COMPUTED TOMOGRAPHY PERFUSION

PERFUSION CT

- No contrast

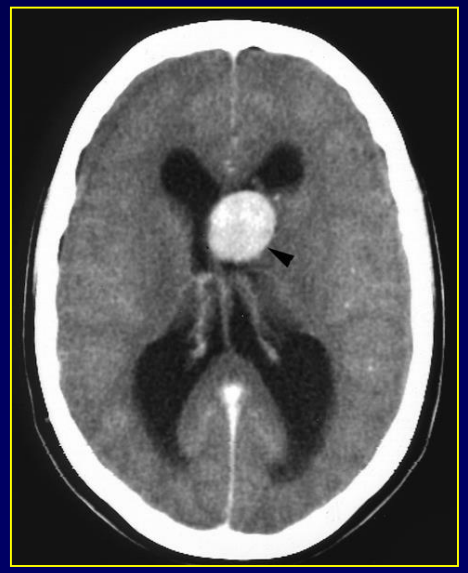
- Administration of contrast media

Vascular studies
Perfusional studies

Parenchymal studies

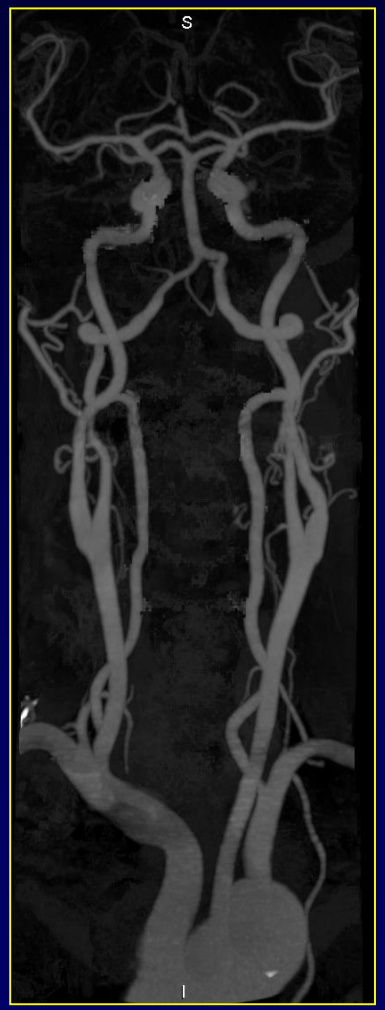
PERFUSION CT

- Iodinated contrast



Parenchymal study

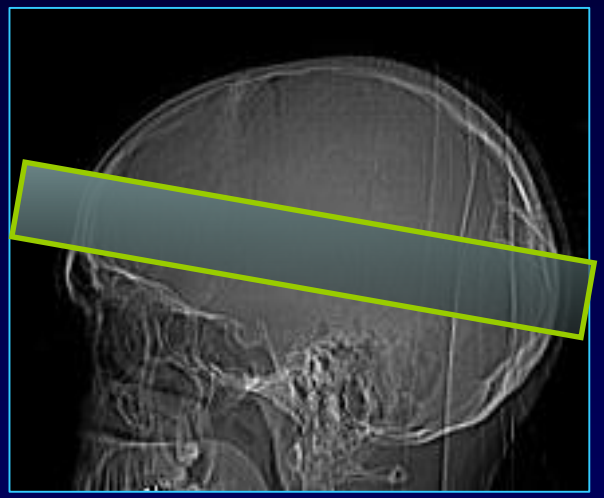
Vascular



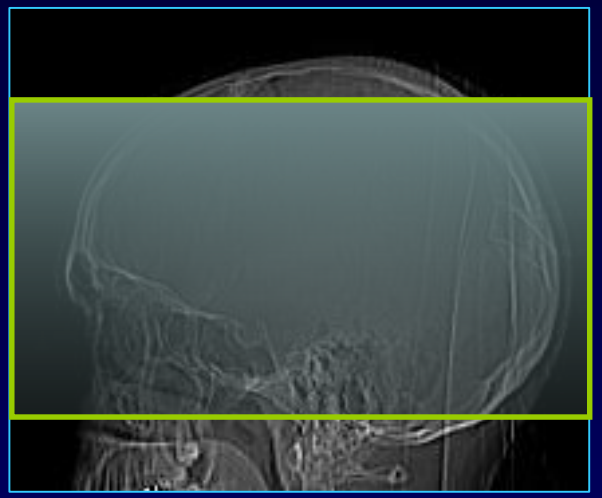
PERFUSION CT

- With perfusion we monitor the first pass of an iodinated contrast agent bolus trough the cerebral vasculature
- CT perfusion allows us to follow temporal course of the iodianted contrast media by performing several dynamic scans on the same cerebral volume

PERFUSION CT



3,2 cm

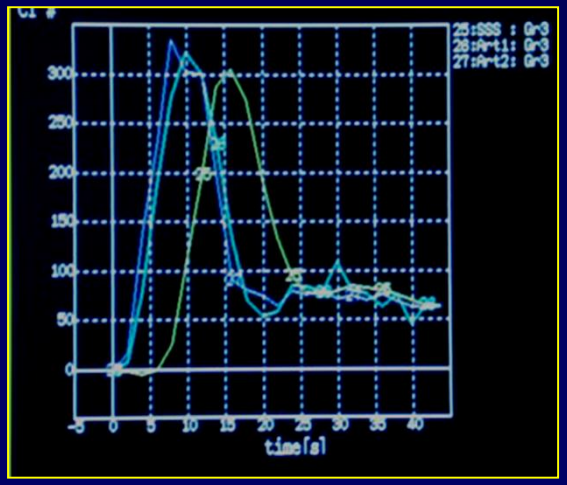


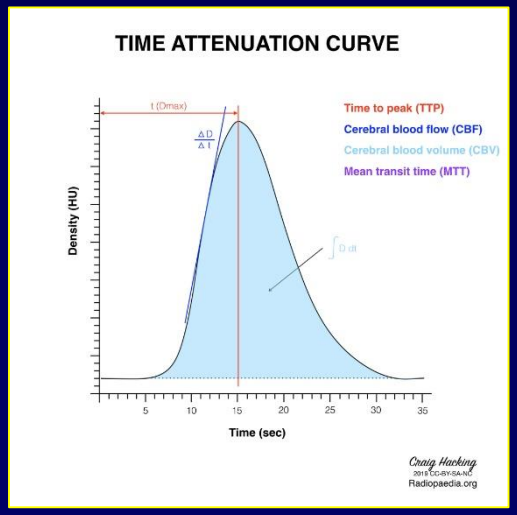
16 cm

- 50 ml of contrast, 4 ml/s, acquisition every 4s, scan duration 60 sec, 80kv, 150 mAs

PERFUSION CT

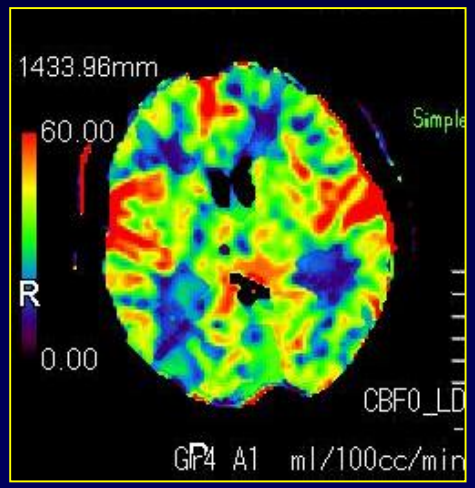
- Arterial input function, venous output
- Reconstruction algorythm: “maximum slope algorithm
  “ deconvolution algorithm”……
  - delay insensitive, delay sensitive



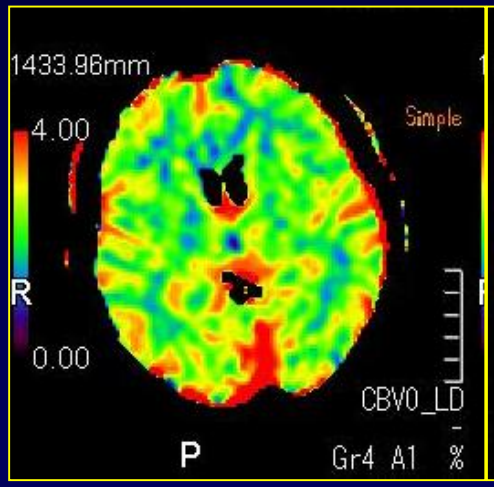


CBF=CBV/MTT

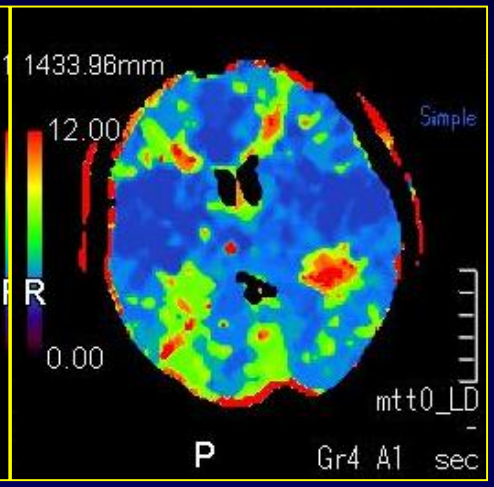
PERFUSION CT



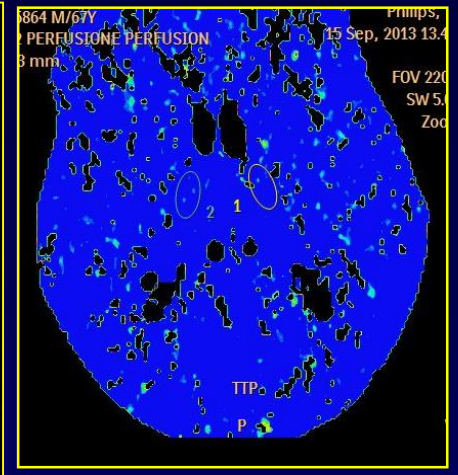
CBF- ml/100 g/min ***(50 ml/100g/min)***



CBV - ml/100 g ***(4 ml/100g)***



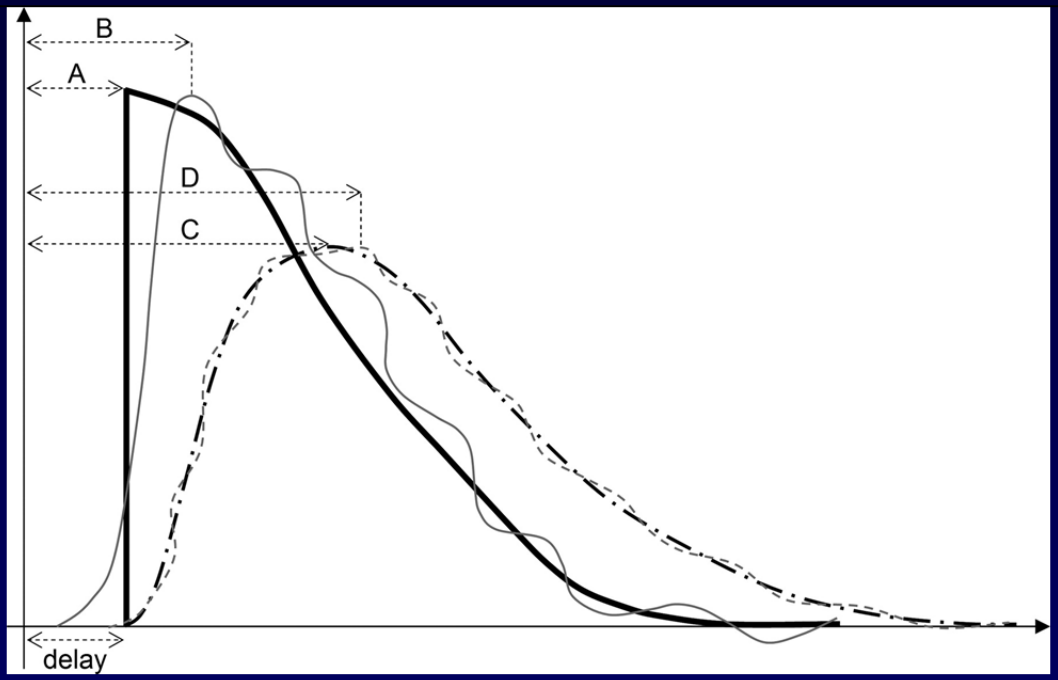
MTT- mean transit time*(5 s)*



TTP- time to peak (s)

➡ The absolute values could depend on different vascular pathology

PERFUSION CT

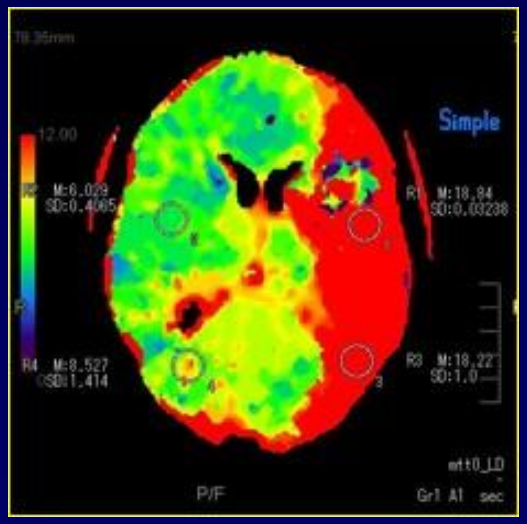


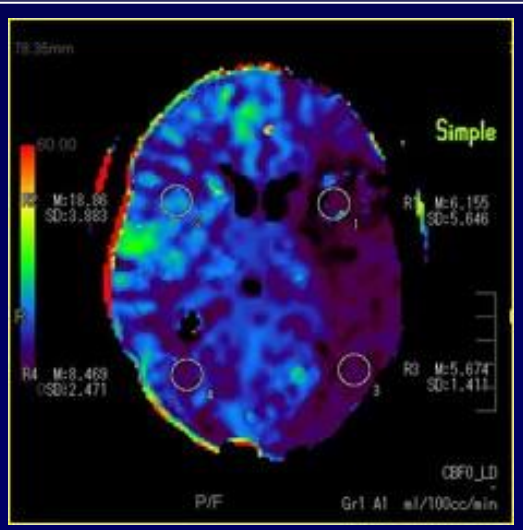
The Physiological Significance of the Time-to-Maximum (Tmax) Parameter in Perfusion MRI, Volume: 41, Issue: 6, Pages: 1169-1174, DOI: (10.1161/STROKEAHA.110.580670)

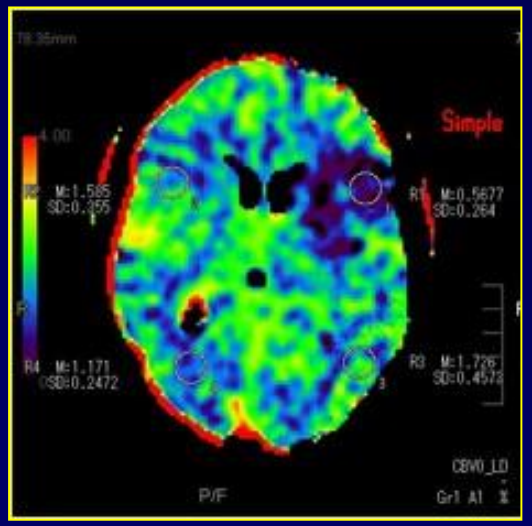
- T max (s): reflects the time delay between the contrast bolus arriving in the proximal large vessel arterial circulation (arterial input function) and the brain parenchyma

PERFUSION CT

- Quantitative evaluation
- Qualitative evaluation (comparison between healthy and affected area)







PERFUSION CT

Role of CT-perfusion

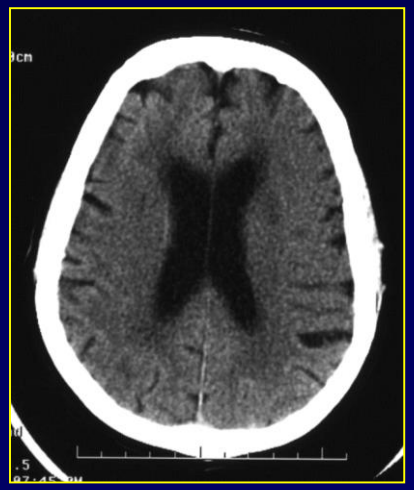
- **Acute Ischemic stroke**
- Tumor evaluation (neoangiogenesis) ⟹ MRI perfusion

IMAGING ACUTE ISCHEMIC STROKE

Computed Tomography

- *Identify early sign of acute stroke*

Obscuration of lentiform nucleus



Hypodense area, sulcal effacement

Dense MCA sign

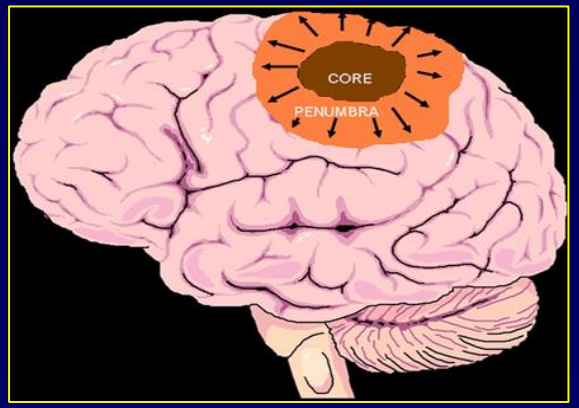
IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- Identify ischemic lesion

- Differentiate between not perfused tissue but still viable tissue
- (⇧MTT⇧CBV ⇩CBF) and irreversibly damaged tissue (⇧MTT ⇩ CBV e ⇩ CBF)

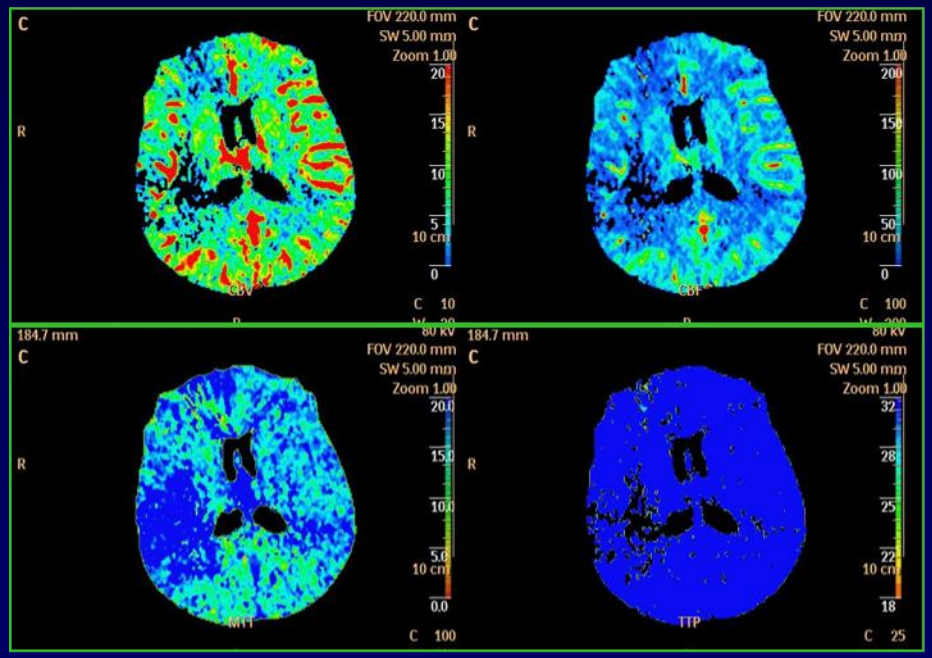
- Penumbra: mismatch between CBV/MTT or CBF, salvageable tissue with appropriate therapy
- Core: irreversible damage tissue

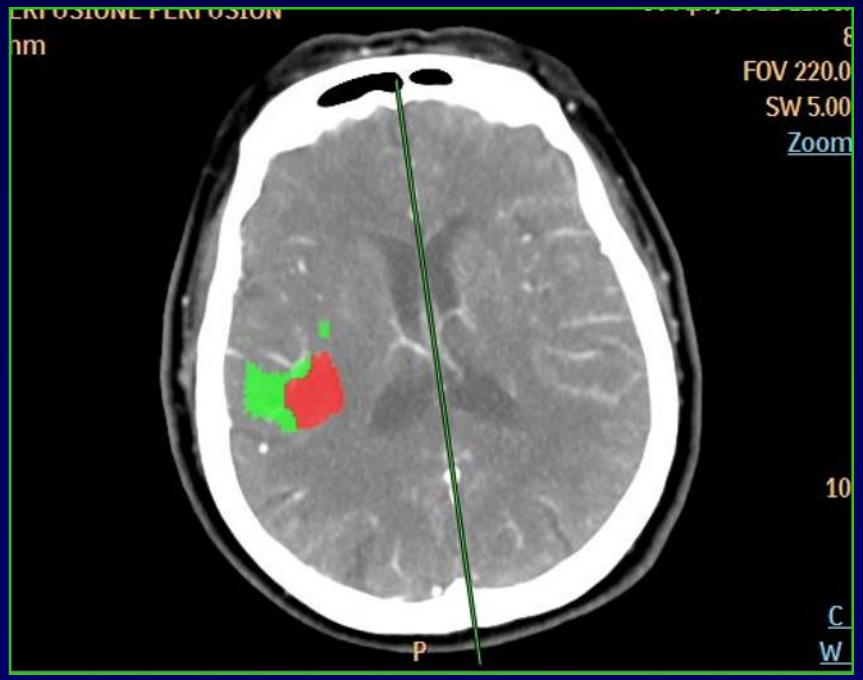


IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- Automatically generate maps





IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- *Wintermark*
- Core: CBV < 2 ml/100 g
- Penumbra : MTT > 145%, CBV > 2ml/100 g

- *Bivard*
- Core: CBF <40%, DT > 2 s
- Penumbra: CBF > 40% e DT > 2s

- *RAPID software*
- Core: CBF <30%
- Penumbra: Tmax > 6s

Wintermark et Al, Stroke 2006
Campbell et Al, Stroke 2011
Bivard et Al, Radiology 2013
Huang et Al, J Neuroimaging 2017

Potter et Al, Radiographics 2019
Demeestere et Al, Stroke 2020
Chen et Al, Front Neurol 2021

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

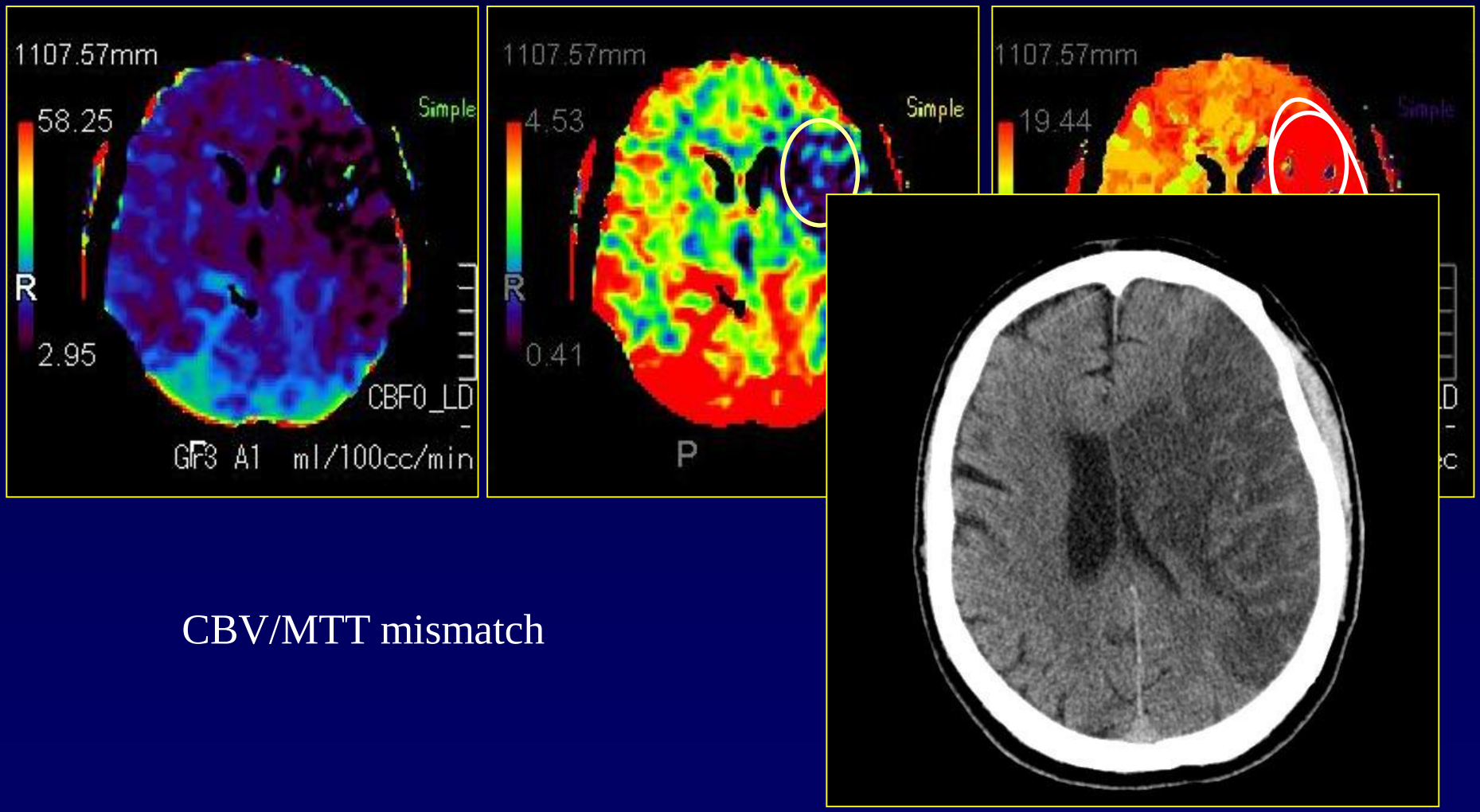
Right hemiparesis

Unenhanced CT

CT perfusion

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion



CBV/MTT mismatch

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

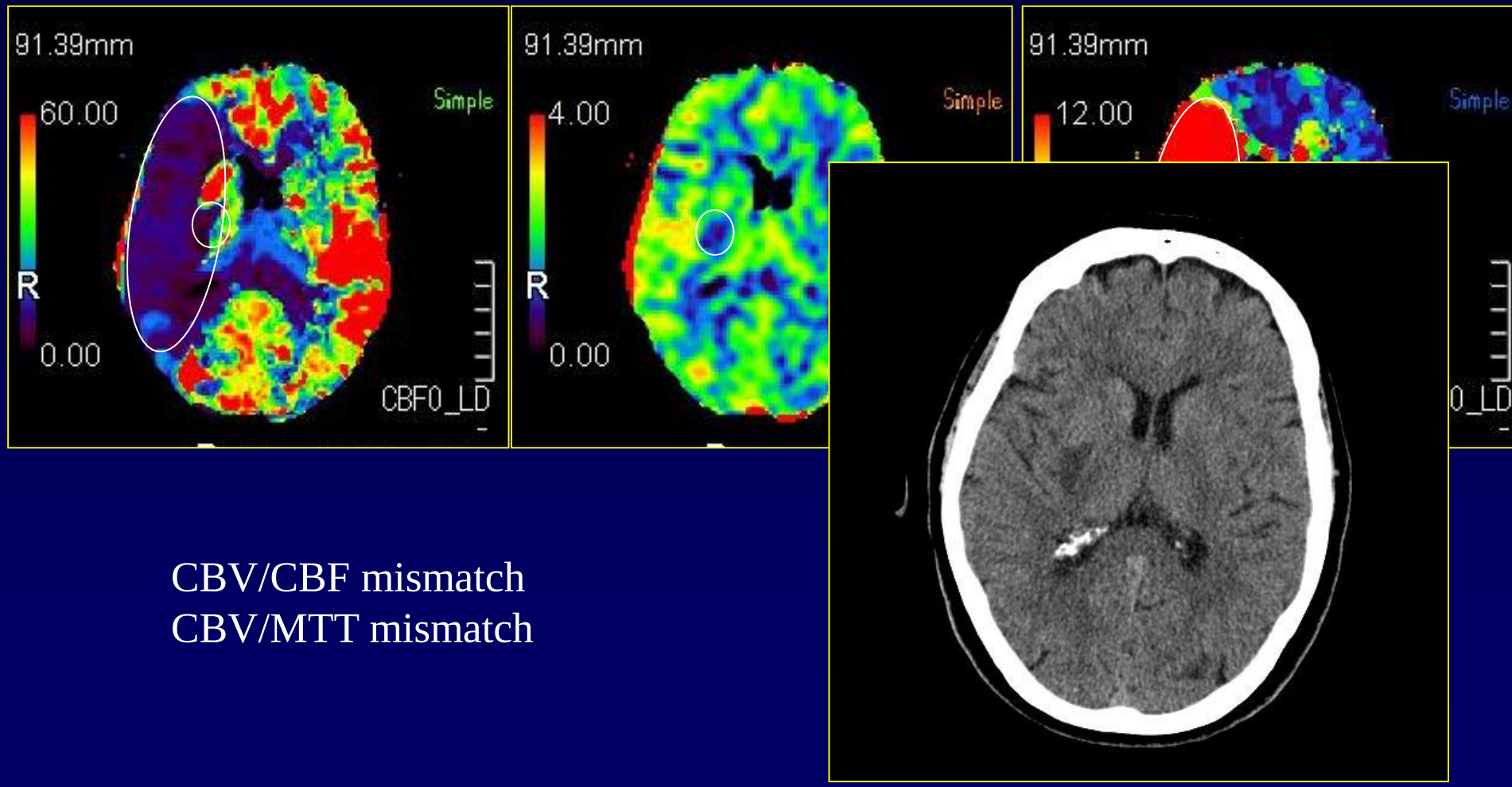
Left hemiparesis

Unenhanced CT

CT perfusion

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

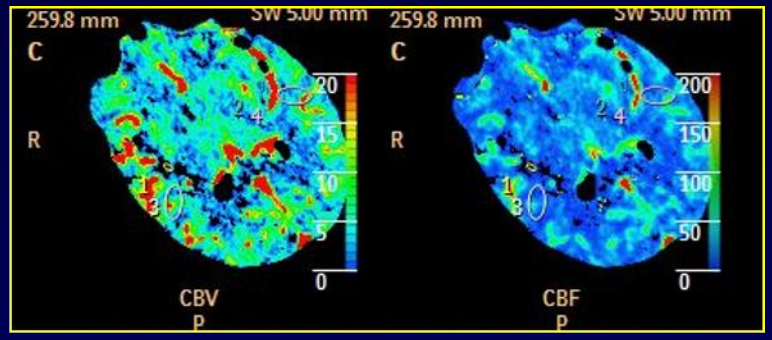


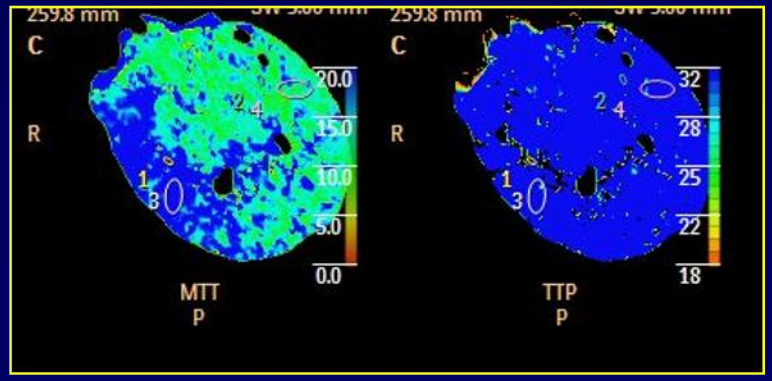
CBV/CBF mismatch
CBV/MTT mismatch

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

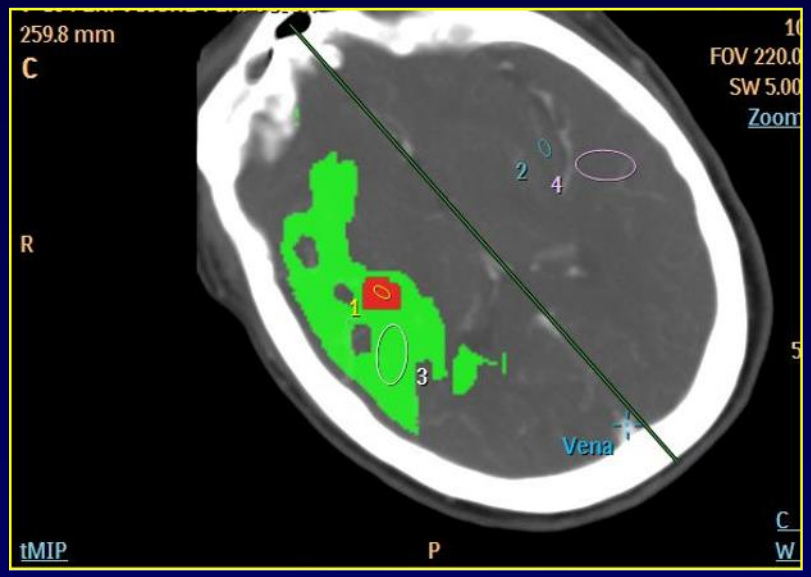
Left hemiparesis



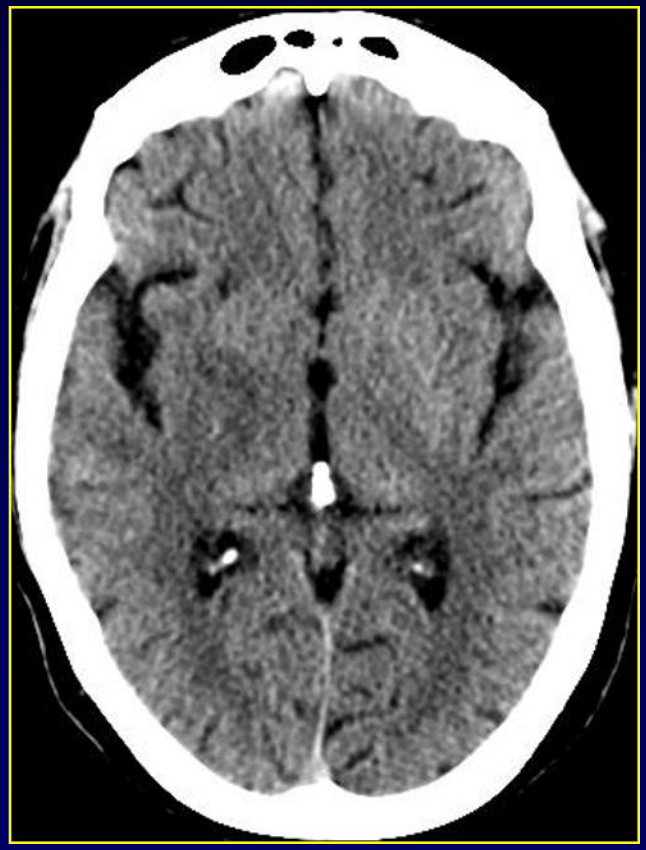


IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion



Automatically generated map

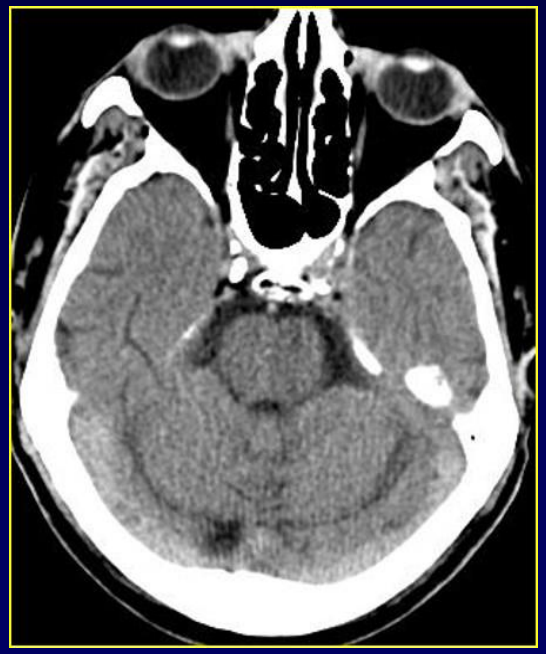


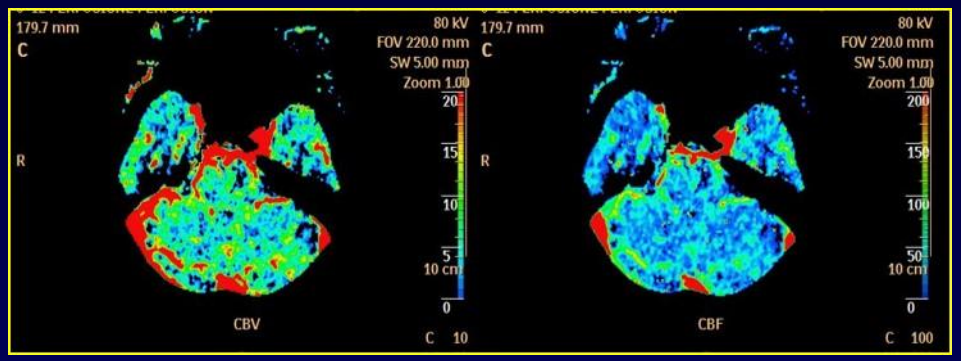
Unenhanced CT-control

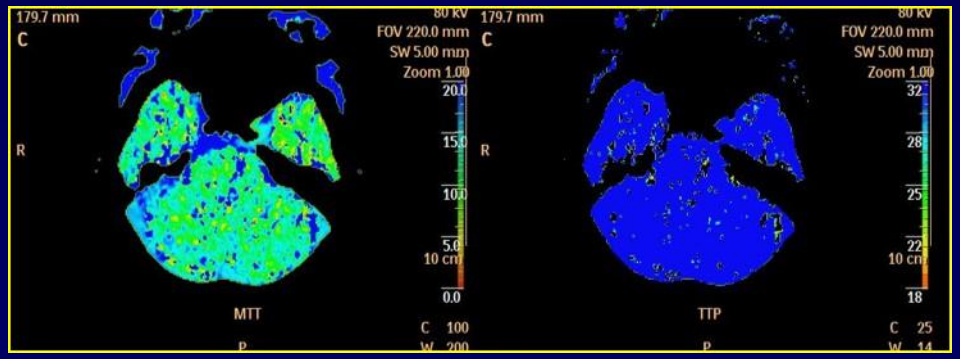
IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

Dysarthria







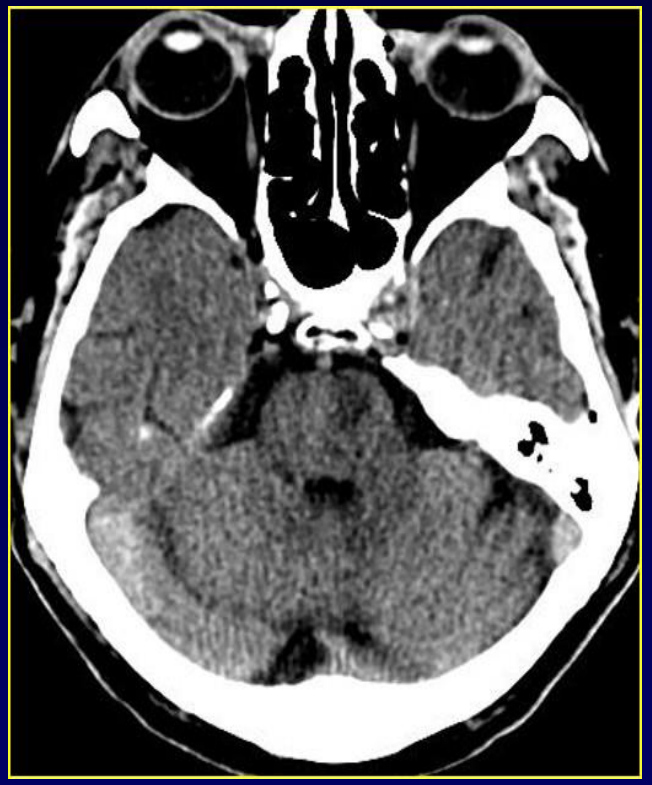
No mismatch

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

Dysarthria

Automatically generated map



Unenhanced CT-control

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

Indications

- Thrombectomy
- Symptoms onset > 4.5 hours
- Unknown onset of symptoms
- Patients stratification

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- thrombectomy

- Presence of mismatch, large therapeuthical window (up to 24 hours if favourable mismatch)

- Optimal mismatch: core < 70 ml, penumbra > 15 ml, ratio core/penumbra >1.8, Tmax >10 s

Lansberg et Al, Ann Neurol, 2017
Potter et Al, Radiographics 2019
Jovin et Al, Int J of Stroke 2017
Nogueira RG et Al, N Engl J Med 2018
Albers GW et Al, N Engl J Med 2018

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- thrombectomy

- In the absence of mismatch thrombectomy is contraindicated

- The presence of mismatch is an indication for thrombectomy not always correlate with the outcome

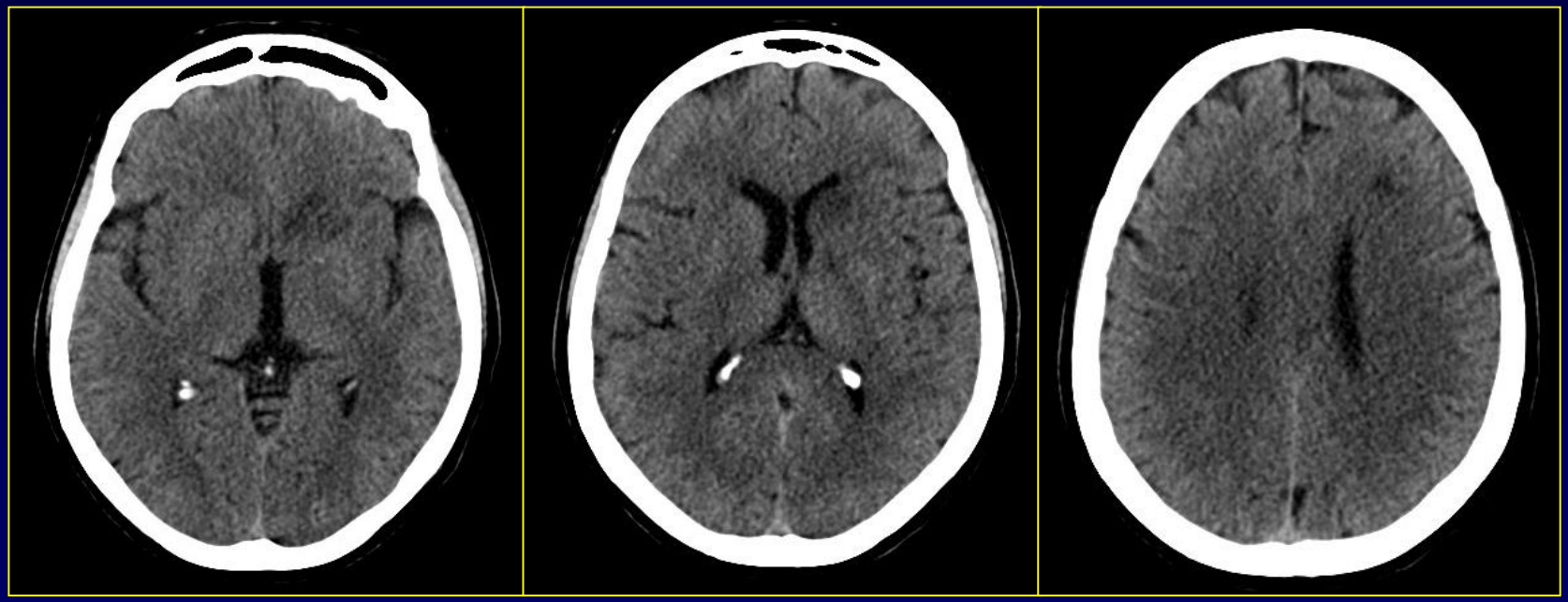
- Evaluation of collaterals is fundamental

- *Basilar artery thrombus: treat if possible*

IMAGING ACUTE ISCHEMIC STROKE

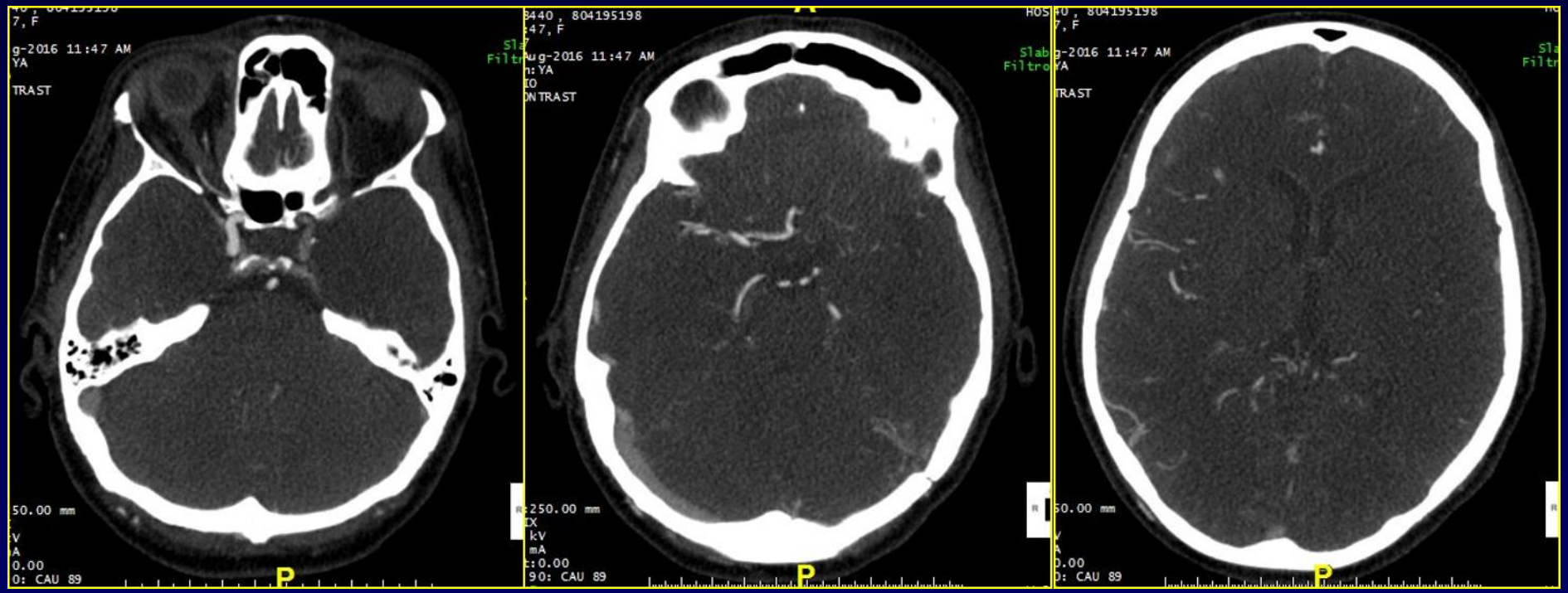
CT-perfusion

Aphasia, right hemiparesis



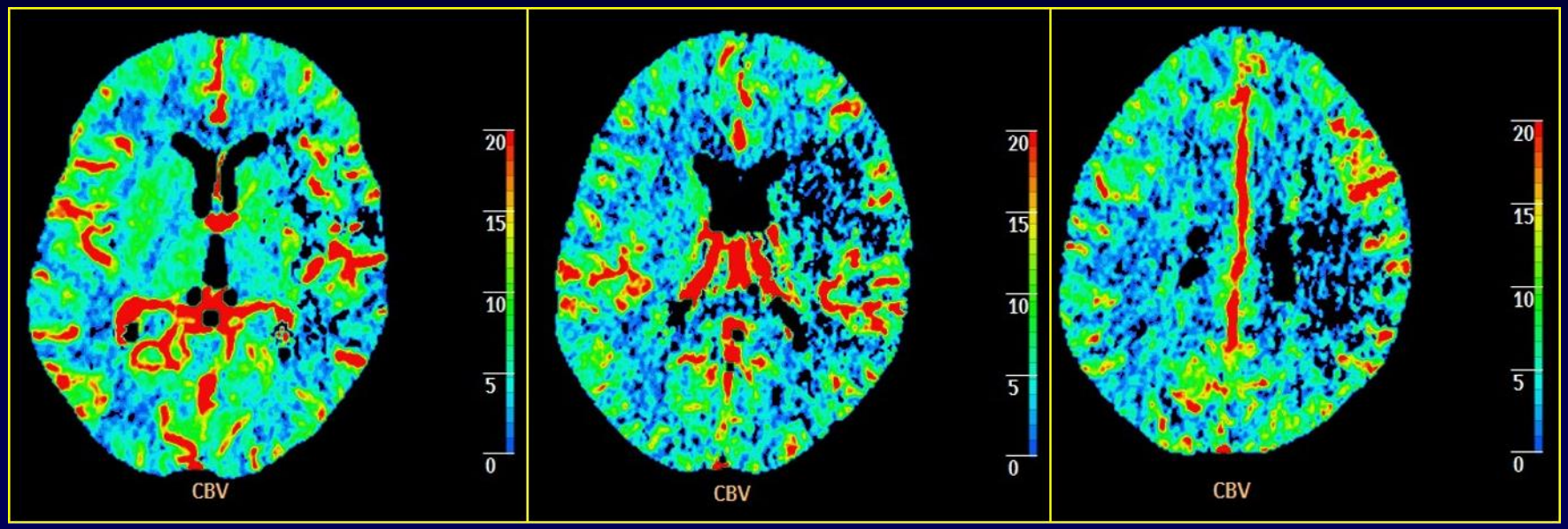
IMAGING ACUTE ISCHEMIC STROKE

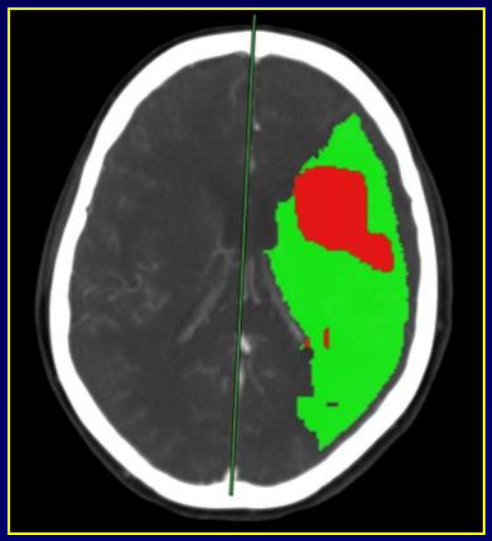
CT-perfusion



IMAGING ACUTE ISCHEMIC STROKE

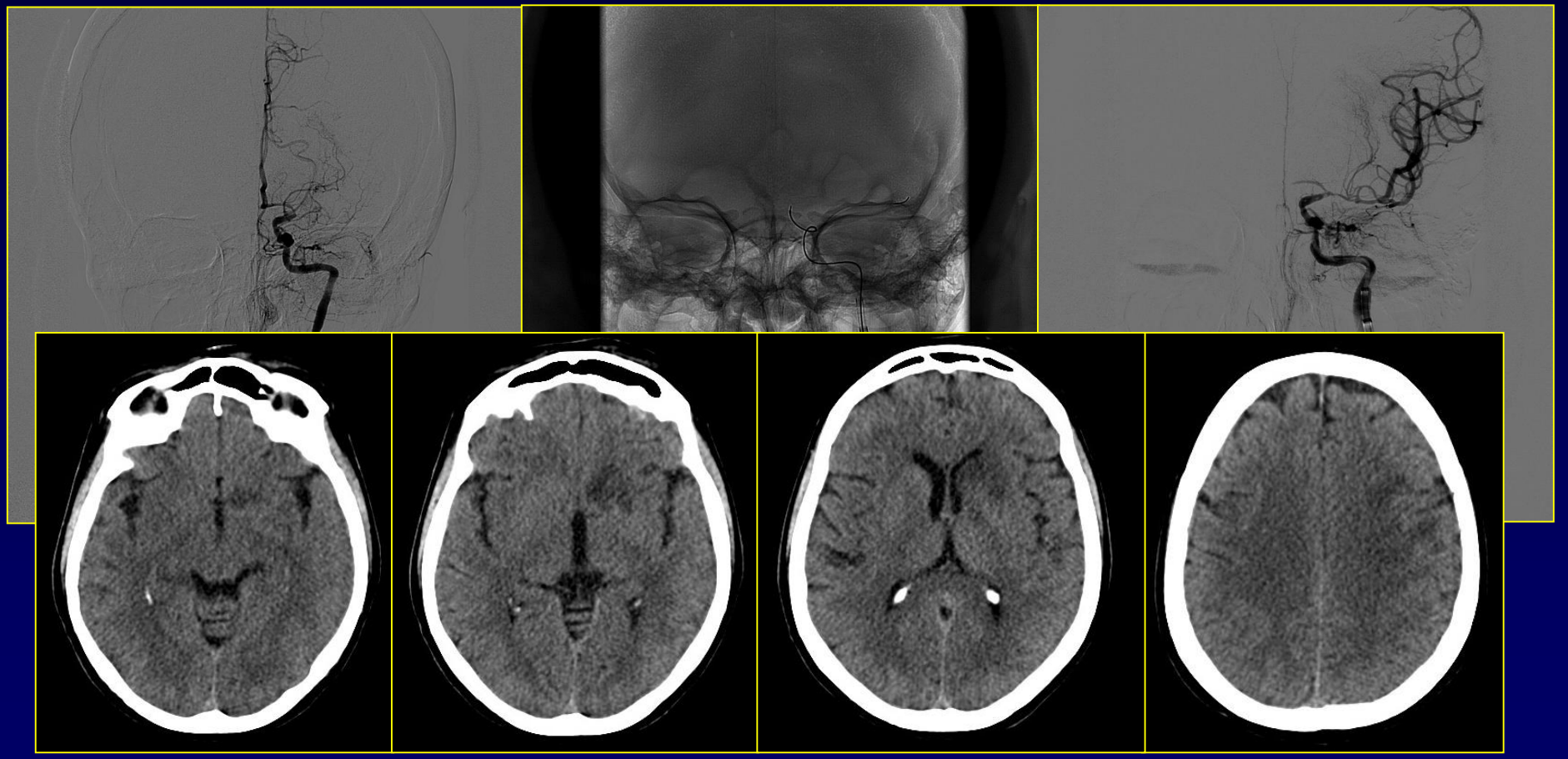
CT-perfusion





IMAGING ACUTE ISCHEMIC STROKE

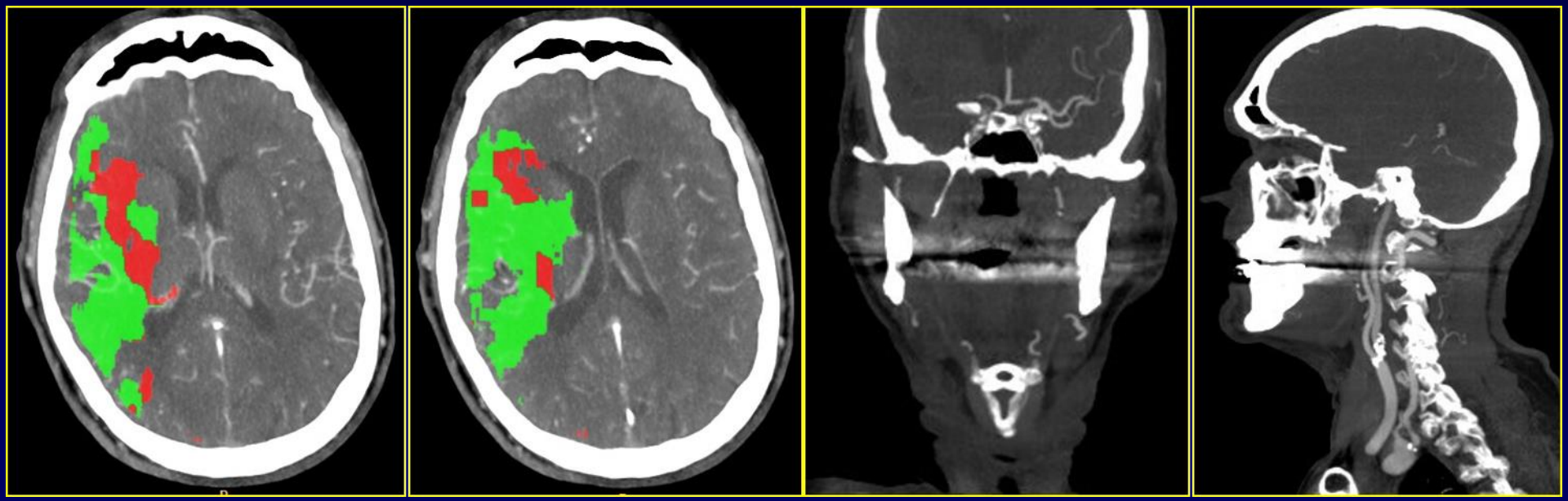
CT-perfusion



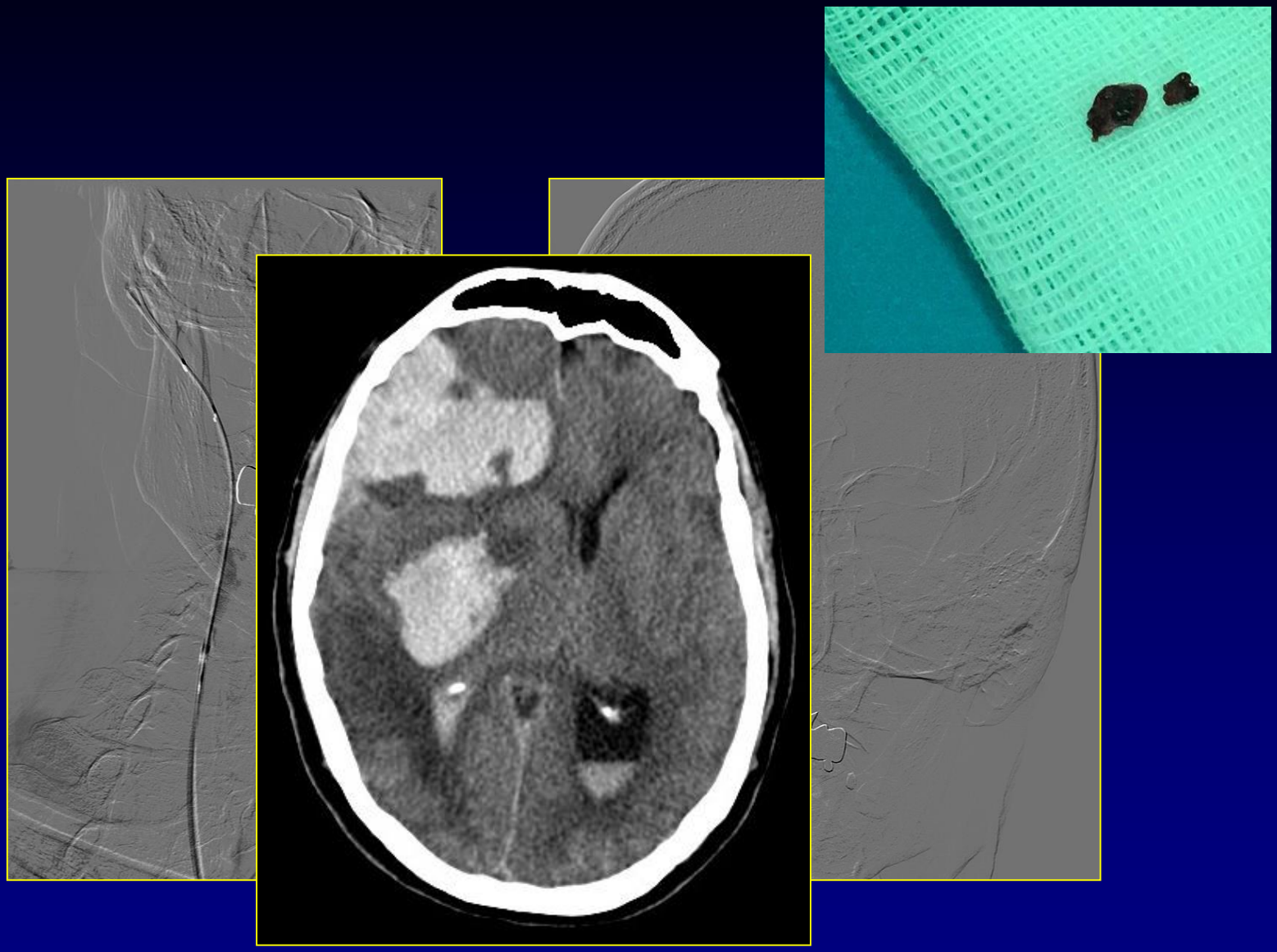
IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

Left hemiparesis, 86 years



IMAGING ACUTE ISCHEMIC STROKE



IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

- Symptoms onset > 4.5 hours, unknown onset of symptoms

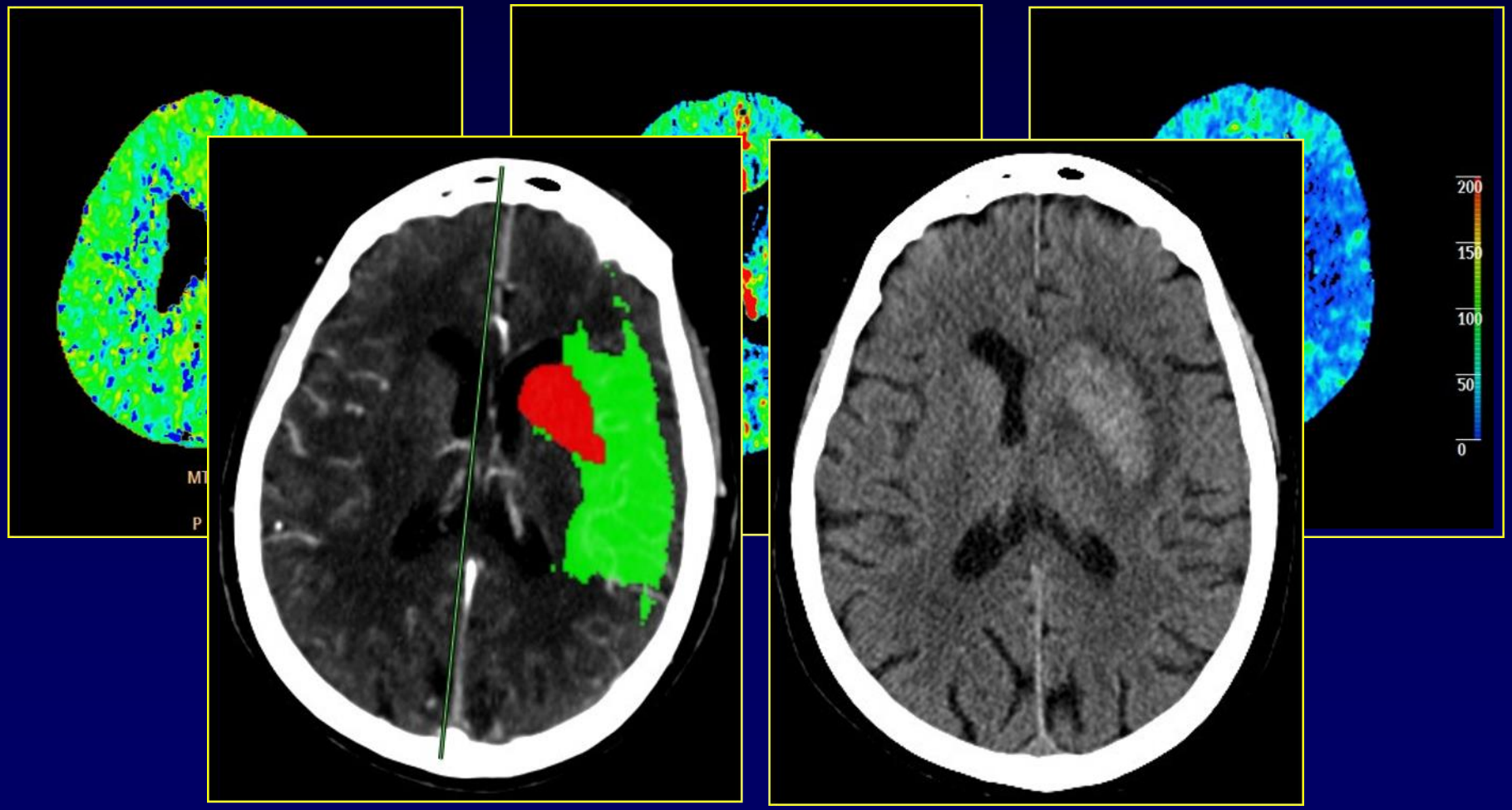
- Identify patients with favourable mismatch, could be treated up to 9 hours

Right hemiparesis

Caruso et Al, Neurol Sci 2018
Campbell et Al, The Lancet 2019

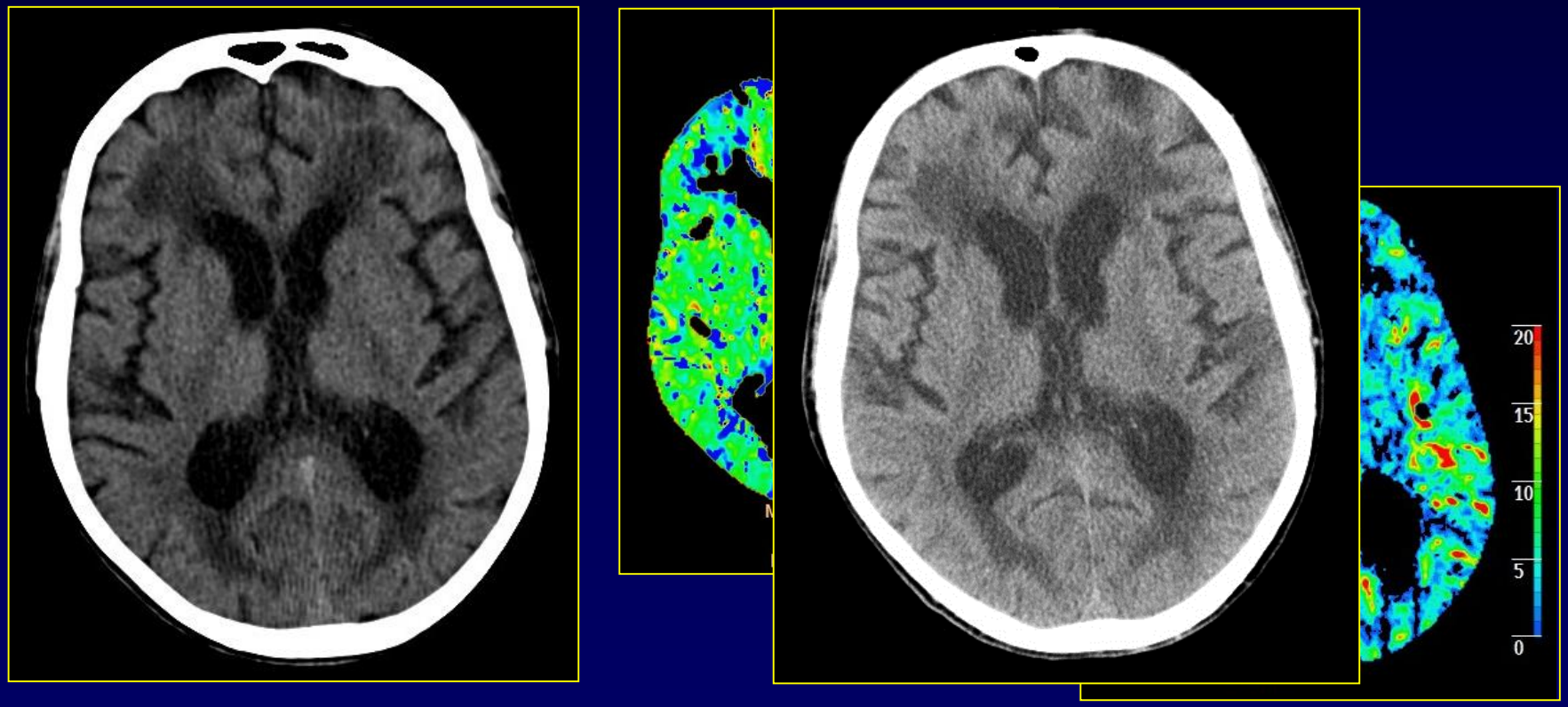
IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion



IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion



Right hemiparesis

IMAGING ACUTE ISCHEMIC STROKE

CT-perfusion

Limits

DD between oligoemia and penumbra

- Oligoemia : a window where brain tissue continues to function normally and can remain mildly hypoperfused without progressing to infarction