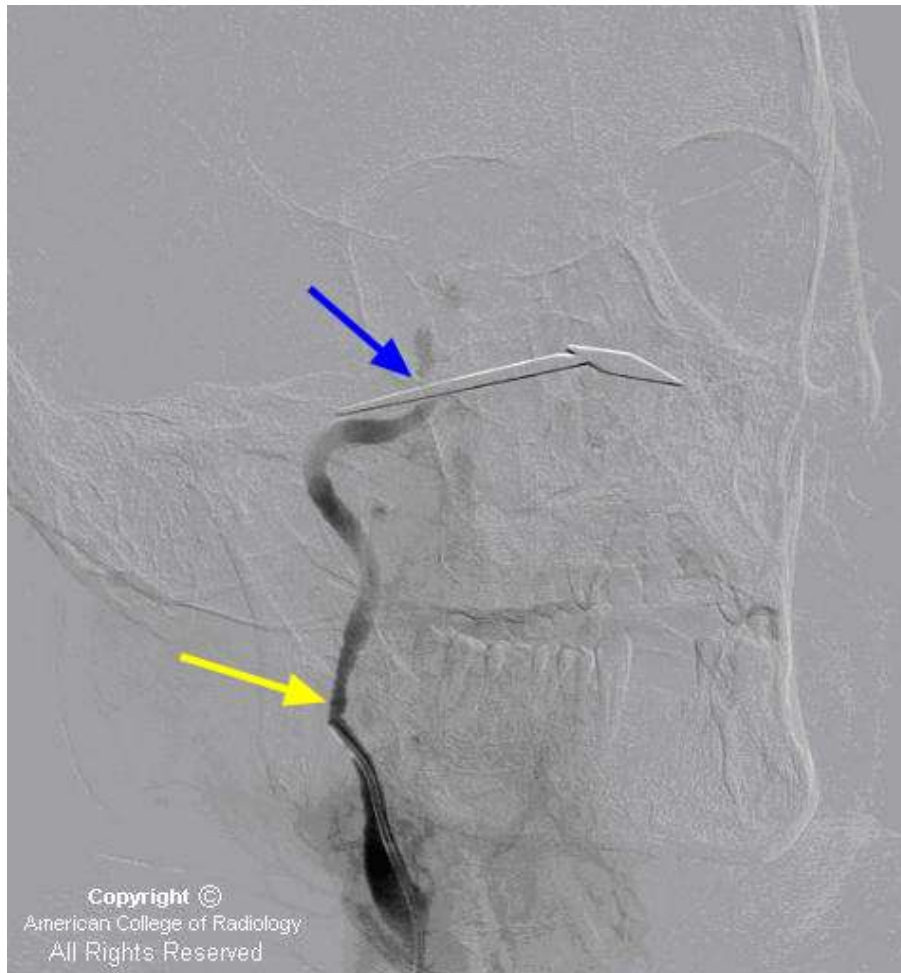
Injured petrous internal carotid with proximal occlusion and clot from stab wound



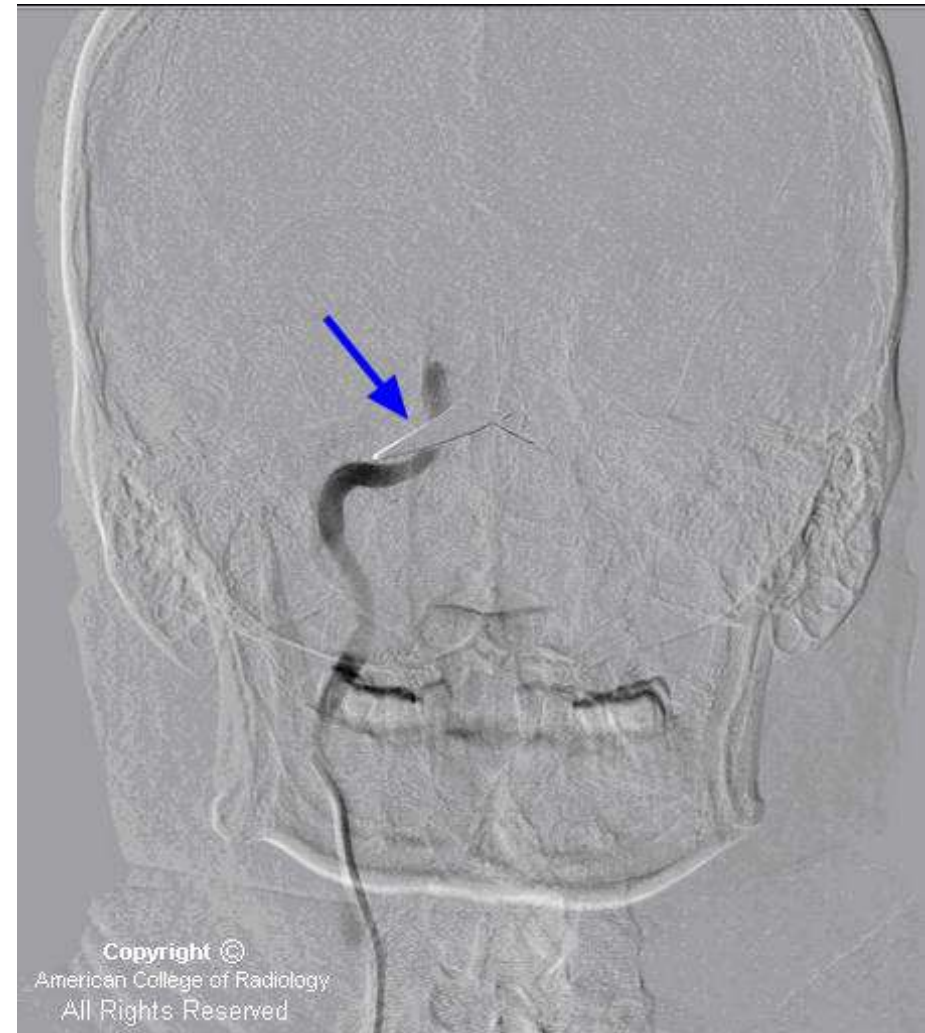
Transaxial CT scan of the brain. Knife traverses the carotid canal with tip at the level of the internal auditory canal (blue arrow)



Transaxial CT scan of the brain. Postoperative pneumocephalus (yellow arrow) and posttraumatic infarction in the distribution of the right middle cerebral artery (green arrow). Knife has been removed

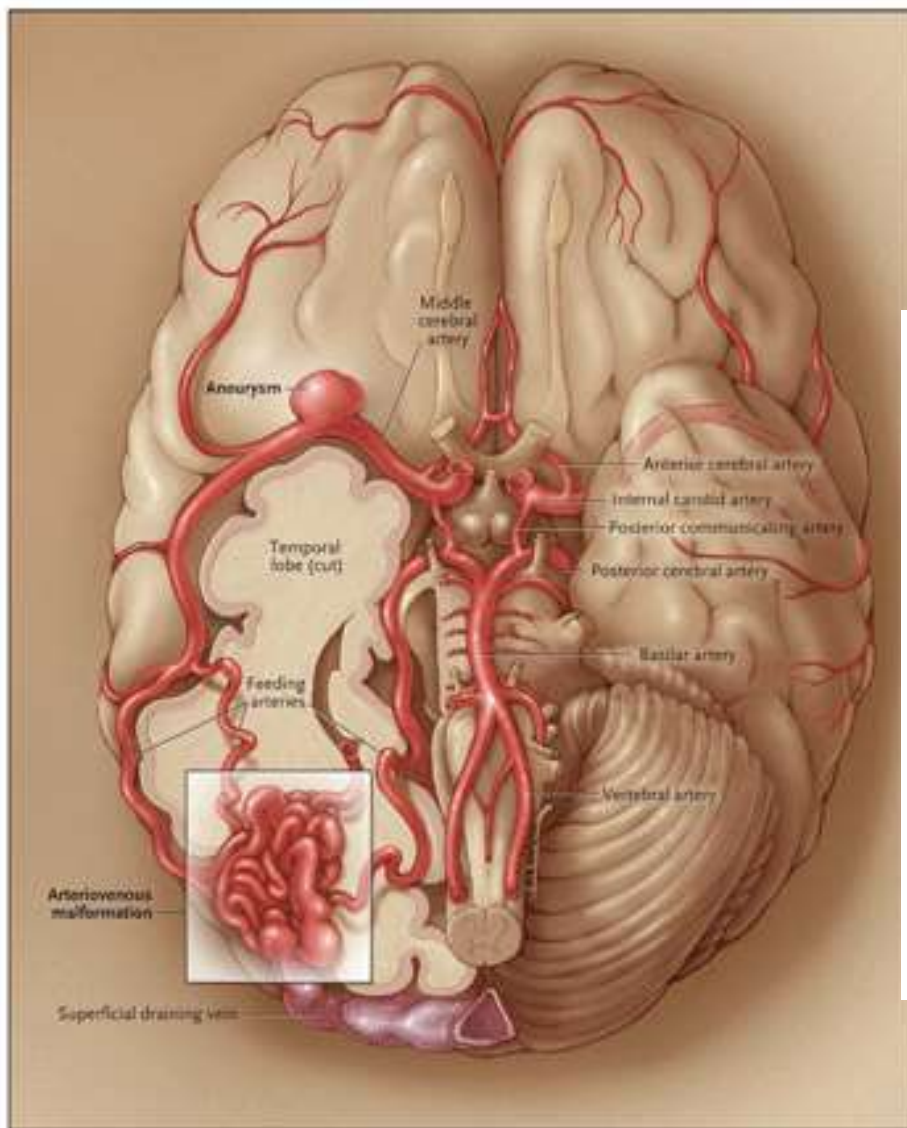


Angiogram of the right internal carotid artery in an oblique projection. **Knife tip in close proximity to the right internal carotid artery** with little flow seen intracranially (blue arrow). **Spasm** noted at the catheter tip in the internal carotid artery (yellow arrow).



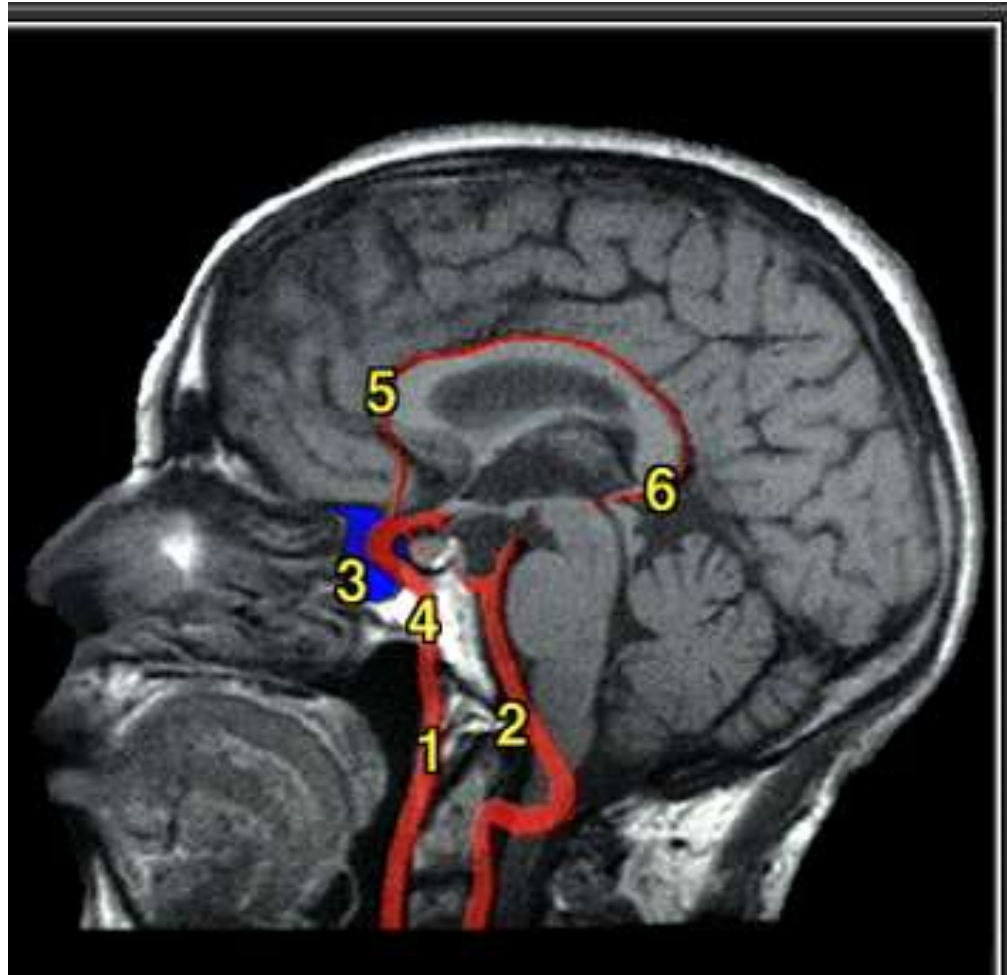
Angiogram of the right internal carotid artery in an AP projection. The knife traverses the midline with the **knife tip in the right carotid canal**.

A-V malformace



peroperačně

NMR – angoigrafie na sagitálném řezu



1 - a.carotis interna

2 - a.vertebralis

3 - sinus cavernosus

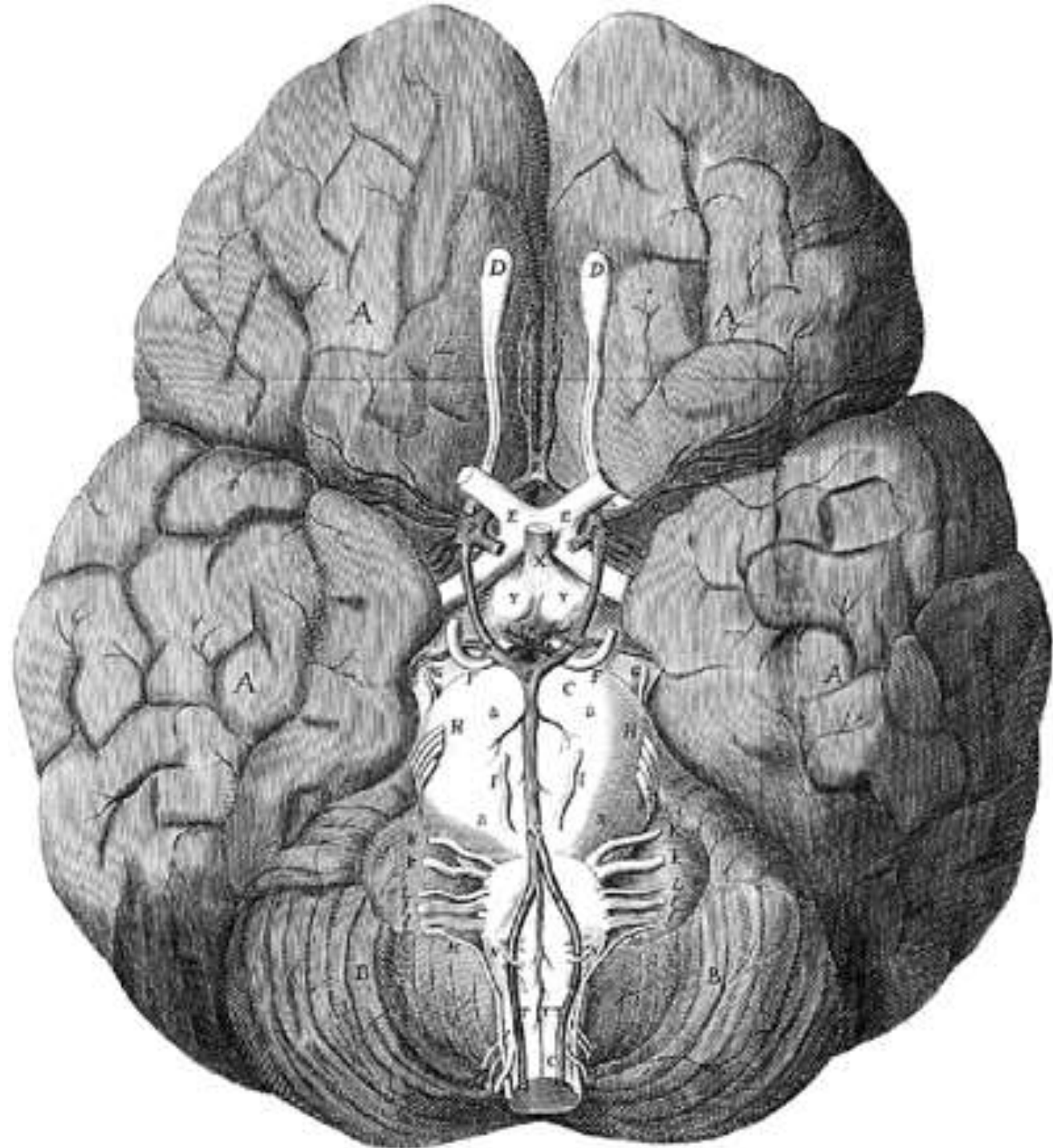
4 - canalis caroticus

5 - a.cerebri anterior

6 - a.cerebri posterior

Thomas Willis
(1621–1675)





The home of Thomas Willis from 1657 to 1667



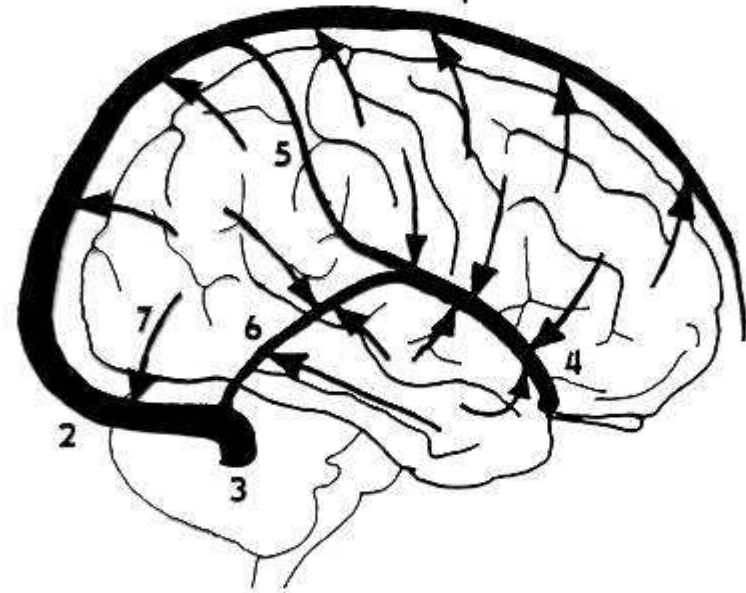
Oxford, Beam Hall

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



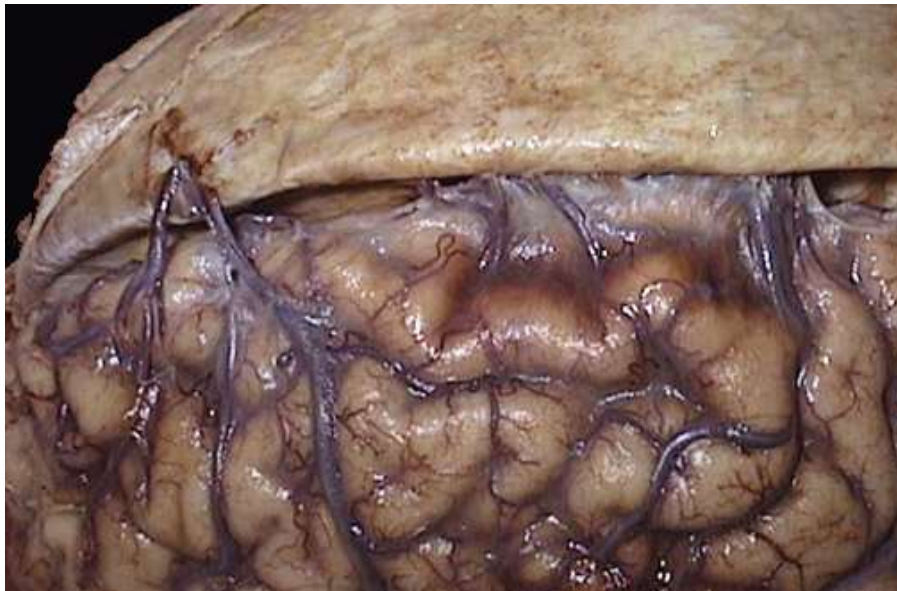
Povrchové mozkové žíly

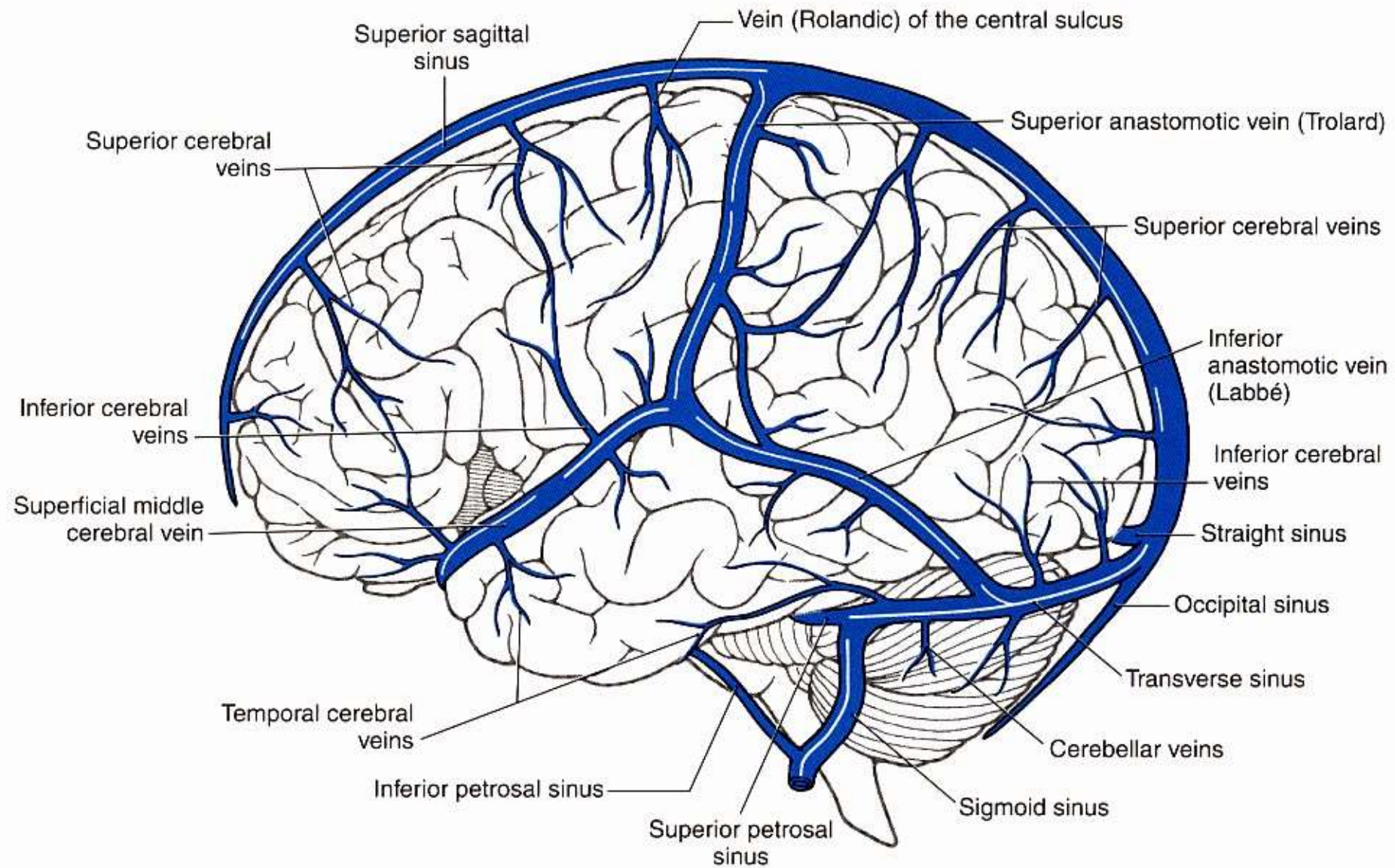


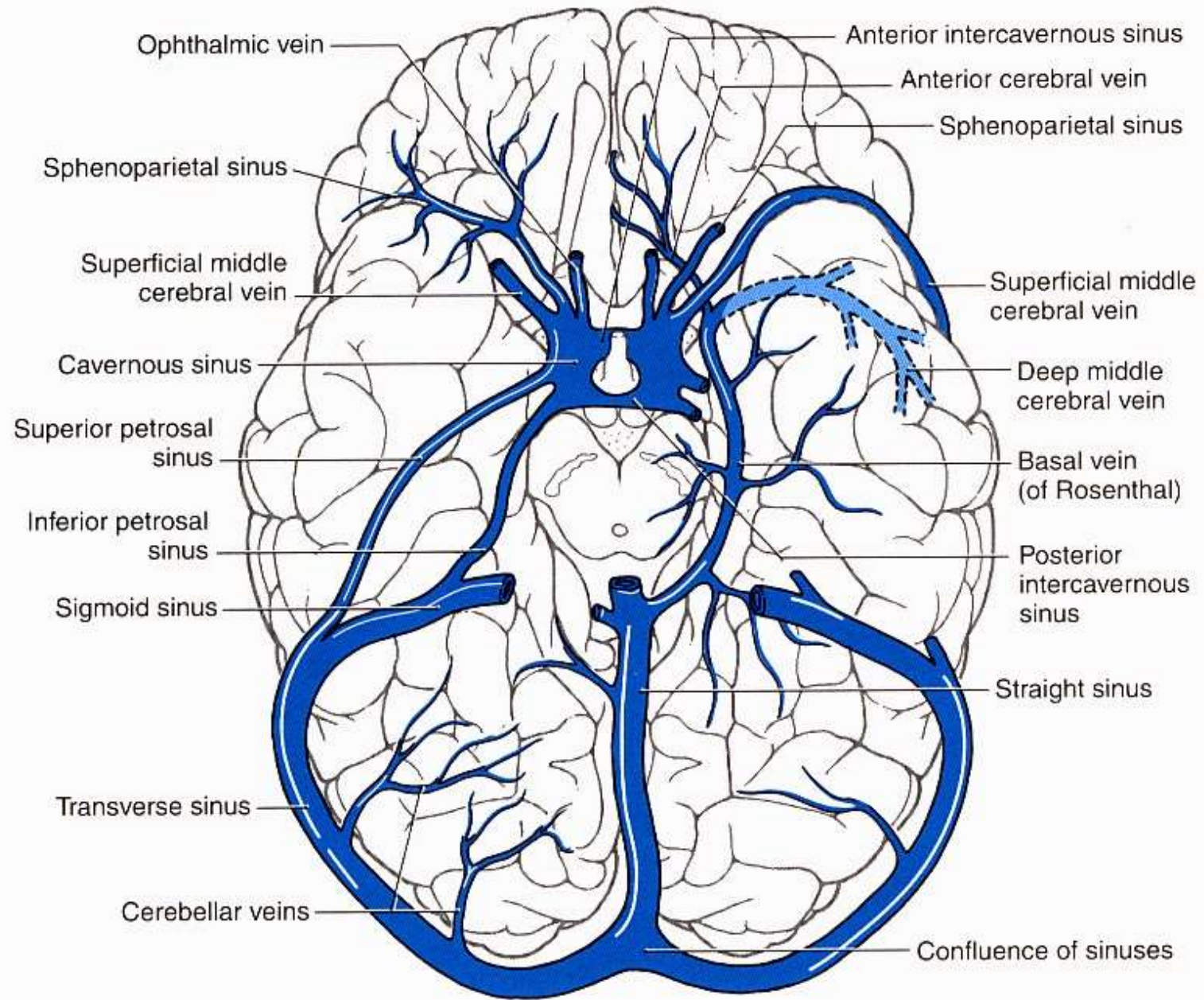
5 Vena anastomotica sup.
(Trolardova)

6 Vena anastomotica post.
(Labbéova) – do sinus
transversus

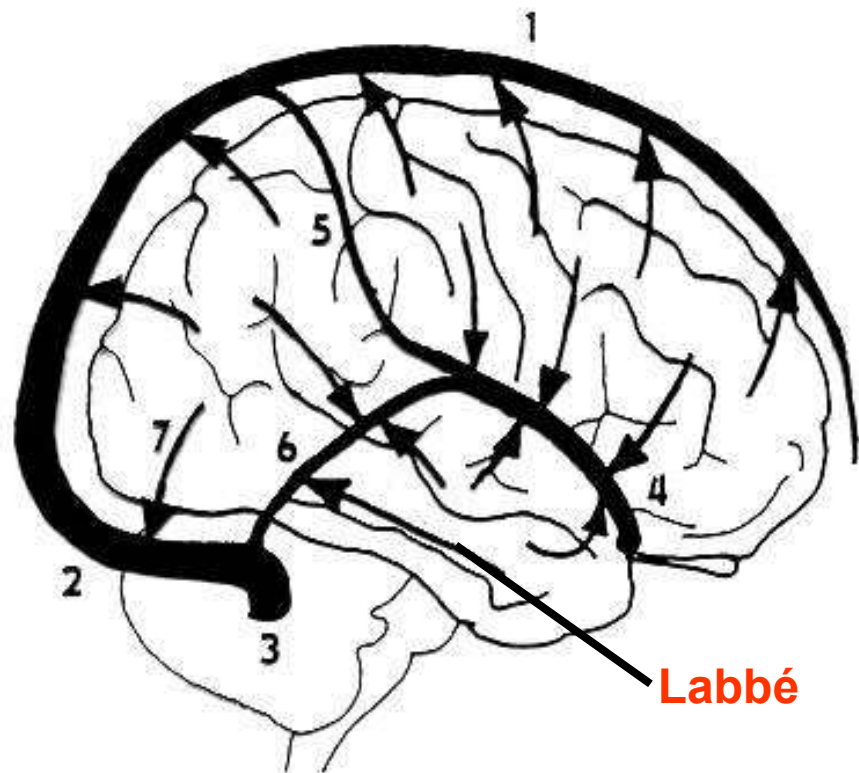
4- v. cerebri media superficialis
– do sinus sphenoparietalis







Povrchové mozkové žíly

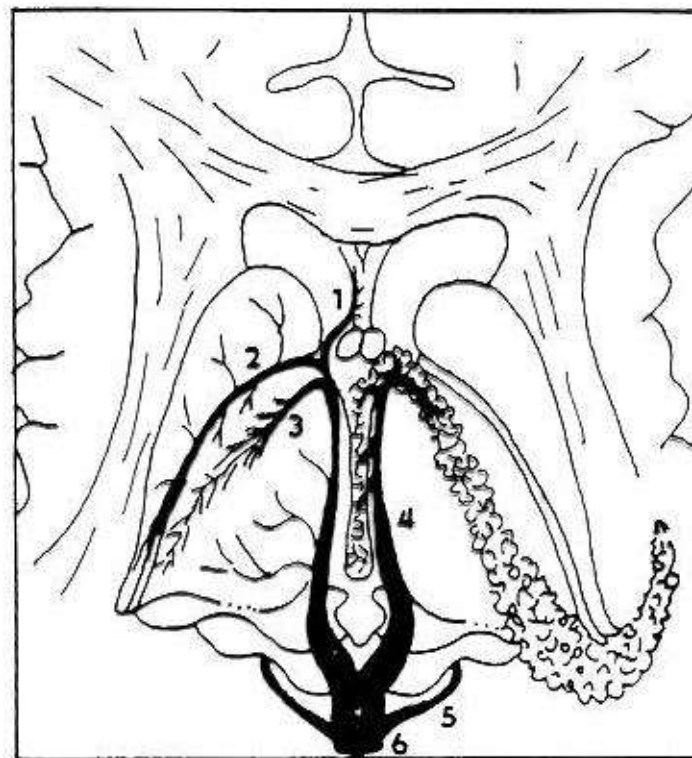


► Labbé

Obr. 65.: Korové žíly na laterální straně hemisféry.

1 - sinus sagittalis superior s vtékajícími vv. cerebri superiores (šipky), 2 - sinus transversus, 3 - sinus sigmoideus 4 - v. cerebri media superficialis, 5 - v. anastomotica superior (Trolardova), 6 - v. anastomotica posterior (Labbéova) 7 - vv. cerebri inferiores.

Hluboké mozkové žíly



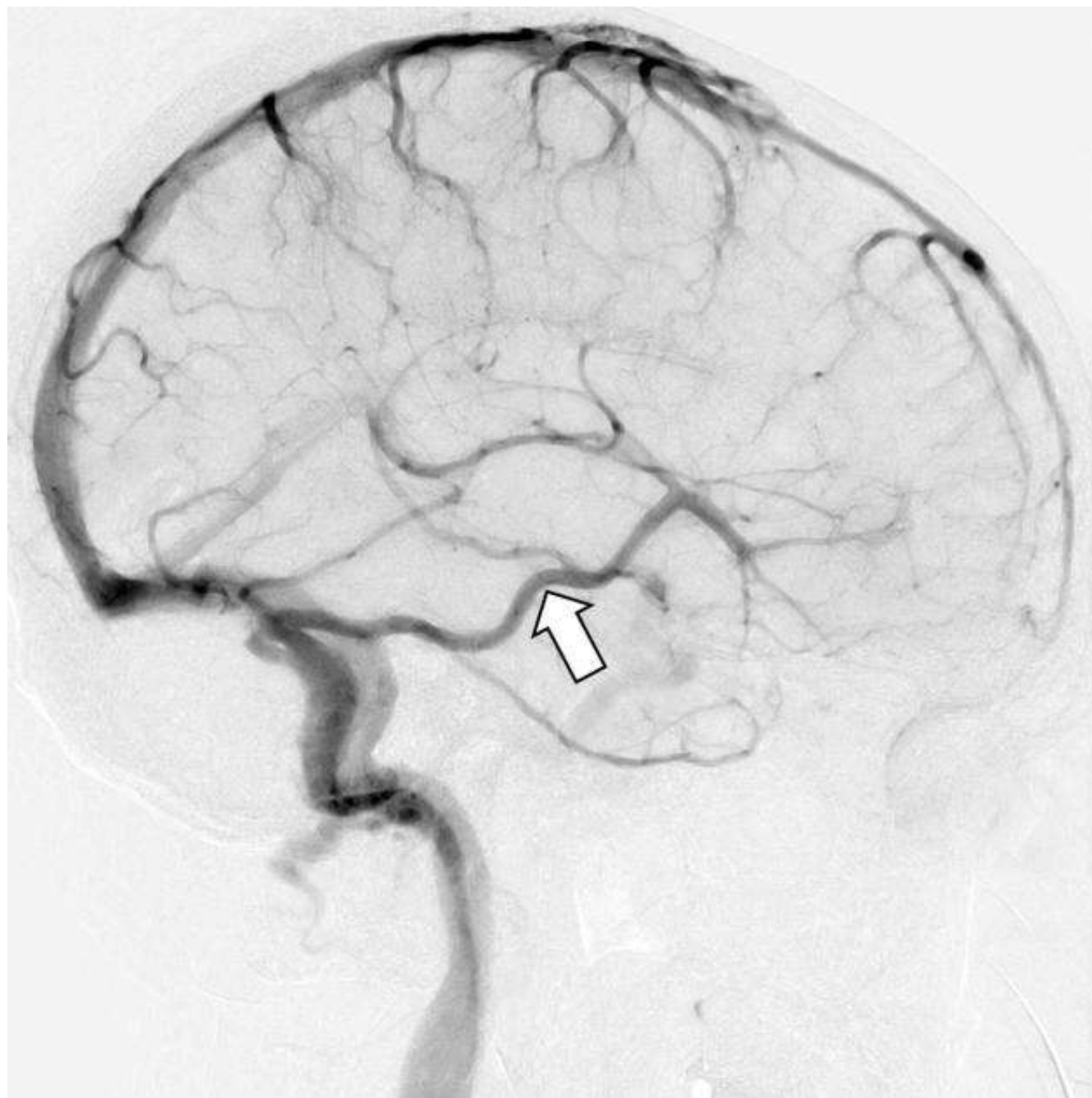
Obr. 66.: Hluboké mozkové žíly.

Jsou zakresleny do obrázku shodného s obr. 23, kde jsou také popsány jednotlivé struktury.

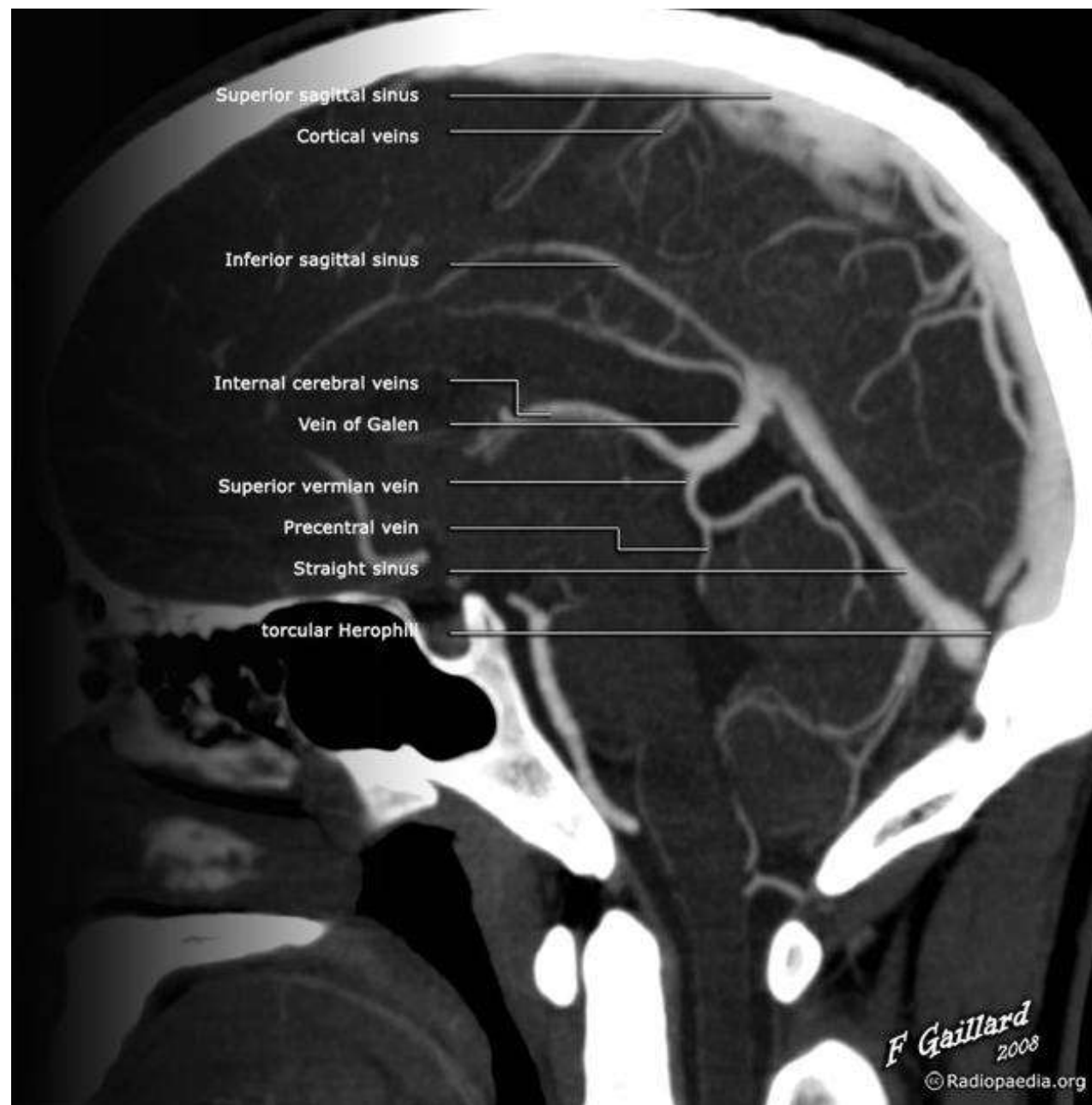
1 - v. septi pellucidi, 2 - v. thalamostriata, 3 - v. choroidea superior, 4 - v. cerebri interna, 5 - v. basalis (Rosenthal) 6 - v. magna cerebri (Galen).

Venogram – povrchové žíly

Labého žíla



Hluboké žíly - venogram



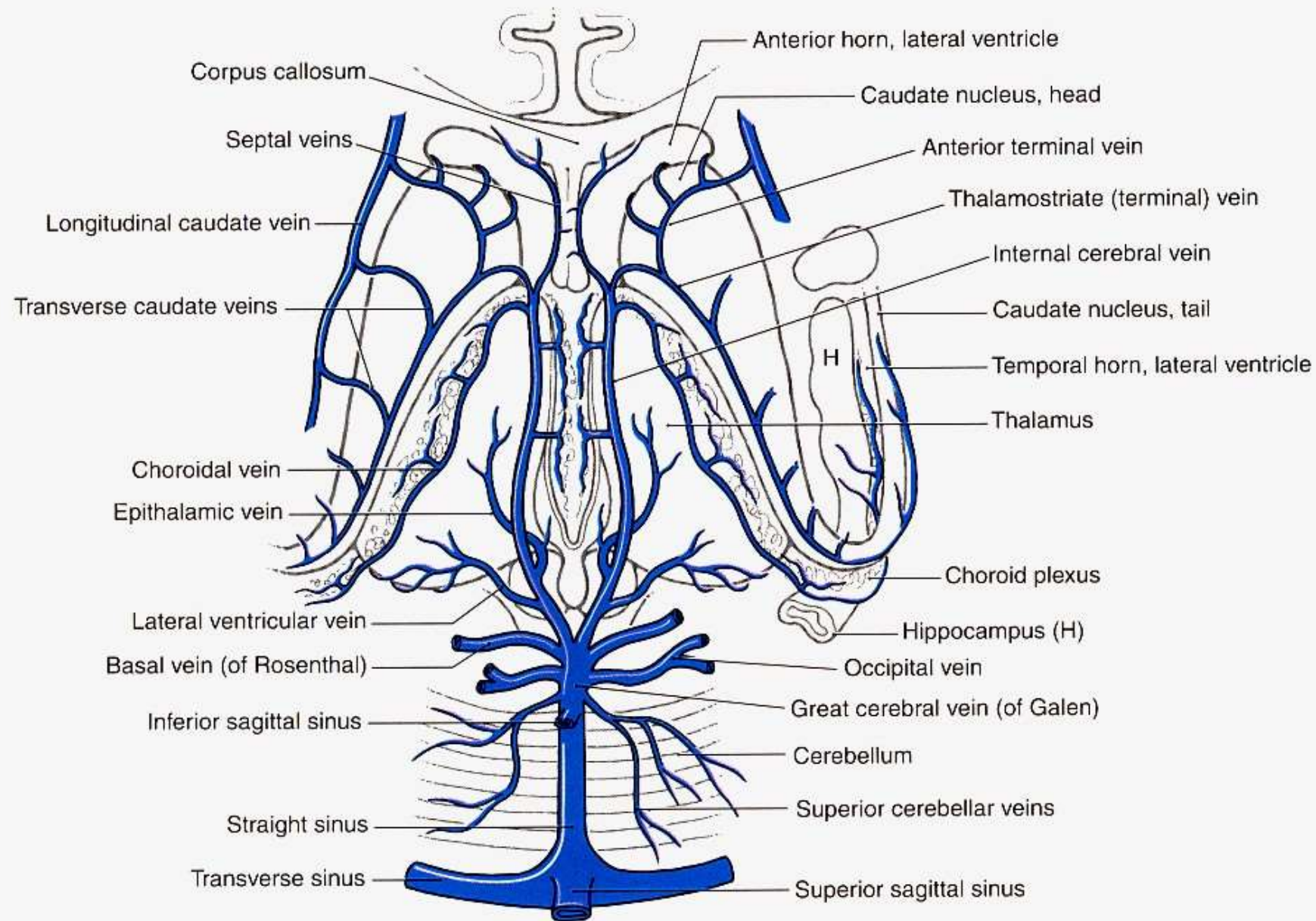
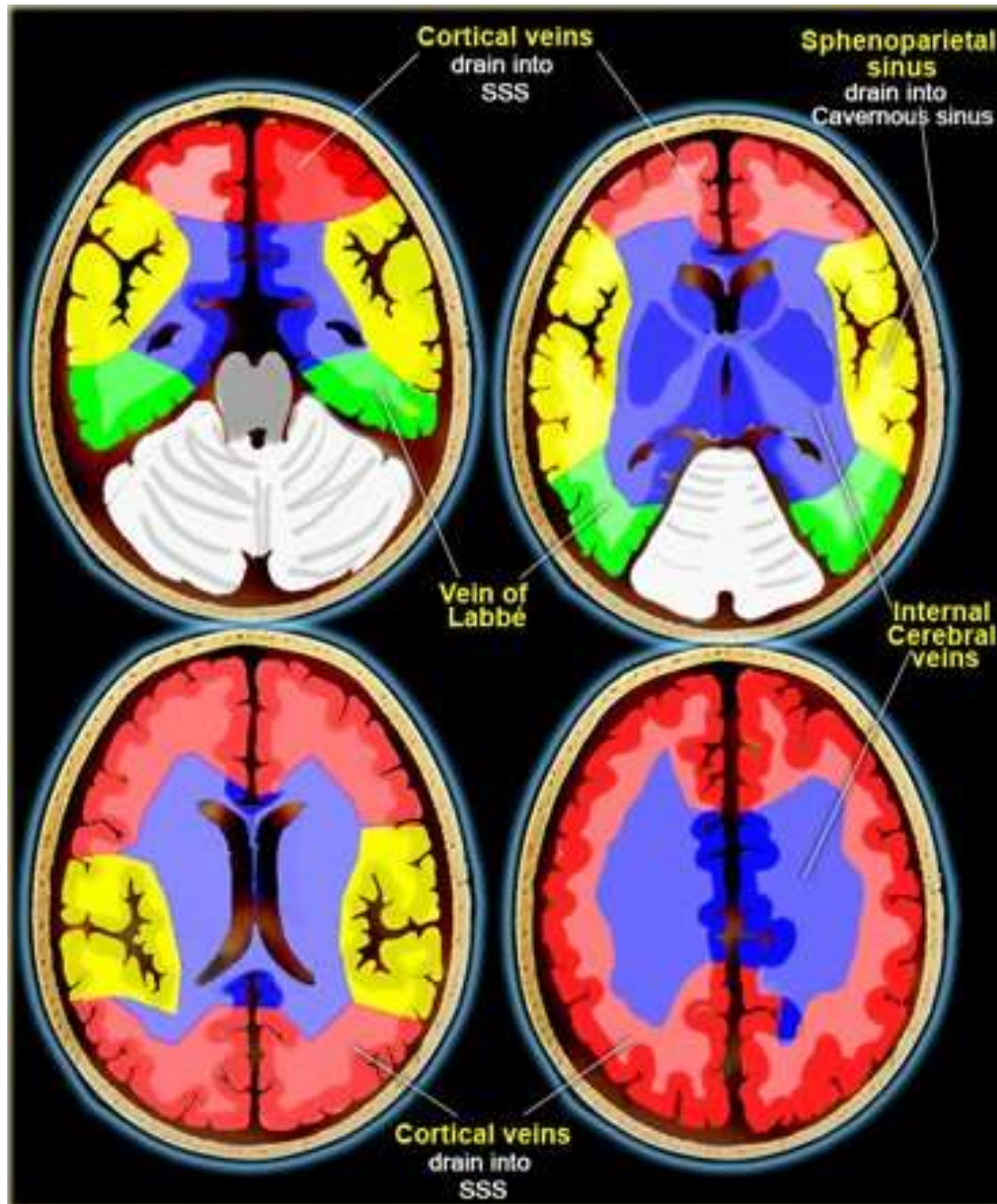


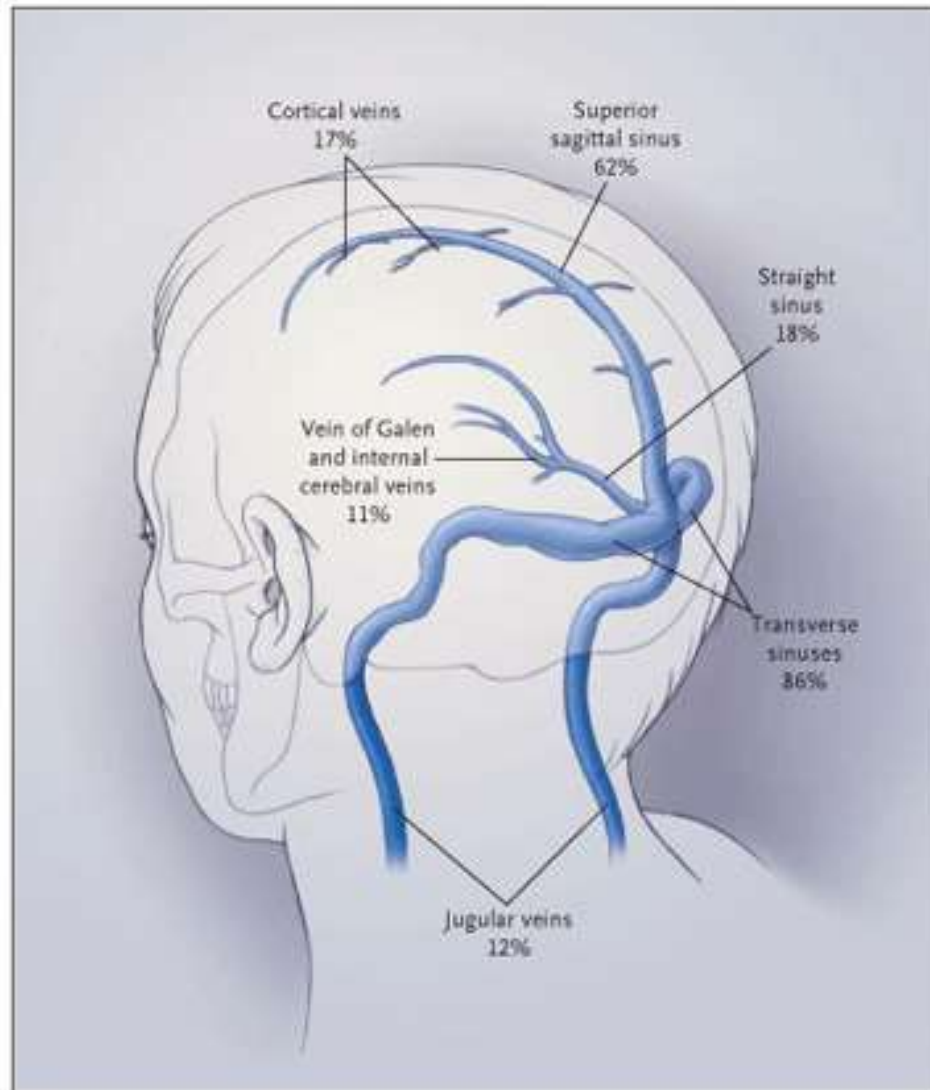
figure 8-17. Veins draining internal areas of the hemisphere and the tributaries of the great cerebral vein and straight sinus, hippocampus.



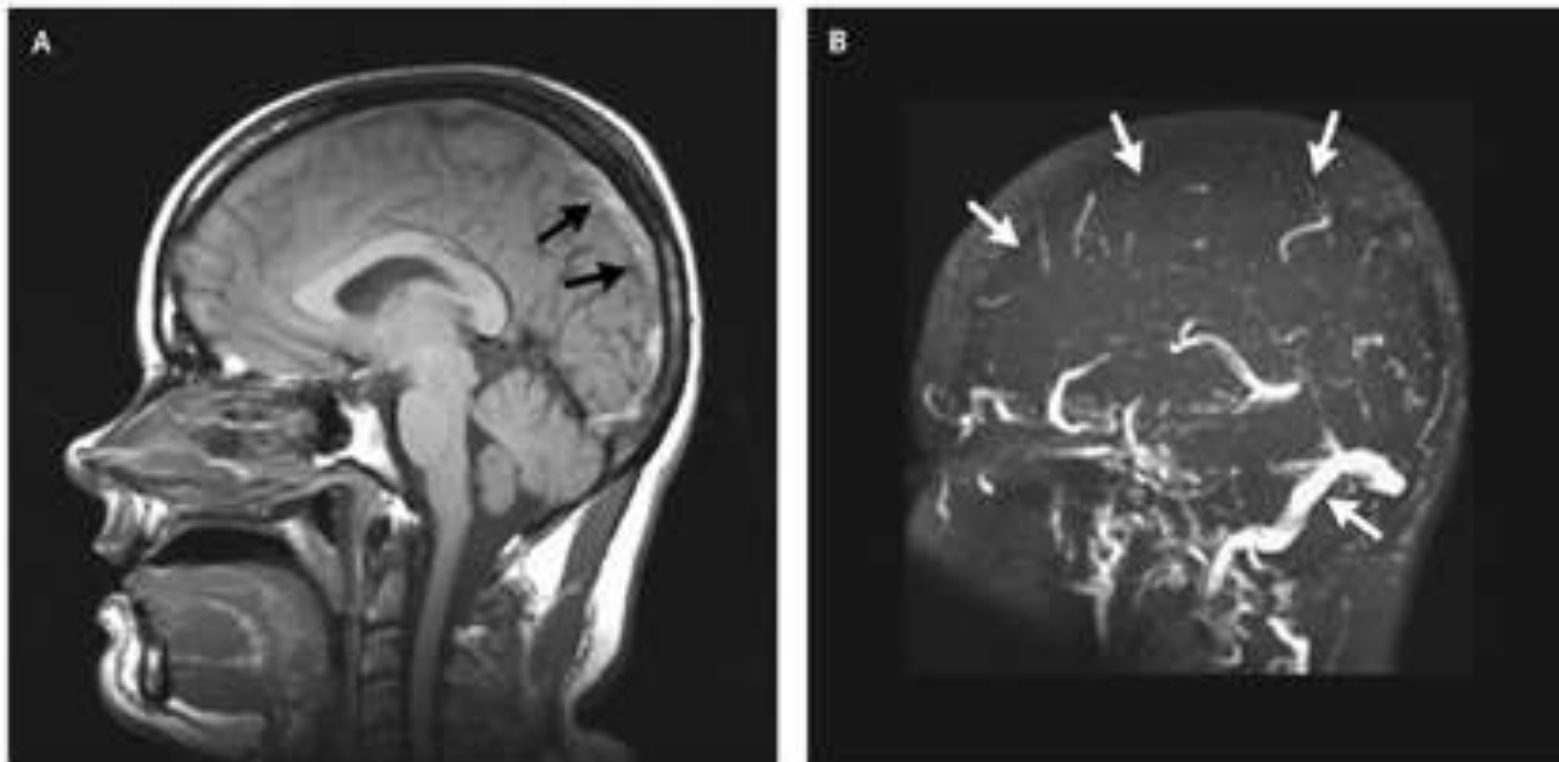
Cerebral Venous territories „rough guide“

- superior sagittal sinus
- internal cerebral veins
- sphenoparietal sinus
- vein of Labbé

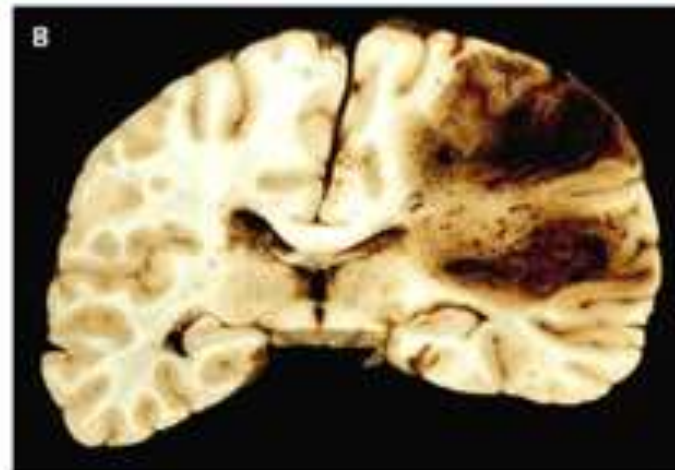
Žíly mozku - odtok přes žilní splavy do v. jugularis interna



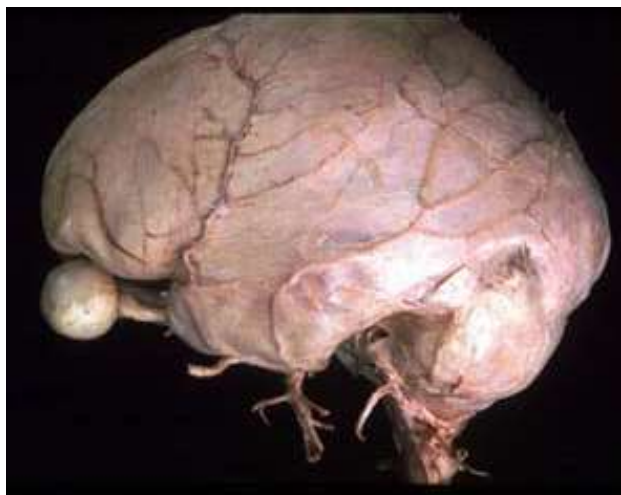
Trombosa sinus sagittalis superior



Trombosis vv. cerebri
superiores



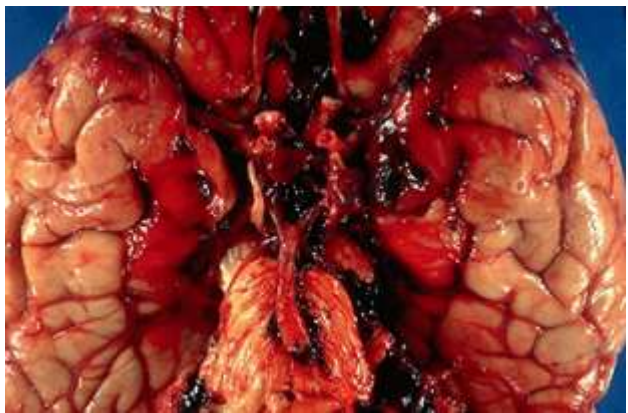
1. Epidurální hematom



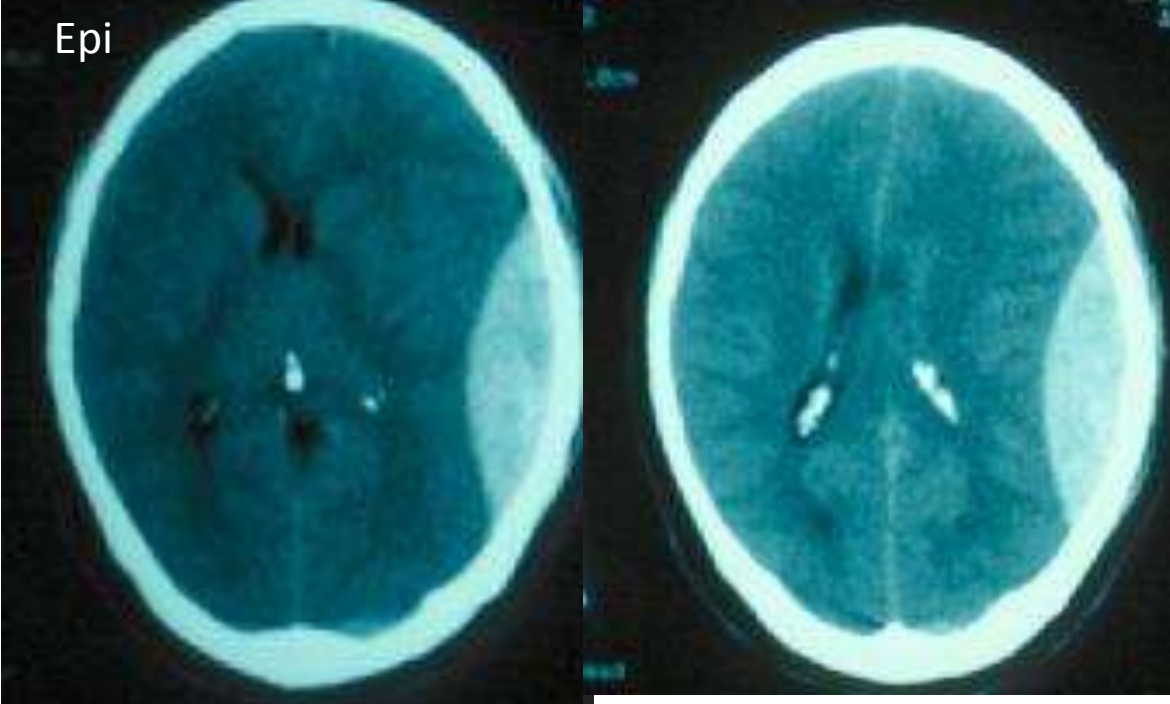
2. Subdurální hematom



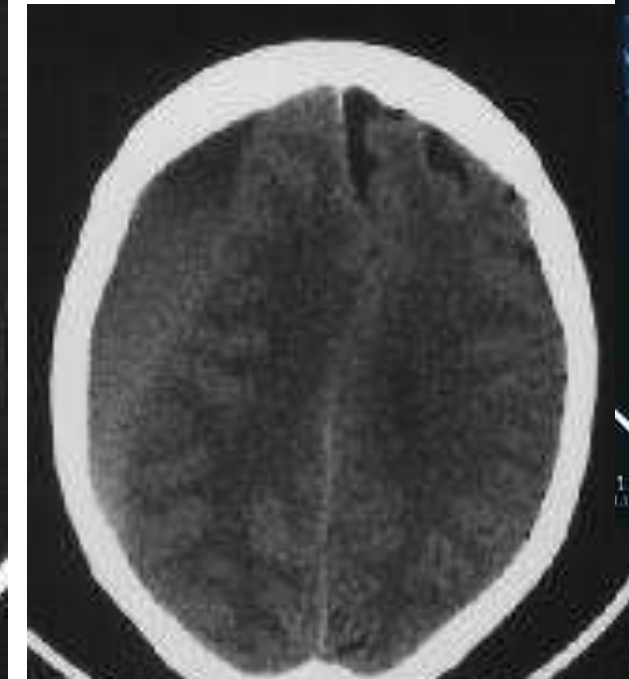
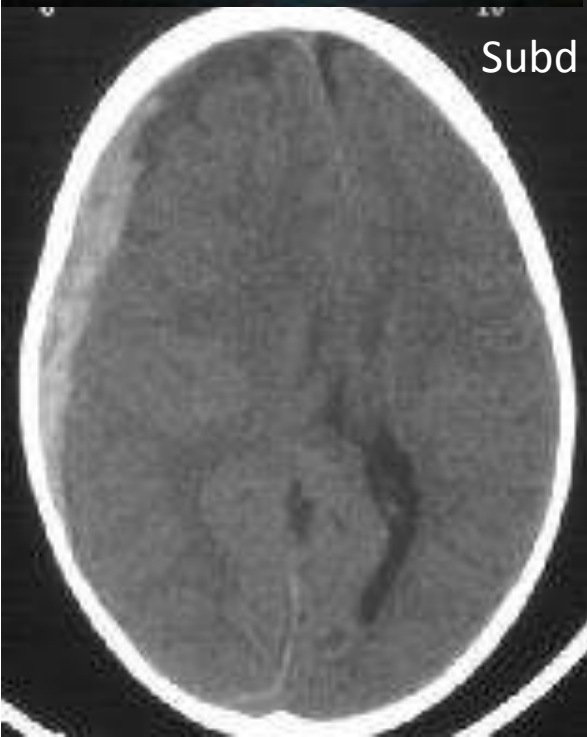
3. Subarachnoidální hematom



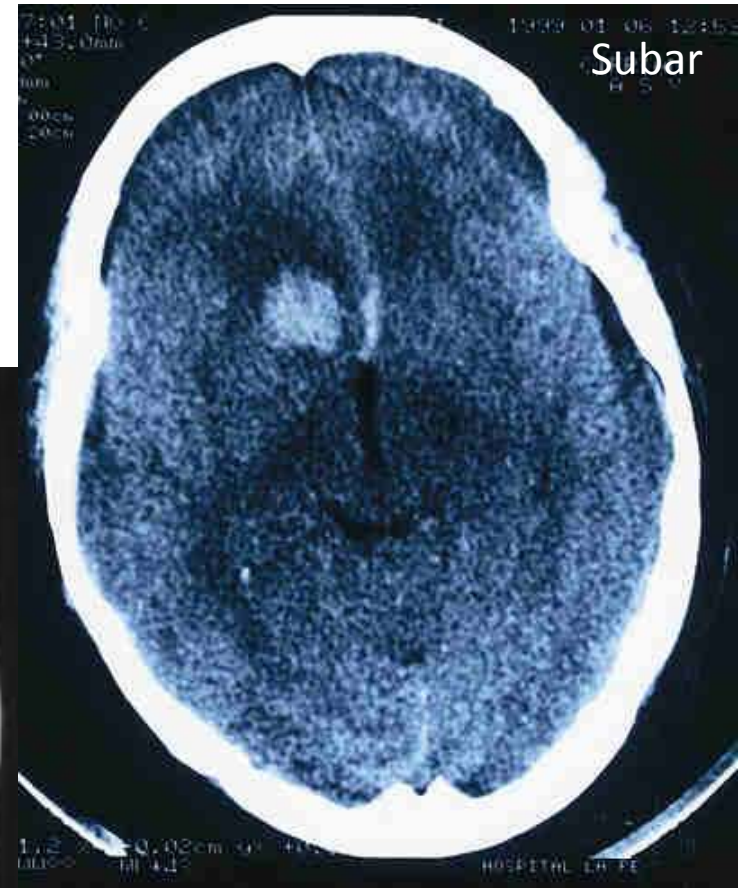
Epi



Subd

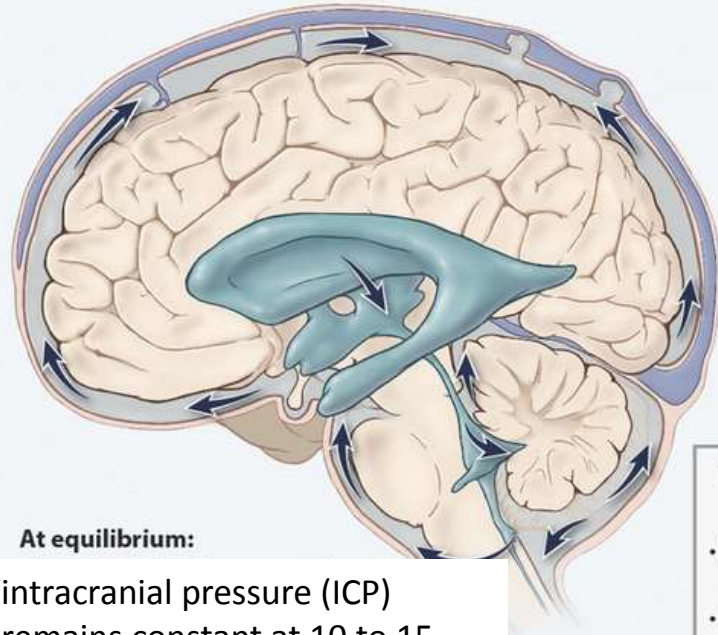


Subar



Intracranial Pressure under Normal and Abnormal Conditions.

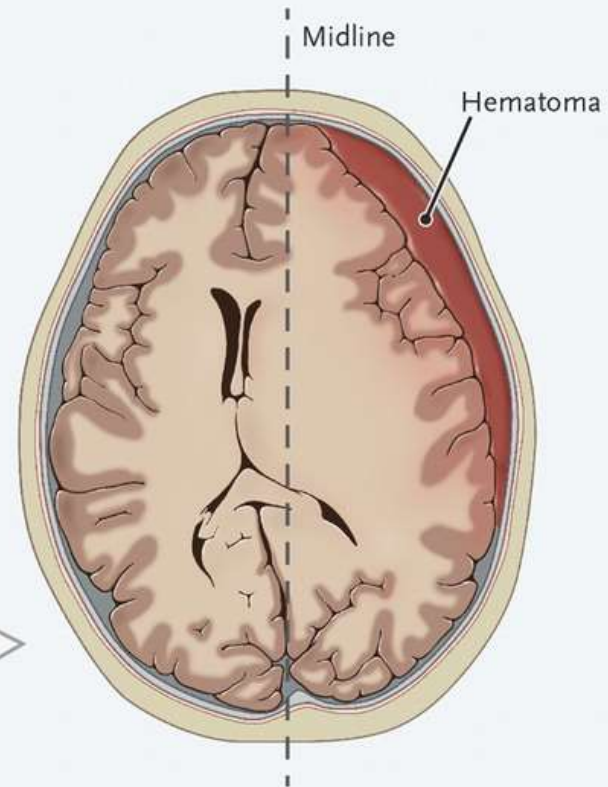
A Intracranial pressure under normal conditions, sagittal section



At equilibrium:

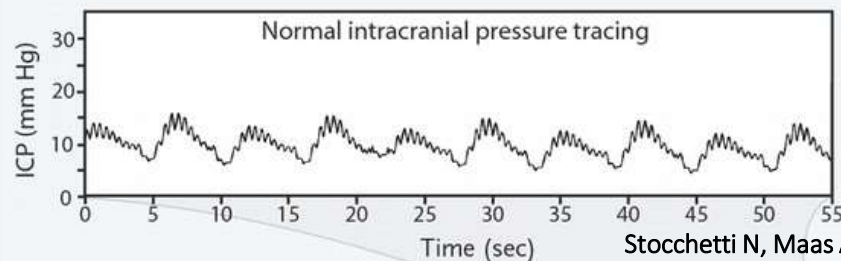
intracranial pressure (ICP) remains constant at 10 to 15 mm Hg, fluctuating with cardiac and respiratory cycles

B Acute subdural hematoma, axial section



Intracranial causes of increased intracranial pressure

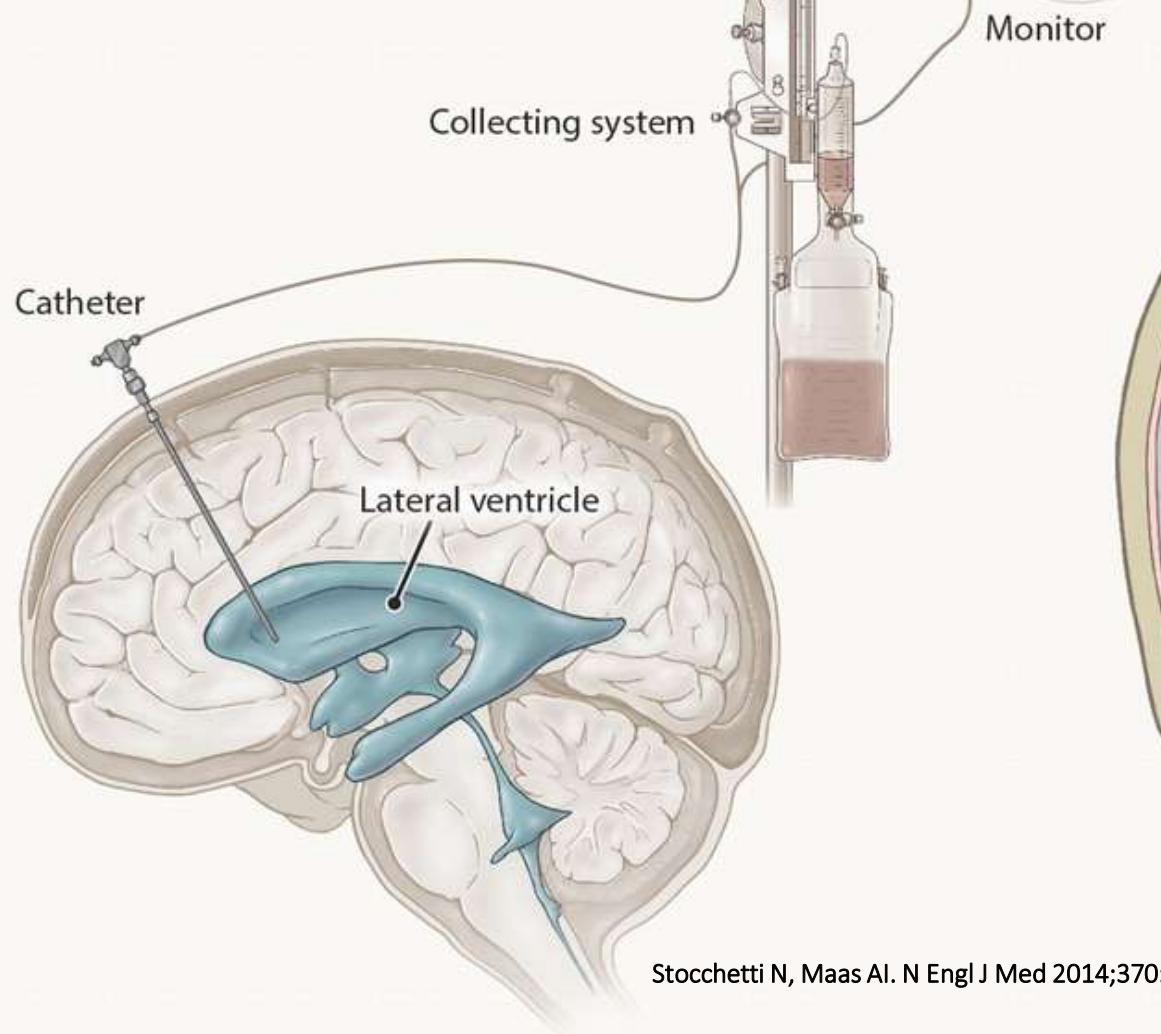
- Mass lesions (e.g., traumatic hematomas, tumors)
- Edema
- Vasodilatation
- Disturbed central spinal fluid circulation



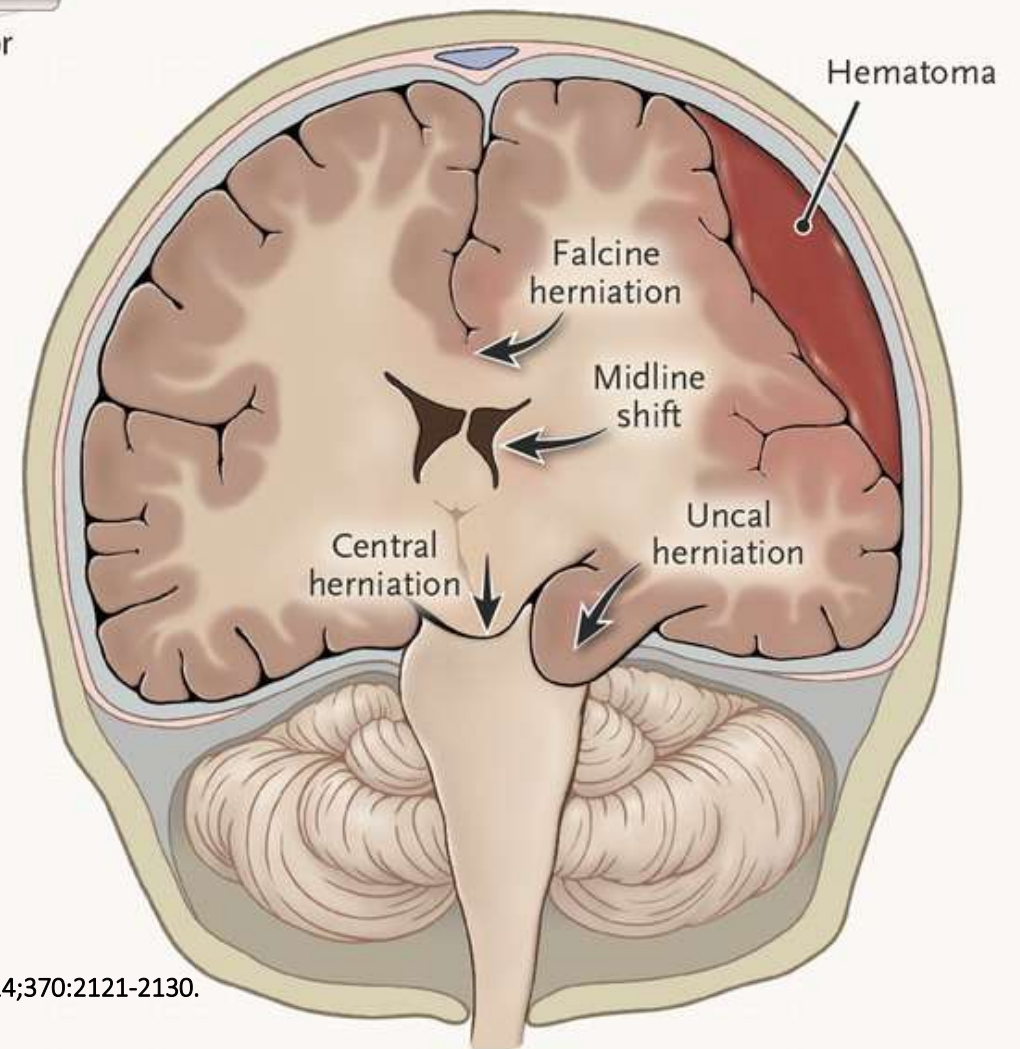
Stocchetti N, Maas AI. N Engl J Med 2014;370:2121-2130.

**Intracranial Pressure
under Normal and
Abnormal Conditions.**

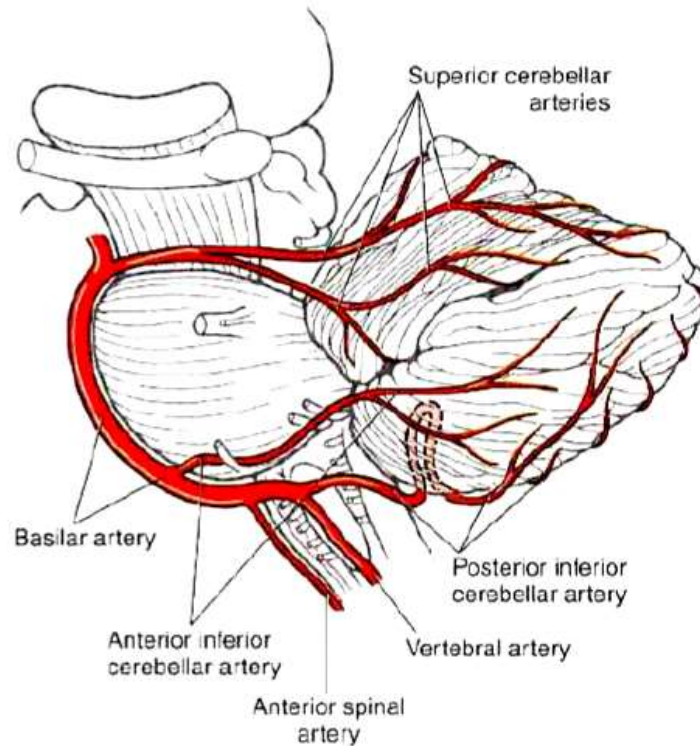
C Intracranial pressure monitoring
by ventricular catheter



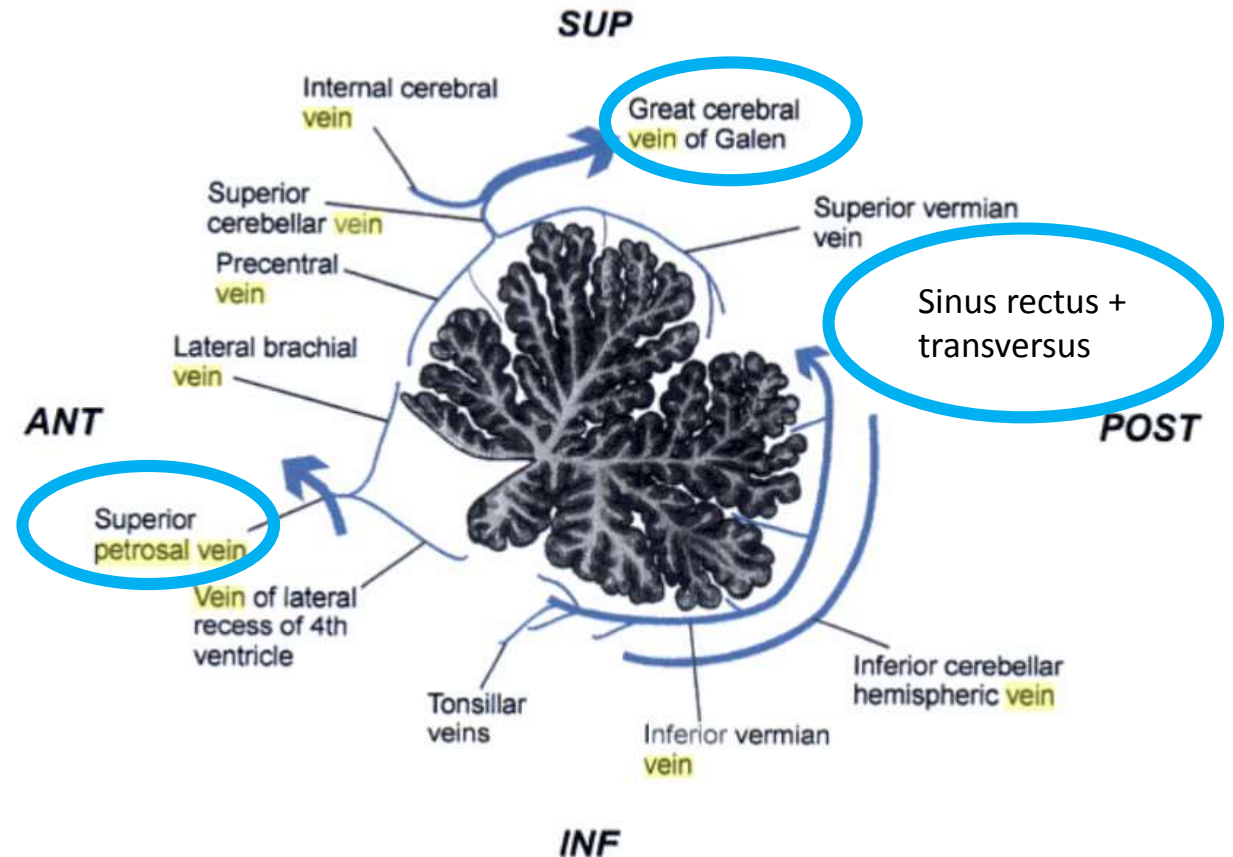
D Herniation, coronal section



Cévní zásobení mozečku



- A. A. cerebellaris superior
- B. A. cerebellaris inferior anterior
- C. A. cerebellaris inferior posterior

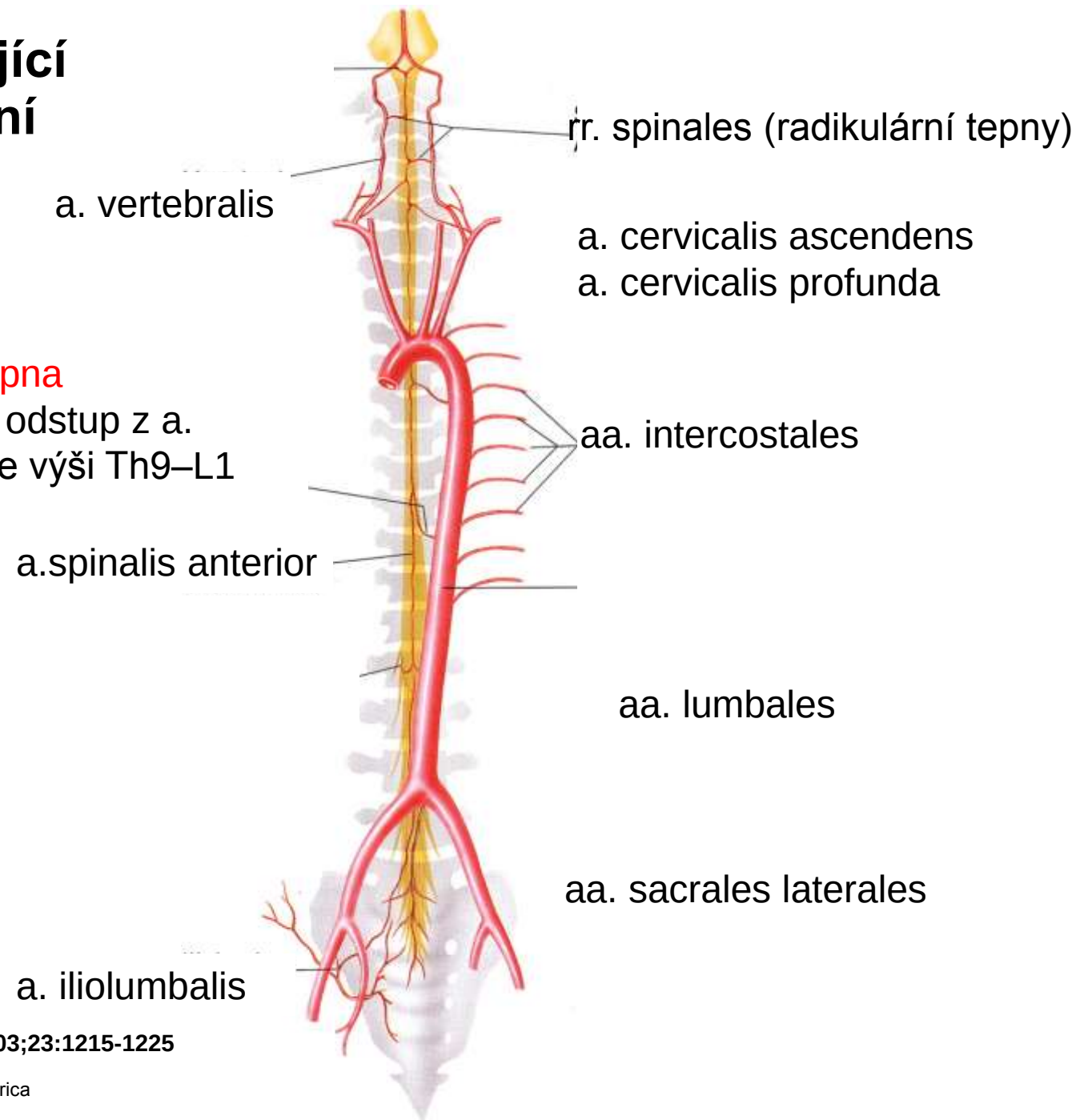


- A. Vv. cerebelli superiores - v. magna cerebri
- B. Přední skupina - V. petrosa – sinus petrosus sup + inf
- C. Zadní skupina – sinus rectus + transversus

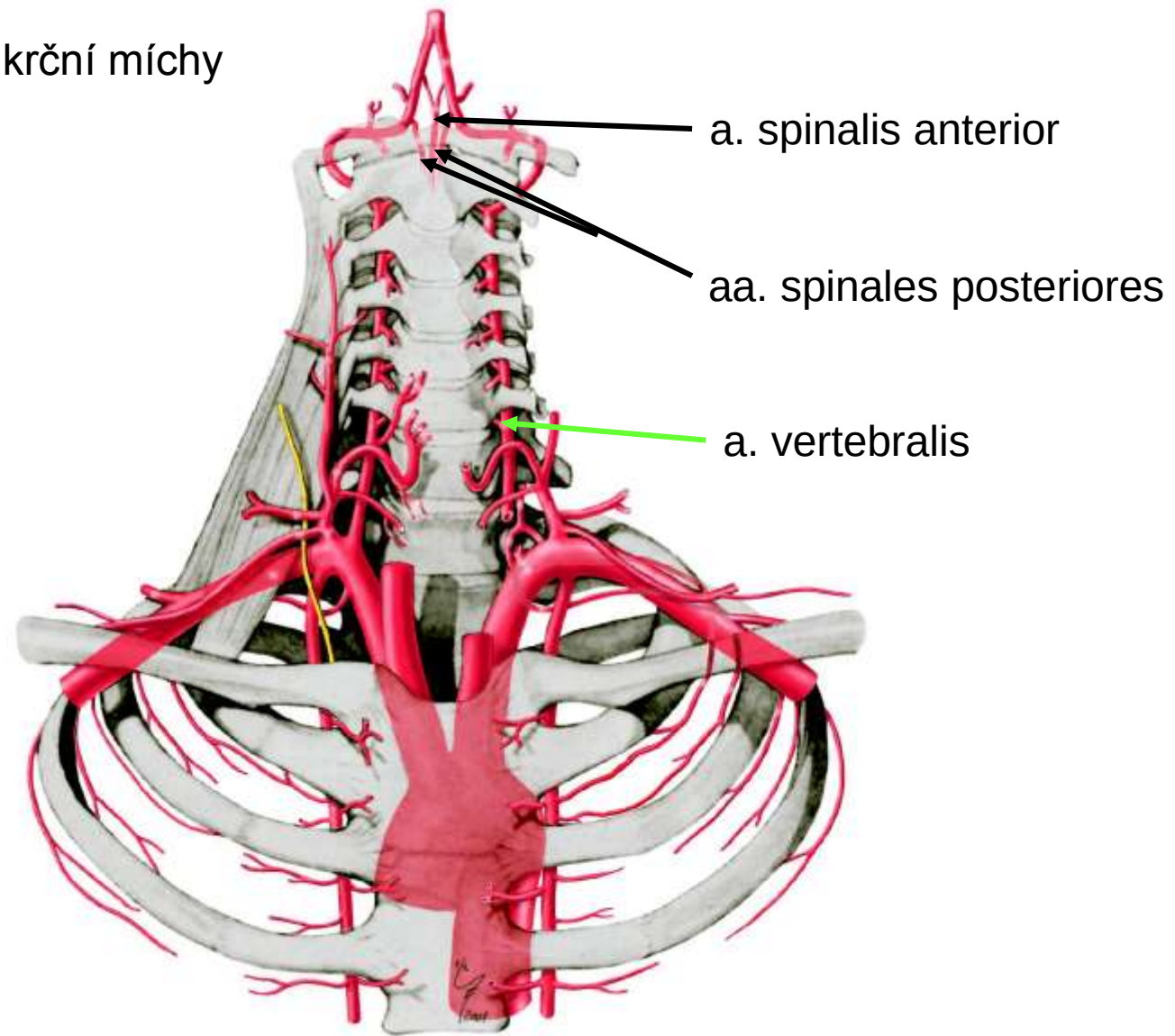
Tepny zásobující míchu a páteřní kanál

Adamkiewiczova tepna

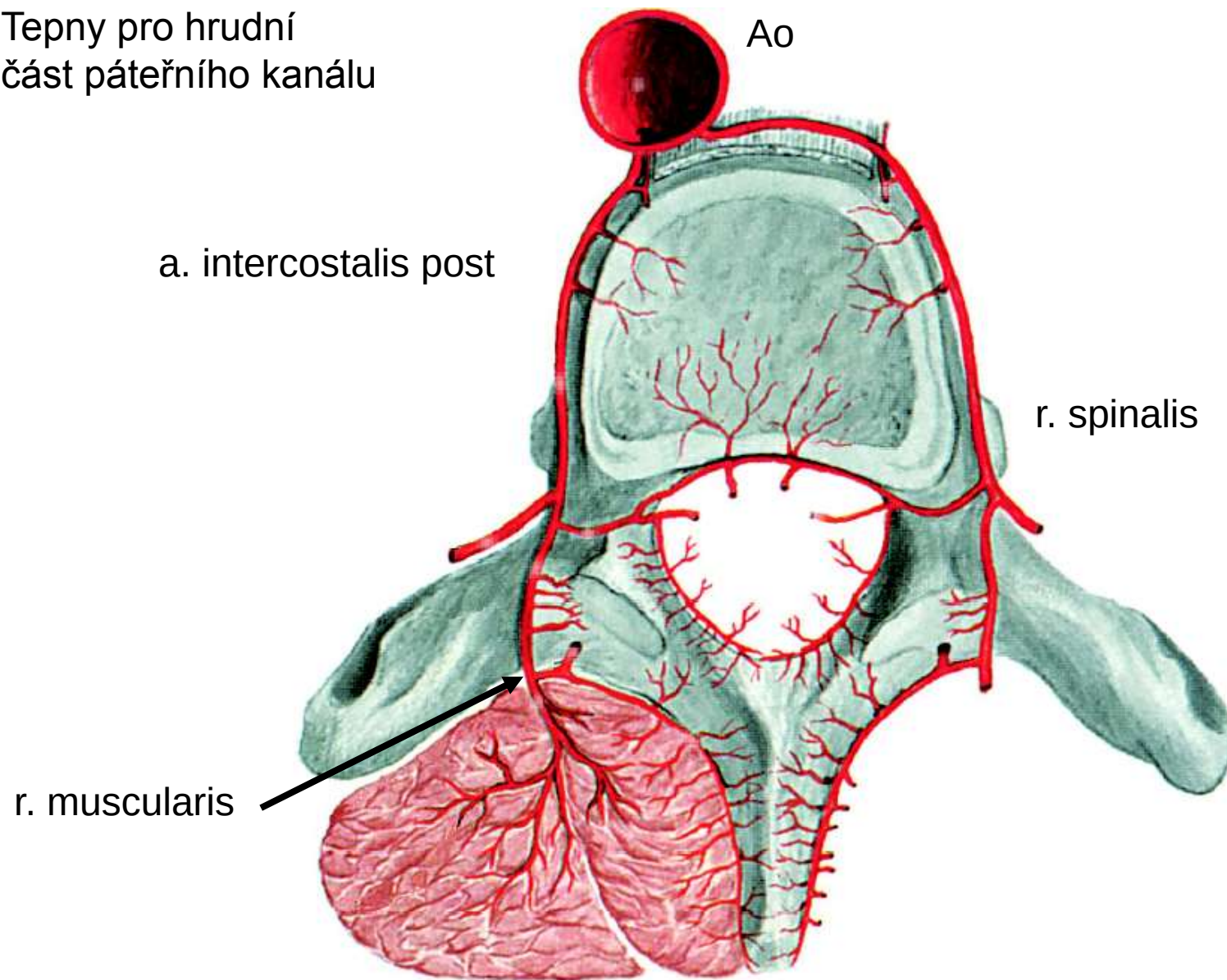
(a.spinalis magna) odstup z a.
intercostalis post. ve výši Th9–L1
(Th7-L2)



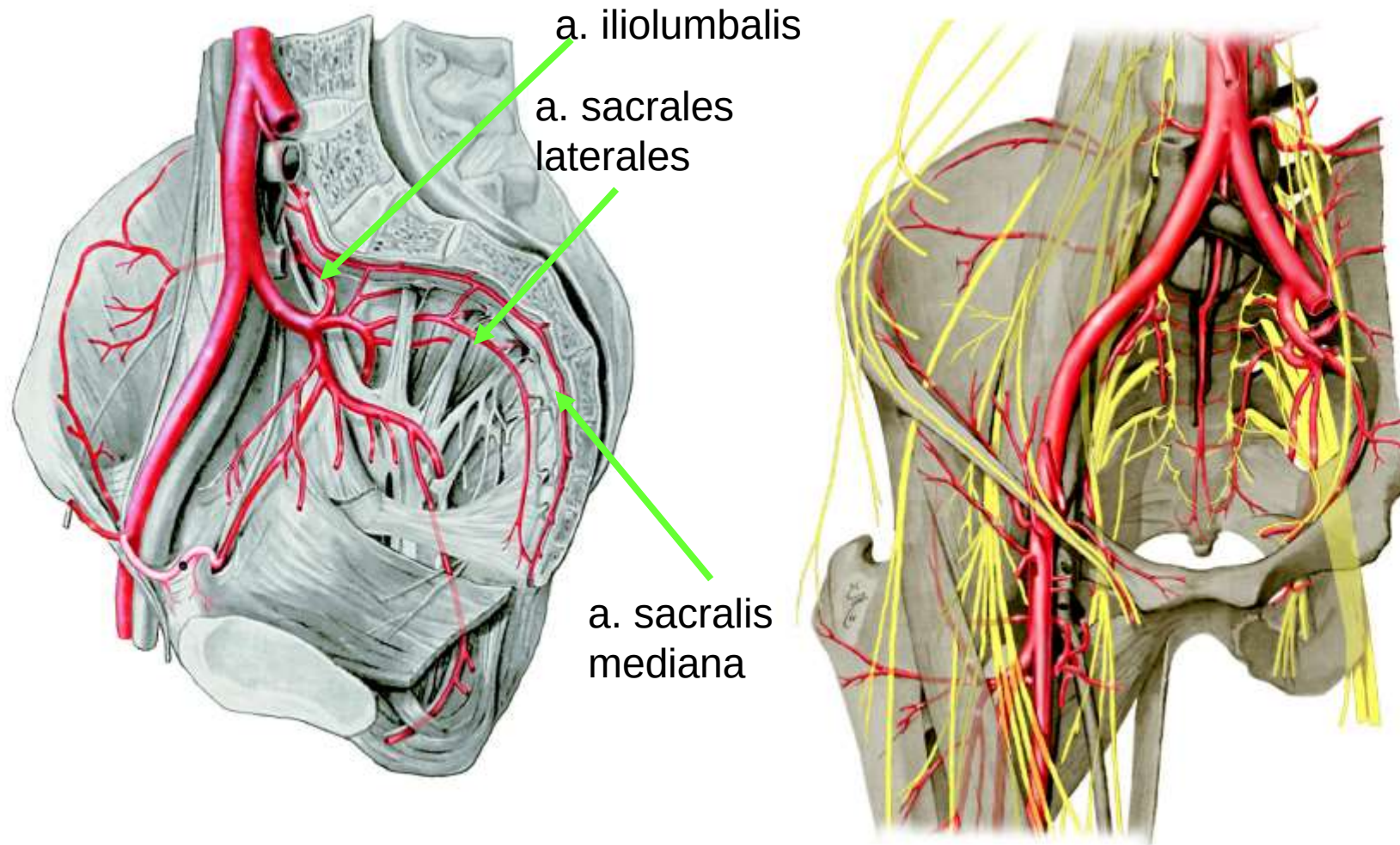
Zásobení krční míchy



Tepny pro hrudní
část páteřního kanálu



Cévy zásobující dolní část páteřního kanálu



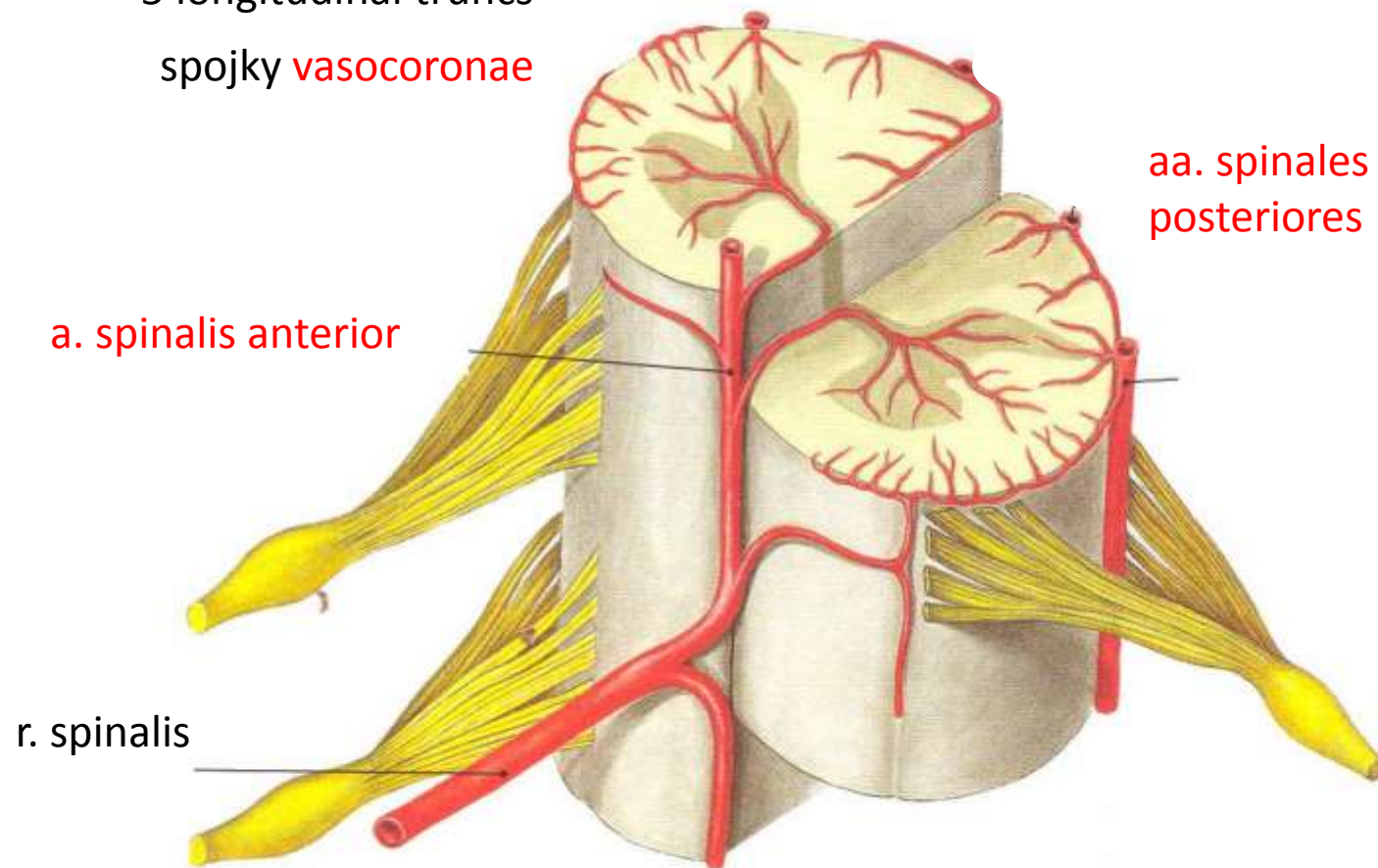
Tepny míchy

Spinal cord -arteries

5 podélně probíhajících kmenů

5 longitudinal trunks

spojky **vasocoroneae**



Tepny míchy

5 podélně probíhajících kmenů

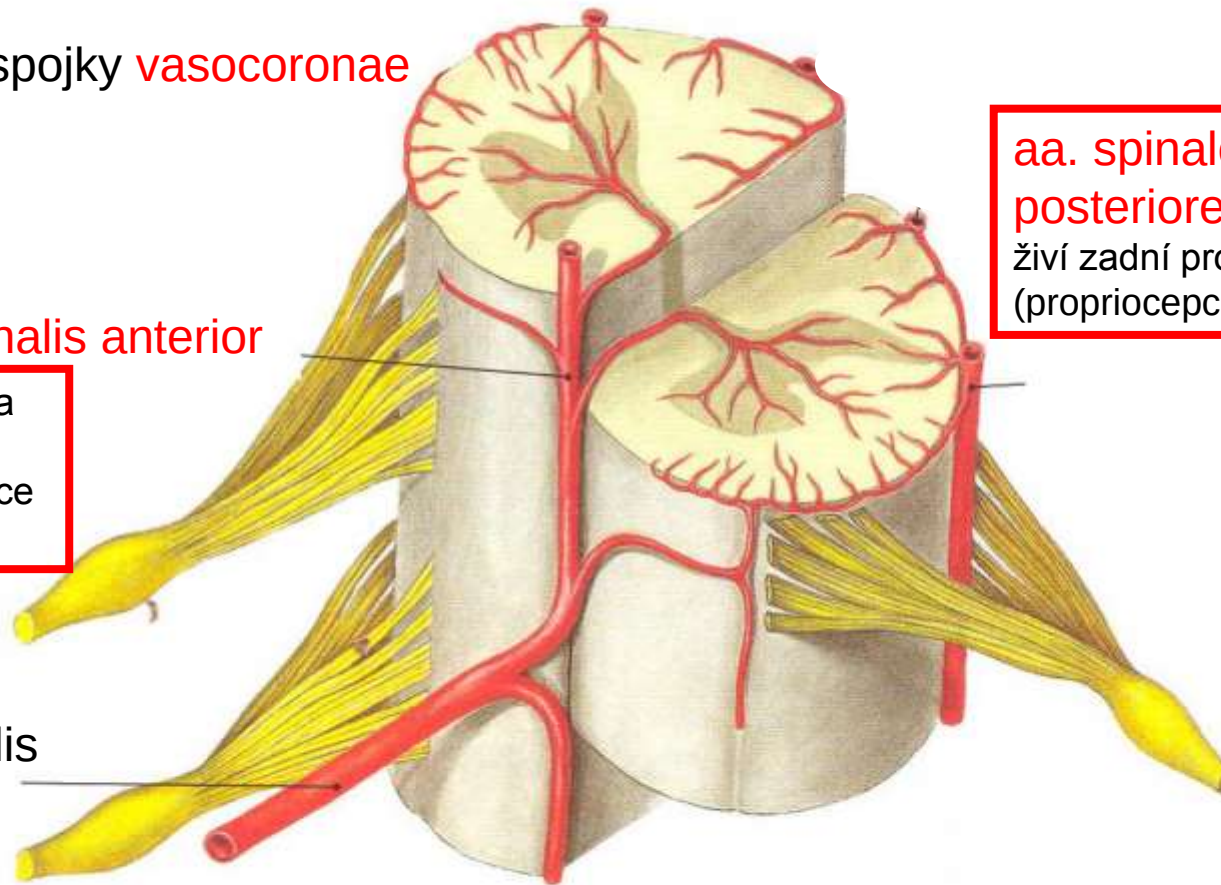
spojky **vasocoroneae**

a. spinalis anterior

živí přední rohy a
provazce a
laterální provazce
(hybnost)

r. spinalis

**aa. spinales
posteriores**
živí zadní provazce
(propriocepce)



Páteřní kanál **žíly**

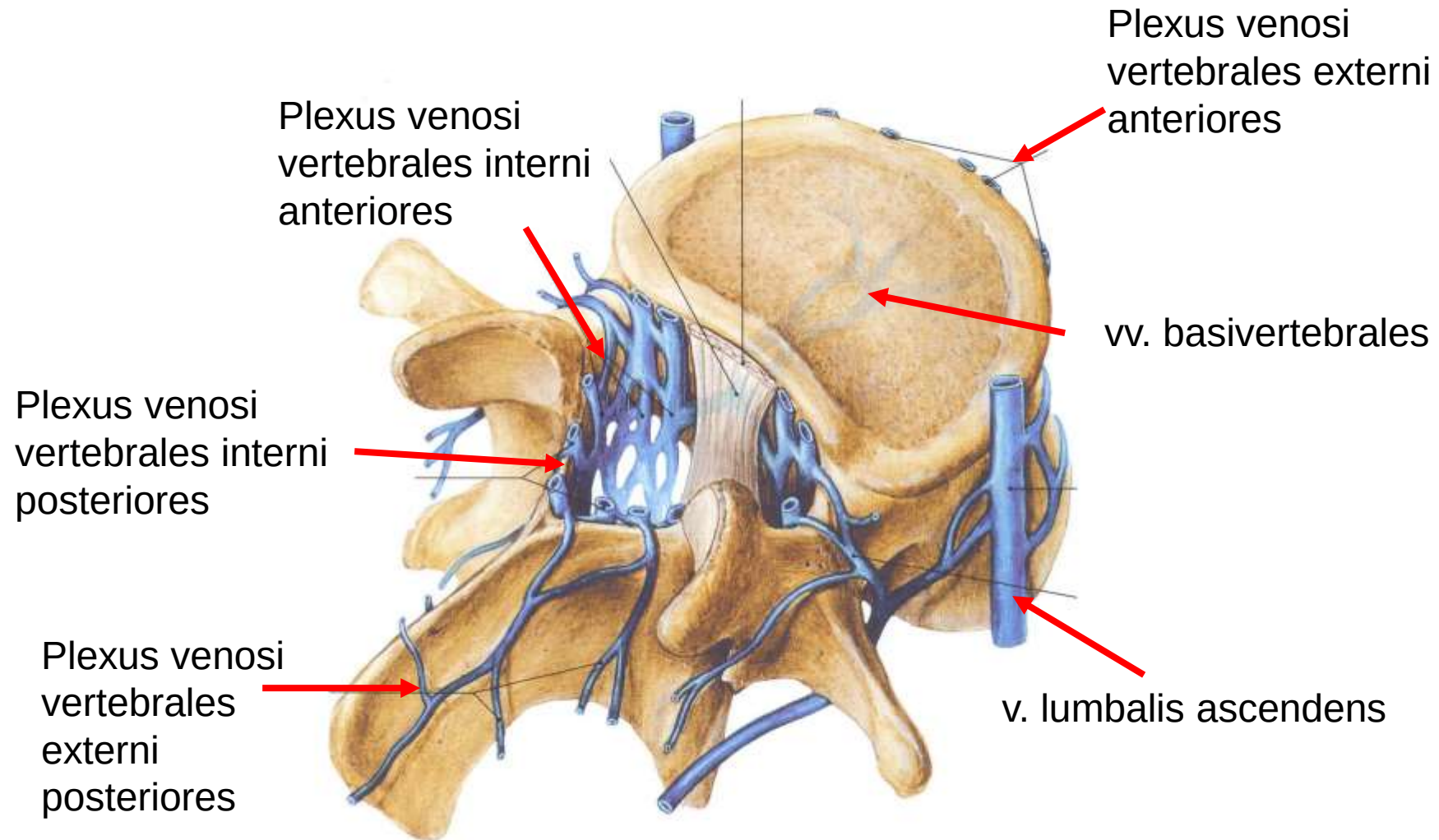
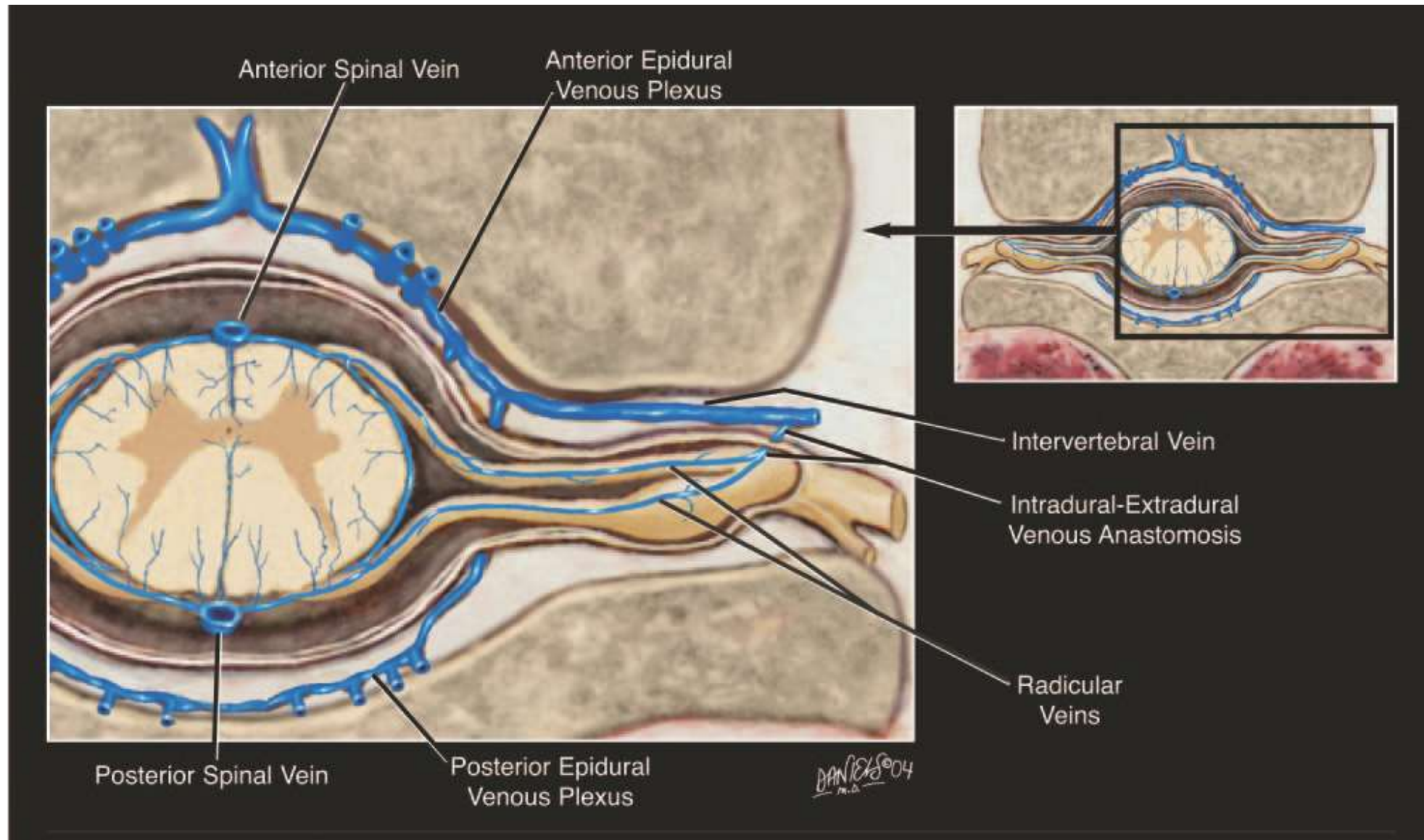
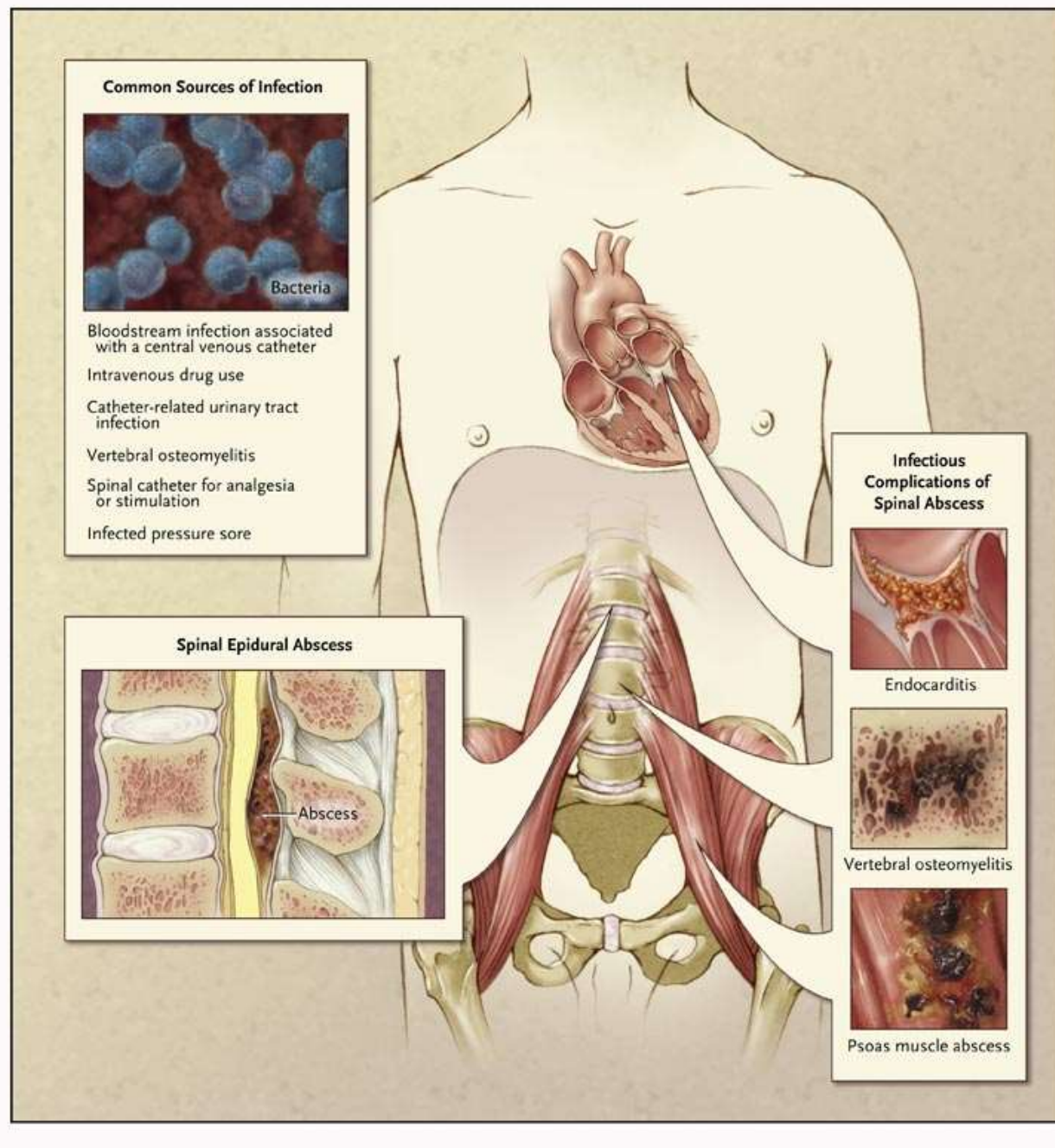


Illustration of intradural-extradural venous anastomosis. *Daniels after Netter.*

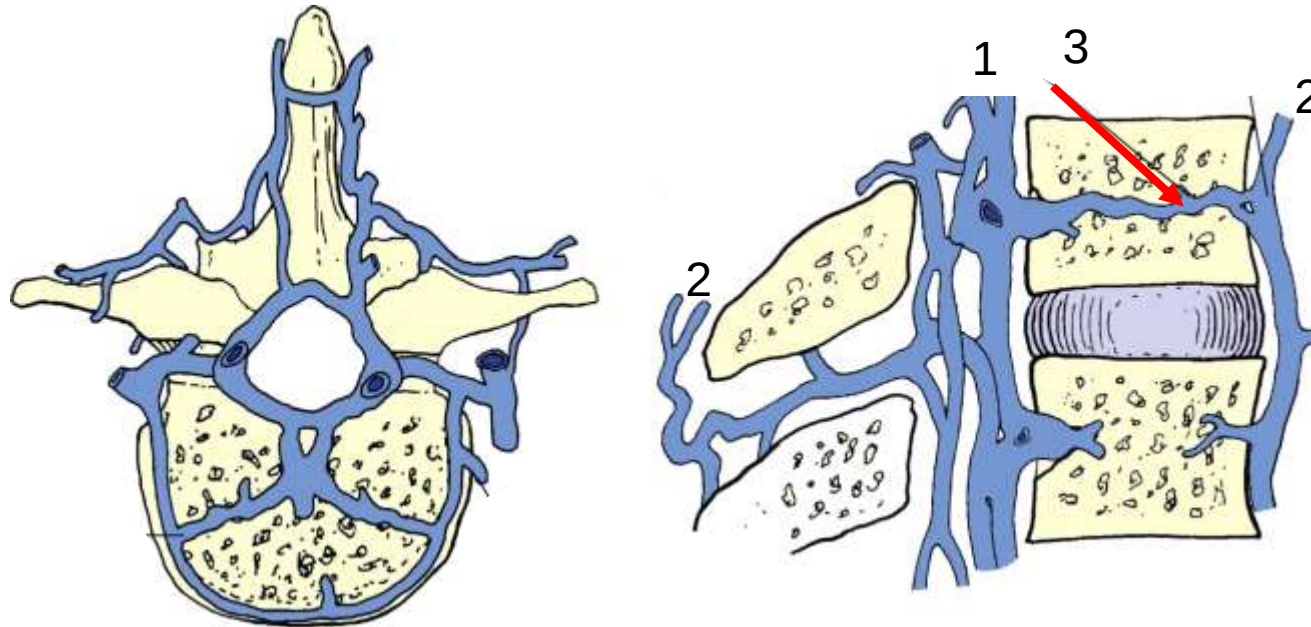


Epidurální absces

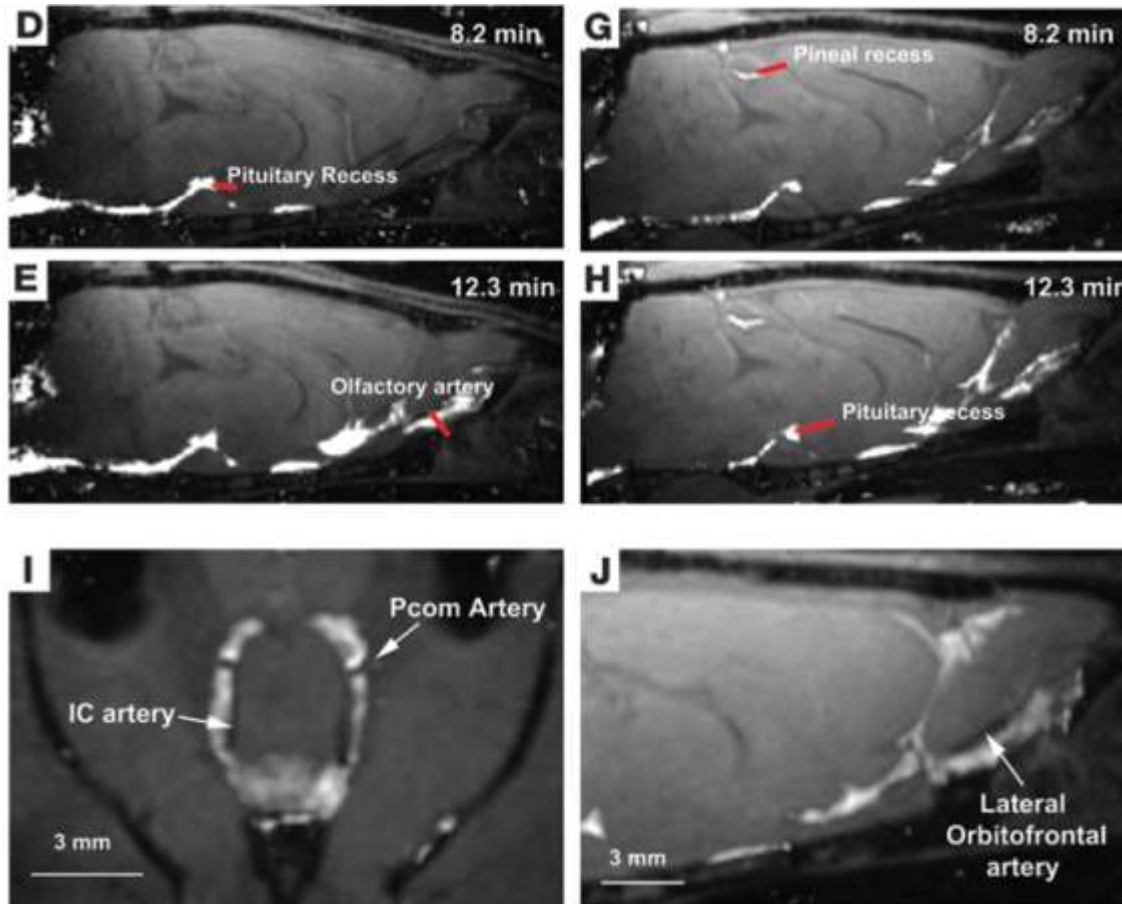


Plexus venosi vertebrales

- plexus venosi vertebrales **nemají chlopně** (šíření zánětu a nádorů) a anastomosují mezi sebou
- **anastamosují** s žilními plexy kolem os sacrum a pánve
- jsou: 1) uvnitř kanálu v epidurálním prostoru (**plexus venosi vertebrales interni**)
- 2) kolem páteře zvenčí (**plexus venosi vertebrales externi**)
- 3) uvnitř obratlových těl (**venae basivertebrales**)



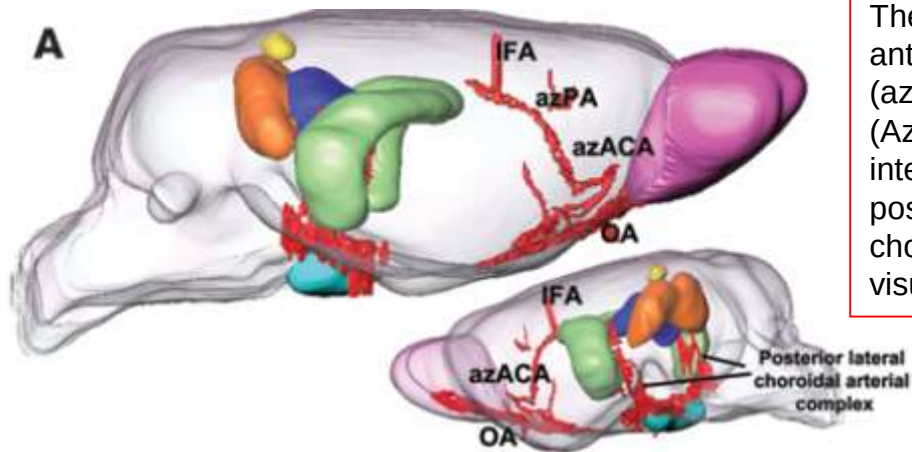
Glymfatický systém mozku – odvádění odpadních produktů
perivaskulárními prostory
aktivní ve spánku – glie se smrsknou a perivaskulární prostory naplní



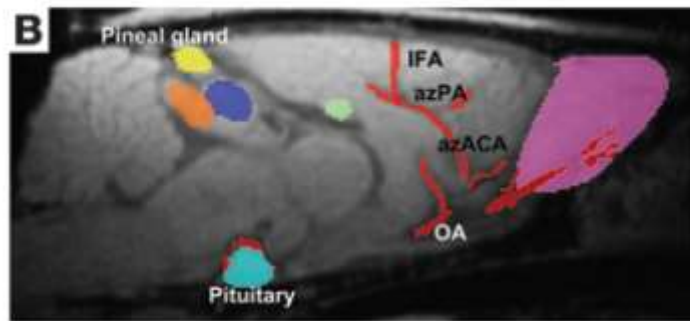
(I and J) Paravascular transport of the paramagnetic contrast agent is demonstrated particularly clearly at the level of the Circle of Willis along the internal carotid (IC) artery, posterior communicating (Pcom) arteries, and lateral orbitofrontal artery. Scale bar: 3 mm.

Brain-wide pathway for waste clearance captured by contrast-enhanced MRI

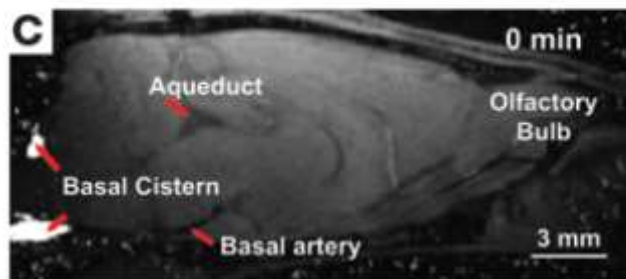
Jeffrey J. Iliff,¹ Hedok Lee,² Mei Yu,² Tian Feng,³ Jean Logan,^{4,5} Maiken Nedergaard,¹ and Helene Benveniste^{2,5}



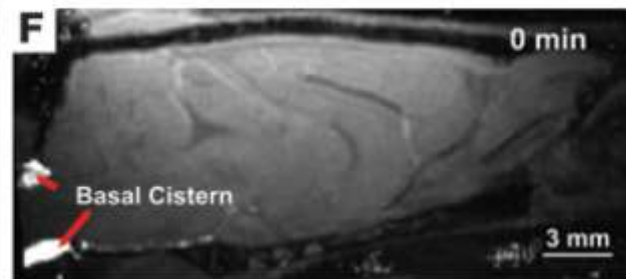
pituitary hippocampus superior colliculus inferior colliculus pineal gland and arterial segments (red). The olfactory artery (OA), azygos of the anterior cerebral artery (azACA), azygos pericallosal artery (AzPA), the middle internal frontal artery (IFA), and the posterior lateral choroidal arterial complex were visualized.



Gd-DPTA infusion



GadoSpin infusion



(B) A 2-dimensional T1-weighted MRI with the color-coded anatomical structures displayed.

(C–E) The time series demonstrates early influx of the small molecular weight paramagnetic contrast agent Gd-DTPA (MW 938 Da). (C) The time at which the intrathecally infused Gd-DTPA appears in the cisterna magna is defined as 0 minutes, and (D and E) the earliest part of the influx process is demonstrated in the subsequent time frames and shows that Gd-DTPA enters the brain along paravascular pathways. (F–H) The dynamic time series of early influx of the large molecular weight paramagnetic contrast agent GadoSpin (MW 200 kDa) also shows that transport into the brain is paravascular. Note that it is evident that even though the 2 paramagnetic contrast agents differ in molecular weight, they pass through paravascular conduits at similar rates, supporting that CSF bulk flow governs this process.

Brain-wide pathway for waste clearance captured by contrast-enhanced MRI

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