MR PERFUSION

MR PERFUSION

- No contrast

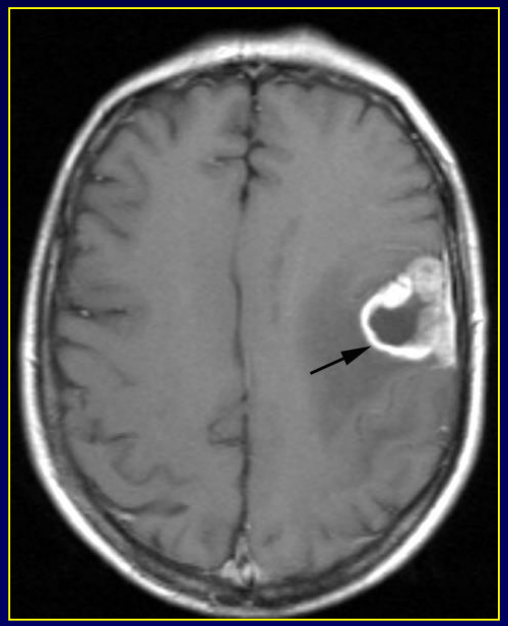
- Administration of contrast media

Vascular studies
Perfusional studies

Parenchymal studies

MR PERFUSION

- Paramagnetic contrast



Parenchymal study

Vascular

MR PERFUSION

- Injection of contrast media (gadolinium)

- Dynamic susceptibility contrast (DSC) MR perfusion
- Dynamic contrast enhanced (DCE) MR perfusion

- Without the use of contrast media

- Arterial spin labeling (ASL)

MR PERFUSION

- DSC perfusion

- Allow qualitative and quantitative evaluation of cerebral perfusion by generating maps of:

CBF cerebral blood flow (ml/100g/min)

CBV cerebral blood volume (CBFxMTT)

MTT mean transit time (s)

MR PERFUSION

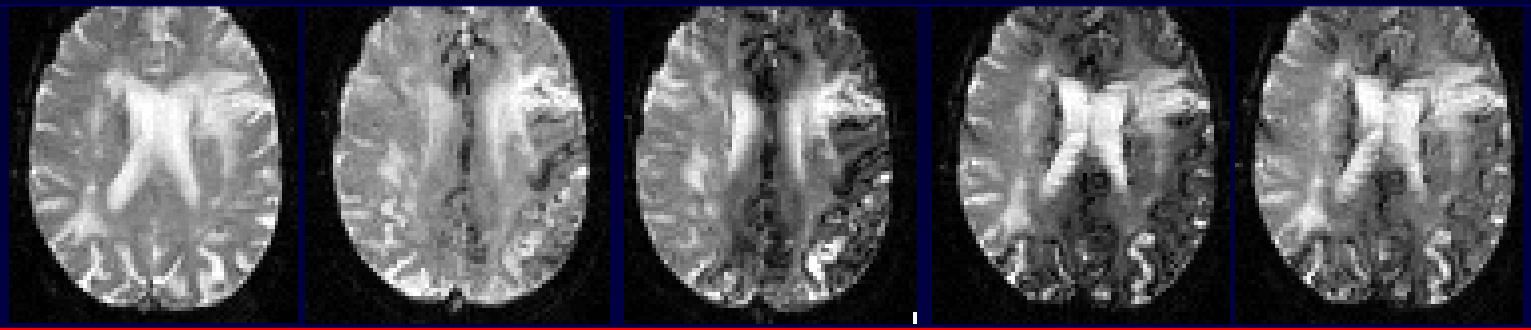
Exogenus contrast media: DSC

- shortened the T1
- shortened the T2
- reduce the homogeneity of the magnetic field

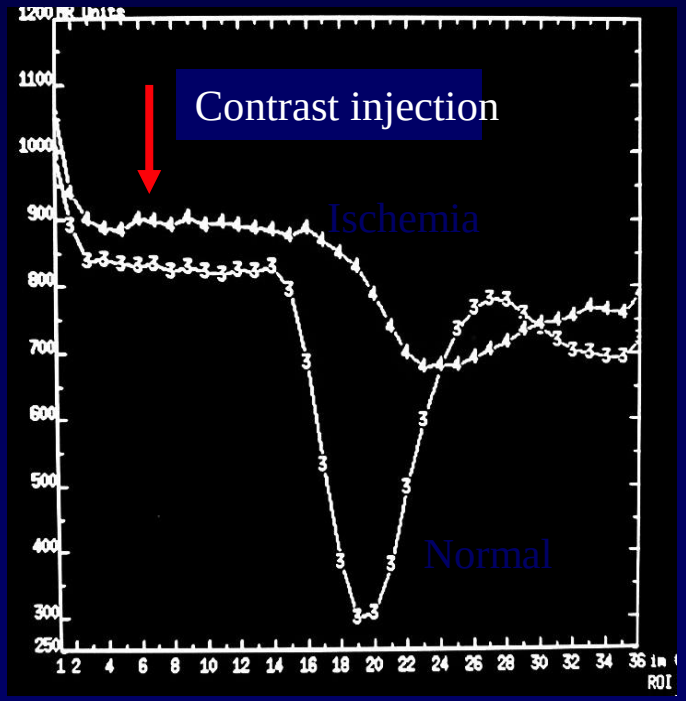
- 0.1 mmol/Kg Gd
- 20 cc saline
- 4.5-5 ml/sec

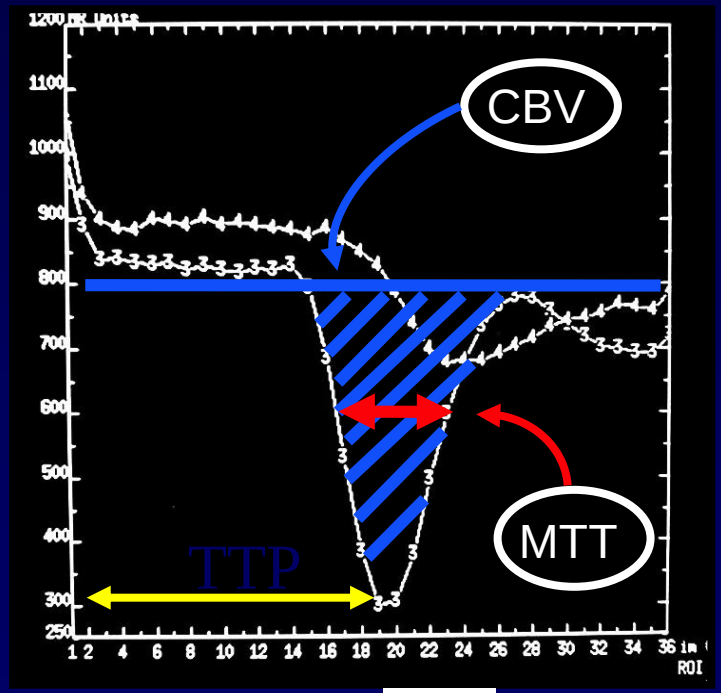
- Dynamic aquisition (20-40 slices)

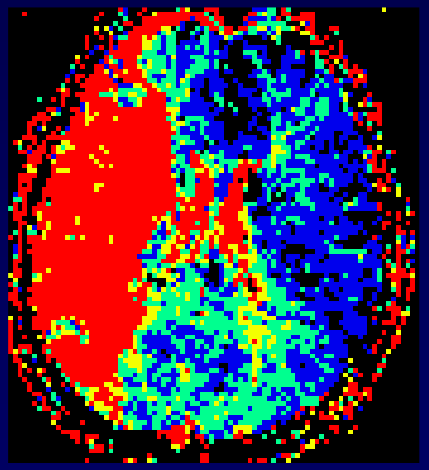
MR PERFUSION



Time (60-90”; 1 slice/1-2”; whole brain coverage)





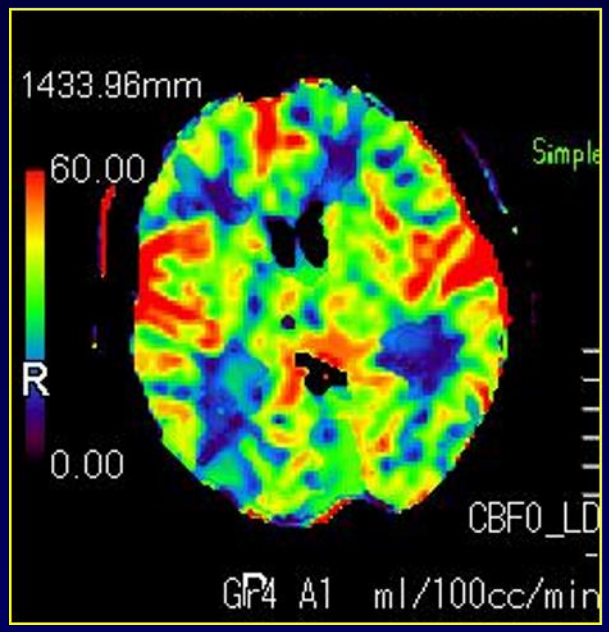


TTP map

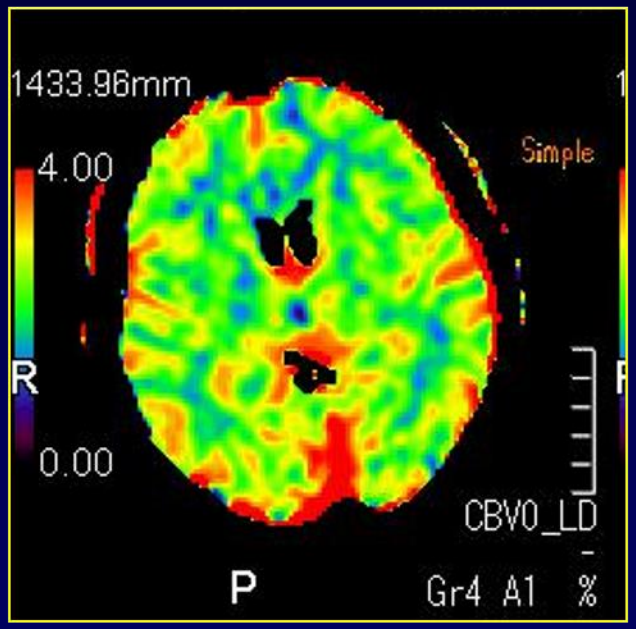
$$CBF = \frac{CBV}{MTT}$$

Courtesy of Prof. Sossio Cirillo

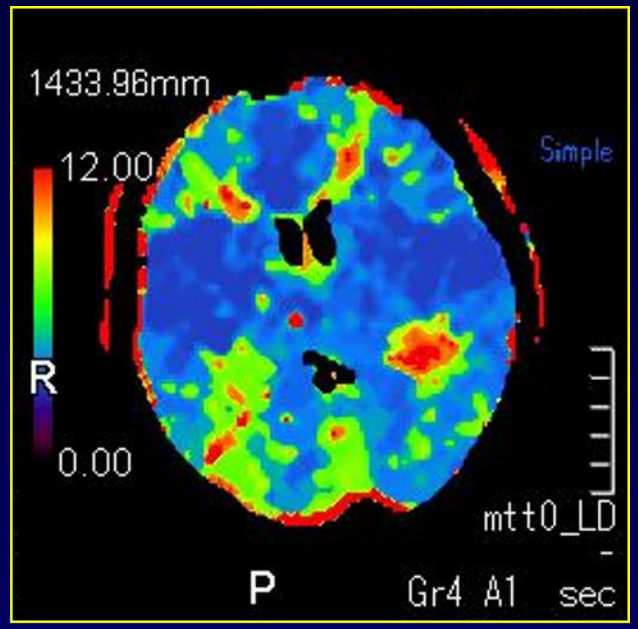
MR PERFUSION



CBF- flow whithin blood vessel per unit of time



CBV- volume of blood vessel



MTT- mean transit time

MR PERFUSION

DSC- T2 perfusion* (CBV)

DCE- T1 perfusion (permeability, k trans, Vp)

Complementary techniques:

DSC: easier post-processing, more robust technique
DCE: insensitive to blood components cranial theca etc, 2 types of permeability: 1. consequent to first passage of contrast media 2. bidirectional passage of contrast media between plasma and extracellular space

MR PERFUSION

Exogenus contrast media: DCE

- DCE perfusion uses T1-weighted images to measure changes in the tissue concentration of intravenous contrast over time.

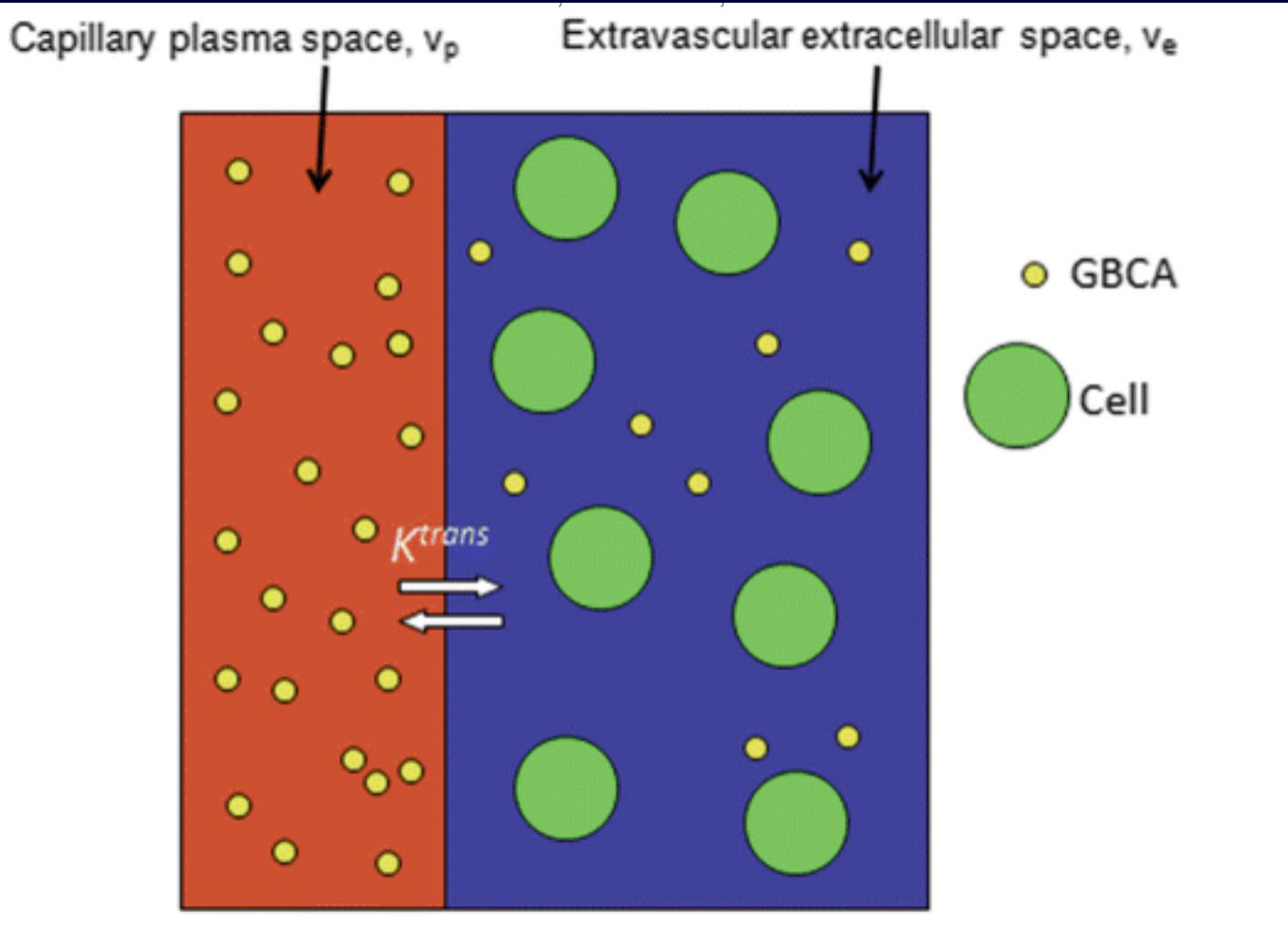
- information is available about the movement of the tracer across the capillary membrane and into the tissue.

- estimate the volume transfer coefficient (Ktrans), which measures the passage of the tracer from the intravascular plasma space to the EES ⟹ measure of capillary leakiness

- Vp (plasma volume) and Ve (extracellular/extravascular volume)

MR PERFUSION

Exogenus contrast media: DCE



Radiology key

MR PERFUSION

DSC- T2 perfusion* (CBV)

DCE- T1 perfusion (permeability, k trans, Vp)

Complementary techniques:

DSC: easier post-processing, more robust technique
DCE: insensitive to blood components cranial theca etc, 2 types of permeability: 1. consequent to first passage of contrast media 2. bidirectional passage of contrast media between plasma and extracellular space

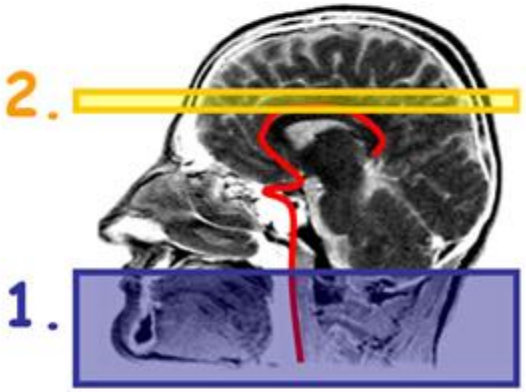
MR PERFUSION

Endogenous contrast media

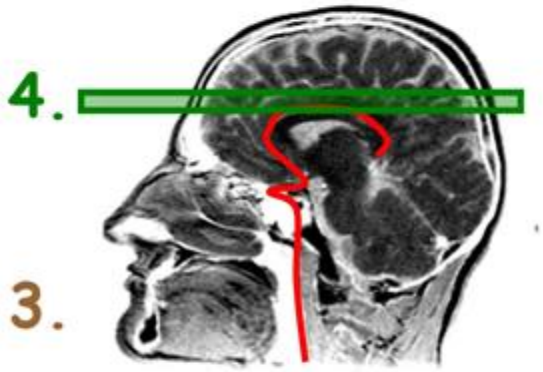
- Arterial spin labeling (ASL) is a non-invasive and cost-effective MRI technique for brain perfusion measurements
- it does not require an exogenous tracer such as gadolinium
- Less robust in comparison to “contrast” technique

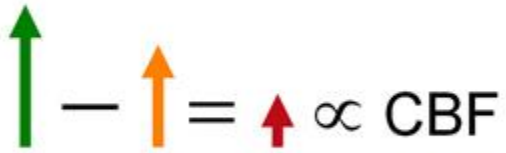
ASL Summary (Generalized)

1. Tag inflowing arterial blood by magnetic inversion
2. Acquire the tag image



3. Repeat experiment without tag
4. Acquire the control image





5. Subtract: Control image - Tag Image

The difference in magnetization between control and tag conditions is proportional to regional cerebral blood flow.

"Labeling" means changing the blood magnetization (more specifically the spin magnetization is inverted, important to know that the magnetization is changed with respect to the rest of the brain).

MR PERFUSION

- Stroke
- Tumors
- Degenerative disorders
- Trauma
- Migraine

MR PERFUSION

- Tumors: neoangiogenesis = ↑ capillaries > cerebral perfusion and volume (CBV)

- *tumors biological agressivness low grade Vs high grade*

- guide to biopsy: areas of high grade glioma

- DD infiltrative perilesional oedema (glioma) and vasogenic oedema as in metastasis (lower CBV)

- DD recurrence vs radionecrosis

MR PERFUSION

- Administration of contrast media

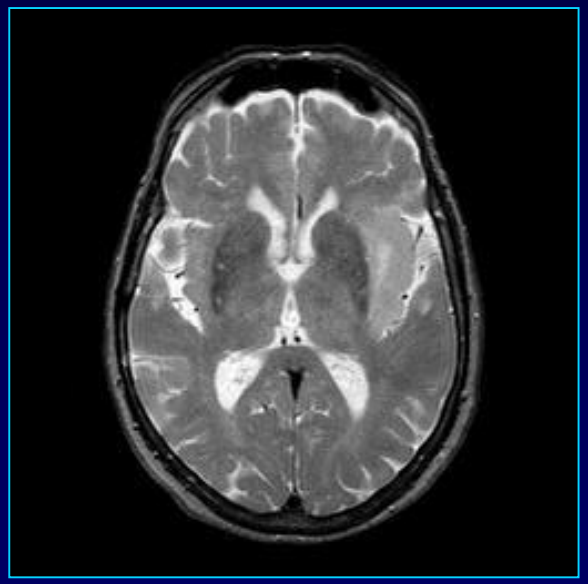
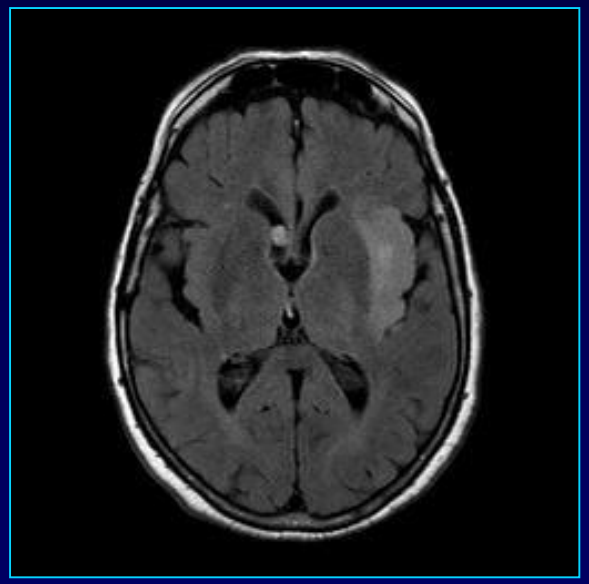
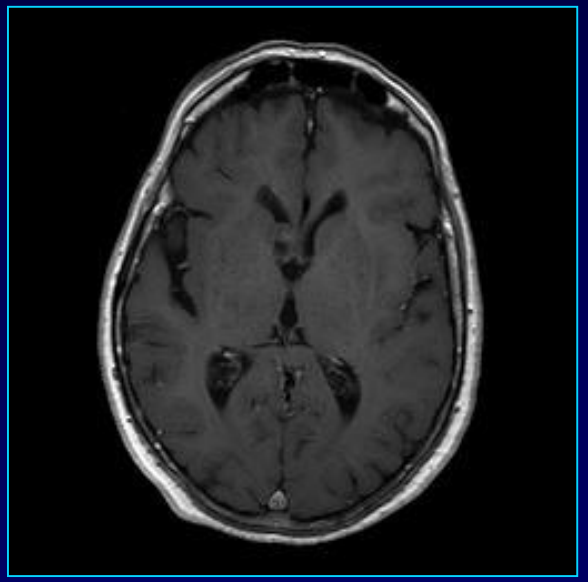
- Enhancement due to BBE leakage

- Enhancement due to neoangiogenesis → perfusion

- CBV is an indication of malignancy
- 10-18% of grade III t. do not enhance
- 10-20% of low-grade t. enhance

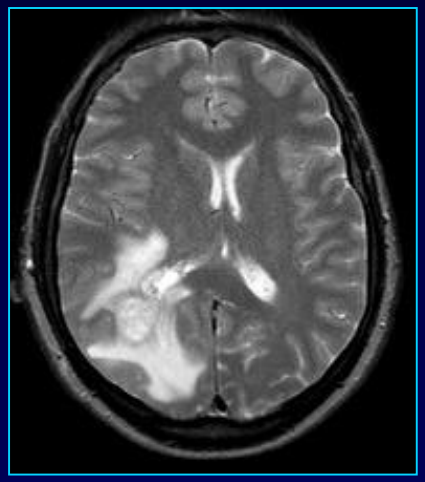
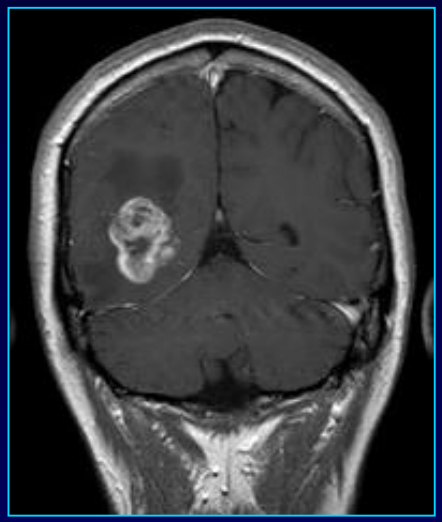
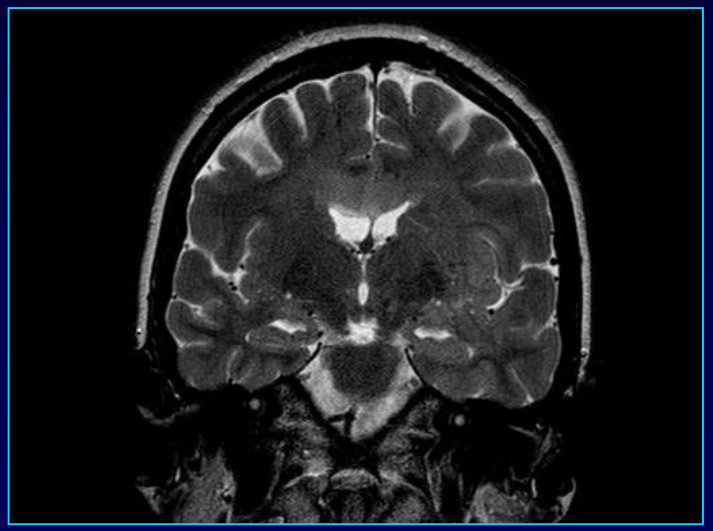
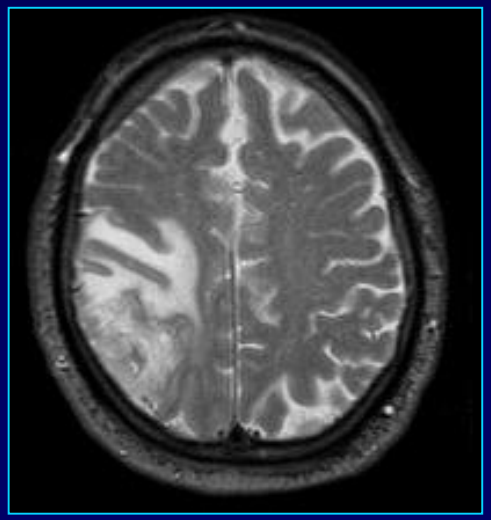
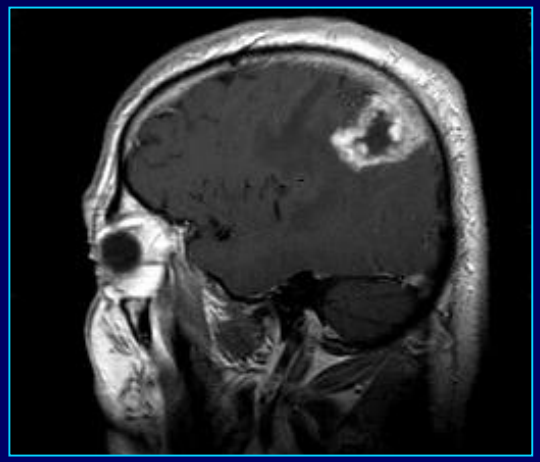
MR PERFUSION

- **Adult diffuse glioma - Low vs high grade**

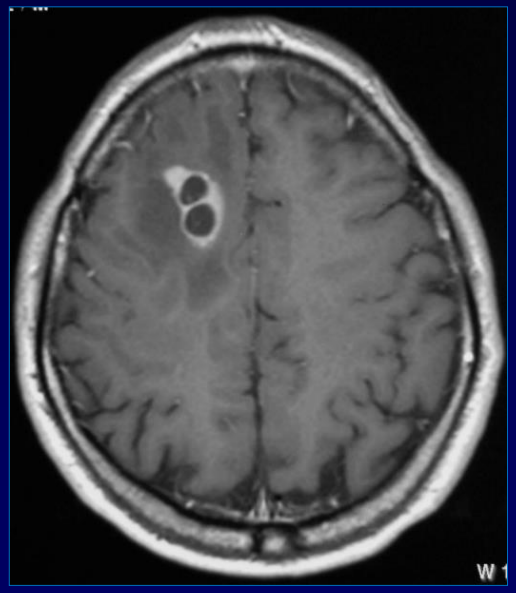
MR PERFUSION

- **Diffuse adult glioma- Low vs high grade**

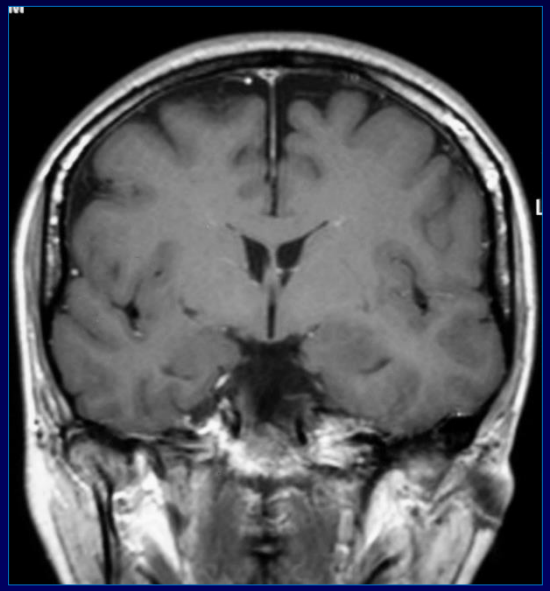






MR PERFUSION

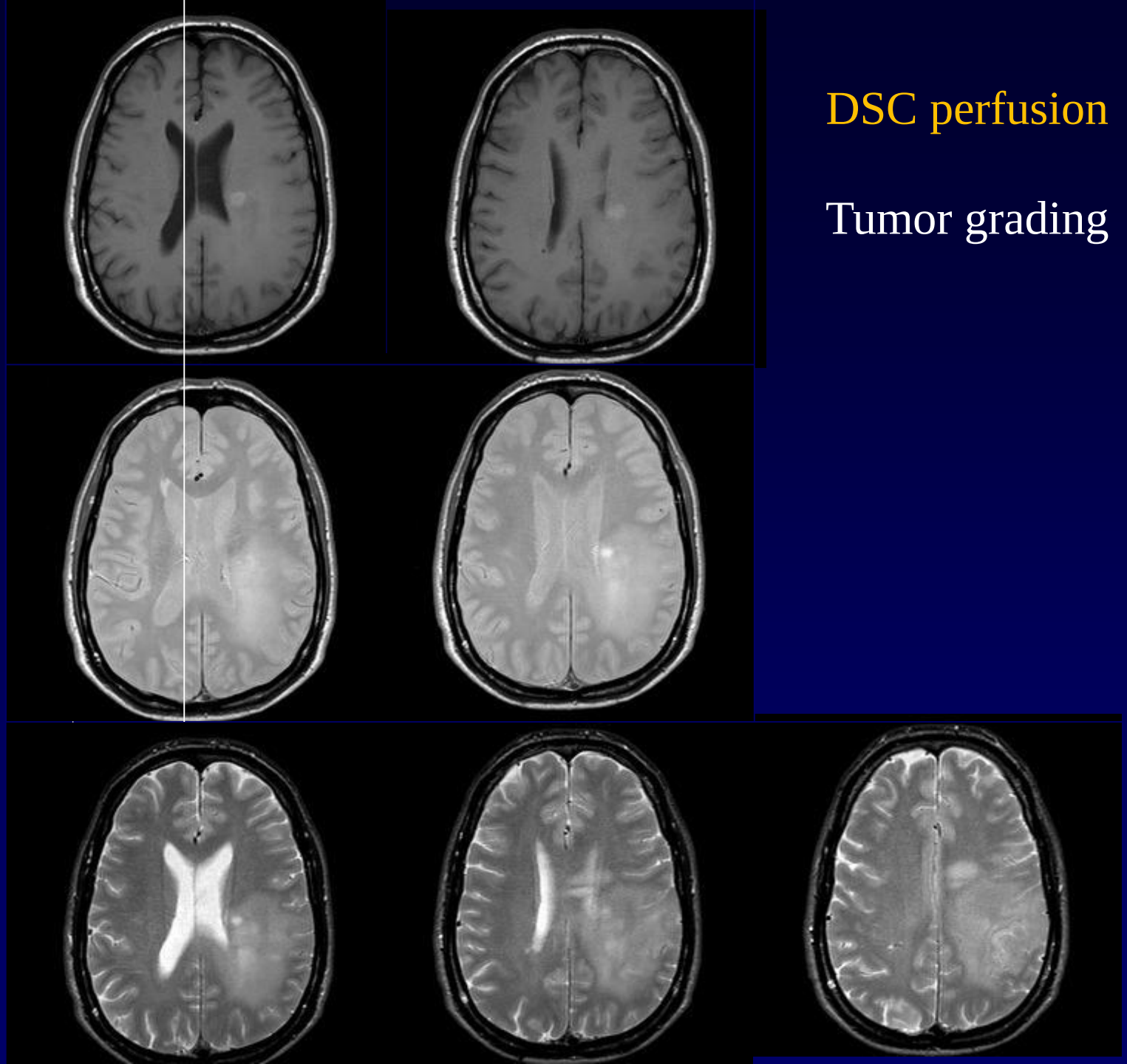
- **Adult diffuse glioma – enhancement**



Astrocytoma 2 grade IDH mutant

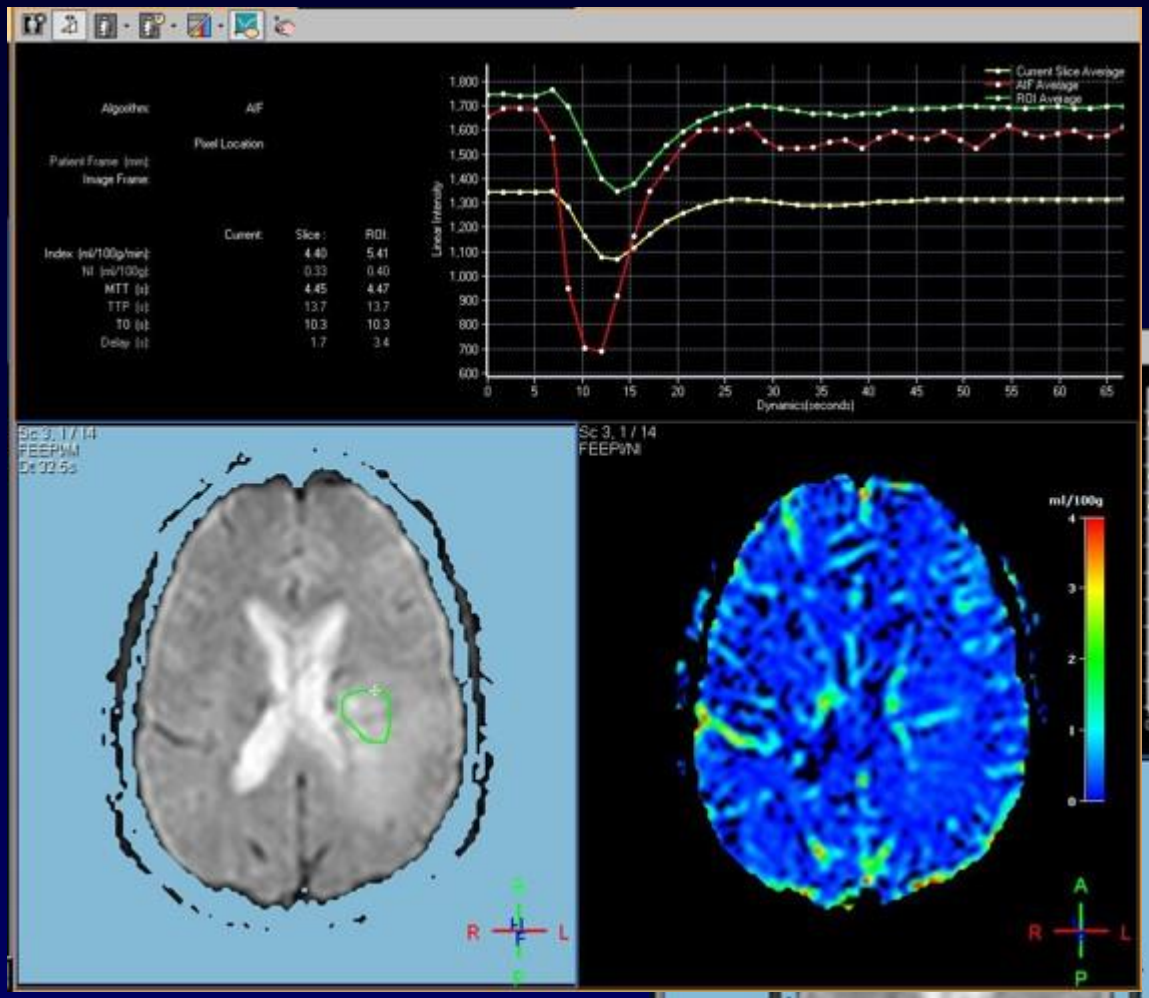


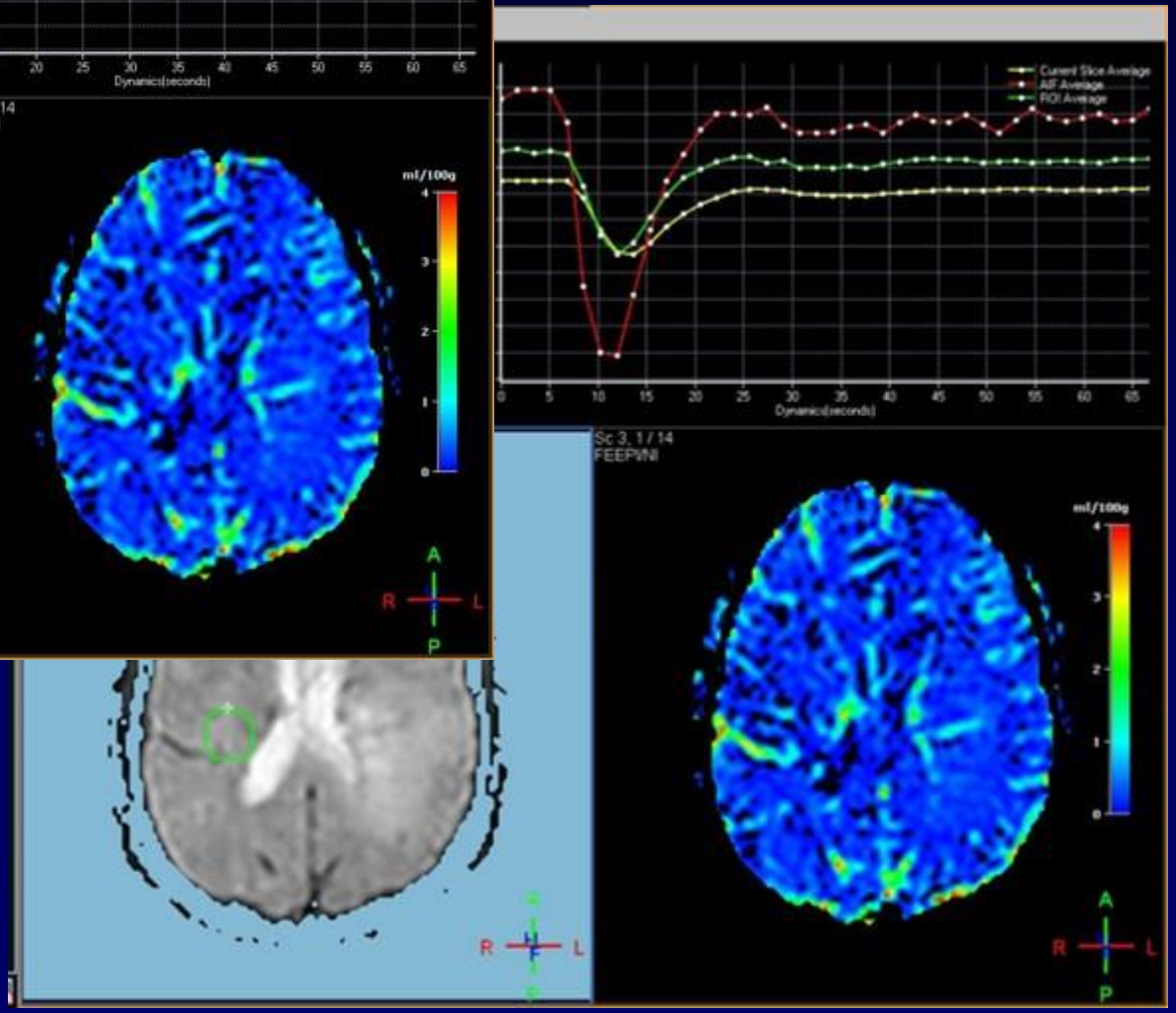
Astrocytoma 3 grade wild type



DSC perfusion

Tumor grading

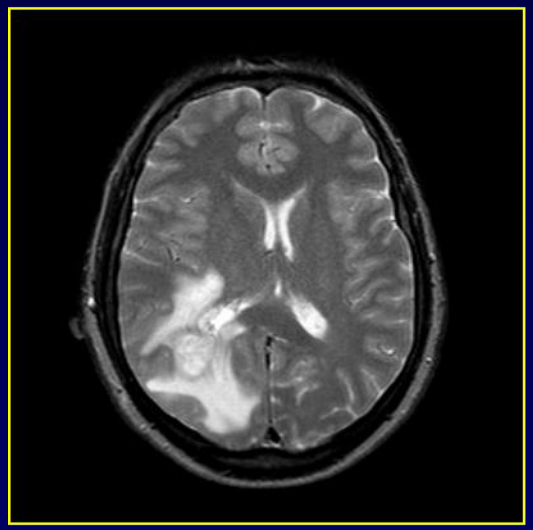


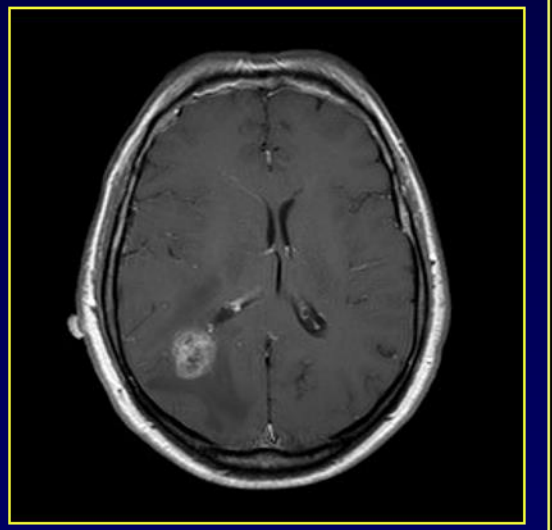


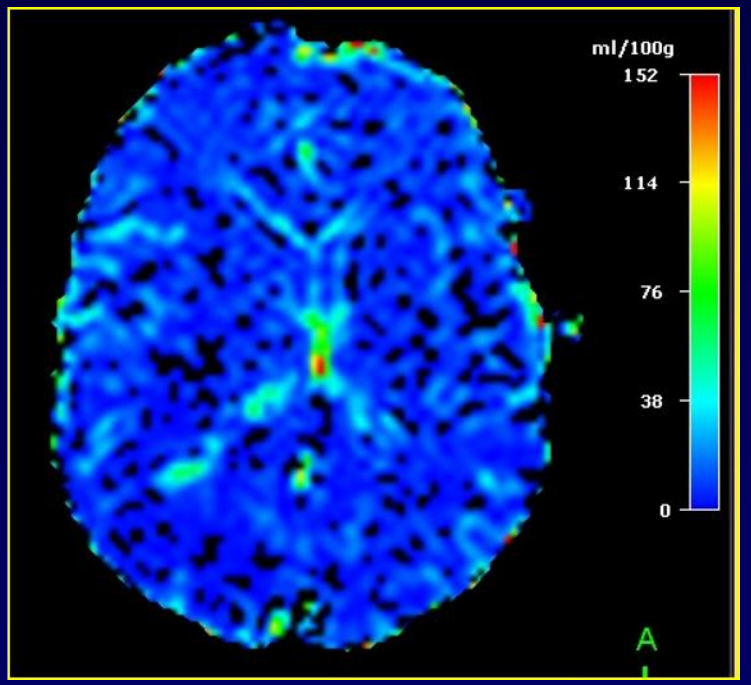
Astrocytoma IDH mutant

MR PERFUSION

Tumor grading

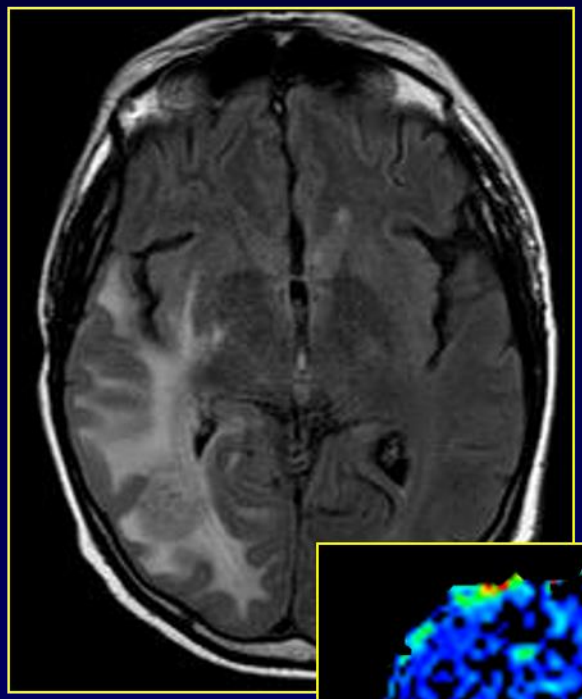


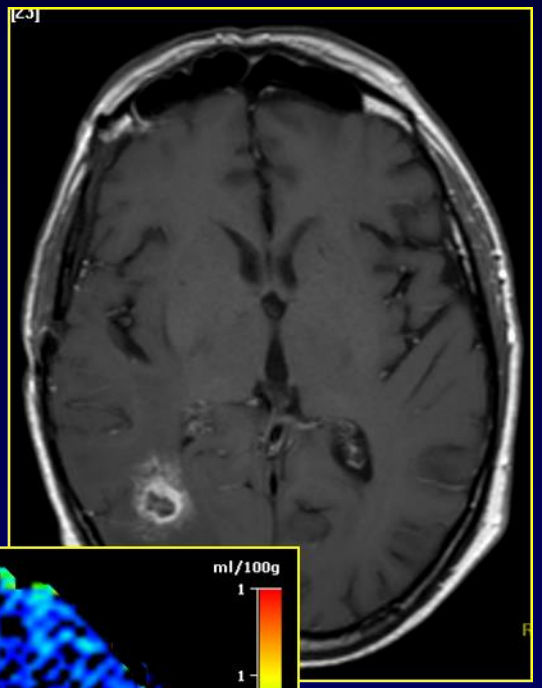


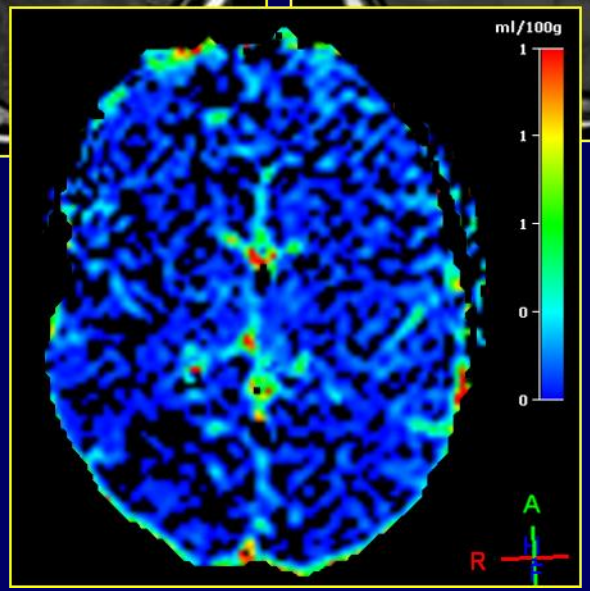


MR PERFUSION

DD recurrence vs radionecrosis



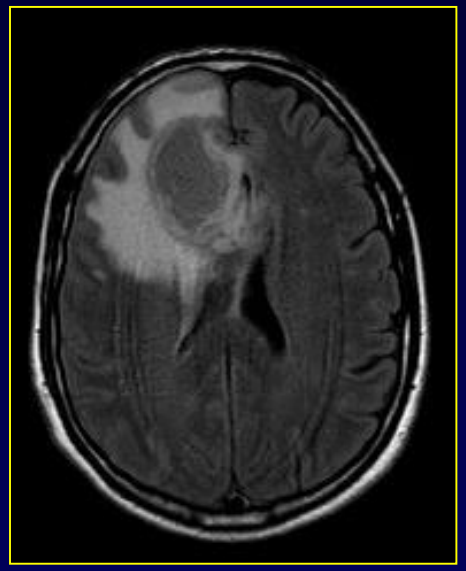
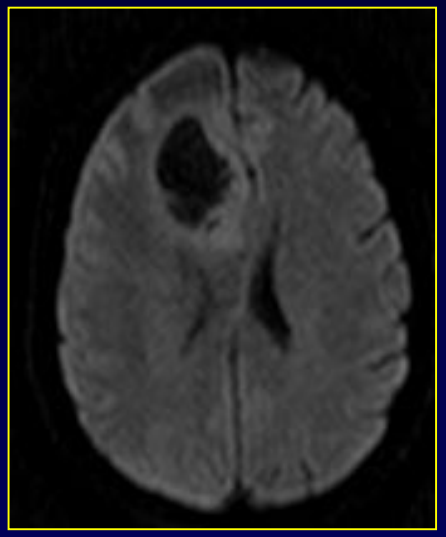
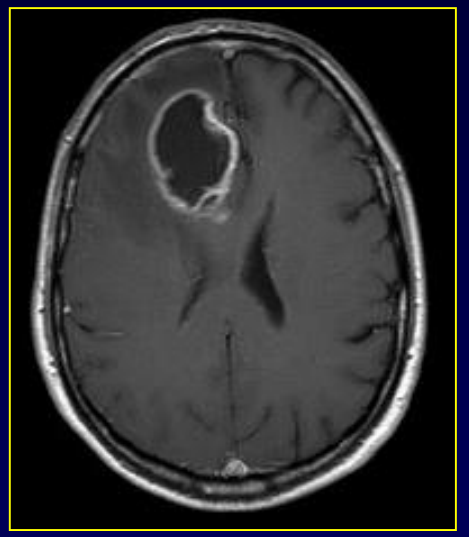
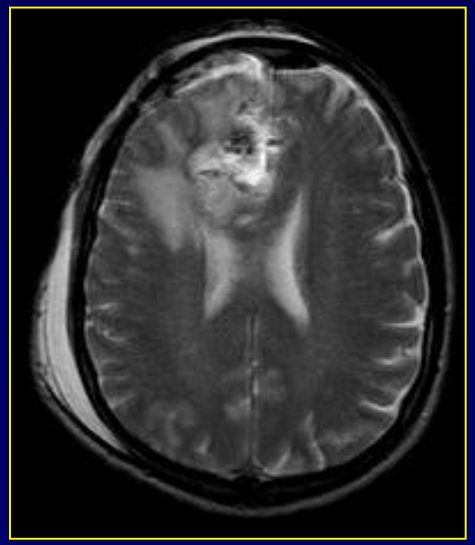
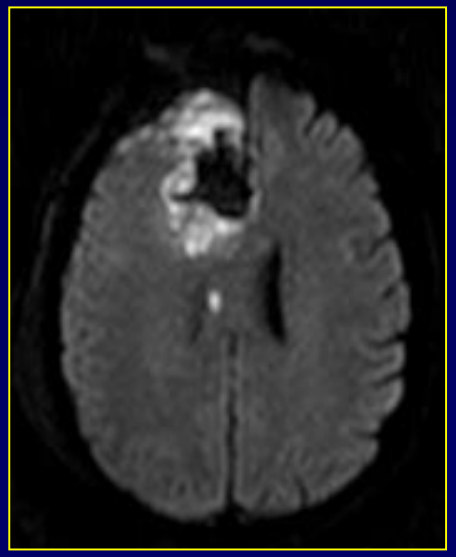
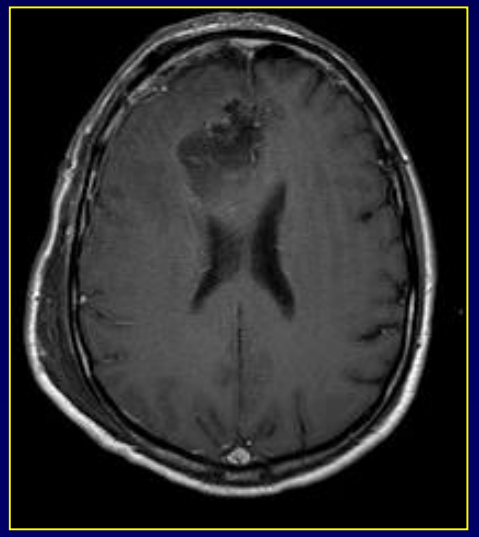




Radionecrosis

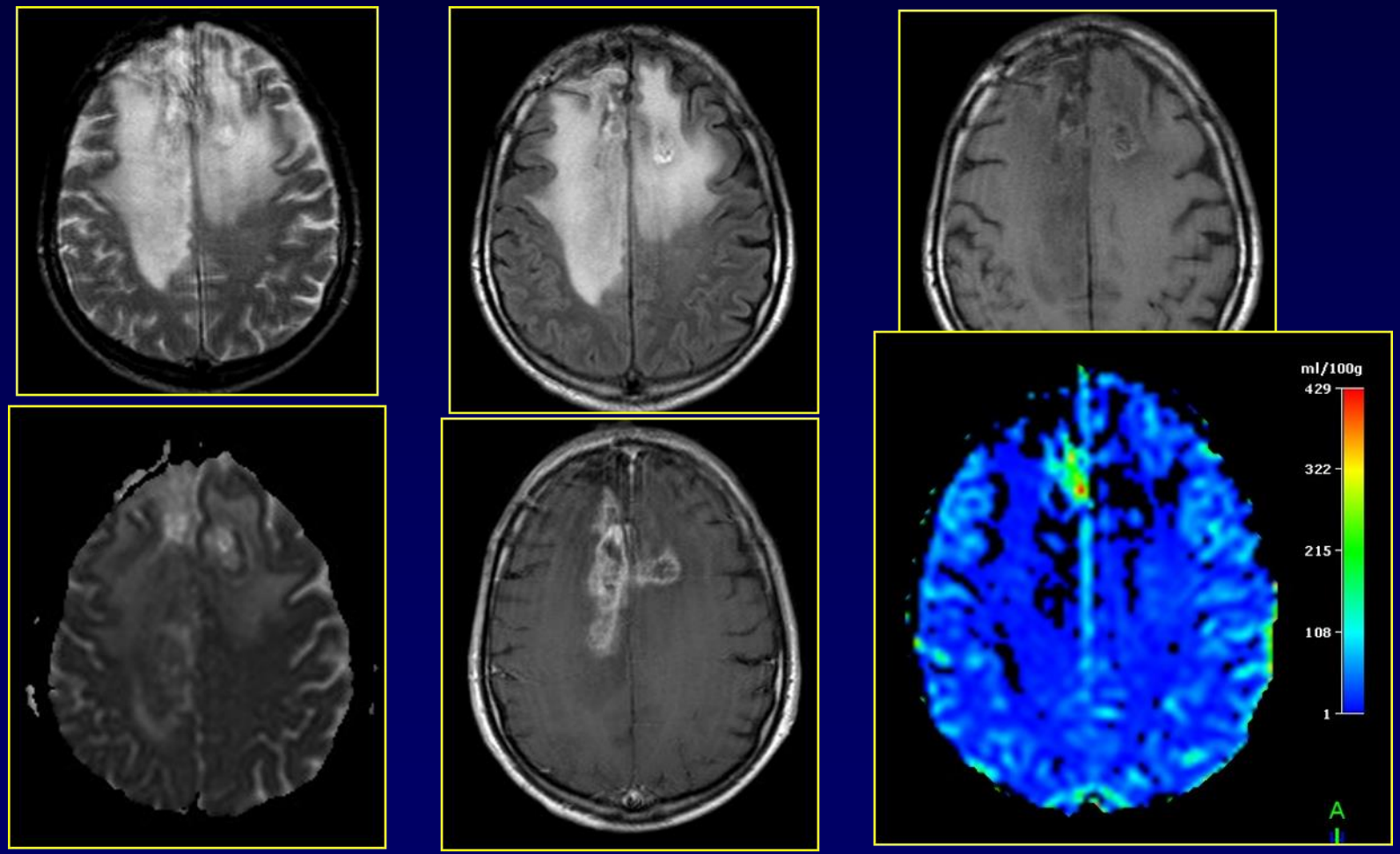
MR PERFUSION

DD recurrence vs radionecrosis

MR PERFUSION

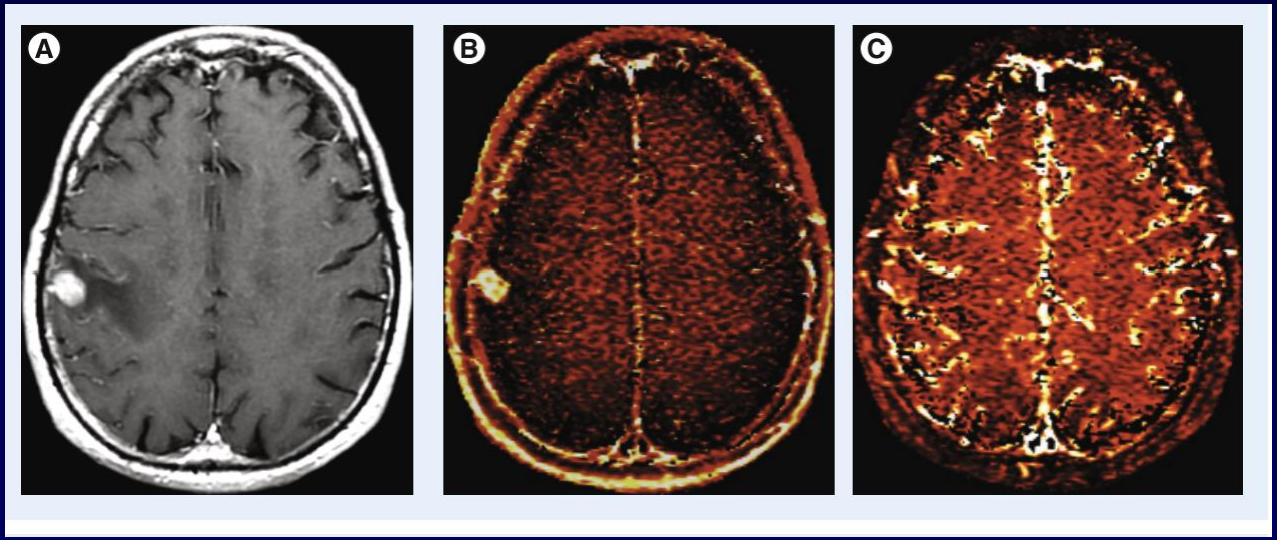
DD recurrence vs radionecrosis



MR PERFUSION

DCE perfusion

Lymphoma



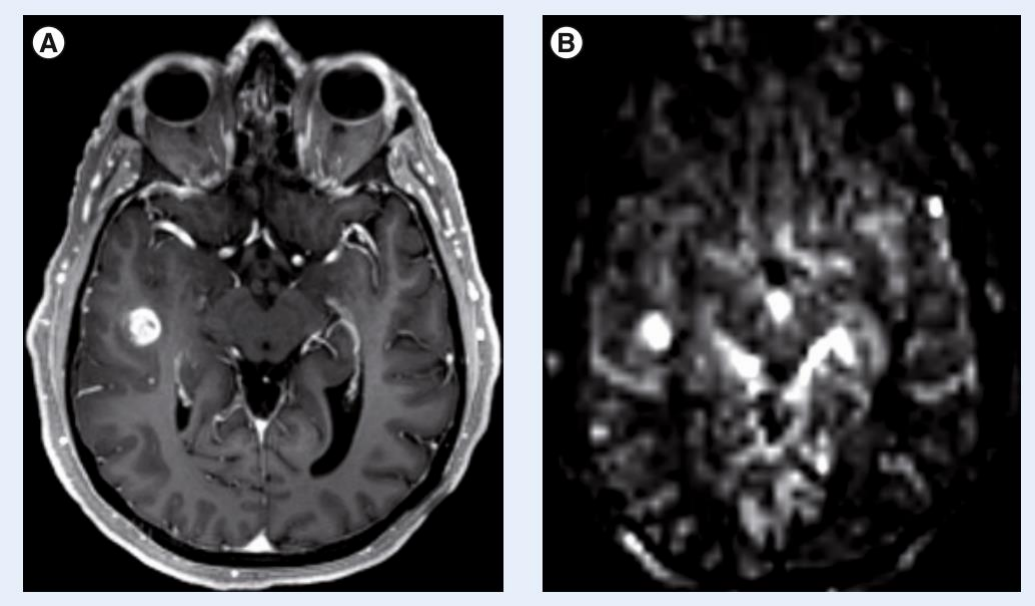
T1 w+ CM K trans Vp

Fussell D, Young R:Imaging Med 2013

MR PERFUSION

ASL

High grade glioma

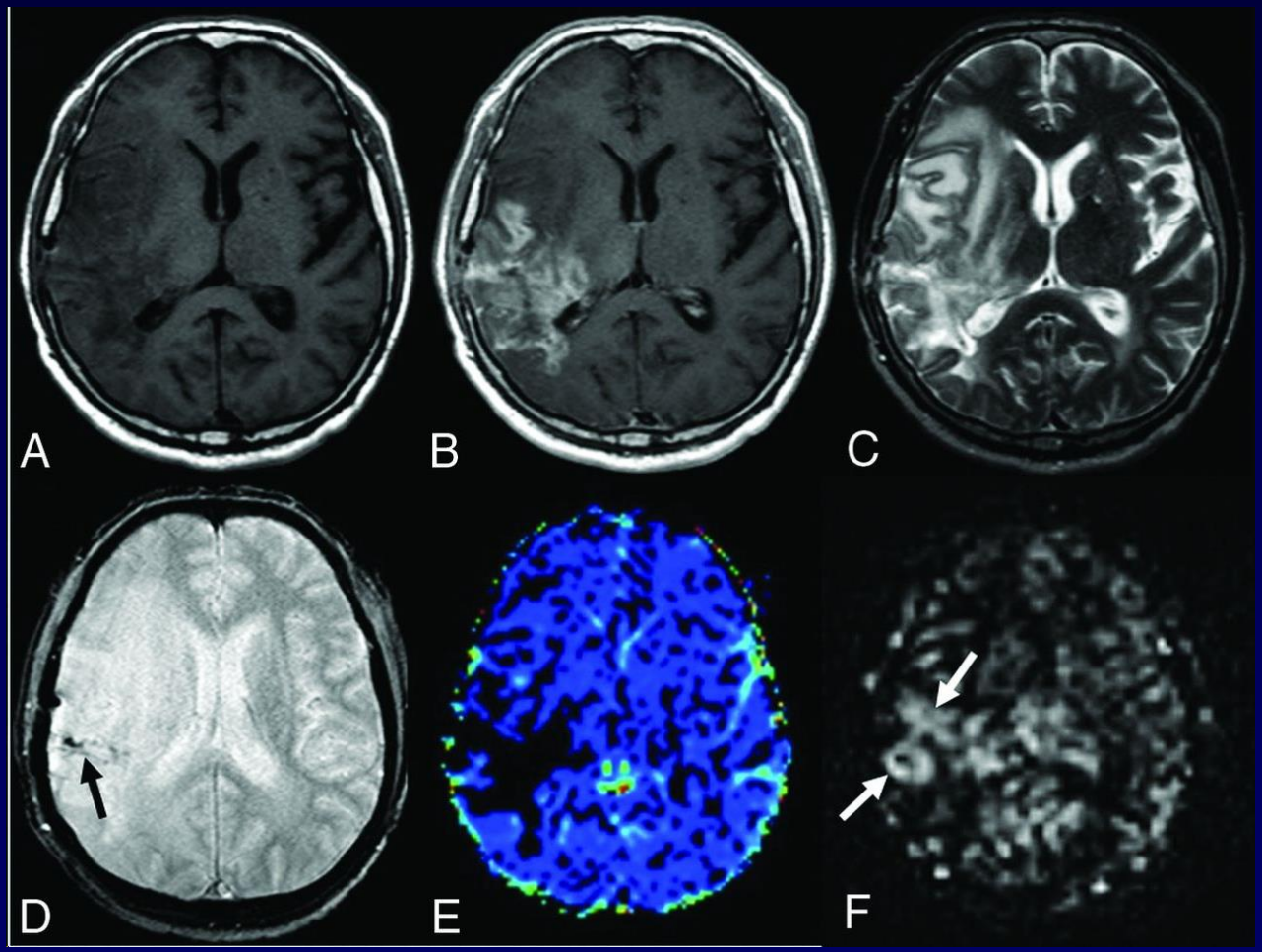


Fussell D, Young R:Imaging Med 2013

MR PERFUSION

Recurrent glioma

ASL vs DSC



Maral et Al, AJNR 2020

MR PERFUSION

- Stroke
- Tumors
- Degenerative disorders
- Trauma
- Migraine

MR PERFUSION

Alzheimer disease

- Predominant involvement (atrophy) of mesial temporal regions, in particular the hippocampus and entorhinal cortex, parietal atrophy (often symmetrical)

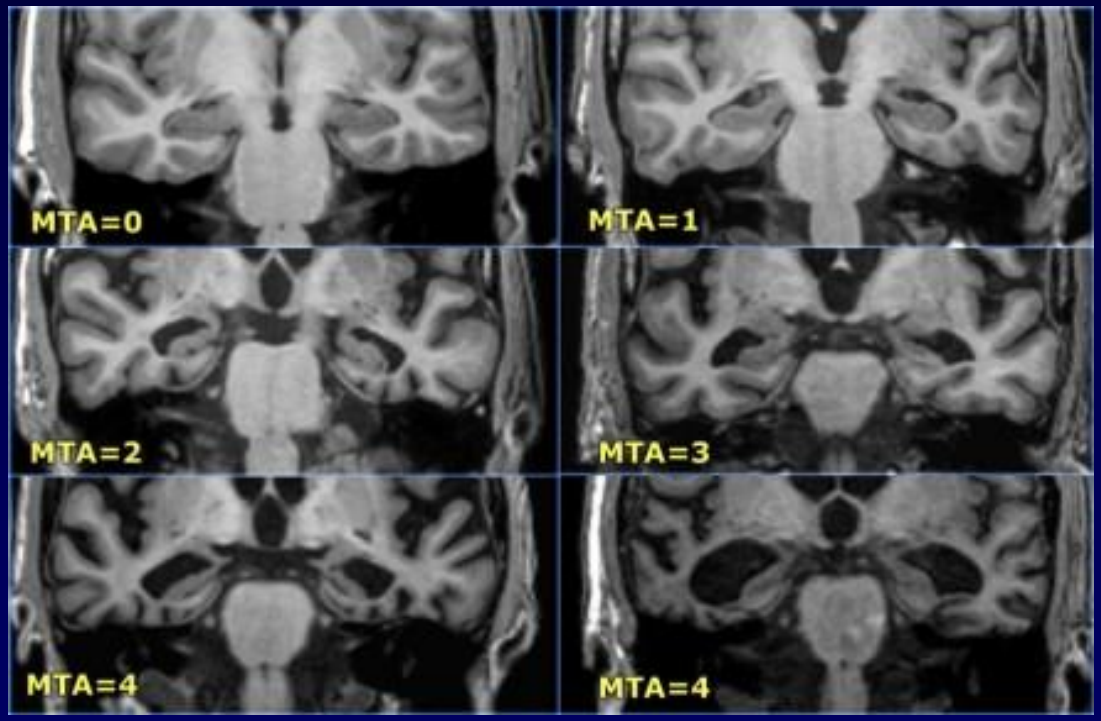
- Dilatation of temporal horns, choroid scissura and sylvian scissura
- Late findings

- Initially important to assess progression of findings (specific software)

- Important is the DD form normal aging

Atrophy

MTA- medial temporal atrophy (Schelten's scale)



MTA visual rating scale

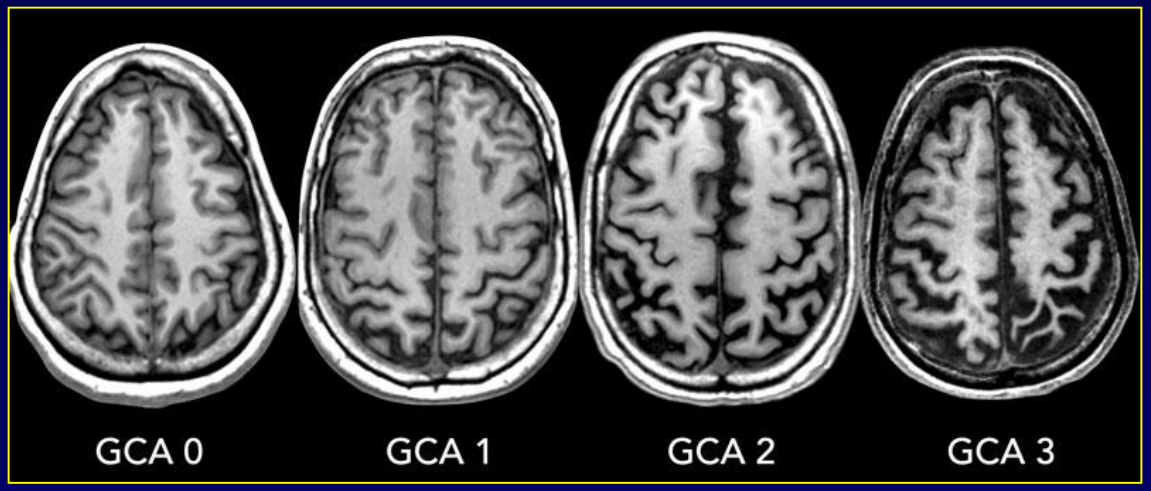
Score	Width of choroid fissure	Width of temporal horn	Height of hippocampal formation
0	N	N	N
1	↑	N	N
2	↑↑	↑↑	↓
3	↑↑↑	↑↑↑	↓↓
4	↑↑↑	↑↑↑	↓↓↓

Radiology Assistant 2012

Atrophy

GCA-scale for Global Cortical Atrophy

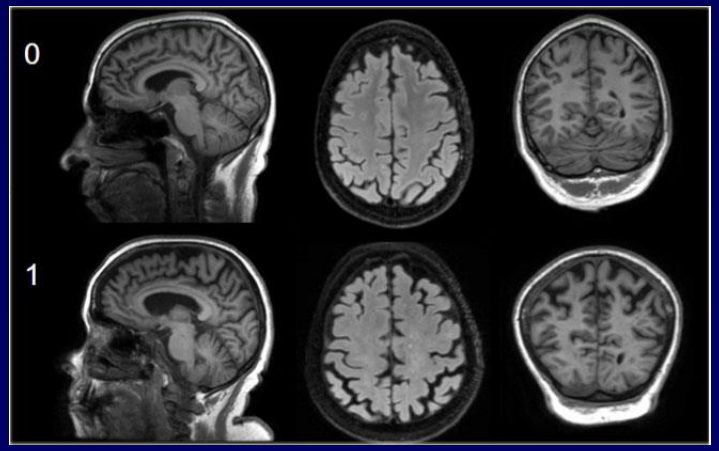
0: no cortical atrophy
1: mild atrophy: opening of sulci
2: moderate atrophy: volume loss of gyri
3: severe end-stage atrophy: 'knife blade'.

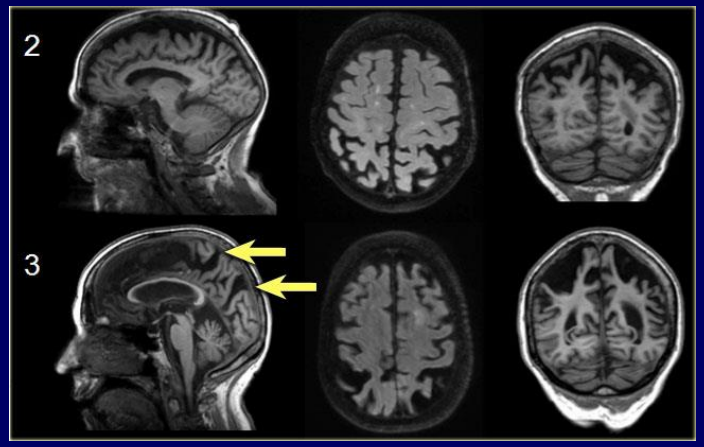


Atrophy

Koedam score for parietal atrophy

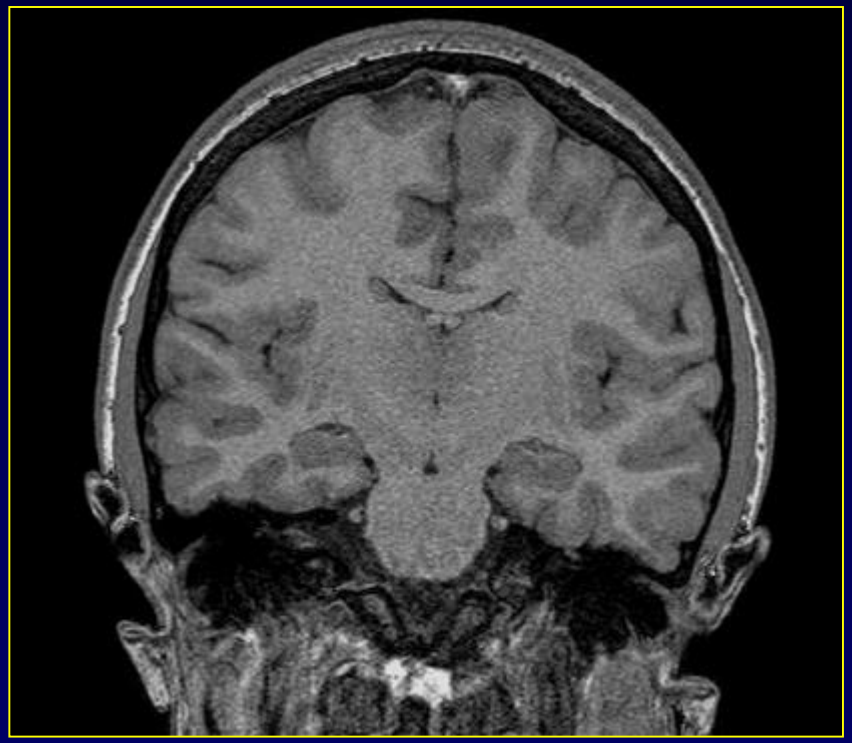
Koedam score for Parietal Atrophy		
Grade 0	No cortical atrophy	Closed sulci of parietal lobes and cuneus
Grade 1	Mild parietal cortical atrophy	Mild widening of posterior cingulate and parieto-occipital sulci
Grade 2	Substantial parietal atrophy	Substantial widening of sulci
Grade 3	End-stage „knife-blade" atrophy	Extreme widening of posterior cingulate and parieto-occipital sulci

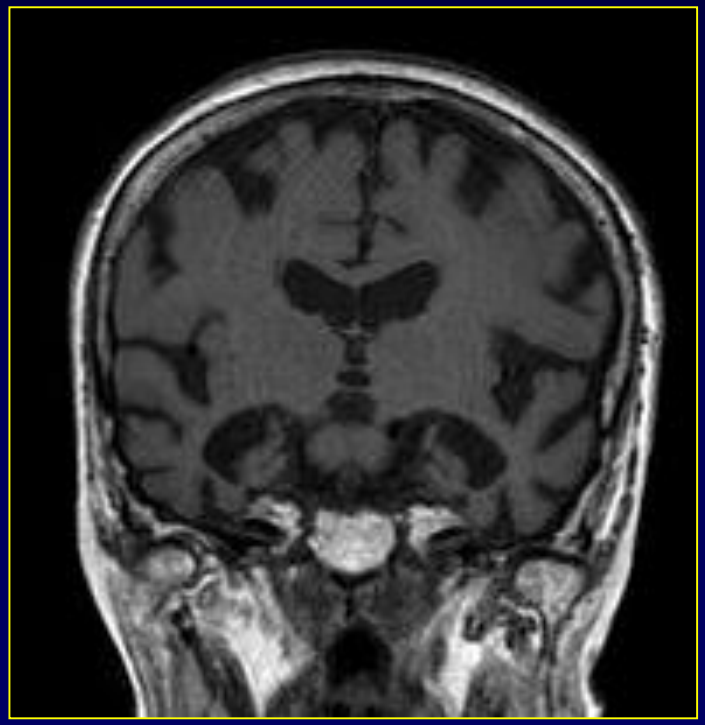




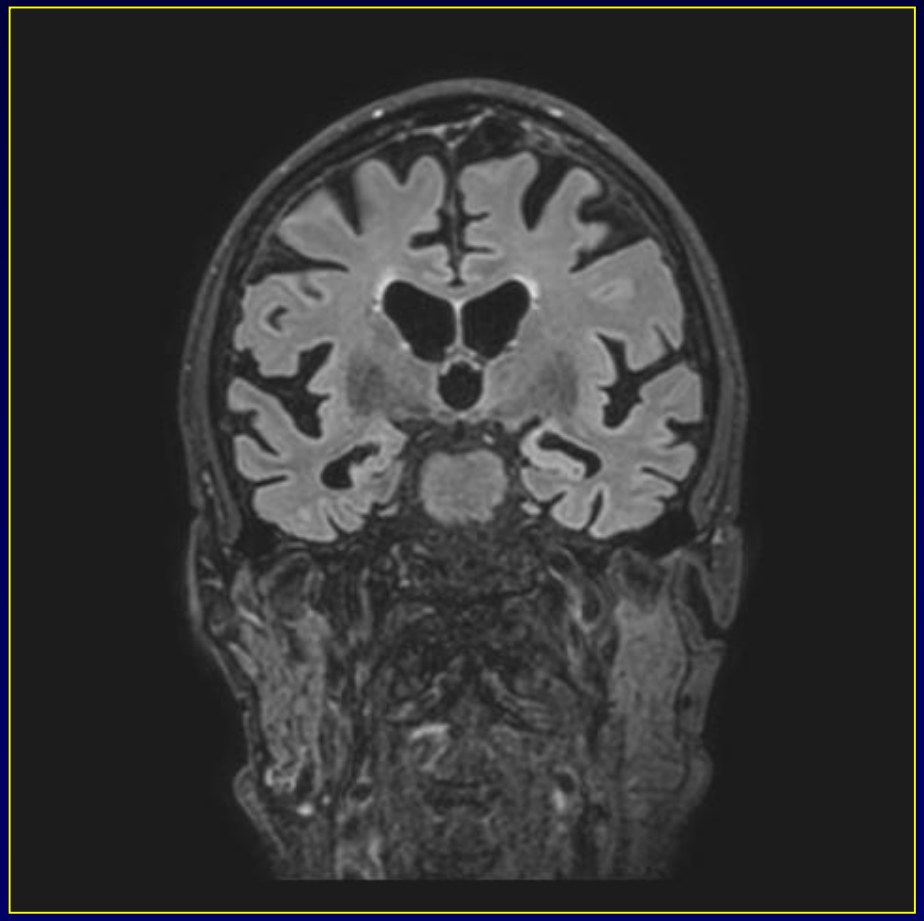
Radiology Assistant 2012

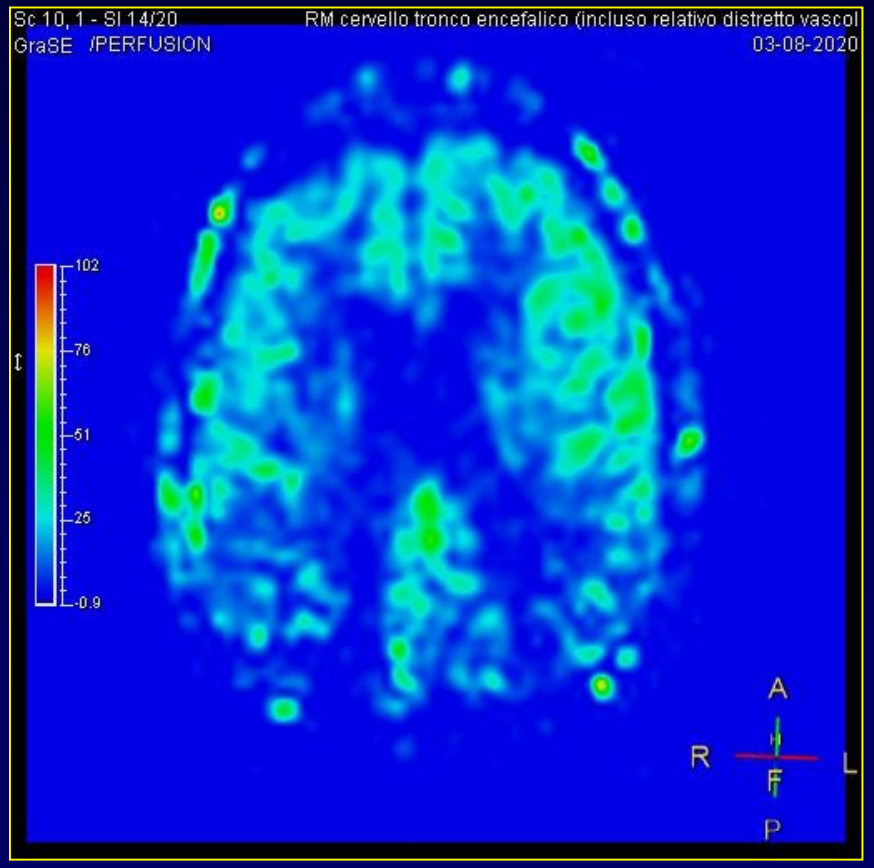
MR PERFUSION





MR PERFUSION





MR PERFUSION

MCI → M. di Alzheimer

- **Ipoperfusion (CBF and CBV) ⇒ temporo-parietal cortex**
- **No clear distinction between MCI e AD**

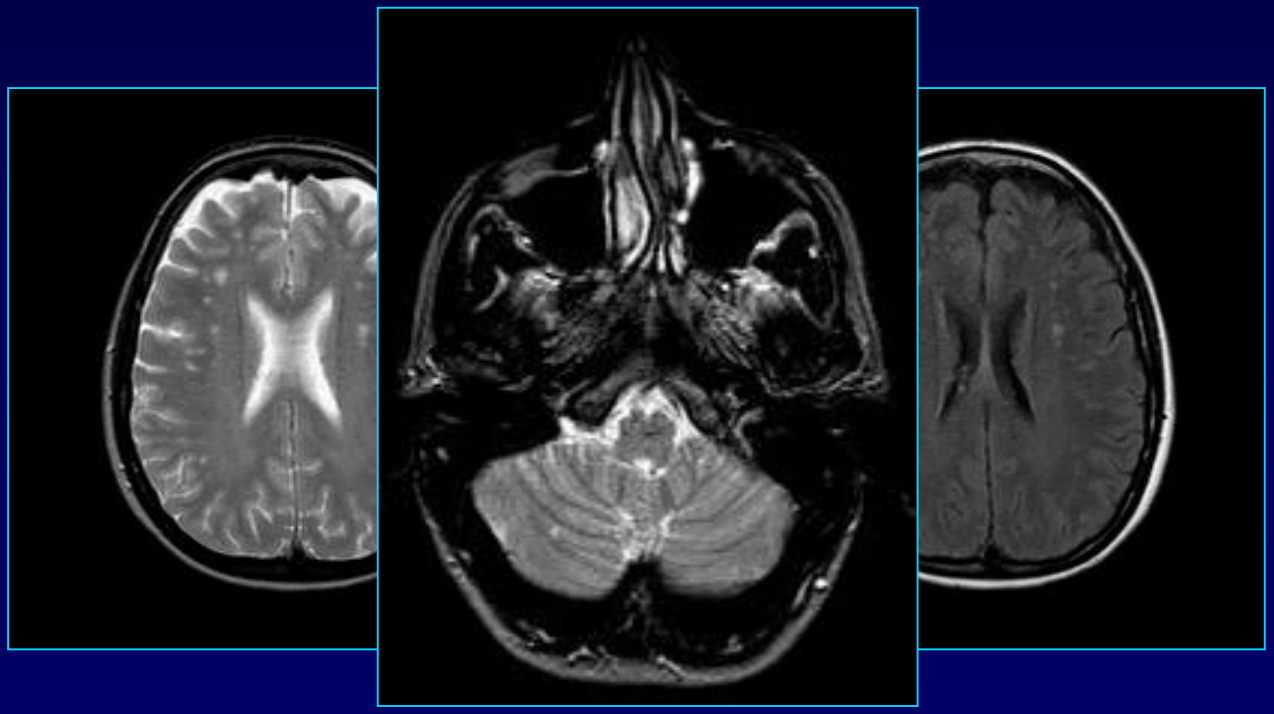
MR PERFUSION

- Stroke
- Tumors
- Degenerative disorders
- Trauma
- Migraine

MR PERFUSION

MIGRAINE

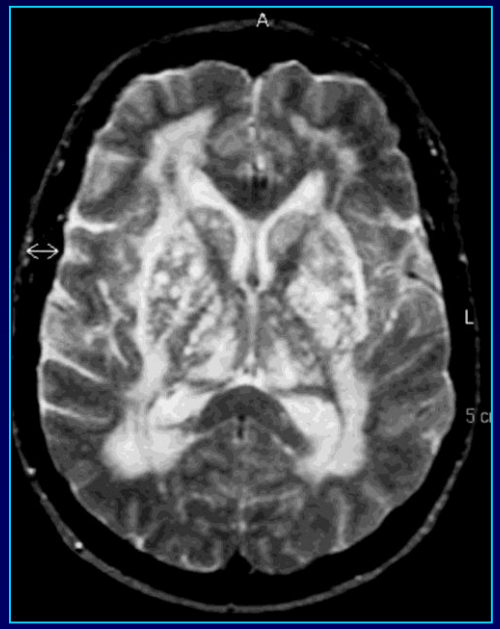
- **White matter hyperintensities**



MR PERFUSION

MIGRAINE

- Increase in number and width of perivascular spaces



MR PERFUSION

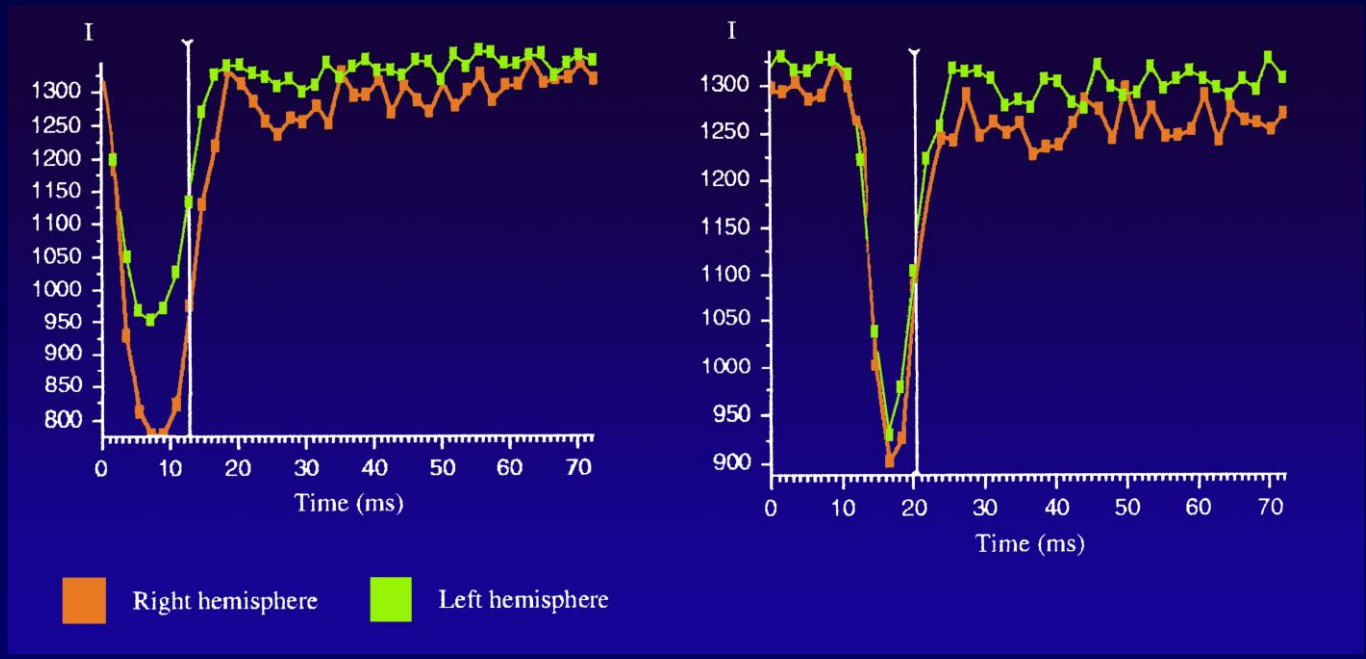
MIGRAINE

→ Reduced perfusion during aura

↓ CBF r, ↓CBV, ↑ MTT

MR PERFUSION

MIGRAINE



MR PERFUSION

MIGRAINE