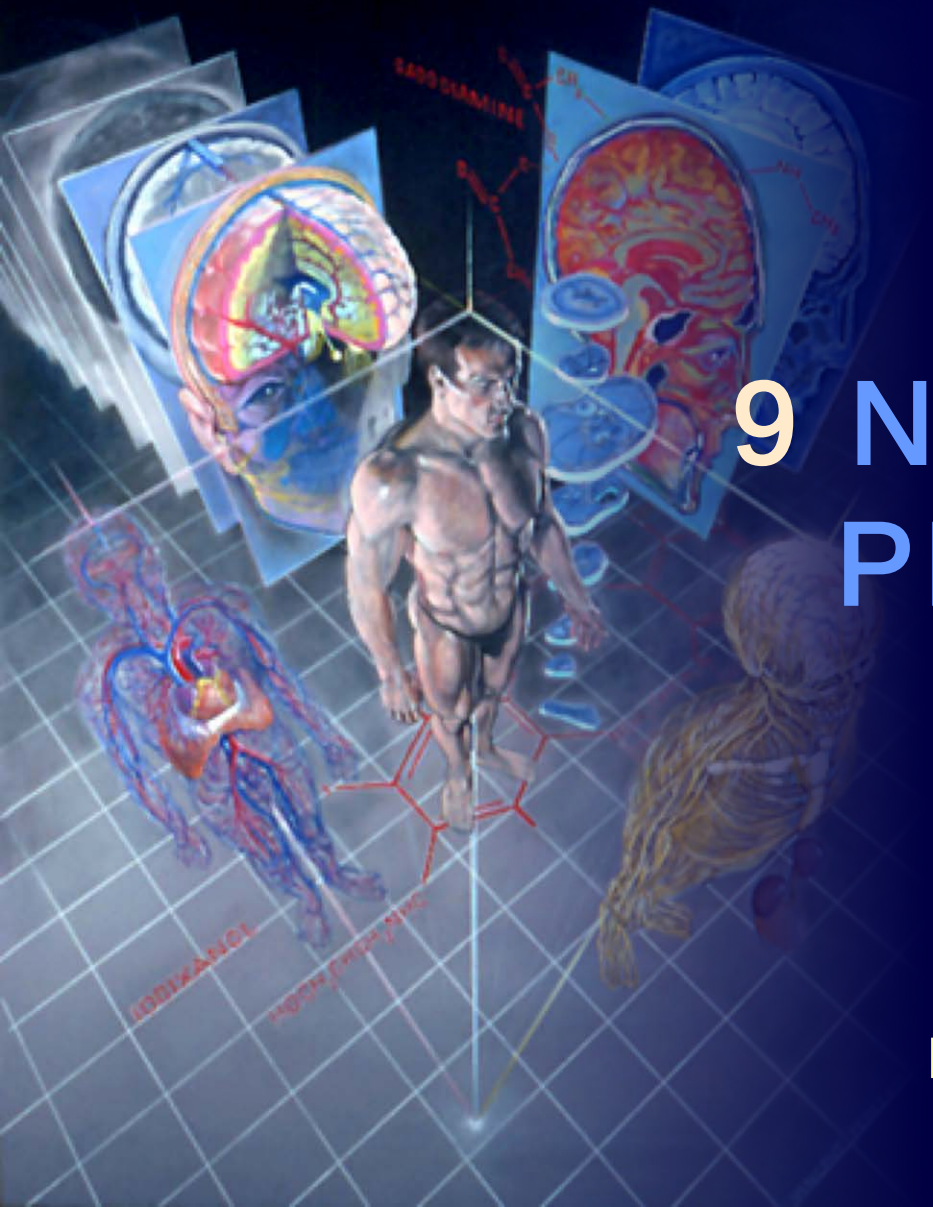
Lectures
General medicine
Stomatology
Special pathophysiology
1995 -2025



9 NEUROPATHO-PHYSIOLOGY

Stroke

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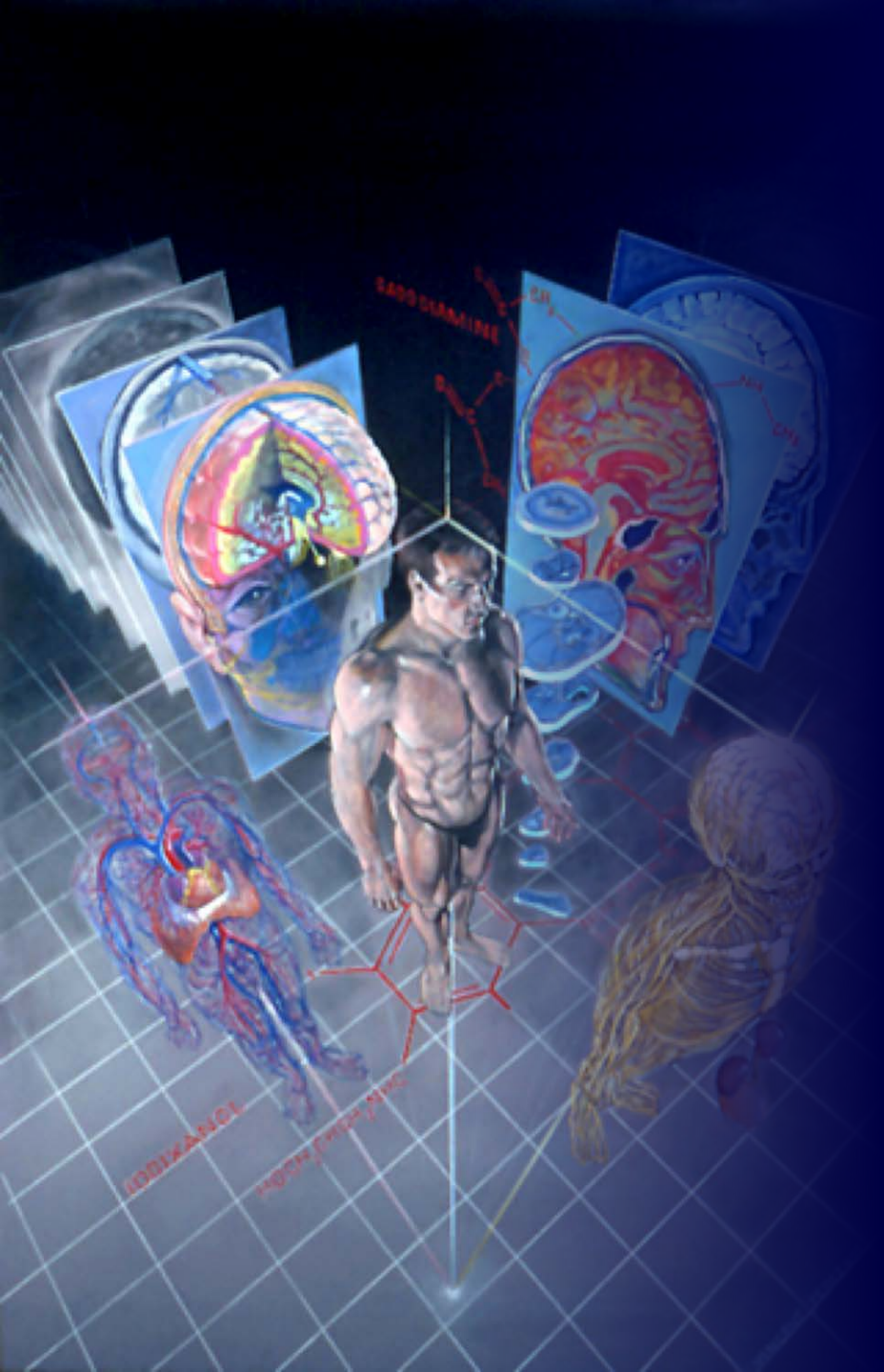
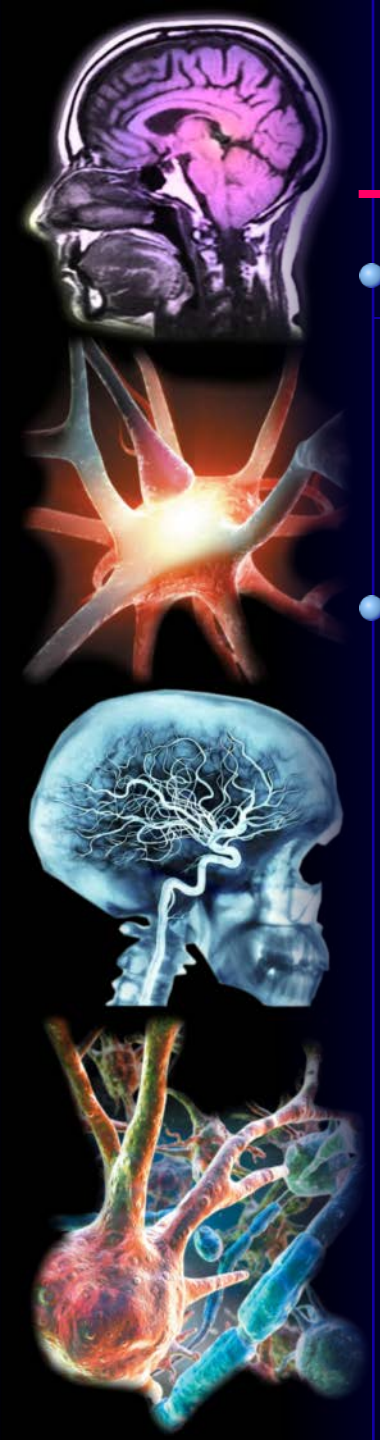
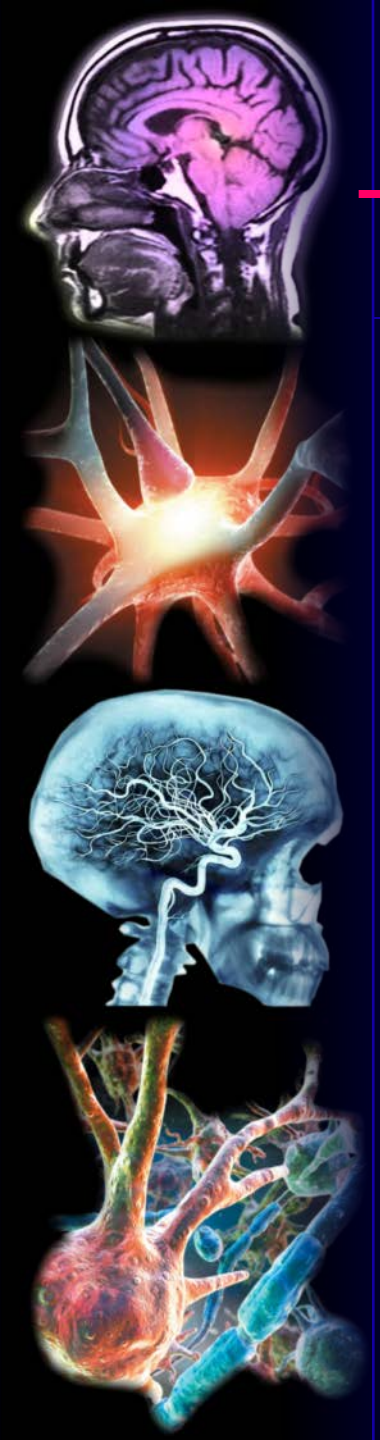


Ischemic stroke



Stroke - characteristics

- Def: **Acute stroke** (cerebrovascular accident, CVA): Stroke (ictus) is a clinical syndrome characterized by the sudden onset of a neurological disorder (of varying nature, with or without significant impairment of consciousness) that persists for at least 24 hours and is caused by abrupt changes in cerebral circulation.
- Epi: Globally, the 2nd–3rd most common cause of mortality. More than 400,000 cases in the U.S.; $28 billion annually; in Slovakia (2021) > 16,000; typically aged 20–40 (45 years); M > F; incidence increases with age; incidence ranges from 0.2% to 1.6%; most common lesions are in the internal carotid artery, followed by the middle cerebral artery (MCA) and the vertebrobasilar vessels; ~54% occur in the left hemisphere and ~43% in the right hemisphere., M > F; Incidence increases with age;
  - Incidence ranges from 0.2% to 1.6%; most common lesions are the internal carotid artery, followed by the middle cerebral artery (MCA) and the vertebrobasilar vessels; ~54% occur in the left hemisphere and ~43% in the right hemisphere.
  - ~10% of people with stroke recover almost completely; 25% recover with minor impairments. Up to 40% have moderate to severe disability.



Stroke - Characteristics

- Classification: Based on pathogenesis:

a) Ischemic stroke (accounts for 80–85%),

b) Hemorrhagic NCMP (accounts for 15–20%). Based on the location and extent of the hemorrhage and the symptoms, it is classified as:

i) Intracerebral hemorrhage (ICH) – bleeding into the brain tissue, which is surrounded by the hemorrhage, partially limiting its extent, or intraventricular hemorrhage, which occurs when the blood spreads into the ventriclesin,

ii) Subarachnoid hemorrhage (SAH), typically resulting from aneurysms in the Circle of Willis.

- Risk factors:
- *Non-modifiable risk factors* include age, sex, race, and genetics. Risk increases with age; it is higher in younger men, but the overall risk of death is higher in women. The risk is significantly higher among African Americans and slightly higher among Hispanics compared to Caucasians (in the Americas).
- *Modifiable risk factors* – contribute to both ischemic and hemorrhagic stroke – include hypertension, smoking, obesity, alcohol use, hyperlipidemia, physical inactivity, diabetes, and atrial fibrillation (ICP).

Stroke - Characteristics

▶Def: Ischemic stroke is caused by restriction of cerebral tissue perfusion (complete or incomplete occlusion) associated with both restriction of capillary perfusion and impaired blood outflow.

▶Forms: A) According to the extent of ischemic damage, i.e. the localization of symptoms:

- Global cerebral ischemia (GCI) global cerebral ischemia) which affects the whole brain and is not lateralized in its manifestations
- Local cerebral ischemia (FCI) manifested by symptoms indicating damage to certain parts of the brain.

B) By the onset of symptoms, their duration and severity we know:

- Stroke, major stroke) (ICD-11) –cerebral infarction, necrosis of brain tissue with a solid functional deficit occurs by complete occlusion of a usually larger blood vessel. Depending on the extent of the damage, the condition can lead to acute brain death or to persistent neurological deficit. Symptoms persist for longer typically several days, weeks, months, often permanently
- Reversible ischemic neurologic deficit (RIND) is a stroke with symptoms persisting for more than 24 hours that gradually resolve after 72 hours, mostly completely after 7 days .
- Transient (transitory) ischemic attack (TIA). ministroke, TIA) is a transient episode of neurological dysfunction caused by focal cerebral, spinal cord, or retinal ischemia without acute infarction (tissue death), with manifestations ranging from a few minutes to 24 hours..

Ischemic stroke

Global Cerebral Ischemia (GCI)

▶Etio: Global iCMP – a decrease or cessation of vascular perfusion throughout the brain due to: *a) circulatory failure* (asystole, cardiomyopathy), severe hypotension (shock states – septic, cardiac, hemorrhagic*), b) restricted perfusion* in a large area of the brain, e.g., due to occlusions (usually unilateral) of the common carotid artery, internal carotid artery, or vessels in the vertebrobasilar basin, or due to subclavian steal syndrome, etc., or due to traumatic brain injury and cerebral edema*, c) severe anemia, etc.*

Cerebral ischemic stroke (CIS)

▶Etio: Focal (local, territorial) cerebral ischemia (LCI, TCI)– occurs when perfusion is occluded or restricted in a localized area of the brain. *i) Occlusion of major vessels* – e.g., vessels exiting the Circle of Willis, such as the anterior, posterior, and cerebellar arteries and their branches*. ii) Occlusion of small branches*.

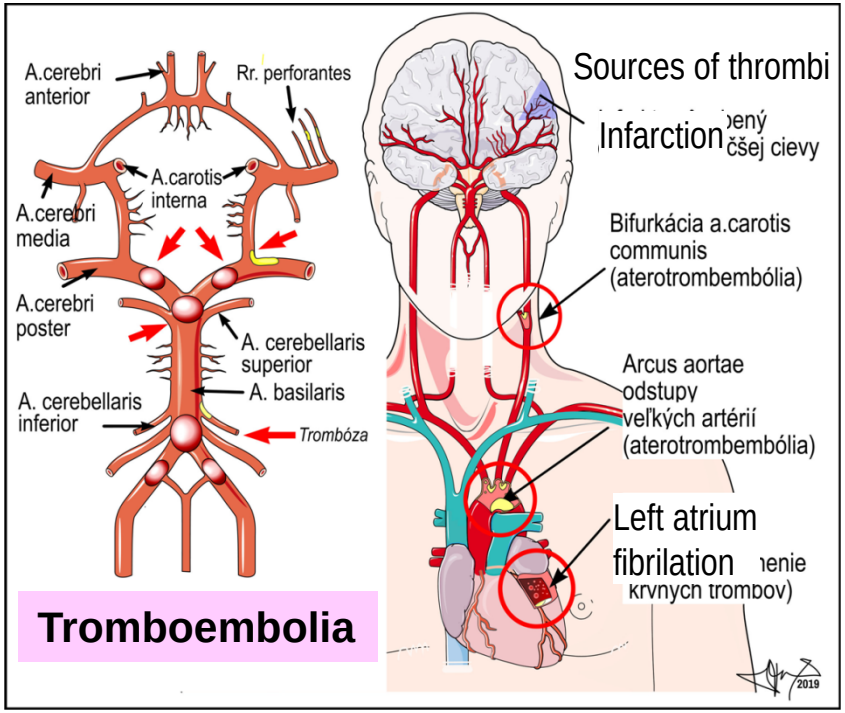
- *Embolization from the heart and large vessels* (thromboembolization, atherothromboembolization, possibly air and fat embolization). Atrial myxomatosis, valvular heart disease (bacterial/non-bacterial endocarditis or mitral valve prolapse, valve replacement). Arrhythmias – atrial fibrillation or changes in brady- and tachyarrhythmias (sick-sinus syndrome) – lead to the release of attached thrombi.

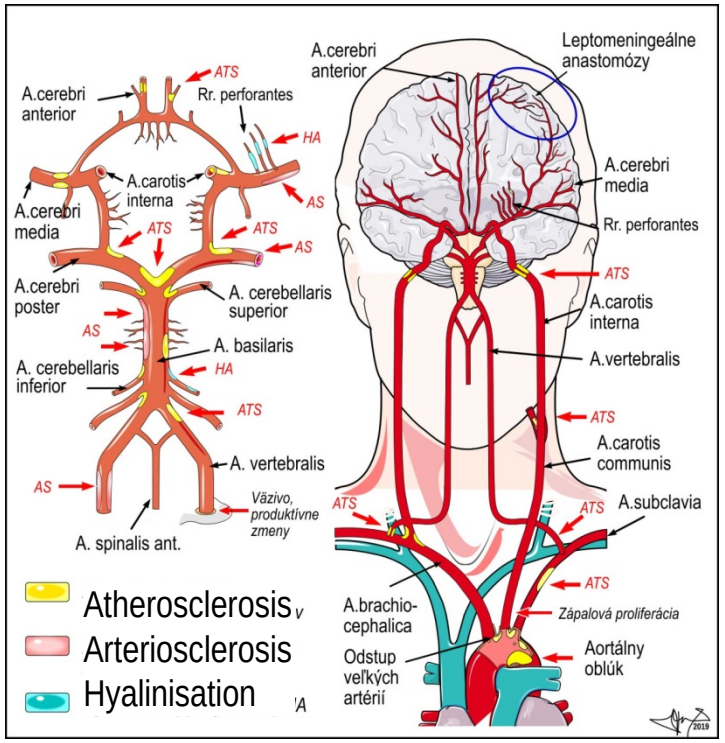
Ischemic stroke

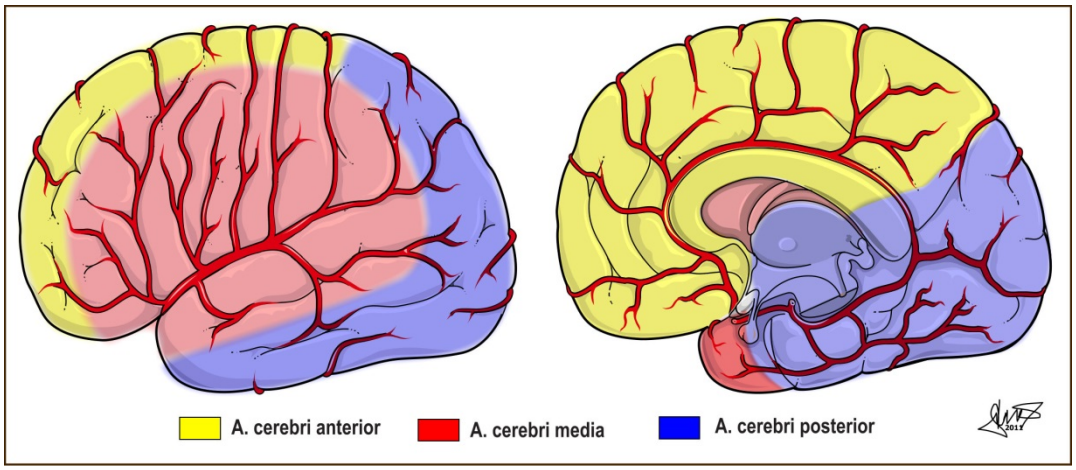
- Paradoxical embolism (PDE) with thrombi from the deep veins of the lower extremities (phlebothrombosis) can occur via the foramen ovale (e.g., during coughing, defecation), an atrial septal defect (PDE in 14% of patients), a ventricular septal defect (during reversal of a left-to-right shunt), or pulmonary AV anastomoses. The incidence may be as high as 1%.

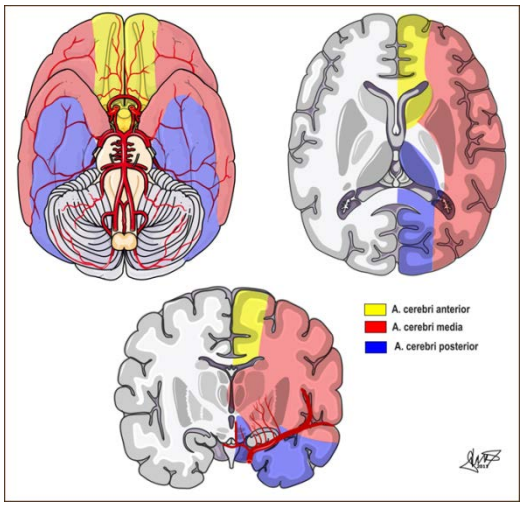
- *Cerebral vessel thrombosis –* an embolus lodges in a normal vessel; a thrombus forms in a diseased vessel *local micro-atherothromboembolization,*
  - *Hematologic disorders – thrombophilic conditions* (deficiency of protein C, S, or AT III; resistance to APC; antiphospholipid syndrome), hemoglobinopathies*, hyperviscosity syndrome* (polyglobulia, thrombocytosis, macroglobulinemia, myeloma), polycythemia vera, myeloproliferativesyndrome.
- *Local narrowing of blood vessels -* also in combination with low blood pressure (hypotensive conditions) or increased blood viscosity (dehydration), and in prothrombotic conditions.
  - *Atherosclerosis* (larger vessels), *arteriosclerosis, hyalinization* – amyloid (small vessels)
  - *Vasospasms – may occur during emotional stress, due to hyperventilation in predisposed pat.*
  - *Vasculitis* - primary in the CNS, systemic necrotizing with CNS involvement (periarteritis nodosa, large cell arteritis, Wegener's granulomatosis), collagenoses (syst. lupus erythematosus, sclero derma, rheumatoid arthritis), vasculitis (borreliosis, tbc, neurolues, mononucleosis, hepatitis B

Stroke – Ischemic

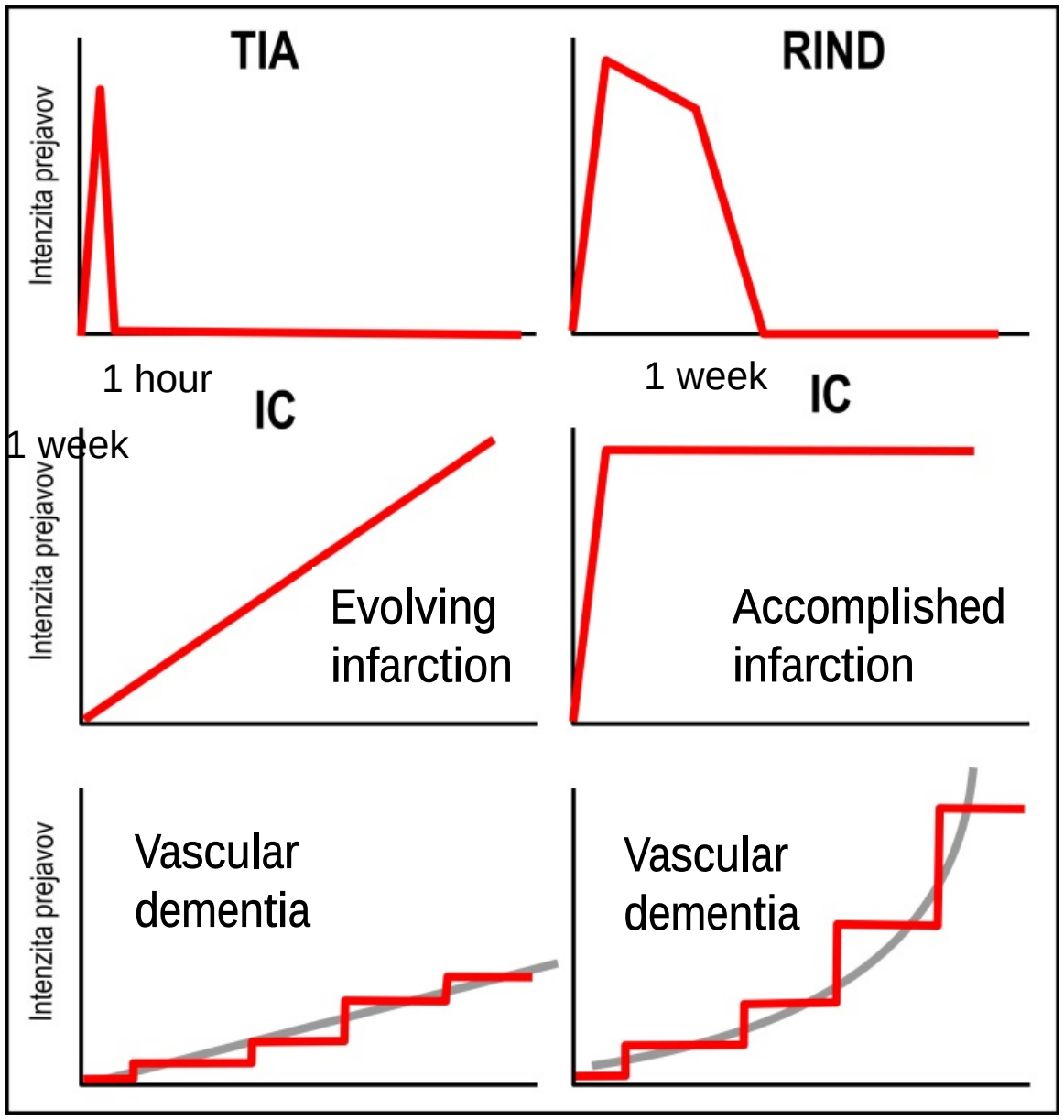








Course of brain vascular lesions



- TIA – transitory ischemic attack
- RIND - reversible ischemic neurologic deficit (RIND
- Infarction (IC)
- Vascular dementia – very commonly chronic microbleedings or focal microischemia

Stroke – Ischemic

- Restriction of vascular flow (constriction or occlusion of the capillary) occurs in the following ways:
- a) from a distant source, outside the brain, typically by emboli.
  - i) thromboembolus (clot), e.g. from the heart, cardiac atria, a. corotis communis, a. internal carotid, event. as the so-called paradoxical embolus originating from systemic veins (through vascular right-left shunts),
  - ii) atherothromboembolus (detached clot with part of the atherosclerotic plaque, originating from eroded ATS lesions in the arch of the aorta including access to large arteries (a. inominata, and subclavian, a. carotis comm. and int. , a. vertebra-les, and, basilaris),
  - iii) air embolus (usually overlooked; arising iatrogenically from manipulation of a central venous cannula, arter. pulmon. catheter, during hemodialysis; during neurosurgery in the sitting position - cervical discs, posterior fossa tumors), cardiothoracic surgery, eventi
  - iv) fat embolism.
- b) defects arising locally in the cerebral circulation, in particular*: i) thromboses in situ ii) atherosclerotic plaque* (rarely forming a complete occlusion), *iii) vascular changes* (hyalinization, inflammatory vasculitis) *iv) spasm* of the vessel.

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- Permanent closure of blood vessels with subsequent ictus is mostly caused by *embolisms*, *rarely by spasms*, or partial closure vs. the stenosis, or other causes. However, in constellation with other co-factors, these too can result in cerebral infarction.

Syndromes of cerebral arteries

Syndrome a. cerebri anterior

Rapid deterioration of consciousness

• Motor sy:

- Contralateral spastic hemiparesis (hemiplegia) or monoparesis, partial paresis (regional)

• Somatosensitive sy:

- Contralateral hemianesthesia; (asomatognosia, amorphognosia, achylognosia, anosognosia, etc.

• Oculomotor sy:

- Homonymous hemianopsia; inability to deviate the eyes and head to affected party

• Other: Vomiting

Syndrome a. internal carotid

(symptoms are usually present unilaterally)

•Contralateral hemiparesis and facial asymmetry

• Contralateral sensory deficit, paresthesias

•Contralateral hemianopsia

•Homolateral amaurosis fugax, attacks of blindness

• Carotid bifurcation murmur

• Horner's syndrome (cervical sympathetic sy.)

Syndrome a. cerebral media

• Psychic systems. : confusion, amnesia, persevera tions, personality changes, flattening of affectivity, apathy gnostic: attention disorders, slowing down of performance, deteriorationof the intellect, expressive aphasia (in case of damage to the dominant hemisph)

• Motor system:

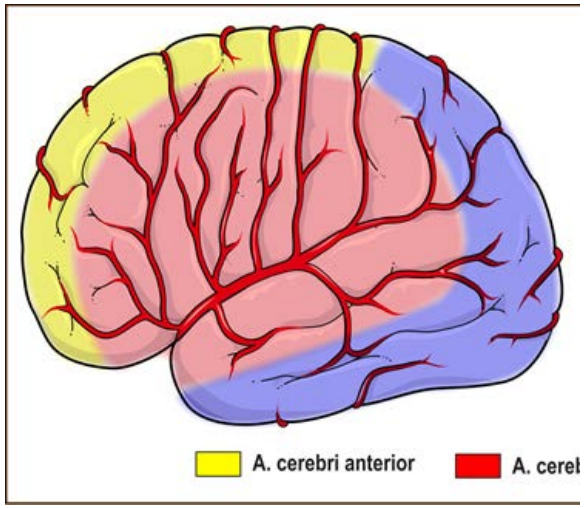
- Contralateral spastic hemiparesis (hemiplegia), monoplegia (cepalica, braíbhialis,pelvica),paraplegia
- Contralateral frontal ataxia (ideomotor & motor gait and posture dyspraxia)

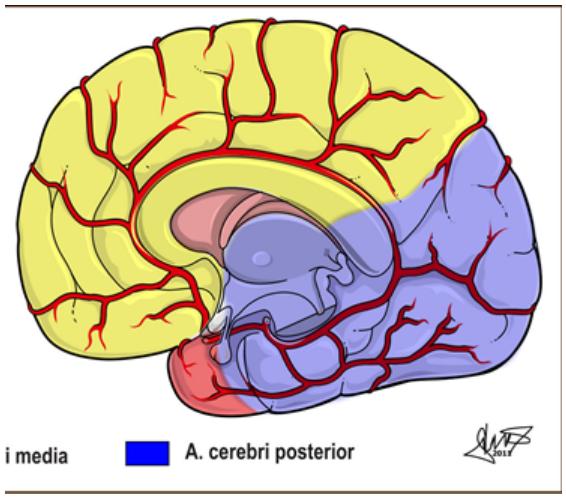
- Deviation of the eyes and head towards the affected side

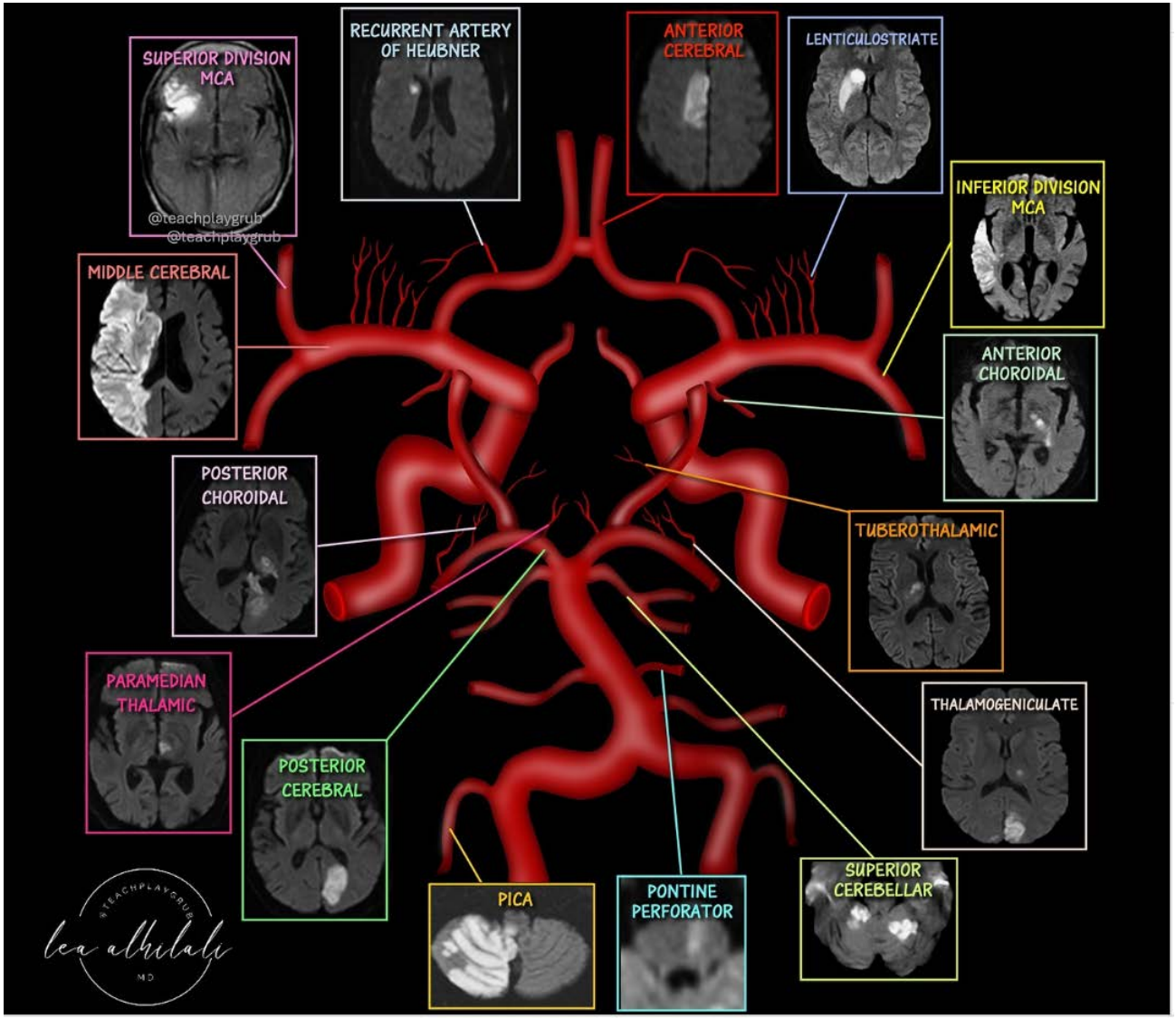
- Abulia (inability to make decisions when making motor events)

• Somatosensitive sy.: Contralateral dysaesthesia (anesthesia) for all sensory modalities, asomatognosia

Stroke teritories







Syndromes of cerebral arteries

Syndrome of a. cerebral media (MCA)

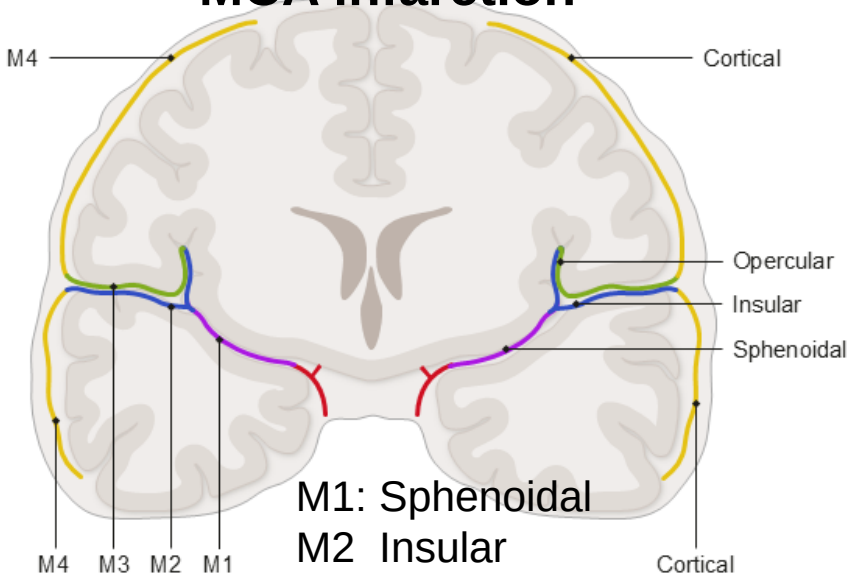
• Mental defects : confusion, amnesia, persevera tions, personality alt., flattening of affectivity, apathy
Gnostic funct.: attention disorders, slowing down of performance, deterioration of the intellect,
Broca aphasia (dominant hem), Dysarthria, faciobrachial; Contralateral hemineglect; Anosognosia, Aprosodia:

• Motor system:
- Contralateral spastic hemiparesis (hemiplegia), monoplegia (cepalica, braíbhialis,pelvica),paraplegia
- Contralateral frontal ataxia (ideomotor & motor gait and posture dyspraxia) + Abulia

- Contralateral Hemineglect; Anosognosia, Aprosodia:
- Conjugate eye deviation toward the side of the lesion (ipsilateral side) due to frontal eye field.

• Somatosensitive sy.: Contralateral dysaesthesia (anesthesia) for all sensory modalities,
- Asomatognosia

MCA infarction



M1: Sphenoidal
M2 Insular
M3: Opercular
M4: Cortical

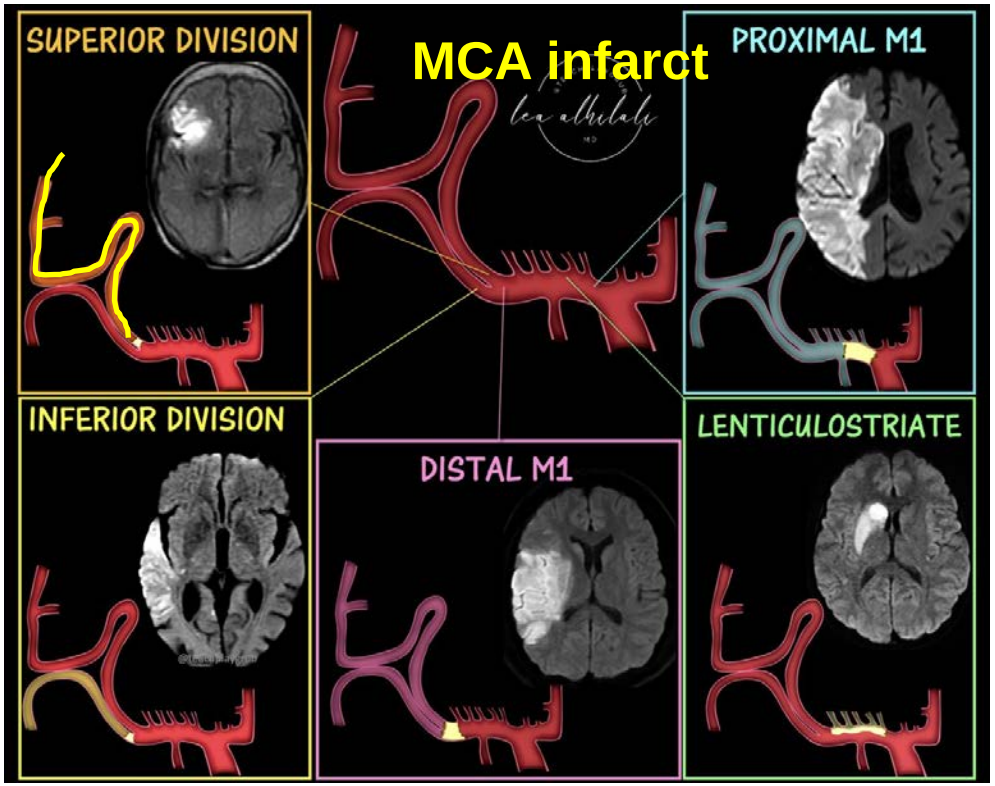
■ **Full Stem Occlusion:** A stem occlusion causes a full MCA syndrome (global aphasia, hemiplegia, hemianopia),

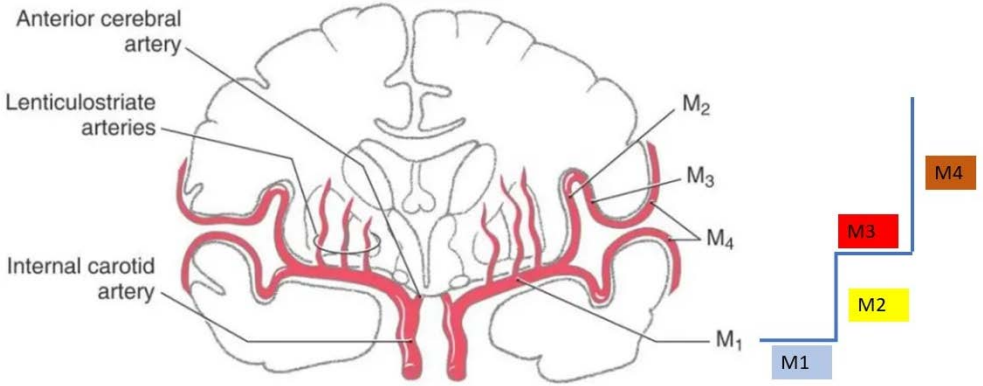
■ **Lenticulostriate artery** (LSA) (M1 deep): aphasia & visual hallucinations; hemiparesis, sensory deficits a Broca aphasia

MCA infarction

- Superior division middle cerebral artery (MCA) (M4 up, M3, M2) = typically affect the lateral frontal and superior parietal lobes, leading to motor-dominant, contralateral deficits that primarily impact the face and upper limb (faciobrachial) rather than the legs. The superior division M2 branches supply the lateral inferior frontal lobe (including Broca's area in the dominant hemisphere) and the pre- and post-central gyri.
- Lenticulostriate artery (LSA) syndrome (M1) = damage to the lenticulostriate arteries, which are small, deep perforating branches arising primarily from the middle cerebral artery (MCA) to supply crucial structures, including the basal ganglia and the internal capsule. Typically involve lacunar infarctions (ischemic strokes) or deep intracerebral hemorrhage (ICH) due to underlying vasculopathy or aneurysms.
- Inferior division Middle Cerebral Artery (MCA) strokes primarily affect the lateral temporal and parietal lobes, leading to distinct language or behavioral deficits depending on the hemisphere involved, often without significant motor weakness.
- Distal M1 syndrome (blockage in the terminal (distal) part of the MCA horizontal (M1) segment just before its bifurcation). It causes significant ischemic stroke, including contralateral hemiparesis and sensory deficits, often with a high stroke severity score (NIHSS) due to reduced collateral flow compared to more proximal occlusions
- Proximal M1 syndrome = first horizontal segment (M1) of the MCA : contralateral hemiplegia (face/arm/leg), sensory loss, hemianopia, and, if the dominant hemisphere is affected, aphasia. The proximal M1 segment supplies essential deep lenticulostriate arteries.

MCA infarction





- Superior MCA division (M2, M3. M4):
- Psy: Acute confusion or depression,
- Moto: Contralateral hemiparesis/- plegia of the lower half of the face and the upper extremity;
- Sens: Contralateral sensory faciobrachial loss (touch, pain, temperature).
- Dom Hemisph (Left): Broca's Aphasia: Oral apraxia: motor planning for speech, Dysarthria (severely Slurred speech).
- Nondominant (Right): Contralateral Hemineglect: Lack of awareness of the left side of the body or visual field Anosognosia: Lack of insight into the disability. Aprosodia: Lack of emotion in speech.
- Conjugate eye deviation toward the side of the lesio
- Inferior division Middle Cerebral Artery (MCA)
- Visual: Contralateral homonymous hemianopia or superior quadrantanopia ("pie in the sky" deficit).
- Sens: Contralat hypoesthesia (face + arm)
- Dom Hemisphere: Wernicke's Aphasia (Receptive Aphasia): Lexical-Semantic Deficits: Impaired understanding of word meaning.
- Non-Dom Hemi: Left side hemineglect; constructio nal apraxia; Behavioral Disturbances: acute confusion, agitation, delirium.; Aprosodia:

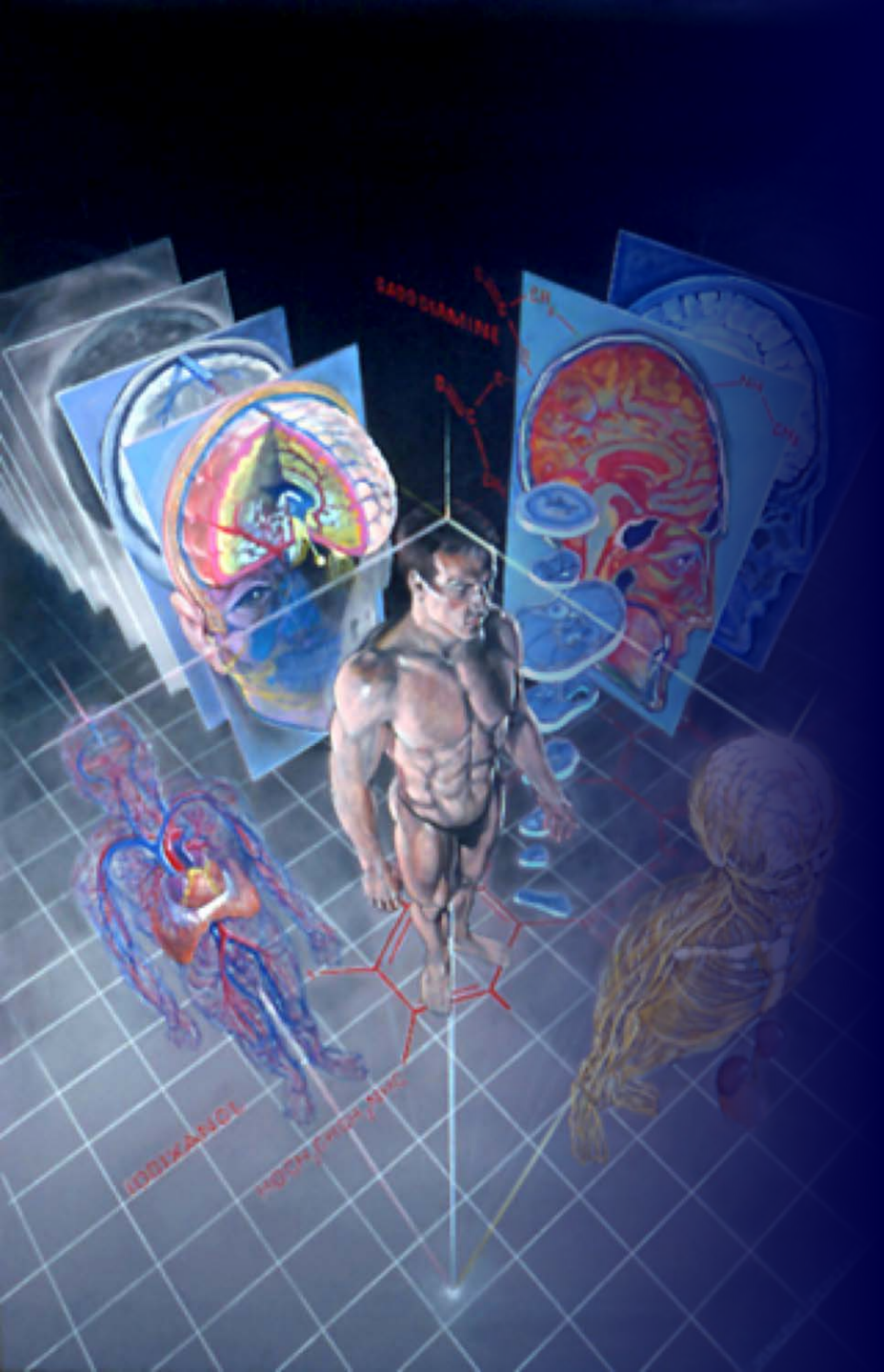
Syndromes of cerebral arteries

Syndrome of a.cerebri posterior

Visual disturbances:
Homonymous haemoanopsia, cortical blindness, loss of spatial visual perception, visual hallucinations, loss of peripheral extraocular vision
Cognitive disorders:
Deficit of long-term memory, perseveration, dyslexia
Involvement of the thalamus and subthalamic nuclei
Diffuse sensory disturbances, mild contralateral hemiparesis, intention tremor
Involvement of pedunculi cerebrales:
Contralateral hemiplegia and oculomotor deficit
Trunk involvement:
pupillary disorders, nystagmus, disorder of conjugated bulbar movements

Vertebro - basilar syndrome

(symptoms are usually present bilaterally)
Disorders of consciousness: disorientation, akinetic mutism, Locked-in-syndrome), syncope
Phatic and cognitive symptoms: memory deficit, dysarthria, dysphagia
Vestibular.: vertigo, nausea,
Visual: homonymous hemianopsia, diplopia
- Auditory: tinnitus, hearing loss
- Oculomotor: nystagmus, paralysis of conjugate movements
  bulbs, event. complete ophthalmoplegia
- Motor: facial paralysis; alternating paresis; monoparesis; increased tendons. ref.; cerebellum ataxia (dysmetria, abasia, astasia)

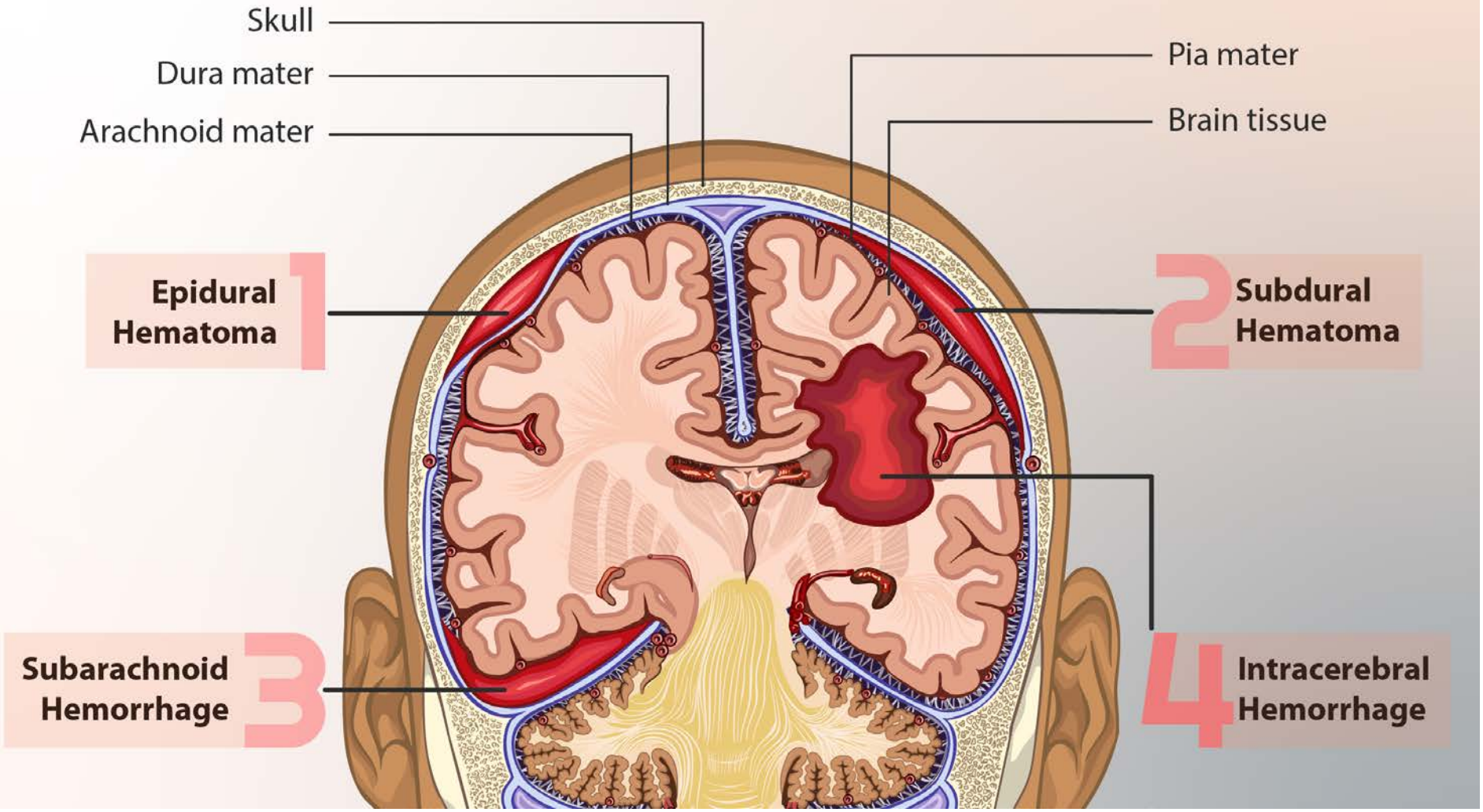


Hemorrhagic stroke

Stroke – Hemorrhagic

- Def:. **Hemorrhagic stroke** is a serious, life-threatening condition in which a blood vessel in the brain bursts and bleeds into or around the brain tissue.
- Occ:. survival probability 36% 1 year; (34%), 2 years (31%) and 3 years (27%). Almost 50% of patients with hypertensive cerebral hemorrhage die.
- Etio:. **Head injury** (fall, traffic accident, sport injury, etc.); **High blood pressure; Leakage from vascular malformations** (arteriovenous malformation). **Aneurysm rupture**, cerebral **amyloid angiopathy, brain tumors**.etc.
- Forms:
- Intracerebral hemorrhage – directly into the brain tissue (in 95% of cases), initially localized; sometimes “spills over” into the ventricles and into the cerebrospinal fluid -- onset hydrocefaluIntracerebral bleeding - directly into the brain tissue (in 95%) first limited; sometimes it "rolls over" into the ventricles into the cerebrospinal fluid -- the formation of hydrocephalus
- Intraventricular hemorrhage - this bleeding occurs in the ventricles of the brain, which are specific areas of the brain (cavities) in which the body produces CSM (fluid that protects the brain and spinal cord).
- Subarachnoid hemorrhage - between the membranes of the brain - this type of bleeding threatens the brain, especially by oppression

Types of brain hemorrhage



Stroke – Hemorragic

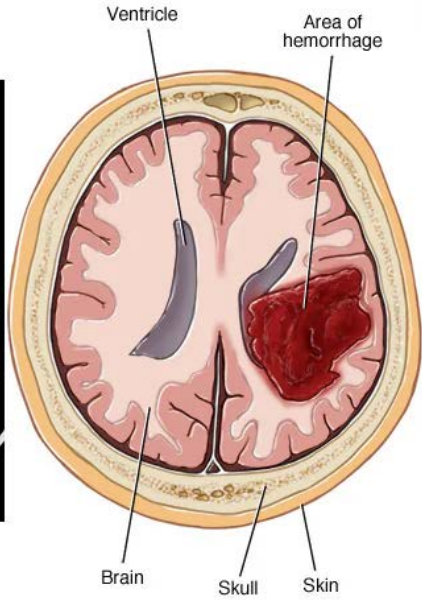
Intracerebral hemorrhage

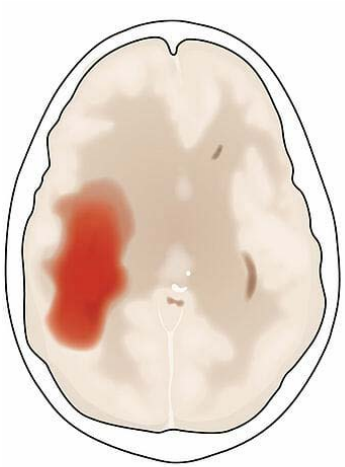
- Def.: Intracerebral or Intraparenchymal hemorrhage is an effusion of blood into the brain tissue. The pressure of the blood creates a cavity, the walls of which are formed by the brain tissue that closes it. Parenchymatous cerebral bleeding or hematoma has a high mortality rate and occurs in 6% after intravenous thrombolysis.
- Etio: Occurs as a result of rupture of penetrating arteries; most often in the area of the basal ganglia, thalamus, cerebellum and pons.
- Sy: Neurological deficit depends on the location and severity of bleeding. Onset is fast. It develops within 30-90 min. Due to the expansiveness of the lesion, *headaches,* vomitus, *meningeal symptoms (stiffness of the neck), stupor, coma, convulsions* appear.

Hemorrhagic transformation (HT)

- Description: Hemorrhagic infarction that occurs after venous thrombosis or arterial thromboembolism (in 18–42% of acute ICMP); certain stages of HT can be seen in up to 50% of cases. an important insight in reperfusion techniques for solving ICMP

Stroke – Hemorrhagic

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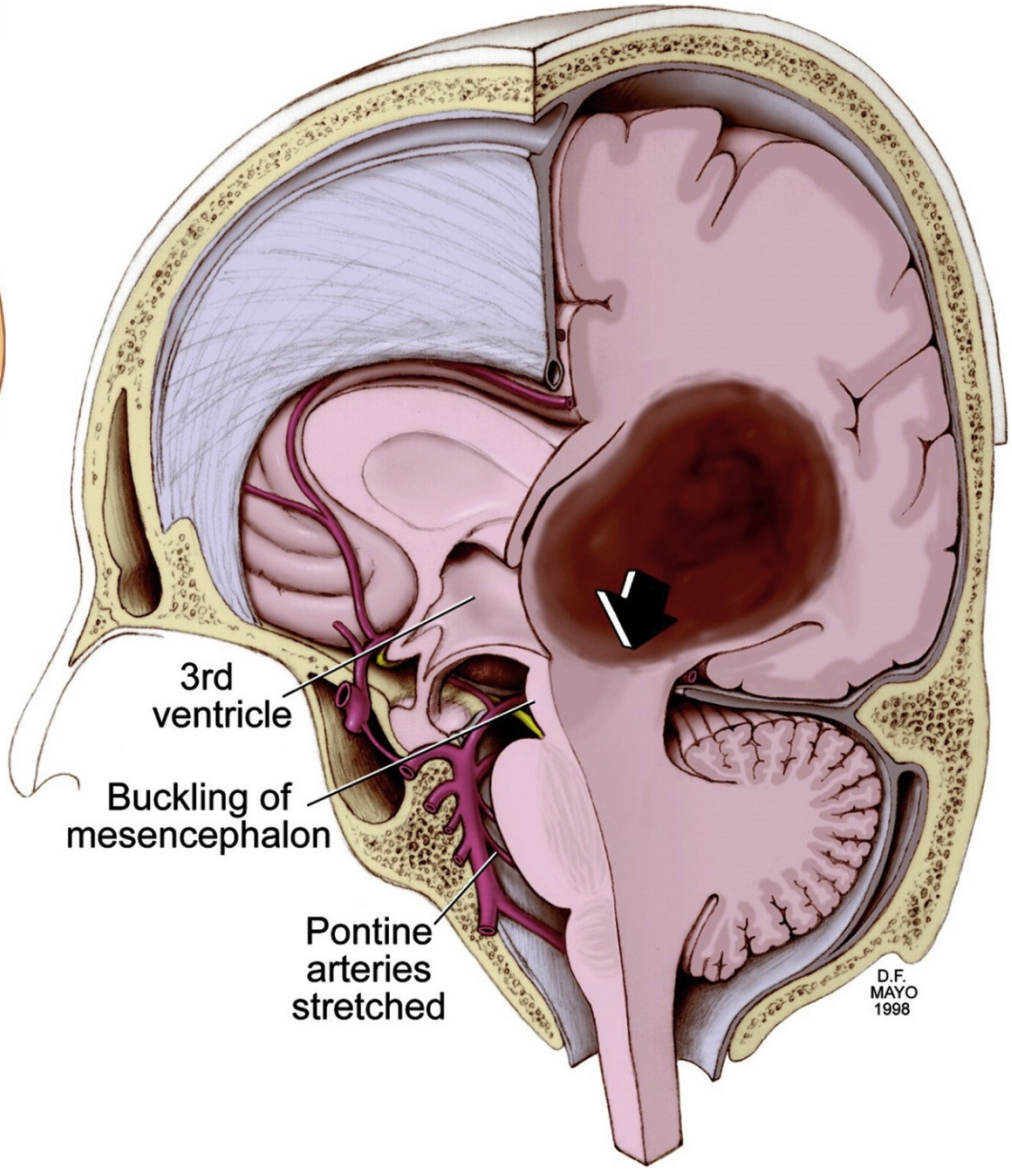
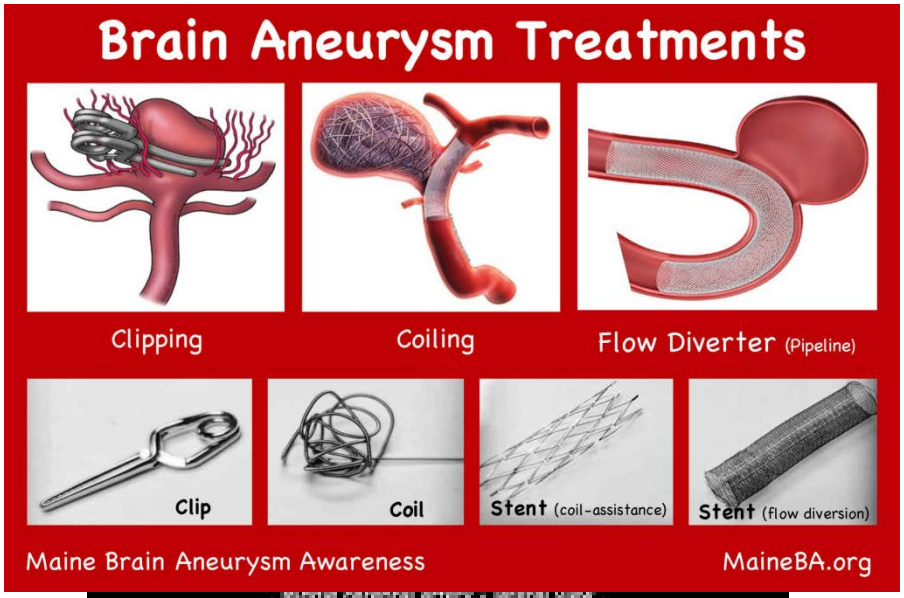
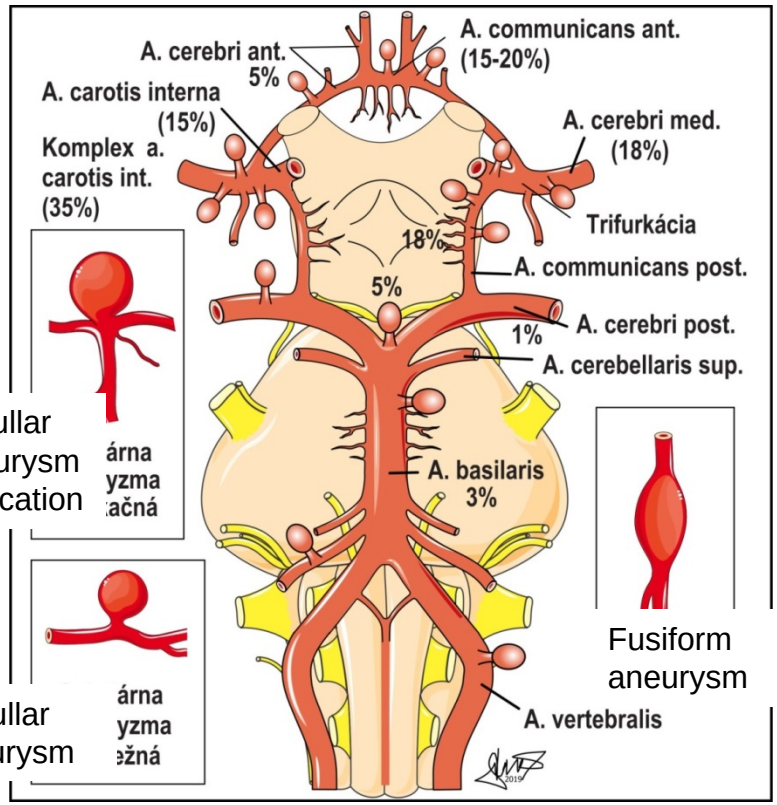
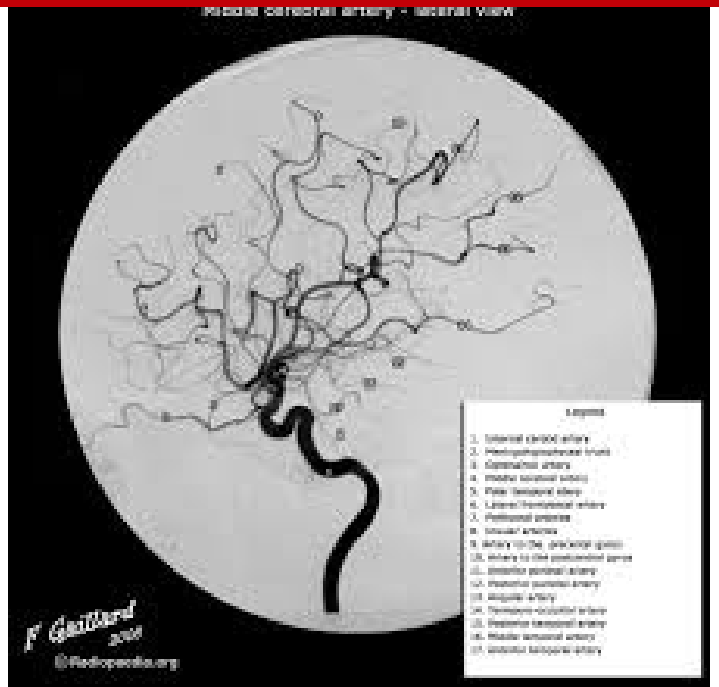


Stroke – Hemorrhagic







Stroke – Hemorrhagic

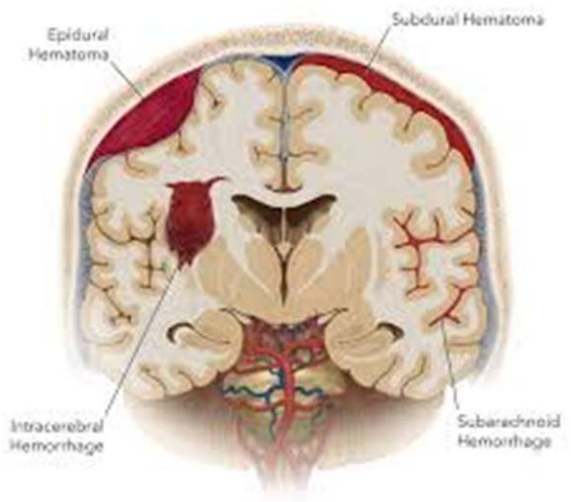
Subarachnoid hemorrhage

- Def. Subarachnoid haemorrhage (SAH) = a pathological condition arising as a result of blood spilling into the subarachnoid space. The consequence can be severe neurological deficit and death. It occurs immediately or before arrival at the hospital (10–15%), or after admission (within 24 hours, 25%) and hospitalization (within a month, 45%!).
- Occ: The incidence of SAH is ~10-12/100,000 inhabitants per year. It is higher in women than in men (1.5 - 2:1) and increases with age (the average age of occurrence is 50 - 55 years). There is an increased incidence in smokers and with hypertension. About 10-15% of patients mention working in a forward bend, lifting heavy objects and other strenuous activities immediately before the attack.ncidencia SAH je ~10 – 12/100 000 obyvateľov ročne.
- Etio: SAH accelerators include cocaine use, sickle cell anemia, coagulation disorders, anticoagulant therapy, vertebral artery dissection.
- Pathol: *Saccular aneurysms* - are thin-walled bulges from an intracranial artery, where the tunica media and internal elastic are often missing. It is caused by hemodynamic stress. Turbulent flow causes structural fatigue, separation of individual layers and the development of an aneurysm, which is contributed by hypertension and congenital connective tissue changes.

Stroke – Hemorrhage

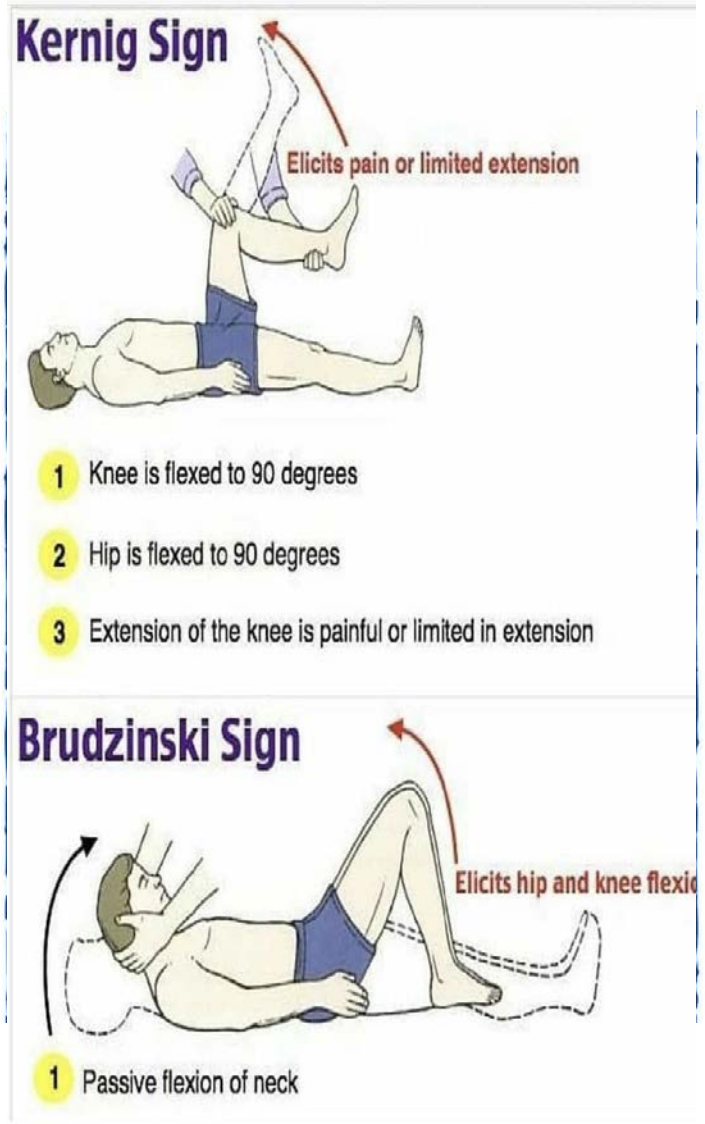
- *Fusiform aneurysms* - are caused by dilation of the entire circumference of the vessel, often in the vicinity of atherosclerosis.
- *Mycotic (infected) aneurysms* - are mostly the result of an infectious embolus from the heart (infective endocarditis). An aneurysm <1 cm has a small chance of SAH.

- Forms:
- *Traumatic SAH (tSAH)* 10% of cases. SAH - occurs near a skull fracture and intracerebral contusion as a result of trauma
- *Atraumatic SAH (aSAH)* 85% of SAH cases:
  - rupture of intracranial aneurysms (80% of cases) (often in the circle of Willis and its branches). saccular aneurysms
  - idiopathic with no obvious source (20% of patients), the source of bleeding is not detected on angiography.
    - 50% is ponto-mesencephalic haemorrhage into the CSM by rupture of a dilated vein, respectively. arteriovenous malformation in the prepontine or interpeduncular cistern.
    - vertebral artery dissection



Stroke – Hemorrhagic

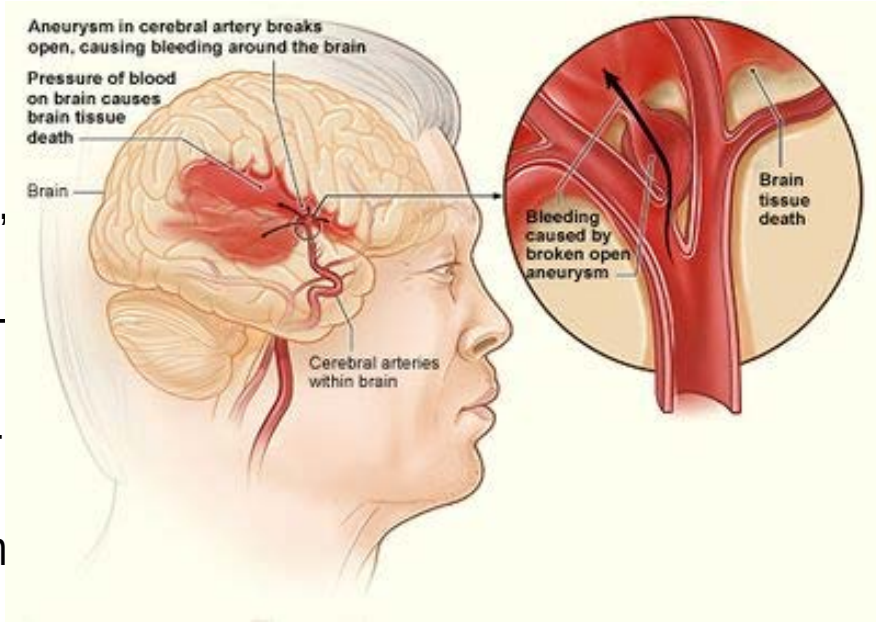
- Manifestations:
  - Pre-illness. days, month, appear quite suddenly without previous symptoms of headache (so-called. warning headache), ← an increase in the aneurysmal sac, but also minor bleeding from the aneurysm (so-called. (Sentinel bleeding).
  - Initial. minutes and initial hours after the lesion
    - *A sharp throbbing headache* that develops within seconds to minutes and has a maximum intensity at the beginning (thunderclap) →occipital region and laterally mostly correspond to the source of bleeding
    - *Nausea and vomiting*. irritation of the emetic
    - *Disturbance of consciousness* (obtundation, confusion, delirium *Epileptic seizures* (generalized and focal) 10-25% (-30%) of cases
  - Early. After about 6 hours. symptoms of meningeal irritation - typical neck stiffness positive : *Kernig's* sign (inability to fully extend the knees when the thighs are flexed at the hips and knees at 90-degree angles) and *Budzinski's sign* (hip and knee flexion with passive neck flexion) or *Lassegue sign.*

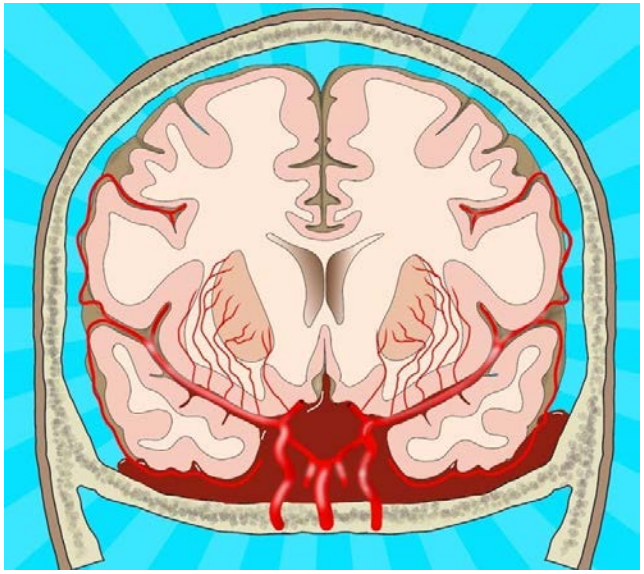


NCMP – Hemoragická

- Late. Up to 25-30% of patients (!) die within 24 h before and after arrival at the hospital
  - Sympathetic hyperfunction - increase (fluctuation) in blood pressure, cardiac arrhythmias (changes in T wave, QT interval, U wave) and cardiac arrest
  - Neurological : hemiparesis, oculomotor disturbances - may indicate impairment in the circle of Willis, asymmetric pupil size and loss of pupillary photoreflex - herniation of the brain with rising intracranial pressure.
  - Vasospasm - 3 days after onset of SAH with a peak on day 5-7 of cerebral vasculature induced apparently by mediators from the blood (candidates are thrombin, TXA2 or serotonin (5-HT) and norepinephrine). Requires intravenous infusion to achieve 3H hypertension, hypervolemia, and hemodilution). Medzi komplikácie SAH patrí hydrocefalus,

  - Lab.finding: CSM - the presence of blood and later its degradation products - bilirubin





Meningeal irritation