

11 - 4. Imaging of the nervous system

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Computed Tomography - CT □ The most widely available scan in clinical practice □ CT scanners effectively take a series of head X-ray pictures from 360 degrees around a patient's head. □ The CT image contrast is determined by the degree to which tissues absorb X-rays. □ Structures close to bone may appear obscured in a CT image e.g. brainstem □ The difference in the attenuation between gray matter and white matter is not very high. □ CT is limited to one plane of rotation - often axial. □ Appreciation of tumours and areas of inflammation is possible by intravenous infusion of iodine-containing contrast agents. Iodinated compounds in the vascular compartment absorb much more irradiation than the brain tissue and so appear bright. □ One feature that is better visualized on CT scanning is calcification, which may be invisible in MRI. □ CT scans and MRI are the most common neuroimaging tools used in psychiatry. The CT is widely available with shorter scan duration at a low cost, but exposure to radiation is a disadvantage. □ CT has poor sensitivity to early ischemia and has poor visualization capacity for posterior fossa lesions.

Magnetic Resonance Imaging - MRI □ MRI does not rely on the absorption of X-rays but is based on nuclear magnetic resonance (NMR) principle. MRI magnets are rated in Tesla (T) units of magnetic field strength. □ The nuclei of all atoms spin about an axis that is randomly oriented in space. When atoms are placed in a magnetic field, the axes of all odd-numbered nuclei (H1 in particular) align with the magnetic field. This axis deviates away from the magnetic field when exposed to a pulse of radiofrequency electromagnetic radiation oriented at 90 or 180 degrees to the magnetic field. When the pulse terminates, the axis of the spinning nucleus realigns itself with the magnetic field, and during this realignment, it emits its own radiofrequency signal. MRI scanners collect these signal emissions. □ The images can be in the axial, coronal, or sagittal planes. □ The rate of the realignment of the H1 axis is determined by its immediate environment and the degree of water content. □ Hydrogen nuclei within fat realign rapidly, and hydrogen nuclei within water realign slowly. □ Routine MRI studies use 2 different radiofrequency (RF) pulse sequences: T1 and T2. □ T1 images:

© SPMM Course □ The RF pulses are brief, and data collection is brief □ Hydrophobic environments are emphasized i.e., fat is bright on T1, and CSF is dark. □ The T1 image most closely resembles that of CT scans and is most useful for assessing overall brain structure. □ T1 is

also the only sequence that allows contrast enhancement with the contrast agent gadolinium-diethylenetriamine pentaacetic acid (gadolinium-DTPA). □ On T1 images, gadolinium-enhanced structures appear white. □ T2 images □ This RF pulse lasts four times as long as T1 pulses, and the collection times are also extended. □ Emphasizes signal from hydrophilic areas i.e. brain tissue is dark, and CSF is white on T2 images. □ Areas of the brain tissue that have abnormally high water content, such as tumors, inflammation, or strokes, appear brighter on T2 images. T2 images reveal brain pathology most clearly. □ The proton density sequence □ A short radio pulse is followed by a prolonged period of data collection, □ Useful to see periventricular structures □ Fluid attenuated inversion recovery (FLAIR) □ The T1 image is inverted and added to the T2 image to double the contrast between gray matter and white matter. □ Very useful for detecting sclerosis of the hippocampus caused by temporal lobe epilepsy and for localizing areas of abnormal metabolism in degenerative neurological disorders. □ MRI scans are contraindicated in patients with pacemakers or implants of ferromagnetic metals. Claustrophobia is a relative contraindication. □ MRI is less useful in emergencies due to limited availability and longer scan duration, in addition to higher costs. But it involves no radiation and can use water soluble Gadolinium for contrast studies. It has good sensitivity for early ischemia with better posterior fossa visualization.

Structures / pathology	CT scan	T1 image	T2 image	Infarct	Dark	Dark	Bright	Bleed (haemorrhage)
Bright	Bright	(unless too old / too fresh)	Bright	(unless too old / too fresh)	Tumour	Dark	Dark	Bright
MS plaque	Dark	Dark	Bright					

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