

DEPARTMENT OF RADIOLOGY

**Radiological research methods and radiological  
semiotics of acute cerebrovascular accident**

Almaty 2021

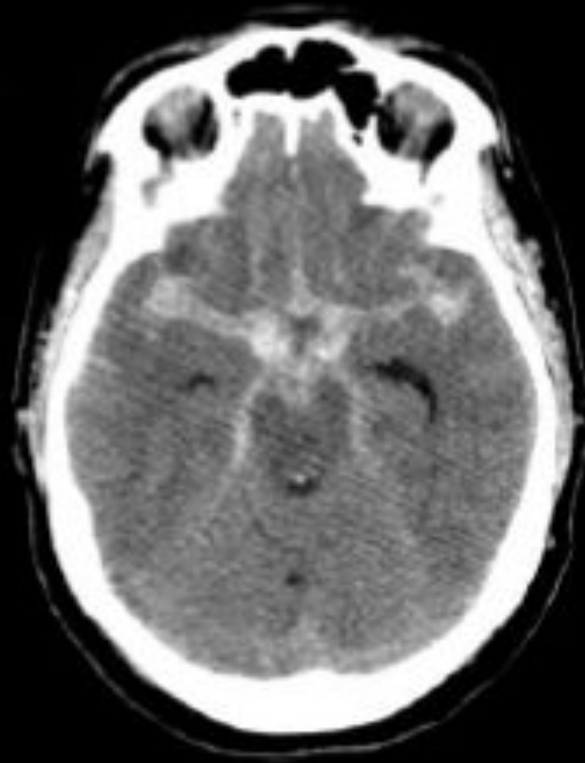
# ACUTE CEREBROVASCULAR ACCIDENT(CVA, STROKE)

- – acute and severe brain disease. Blood may be interrupted or stop moving through an artery, because the artery is blocked (ischaemic stroke) or bursts (haemorrhagic stroke).

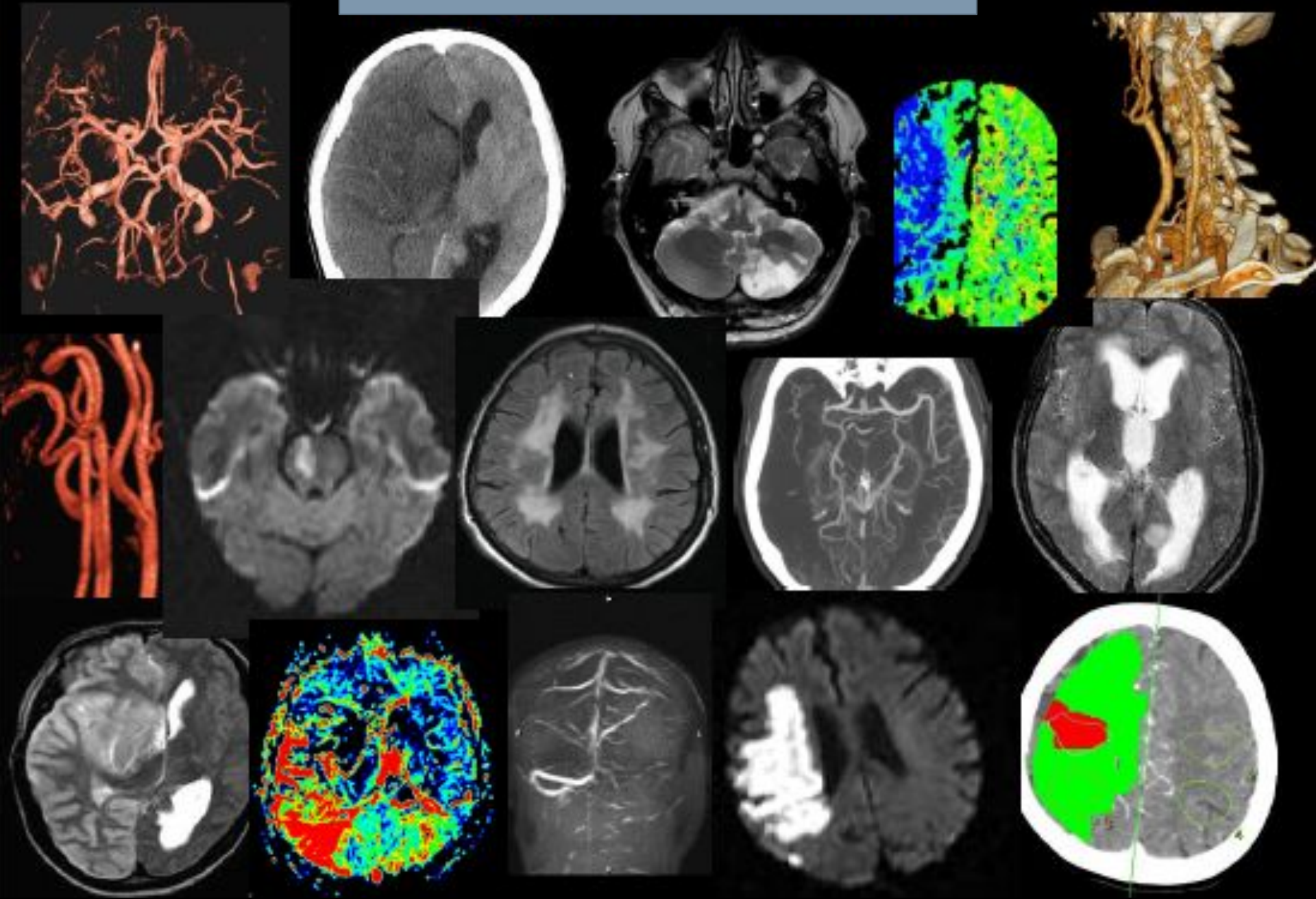
# Types of stroke

Ischemic-20%

Hemorrhagic-80%



# CT and MRI



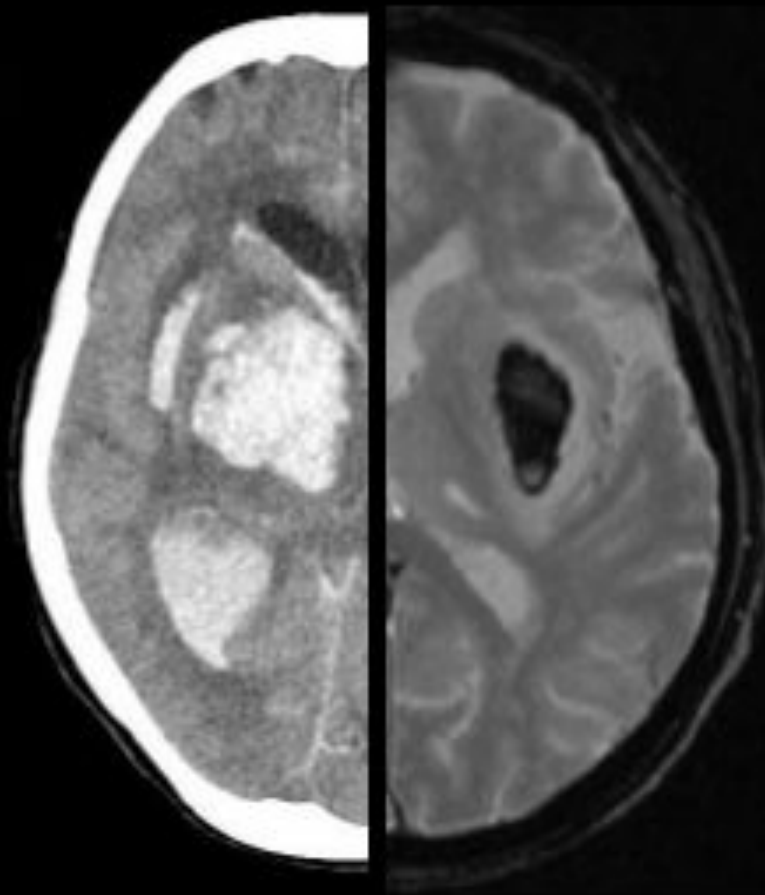
# Neuroimaging tasks

Define:

1. Intracerebral hemorrhage/infarction
  2. Localization and size of the lesion
  3. Time from the beginning progression infaction
  4. The state of intracranial vessels and collateral blood flow
  5. Penumbra zone
  6. The effectiveness of the therapy
-

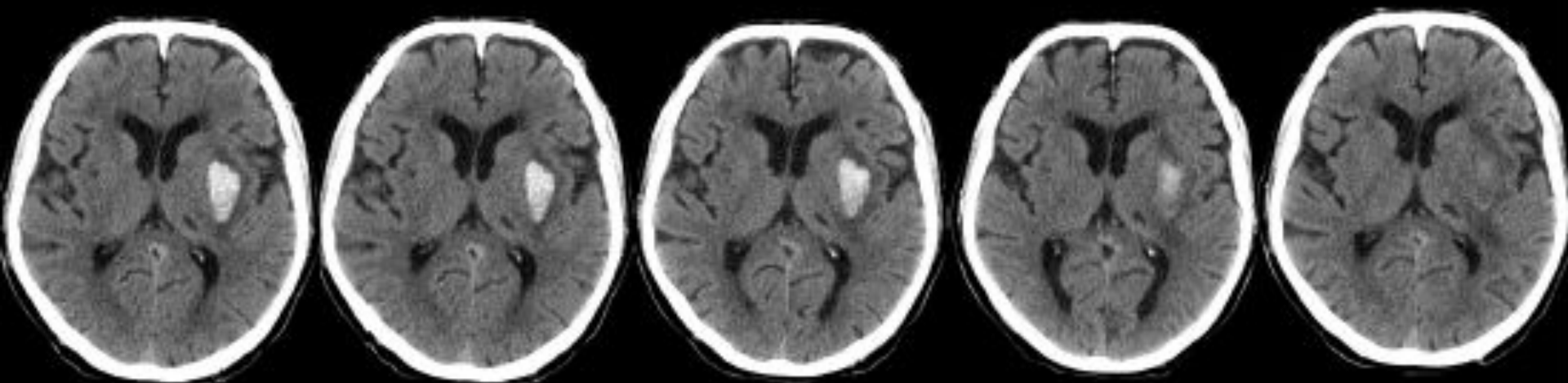
# CT or MRI?

Exclude ICH





# CT and MRI in the dynamics



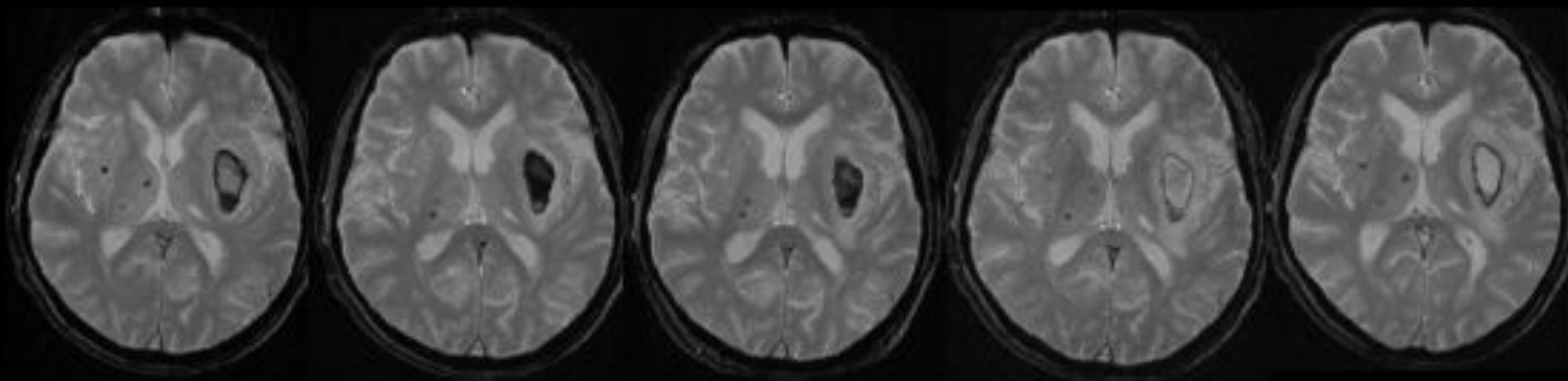
1 сутки

3 сутки

7 сутки

14 сутки

21 сутки



T2\*

# EVOLUTION OF INTRACEREBRAL HEMATOMA



stage of hematoma	transformation of blood elements	T2	T1
Hyperacute (4 to 12 hours)	oxyhemoglobin	hyperintensive	isointensive
Acute (1 to 3 days)	deoxyhemoglobin	hypointensive	isointensive
Early subacute (3 to 7 days)	intracellular methemoglobin	hypointensive	isointensive with a hyperintensive rim
Late subacute (7 to 28 days)	extracellular methemoglobin	hyperintensive	hyperintensive
Chronic (more than a month)	ferritin in the form of hemosiderin	hyperintensive with a pronounced hypointensive rim	hypointensive





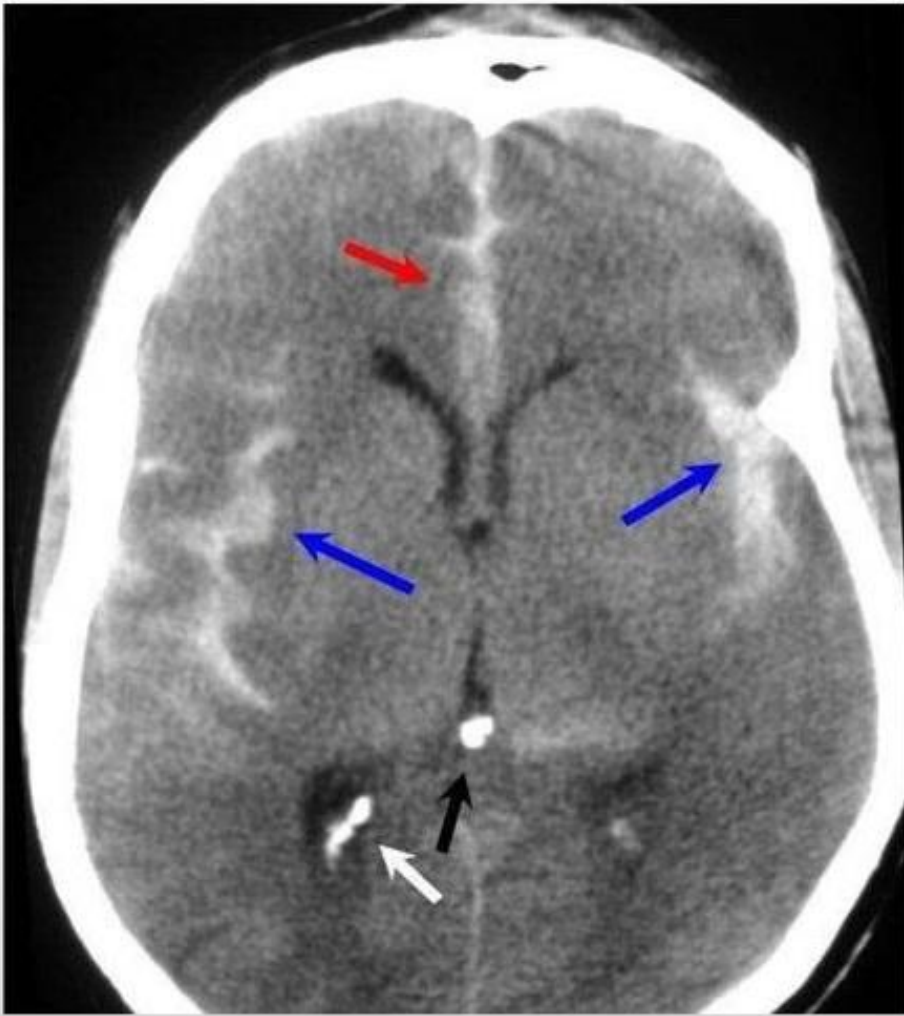
# Hemorrhagic strokes

- CT - is a “gold standard” of diagnosis.
- Hemorrhage is a focus of increased density of matter (hyperdense zone) of the brain of a rounded or oval shape, sometimes there are signs of a volumetric effect on the cerebrospinal fluid spaces and the ventricular system of varying degrees of severity, depending on the size and localization of the hemorrhage.
- In the dynamics of the hemorrhage focus, there is a gradual decrease in the density of the hemorrhage focus in the brain tissue – the phenomenon of a "melting sugar cube".

# ***SUBARACHNOID HEMORRHAGE***

- The sensitivity of CT to the presence of blood in the subarachnoid spaces is associated with the amount of blood and the time elapsed since the hemorrhage.
- The diagnosis is suspected in the presence of **high-density staining of subarachnoid spaces**.
- In most cases, it is observed near the Willisian circle, since most sac aneurysms are localized in this area (~65%), or in the sylvian fissure (~30%). Small hemorrhages in terms of the amount of blood can sometimes be detected due to accumulation in the medullary cistern or in the form of a hyperdense triangle in the occipital horn of the lateral ventricle.

## Subarachnoid hemorrhage



# CT or MRI?

## Types of ischemic edema

- Cytotoxic edema ( $\text{CBF} < 30 \text{ ml/ 100 g x min}$ ) - reversible changes
- Ionic edema ( $\text{CBF} < 10 \text{ ml/ 100 g x min}$ ) - irreversible changes
- Vasogenic edema is the result of a violation of HEB and the penetration of blood plasma into the intercellular space



capillary

intercellular fluid



neuron

# CT or MRI?

## Types of ischemic edema

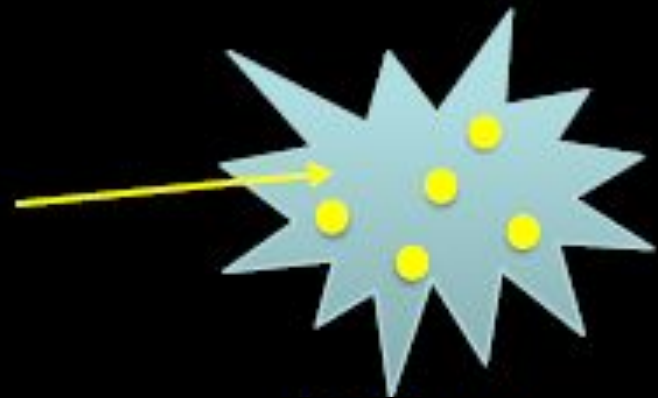
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capillary



intercellular fluid

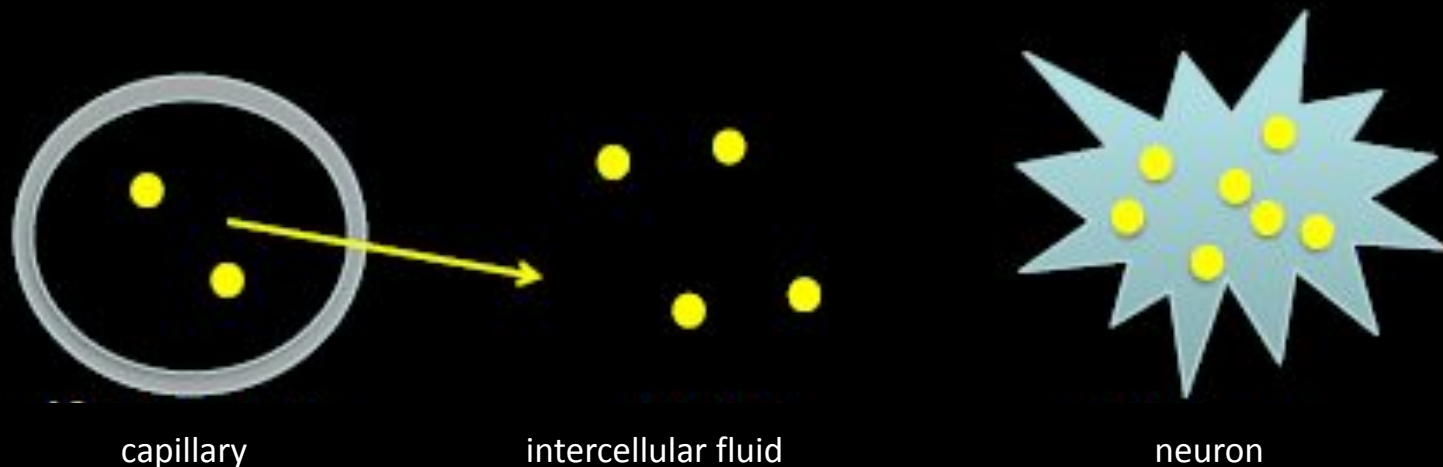


neuron

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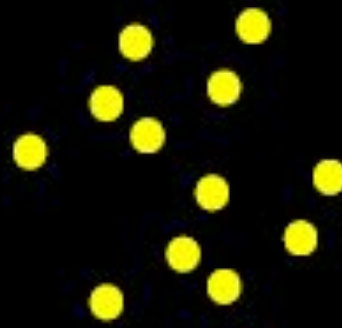
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capillary



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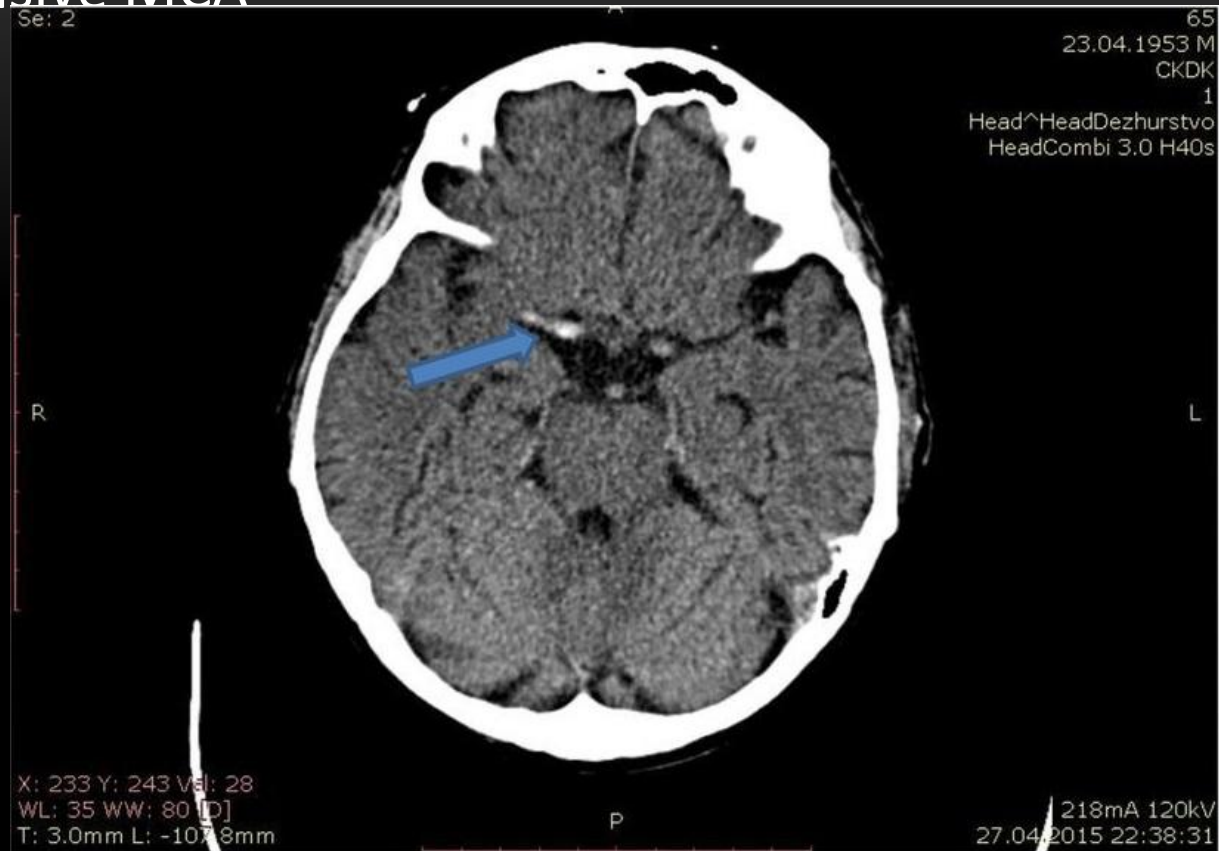
neuron

## Early CT signs CVA

- Arterial hyperdensity (a sign of intravascular thrombosis: hyperdense middle cerebral artery, a "point" symptom)
- Loss of differentiation of gray and white matter
- Edema of brain tissue with smoothness of cortical furrows, convolutions, subcortical nuclei
- Decrease in the density of brain matter
- Loss of the ability to visualize the insula of the brain
- Disappearance of the normal outlines of the lenticular nucleus
- Mass effect with dislocation

**The presence of a clear demarcation line of the ischemic focus on the RCT indicates the limitation period of a stroke-outside the "therapeutic window"!**

# Hyperdense MCA



- It is manifested by an increase in the density of the proximal sections of the MCA , and is associated with thrombosis of the M1 segment of the MCA.
- The same pathological mechanism in the distal parts of the MCA gives a point increase in the density of MCA .
- Hyperdensity of MCA is visible after ~90 minutes from the moment of ischemia development

# ASPECTS SCORE

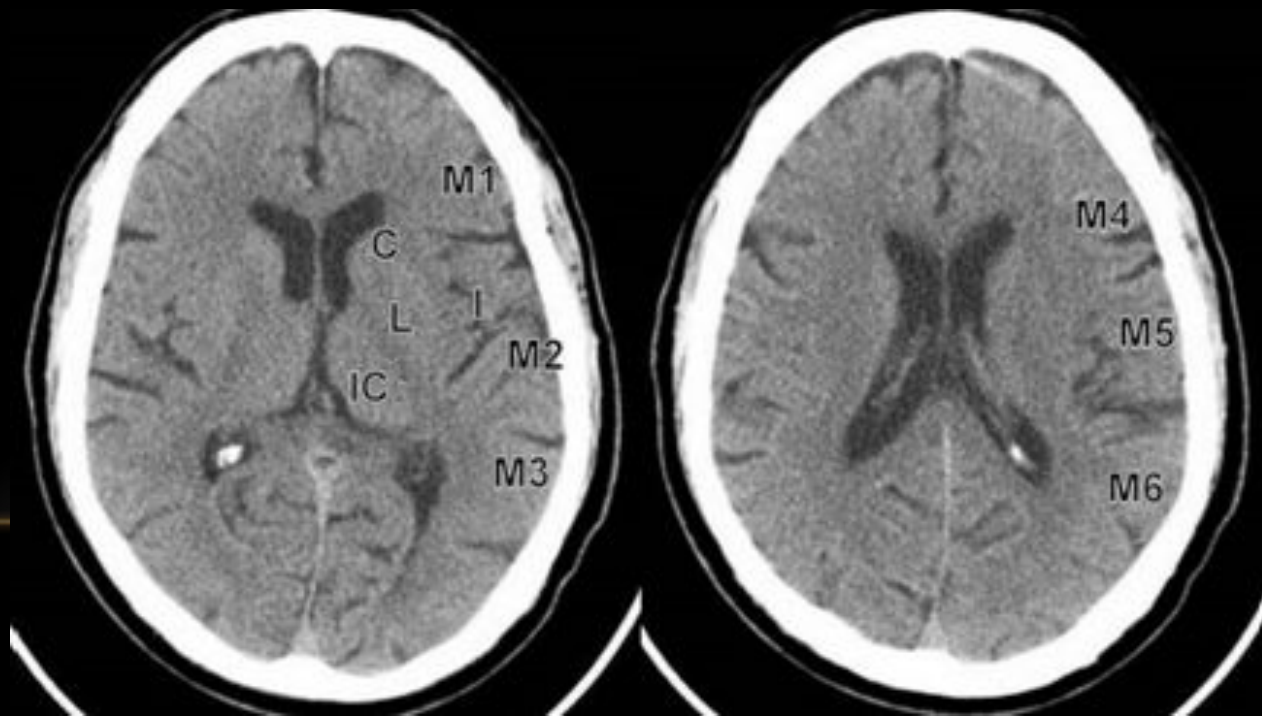
*The Alberta stroke programme early CT score (ASPECTS) 1 is a 10-point quantitative topographic CT scan score used for patients with CVA*

## **The need for the ASPECTS scale:**

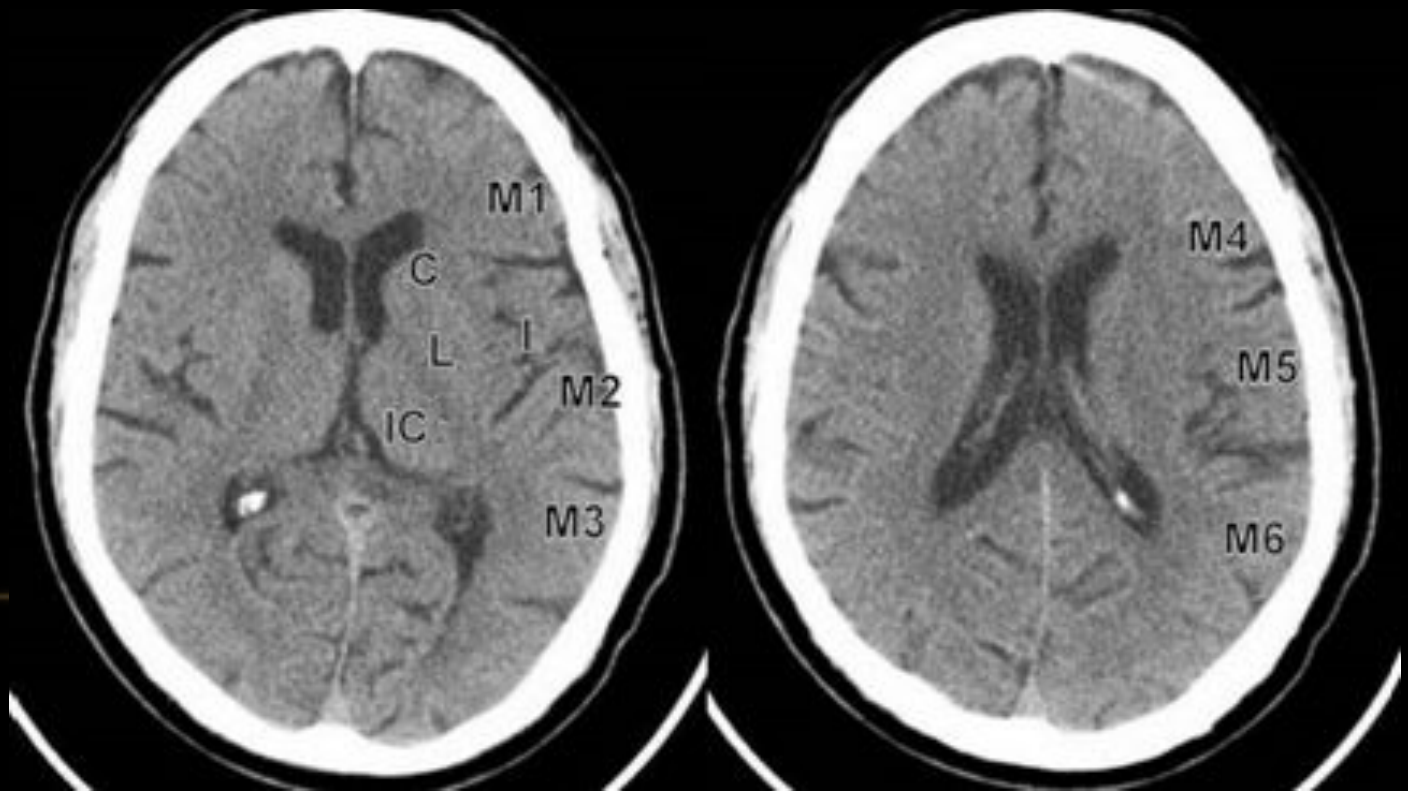
- the assessment of early ischemic changes is important in the assumption of a response to thrombolysis
- thrombolysis increases the chances of a good functional outcome in patients with small (less than 1/3 of the MCA) sizes of the hypodense zone on non-amplified CT scans, and quantifying the volume of one third of the territory is inconvenient for routine practice
- ASPECTS was developed to standardize the identification of changes and the compilation of descriptions (reports) of the degree of hypodensiveness of ischemia

The assessment on the ASPECTS scale is carried out by determining changes in the MCA territory at two standard levels::

- *basal ganglia level - the level at which the thalamus, basal and caudate nucleus are visualized,*
- *rostral level, the level at which the radiant crown and semioval centers are visualized.*



- C - caudate nucleus,
- I - insular cortex,
- IC - internal capsule,
- L- nucleus lentiformis,
- M1 - anterior cortex of the MCA ,
- M2 - cortex lateral to the insular,
- M3- posterior cortex of the MCA ,
- M4, M5, M6 - anterior, lateral and posterior area of the MCA





## Results:

The basal ganglia are estimated at 3 points (C, L, and IC).

The crust of the MCA territory is estimated at 7 points (the crust of the island, M1, M2, M3, M4, M5 and M6).

- A score of 7 points or less indicates an extensive hypodense zone in the MCA territory and correlates with the prognosis of a poor functional outcome, as well as with the risk of intracerebral hemorrhage.
- According to the studies of R. I Aviv et al, patients with a score of less than 8 points on the ASPECTS scale did not have a good clinical outcome from the use of thrombolysis.

# PATHOPHYSIOLOGY AND MR-PICTURE OF CEREBRAL ISCHEMIC STROKE

- **acute stage(0-3 days).**

Pathoanatomically-focal cytotoxic edema, macroscopically-thickening of the brain gyrus and loss of clear distinctions between gray and white matter.

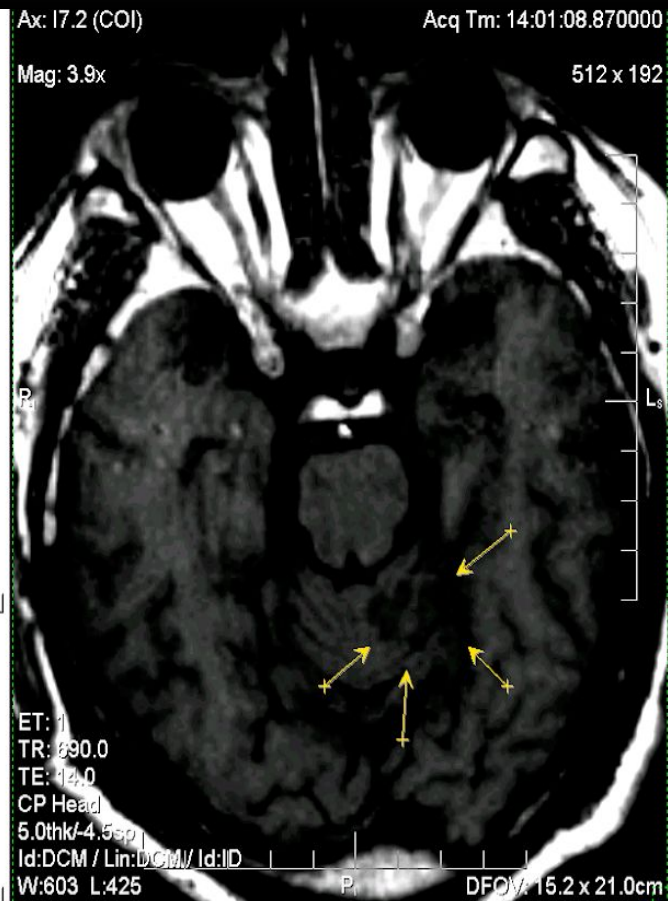
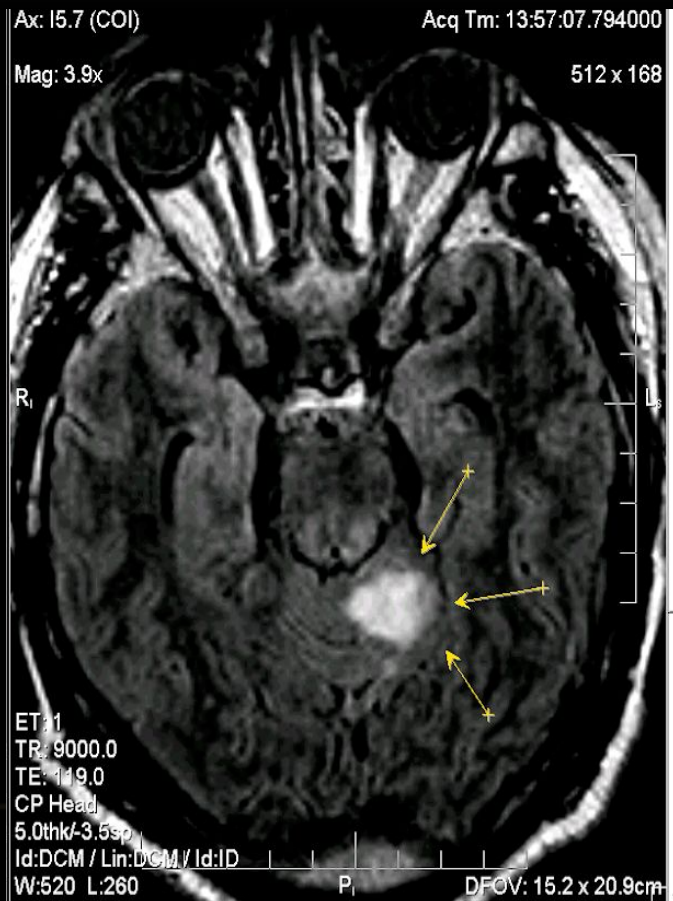
**MRI: the focus or zone of a sufficiently uniform increase in the signal for T2 and FLAIR, a moderate uniform decrease for T1. Compliance with the territory (according to the form) Violation of the differentiation of gray and white matter of the brain + mass effect of varying degrees of severity, depending on the volume of the lesion. .**

# THE FOCUS OF ACUTE ISCHEMIC CVA

## THE TERRITORY OF THE LEFT SUPERIOR CEREBELLAR ARTERY.

FLAIR

T1- weighted image



# PATHOPHYSIOLOGY AND MR-PICTURE OF CEREBRAL ISCHEMIC STROKE

- **Subacute stage (3 days-10-14 days).**

The combination of cytotoxic and vasogenic edema, the onset of encephalomalacia with the formation of necrotic zones in combination with reparative processes – the appearance of a symptom of "girial" amplification.

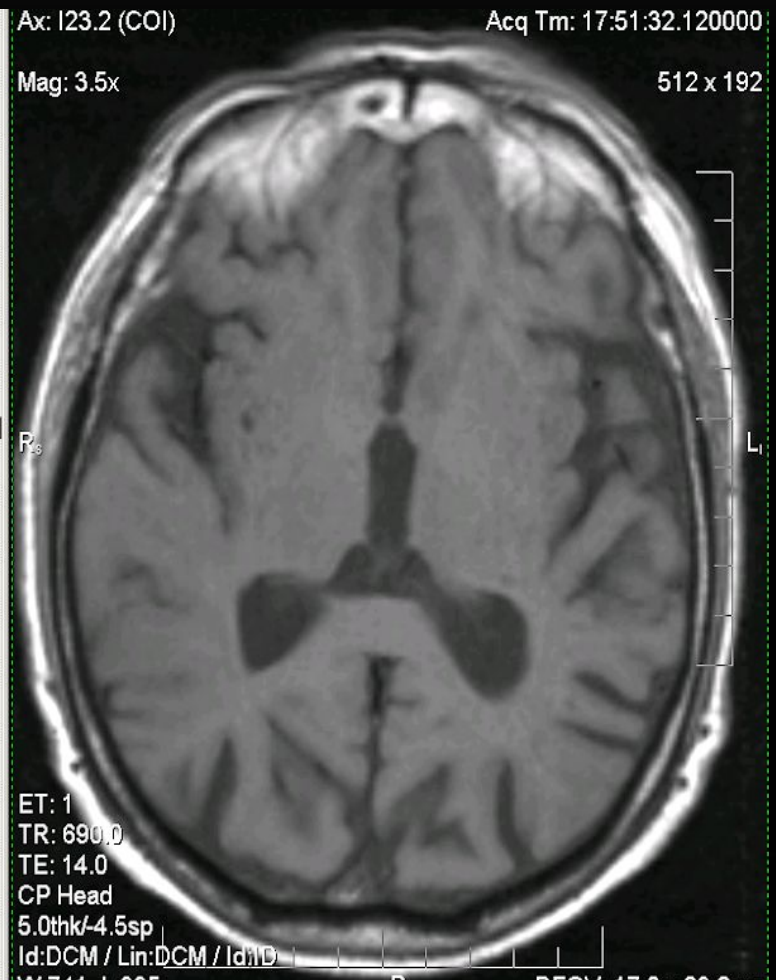
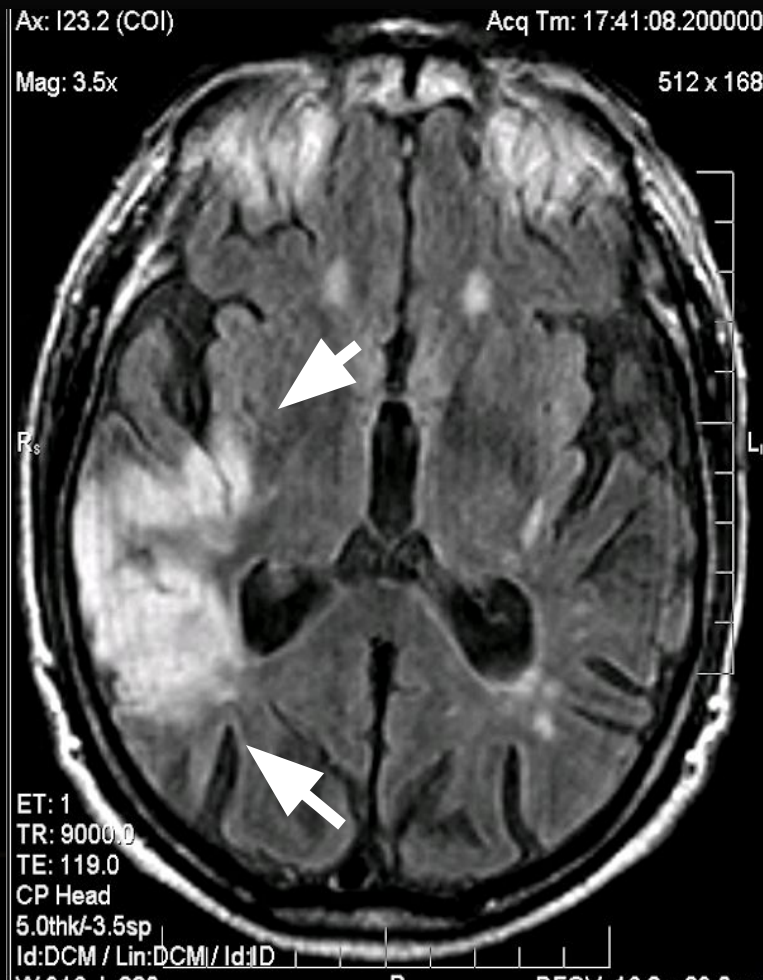
**MRI:** focus or zone of **NON-UNIFORM** increase in the signal for T2 and FLAIR, an indistinctly expressed **NON-uniform** decrease for T1 or isointensive MRS (a symptom of "veiling") . There is a violation of the differentiation of gray and white matter of the brain, a decrease in the mass effect or its absence.

# Zone of the subacute ischemic stroke

## Middle cerebral artery circulation .

FLAIR

T1-weighted image



# PATHOPHYSIOLOGY AND MR-PICTURE OF CEREBRAL ISCHEMIC STROKE

- **Chronic stage (end of the 2nd week and beyond).**
- resorption of necrotic masses, the formation of a cystic cavity with perifocal gliosis, may be accompanied by dilation of the ipsilateral ventricle. The decrease in the intensity of the MR signal corresponds to the prescription period of cyst formation, after 3-6 months it corresponds to the characteristics of the cerebrospinal fluid.

**MRI: foci or zones of cystic-glious or infiltrative-glious transformation +local atrophy**

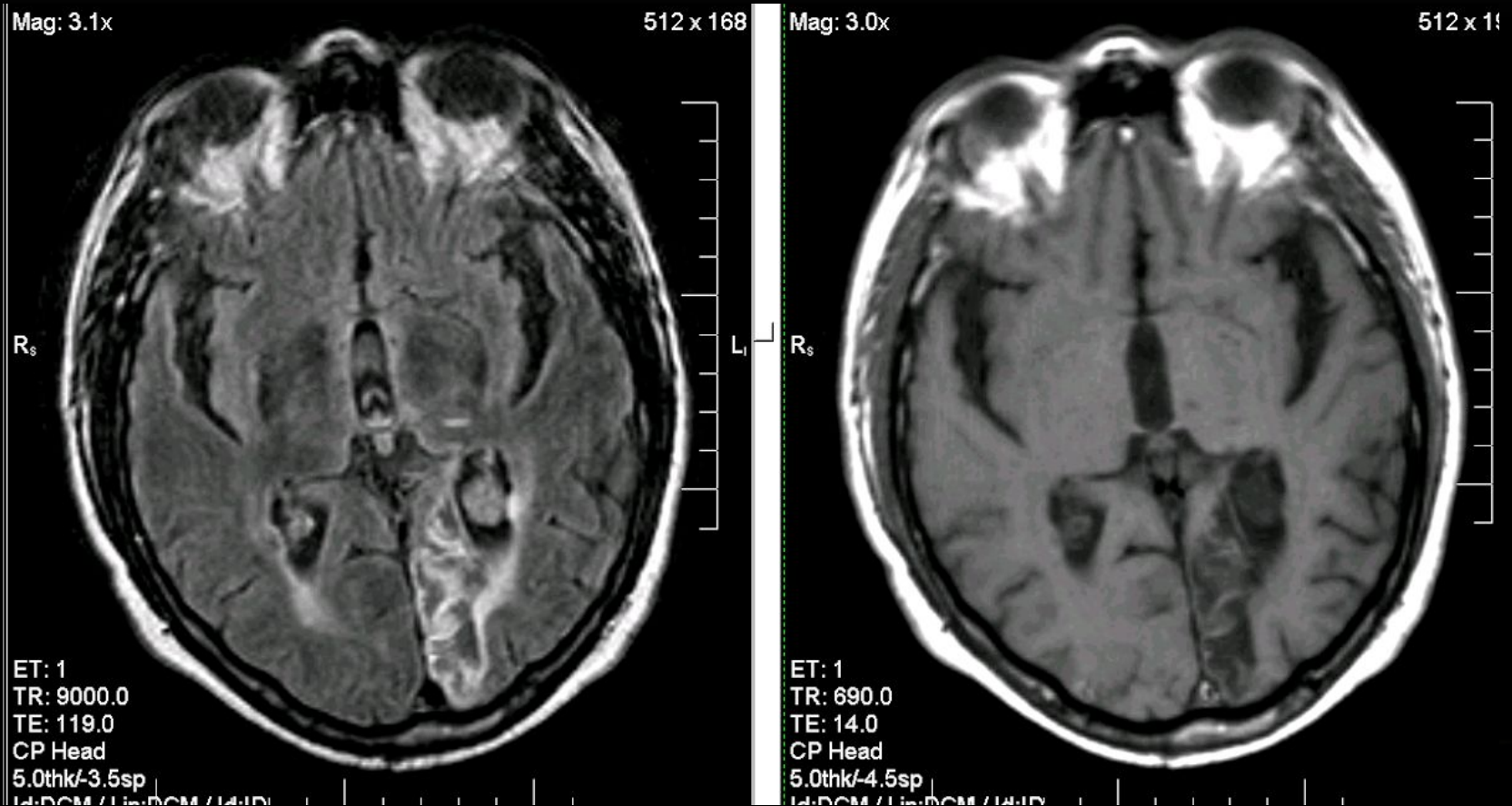


# Zone of the chronic ischemic stroke

Left posterior cerebral artery circulation .

FLAIR

T1-weighted image



# CEREBRAL VENOUS THROMBOSIS

## CT signs

Direct signs( $\frac{1}{3}$  cases ):

**Triangle sign** – visualization of a blood clot on the contrast-free part of

the study in the form of a dense triangle or circle on the back of the SSS

**The negative delta sign** (empty triangle, empty delta) is a triangular pattern

of contrast enhancement on the back of the SSS

Cord symptom, curved or linear hyperdensity on contrast enhancement,

visualizing a thrombosed cortical vein

Indirect signs( 60-80%):

Hemorrhagic: ICH,SAH

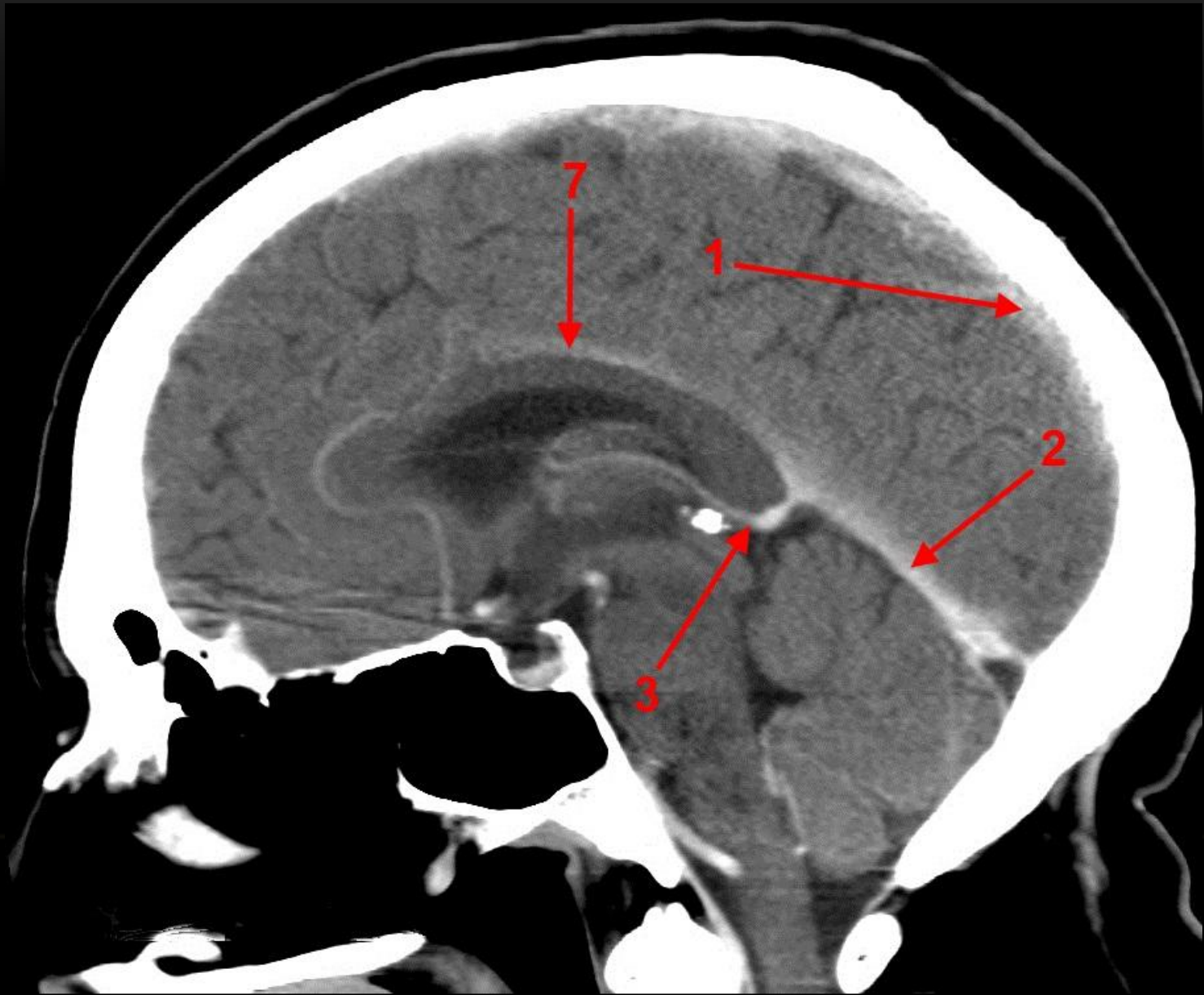
Non-hemorrhagic: focus of hypodensiveness caused by edema or infarction of the brain, usually not corresponding to the zones of

arterial circulation,

diffuse edema of the brain

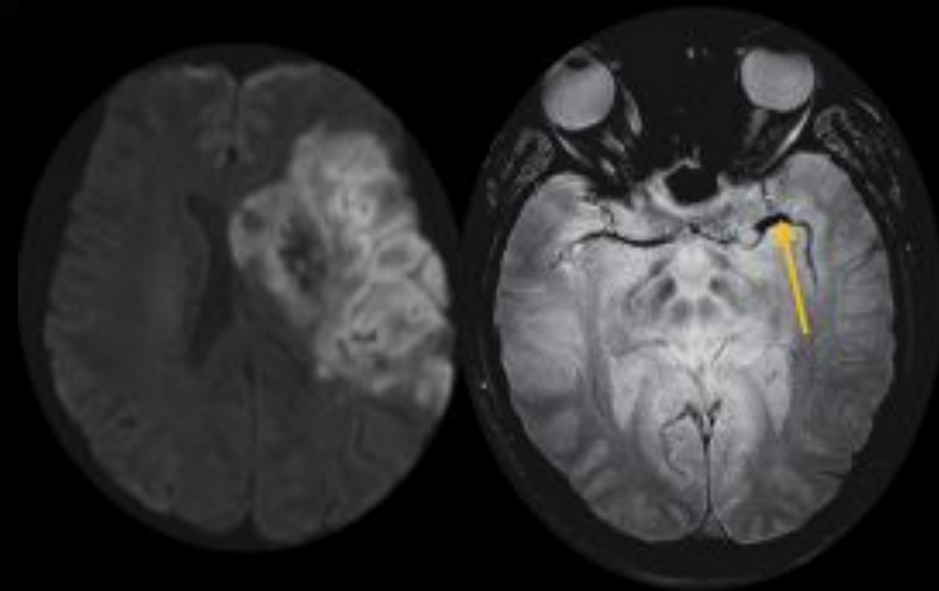
Disappearing stroke in serial research

# CEREBRAL VENOUS THROMBOSIS



# CT or MRI?

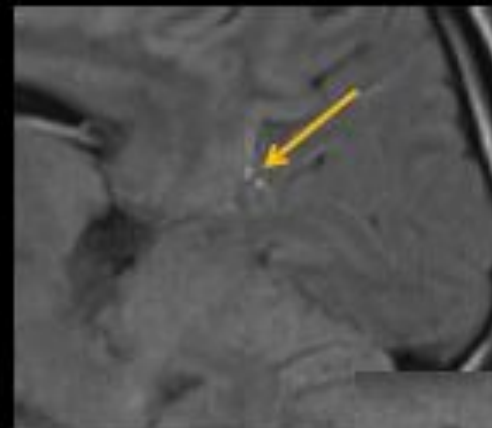
the state of intracranial vessels and collateral blood flow



T2\*

Thrombus size > 8  
mm-systemic thrombolysis  
is not effective

C.H. Riedel et al. Stroke 2011

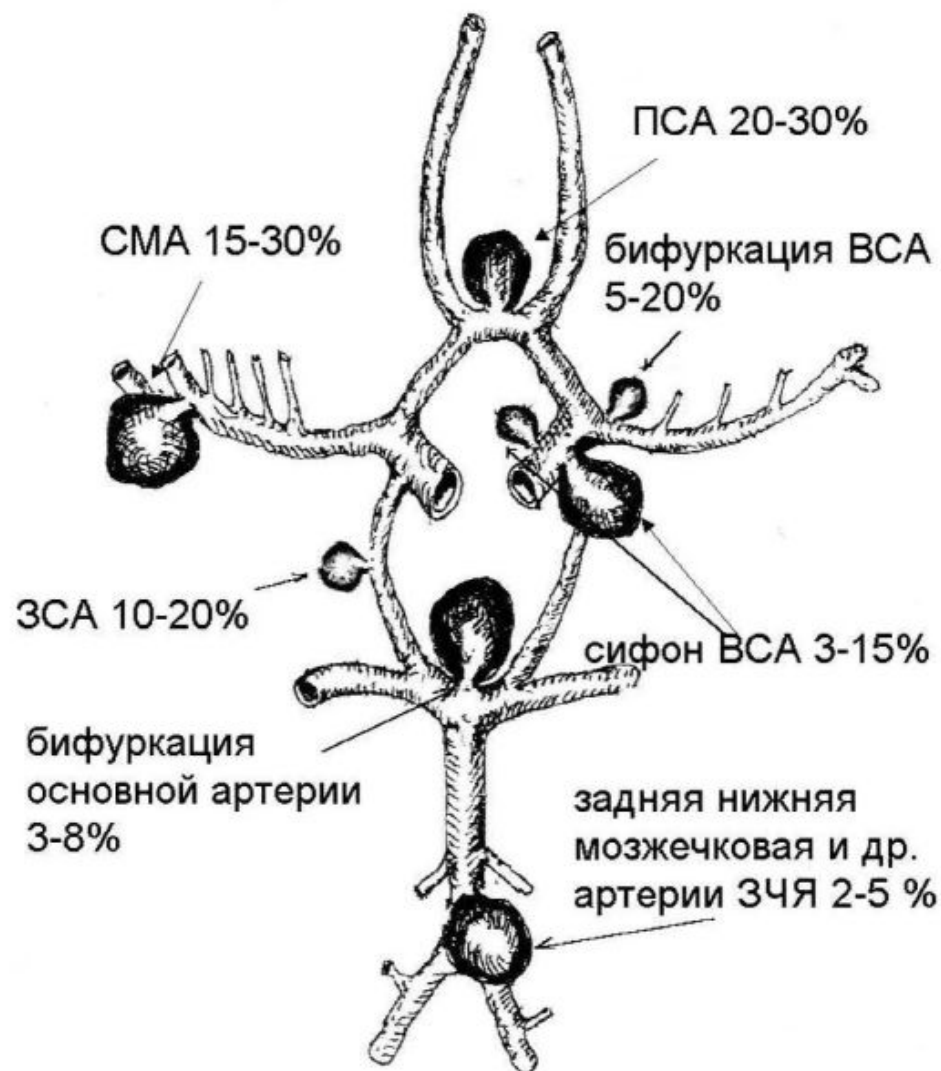


FLAIR



SWI

Detection of distal blood clots

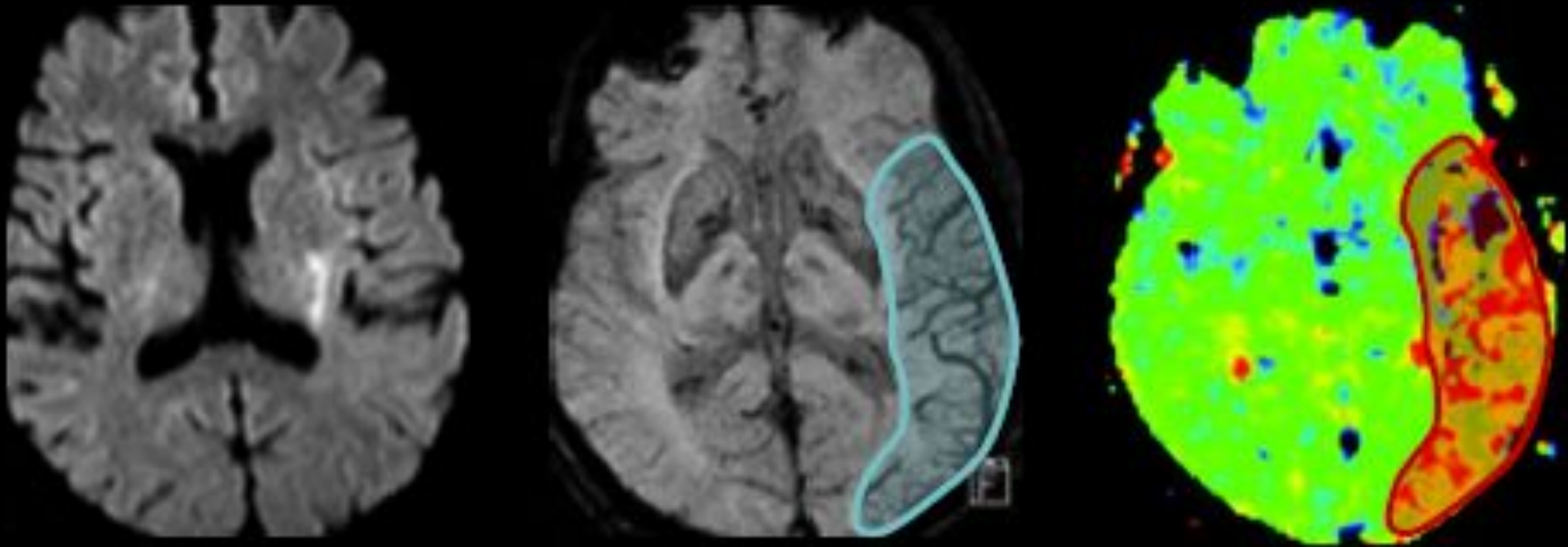


**Рис. 5.159.** Схема расположения и частота встречаемости мешотчатых аневризм большого артериального круга основания мозга.



# CT or MRI?

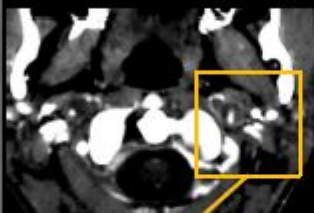
The state of intracranial vessels and collateral blood flow  
Advantages of SWI



The size of the hyperperfusion zone

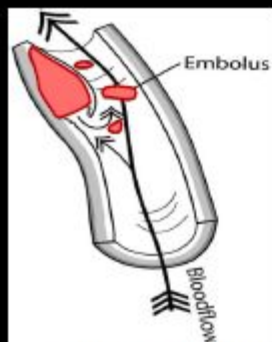


состояние сосудов: экстракраниальная диссекция

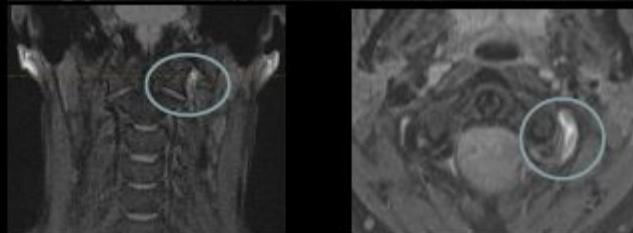
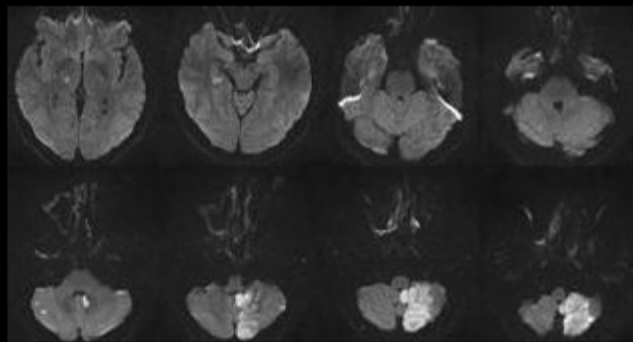


T1fs: интрамуральная гематом

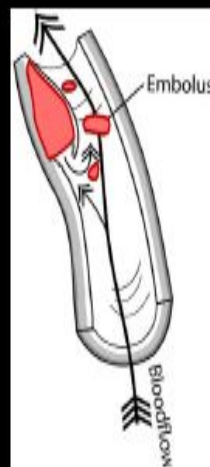
состояние сосудов: диссекция



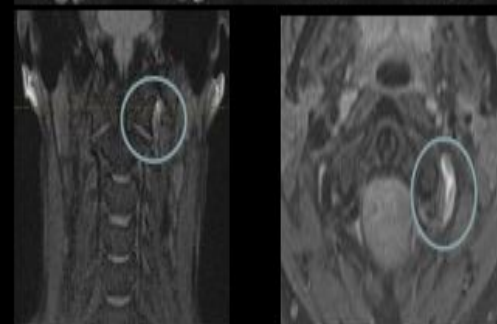
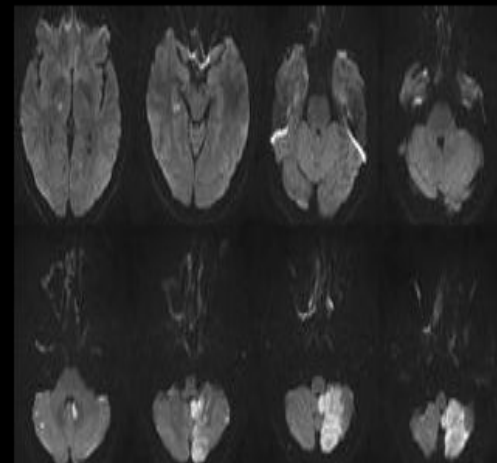
Эмболический



состояние сосудов: диссекция



Эмболический



Оценить зону пенумбры

ПКТ

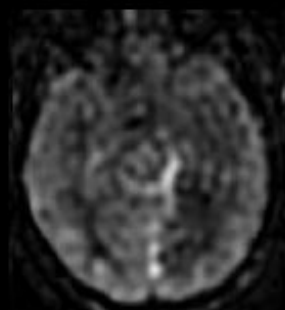
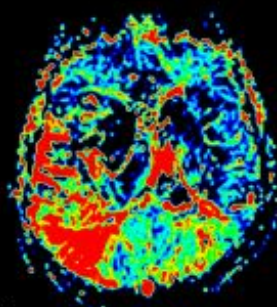
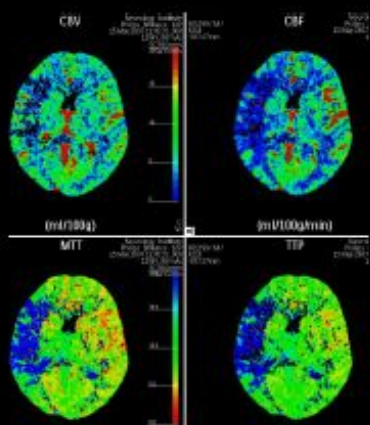
+C

ПВ-МРТ

+C

ASL

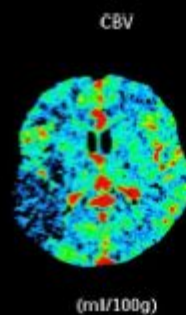
-C



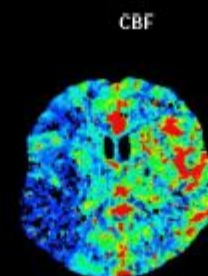
CBF

Оценить зону пенумбры

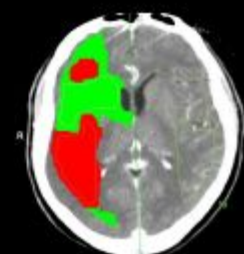
CBV-CBF  
mismatch



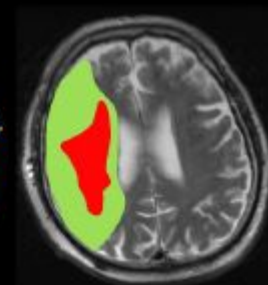
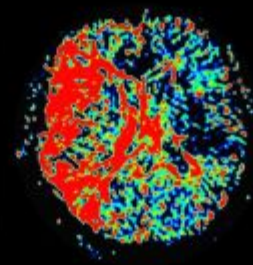
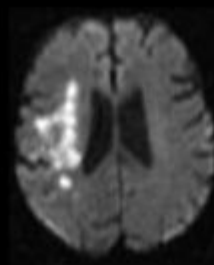
(ml/100g)



(ml/100g/min)



DWI-PWI  
mismatch

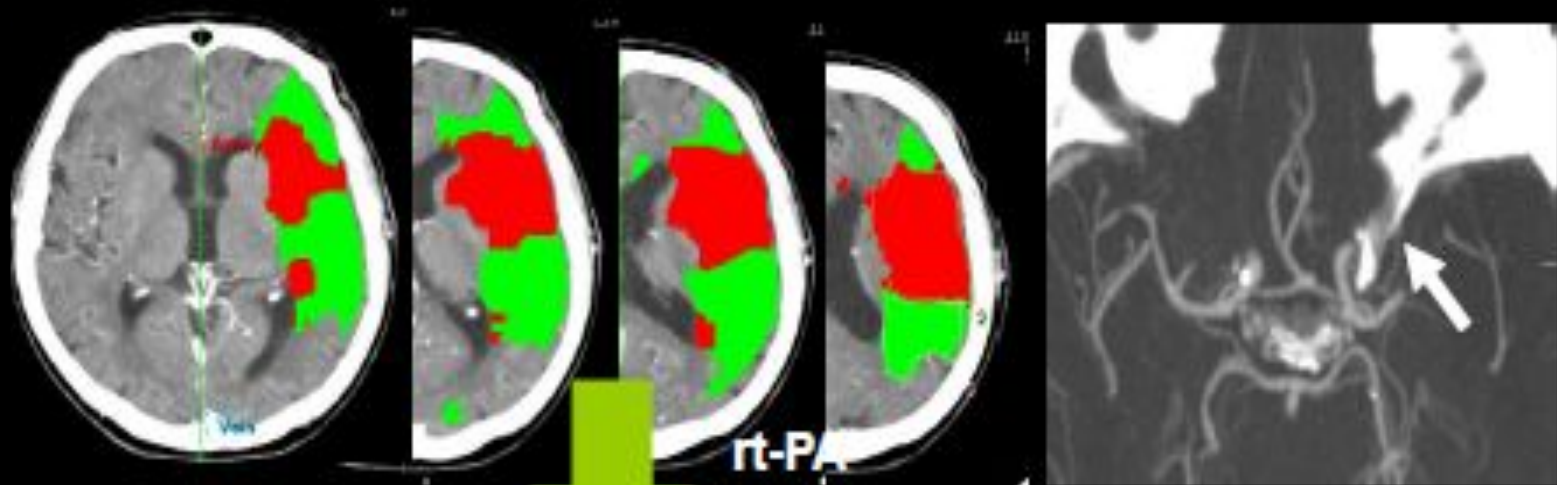


# Evaluation of the effectiveness of the conducted therapy

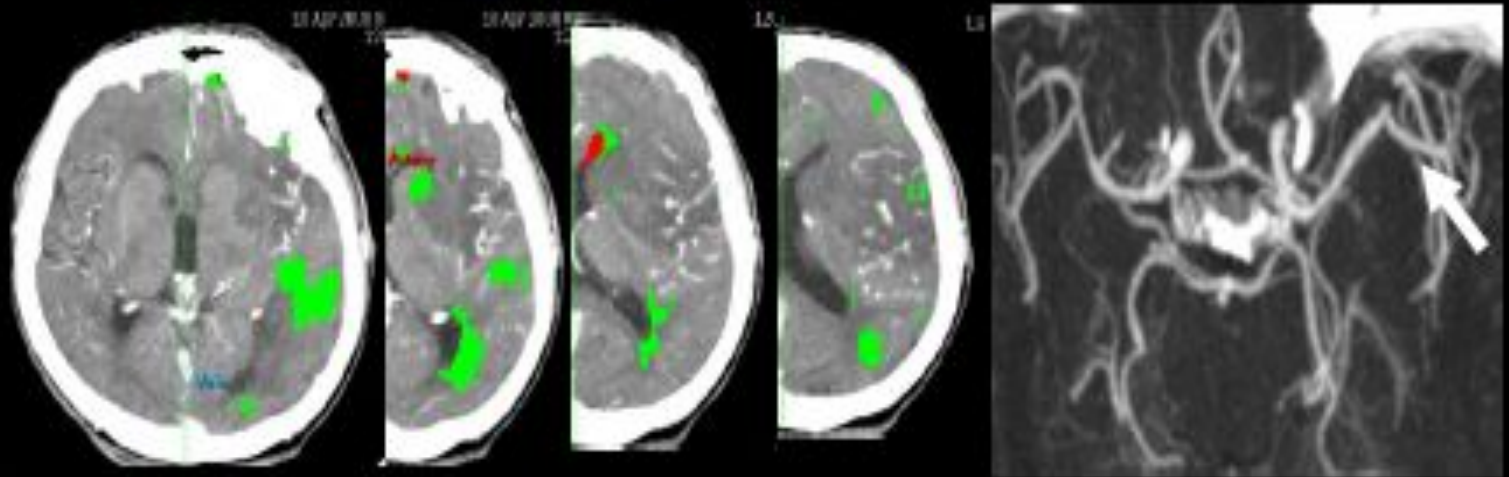
## Reperfusion after thrombotic therapy

Patient A.  
67 years

1 hour  
before  
stroke



24 hours



# CT and MRI

- allows you to exclude intracerebral hemorrhage in the acute stage
- data on the state of blood vessels and collateral blood flow
- assessment of the stroke nucleus and penumbra
- evaluate the effectiveness of treatment
- detection of ischemia and hemorrhage in the early hours
- high information content in the detection of a small focus
- detection of a focus in the brain stem
- the exact location of the blood clot
- non-invasive assessment of hypoperfusion
- no radiation load

## **BUT :**

- **duration of the study**
- **contraindications**
- **high cost**
- **the need for patient immobility**

accessible

fast

convenient