

# Metabolic Neuroimaging

Last updated: September 5, 2017

POSITRON EMISSION TOMOGRAPHY (PET) .....	1
MAGNETIC RESONANCE SPECTROSCOPY (MRS).....	2
SPECT, fMRI – see D66 p.	

PET, SPECT - **image function predominantly** (*anatomy* to lesser degree) - most useful in:

- disease **without** easily identifiable **anatomic correlates** (e.g. Parkinson's disease).
- diffuse** brain disease (e.g. degenerative dementias - Alzheimer's disease, Pick disease).
- defining **epileptic** focus noninvasively.
- differentiation **recurrent tumor** from **radiation necrosis**.

**Earliest possible diagnosis** (altered metabolic activity precedes neuronal loss and even electrical cortical changes)

N.B. in these disorders CT / MRI are often normal, even with advanced cases! (or only nonspecific atrophy)

## Positron Emission Tomography (PET)

- tomographic imaging of **injected radioisotopes** (that cross BBB).

- physical-mathematical principles similar to CT, but source of radiation is internal to imaged organ.
- isotopes emit **positrons**\* (vs. SPECT – photons) → PET scanner identifies gamma-rays → CT-like image is developed.

\*when isotope decays, positron is emitted, which combines with electron, both particles then being annihilated to release two gamma-rays that radiate in 180° opposite directions.

- isotopes are short-lived - require production in adjacent cyclotron - *expense and technical complexity!*

**Less favorable cost/benefit ratio than SPECT!**

- images can be displayed in axial, coronal, or sagittal projections.
- spatial resolution is inferior to CT and MRI.

PET is superior to any other technique in ability to image **specific receptors**, as well as **related functions**:

- GLYCOLYSIS evaluation**: **2-[<sup>18</sup>F]-fluoro-2-deoxy-D glucose (FDG)** - glucose analog that only enters living cells → once phosphorylated to FDG-6-phosphate, cannot proceed further in glycolytic pathway, and remains metabolically trapped intracellularly.
  - gray matter* accumulates more FDG than does *white matter*.
  - motor, language, visual, or other sensory task → ↑glucose metabolism in involved cortical region.
  - decreased glucose metabolism in PET correlates with decreased rCBF in SPECT!
- PROTEIN SYNTHESIS evaluation**: **<sup>11</sup>C-methionine**.
- DNA SYNTHESIS evaluation**: **<sup>11</sup>C-thymidine**.
- RECEPTORS** (e.g. on tumors): radiolabeled chemotherapeutic drugs, monoclonal antibodies, and receptor ligands.

- **fluorodopa** – activity of nigrostriatal dopaminergic system in clinically unclear Parkinson's disease cases (correlation between fluorodopa uptake and striatal dopamine content).

Biochemical flexibility and sensitivity of PET are unparalleled!

- TRULY METABOLIC IMAGES OF BRAIN

States with hypometabolism: anoxia, degenerative disease, trauma, aging.

States with hypermetabolism: tumor, infection, seizure foci.

## Magnetic Resonance Spectroscopy (MRS)

- noninvasive in vivo method of analyzing detailed chemical spectrograms.

- **protons** are currently being imaged clinically.
- proton MRI spectrum is characterized by at least three PEAKS\* representing:
  - 1) **creatine (CR)** - cellular **energy** metabolism; present in much higher concentrations in glia than in neurons.
  - 2) **choline (CHO)** - cell **membranes**; present in much higher concentrations in glia than in neurons.  
CHO↑ - abnormal membrane metabolism: myelin breakdown, inflammation, neoplasia.
  - 3) **N-acetyl aspartate (NAA)** is found primarily within neurons and precursor cells; NAA is marker of **neuronal integrity**.  
NAA↓ - neuron loss.

\*height of peak reflects concentration of metabolite
- additional peaks (not detectable in MRS of normal brain):
  - 4) lactate – inflammation, infarction.
  - 5) inositol
  - 6) methyl group of lipids
  - 7) GABA, glutamate, glutamine.
- MRS indications:
  - 1) localization of **seizure** focus.
  - 2) diagnose and classify **dementias** (such as Alzheimer's disease).
  - 3) differentiating **tumor recurrence** from **radiation necrosis**. see Onc1 p.

BIBLIOGRAPHY for ch. "Diagnostics" → follow this [LINK >>](#)