Stroke

Peter Kapeller
Dept. o. Neurology – LKH Villach
Austria

Disclosures

- I serve on scientific advisory boards for Bayer-Schering, Böhringer Ingelheim, Biogen Idec, Genzyme, Merck Serono, Pfizer, Novartis, Perceptive Informatics and Teva Pharmaceutical Industries Ltd.

- I have received speaker honoraria and support from Biogen Idec, Böhringer Ingelheim, Bayer Schering, Merck Serono, Novartis, Pfizer, Sanofi-Aventis and Teva Pharmaceutical Industries Ltd.

Acute phase

Subacute/chronic phase

Acute phase

Ischemia
Intracerebral hemorraghe (ICH)
Subarachnoid hemorrhage (SAH)

In the acute phase imaging is driven by the question whether or not to apply systemic thrombolyses

ICH excluded? – lesion size?

Neuroimaging in the management of acute ischemic stroke

Relevance for what ?

- Diagnosis
  - Is it ischemic stroke ?
- Acute treatment
  - Whom to treat ?
  - How to treat ?
- Preventive treatment strategies
  - Stroke etiology

Imaging techniques to consider

- CT
- MRI
- Vascular Imaging
  - Intracranial
  - extracranial
- Perfusion Imaging
- Multimodal imaging

Sensitivity and specificity of CT versus MRI in the diagnosis of stroke

	n	Acute stroke		Acute ischaemic stroke	
		CT	MRI	CT	MRI
Sensitivity					
All	356	26% (20–32)	83% (78–88)	16% (12–23)	83% (77–88)
>12 h	135	22% (14–33)	91% (82–96)	16% (9–27)	92% (83–97)
3–12 h	131	29% (19–41)	81% (70-89)	20% (12–33)	81% (69–90)
<3 h	90	27% (17–40)	76% (64–86)	12% (5–24)	73% (59–84)
Specificity					
All	356	98% (93–99)	97% (92–99)	98% (94–99)	96% (92–99)
>12 h	135	98% (89–100)	96% (86–99)	98% (90–100)	97% (88–99)
3–12 h	131	97% (87–99)	98% (90–100)	96% (87–99)	99% (91–100)
<3 h	90	100% (85–100)	96% (79–100)	100% (89–100)	92% (78–98)

Data in parentheses are 95% CI.

Chalela JA et al., Lancet 2007;369:293-298

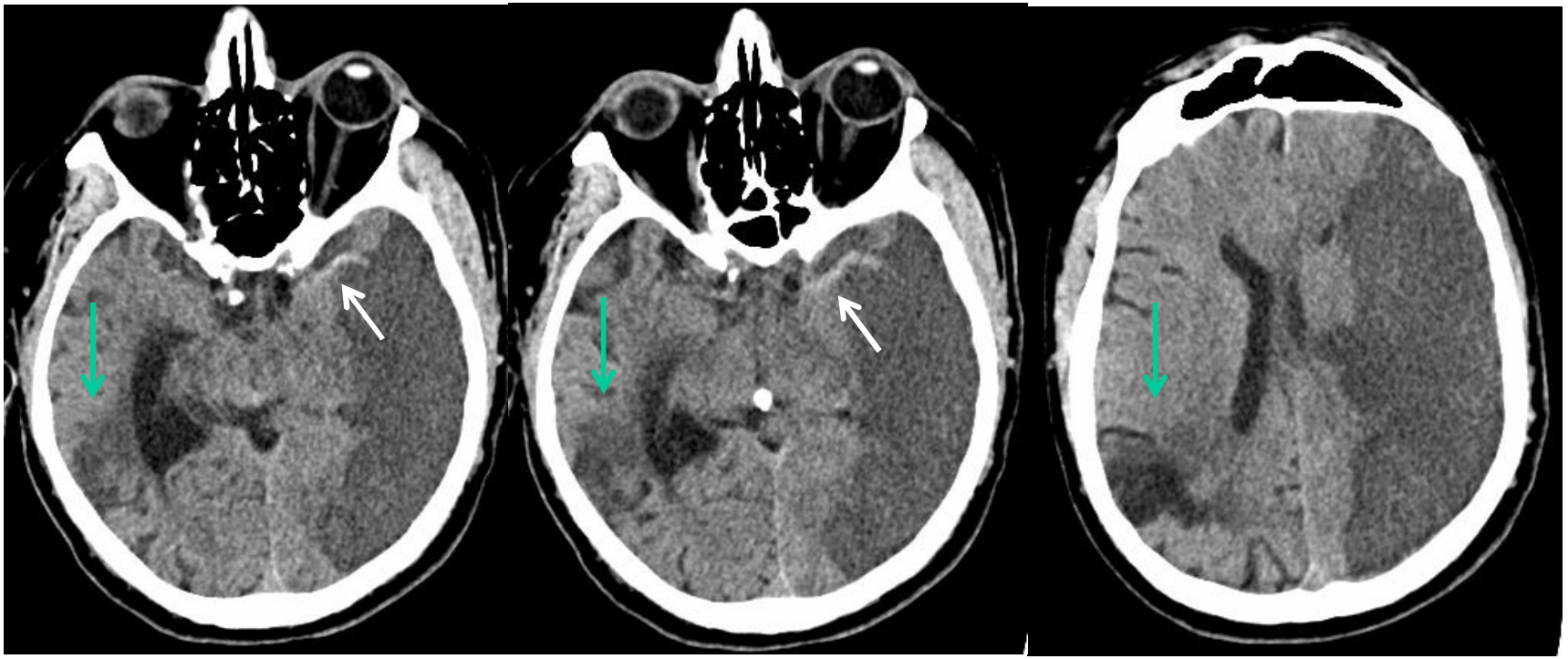
Acute ischemia

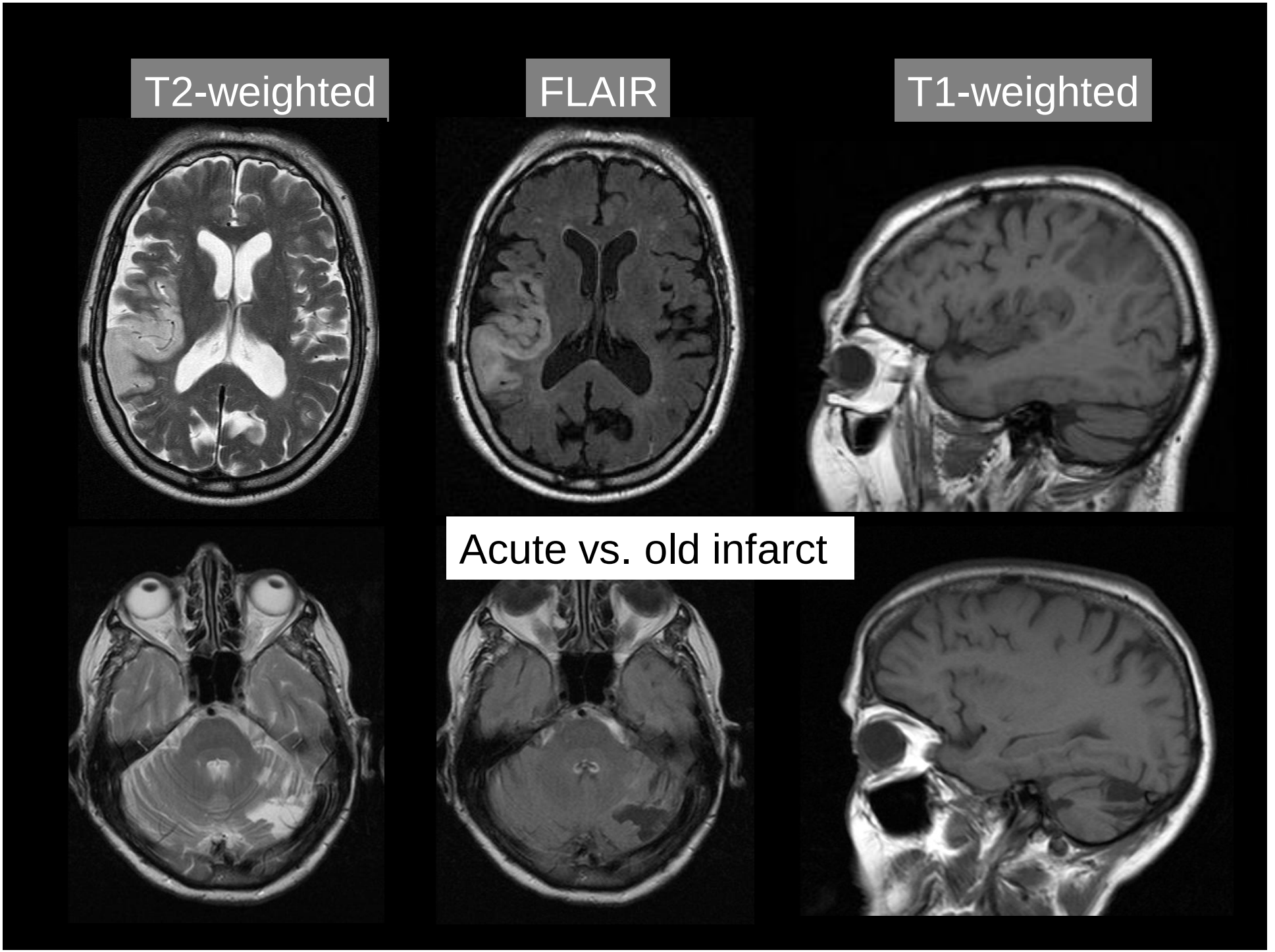
MR sequence	Time from attack	Sensitivity	Specificity
DWI	45 – 90 min	+++	+++
FLAIR / T2 / PD	60-120 min	++	+
T1	> 90 min	0	0
T1 + Gad pos. / enhancement	3-7 days	+	++

CT characteristics of acute ischemic lesions and their evolution

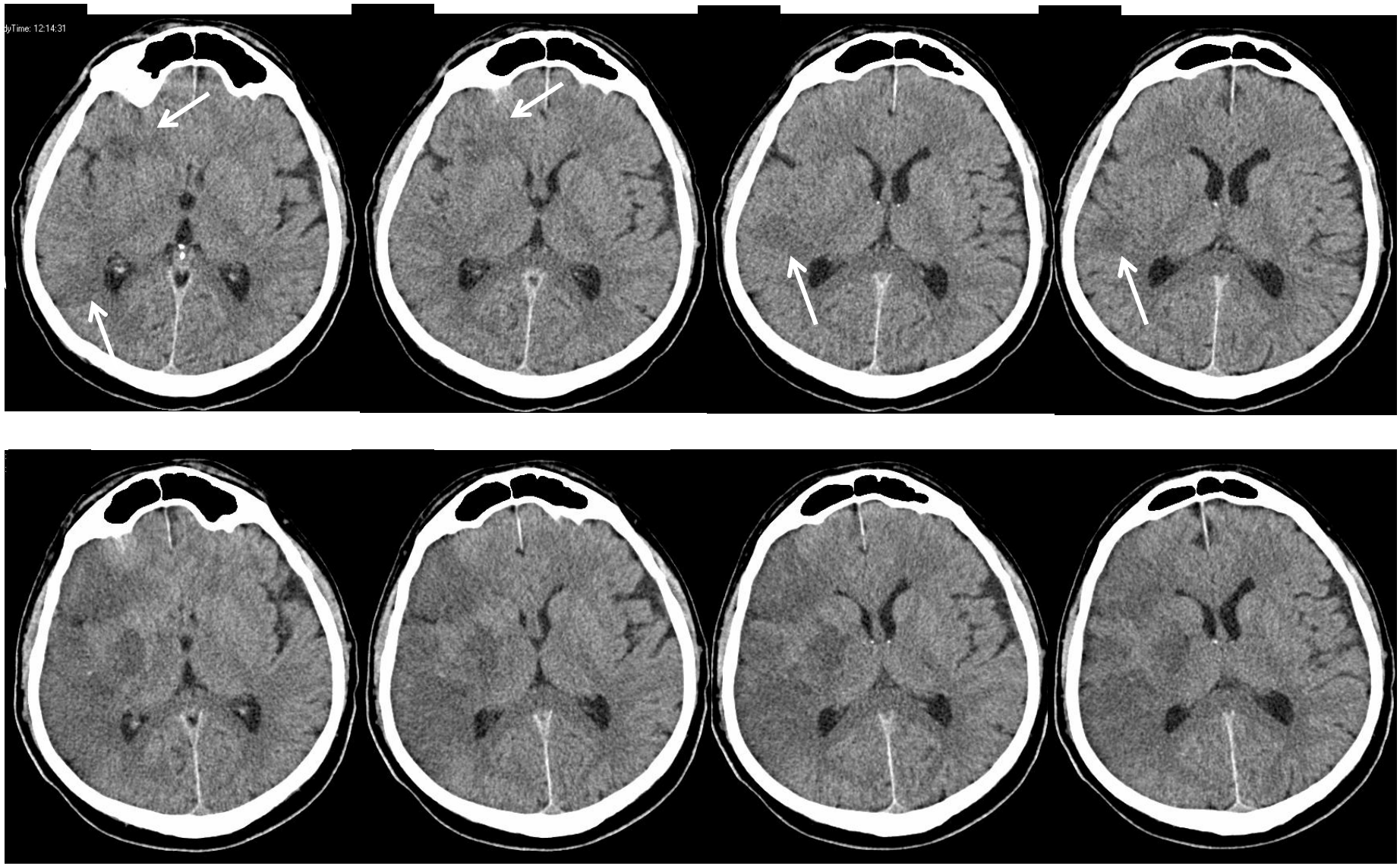
stages	*Morphologic changes*	*time*
initial (acute)	vague blurring of grey-white matter boundaries, slight attenuation of the insular ribbon, slight indistinctness of basal ganglia grey matter, suggestion of crowding sulci (subtle mass effect) “dense artery” sign changes become increasingly distinct	first hours ↓
developmental (subacute)	distinctly hypodense area within territory of vascular supply focal swelling / mass effect (sulcal and / or ventricular effacement) contrast enhancement (especially of grey matter structures) “fogging” (area of ischemia becomes poorly recognizable - rare)	> day 1 to 2-4 weeks ↓ 2-3 weeks
late (old infarct)	demarcated area of pronounced hypodensity (close to CSF), cystic cavity focal atrophy	4-6 weeks ↓

Acute and old infarcts



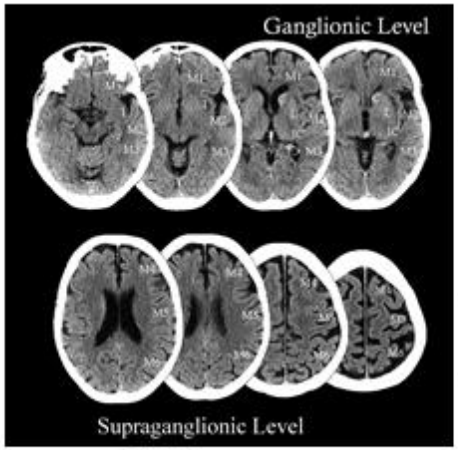

T2-weighted
FLAIR
T1-weighted
Acute vs. old infarct

Very early infarct signs



Understanding Alberta Stroke Program Early CT Score (ASPECTS)

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY



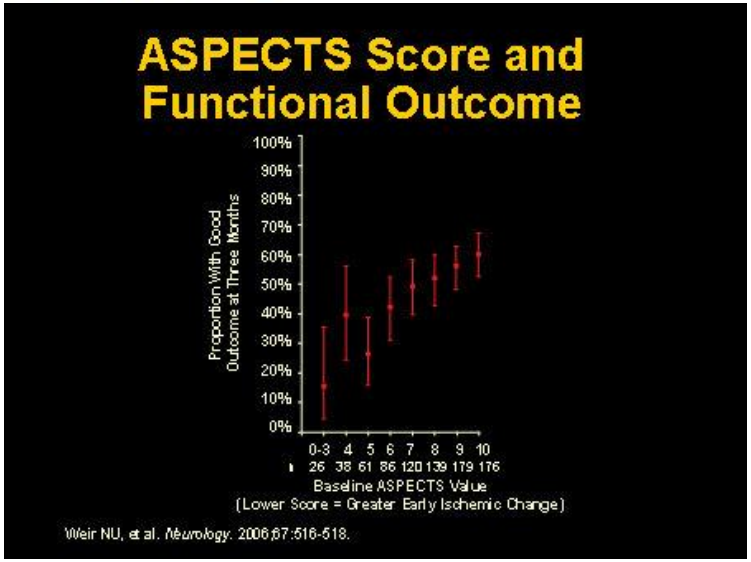
What is ASPECTS

- Alberta Stroke Program Early CT score (ASPECTS) is a 10-point quantitative topographic CT scan score
- ASPECTS was developed to offer the reliability and utility of a standard CT examination with a reproducible grading system to assess early ischemic changes on pretreatment CT studies in patients with acute ischemic stroke of the anterior circulation

How to compute ASPECTS

- ASPECTS is determined from evaluation of two standardized regions of the MCA territory: the basal ganglia level, where the thalamus, basal ganglia, and caudate are visible, and the supraganglionic level, which includes the corona radiata and centrum semiovale
- All cuts with basal ganglionic or supraganglionic structures visible are required to determine if an area is involved. The abnormality should be visible on at least two consecutive cuts to ensure that it is truly abnormal rather than a volume averaging effect
- To compute the ASPECTS, 1 point is subtracted from 10 for any evidence of early ischemic change for each of the defined regions.
- A normal CT scan receives ASPECTS of 10 points.
- A score of 0 indicates diffuse involvement throughout the MCA territory

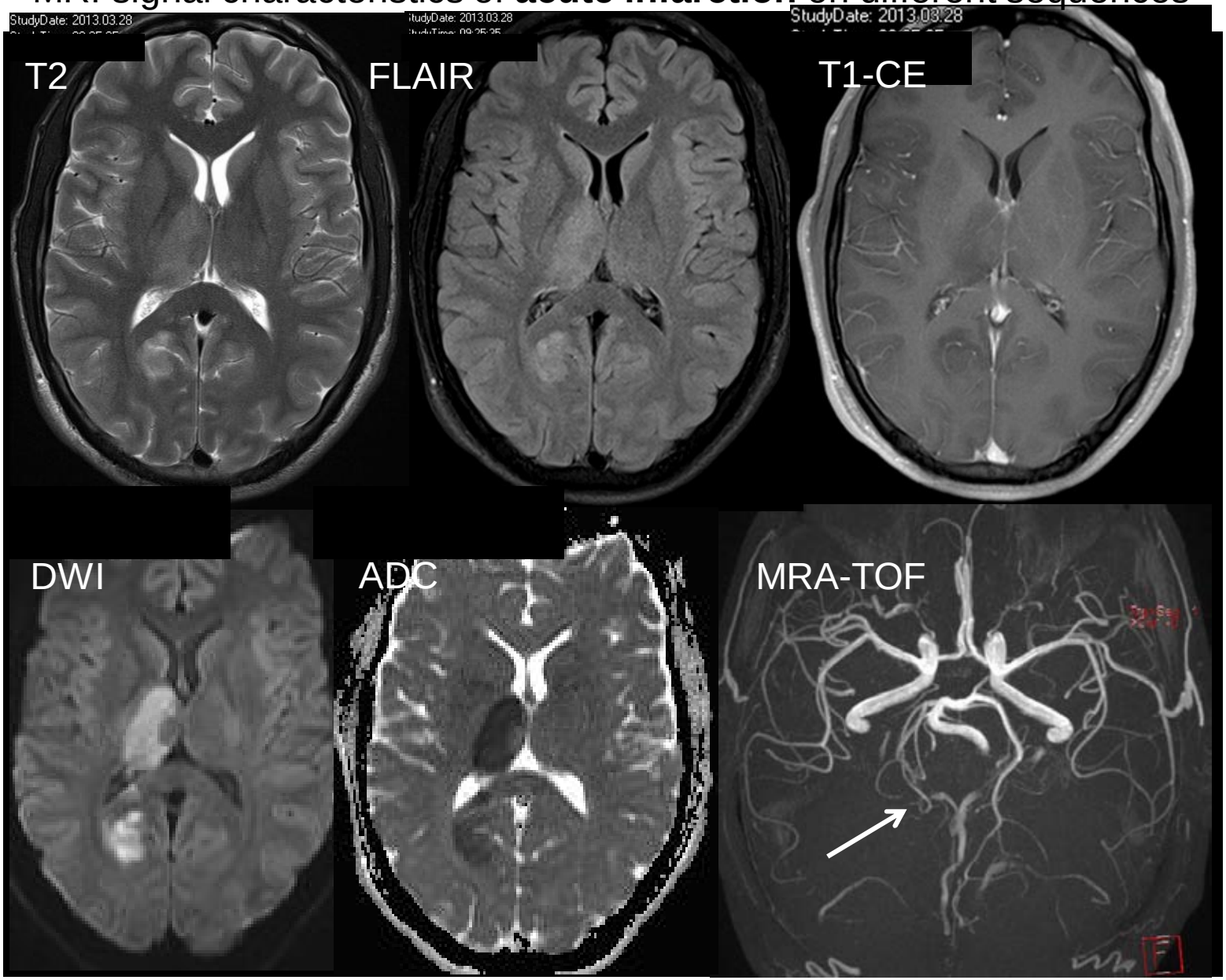
Axial NCCT images showing the MCA territory regions as defined by ASPECTS. C- Caudate, I- Insularribbon, IC- Internal Capsule, L- Lentiform nucleus, M1- Anterior MCAcortex, M2- MCA cortex lateral to the insular ribbon, M3- PosteriorMCA cortex, M4, M5, M6 are the anterior, lateral and posterior MCAterritories immediately superior to M1, M2 and M3, rostral to basalganglia. Subcortical structures are allotted 3 points (C, L, and IC).MCA cortex is allotted 7 points (insular cortex, M1, M2, M3, M4, M5and M6)



MRI characteristics of acute ischemic lesions and their evolution

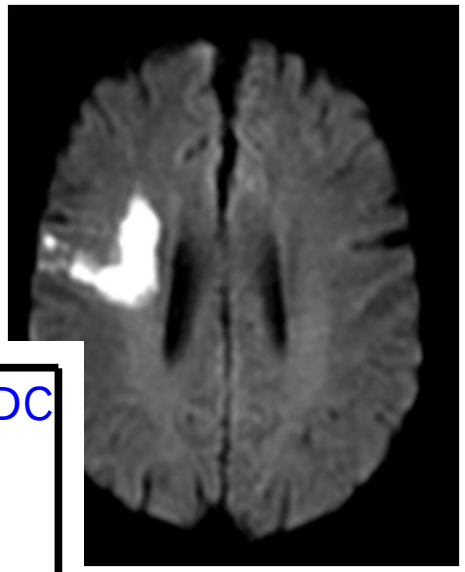
stage	*signal changes*	*time*
initial (acute)	DWI hyperintensity (reduced ADC) T2 hyperintensity (T2-weighted sequences, FLAIR), often early on vague and indistinct No or minimal T1 hypointensity subtle mass effect Absence of “flow void”, “vessel signs”	45 – 90 minutes 60 minutes to first hours
developmental (subacute)	bright lesion on DWI (reduced ADC), “light bulb” well defined area of T2 hyperintensity (T2-weighted sequences, FLAIR) T1 hypointensity mass effect (sulcal and /or ventricular effacement) gyriform contrast enhancement	> day 1 to 2-4 weeks > 3-7 days
late (old infarct)	demarcated lesion with central isointensity to CSF on all sequences, ie. cystic cavity focal atrophy	4-6 weeks ↓

MRI signal characteristics of **acute infarction** on different sequences

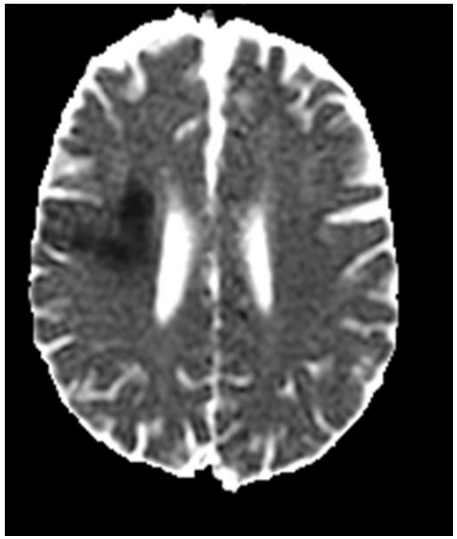


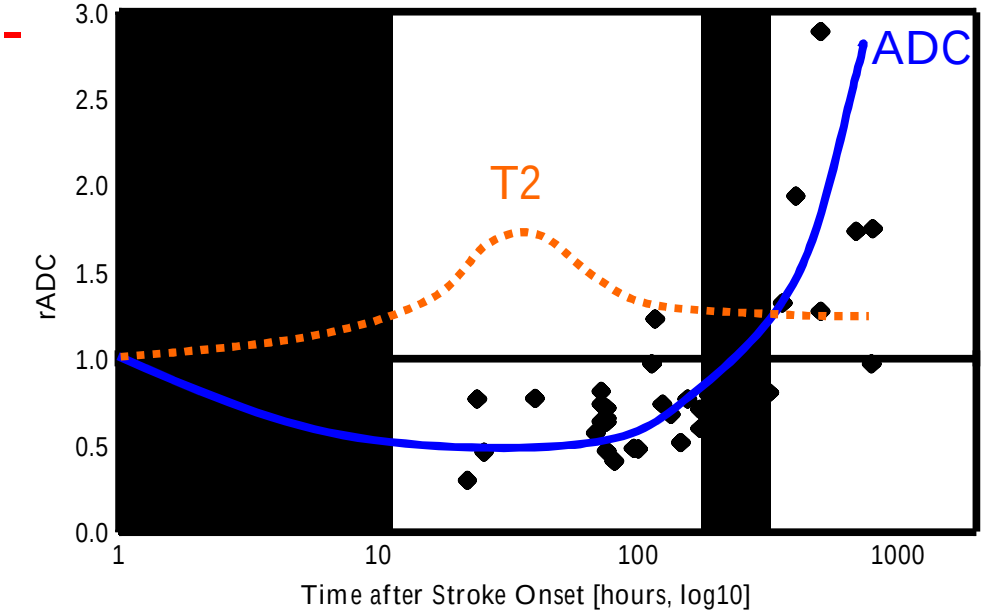
Diffusion weighted MRI

Diffusion weighted image



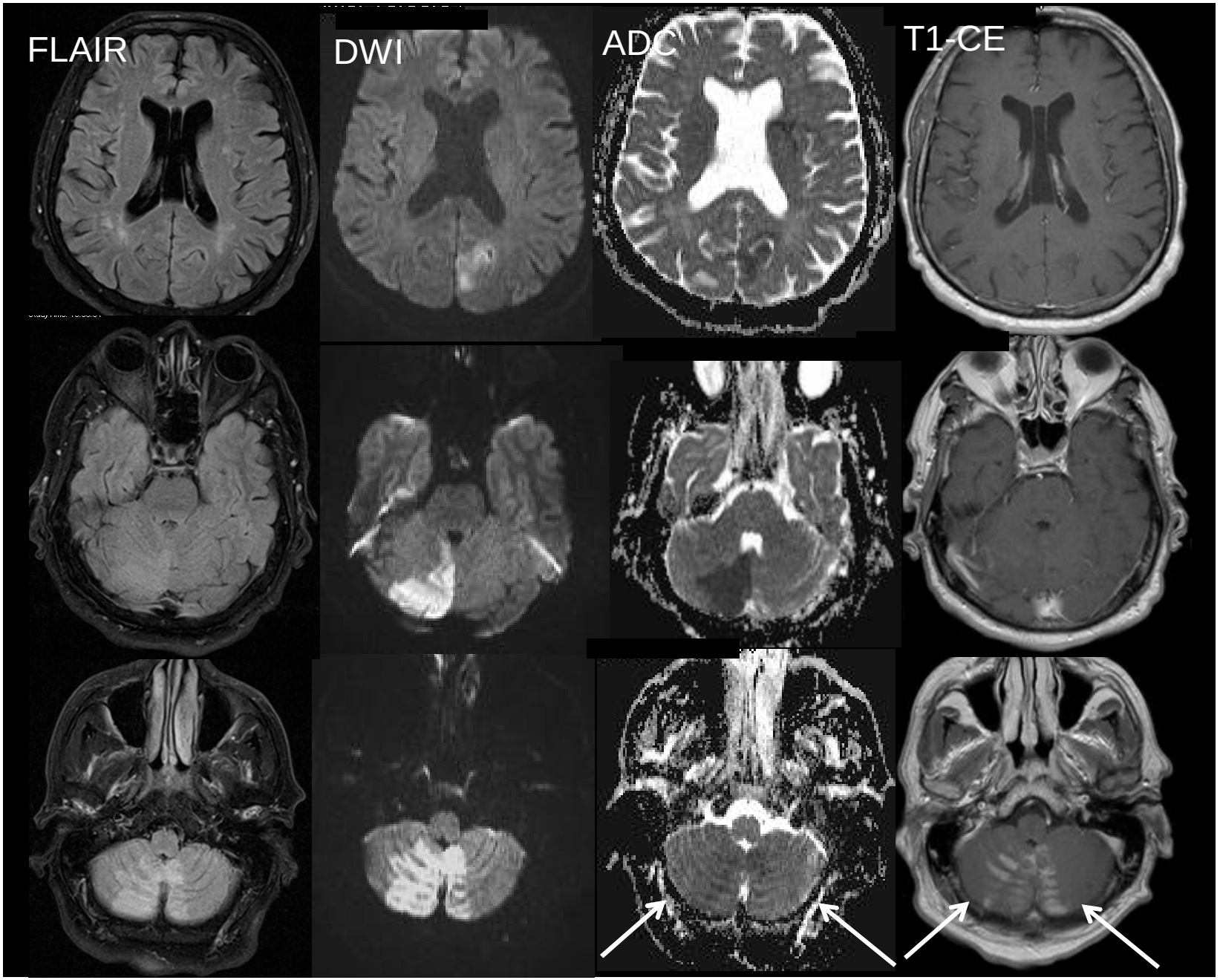
ADC map



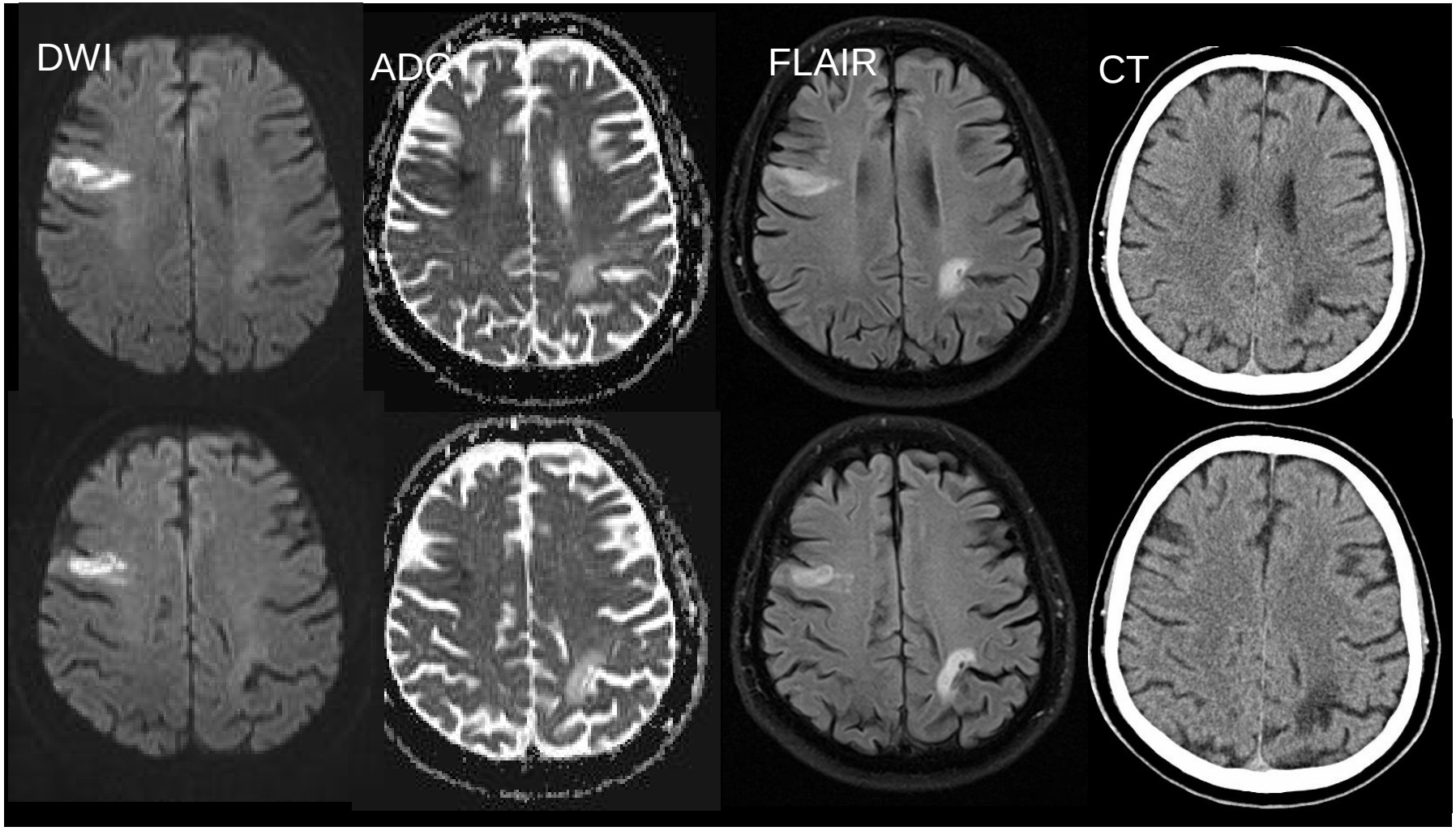


ADC = Apparent diffusion coefficient

MRI signal characteristics of **subacute infarction** on different sequences



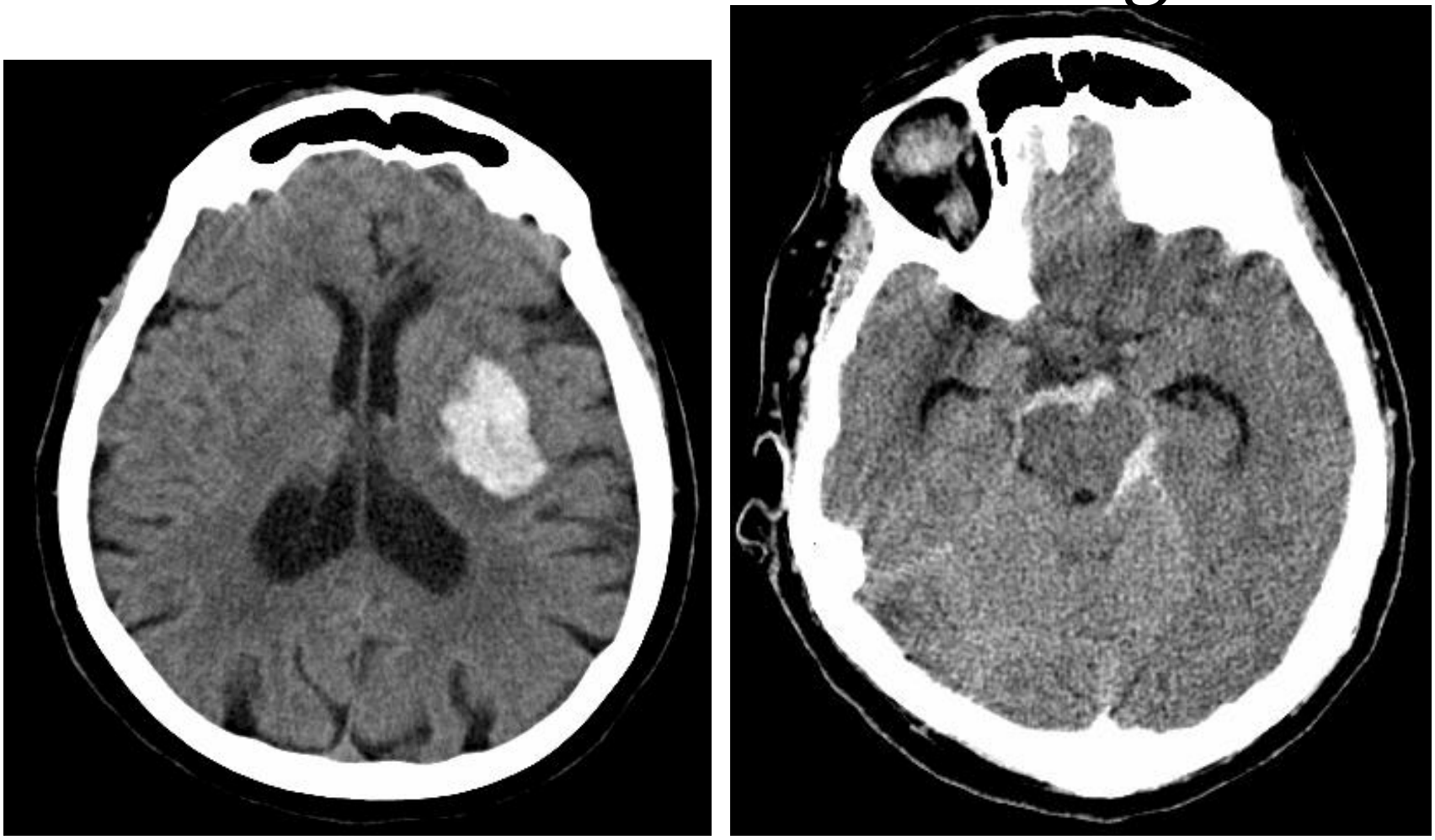
MRI and CT of acute and old infarcts



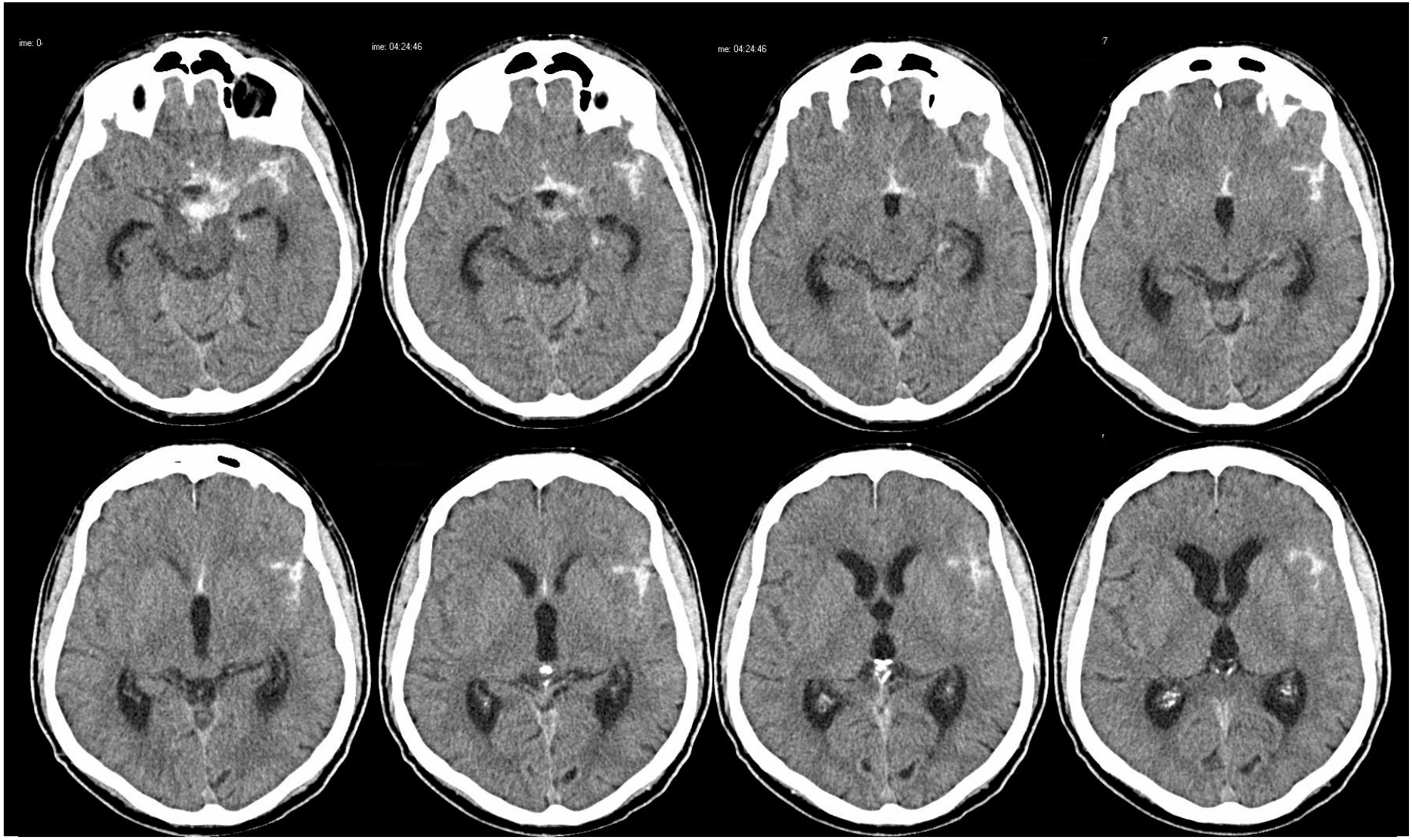
CT characteristics of intracerebral hemorrhage (ICH)

stage	*morphologic changes*	*time*
acute	hyperdense (~ 80 H.U.) density may be less with anemia or coagulopathy	within minutes
	mass effect	within hours
	perifocal edema	
subacute	isodense with brain	> 10 days
chronic (old ICH)	cystic lesions with density similar to CSF	several weeks ↓

Acute intracerebral and subarachnoid bleedings



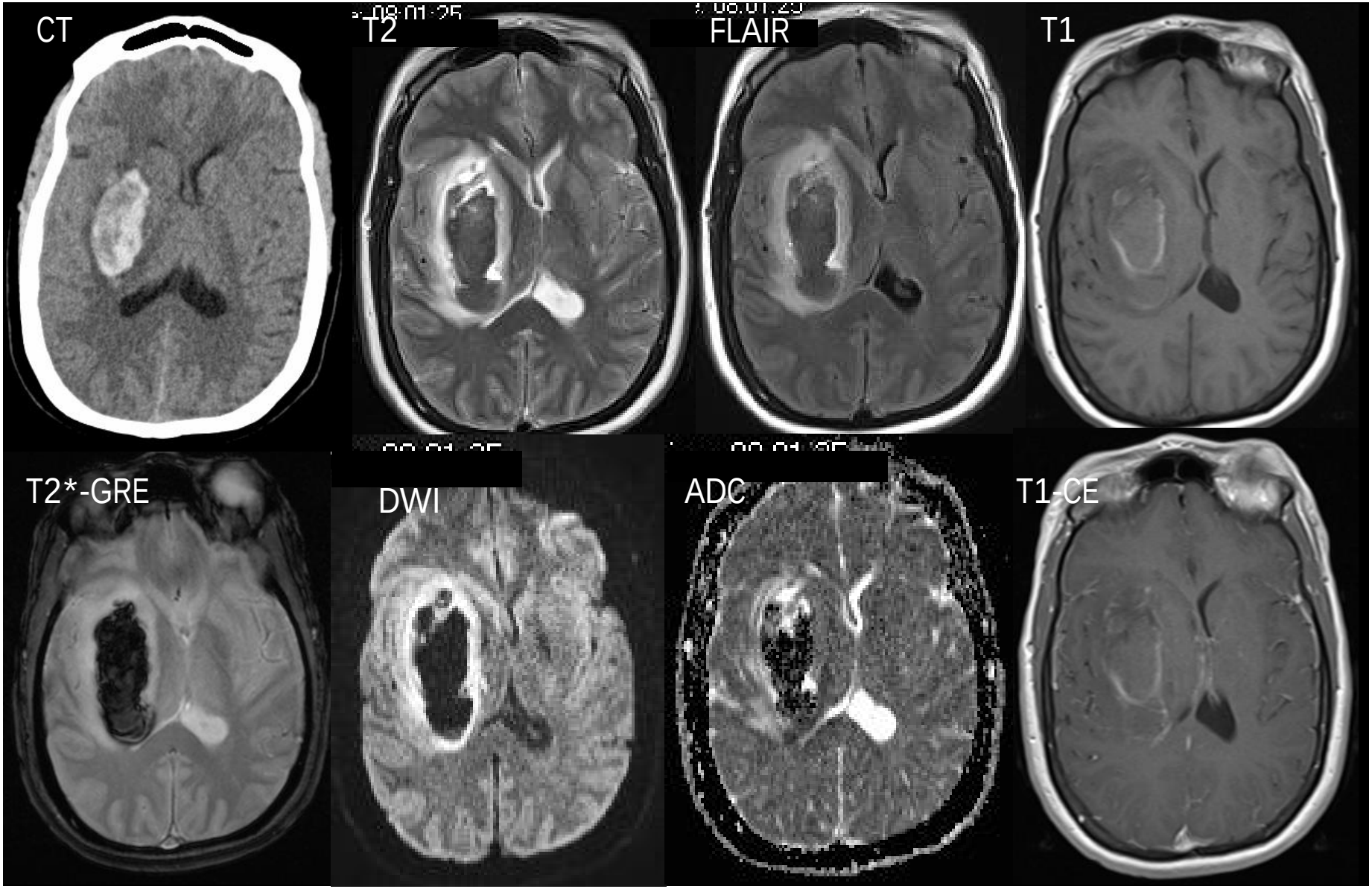
Subarachnoid hemorrhage



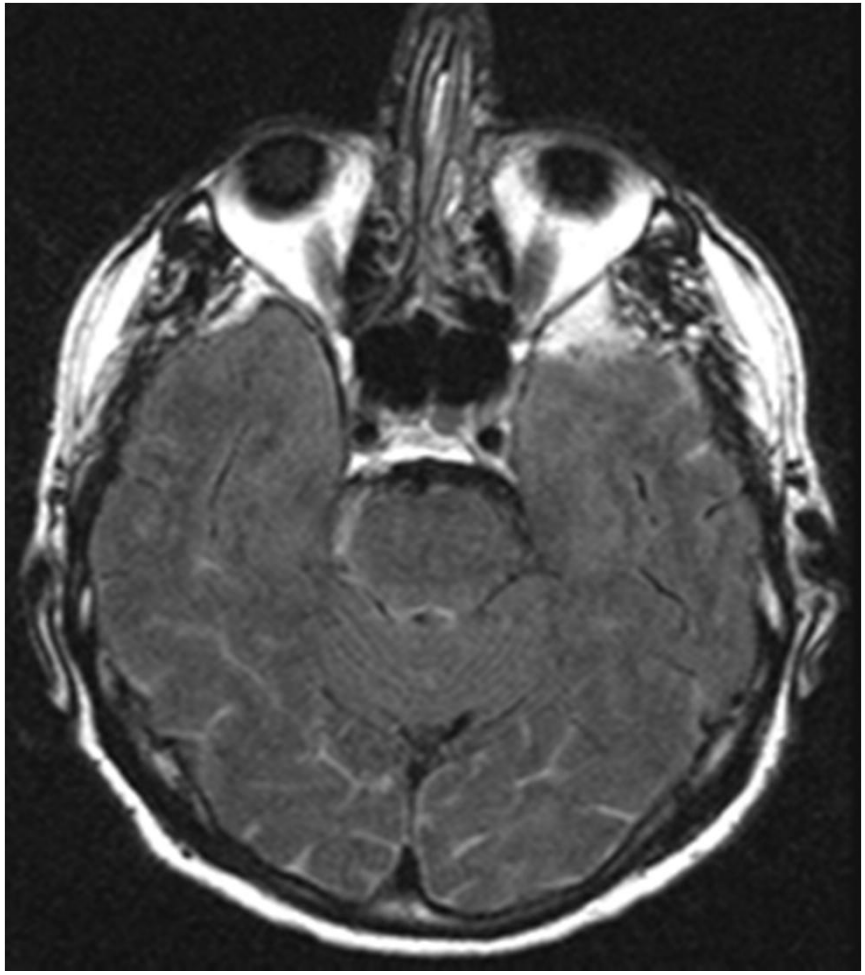
MRI characteristics of intracerebral hemorrhage (ICH)

stage	*signal intensity*			*other characteristics*
	T1	**T2**	**T2 ***	
hyperacute (minutes to hours)	—	↑	periphery ↓↓ central — ↑	
acute (hours to several days)	↓	↓	↓	surrounding high signal of edema on T2
subacute (several days to weeks)	↑ ↑ ↑	early ↓ then ↑ ↑	↓ ↓	change of signal intensities starts at periphery of hematoma
chronic (old ICH) (> several weeks)	↓	periphery ↓ central ↑ ↑	periphery ↓ ↓ ↓ central ↑	focal atrophy / cystic cavity

MRI characteristics of intracerebral hemorrhage (ICH)

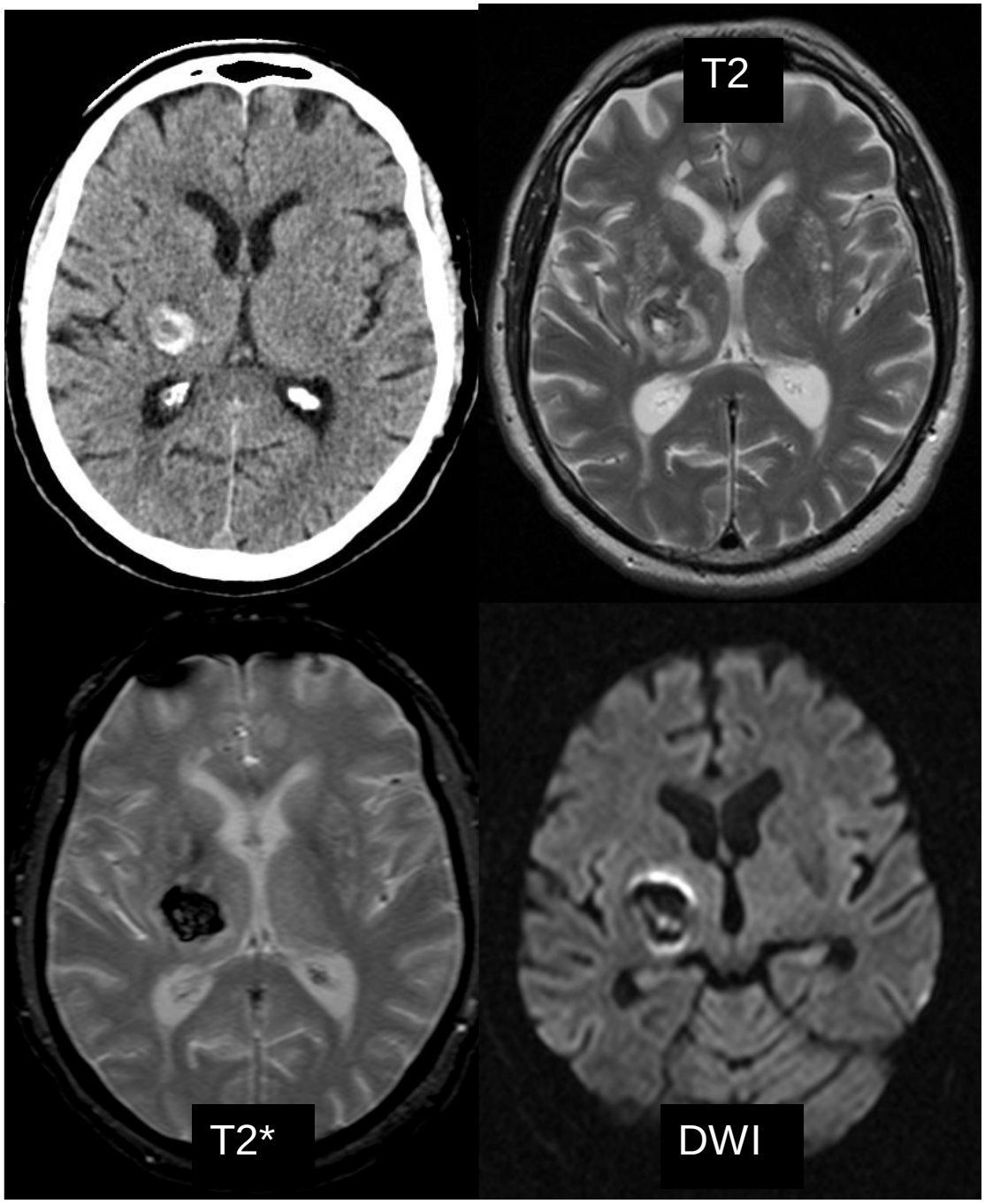


Subarachnoid hemorrhage on MRI

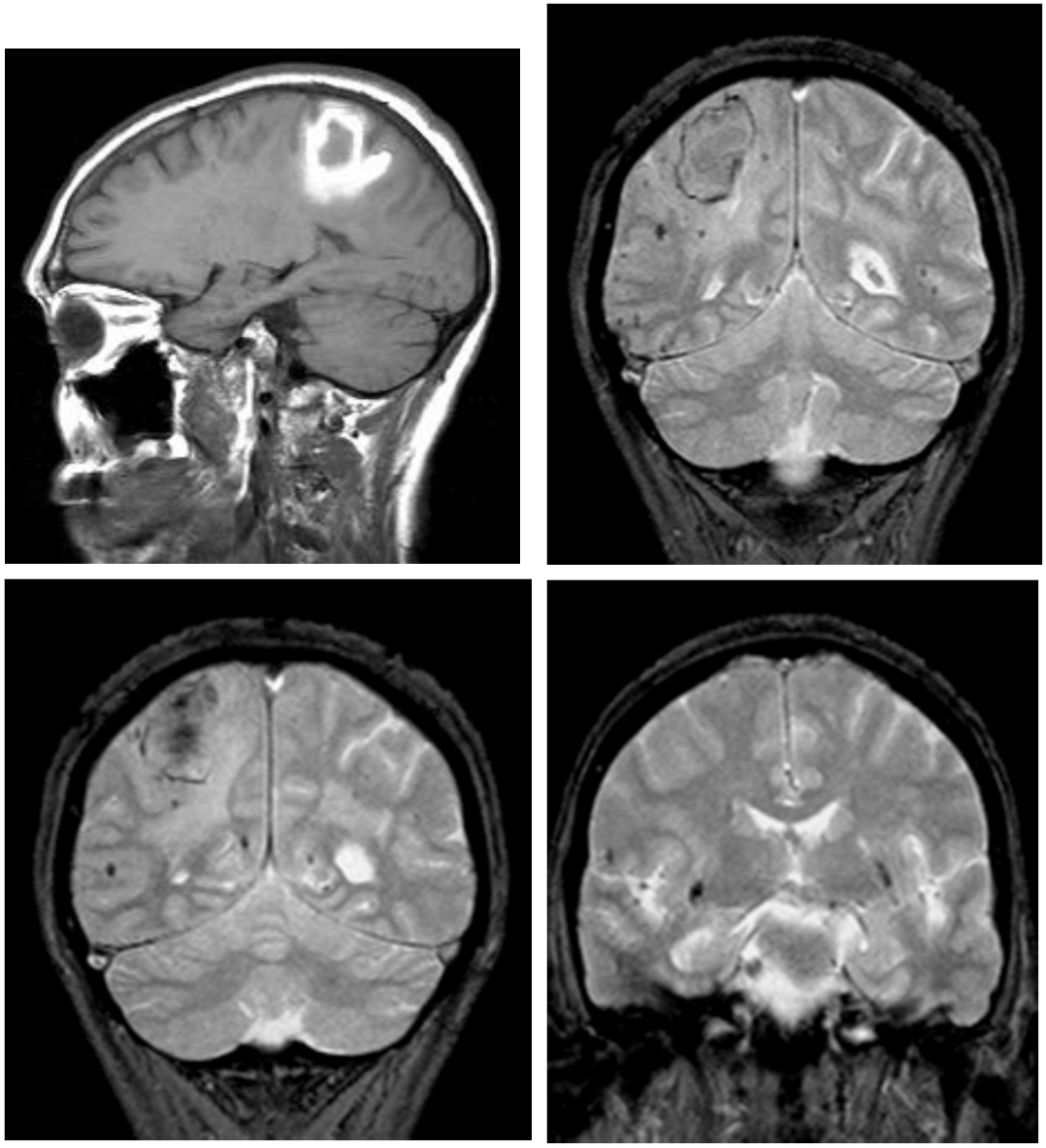


MRI allows to detect intracerebral bleeding with a sensitivity at least as high as that of CT

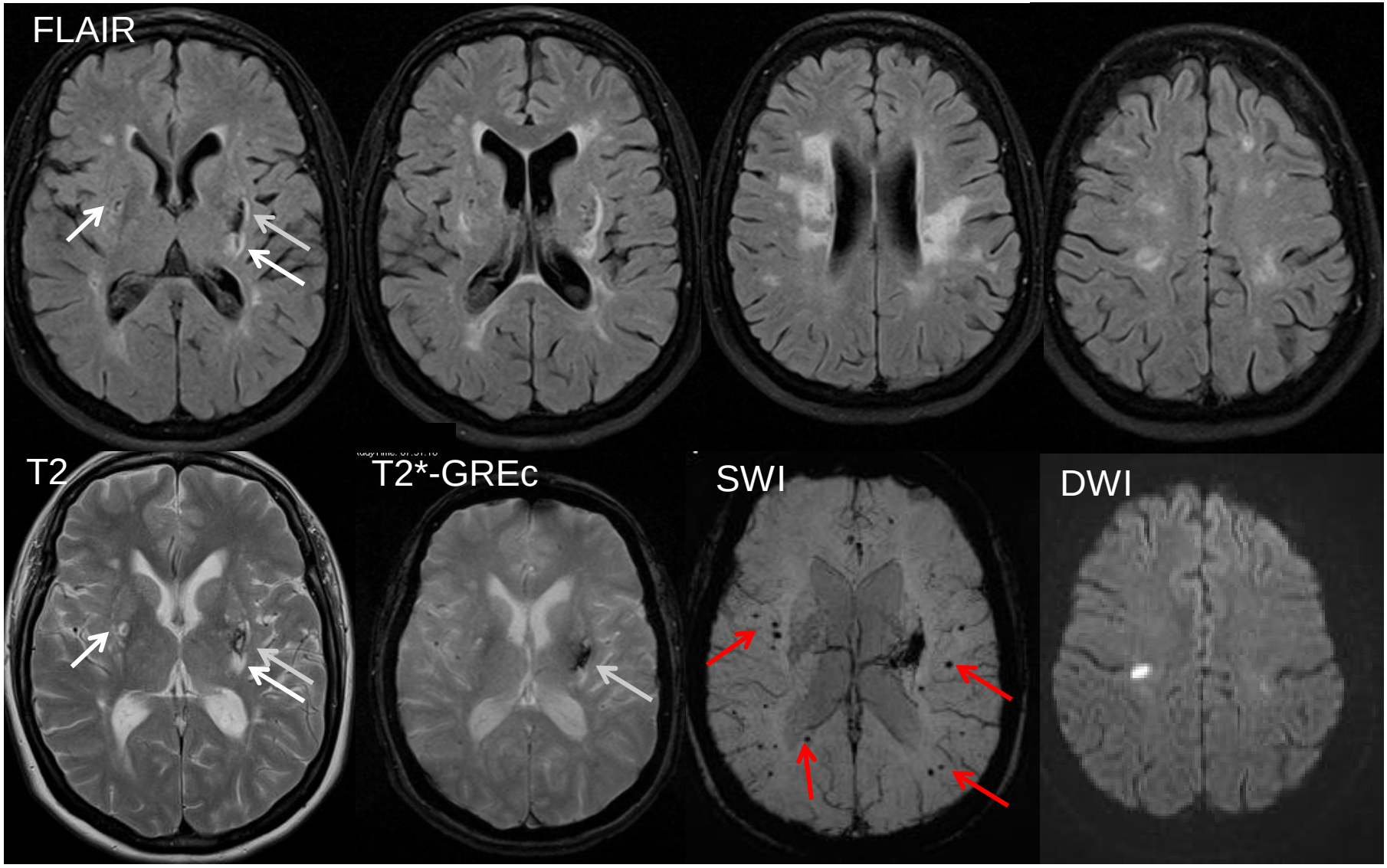
MRI is still inferior to CT concerning the detection of SAH



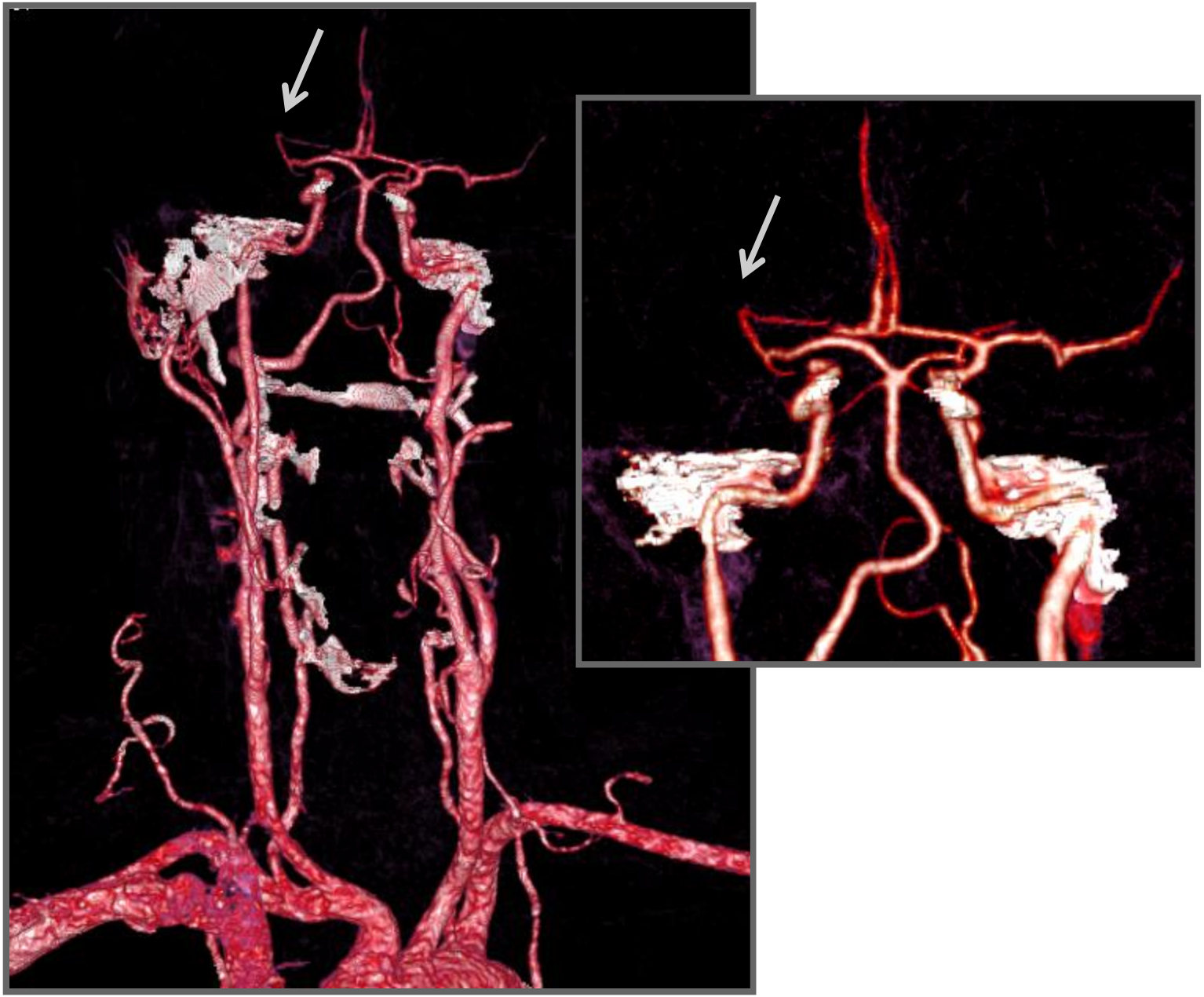
Subacute and old bleds / microbleeds – a clue to diagnosis ?



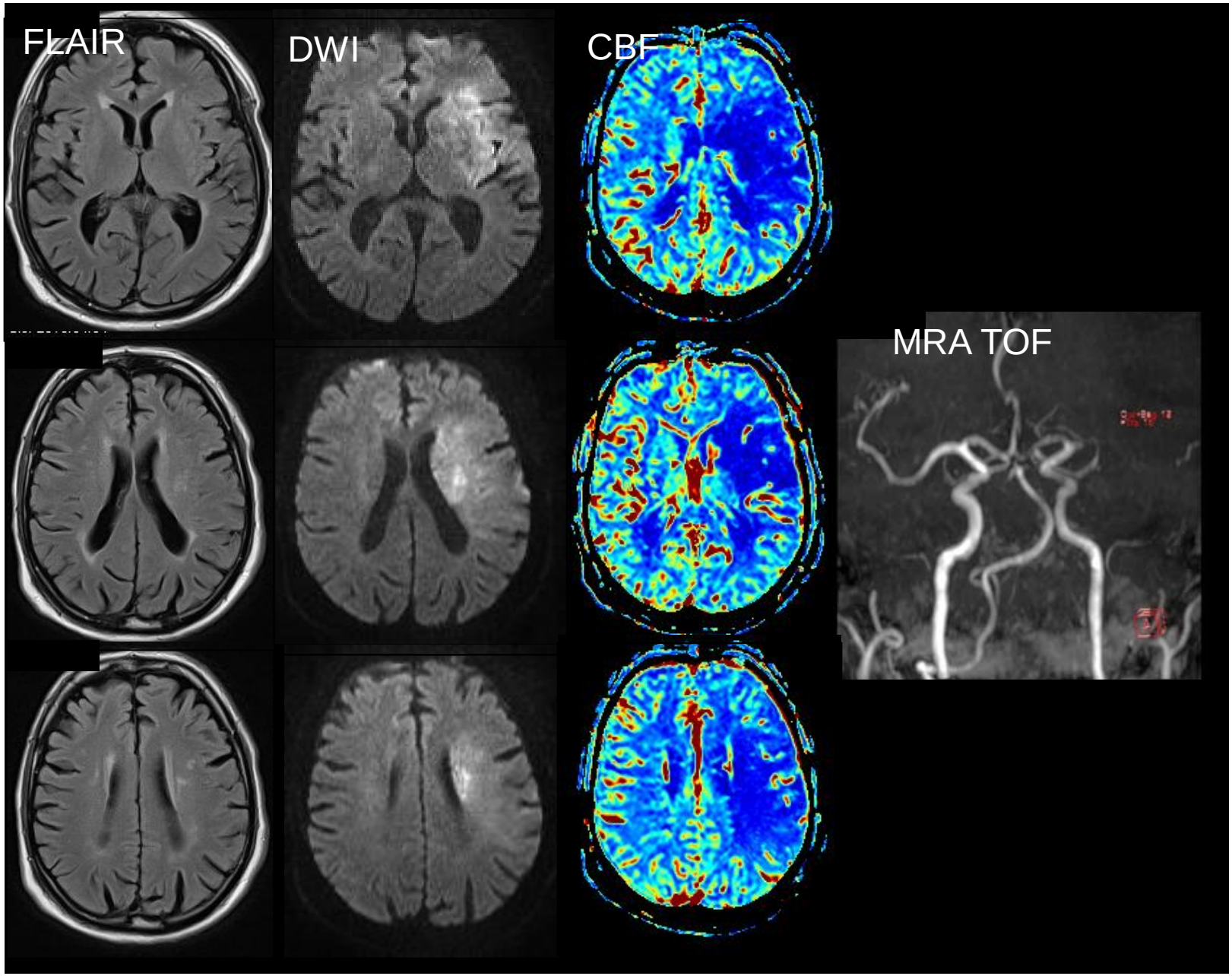
Characteristics of small vessel disease



The contribution of CTA amd MRA



The contribution of MR perfusion



Rules

- You just see what the method / sequence can show. This is also true for the selection of the region to be examined J
- Changes in density / signal intensity have a time course. For every interpretation you need to consider the interval between the clinical event and the time of imaging.
- Typical patterns of signal changes on different sequences and their likely „timing“ can serve to support or refute your suspected diagnosis.
- Look carefully at all structures, regions, sequences in order not to miss concomitant / incidental abnormalities which may still be important.
- A negative finding on CT **or** MRI does not necessarily exclude the diagnosis of stroke**.**

Special thanks goes to

FRANZ FAZEKAS

for providing numerous slides for this presentation