

## **EANS/UEMS European examination in neurosurgery**

Variants of questions with answers (compilation - Vyacheslav S. Botev,  
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### **MRI Sequences (T1, T2, FLAIR, DWI, ADC)**

#### **Questions**

1. What structures are better visualized by T1-weighted MR images?
2. What structures are better visualized by T2-weighted MR images?
3. What is a FLAIR MRI?
4. What is a STIR MRI?
5. How does the appearance of intraparenchymal brain hemorrhage change over time on T1WI versus T2WI?
6. What is DWI?
7. What is T2 “shine-through”?
8. How is T2 shine-through differentiated from areas of true restricted diffusion?
9. What is the differential diagnosis of an area of bright signal on DWI?
10. What is a FIESTA protocol MRI?
11. What is an MP-RAGE MRI?

### **Magnetic Resonance Spectroscopy (MRS)**

#### **Questions**

1. What can magnetic resonance spectroscopy (MRS) distinguish?
2. What is MRS based on?
3. How does MRS work?
4. How many milliliters of brain tissue are included in single-voxel MRS?
5. Does contrast affect the metabolic results?
6. How long does it extend standard MRS time?
7. What are the main peaks in  $^1\text{H}$ -MRS (hydrogen MRS) and their meaning?
8. Which peaks are considered physiologic?
9. Which two peaks are undetected in normal brain?
10. Which two peaks appear both in tumors and in nonneoplastic diseases?
11. Metastases usually have elevation of which peak?
12. What is Hunter’s angle?
13. What is usually significantly decreased in metastasis?

14. When is the Cho peak elevated?
15. What two ratios are elevated in tumoral lesions?
16. What ratio is typically decreased in brain tumors?
17. Which glioma is the exception?
18. What are the typical findings in radiation necrosis?
19. What index is particularly high in gliomatosis cerebri?
20. What peak is decreased in Canavan's disease?
21. Which peak correlates with cognition and intellectual performance (IQ)?
22. True or false: Larger neurons have more NAA than smaller neurons.
23. Which ratio is decreased in temporal lobe epilepsy (TLE) and restored after lobectomy?
24. What ratio is decreased in multiple sclerosis?
25. What ratio is decreased in AIDS dementia complex?
26. What ratio is decreased in systemic lupus erythematosus (SLE)?
27. Exposure to cocaine in utero can elevate significantly which peak?
28. What infective process has been found to have elevated Cho?
29. Presence of elevated pyruvate may indicate which parasitic process?
30. What is the significance of elevated choline peaks and reduced N-acetyl-aspartate (NAA) levels in spectroscopic evaluation of brain tumors?

## **MRI Sequences (T1, T2, FLAIR, DWI, ADC)**

### **Answers**

1. Fat, subacute hemorrhage (>48 hours old), onyx, melanin. T1WI is usually considered best for imaging anatomy as opposed to pathology. White matter contains more fat than gray matter and is thus hyperintense to gray matter on T1WI.
2. Water (CSF, edema). T2WI is usually considered best for imaging pathology. Gray matter typically contains more water than white matter and is thus hyperintense to white matter on T2WI.
3. Fluid-attenuated inversion recovery image. Similar to T2WI except CSF is dark. Periventricular lesions (e.g., MS plaques) may appear more prominent.

4. Short tau inversion recovery image. Known as a “fat-suppression image” due to the fact that fat is hypointense. May be useful in spine for showing bone edema.
5. Mnemonic for acute to chronic appearance is “Itty bitty baby daddy” or “ID BD BB DD.”

	T1	T2
Hyperacute (4–6 h)	Isointense	Bright
Acute (7–72 h)	Isointense	Dark
Subacute (4–7 d)	Bright	Dark
Subacute 2 (1–4 wks)	Bright	Bright
Chronic (months)	Dark	Dark

6. Diffusion-weighted imaging. The image is sensitive to brownian motion (diffusion) of water molecules. Actively diffusing water appears dark on DWI, whereas nondiffusing (or diffusion-restricted) water appears bright.
7. DWI is based on a T2WI, and any structures appearing bright on T2 may also appear bright on DWI; thus, a bright signal on DWI may be due to restricted diffusion or T2 shine-through.
8. The ADC (apparent diffusion coefficient) map: areas of true restricted diffusion will be dark on the ADC, whereas T2 shine-through will be bright.
9. Acute ischemia or infarct (DWI changes may be seen within minutes of ischemia; TIAs often produce DWI abnormalities), abscess, active MS plaques, certain tumors (e.g., epidermoid cysts, some meningiomas)
10. Fast imaging employing steady-state acquisition.  
A high-resolution, thin-slice T2 MRI using CSF as a contrast medium. Often used to evaluate inner ear structure, the auditory nerve, vestibular schwannoma, and posterior fossa vasculature (vascular compression of trigeminal nerve in trigeminal neuralgia).
11. Magnetization-prepared rapid gradient with echo, a high-resolution three-dimensional T1 image.

# Magnetic Resonance Spectroscopy (MRS)

## Answers

1. Mnemonic is **T-PRIDE**:

**T**umors from nontumoral lesions including edema

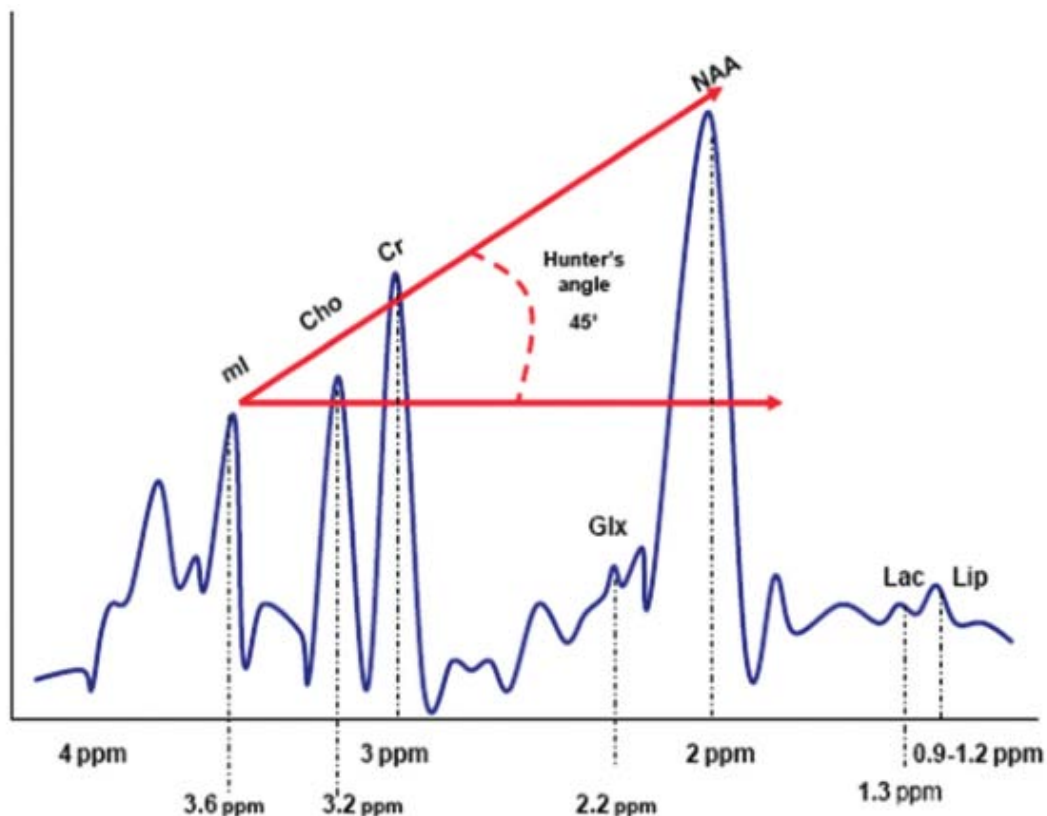
**P**redicting tumoral grade

**R**esidual tumor versus radiation necrosis

**I**nfections (abscess)/Ischemia (stroke)

**D**iagnosis of gliomatosis cerebri

**E**ncephalopathies (HIV, hepatic, etc.)/Edema



Tumor	Infection	Ischemia
Increased Cho-Cr ratio	Increased myoinositol	Decreased choline
Decreased NAA, Cr + NAA/Cho	Increased lipid	Decreased NAA
Increased Lip + Lac (metastasis)	Increased lactate	Increased lactate

Normal MRS peaks

2. The detection of metabolites that have a concentration of at least 0.5 to 1.0 mM (millimolar).
3. By placement of a voxel in the region of interest and comparing the relative concentration of metabolites in that region.
4. Approximately 8 cc.
5. No, but it allows better positioning of the voxel.

6. By about 15 to 30 minutes.
7. Myoinositol: membrane precursor/glial marker.  
Choline (Cho): cellular and membrane turnover/density.  
Creatinine (Cr): cell metabolism and energy store.  
N-acetyl-aspartate (NAA): Neuronal viability and density.  
Glutamate–Glutamine (Glu-Gln or Glx): neuronal amino acids.  
Lactate (Lac): cell anaerobic metabolism.  
Lipid (Lip): cell necrosis (increase in tumor/ infections).
8. Choline, creatinine, and NAA.
9. Lactate and lipid peaks.
10. The same two peaks: lactate and lipids!
11. Lipids and lactate are usually identified more frequently than normal tissue.
12. The imaginary angle if we connected a line between the myoinositol peak and the NAA peak. It usually measures 45 degrees and is inverted (high Cho, low NAA in case of tumoral lesions and some infections/inflammatory disorders).
13. Creatinine!
14. When the cellular and/or membrane turnover is high, such as tumors and demyelinating diseases.
15. Cho/NAA and Cho/Cr.
16. NAA/Cr.
17. Low-grade gliomas can have a high NAA/Cr ratio.
18. All indexes low (Cho/Cr, Cho/Cho-n, NAA/Cr); Cho/Cho-n is the ratio of the lesion's choline peak to the contralateral normal-appearing brain tissue's choline peak.
19. Cho/NAA.
20. NAA.
21. NAA.
22. True!
23. NAA/Cr.
24. NAA/Cr (yes, the same).
25. NAA/Cr (again, the same ratio).
26. NAA/Cr (once more, the same ratio is decreased).
27. Creatinine.
28. Cryptococcus.
29. Neurocysticercosis, which is particularly useful in distinguishing this from some cystic tumors.
30. Increased choline levels indicate increased membrane turnover. NAA (which reflects neuronal integrity) is reduced in tumors. The combination of both of these findings indicates tumor infiltration.