Department of Neurology

- 1st semester
  - 15 lectures
  - 5x2 hours practices

+ 1 week block practice

11-14. weeks

- 2nd semester
  - 10 lectures
  - 5x2 hours practices

Suggested readings:
Lectures
Selected topics of Neurology
Neurology and Neurosurgery Illustrated

Homepage: different !!!
http://www.neurology.dote.hu/

Participation on the lectures is strongly recommended!!!
Competition questions are based on the lectures!!!

Exam at the end of the 1st and 2nd semesters of the 5th year: test exam (grade is offerred for the best students by the result of the competition)
Exam at the 6th year **FOR EVERYBODY**:

- Minimum questions (computer)
- Practical exam
- Oral exam

Main neurological diseases

- Stroke
- Epilepsy
- Headaches, pain syndromes
- Vertigo
- Tumors of the nervous system
- Extrapyramidal diseases (e.g.: Parkinson’s disease)
- Demyelinating diseases (MS)
- Dementias (e.g. Alzheimer’s disease)
- Diseases of the peripheral nerves
- Neuromuscular diseases (e.g. Myasthenia gravis)
- Infectious diseases (meningitis, encephalitis)
- Head traumas
- Disorders of spinal cord, roots… (e.g.: disc hernia)

Neurological examination

- History
- Inspection (see, smell, hear), palpation, auscultation
- Examination of
  - meningeal signs
  - cranial nerves (I-XII)
  - motor system (muscle bulk, tone, power)
  - sensory system
  - reflexes (pathological and physiological reflexes)
  - co-ordination, cerebellum
  - speech
  - conscious state
  - + short psychiatric examination

INTRODUCTION

Nervous system

- Central nervous system
  - brain
  - spinal cord
- Peripheral nervous system
  - lower motor neuron – anterior radix – peripheral nerve – NMJ – muscle
  - sensory receptors – peripheral nerve – posterior radix – sensory ganglion

Neurological examination

- Aim:
  - to localize the lesion
    - central or peripheral
      - brain or spinal cord, if central
      - motor or sensory neuron, radix, plexus, nerve, NMJ, or muscle, if peripheral
  - to determine if one lesion may cause the symptoms
  - to determine the damaged system (motor, sensory, vegetative or mixed)
  - to find the etiology

After localizing the lesion, different investigations may confirm our suspicion regarding the location and etiology...

Investigations in neurological practice

- CT, MRI
- CTA, MRA, DSA
- CSF sampling, CSF analysis
- ENG, EMG, repetitive stimulation
- EEG
- Evoked potentials
- Duplex ultrasound and transcranial Doppler

1919-2004

Nobel prize in 1979

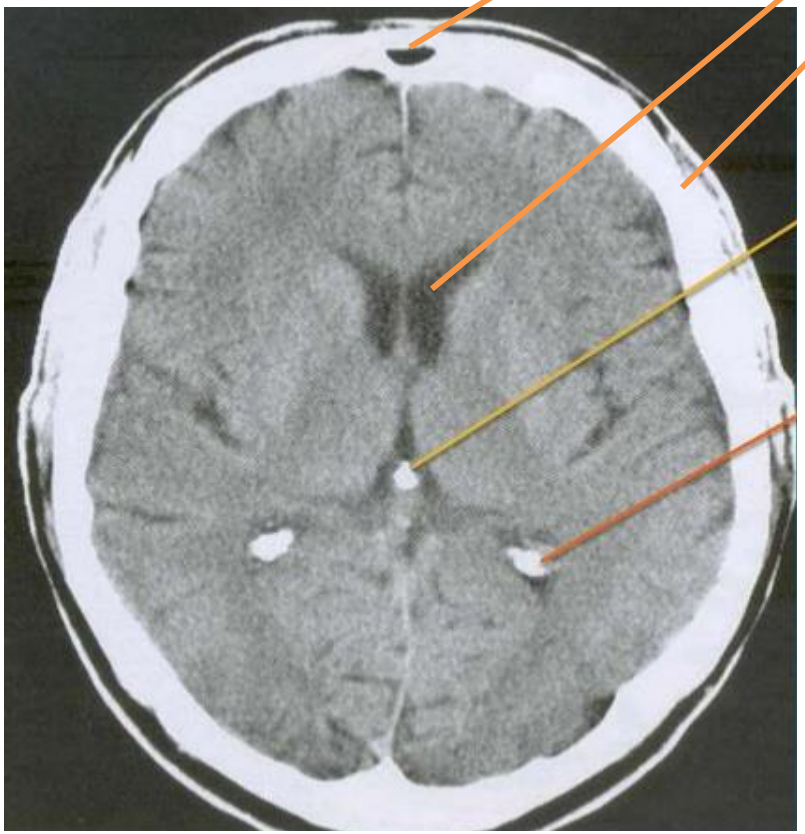
Sir Godfrey N. Hounsfield

Substance	HU
Air	−1000
Lung	−500
Fat	−100 to −50
Water	0
CSF	15
Kidney	30
Blood	+30 to +45
Muscle	+10 to +40
Grey matter	+37 to +45
White matter	+20 to +30
Liver	+40 to +60
Soft Tissue, Contrast	+100 to +300
Bone	+700 (cancellous bone) to +3000 (dense bone)

CT (native or post-contrast)

Lesion can be hypodense, isodense, or hyperdense

hypodens: air, water, CSF, fat



Bone

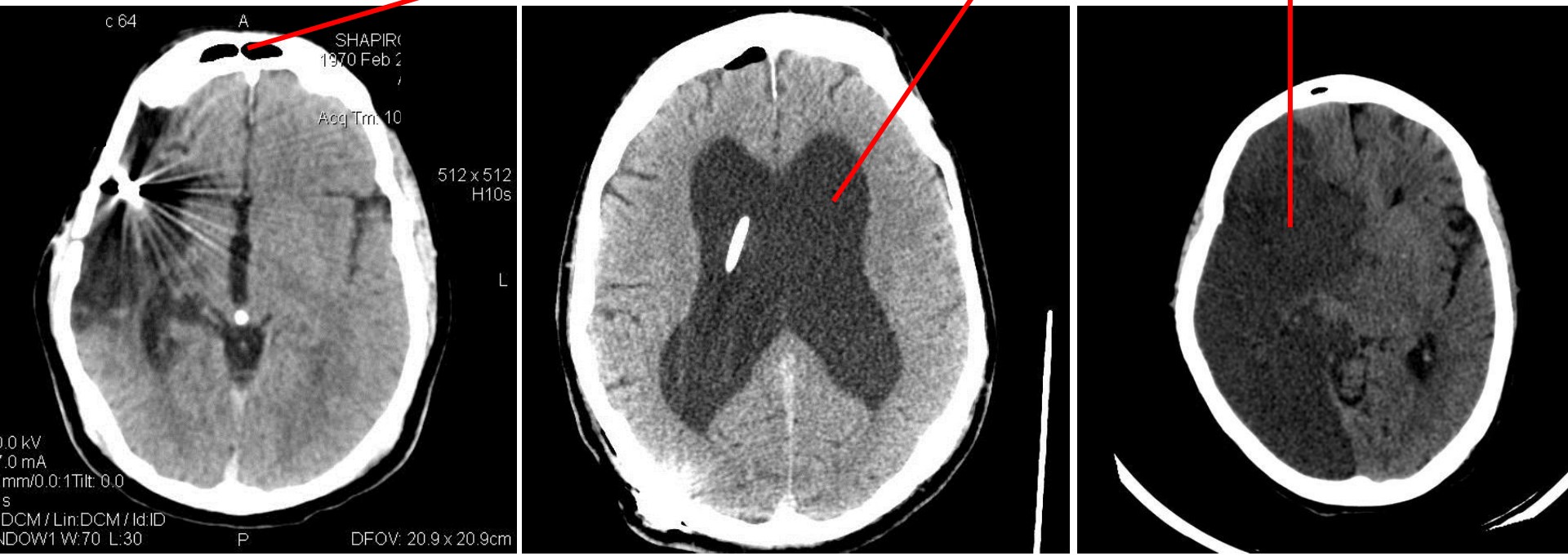
Calcified pineal gland

Calcified chorioid plexus

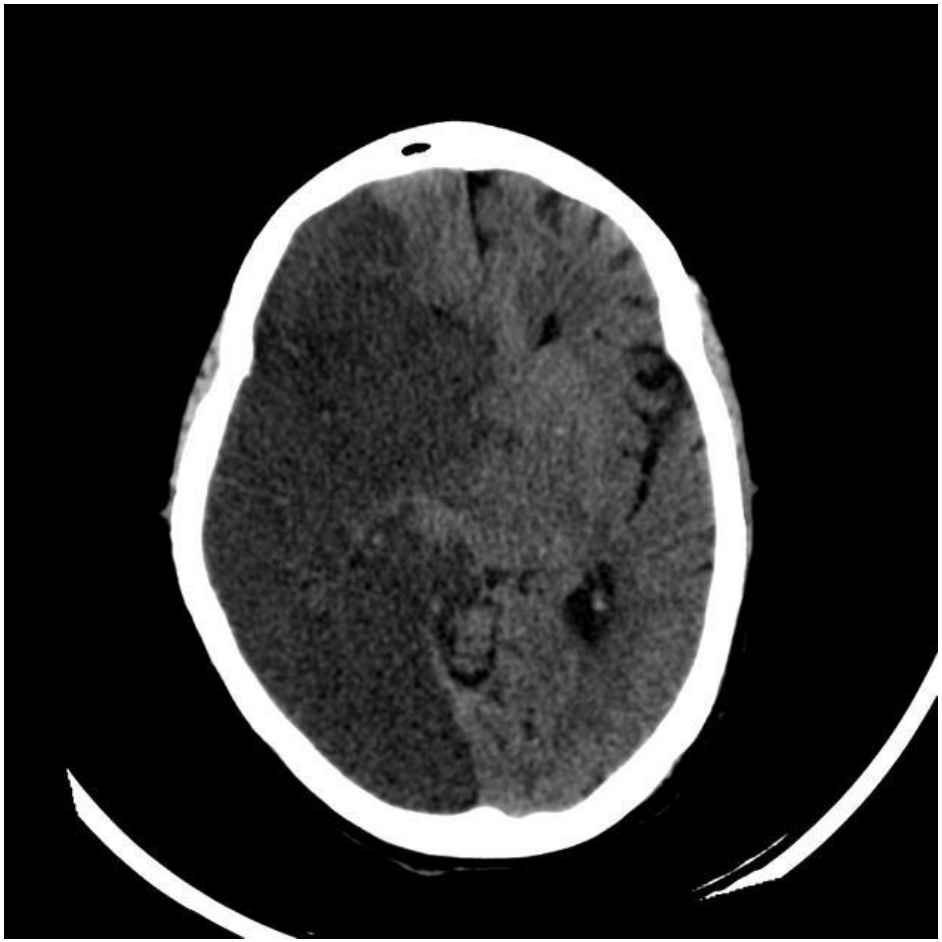
+blood, metal
contrast material

hyperdens

Hypodensities on CT



Importance of CT in stroke

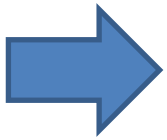


Similar symptoms of hemorrhagic and ischemic strokes!!!
The 2 main types of stroke cannot be differentiated only by symptoms!

CT in stroke

- There is no visible hypodensity in the hyperacute phase of ischemic stroke

- In cerebral hemorrhage, the hyperdensity can be seen immediately

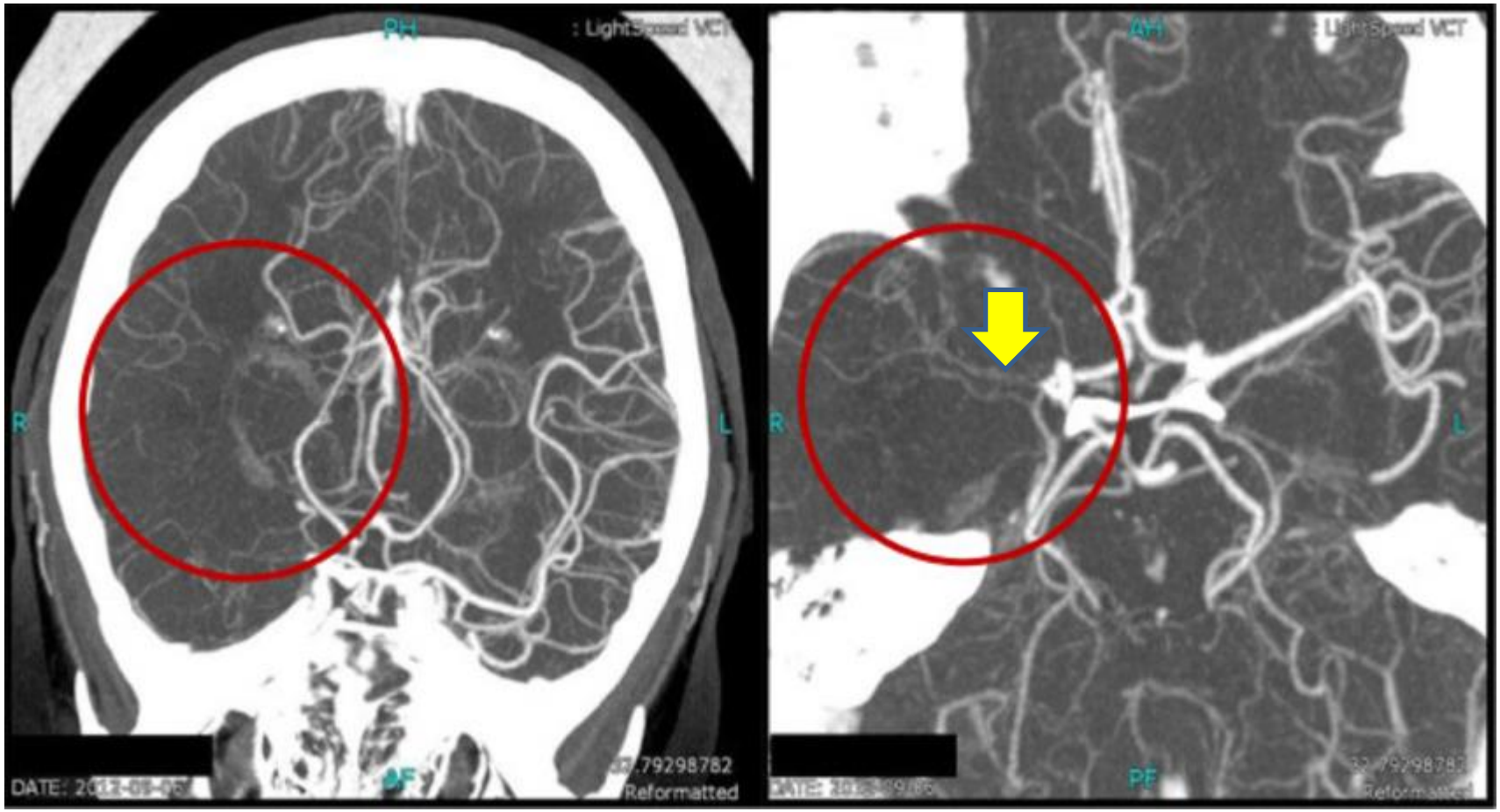


In hyperacute stroke, the CT is suitable to exclude cerebral hemorrhage!!!

Consequence of MCAO

Ischemic stroke
Infarction
Emollition
Ischemic stroke

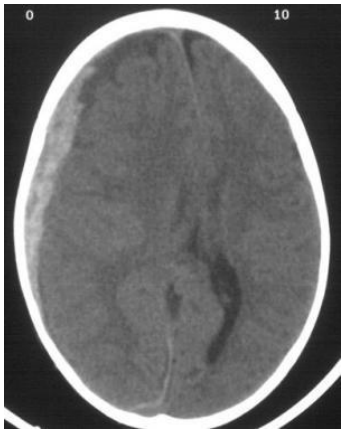
CT-angiography
(contrast material in the vessels)



Consequences of head traumas

- Cerebral concussion (neg. CT)

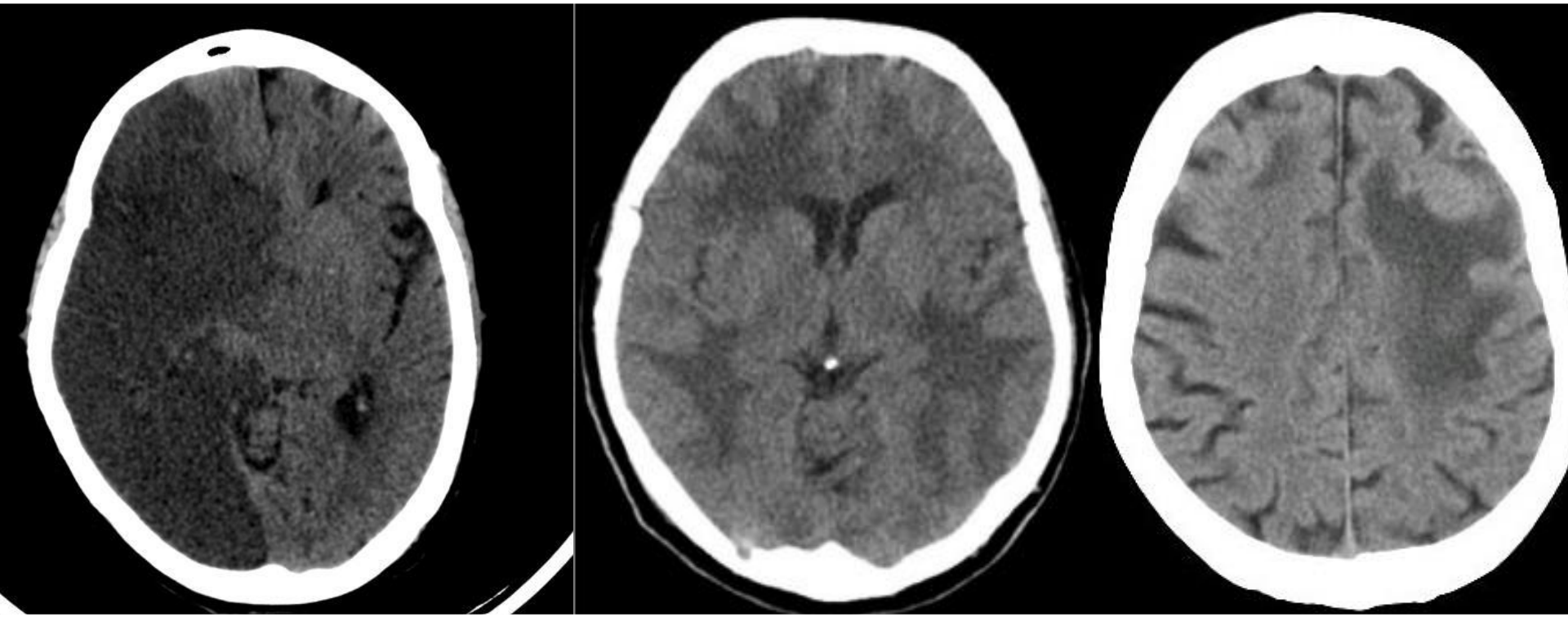
- Cerebral contusion



- Subdural hematoma

- Epidural hematoma

Oedema on CT



CYTOTOXIC OEDEMA

Cell swelling

Intracellular edema

Grey-white matter margin lost

Treatment: osmotic dehydration (Mannitol)

VASOGENIC OEDEMA

Increased permeabilty of capillaries

Extracellular edema

Grey matter is preserved → **finger-like oedema**

Treatment: stabilisation of capillary permeabilty (steroid – dexamethason)

Contraindications of CT

- Pregnancy
- Hypersensitivity to iodine (contrast agent) → native CT can be performed

Relative contraindication

- Young age/radiation exposure
- Renal insufficiency

Radiation hazard

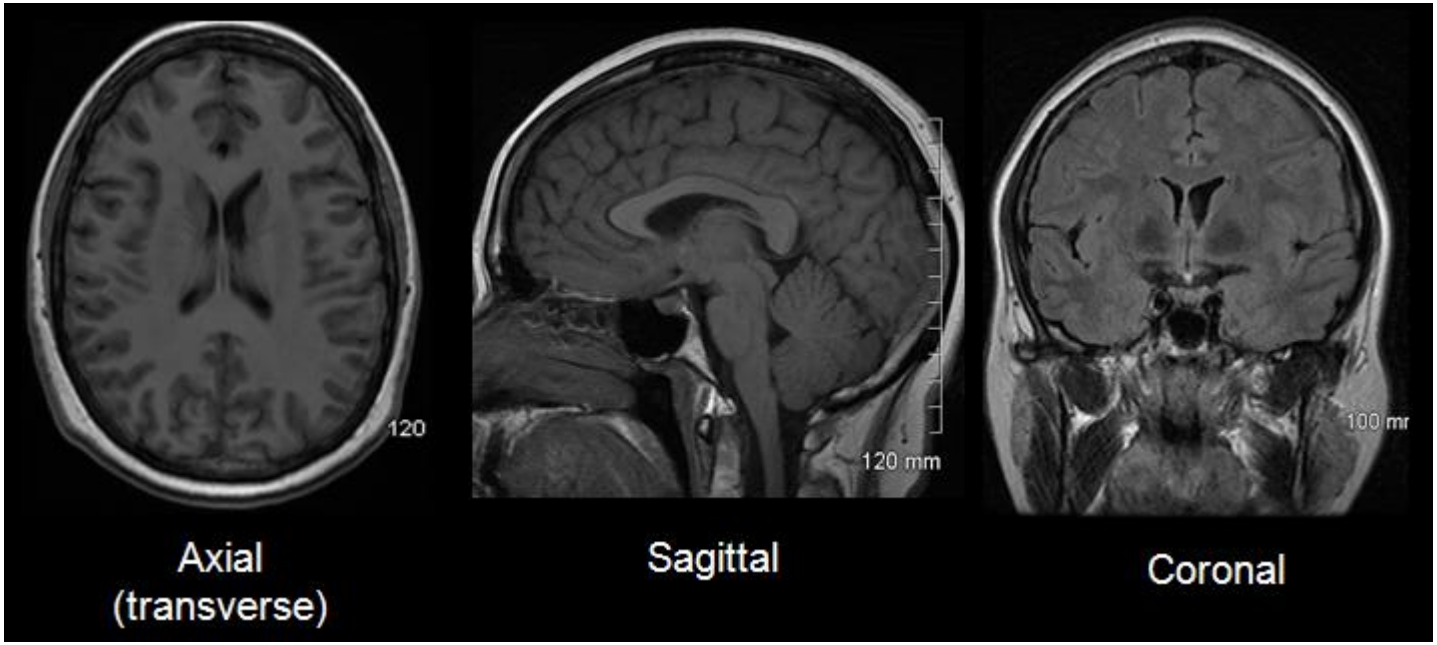
Type of Exposure	Effective Dose (mSv)		Equivalent to Days of Background Radiation
Airplane Flight	.01-.03		1-4 days
Chest X-Ray	.1		10 days
Mammogram	.7		3 months
CT Scan: Head	2	20x	8 months
CT Scan: Chest	8	80x	2 years
CT Scan: Pelvis	10-20	100-200x	3-6 years
MiniCat CT Scan: Head	**.17**		**20 days**

Number of chest x ray for equivalent effective dose

CT-MR examinations

CT	MR
• Ionizing radiation • Not suggested in pregnancy • • Worse resolution • Not suitable for examination of spinal cord and MS	• No ionizing radiation • Not suggested in pregnancy, but if necessary, can be performed • Better resolution • Good for examination of spinal cord, and MS!!!
• Simple • Lasts for seconds/minutes (good for confused pts too) • No claustrophobia • Better for hemorrhagic stroke • Better for bones • Metals do not limit the CT	• Complicated • Lasts for more than 10 minutes (not suitable for confused pts) • Claustrophobia may limit the MR • Worse for hemorrhagic stroke • Metals limit the MR (pacemaker,…) MR compatible life support equipment is necessary

MRI planes

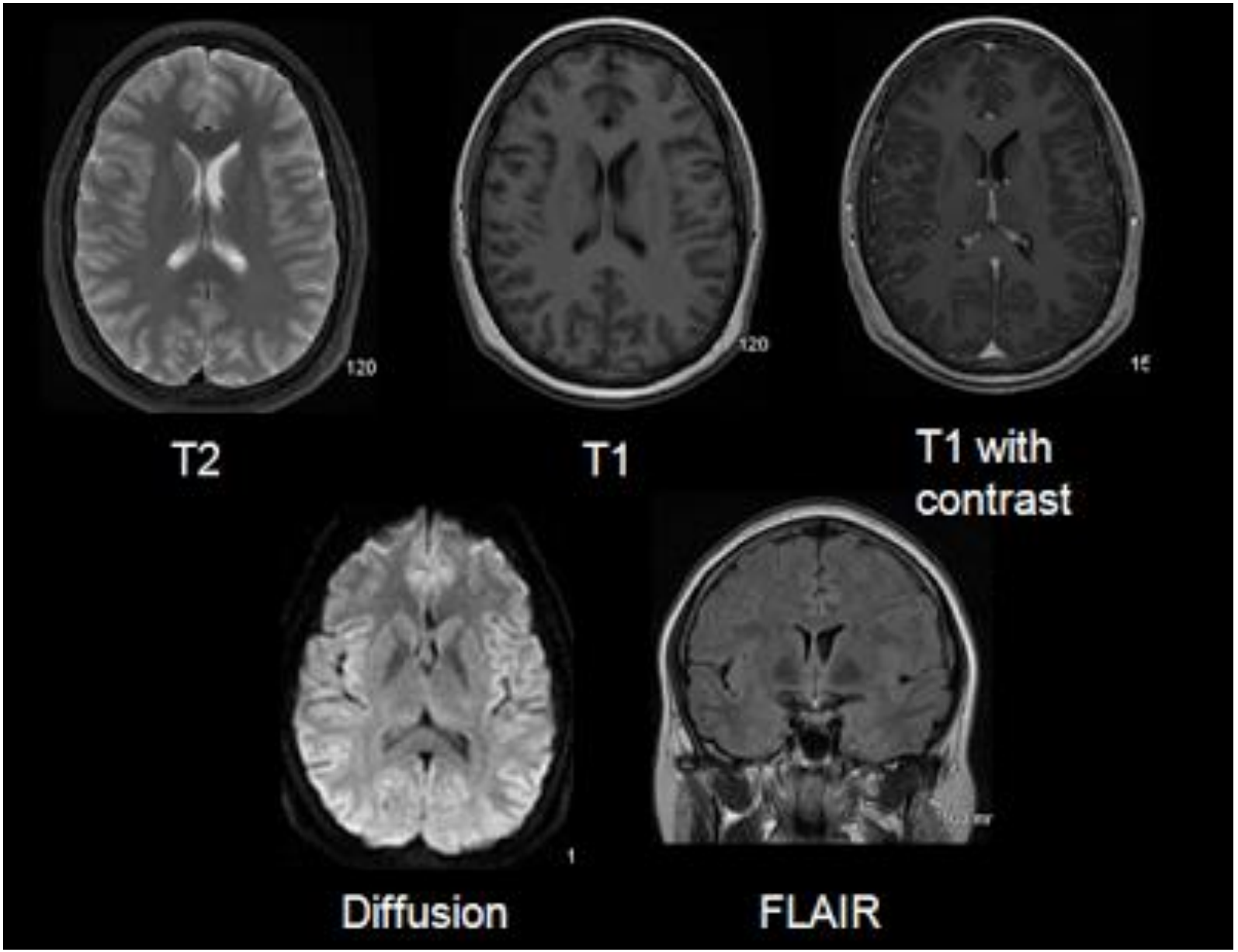


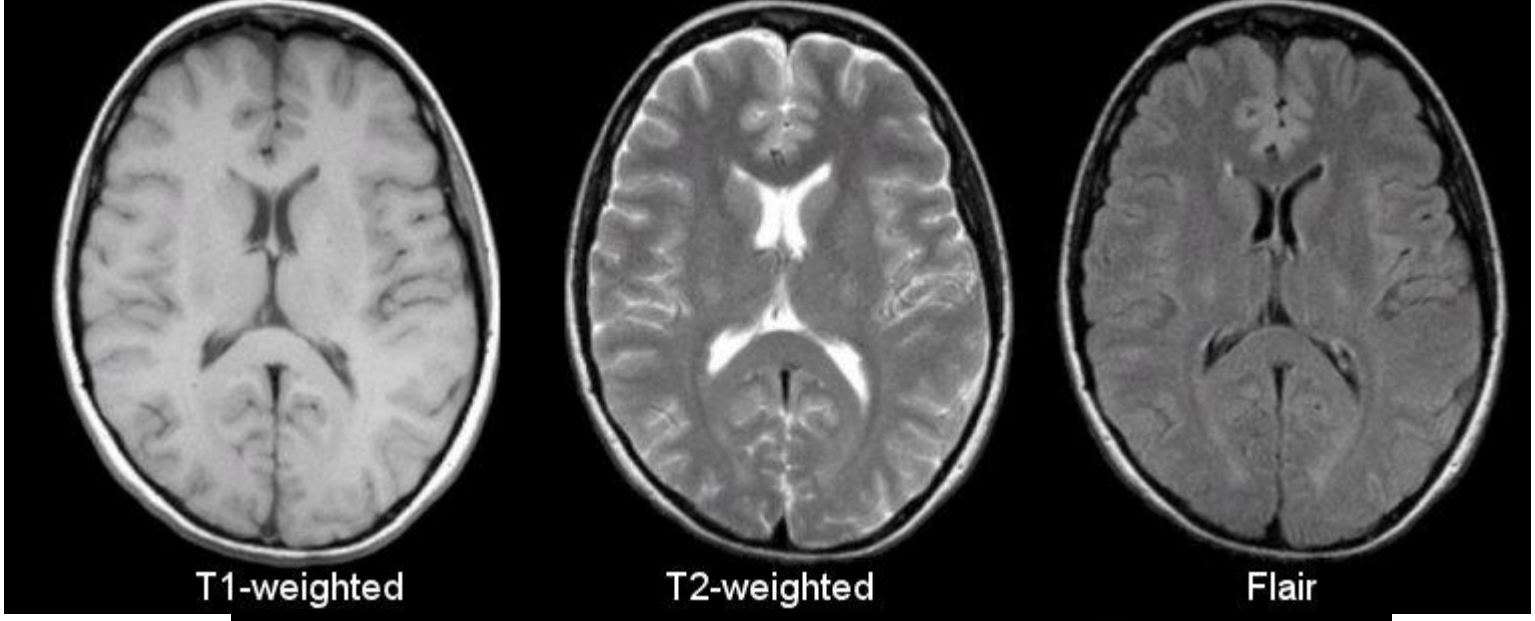
The tissue and imaging characteristics are a lot more complicated in MR images than in case of CT. There are several sequences. Each sequence has to be acquired separately, which means that an MRI will take a lot longer to perform than a CT.

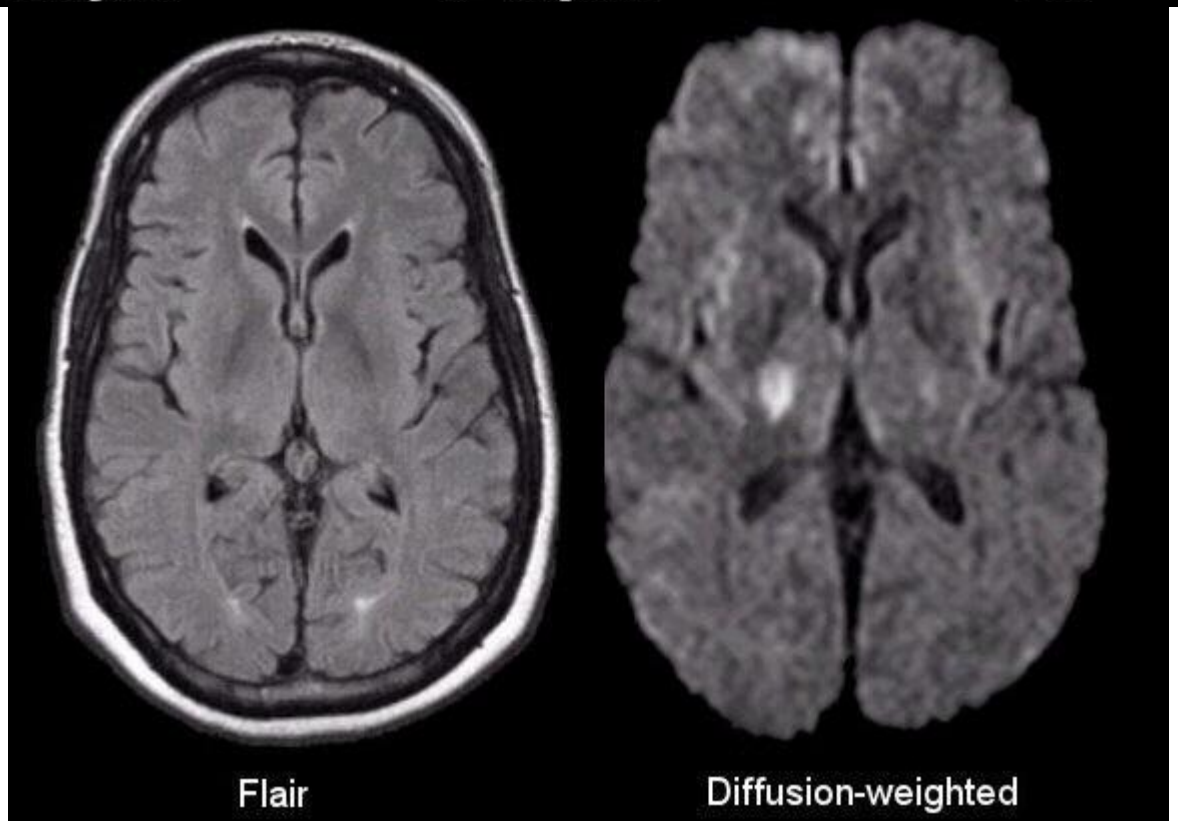
MRI sequences

MRI sequence	Property	Characteristic/practical
T1w	fat high, water low	evaluation of normal anatomy
T2w	water high, fat low	evaluation of pathology
Proton Density (PD)	number of protons per volume	evaluation of menisci & gray/white matter
STIR	selective suppression of fat signal	suppression of intra-abdominal fat, evaluation of bone marrow edema
FLAIR	T2 weighted image with selective suppression of CSF signal	detection of white matter abnormalities
Gadolinum (Gd)	reduced T1 relaxation time	detect & characterize lesions, MR angiography
DWI & ADC	motion of protons	restriction in acute ischemia, abscess/infection, cell-rich tissue
In-Out-phase	detection of microscopic fat	characterize adrenal lesion
Gradient echo (GE)	*FLASH (Siemens), FISP (Siemens), THRIVE (Philips), FFE (Philips), FE (Toshiba),FIESTA (GE healthcare)	fast sequence! detect blood products
Spin echo (SE)	*Turbo SE (Siemens/Philips), HASTE (Siemens), FAST SE (Toshiba / GE healthcare)	fewer susceptibility artifacts

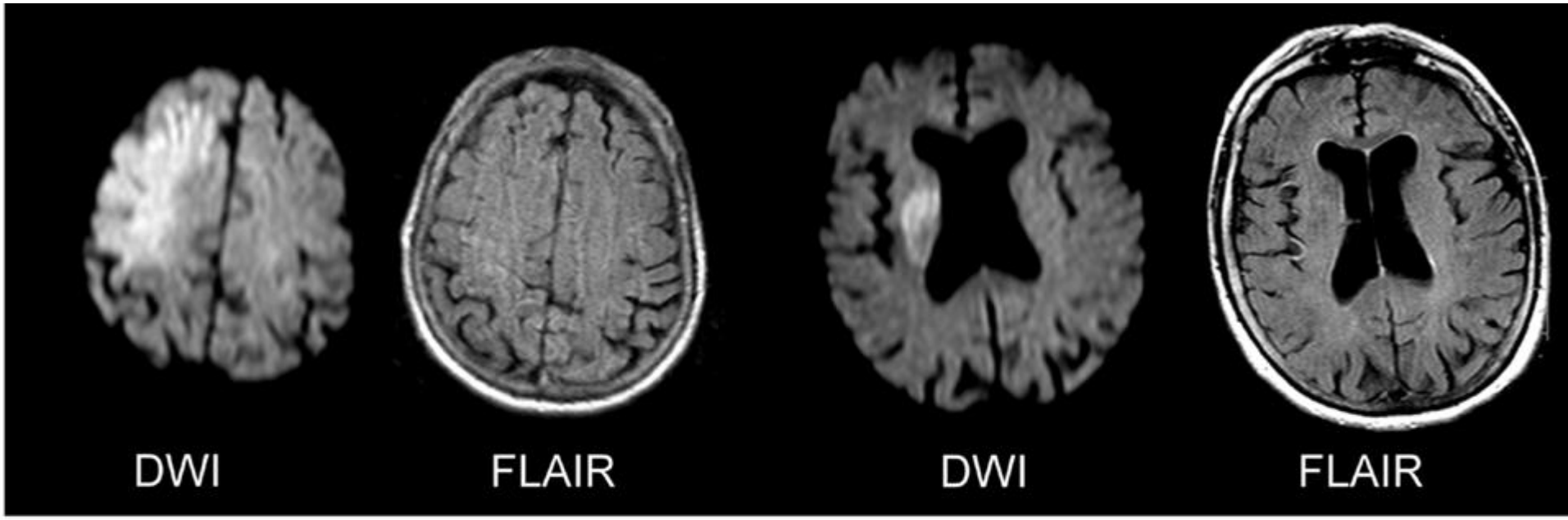
MRI: not density, but intensity!
E.g. CSF is hyperintense on T2WI




T1-weighted
T2-weighted
Flair


Flair
Diffusion-weighted

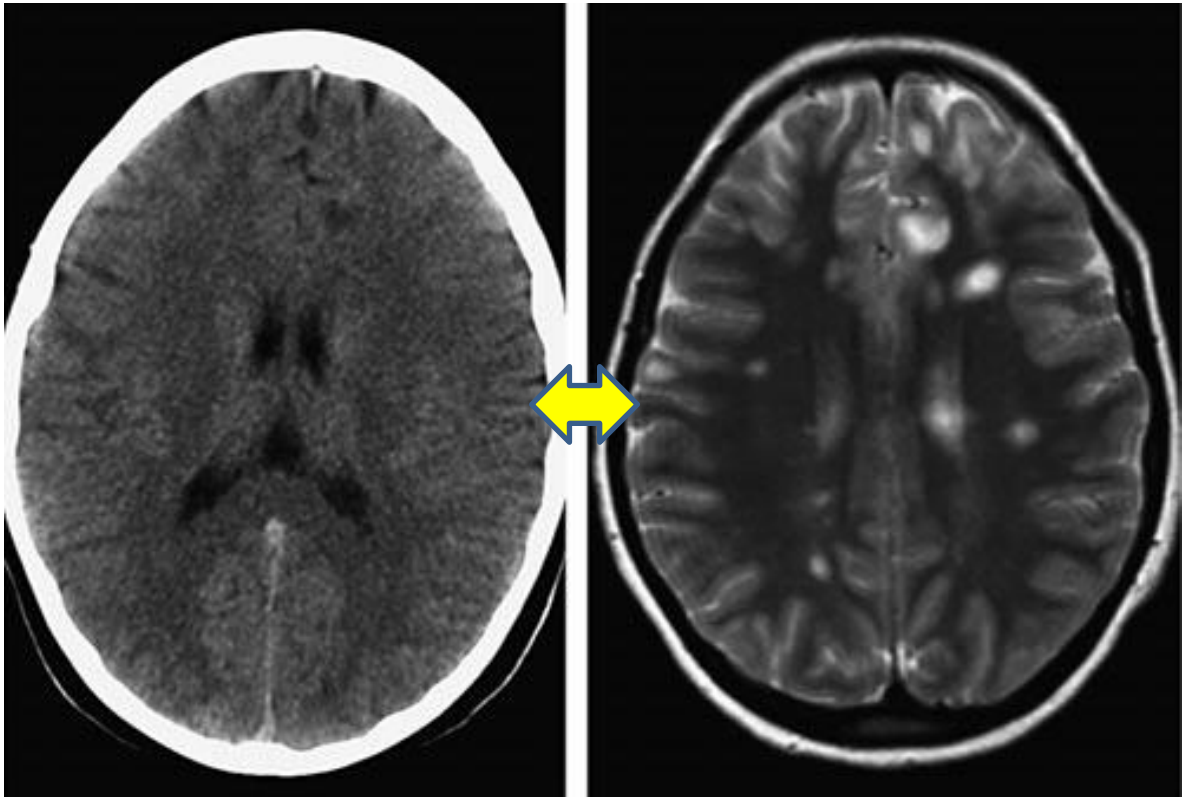
Diffusion weighted image in acute ischemic stroke



Positive already minutes after the onset of ischemic stroke

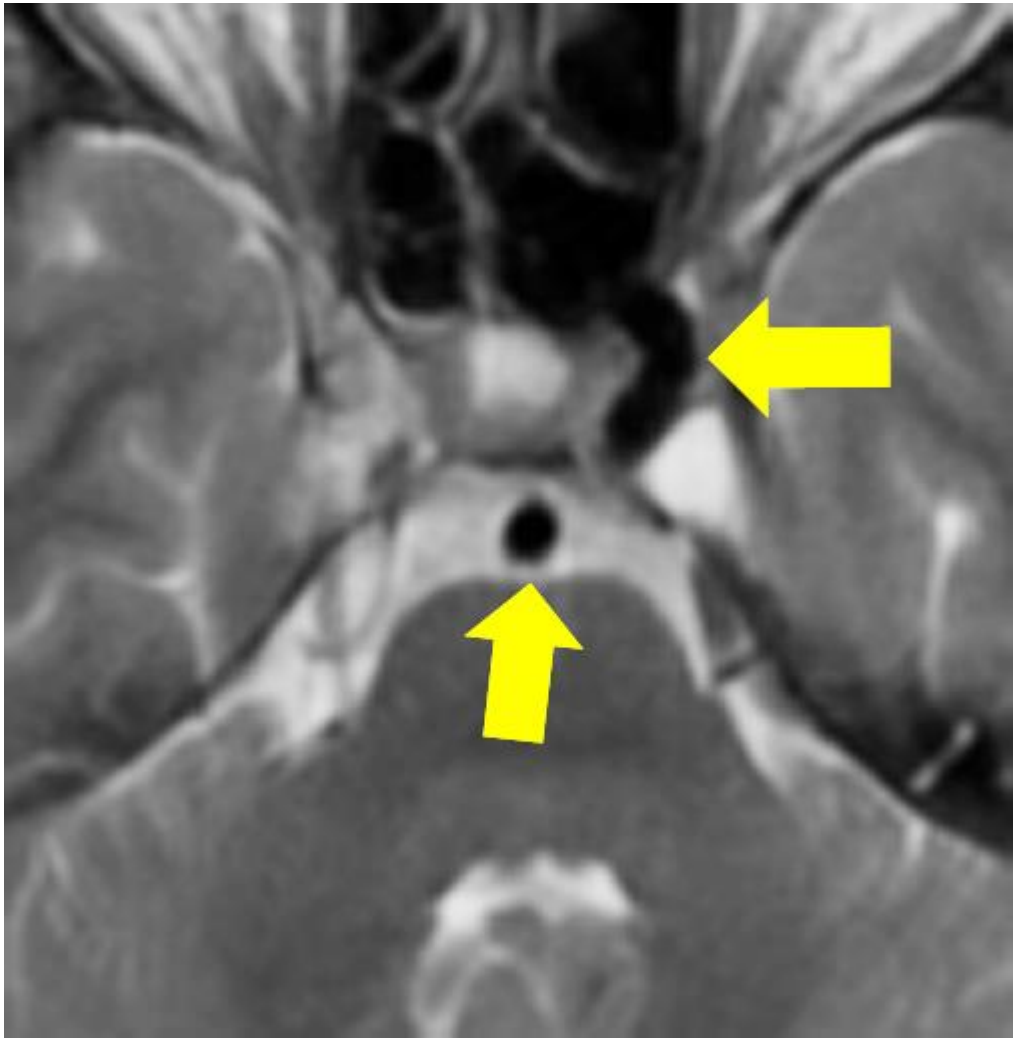
FLAIR is positive about 3 hours after the onset of ischemic stroke

MRI in multiple sclerosis (MS)



CT is not suitable in MS
Do not order CT
in suspicion of MS

Flow voiding



Normal flow-related signal loss

MRA - aneurysms

CONTRAINDICATIONS TO MRI

- Implanted devices and other metallic devices

- Pacemakers and other implanted electronic devices
- Aneurysm clips and other magnetizable materials
- Cochlear implants
- Some artificial heart valves

- Intraocular metallic foreign bodies

- Screening CT of the orbits if history suggests possible metallic foreign body in the eye

- Unstable patients (most resuscitation equipment cannot be brought into the scanning room)

- Pregnancy (relative contraindication due to unknown effects on the fetus)

- Other – severe agitation, or claustrophobia (may require anesthesia assistance)

Digital subtraction agiography

CSF sampling

Characteristics of CSF

CSF	Lumbar puncture	Cisternal puncture
Colour	Clear, colourless	Clear, colourless
Number of cells	1-4/mm3	1-2/mm3
Protein content	0.2-0.5 g/L	0.1-0.2 g/L
Glucose level	2/3 of the serum glucose	2/3 of the serum glucose
Pressure	positive	negative

Meningitis - CSF

Bacterial meningitis

>1000 cells/mm^3

mostly leukocytes

glucose: decreased

protein: increased

Viral meningitis

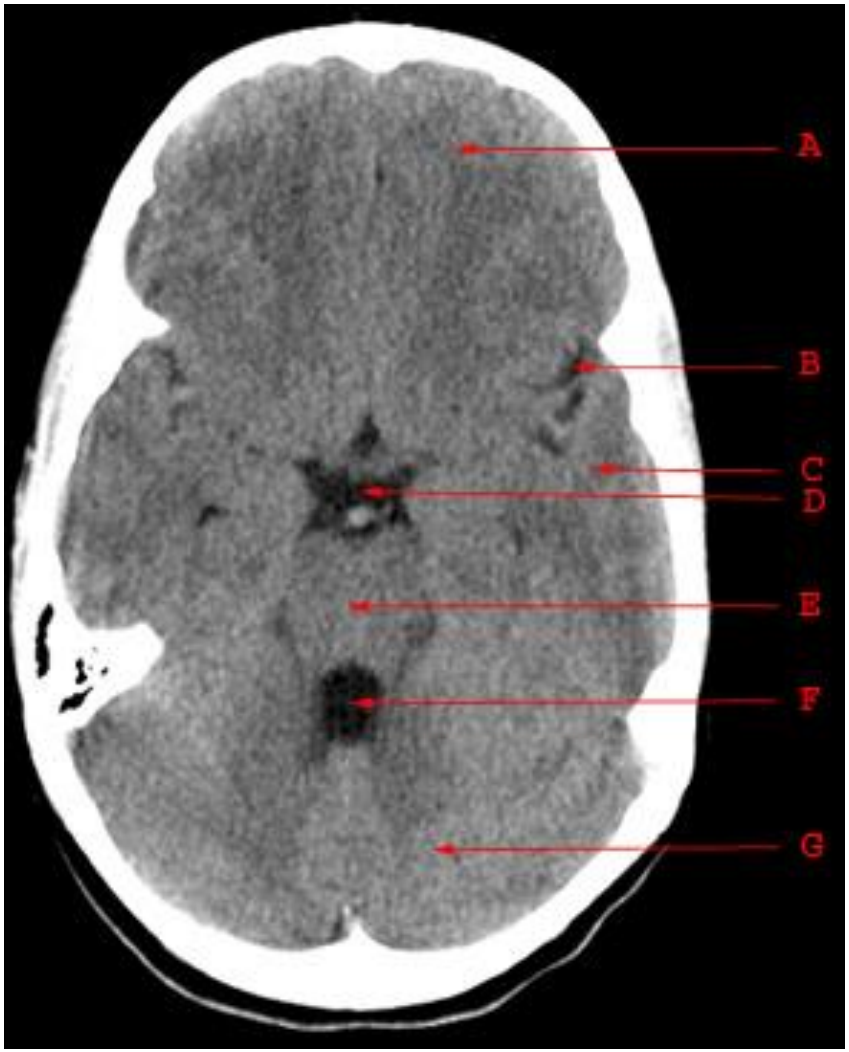
<1000 cells/mm^3

mostly lymphocytes

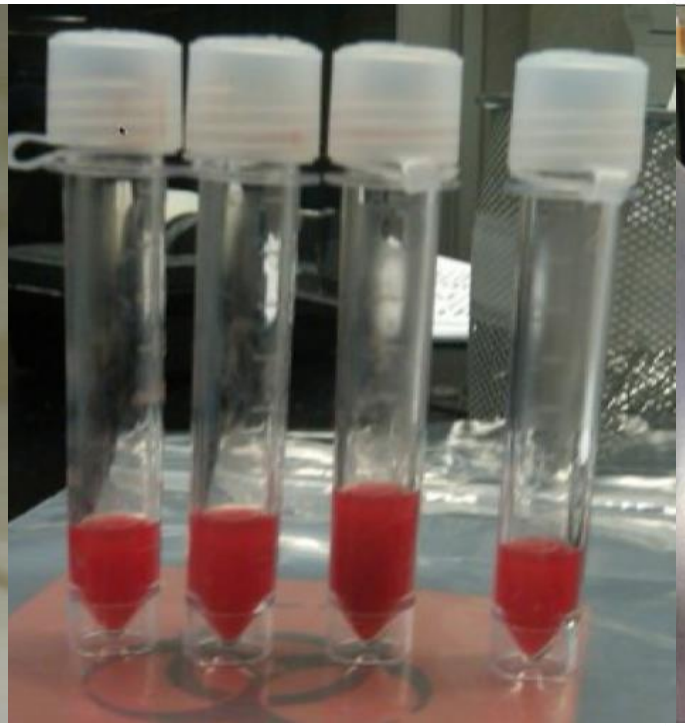
glucose: normal

protein: increased

The worst headache in my life…

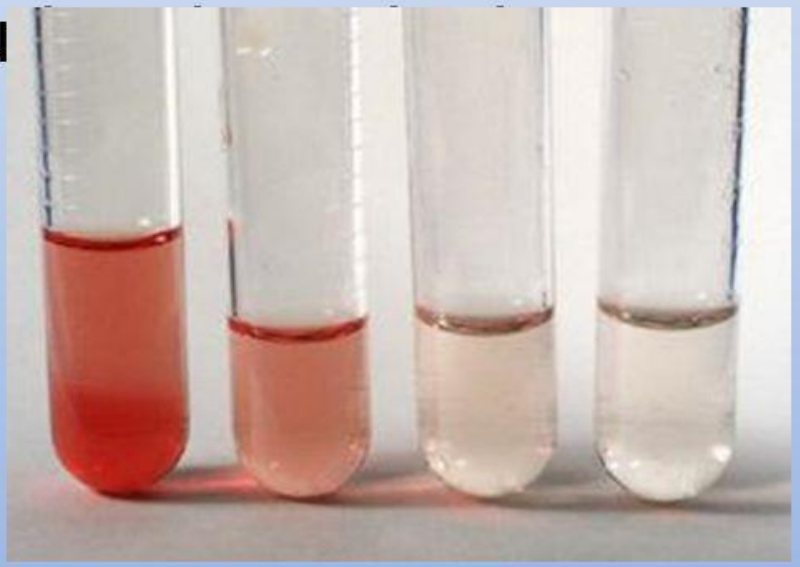

A
B
C
D
E
F
G

Subarachnoidal hemorrhage, meningitis

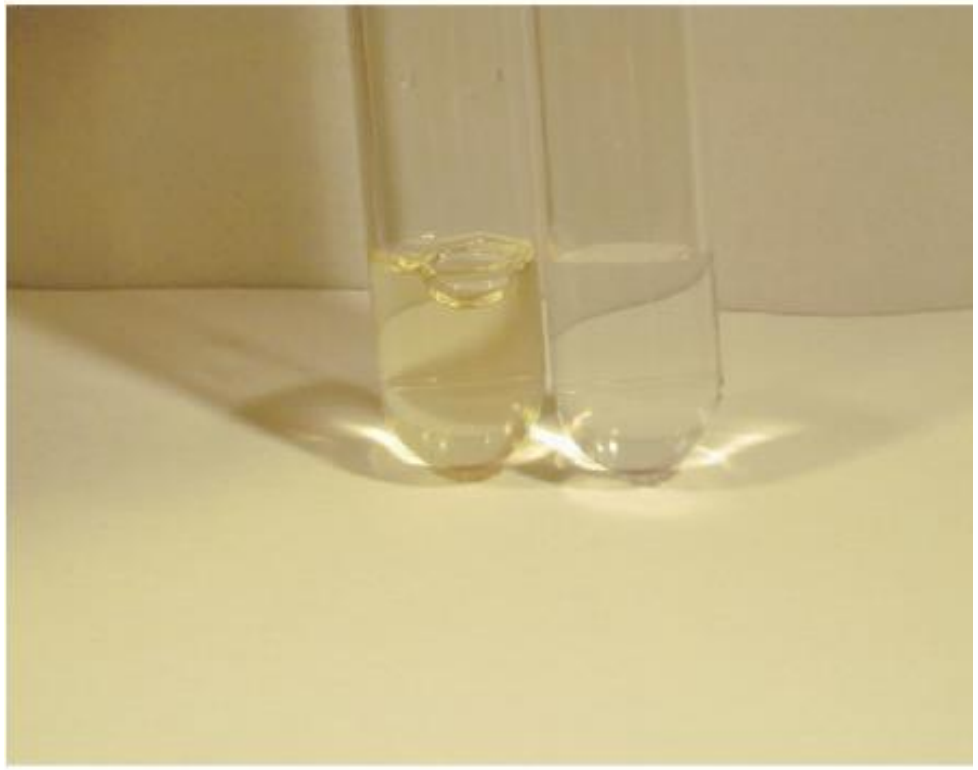

- **Bloody**

  Grossly bloody CSF can be an indication of subarachnoid hemorrhage, but it also may be due to the puncture of a blood vessel du
  procedure.



Supernatant after centrifuge

Yellowish: supports SAH
Clear: supports artefically bloody CSF

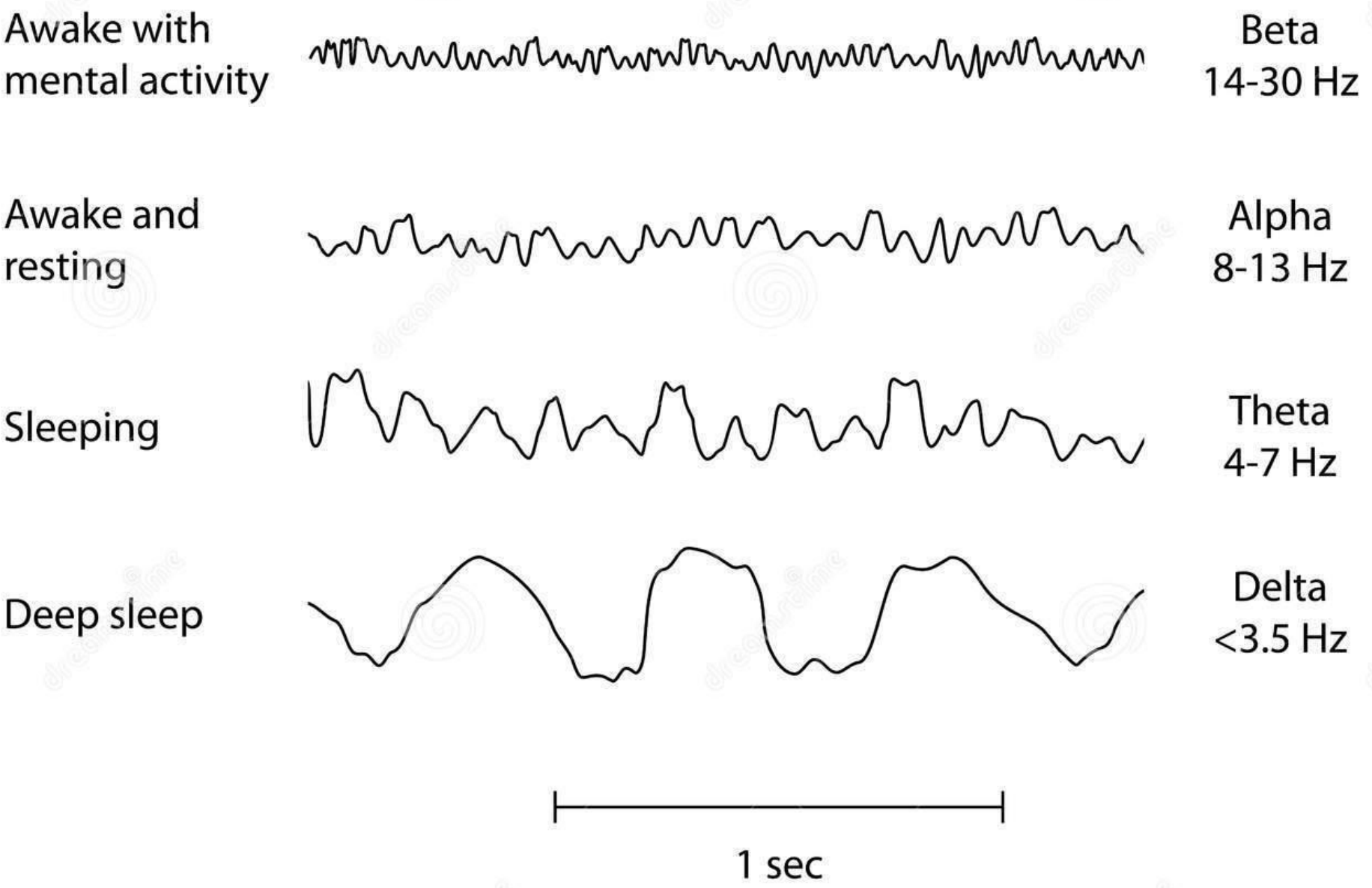


Electroneurography (ENG)

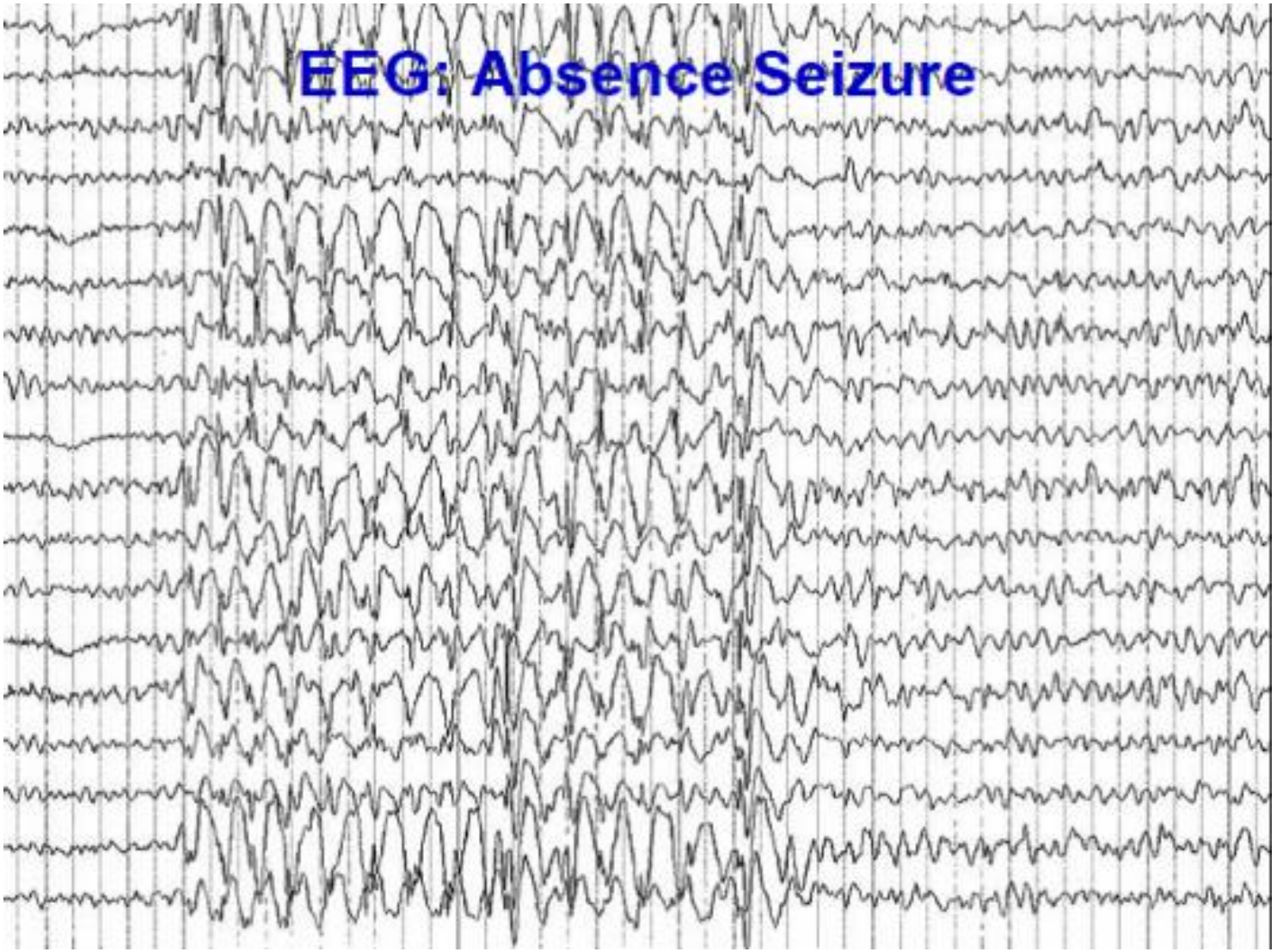
Electromyography (EMG)

Electroencephalography (EEG)

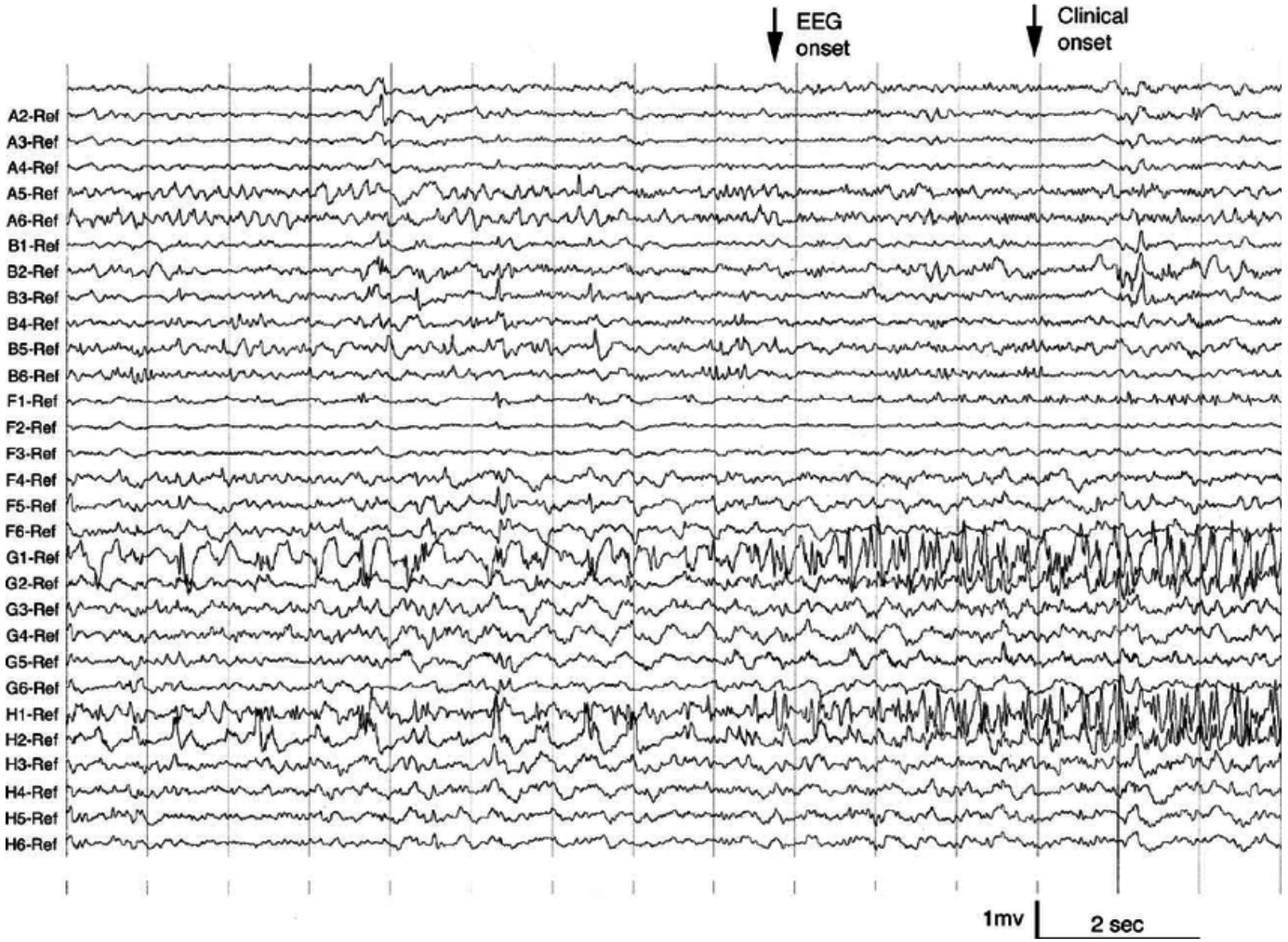
Normal Adult Brain Waves



EEG: Absence Seizure



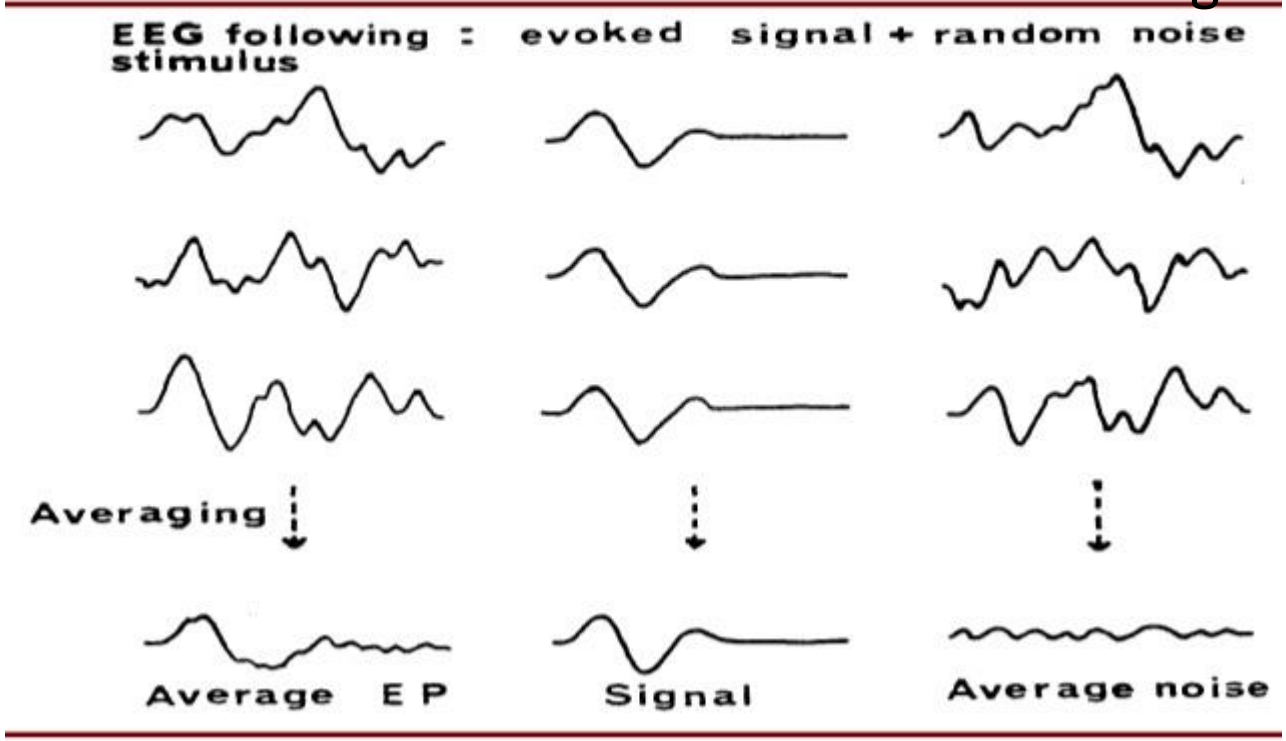
Focal seizure



Evoked potentials (based on EEG)

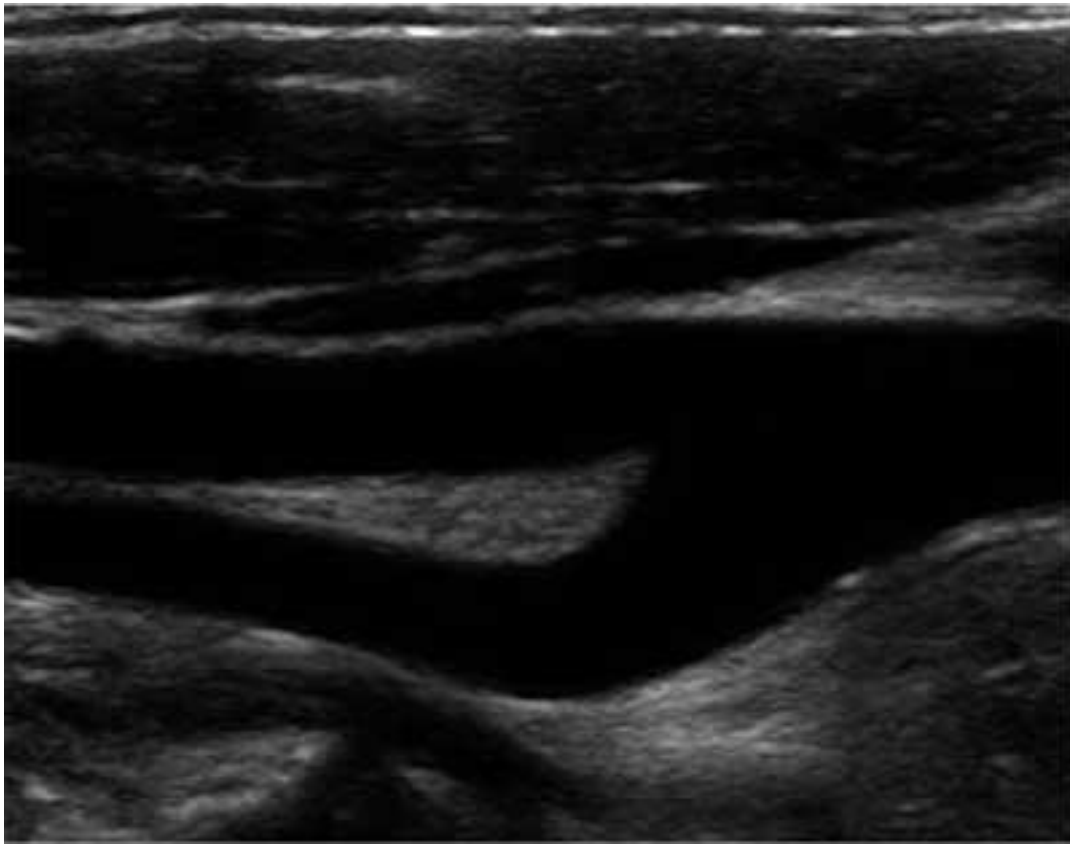
Averaging of EEG waves, detected by a properly localised electrode, after a certain stimulus

Averaging → Evoked signal is augmented
Background noise is decreased

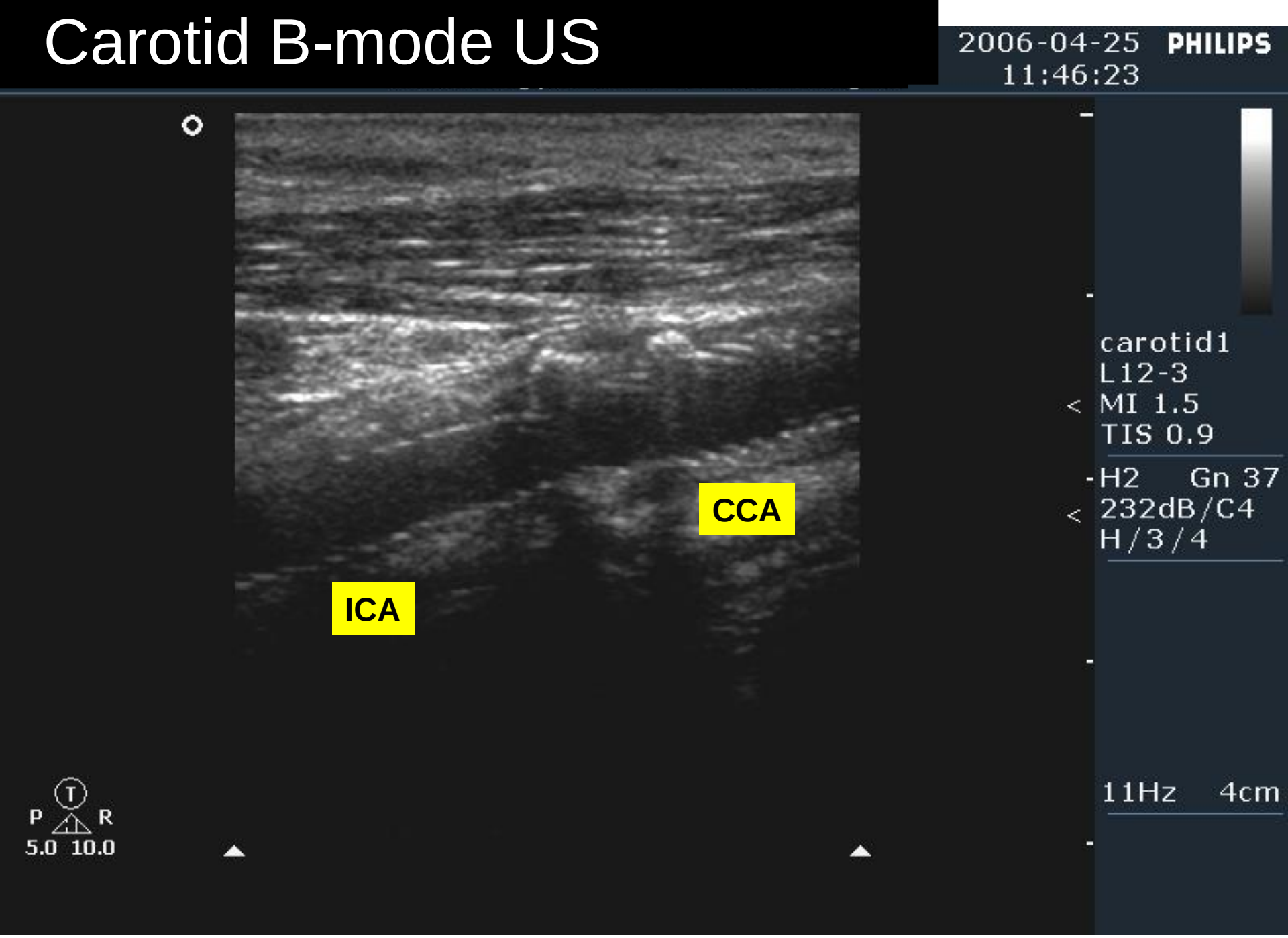


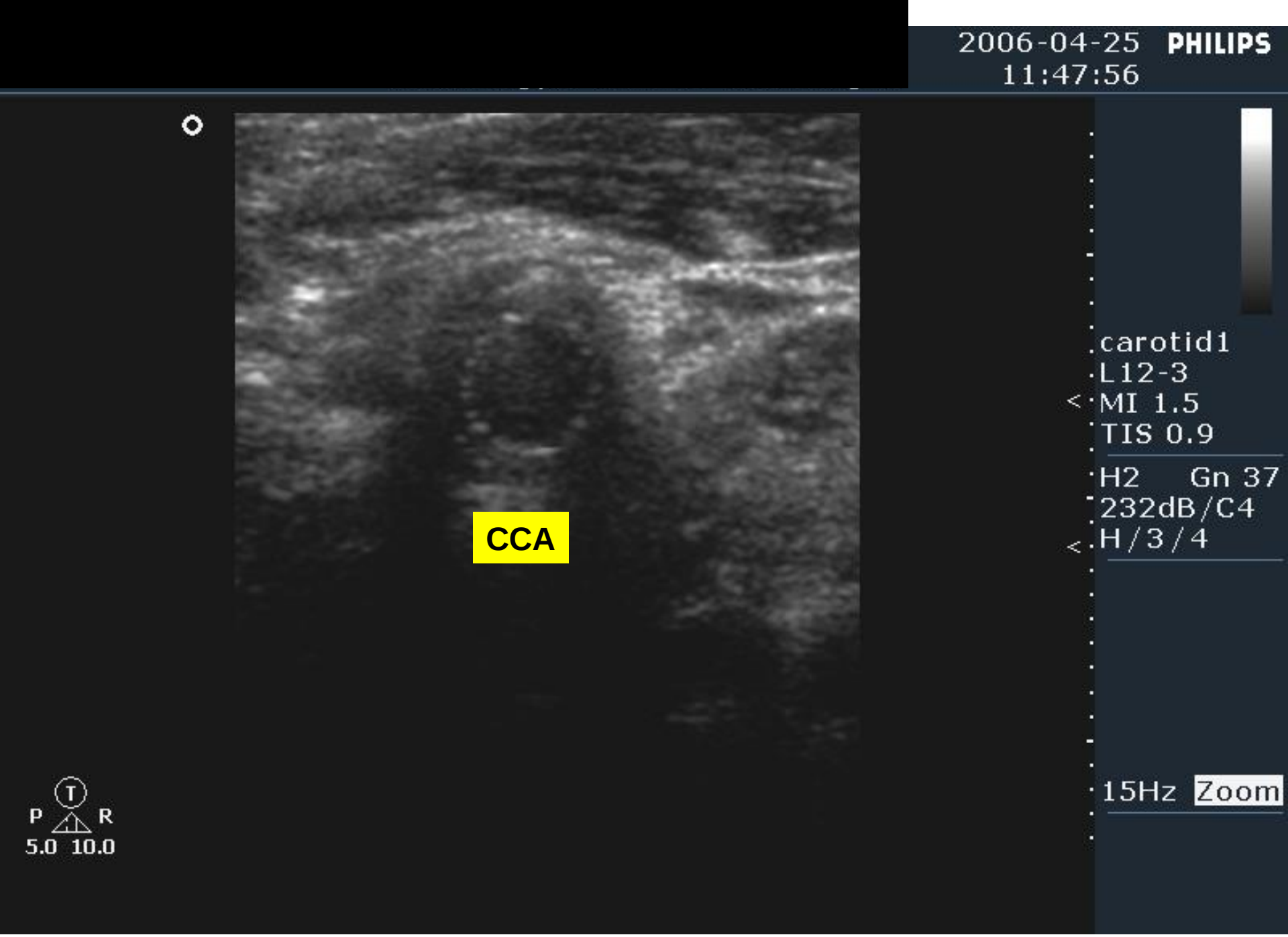
Ultrasound

B-mode US



Carotid B-mode US




2006-04-25
11:47:56
PHILIPS
CCA
carotid1
L12-3
MI 1.5
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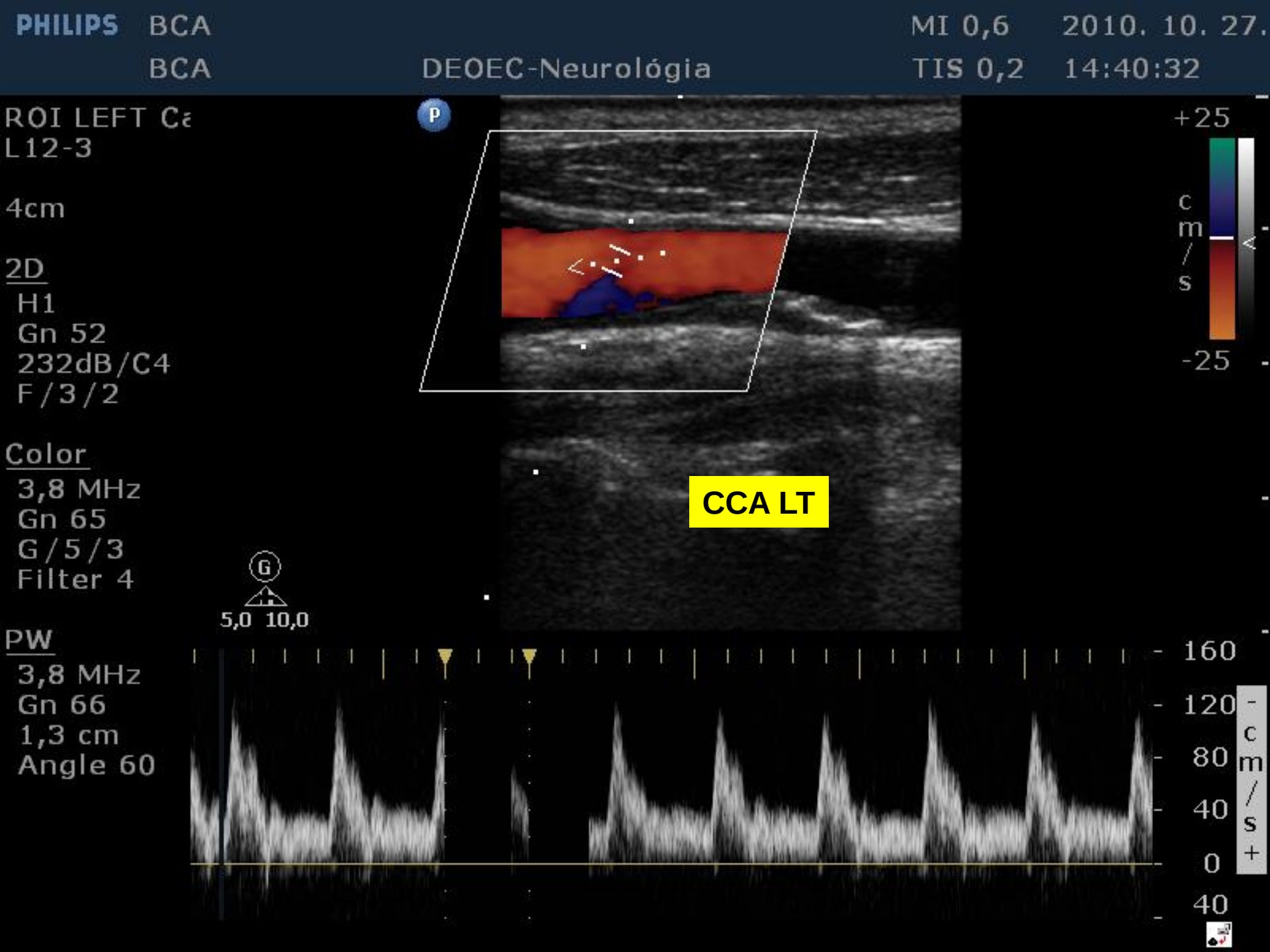
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BCA
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MI 0,6
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14:40:32
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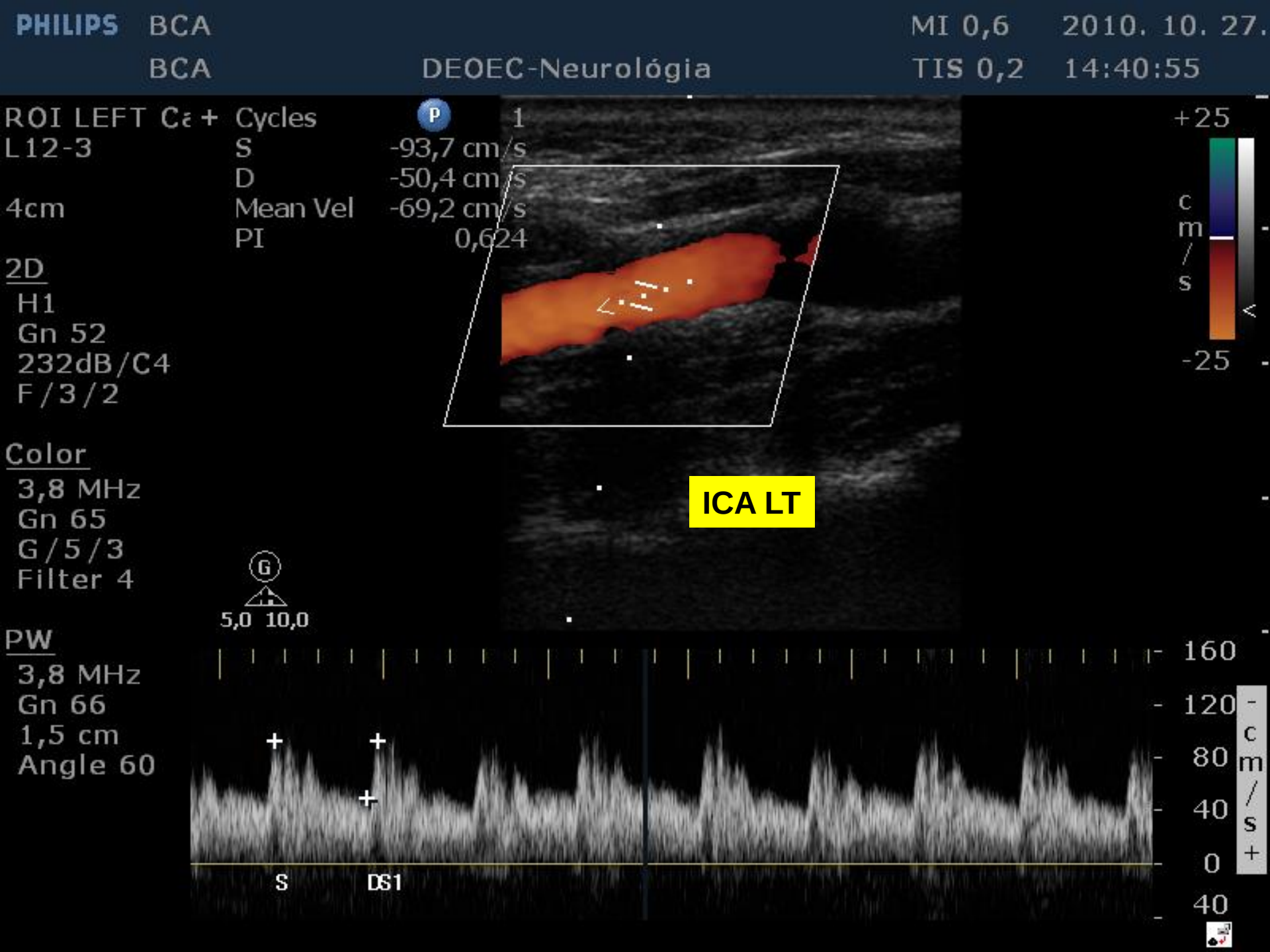
PHILIPS BCA
BCA
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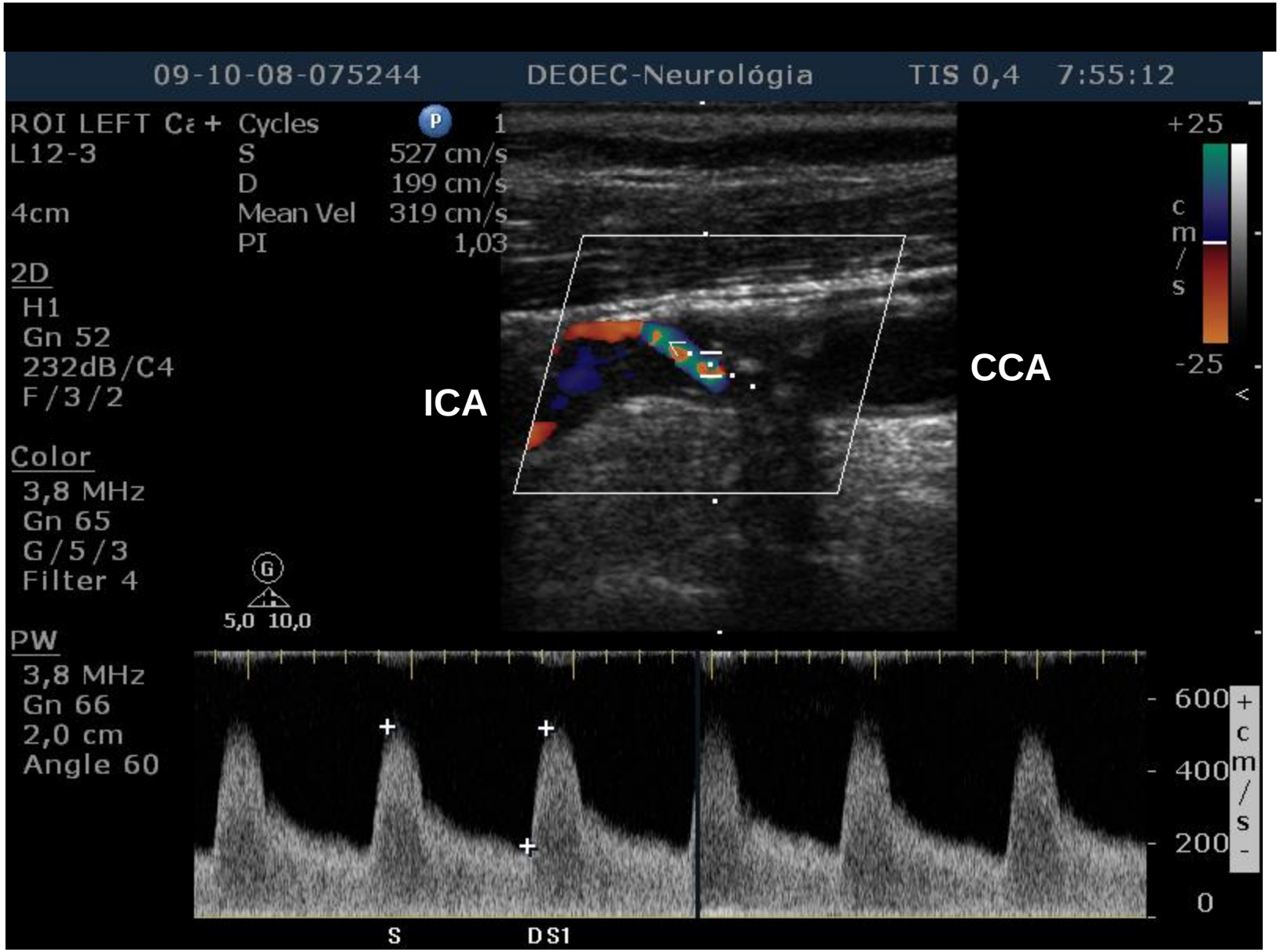
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DEOEC-Neurológia
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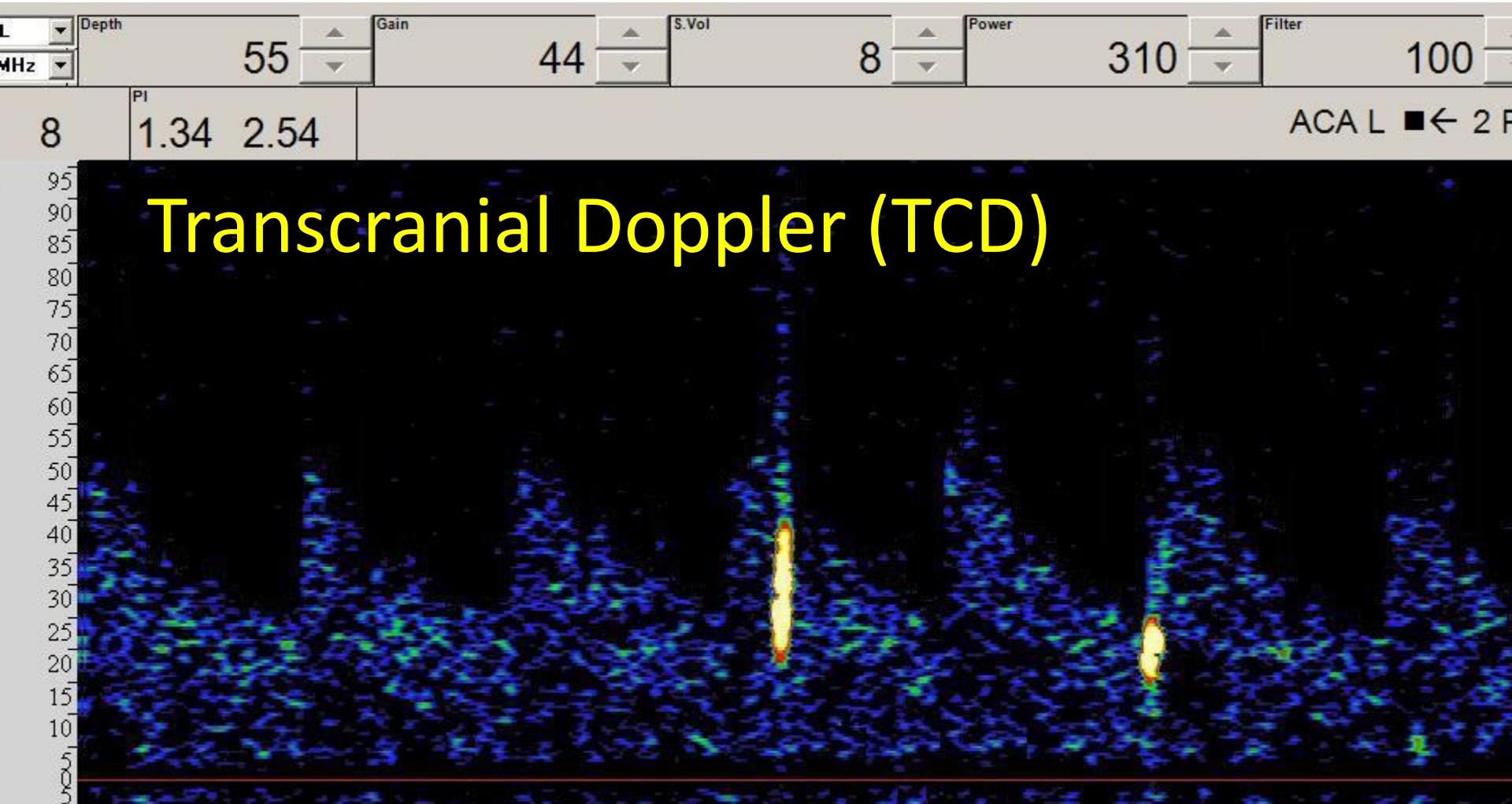
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ACA L
Transcranial Doppler (TCD)

Summary

- CT, MRI
- CTA, MRA, DSA
- CSF sampling, CSF analysis
- ENG, EMG, repetitive stimulation
- EEG
- Evoked potentials
- Duplex ultrasound and transcranial Doppler