Lecture 3

Magnetic Resonance Imaging (MRI)

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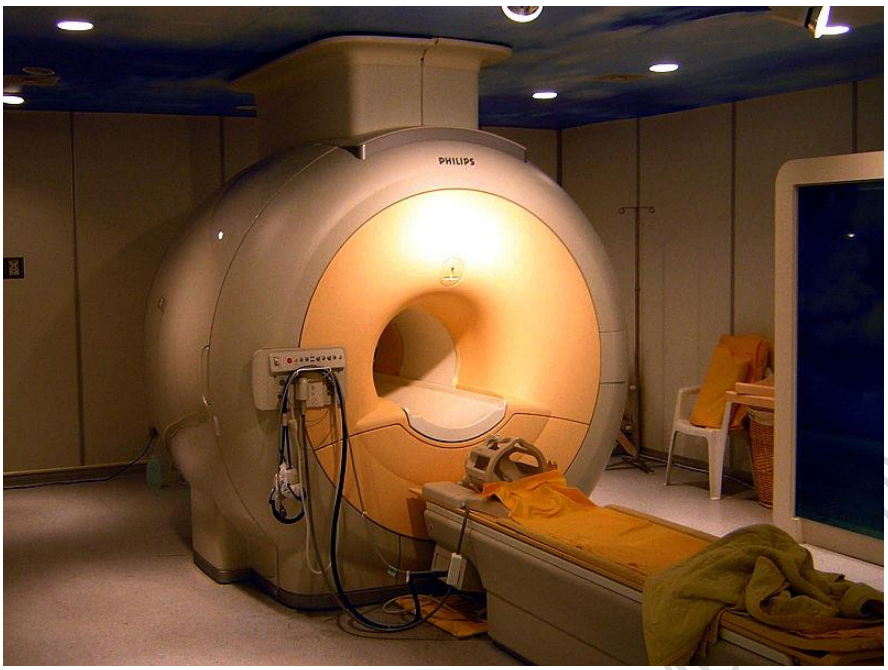
Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body. MRI scanners use strong magnetic fields, magnetic field gradients, and radio waves to generate images of the organs in the body. MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT and PET scans. MRI is a medical application of nuclear magnetic resonance (NMR) which can also be used for imaging in other NMR applications, such as NMR spectroscopy.

MRI is widely used in hospitals and clinics for medical diagnosis, staging, and follow-up of the disease. Compared to CT, MRI provides better contrast in images of soft tissues, e.g. in the brain or abdomen .

MRI was originally called NMRI (nuclear magnetic resonance imaging), but "nuclear" was dropped to avoid negative associations Certain atomic nuclei are able to absorb radio frequency energy when placed in an external magnetic field; the resultant evolving spin polarization can induce an RF signal in a radiofrequency coil and thereby be detected. In clinical and research MRI, hydrogen atoms are most often used to generate a macroscopic polarization that is detected by antennae close to the subject being examined. Hydrogen atoms are naturally abundant in humans and other biological organisms, particularly in water and fat. For this reason, most MRI scans essentially map the location of water and fat in the body. Pulses of radio waves excite the nuclear spin energy transition, and magnetic field gradients localize the polarization in space. By varying the parameters of the pulse sequence, different contrasts may be generated between tissues based on the relaxation properties of the hydrogen atoms therein. Computed Tomography (CT) Scan Work.



MRI machine

Real-time MRI

Real-time MRI refers to the continuous imaging of moving objects (such as the heart) in real-time. This gives a temporal resolution of 20–30 ms for images with an in-plane resolution of 1.5–2.0 mm. Real-time MRI is likely to add important information on diseases of the heart and the joints, and in many cases may make MRI examinations easier and more comfortable for patients, especially for patients who cannot hold their breathing or who have an arrhythmia.

- Physically, it depends on magnetic fields (or magnetic field) and radio waves.
- The idea of magnetic resonance depends on stimulating the protons in the atoms of the elements present in the body to emit a signal, and then capturing it, determining its location in the body.
- The most stimulating element is hydrogen, due to its abundant presence in living bodies and the presence of one proton in the atomic nucleus.

Interventional MRI

The lack of harmful effects on the patient and the operator make MRI well-suited for interventional radiology, where the images produced by an MRI scanner guide minimally invasive procedures. Such procedures use no ferromagnetic instruments. A specialized growing subset of interventional MRI is intraoperative MRI, in which an MRI is used in surgery. Some specialized MRI systems allow imaging concurrent with the surgical procedure. More typically, the surgical procedure is temporarily interrupted so that MRI can assess the success of the procedure or guide subsequent surgical work.

Uses of Computed Tomography (CT) Scan

1-Anomalies of the brain and spinal cord 2-Tumors, cysts, and other anomalies in various parts of the body 3-Breast cancer screening for women who face a high risk of breast cancer 4-Injuries or abnormalities of the joints, such as the back and knee 5-Certain types of heart problems 6-Diseases of the liver and other abdominal organs 7-The evaluation of pelvic pain in women, with causes including fibroids and endometriosis 8-Suspected uterine anomalies in women undergoing evaluation for infertility

MRI Contrast Agent

Gadolinium-based contrast agents:

paramagnetic Gadolinium (III)-based contrast agents are categorized into three groups: extracellular fluid (ECF) agents, blood pool contrast agents (BPCAs) and organ-specific agents.

Manganese-based contrast agents: paramagnetic

Manganese, in the form of manganese chelates or manganese-based nanoparticles, is used as a contrast agent. Manganese chelates, including manganese dipyridoxyl diphosphate (Mn-DPDP), markedly enhance the T1 signal intensity, and has been used to detect hepatic lesions. In the human body, the chelate dissociates into manganese and DPDP. Manganese is taken up by the liver cells and excreted into the bile, whereas the DPDP component is excreted by the kidneys.

NOTE:

It is extremely rare that a patient will experience side effects from an MRI scan. However, the contrast dye can cause nausea, headaches, and pain or burn at the point of injection in some people. Allergy to the contrast material is also seldom seen but possible and can cause hives or itchy eyes. People who experience claustrophobia or feel uncomfortable in enclosed spaces sometimes express difficulties with undergoing an MRI scan

1. …… is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body.

A- MRL B- MRI C- MIR D- nothing E-All of them

2. MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT and ……..scans

A- PET B- PTE C-TPE D- ETP E-PPT

3. MRI provides better contrast in images of soft tissues, e.g. in ……

A- the brain B- the hair C- Arteries D- Veins E- All of them

4. In clinical and research MRI, …… atoms are most often used to generate a macroscopic polarization that is detected by antennae close to the subject being examined.

A- Nitrogen B- HELIUM C- hydrogen D- Oxygen E- nothing

5. Real-time MRI of a human heart at a resolution of ……:

A- 50 ms B-150 ms C- 250 ms D- 100 ms E-200 ms

6. The DPDP component is excreted by the ……..:

A- Small intestine B- gut C- kidneys D- the bile E- nothing

7. One of the classifications of contrast agents based on gadolinium (III):……

A- EFC B- CEF C- ECF D-FEC E-FCE