Al-Mustaqbal University
College of Health and Medical Technologies
Radiological Techniques Department

Magnetic Resonance Imaging

First Semester

Lecture 10, 11 : MRI safety, Preparation and contrast agent

2025/2024

Introduction:

MRI is a **valuable diagnostic tool, and safety measures are in place to ensure the well-being of patients and staff. Communication between patients and healthcare providers, as well as adherence to safety protocols, are essential for a safe MRI experience.** Patients with concerns about MRI safety should discuss them with their healthcare team to address any specific risks or considerations.

Scientific Content:

•Patient preparation and safety:

1. Identity: - Prior to any examination being performed, **the identity of the patient must be checked by the technologist.** Patients arriving into MRI department are often **worried or apprehensive** and this may make it difficult for them to understand the instructions or may produce an **apparently aggressive attitude**. In such cases, the technologist should convince amicably and soft tone of voice often do a great deal of comfort and gives the patient confidence that he is in an efficient hand. The technologist should make every effort to obtain the willing cooperation of the patient consent. **Children and uncooperative patients should be sedated before examination.**

2. Before entering the equipment room, **the patient must wear a hospital gown and should remove all personal possessions such as watch, wallet, keys, hair pins, jewels, coils, removable dental bridge work etc.** Even credit cards and cell phones must be secured as the scanner will erase the information on them.

3. **Wheelchair and trolleys must always be kept outside the magnet room.**

4. The patient is made to lie down on a table. This **table then passes through a tunnel within the equipment**. Inside the tunnel, it is quite noisy when the scanning is going on. **The region of interest is positioned at the center of the magnet**. The patient can hear the voice of the radiologist or technologist and can respond. While the patient lies within the tunnel, **images of the interested regions are taken from different angles**. These images can be seen on a computer screen. The entire procedure takes 30 to 40 min approximately depending upon the strength of the magnetic field and the parameters set on. **It is most important that the patient should remain relaxed and completely still during the scan**. The patient can resume the routine activities after getting the scan done.

5. **The patient should always be informed as to what is going to happen and what he expected to do,** so that he can cooperate as much as possible.

6.**The patient should attend without any makeup because some products may contain metallic particles.**

7.**The patient must be made comfortable as far as possible** because if the patient is in pain or in distress, it is unlikely that he will be able to remain still for long

8. **Clear instructions regarding breathing or swallowing** should be given and **rehearsed** to ensure that the patient does hold his breath or swallow when required to do so.

9. Due to the high magnetic field strengths used during MRI examination, **certain patients are unsuitable for imaging. These include patients who have:** -

A- Aneurysm clips (older ferromagnetic types).

B- Cardiac pacemakers.

C- Patients with otologic implants and ocular implants.

D- Cochlear implants.

E- Metallic foreign bodies, esp. within the eye.

- Precautions:

1. **Always screen the patient and accompanying person for any metallic objects.** Metallic objects can form projectile because of strong magnetic attraction. This can lead to life threatening consequences.
2. **Always see to it that wires and coils are well insulated and are not touching patient's body.** It can cause burns. Patient's body part should also not be touching magnet bore.
3. **Avoid loop formation: Wires of pulse oximeter, ECG leads, etc. should never form a loop.** Loop formation can lead to induction of current and burns. Even loop formation of body parts for example crossed arms or legs can form a large conductive loop and can result into induction of current.
4. In case of emergency first approach must be to remove the patient out of scanner room as early as possible and start resuscitation.
5. Doors of scanner room should have label with pictures of object that are prohibited to take inside scanner room.

Effects of RF power: -

The RF pulses used in MR causes tissues to absorb RF power under certain conditions. **This may cause tissue heating**. The amount of heating depends on several factors such as **patient size and pulse sequence timing**.

-Before the patient is being scanned, the computer estimates the level of heating and compare it to the predetermined exposure limits. If the scan exceeds these limits, **the system then adjusts the scan parameters before starting the scan.** The complete estimate is based partially on **patient weight.** Therefore, **take care to enter the patient's weight correctly to prevent excessive RF.**

Claustrophobia and sedation: -

Claustrophobia and sedation: - Although not thought of as a main safety issue, **patient anxiety and claustrophobia** (specifically the fear of enclosed spaces) may be sufficient in some instances to prevent the completion of the scan.

- Published figures for the percentage of aborted scans in these situations vary widely from 1 to 20%. Undoubtedly, **the type of scan (e.g., used of head coil) and the method of entry (head or feet first) makes a significant difference.** **Methods to improve patient comfort, not only to alleviate stress but also to minimize movement**, include bore lighting, ventilation, and head coil mirrors to maintain visible contact with Saff outside the scanner.

Emergency preparedness: -

MRI facilities have emergency procedures in place in case of accidents. This includes **protocols for dealing** with metal objects accidentally brought into the MRI room and for responding to medical emergencies that may occur during the scan.

Pregnancy and MRI: -

While there is no known harm to the fetus from the MRI magnetic field or radio waves, **MRI during the first trimester is generally avoided unless medically necessary.** Pregnant patients should inform their healthcare providers and MRI technologists before the scan.

Acoustic noise:

It is **a consequence of the force exerted on the gradient coils due to the rapidly varying current within them in the presence of the main field**. The frequency of the current is such that the coils vibrate against their surroundings and produce noise at an acoustic level. **This noise, which increases with field strength and varies considerably with the type of sequence being used**, is sufficient to warrant ear protection for all patients.

Quenching: -

A magnet quench will result **in several days of down time**. So, do not press or push the button except in a **real emergency**. Do not test that button. It should be tested only by qualified service personnel.

Quench button is **located near the magnet**. If the patient needs medical attention, press an emergency stop button on the consol or magnet and remove the patient from the scan room.

• Note: MRI systems are equipped with **laser alignment lights**. **Exposing eyes to the laser alignment lights may result in eye injury.** Do not stare directly into the laser beam. Instruct the patients to close their eyes during land marking in order to avoid eye exposure to the alignment light while the laser light is "ON". Do not leave the laser beam ON after you position the patient.

Contrast agents and kidney function: -

Gadolinium-based **contrast agents** are sometimes used in **MRI to enhance the visibility of certain tissues.** These agents are **generally safe**, but they can pose a risk to individuals with **impaired kidney function**. Patients with kidney problems should closely monitored and may need to undergo alternative imaging tests.

•Contrast media:

Depending on relaxivity, MR contrast media classified into:

A- Positive relaxation agents (T1 agents) **These agents affect T1 relaxation of the tissues.** T1 of the tissue in which contrast media is accumulated is reduced. Reduction in T1 results into increase in the signal intensity on T1-W images hence these agents are called **positive relaxation agents like Gadolinium.**

B- Negative relaxation agents (T2 agents) They affect T2 relaxation and reduce T2 of the tissue where they accumulate. This results in reduction in the signal intensity of the tissue on T2-W images and is called **negative relaxation agents like Iron oxide.**

•Gadolinium: - (Gd) is a paramagnetic agent. It has a large magnetic moment and when it used the T1 relaxation times of nearby water protons are therefore reduced, **resulting in an increased signal intensity on T1WI**. For this reason, Gd is known as T1 enhancement agent.

- Gadolinium is a rare-earth metal that **cannot be excreted** by the body and would cause long term side effects, as it binds to membranes.

- Side effects: -

1- A slight transitory increase in bilirubin and blood iron.

2- Mild transitory headaches.

3- Nausea.

4- Vomiting.

5- Hypotension.

6- Gastro-intestinal upset.

7- Rash.

-Contra-indications: -

1- Hematological disorders.

2- Sickle cell anemia.

3- Pregnancy.

Administration: -

The effective dosage of Gd is 0.1 millimole (mmol) per kilogram (kg) of body weight (mmol/kg), approximately 0.2ml/kg.

•Clinical applications: -

Gadolinium has proven very useful in imaging the CNS because of its ability to pass through breakdown in the blood-brain barrier (BBB). Clinical indications for Gd include: -

1- Tumors pre- and post-surgery.

2- Pre and post radiotherapy.

3- Infection.

4- Infarction.

5- Inflammation.

6- Post-traumatic lesions.

7- Post- operation lumbar disc.

8- Breast disease.

9- Prostatic disease.

•Iron oxide: - It shorten relaxation times of nearby hydrogen atoms and therefore reduce the signal intensity in normal tissues. This result in a signal loss on proton density or heavily T2WI. **Super-paramagnetic iron oxides** are known as T2 enhancement agent.

•Side effects: -

1- Mild to severe back, leg and groin pain is experienced and, in a few cases, head and neck pain.

2- Patient experience digestive side-effects including nausea, vomiting and diarrhea.

3- Anaphylactic like reactions and hypotension have been reported in a few patients.

- Contra-indications: -

1-Contra-indicated in patients with known allergies/hypersensitivity to iron.

2-Since the infusion is dark in color, skin surrounding the infusion site might discolor if there is extravasation.

Administration: -

The recommended dose of iron oxide is 0.56 mg of iron per kg of body weight. If using Feridex dilute in 100 ml of 50% dextrose and give I.V. over 30min.

- Clinical applications: -

This is mainly used in **liver imaging where normal liver is dark on T2WI and lesions appear bright.**

•Other contrast agents: -

Gastrointestinal contrast agents are sometimes used for bowel enhancement. These include **barium, ferromagnetic agents and fatty substances**. However, due to constant peristalsis, these agents enhance bowel motion artifacts more often than enhancing pathologic lesions. The use of anti-spasmodic agents helps to retread peristalsis to decrease these artifacts. Other agents include **helium** which is inhaled and assists in the evaluation of **lung perfusion.**