



Neuroimaging: introduction

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Neuroimaging

- Why?
- By whom?
- How? CT
 MRI
 DSA
 Strategies for interpretation

Neuroimaging - why?

- Diagnosis - treatment decisions including 'leave alone'
- Surveillance/treatment monitoring
- Guide surgery and/or DXT
- Prognosis
- Counselling

Neuroimaging - by whom?

- Radiographers
- Nursing staff - patient care, sedation
- Anaesthetists - GA, sedation
- Physicists - image acquisition, processing
- Neuroradiologists - appropriate technique protocols interpretation
- Clinicians

CT

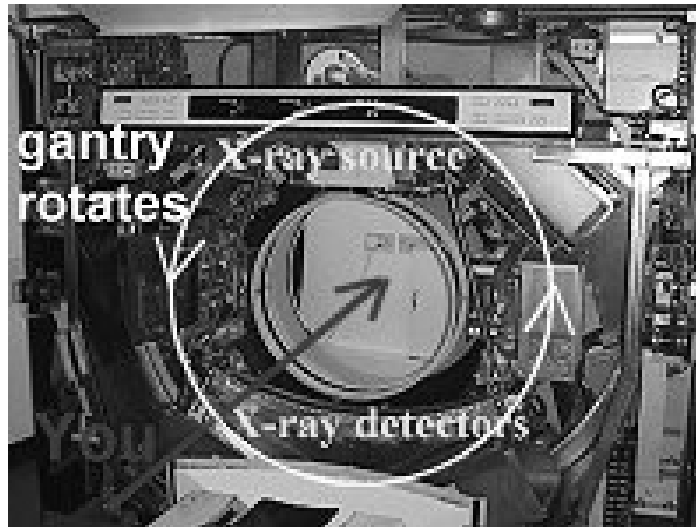
Computed Axial Tomography

- Measures density of tissue by X-ray attenuation (combination of absorption and scatter).
- Slices reconstructed from attenuation measured from different angles.
- Much better soft tissue contrast than plain X-rays and gives 3D information

CT Scanner



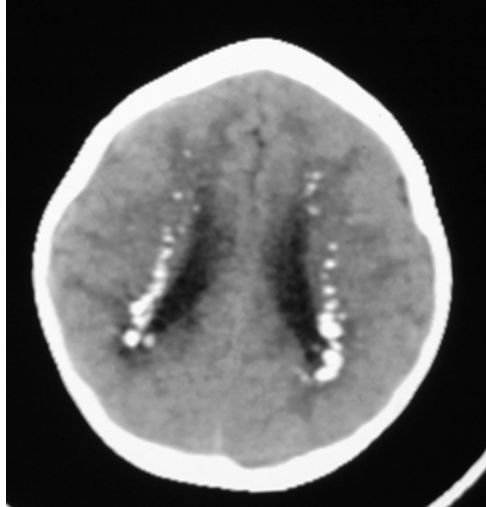
CT scanner - inside



CT good for:

- Bones
- Calcium/blood
- Shunts
- Ventricles
- Orbits
- Middle/inner ear - sclerosis

CT: calcification



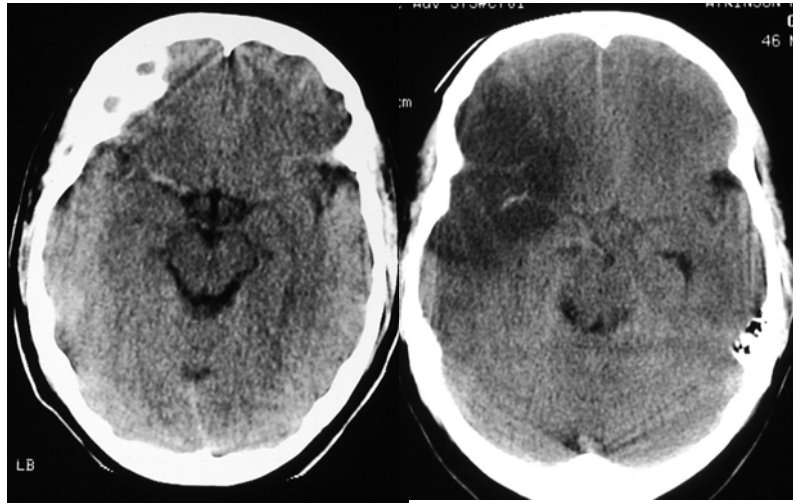
CT: good for



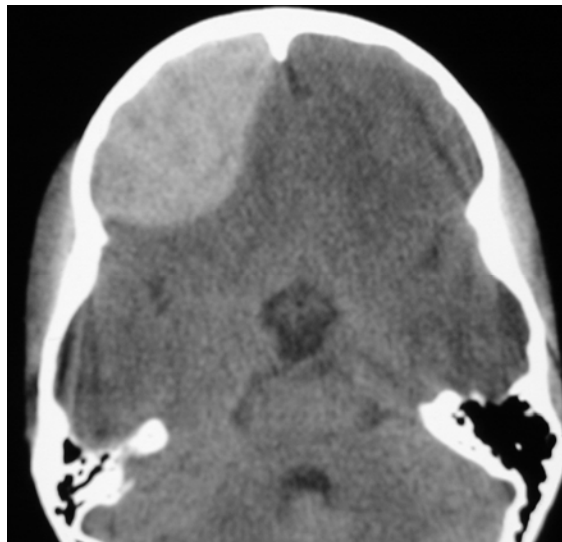
CT ischaemic stroke

day 1

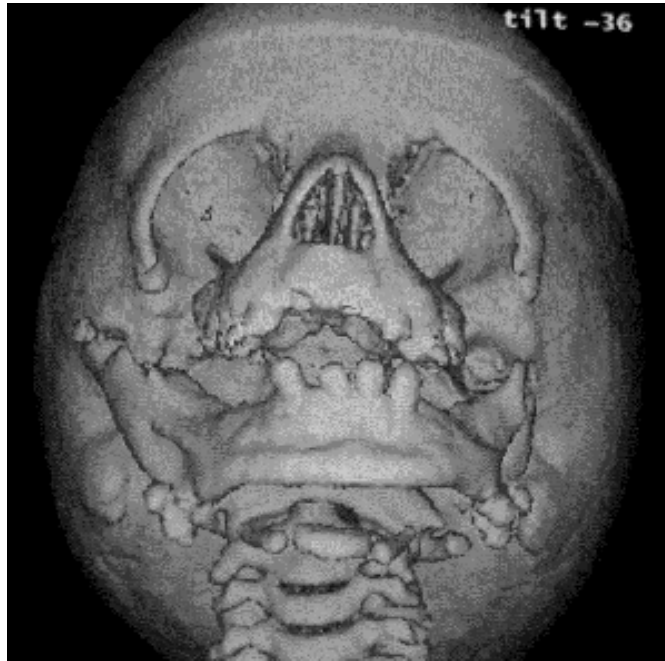
day 5



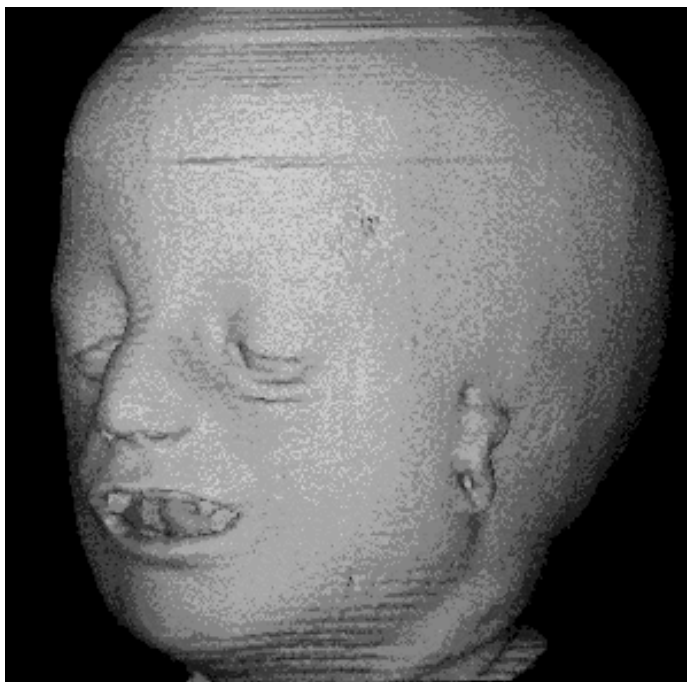
Acute extradural haematoma



CT



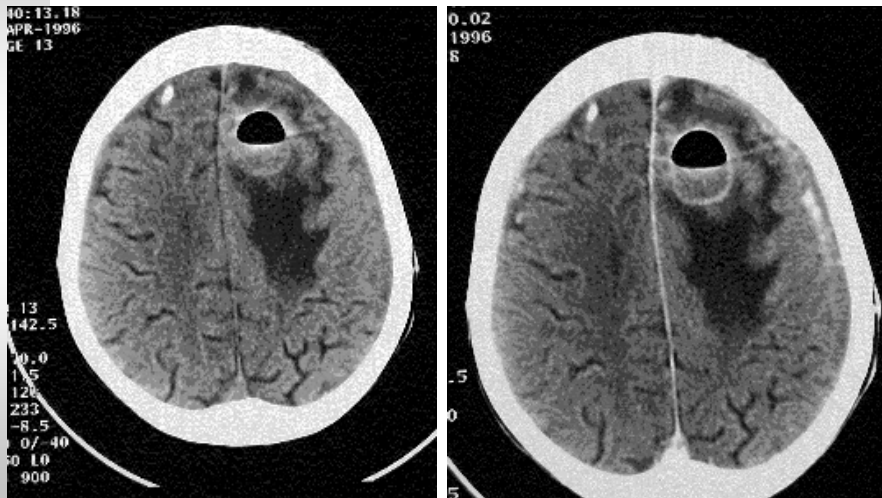
CT



CT: inherent contrast intravenous contrast

- Iodinated compounds – electron dense
- Absorb X-rays: increase CT density
- Where BBB is not intact, enters interstitial space
- Increase tissue contrast

CT - intravenous contrast



CT Pros and Cons

- Bones
- Blood/calcium
- Rapid - sick patients
- Accessible (shorter waiting list)
- Ionising Radiation
- Posterior fossa
- Limited soft tissue contrast - brain parenchyma
- Axial plane (reformat)
- Contrast reactions to iodine (rarely severe)

MRI

- Technique of choice for most neurological imaging
- Increasingly available but high demand means long waiting lists for routine studies

MRI Scanner

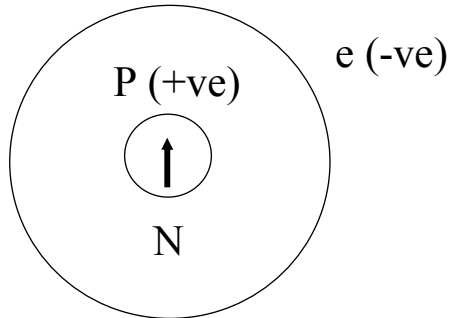
- Noisy
- Claustrophobic
- Difficult Access



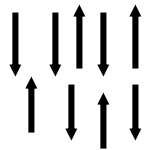
MRI - *Nuclear* Magnetic Resonance Imaging

- Relies on signals from protons (hydrogen nuclei) mostly in water
- Requires a powerful external magnetic field
- Radio waves
- No X-rays

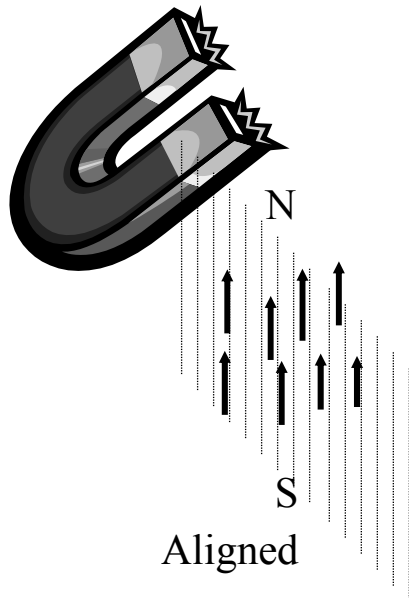
MRI - magnetic properties of the nucleus



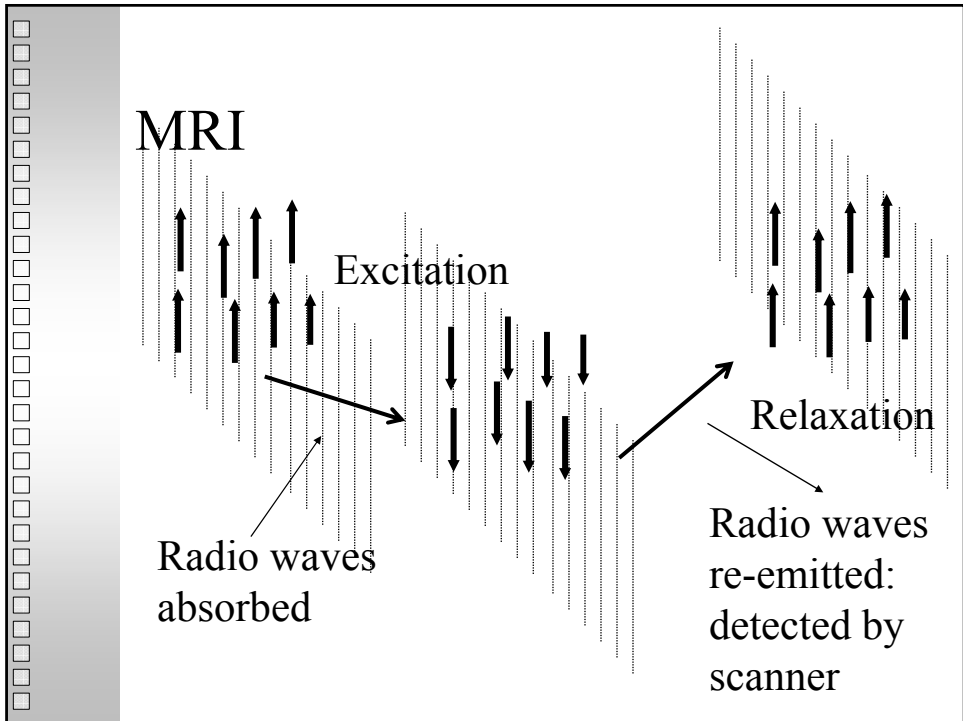
MRI



Random

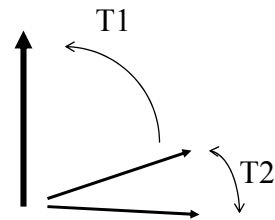


Aligned



Relaxation

- Relaxation by two main processes
- Transverse relaxation: T2
- Longitudinal recovery: T1



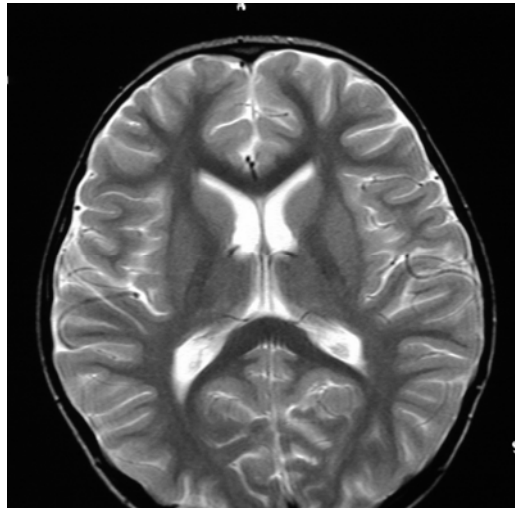
MRI - localisation and weighting

- The relative predominance of T1 and T2 varies between different tissues
- By varying the scanner detection parameters images can emphasize either, hence are:
 - ‘T1 - weighted’ or
 - ‘T2 - weighted’
- Gives tissue contrast
- Localisation - field gradients

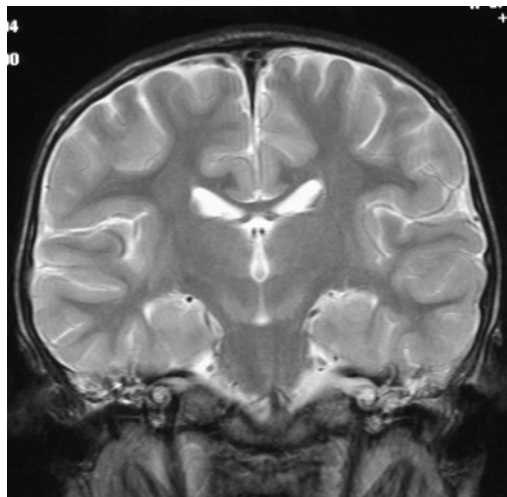
T1 weighted sagittal



T2 weighted axial



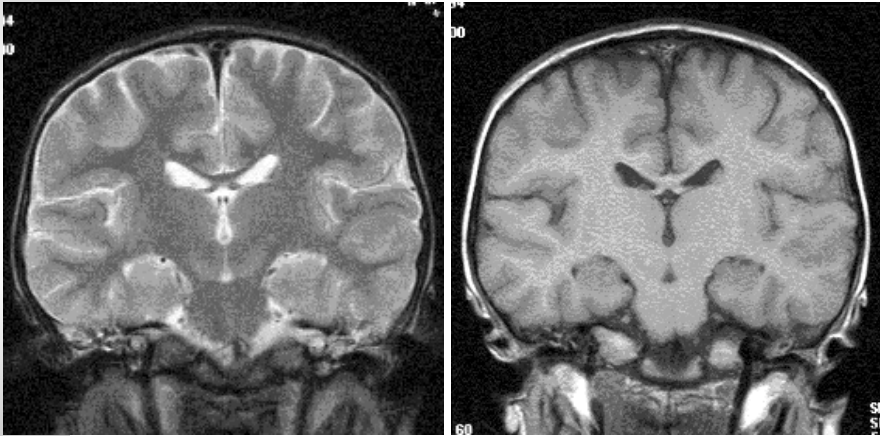
T2 weighted coronal



T2

coronal

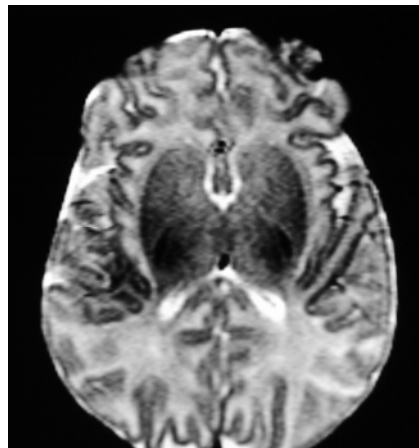
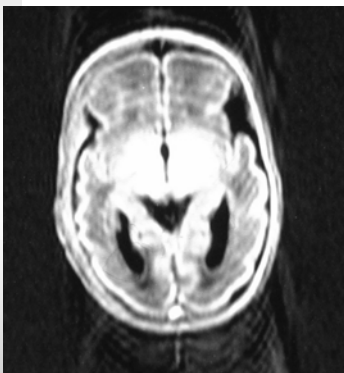
T1



Normal appearances

32/40

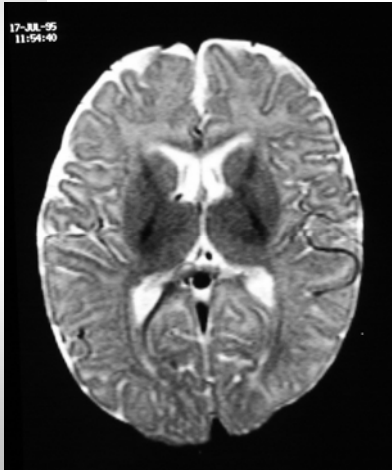
1/12



.....change with age

6/12

18/12



Strategies for Interpretation

- Clinical details
- Know normal appearances
- Pattern recognition
- Number and Location of lesions
- Shape and signal characteristics
- Changes with time
- Conclusion



Clinical Details

- Age
- History
- Clinical examination
- Other relevant investigations
- ‘Clinical question’ being asked



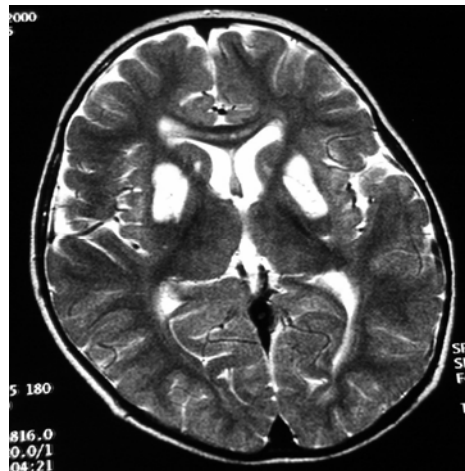
Pattern recognition

- ‘Aunt Minnie’ - you know who she is because you’ve met her many times

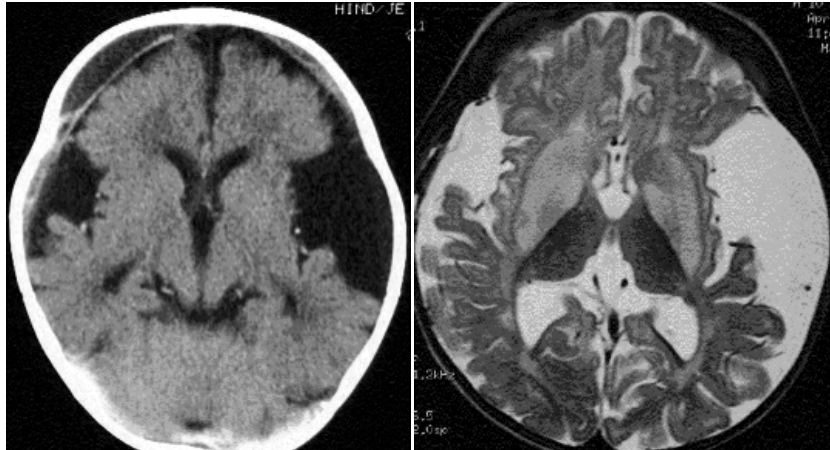
Discriminant features

- Solitary vs multiple; symmetrical?
- Intra-axial vs Extra-axial
- Grey matter/white matter/both
- Signal T1 and T2
- Heterogeneous/homogenous
- Contrast enhancement: damaged BBB?
- Associated features e.g. mass effect, oedema

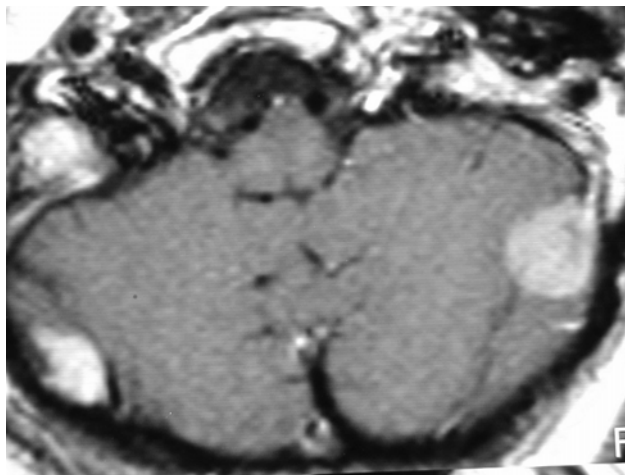
Respiratory chain disorder



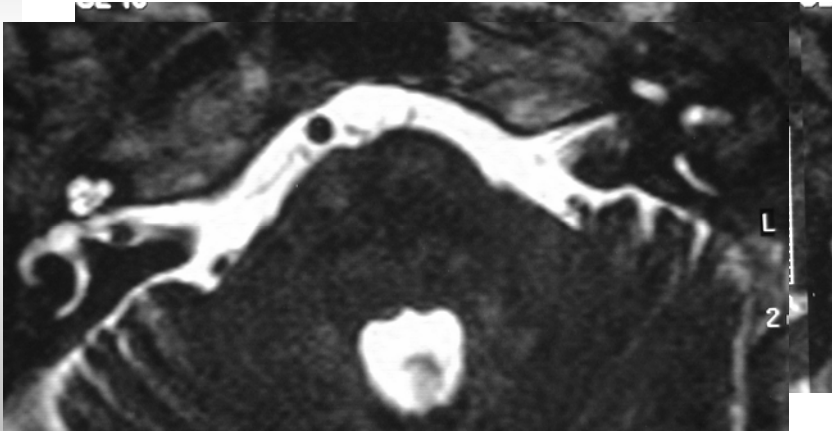
Glutaric aciduria



Extra-axial



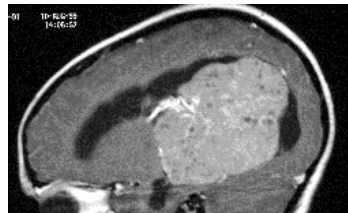
Schwannomas



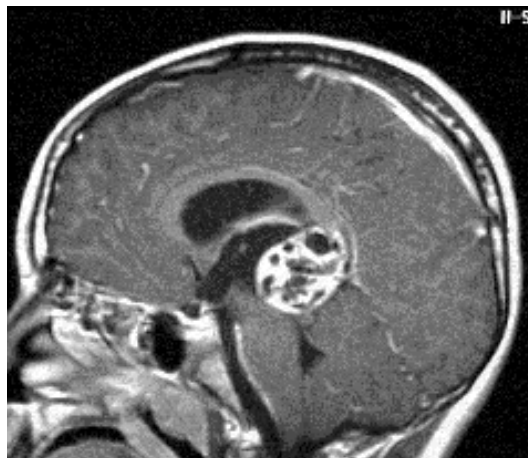
MRI - i.v. contrast agent Gadolinium

- Alters magnetic properties of tissue shortens T1 ('relaxivity') and disturbs local magnetic field ('susceptibility')
- Only diffuses into tissue interstitium when BBB is absent /broken down
- Accumulates in areas of pathology
- Increases tissue contrast (higher signal on T1-weighted images)
- Very safe in form given (renal clearance)

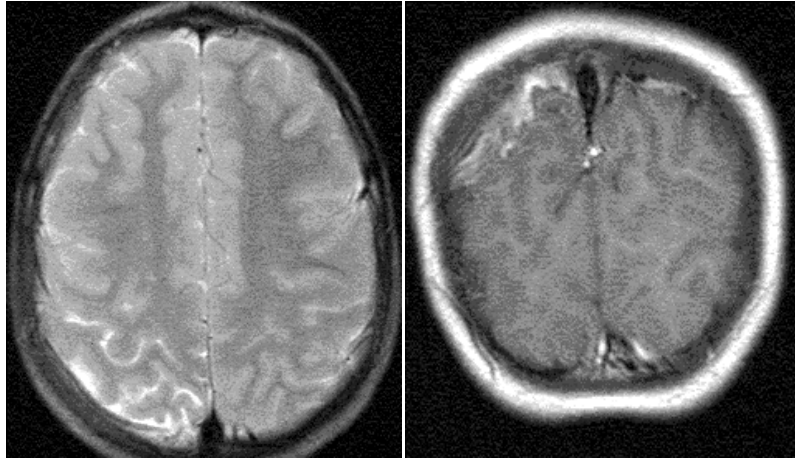
Position



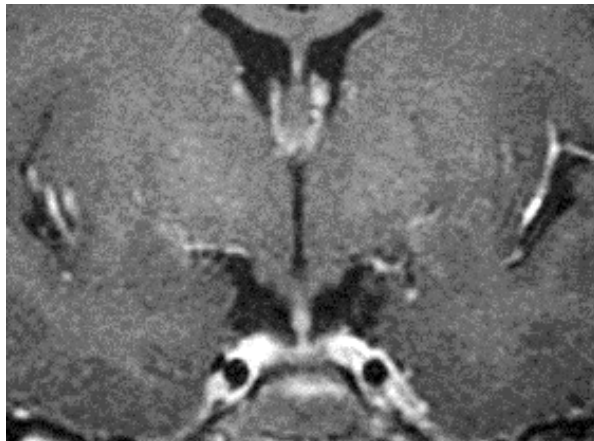
Pineal region teratoma



Pial Angioma - Sturge-Weber



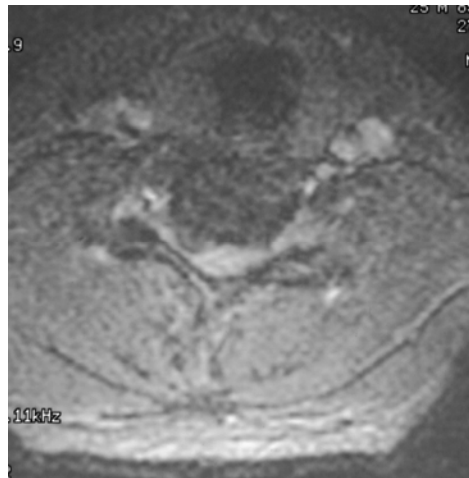
Langerhans Cell Histiocytosis



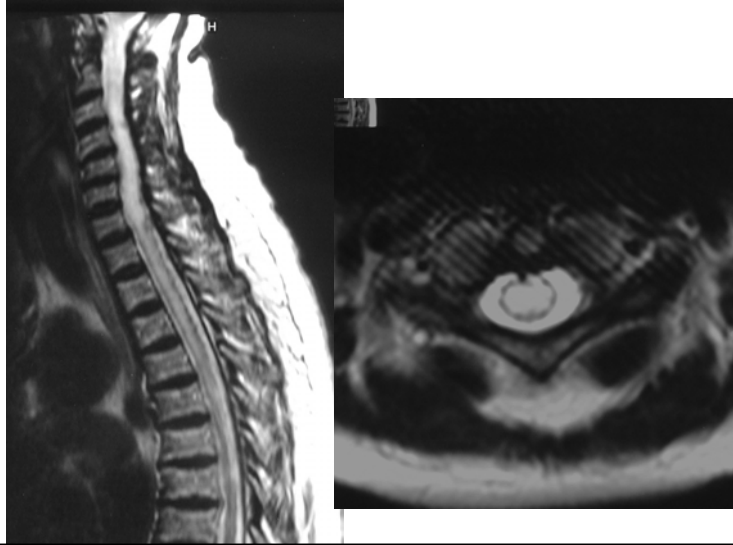
MRI spine

- Cover multiple levels
- Examine spinal cord – external impingement, intrinsic lesions
- Soft tissues

Cervical disc prolapse



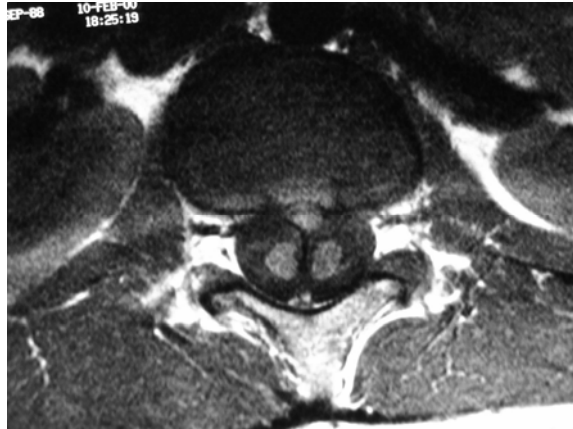
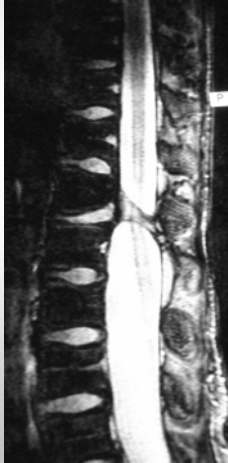
Spinal cord infarct



Spinal cord tumour



Spine: diastematomyelia



MRI

Pros

- Excellent soft tissue detail and contrast in most areas of the neuro-axis
- Varying acquisition sequences yield different information
- Multiplanar imaging
- No ionising radiation

Cons

- Less good for bone/calcification
- Longer scan time
- Access during scan
- Metal artifact
- Contraindications

Other MR Techniques

vascular or physiological information

- MR Arteriography/MR Venography
- MR spectroscopy - *in vivo* biochemistry
- MR Perfusion - local blood flow
- MR Diffusion - local ultrastructure

Diffusion Weighted Imaging (DWI)

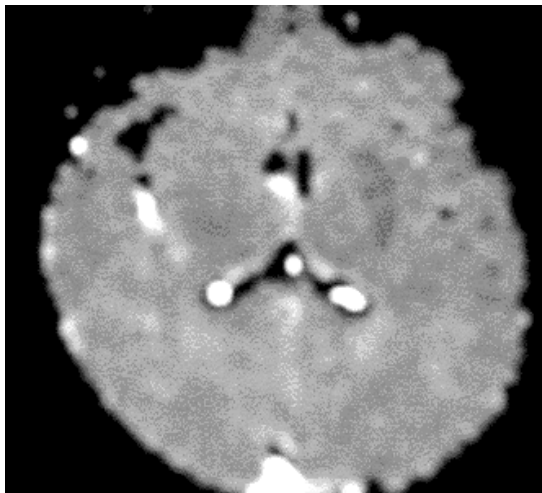
Microscopic random (Brownian) motion of water molecules important for inter- and intra-cellular transport processes

DWI signal intensity depends on freedom of water diffusion - mostly extra-cellular.

DWI - clinical applications

- Acute ischaemic stroke - restricted diffusion due to swelling of dying cells may precede T2-dependent changes
- Distinguishes cytotoxic from vasogenic oedema
- Cellularity in tumours
- Tumours vs abscess
- More sensitive than T2 W

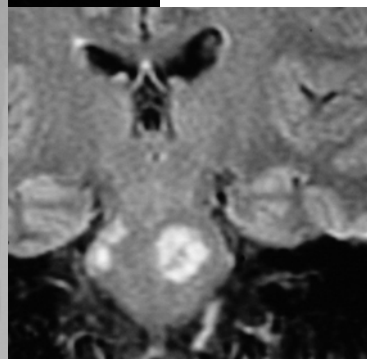
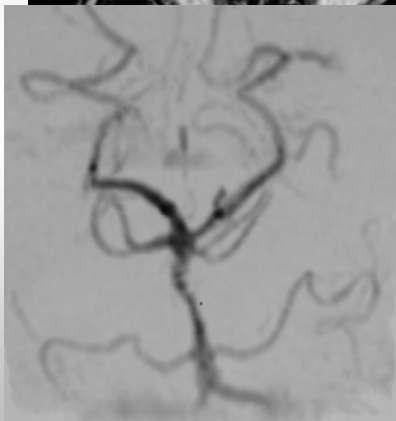
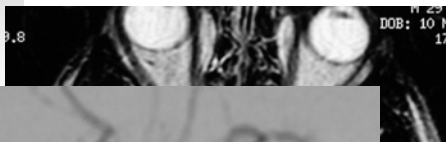
ADC map: acute infarct
left putamen



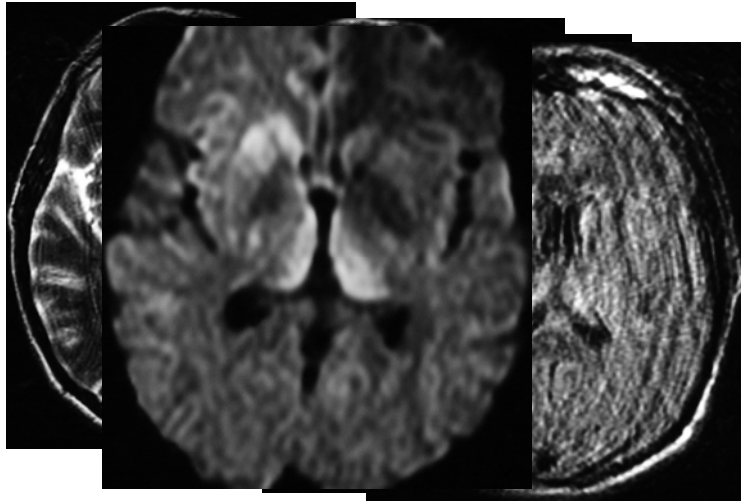
MRA: acute infarct
left putamen



M 30yr sudden right hemiparesis



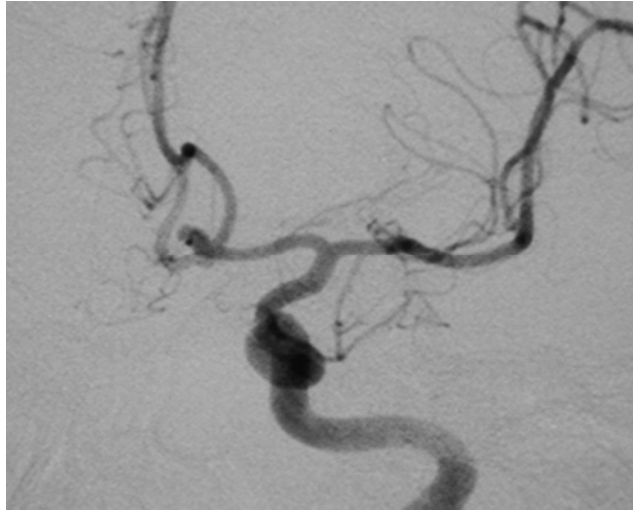
DWI rapid - M 38 yrs dementia



Digital Subtraction Angiography (DSA)

- 'Conventional' arteriography: LA or GA
- Arterial access
- Selective catheterisation of carotid and vertebral arteries
- Inject iodinated contrast agent
- Plain X-rays onto image intensifier
- Digitised mask subtracted from contrast image: bones subtracted away

DSA: 50 yrs F acute SAH



DSA

pros

- Best images of vessels
- Potential for endovascular intervention - coils, glue, stents

cons

- Invasive = risk
- 0.1% stroke risk (25% persistent deficit)
- Contrast reaction
- Haematoma/infection



Report

- Concise
- Conclusion - 'clinical opinion'
- Answer the clinical question (if possible)



Conclusion

- CT, MRI and DSA; advantages and limitations
- Techniques for interpretation

