Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging (MRI) is a **non-invasive medical imaging technique** that provides high-resolution images of internal body structures, especially **soft tissues** such as the brain, spinal cord, muscles, and internal organs.

Physical Principles

MRI is based on the following components:

- A **strong magnetic field** aligns hydrogen nuclei (protons) in the body.
- **Radiofrequency (RF) pulses** disturb this alignment.
- As protons return to their original alignment, they emit signals.
- These signals are detected and processed into detailed images.

Advantages

- No ionizing radiation.
- Excellent soft tissue contrast.
- Multiplanar capabilities (axial, sagittal, coronal, oblique).
- Functional and contrast-enhanced imaging options.

Common Clinical Uses

- **Neurology**: stroke, tumors, multiple sclerosis, epilepsy, trauma
- **Spine**: disc herniation, myelopathy, spinal tumors
- **Musculoskeletal**: ligament/tendon injuries, joint disorders
- **Cardiology**: myocardial viability, congenital heart disease
- **Oncology**: tumor detection, staging, and follow-up
- **Abdominal imaging**: liver, kidneys, uterus, prostate, pancreas

Contrast Agents

- Gadolinium-based agents are used to enhance vascular structures and highlight pathology.
- Usually safe, but used cautiously in patients with severe renal impairment (due to risk of nephrogenic systemic fibrosis).

Limitations and Contraindications

- **Metallic implants**, **pacemakers**, or **ferromagnetic fragments** may pose risks.
- **Claustrophobia** may require sedation or use of open MRI systems.
- Long acquisition times compared to CT.

Variants

- fMRI (Functional MRI)
- MR angiography (MRA)
- Diffusion-weighted imaging (DWI)
- Perfusion MRI
- MR spectroscopy (MRS)

See also:

- Computed Tomography (CT)
- Positron Emission Tomography (PET)
- Neuroimaging techniques