

NEURORADIOLOGY

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УНИВЕРЗИТЕТ
У КРАГУЈЕВЦУ

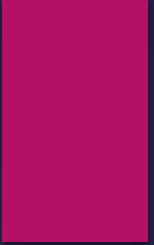


Objectives

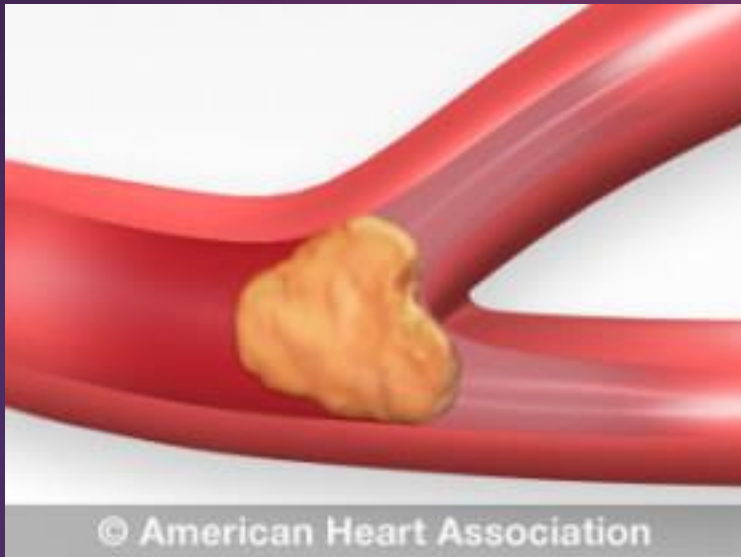
- ▶ Brain infarction,
- ▶ Diseases of the white matter of the brain,
- ▶ Non-traumatic intracranial hemorrhage,
- ▶ Diseases of the spinal column and spinal cord

STROKE

- ▶ **Stroke** or cerebrovascular accident (CVA), is a clinical term that describes a sudden loss of neurologic function persisting for more than 24 hours
- ▶ It is caused by an interruption of the blood supply to the brain

- 
- ▶ Acute, vascular injury to CNS
 - <24hrs = TIA
 - >24hrs= stroke (CVA)
 - ▶ Affects 600,000 people/yr (1 stroke per minute!)
 - ▶ The third leading cause of death worldwide
 - ▶ The first cause of disability
 - ▶ Etiologic risk factor for dementia, epi, depression

TYPES OF STROKE



Ischemic stroke occurs as a result of an obstruction within a blood vessel supplying blood to the brain.



Hemorrhagic stroke occurs when a weakened blood vessel ruptures.

TYPES OF STROKE

- ▶ Ischemic (75-80%):
 - ▶ Thrombotic
 - ▶ intracerebral atherosclerosis
 - ▶ Embolic
 - ▶ Cardiac embolus (thrombus, tumor, septic embolus)
 - ▶ Artery to artery – carotid thrombus (mainly)
 - ▶ Paradoxical embolus (thrombus, fat, air)

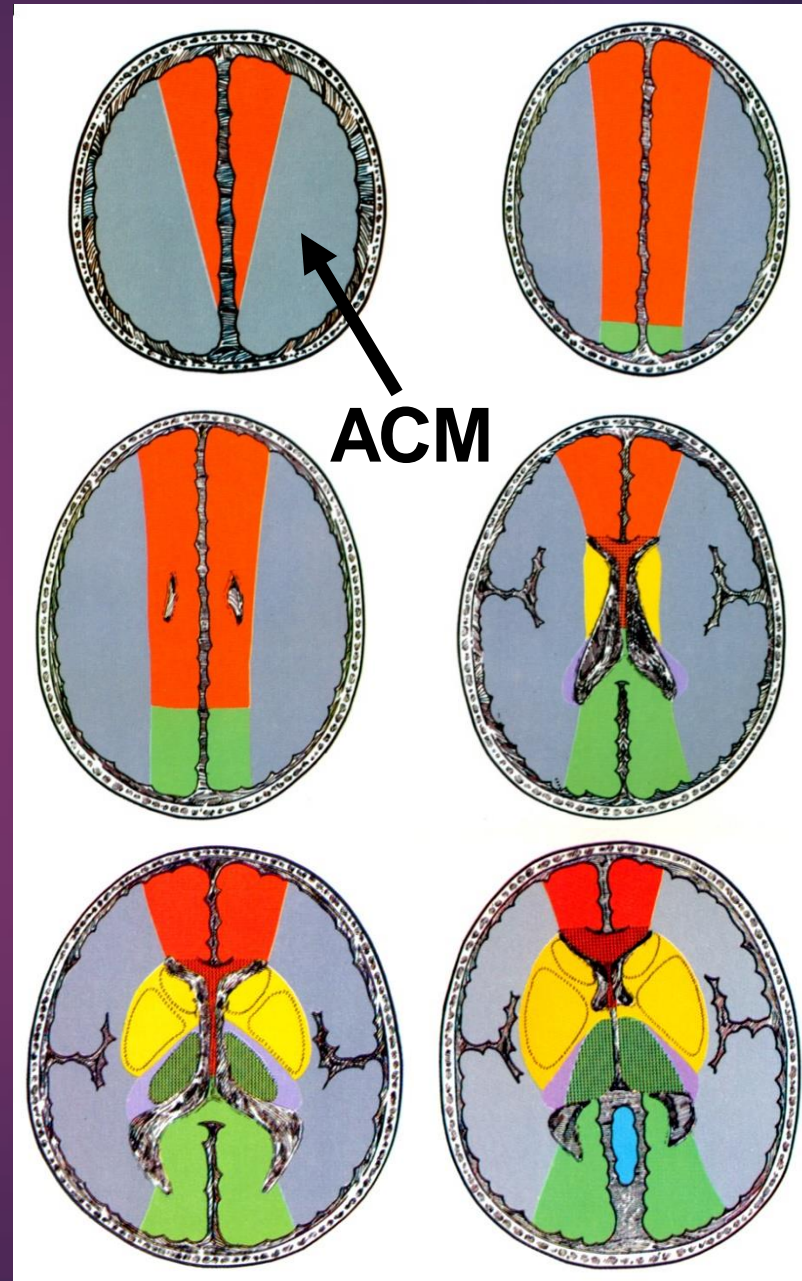
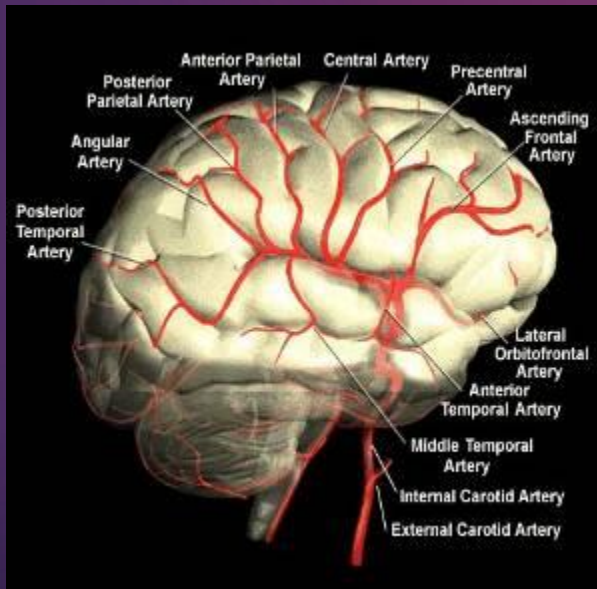
TYPES OF STROKE - Ischemic

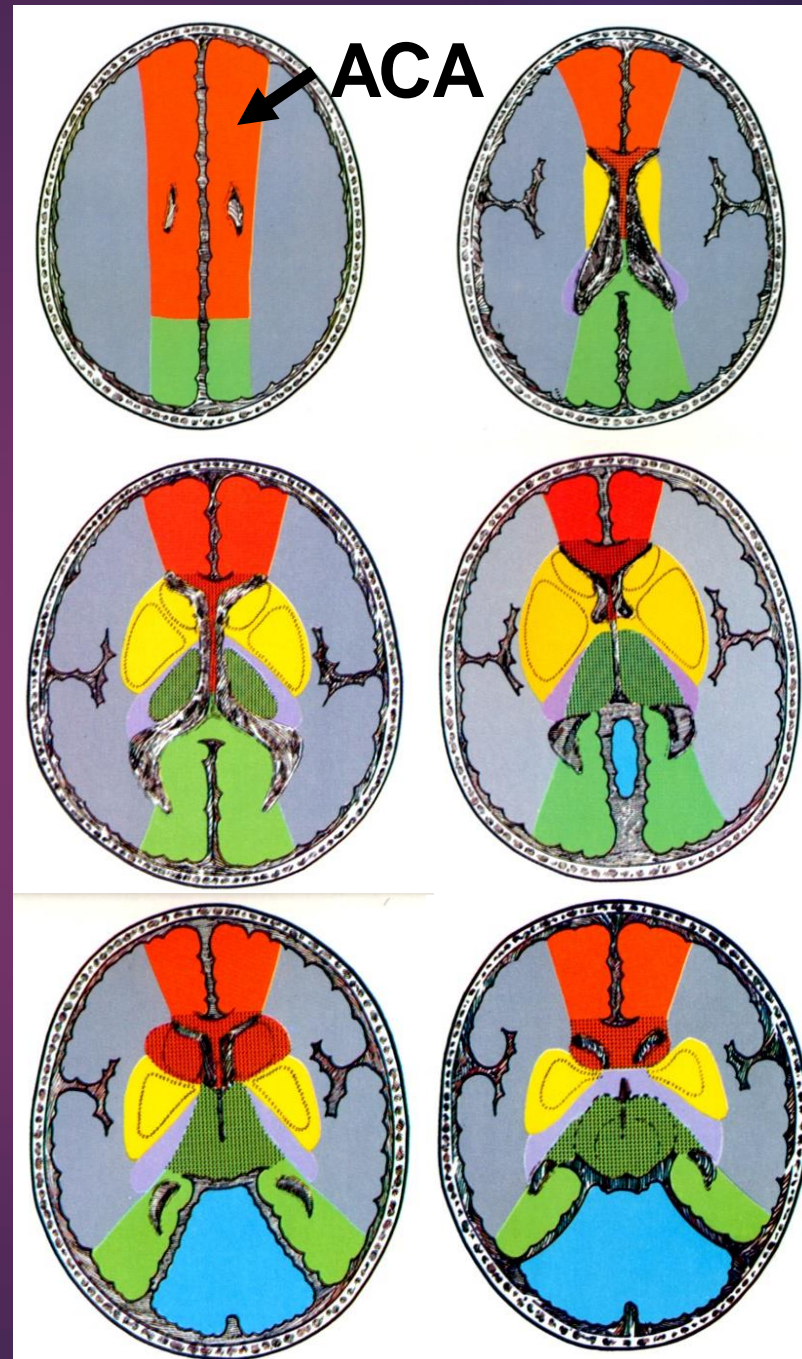
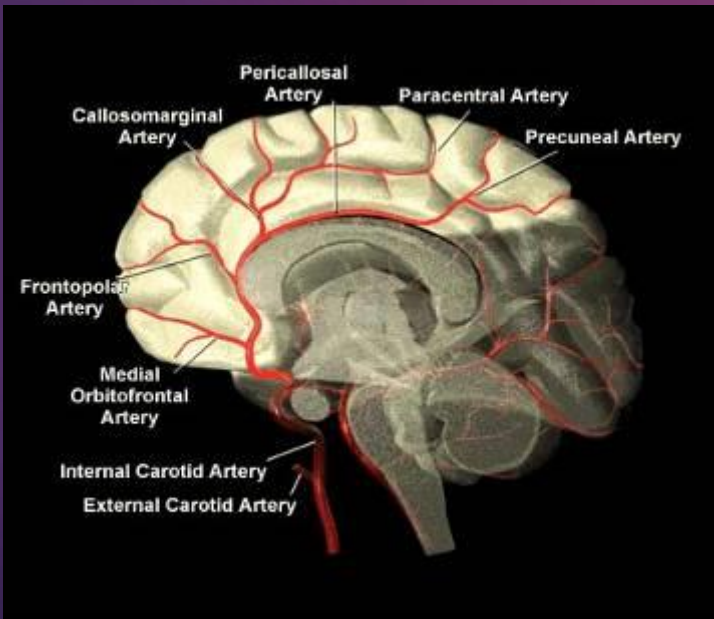
- ▶ Anterior vascular territory

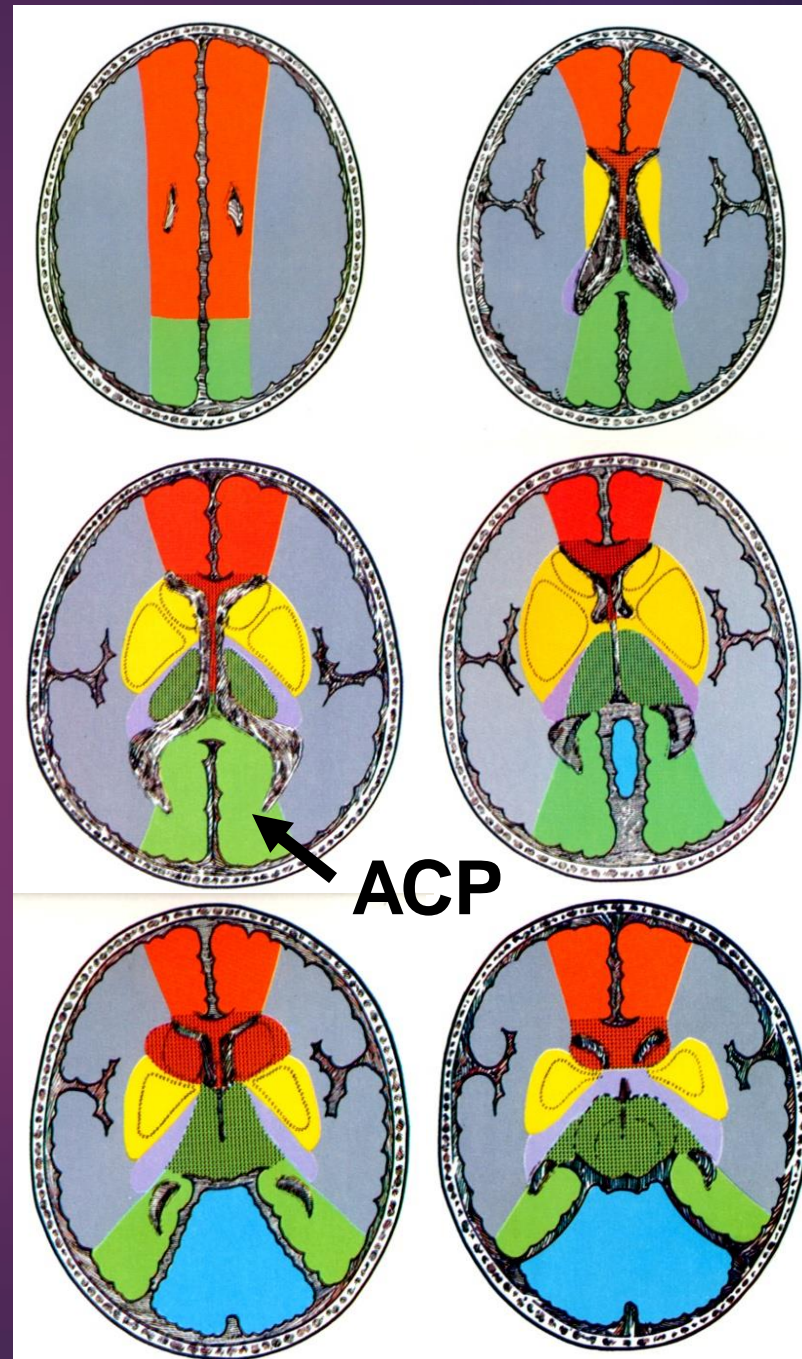
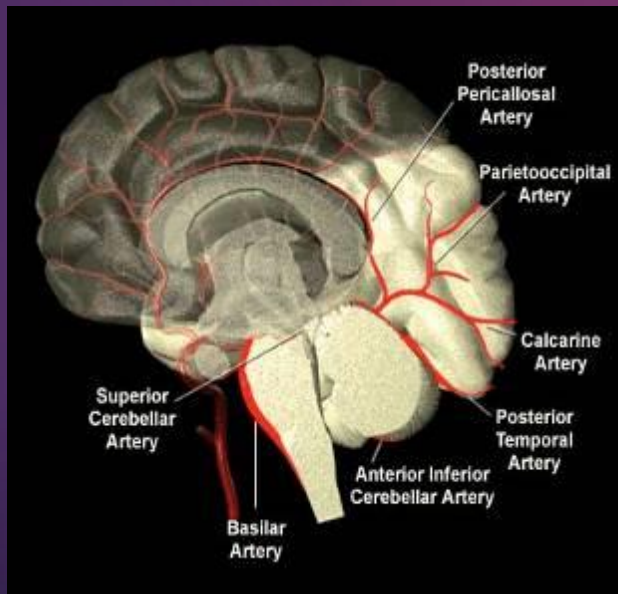
Occlusion ICA (MCA & ACA) – cerebrum.

- ▶ Posterior vascular territory

VB - pons, cerebellum, medulla oblongata, midbrain ± thalamus.







TYPES OF STROKE

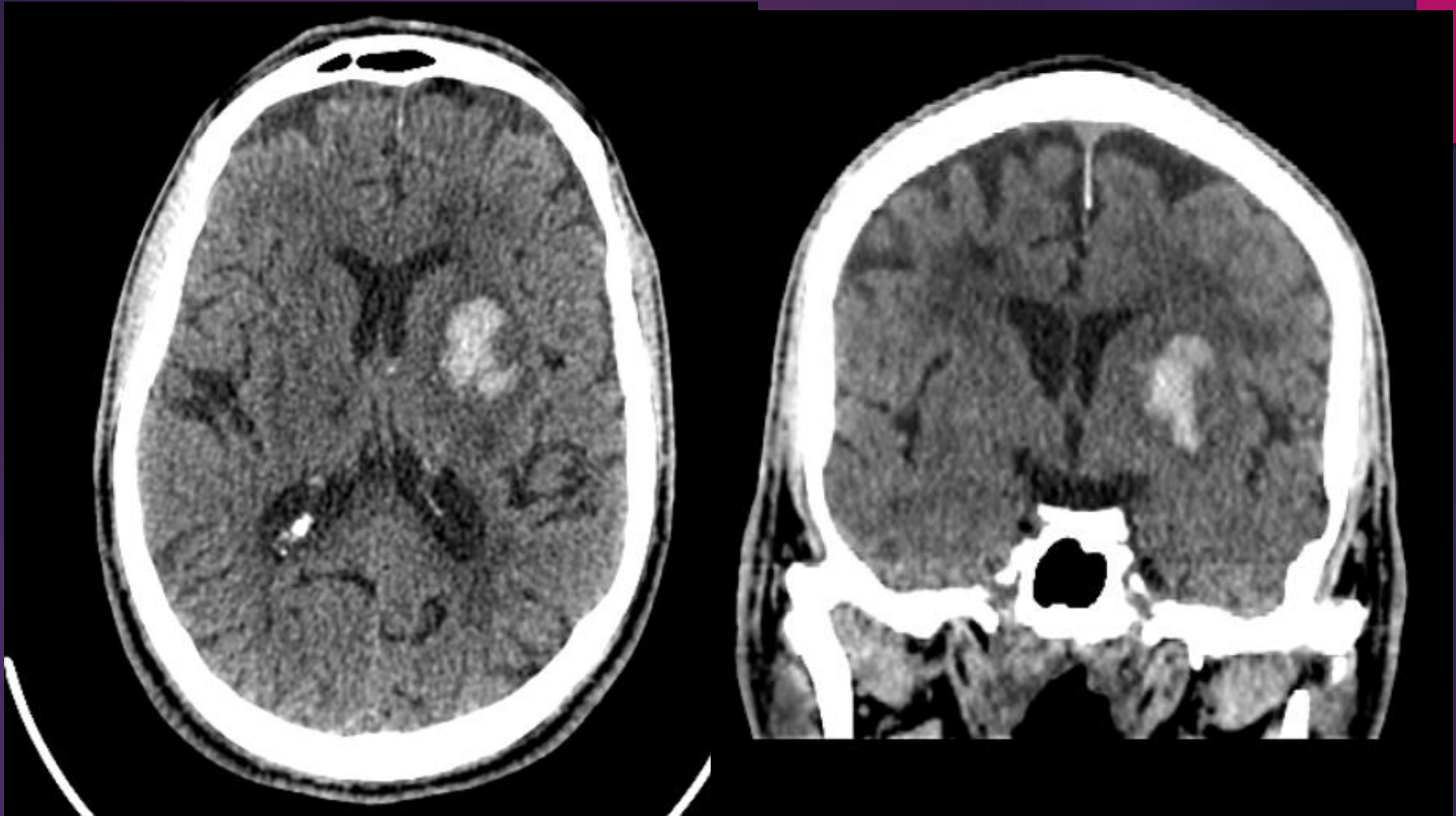
- ▶ Hemorrhagic

- hypertensive hemorrhage (mostly)

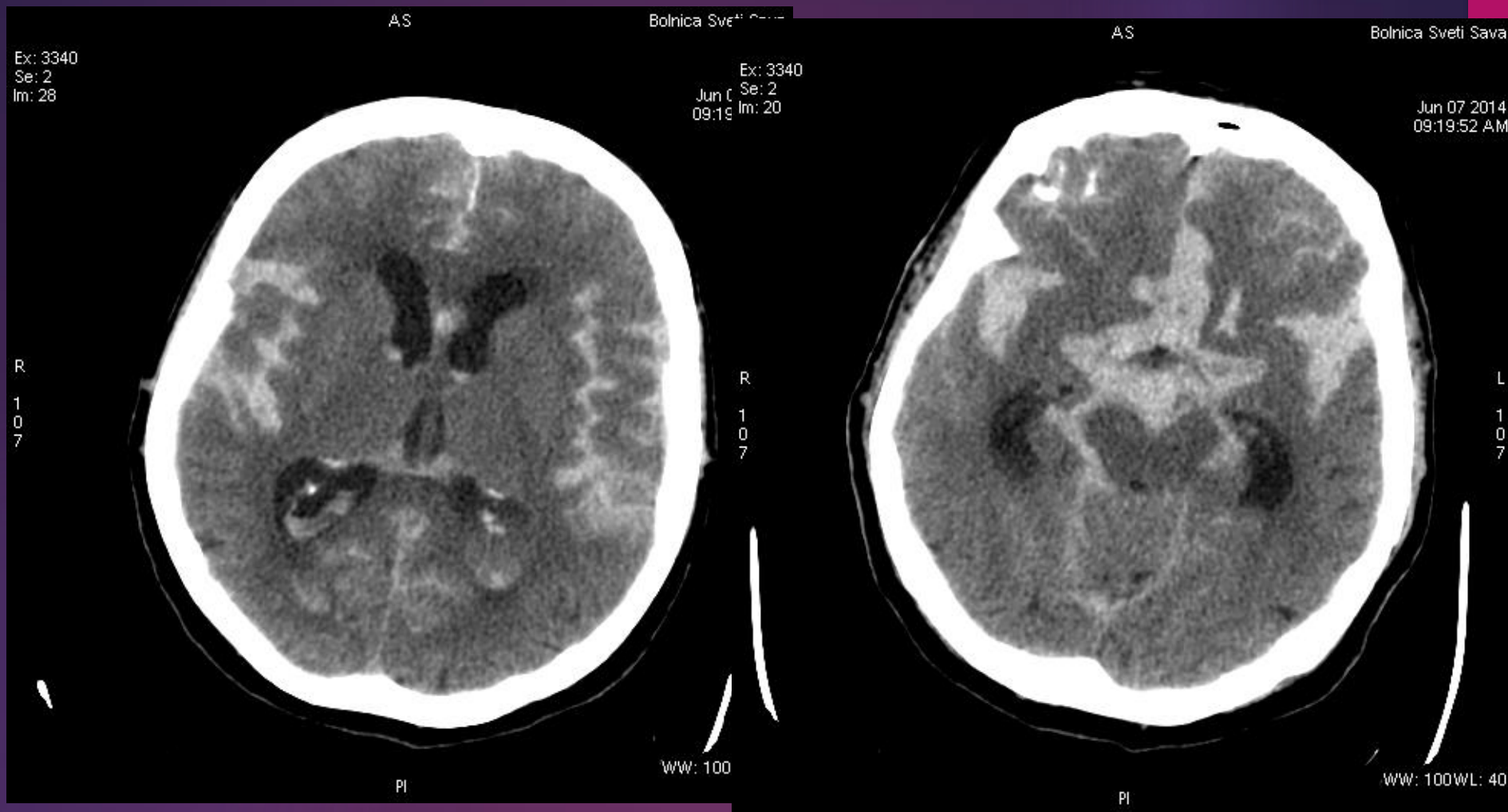
- amyloid angiopathy (elderly)

- SAH (aneurysm/spontaneous)

- AVMs

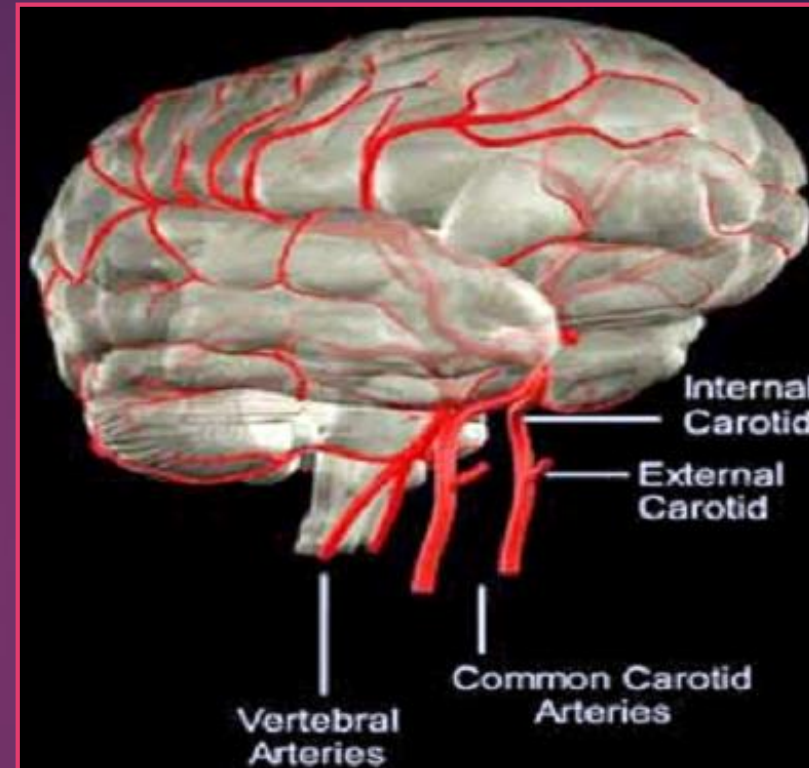
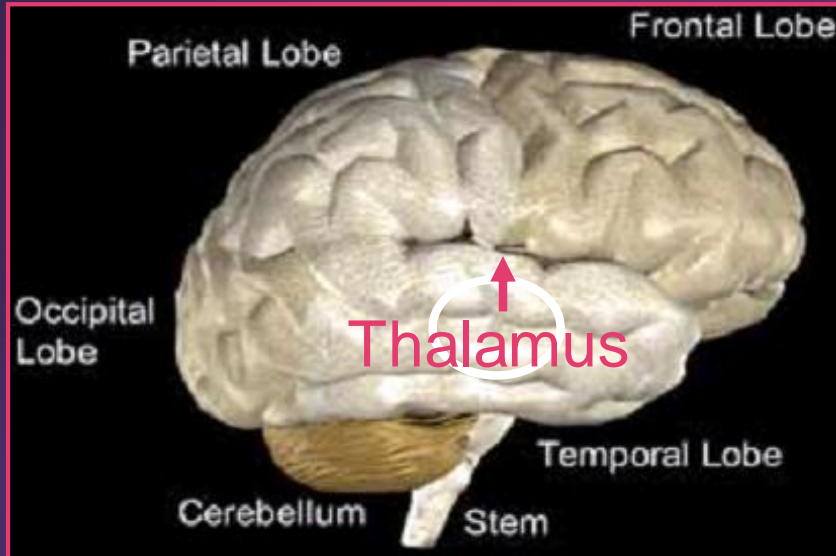


M, 68, right hemiplegia, HTA, vomitus - ICH reg left BG



F, 81y, coma - SAH.

Ischemic stroke



► Localisation:

- Frontal \pm GB > pons > cerebellum > m oblongata/spinalis
- Lacunar infarctions (<15 mm)

STROKE – RISK FACTORS

Unchangeable

- ❖ Age
- ❖ Gender
- ❖ Ethnicity
- ❖ Genetic factors.

Conditional changeable

- ❖ Heart diseases
- ❖ HTA
- ❖ HL
- ❖ DM
- ❖ Drug and ROH abuss

Clinical signs and symptoms

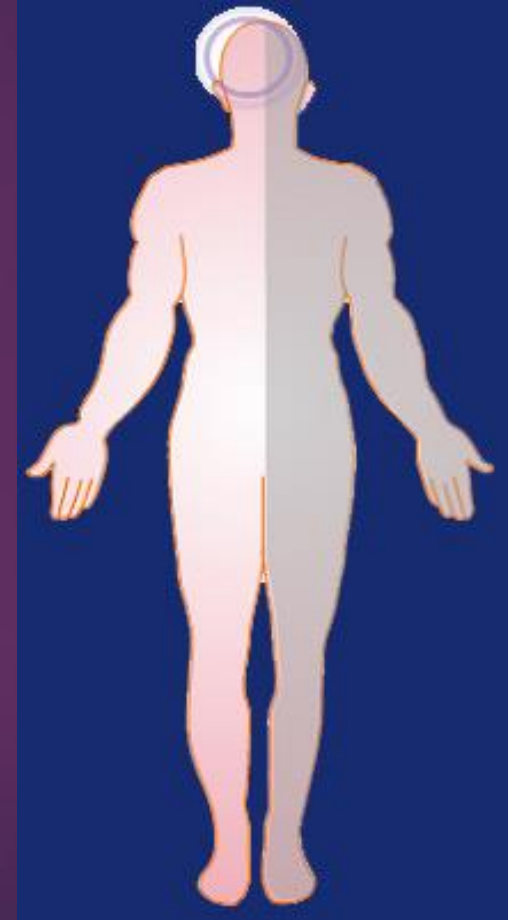
ICA

- ▶ Unilateral hemiparesis/plegia (*contralateral*)
- ▶ Weakness (*contralateral*)

Speech disturbances:

- ✓ Aphasia – troubles with writing, reading, understanding
- ✓ Dysarthria – slur speech .

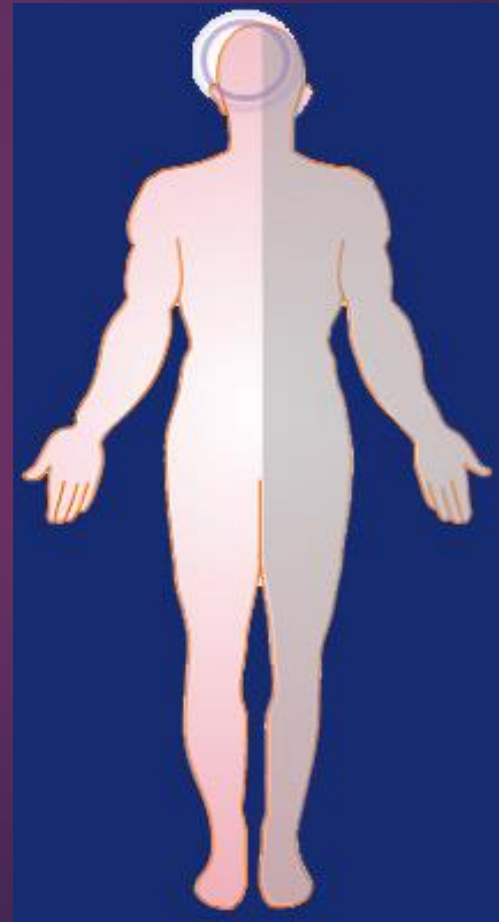
Visual field deficit (*contralateral*)

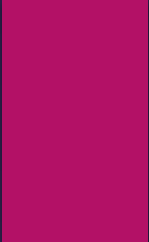


Clinical signs and symptoms

VB

- ▶ Vertigo (rarely in isolation)
- ▶ visual field deficit
 - ▶ Diplopia, nystagmus
- ▶ Hemiparesis (ipsilateral)
- ▶ Weakness
- ▶ Ataxia



- 
- ▶ Symptoms can occur alone, they are more likely to occur in combination.
 - ▶ No historical feature distinguishes ischemic from hemorrhagic stroke
 - ▶ Nausea, vomiting, headache, and sudden change in level of consciousness are more common in hemorrhagic strokes
 - ▶ Younger patients - a history of recent trauma, coagulopathies, illicit drug use (especially cocaine), migraines, or use of oral contraceptives should be elicited.

GOALS OF IMAGING

- ▶ Rule in or out other disease & processes (ICH, SAH, EDH, SDH, AVMs, Tu, etc)
- ▶ Define localization, extent and age of infarct
- ▶ Define “penumbra”
- ▶ Do so rapidly as possible



“TIME IS BRAIN”

PROTOCOLS

- ▶ Routine CT
- ▶ CT perfusion
- ▶ CT angiography
- ▶ MRI & MRA – 3D TOF
- ▶ MR perfusion

CT in Acute Stroke

- ▶ Initial first test of choice / crucial for stroke triage
- ▶ Ischemic vs hemorrhagic infarct
- ▶ Early detection in first few hours of neurological deficit (within 3-4,5-6h?)
- ▶ Identifies others mass lesions (Tu, ICH, SAH, EDH, SDH, AVMs ...)

EARLY SIGNS OF ACUTE STROKE

- ▶ hypo attenuating brain tissue.
- ▶ dense MCA sign.
- ▶ “blurred” nc lentiformis.
- ▶ “ insular ribbon” sign.
- ▶ loss of sulcal effacement

Hypo attenuation of brain tissue

- ▶ **Highly specific for irreversible acute stroke**
- ▶ **It is detected within first 6 hours**
- ▶ **Symptoms of stroke + clearly hypodensity on CT (first 6h)
= larger infarct volumes, more severe symptoms, less favorable clinical courses and a higher risk of hemorrhage.**
- ▶ **No hypodensity on CT - is it a good sign?.**



Loss of gray-white matter
differentiation

Hypo attenuation

Dense MCA sign

- ▶ Thrombus or embolus in MCA.
- ▶ CTA – occlusion MCA .



M, 78 y, left side paresis, CT – dense MCA sign , CTA - occlusion MCA.

“Insular ribbon” sign.

- ▶ Hypodensity of insular cortex.
- ▶ Highly specific for acute MCA stroke.
- ▶ Insular cortex – removed from the collateral flow.

“Blurred” nc lentiformis.

- ▶ “Blurred” basal ganglia.
- ▶ Most frequently and earliest sign of acute stroke.
- ▶ MCA infarction usually involved BG.



Dense MCA sign



“Insular ribbon”



“Blurred BG”

CT Perfusion

Evaluation of brain perfusion.

Methodology:

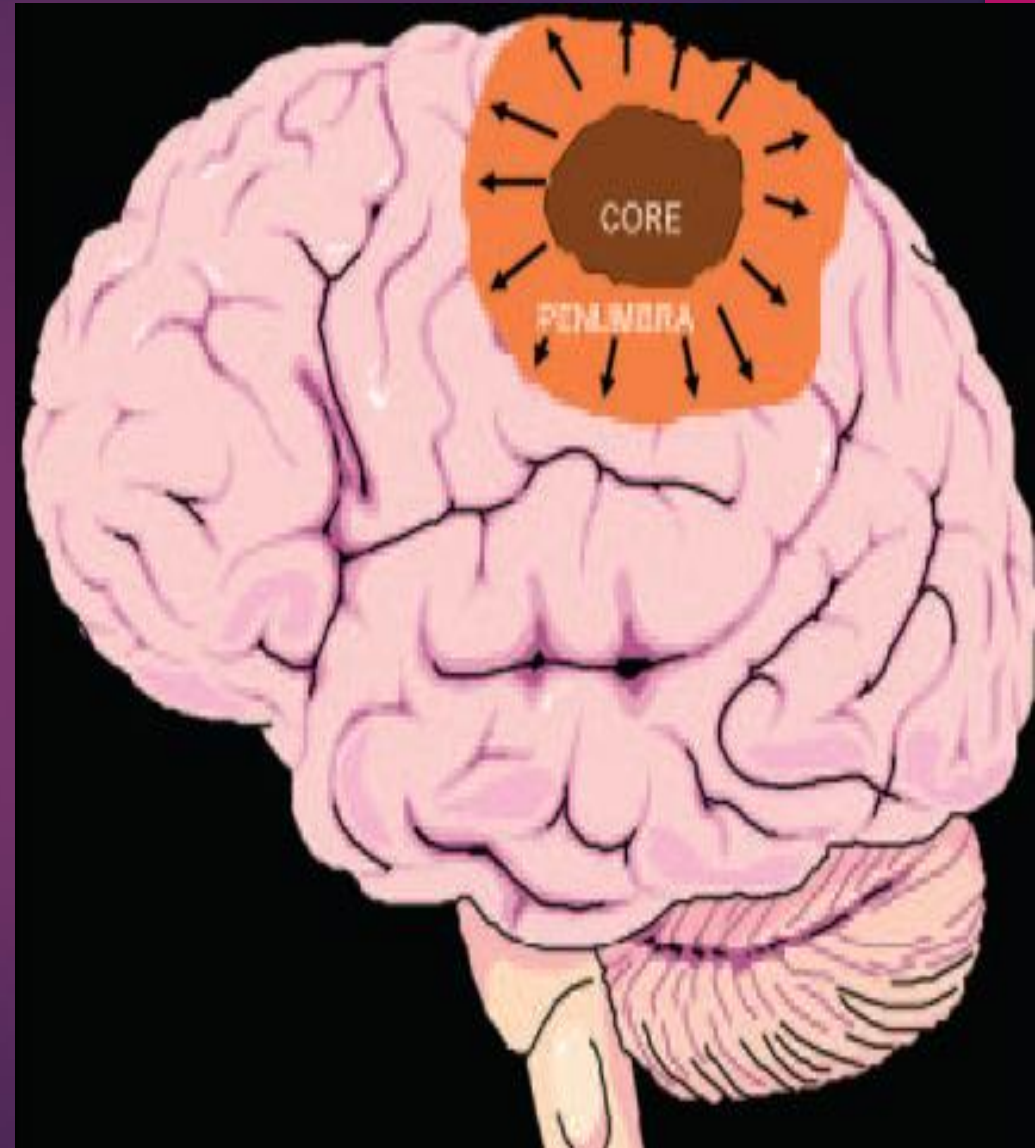
❖ i. v. – Iodinated contrast agent.

Indications:

- ▶ Acute ischemic stroke
- ▶ Tumor vascularization & follow-up after HT/RT

✓ Occlusion – irreversibly damage of brain tissue (**core**).

✓ hypoperfused tissue (collateral flow) – **penumbra**.



LESS TIME WE LOST , outcome will better

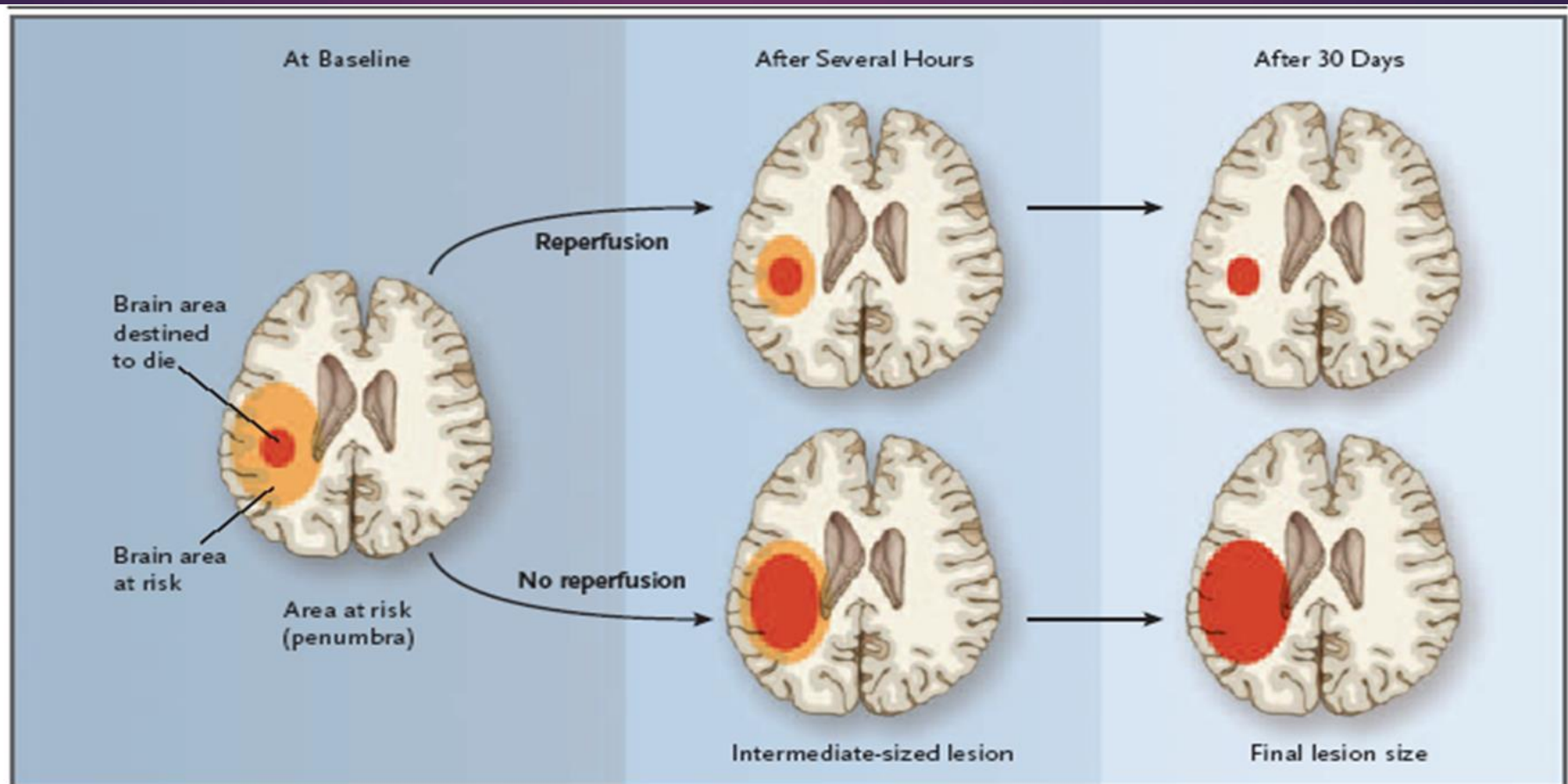
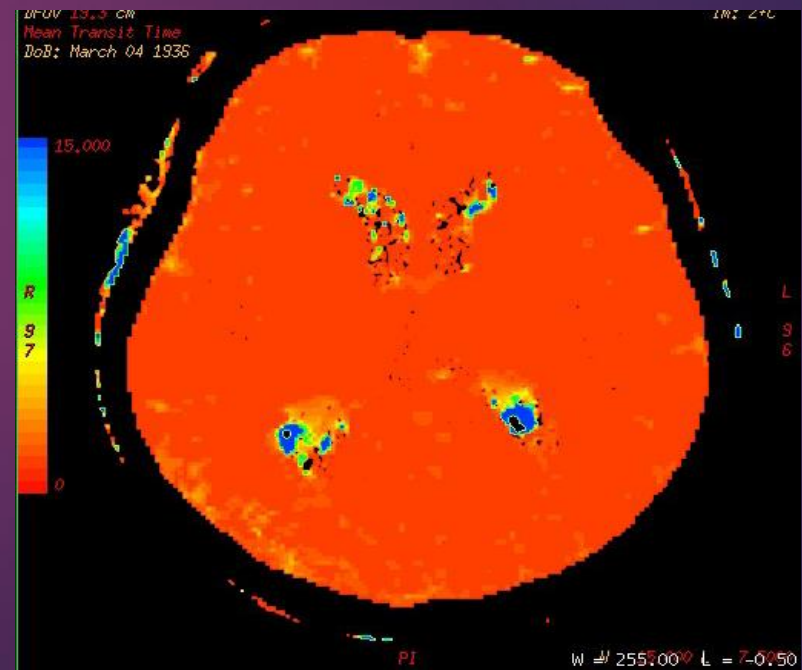
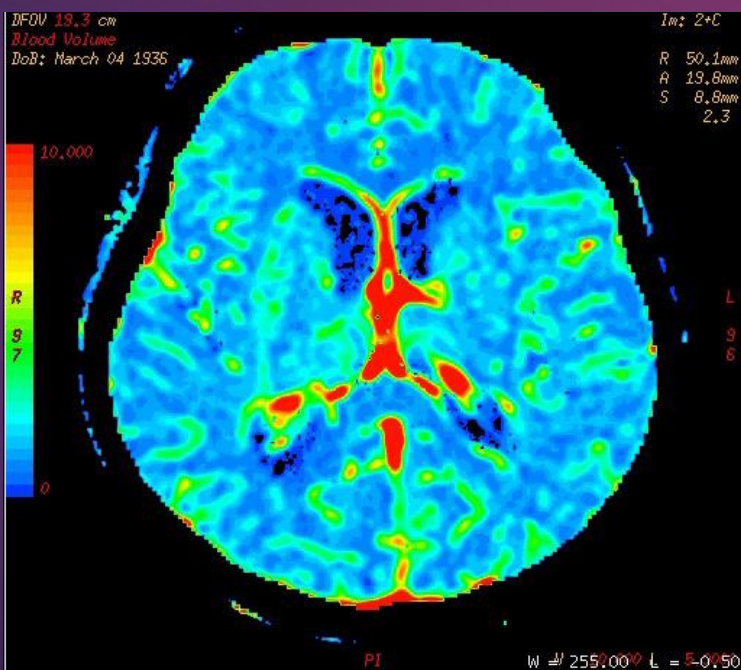
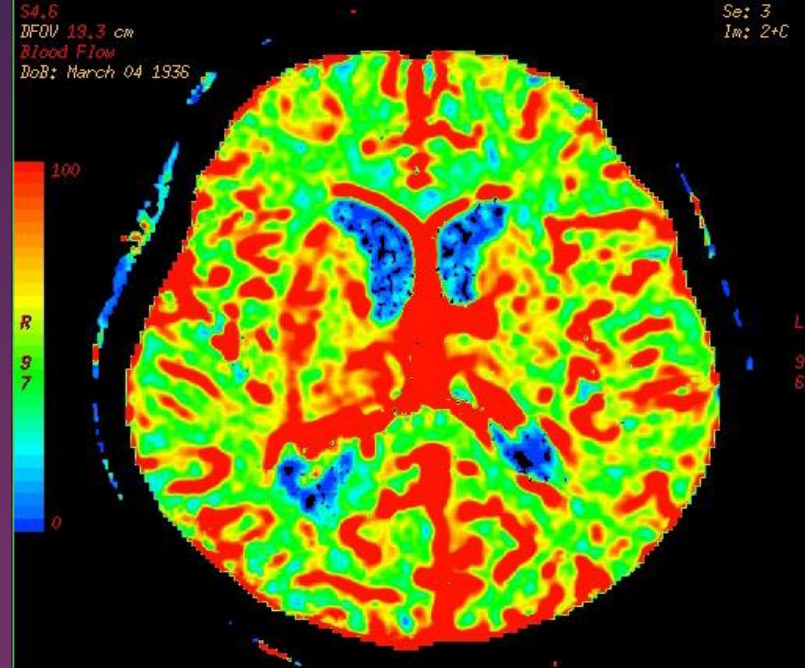
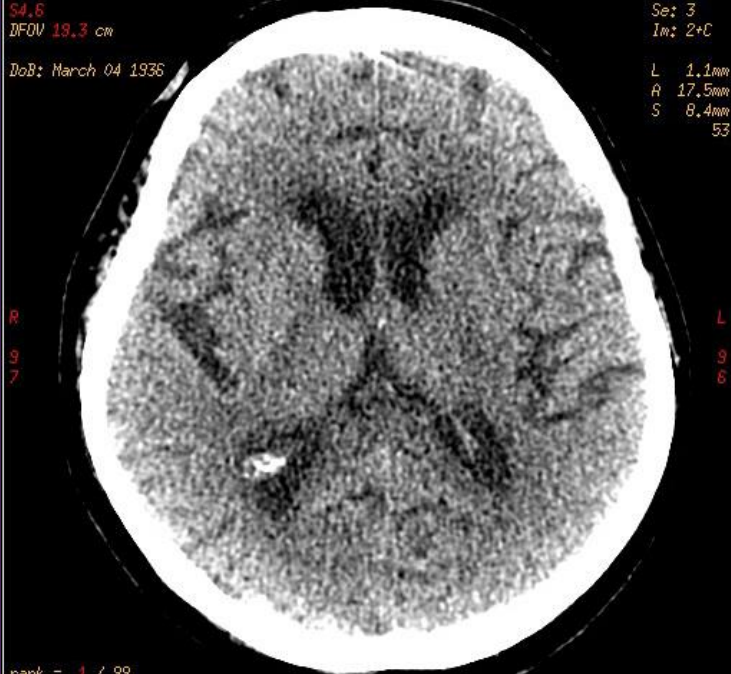


Figure 2. Representation of Penumbra in Acute Stroke.

The territory of the brain at risk for infarction is shown in yellow, and the brain destined to die is shown in red. The tissue shown in yellow represents potentially salvageable brain cells if reperfusion occurs rapidly.

NORMAL CT PERFUSION



GE MEDICAL SYSTEMS
BrightSpeed ct99
Ex: 18635
Se: 2
Im: 13
OM S0.00 0
DFOV 19.9cm
STNDM

AS

R
1
0
2

kV 120
mA 200
Noise Index: 3.9~
Head
2.500mm/5.64 0.562:1
Tilt: S4.5
1s /HE:05.32

PI

GE MEDICAL SYSTEMS
BrightSpeed ct99
Bolnica Sveti Sava
RADELJIC VUCETA
Se: 2
Im: 16
OM S7.59 0
DFOV 19.9cm
STNDM

AS

Mag = 1.21
FL:
ROT:

R
1
0
2

kV 120
mA 202
Noise Index: 3.9~
Head
2.500mm/5.64 0.562:1
Tilt: S4.5
1s /HE:06.65
WW: 100WL: 40

PI

Bolnica Sveti Sava
RADELJIC VUCETA
M72Y
1512
Feb 04 2012
03:48:40 PM
512 X 512

Mag = 1.21
FL:
ROT:

L
9
7

WW: 100WL: 40

M, 72y, right hemiplegia - CT



▶ **CT & CT Perfusion - Advantages:**

▶ **Fast**

▶ **Patient monitoring**

▶ **CT vs MR = f (money)**



▶ **CT & CT Perfusion - Disadvantages:**

- ▶ 4 slices, 2cm of brain tissue - only!!!!
- ▶ Posterior fossa infarction
- ▶ Radiation.

MAGNETIC RESONANCE IMAGING - MRI

- ▶ Routine brain MRI- T1W, T2W, FLAIR/PD, DWI&ADC, T2*/SWI
- ▶ 3D TOF MRA
 - ▶ MR perfusion – MRI PWI
 - ▶ Diffusion tensor imaging - DTI
 - ▶ MR spectroscopy (MRS)
 - ▶ Functional MRI (fMRI).

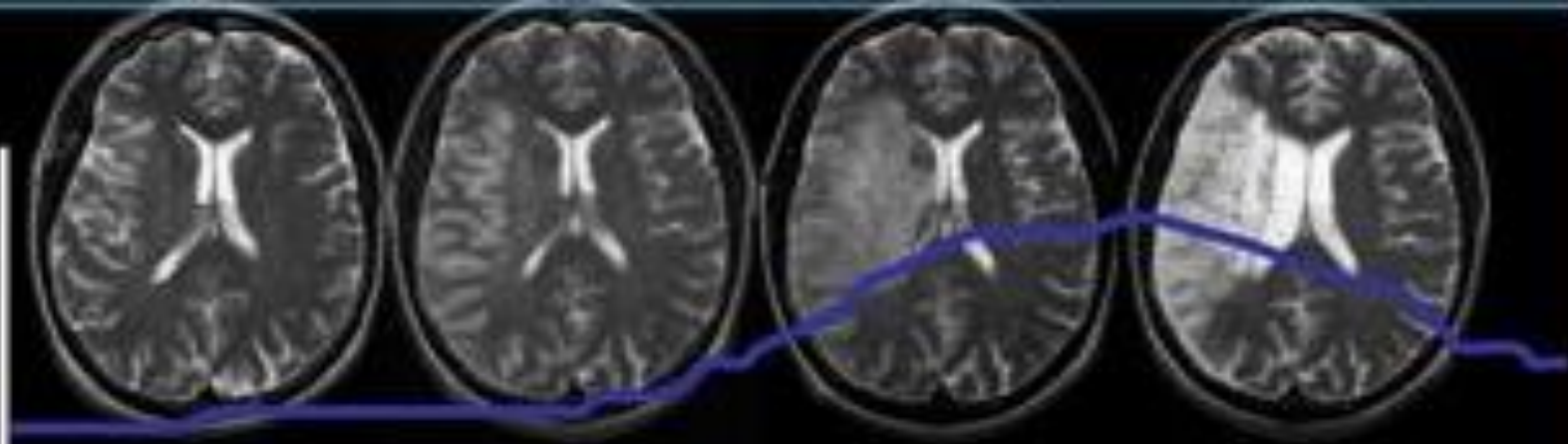
- ❖ DWI is the most sensitive sequence for stroke imaging (within first few hours).
- ❖ DWI is sensitive to restriction of Brownian motion of extracellular water due to imbalance caused by cytotoxic edema.
- ❖ DWI – infarctions of FCP and posterior vascular territory
- ❖ MRI – dg ischemic stroke with atypical clinical presentation

- ▶ Acute stroke - ↑ SI T2WI/FLAIR.
- ▶ MRI - $\geq 80\%$ acute stroke lesions within first 24-48h.
- ▶ ↑ SI T2WI/FLAIR = CT hypodensity (irreversibly brain tissue damage).
- ▶ Negative MRI within first ≥ 6 h.

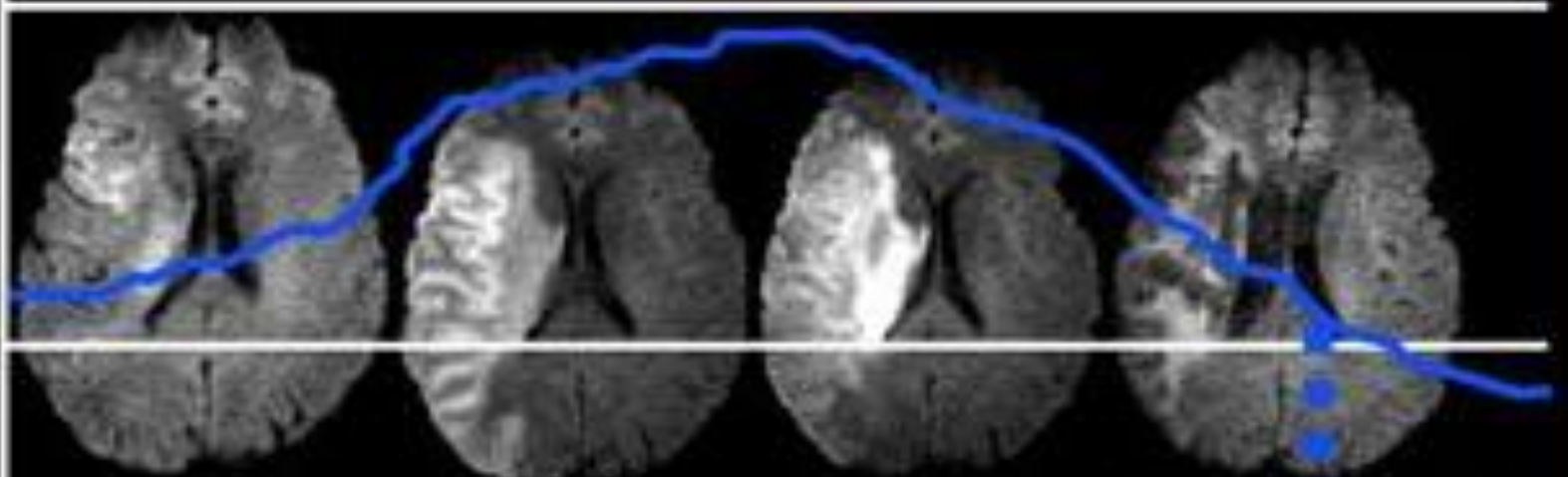
DWI

- ▶ High sensitivity for detection of acute stroke.
- ▶ SI changes – within first 1-2h.
- ▶ SI changes during the time:
 - Acute stroke: ↑ SI DWI
 - Chronic stroke: ↓ SI DWI

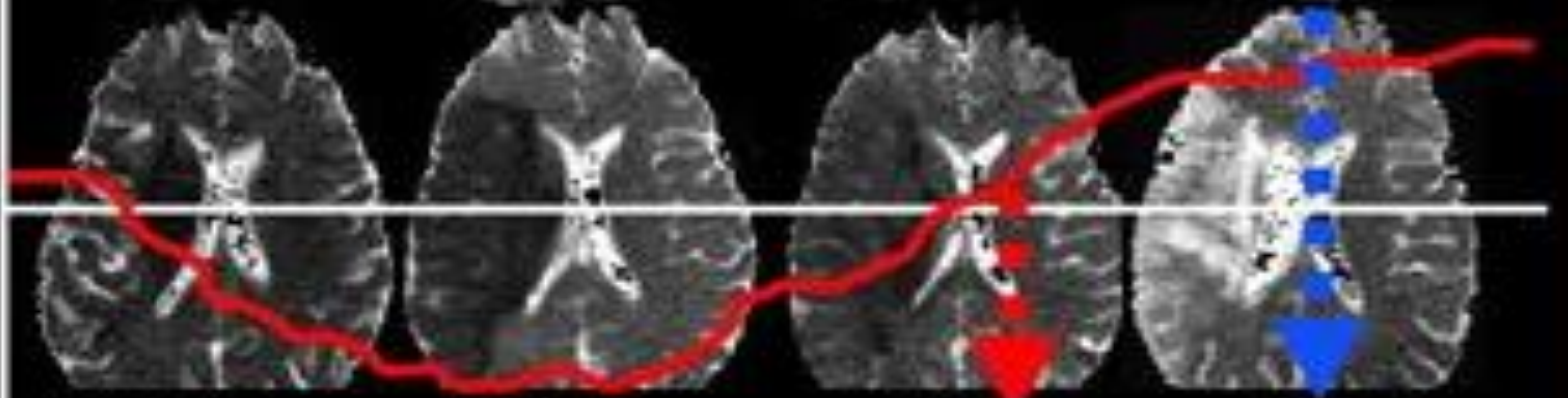
T2WI



DWI



ADC

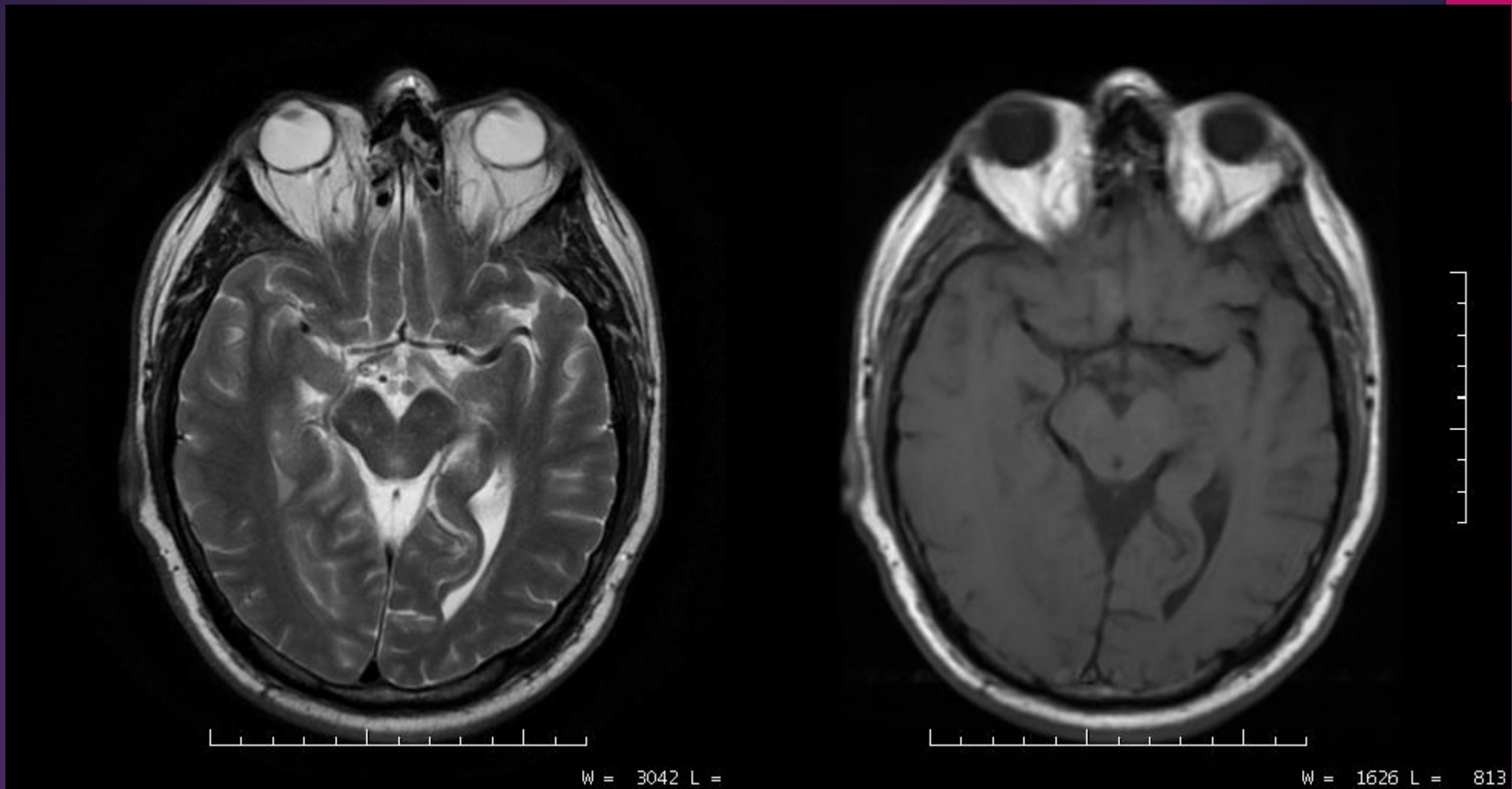


Acute

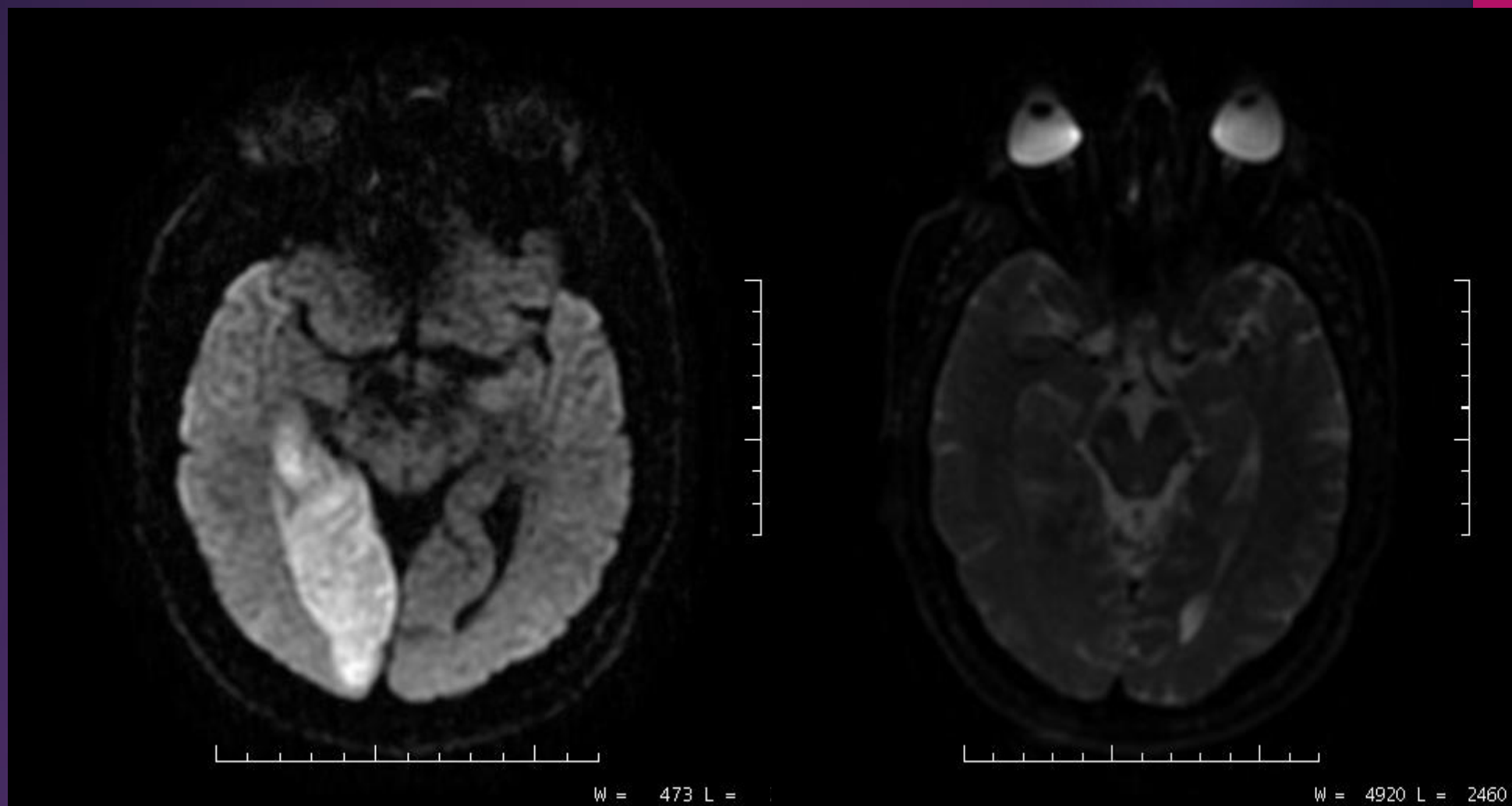
24 h

7 d

30 d



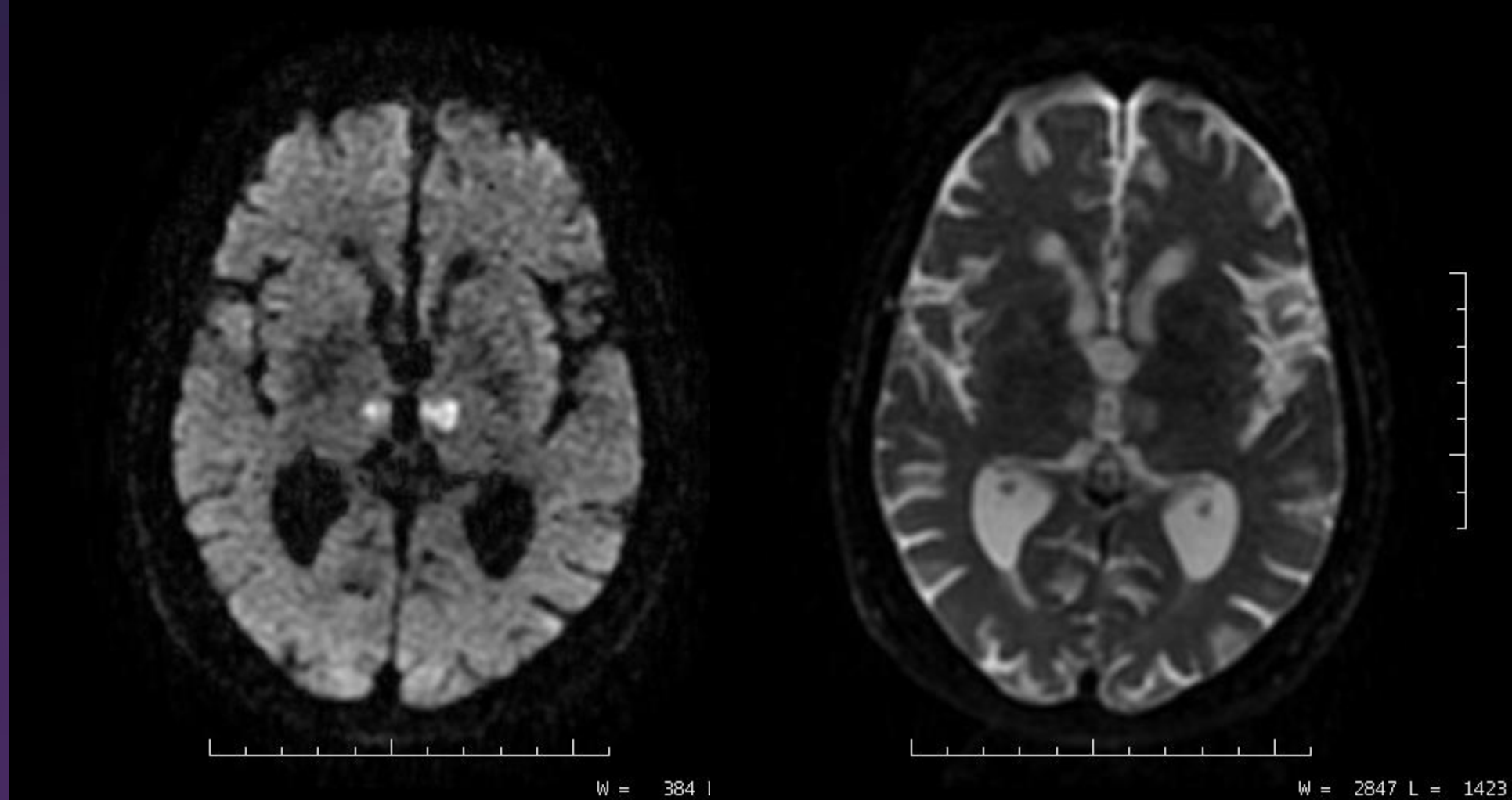
M, 54y, left homonym hemianopsia



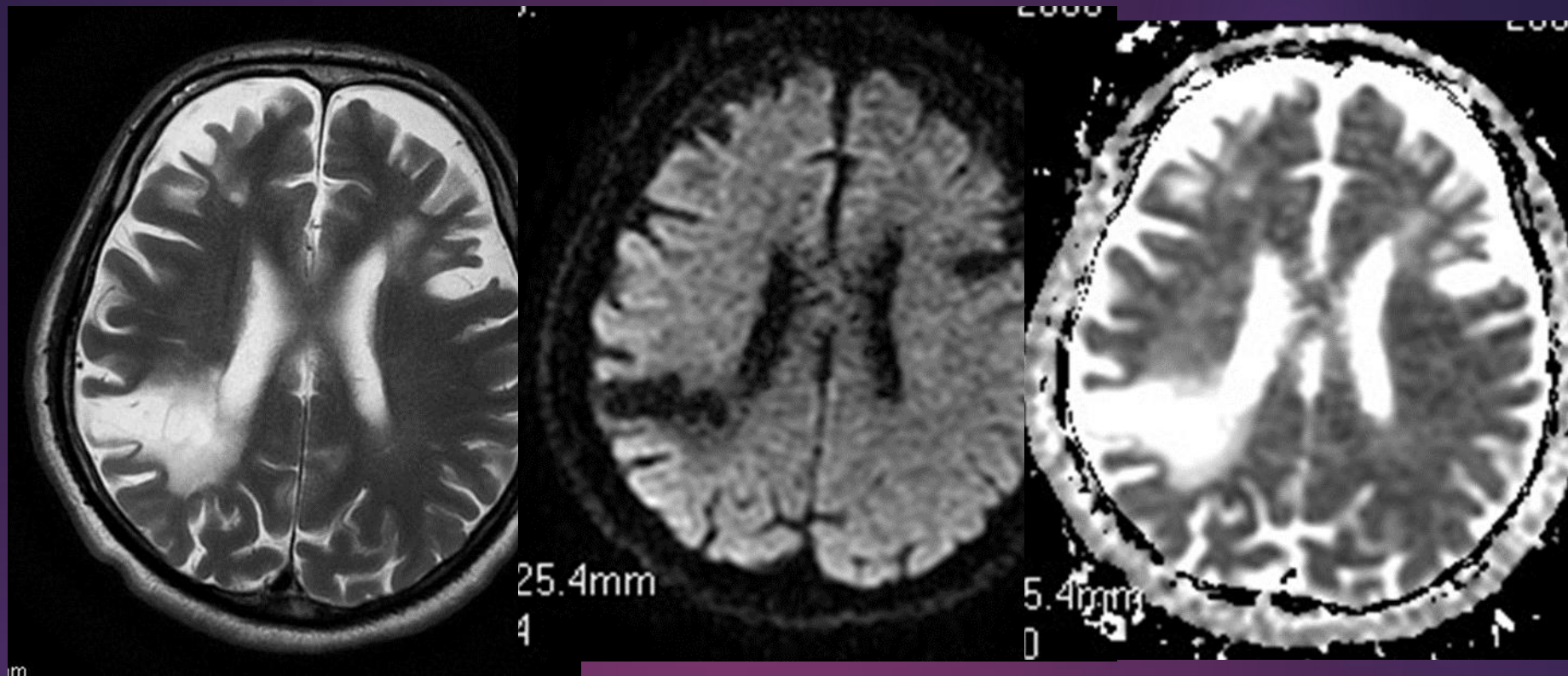
DWI & ADC



F, 78y, epi partial, hedeache, bihemiparesis.



DWI / ADC - bithalamic subacute infarction



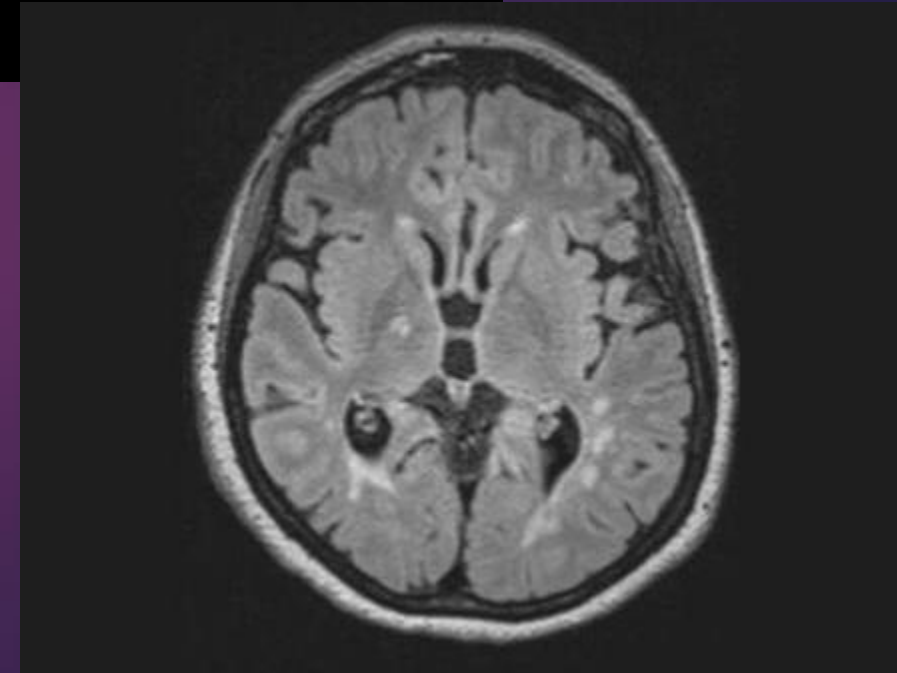
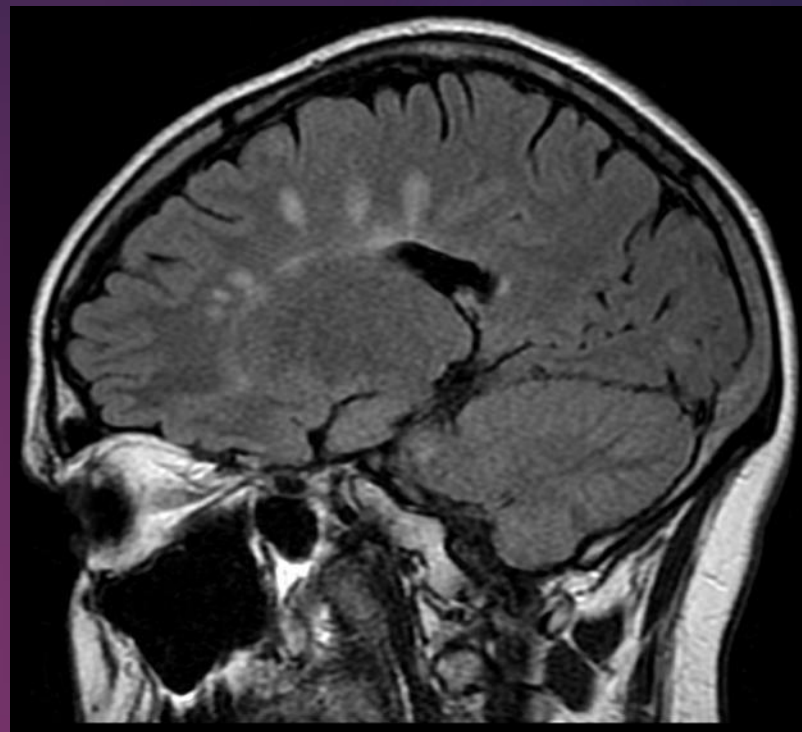
M, 59y, hemiparesis l sin residual

White matter diseases

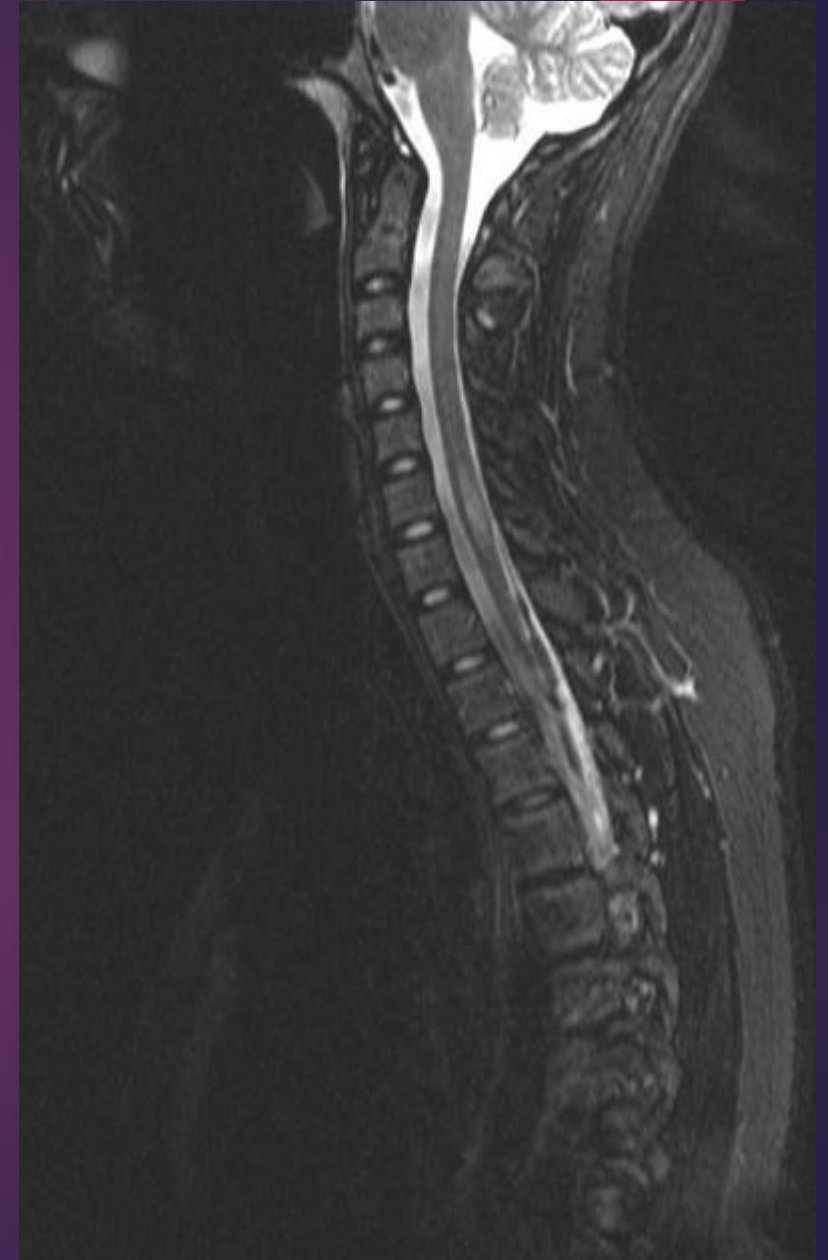
- ▶ White matter diseases are a group of conditions that predominantly or significantly affect the white matter of the brain. They comprise a vast heterogeneous group and have a variety of appearances and presentations. They cause disease by altering the process of normal myelination.
- ▶ White matter disease can be broadly grouped into:
- ▶ **demyelinating disorders:** damage and/or destruction of previously normally myelinated structures, e.g. multiple sclerosis, ADEM
- ▶ **dysmyelinating disorders** : abnormal structure and function of myelin, usually secondary to a hereditary disorder, e.g. leukodystrophies (note, however, that many leukodystrophies have a demyelinating component)
- ▶ **hypomyelinating disorders:** reduction in the amount of otherwise normal myelin, e.g. hypomyelination of prematurity

MULTIPLE SCLEROSIS

- ▶ Plaques can occur anywhere in the central nervous system. They are typically ovoid in shape and perivenular in distribution.
- ▶ Location of the plaques can be infratentorial, in the deep white matter, periventricular, juxtacortical or mixed white matter-grey matter lesions.
- ▶ T2/FLAIR hyperintense
- ▶ active lesions show enhancement



MS



Non-traumatic intracranial hemorrhage

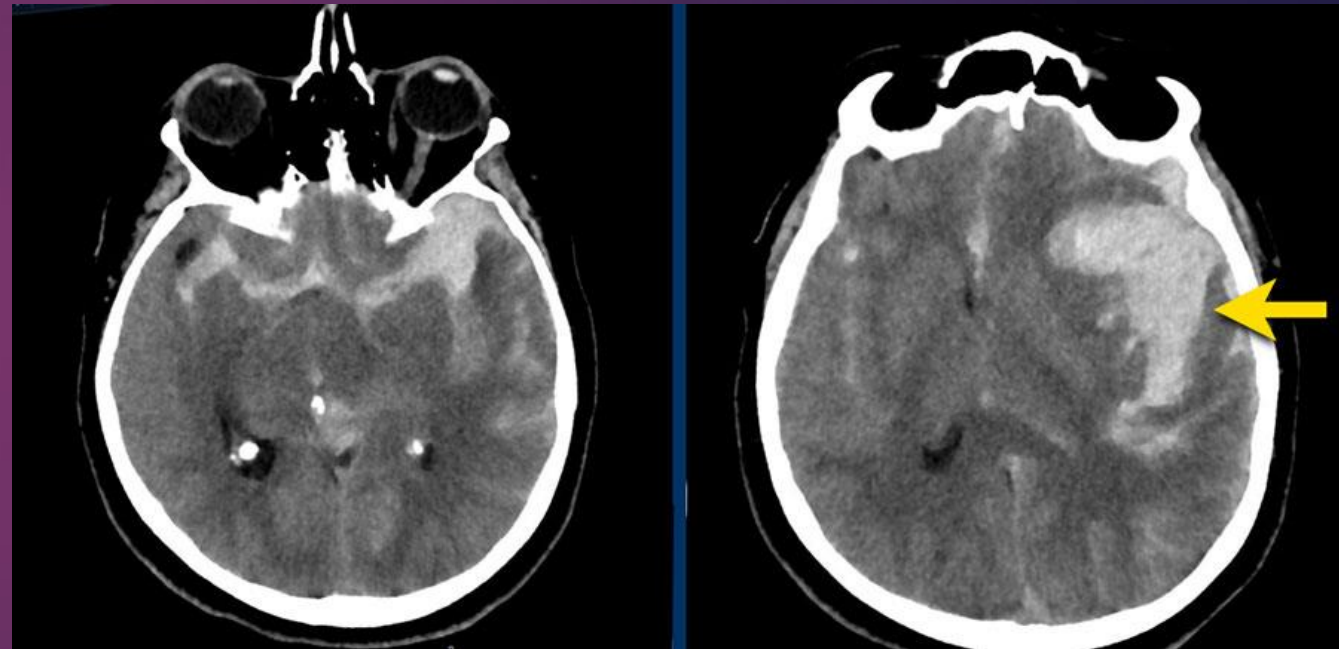
- ▶ 85% of non-traumatic hemorrhages are seen in patients with hypertension or cerebral amyloid angiopathy (CAA).
- ▶ In hypertension the hemorrhages are typically in a central position in the basal ganglia, pons, thalamus and cerebellum, while in CAA they are typically more in a peripheral location - deep in the frontal, parietal or temporal lobes - also called lobar hemorrhages.

Differential Diagnosis by location

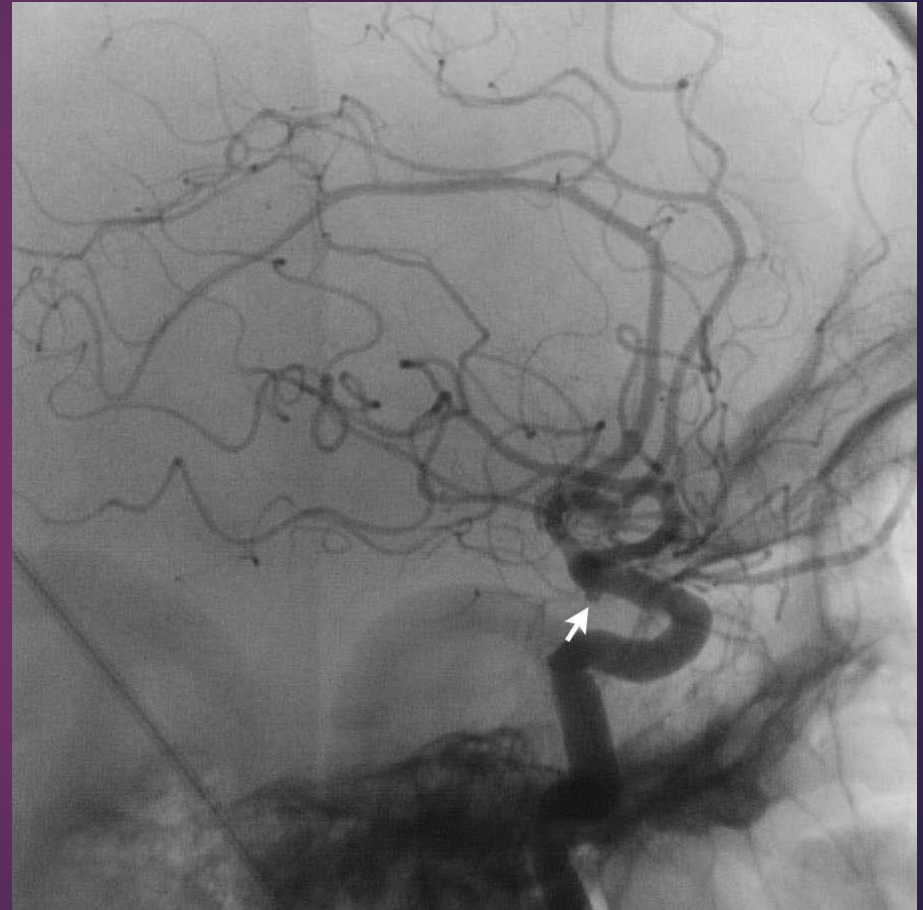
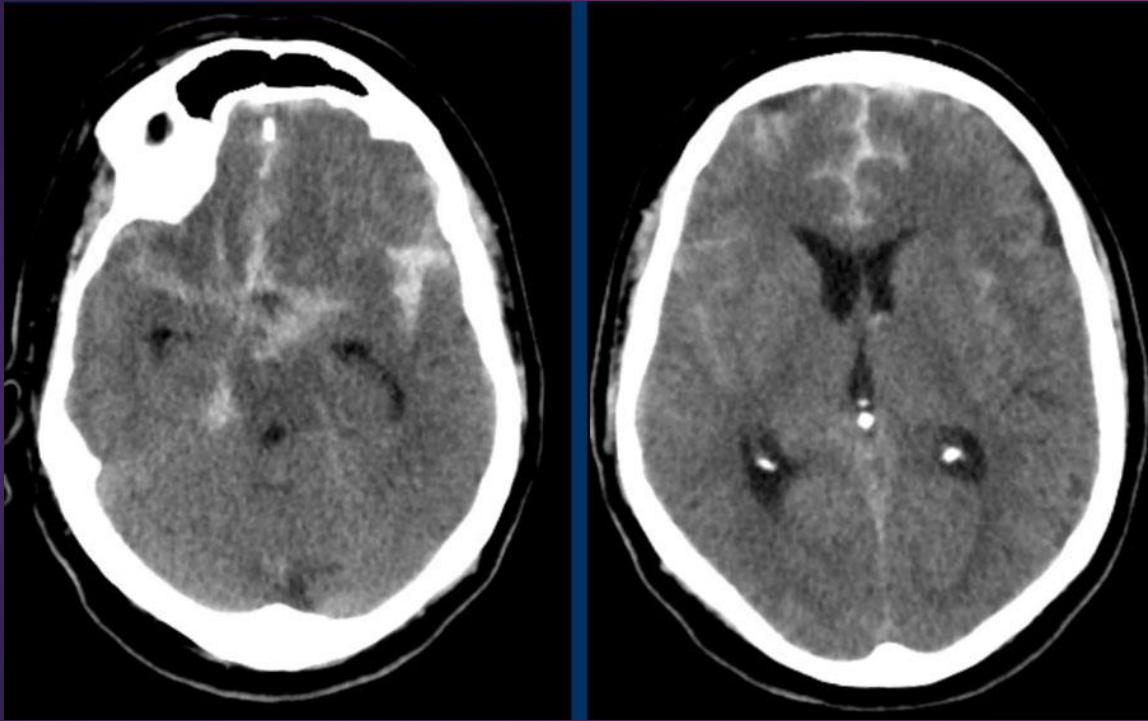
Intraparenchymal	Basal ganglia	}	Hypertension most common
	Pons Cerebellum		
	Lobar hematoma	}	Cerebral amyloid angiopathy Venous infact Vascular malformation Tumor - metastases Hypertension
Subarachnoidal	Aneurysm (80%)		
	Non-aneurysmal perimesencephalic (10%)		
	less common	}	Arteriovenous malformations Drug abuse - Cocaine, XTC PRESS Intracranial dissection

Non-traumatic SAH

- ▶ is usually the result of aneurysmal rupture with spread of blood into the subarchnoidal cisterns
- ▶ The first choice of imaging modality in a patient with a clinical suspicion of SAH is a non-enhanced CT scan (NECT).
- ▶ NECT is positive for SAH in 98% within 12 hours of onset.
- ▶ If the suspicion is strong, but the CT is negative, a lumbar puncture is performed to detect blood in the CSF.



CT images of a patient with a spontaneous SAH.



DSA



Localization of the aneurysm

Aneurysm	Subarachnoid hemorrhage
Carotistop	Suprasellar cistern
Anterior communicating artery	Septum pellucidum (in frontal lobes)
Middle cerebral artery	Sylvian fissure (in temporal lobe)
Anterior cerebral artery	Sylvian fissure
Basilary artery top	Interpenduncular fossa, brainstem or thalamus
PICA	4th ventricle

Complications of SAH

Rebleed

- Highest risk within 48 hours

Communicating hydrocephalus

- Sometimes necessitating shunting

Ischemia

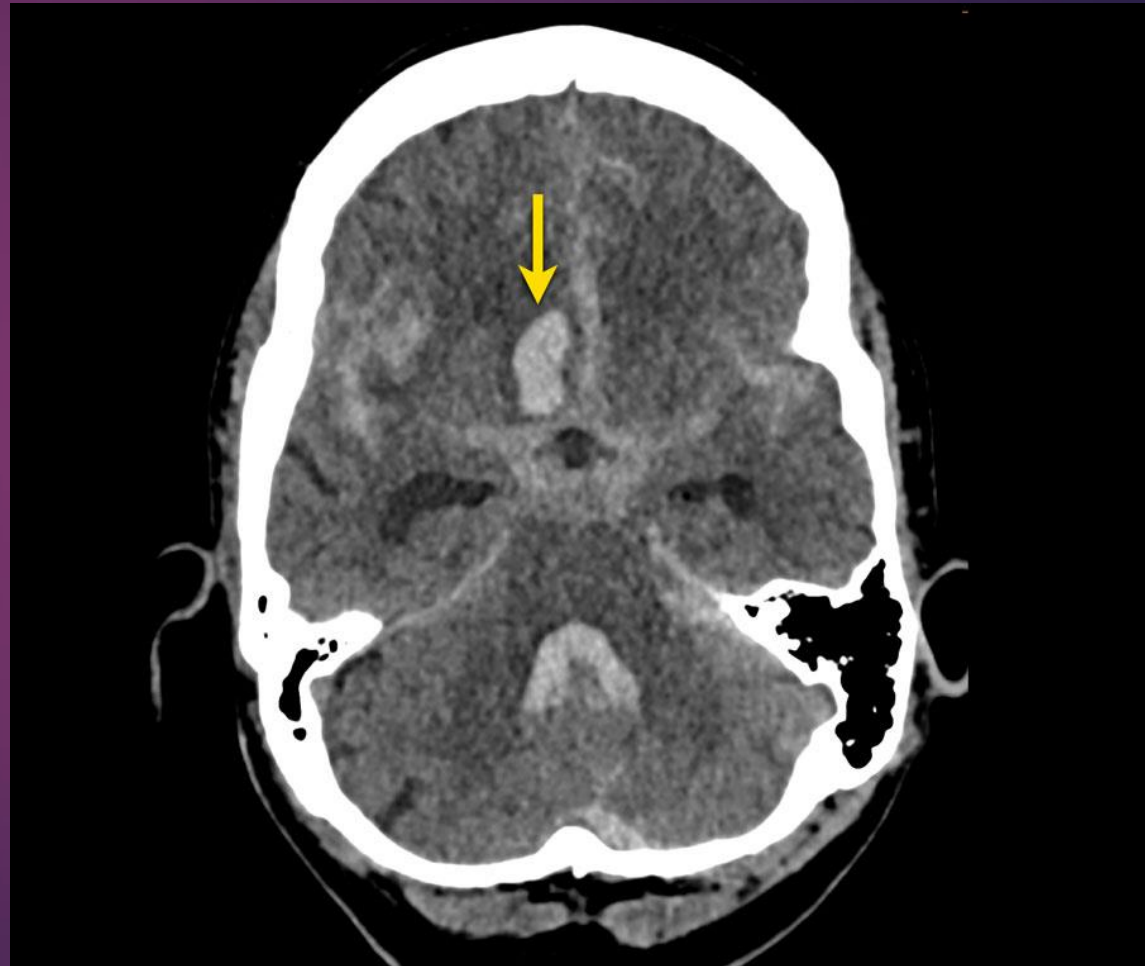
- Secondary to vasospasm (4 -11 days after ictus)
- Due to occlusion of artery (coiling)

Intracranial aneurysms

- ▶ Saccular aneurysms are the most common type of aneurysm. They are round or lobulated and arise at bifurcations of the Circle of Willis.
- ▶ They are multiple in 20%. In 5% they measure over 2,5 cm and are called “Giant aneurysms”.
- ▶
- ▶ Other type of aneurysms are fusiform (extreme focal ectasia in atherosclerotic disease) and mycotic aneurysms. The latter are seen as peripheral located intraparenchymal clots with white matter oedema surrounding haemorrhage. They are caused by septic emboli in patient with known bacteraemia.

Intraparenchymal hemorrhage in SAH

- ▶ When an aneurysm ruptures the pressure of the jet can be so high, that the blood will be injected into the brain parenchyma as can be seen in this example.
- ▶ This patient presented with a subarachnoidal haemorrhage due to an aneurysm in the anterior communicating artery.
- ▶ There is also an intraparenchymal hematoma in the right gyrus rectus



Lumbar Disc Herniation

- ▶ Disc herniation refers to the displacement of intervertebral disc material beyond the normal confines of the disc but involving less than 25% of the circumference (to distinguish it from a disc bulge). A herniation may contain nucleus pulposus, vertebral endplate cartilage, apophyseal bone/osteophyte and annulus fibrosus.

Protrusion

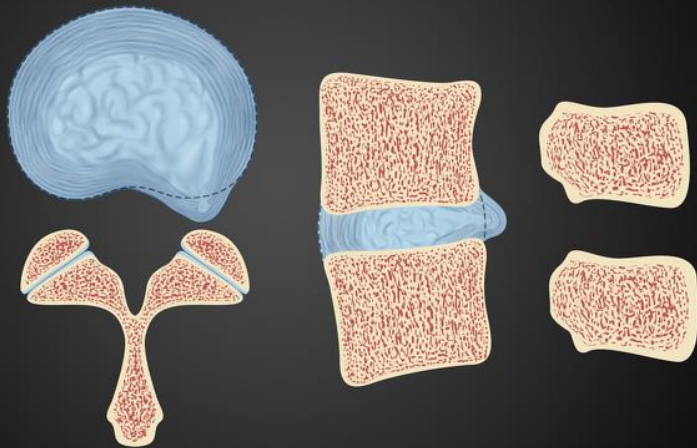
- ▶ base wider than herniation, confined to disc level outer annular fibers intact

Extrusion

- ▶ base (a.k.a. neck) narrower than herniation 'dome'
- ▶ may extend above or below endplates or adjacent vertebrae
- ▶ complete annular tear with passage of nuclear material beyond disc annulus
- ▶ disc material can then migrate away from annulus or become sequestered

Disc protrusion

<25% of disc circumference, base wider than herniation

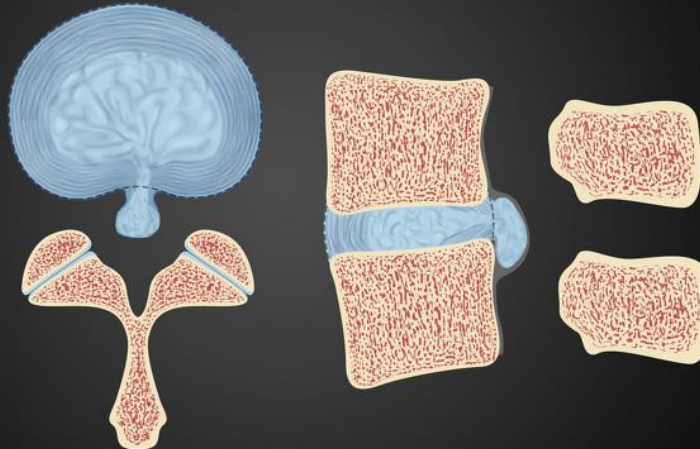


M. Skalski



Disc extrusion

<25% of disc circumference, base narrower than herniation

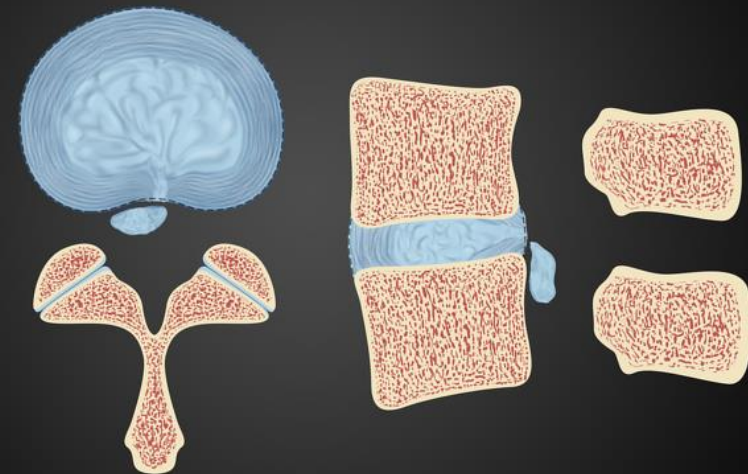


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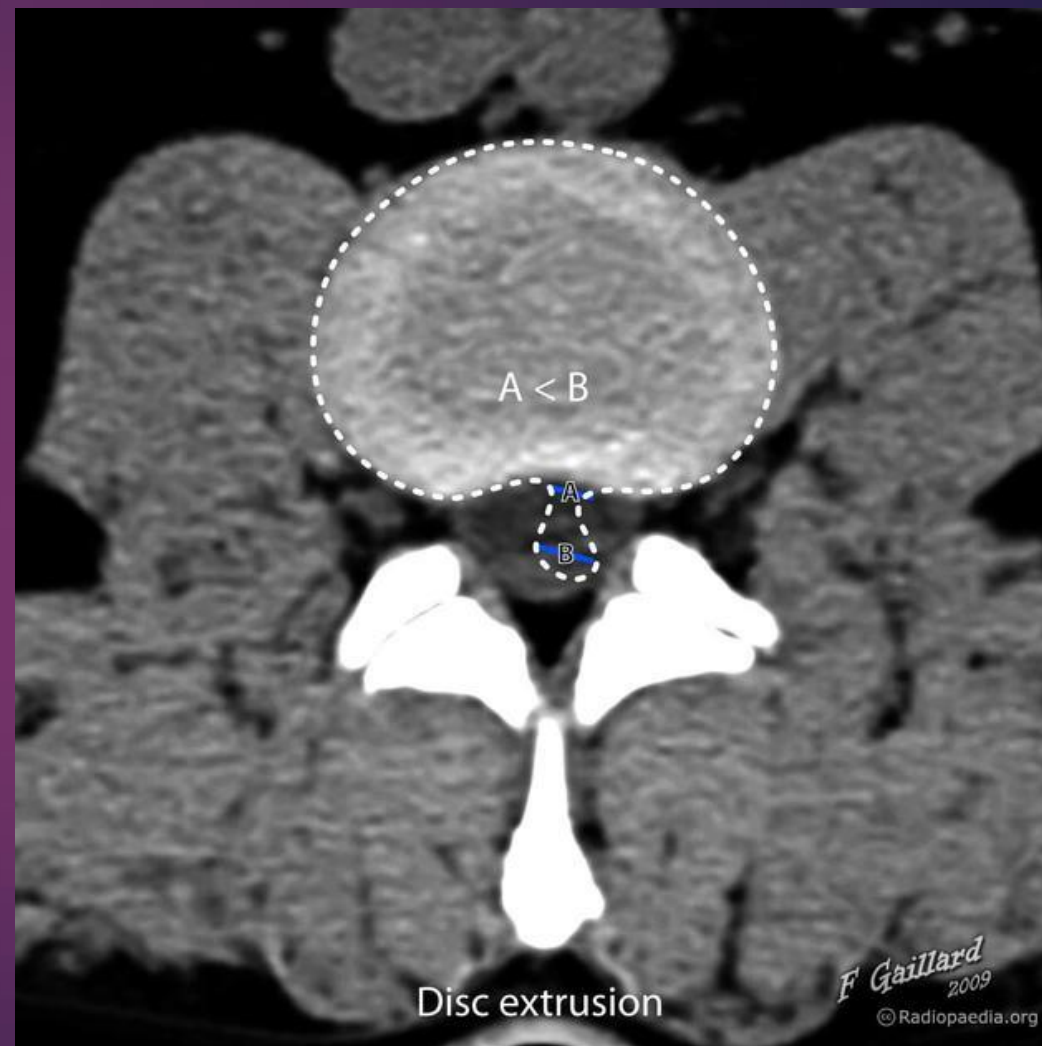
Disc sequestration

free fragment of disc material with no connection to disc



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Thank You