



مبادئ التصوير بالرنين المغناطيسي

MRI MACHINES AND ROLE OF TECHNOLOGIST

Sawa University

جامعة ساوة الاهلية

College of health and medical techniques

كلية التقنيات الصحية والطبية

Department of Radiology Tech.

قسم تقنيات الاشعة والسونار

. Fourth Stage

.المرحلة الرابعة

محاضرة رقم واحد

الجانب النظري

Lecture No. one

Theoretical

تدريسي المادة : م.م فاضل عوفي عواد

INTRODUCTION TO MRI

- Magnetic Resonance Imaging (MRI) is a non-invasive imaging technique.
- - Uses strong magnetic fields and radio waves.
- - Provides detailed images of soft tissues.
- - Key components: Magnet, gradient coils, radiofrequency coils, computer.

Introduction: :

MRI technicians' students need to understand MRI concepts for several reasons, including:

- Performing MRI exams: MRI technicians need to have a thorough understanding of the physical principles of MRI and the general concepts of image contrast.**

MRI technicians need to understand MRI concepts to perform MRI exams effectively, ensure MRI safety, interpret MRI results accurately, and keep up- to date with MRI technology.

MRI concepts can be learned to the student through MRI technology theoretical and practical lectures, continuing education courses. It is important for MRI technician students to stay up-to-date with the latest MRI technology and concepts to provide the best possible care for their patients in the future.

Scientific Content:

•MRI components

Scanners of MRI come in many varieties. The most important hardware within MRI system are as follows (fig 1):

1.A large magnet to generate the magnetic field. The static magnetic field in MRI system can be created by:

A- Permanent magnets, or B- Electromagnets.

2. Shim coils to make the magnetic field as homogeneous as possible.

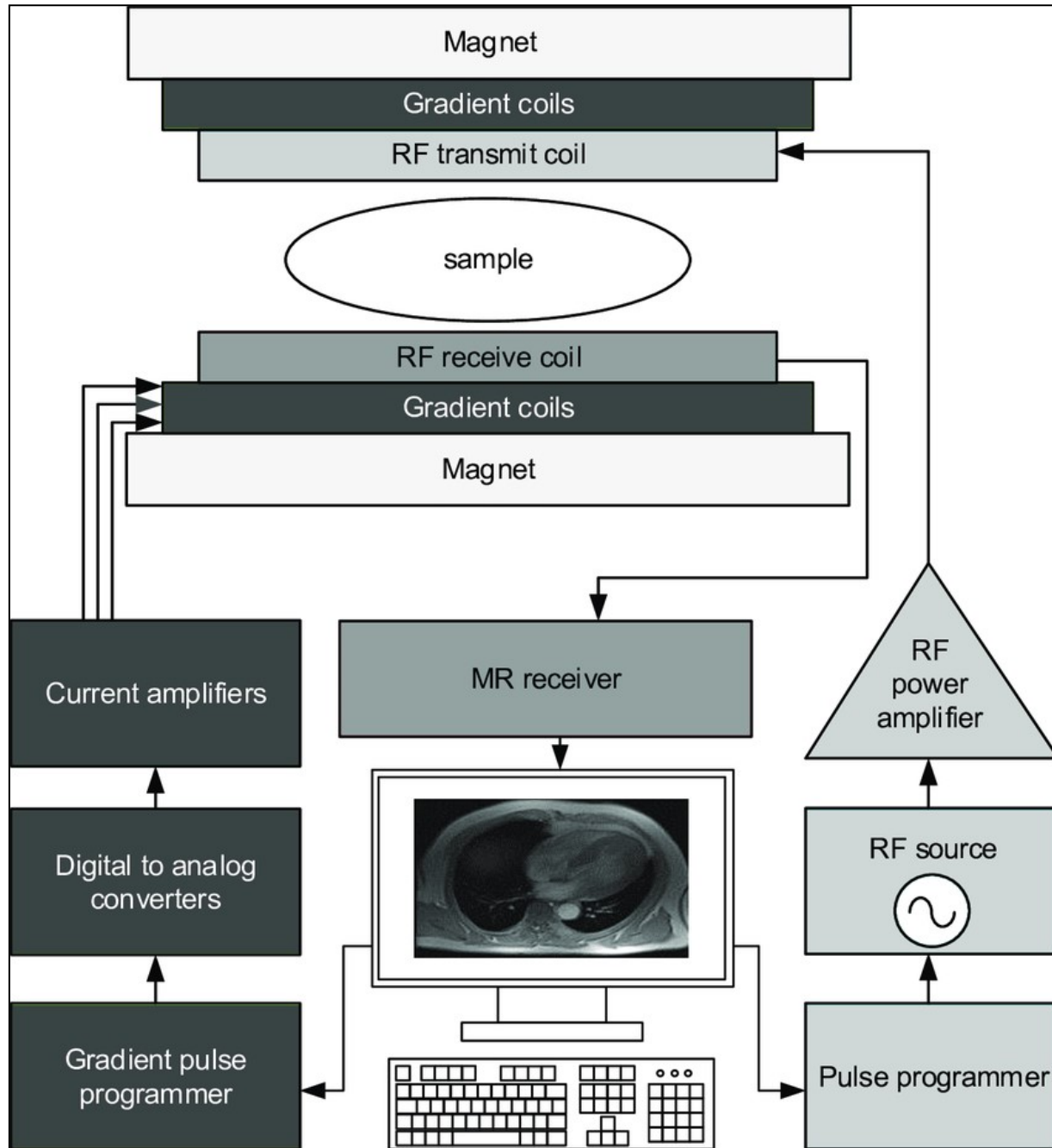
3. A radiofrequency (RF) coil to transmit a radio signal into the body part being imaged.

4. A receiver coil to detect the returning radio signals.

5. Gradient coils to provide spatial localization of the signals.

6. A computer to reconstruct the radio signals into the final image.

Q/What are the most important hardware within MRI system



Patient preparation and safety:

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

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

- 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 strictly prohibited to take inside scanner room .

- **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.**

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



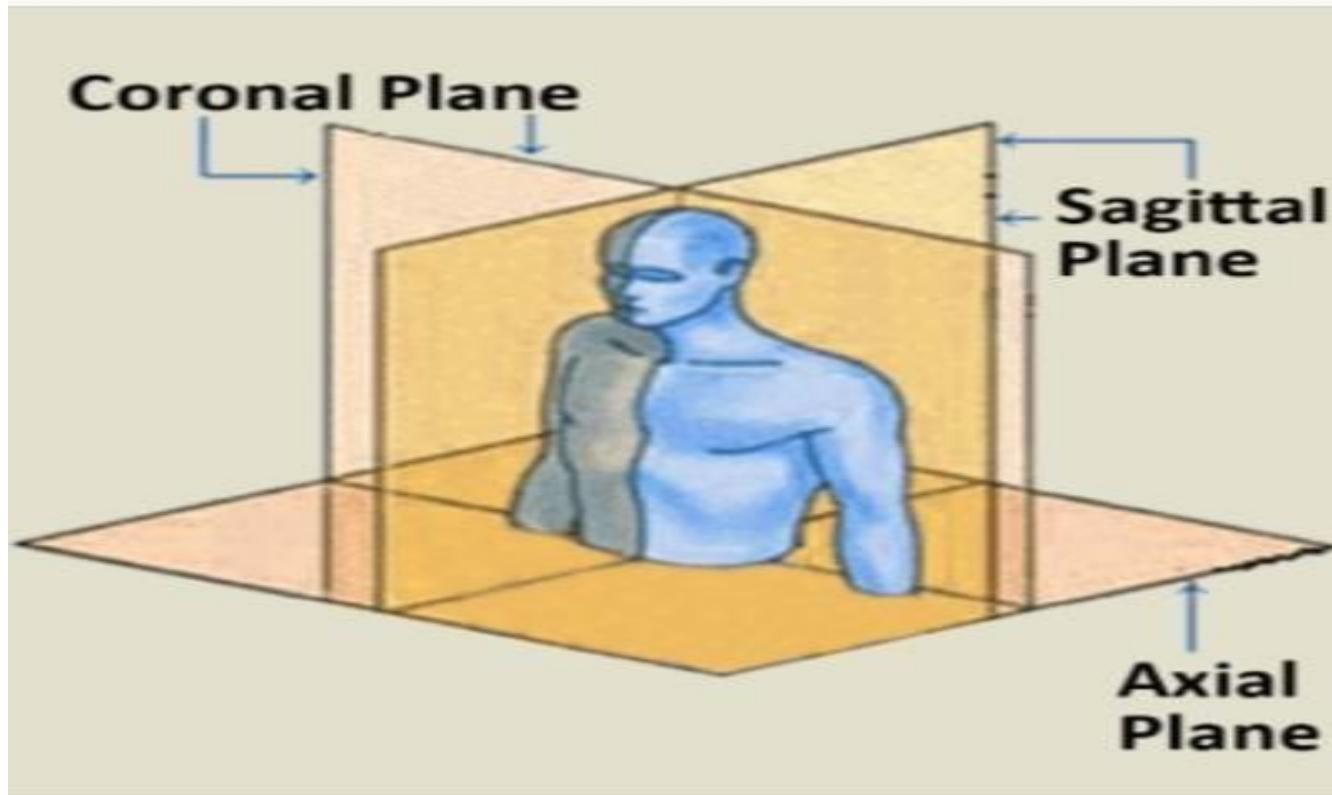


Fig.3: Axial, sagittal, and coronal plane.

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.

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

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. □

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 □

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 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. Leave the scan room.

QUIZ

Pretest:

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Q/What are the most important hardware within MRI system

TYPES OF MRI MACHINES

Illustrations & Comparisons

- 3T Wide Bore MRI
- A 3T machine has a greater signal strength than other MRI machines, in fact, it is the greatest strength an MRI machine can have. 3T MRI scanners create extremely clear and vivid images that can be completed quicker. 3T MRIs are ideal for imaging small bones, breast tissue, musculoskeletal structures, the brain and spine, and vascular flow. While the 3T MRI is great for these fine-detail things, it does have a higher likelihood of artifact — capturing images that are not there — caused by movement, due to the speed and intensity of the imaging.

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- 1.5T Wide Bore MRI
- As we discussed above, the teslas refer to magnetic strength, so a 1.5T has half that of a 3T MRI machine. 1.5 T MRIs are great for visualizing the brain or abdomen, where artifact is more likely to occur on a 3T. For those who have implanted devices — joints, pacemakers, stents, etc. — or other metal in their body, including bullets or shrapnel, the 1.5 is a much safer option. Some people assume, based on the numbers, that the 1.5T is inferior to the 3T, but both are great machines, offering diagnostic images that can make all the difference in treatment and outcome.

- Highfield Open MRI
- A Highfield MRI, like its name implies, is a higher-powered magnetic field in a somewhat more open MRI than the traditional machines. This makes it ideal for patients who are claustrophobic or cannot be accommodated by closed-bore MRI machines but require a higher tesla than what is offered by a truly open MRI. It is considered an open MRI because instead of being a long tube that is closed on one end, it is open on both ends — more reminiscent of a CT scanner — and is flared on the sides to increase the tesla power. The bore exists on all four sides but is much more open. As you can imagine, this does not allow for as high of a magnetic field as that of wide-bore traditional machines, and can only get up to 1.2T. The images produced are still great quality and detailed, allowing your physician to make an accurate diagnosis.

- Open MRI
- An open MRI machine offers the best option for those who are truly claustrophobic and for larger patients who cannot be accommodated by other bores. Options include upright or lying. The machine has two sides that sandwich the patient in the middle rather than closing them in — more similar to an x-ray machine. Because it does not have four sides, the tesla rating is much lower, usually 0.5 to 0.6T. While open MRI machines are more advanced, they may not offer the same detail as closed scanners and can take more time to produce images. The benefits of an open MRI is more open space, which means it can accommodate more body types. An open MRI machine is great for both patient and physician, however, some conditions may require closed MRI to be used, in which case a Highfield MRI may be better suited.

CLOSED MRI (CONVENTIONAL)

- - Tunnel-like bore design.
- - Strong magnetic fields (1.5T–3T).
- - High image quality.
- - Limitation: Claustrophobia and patient discomfort.

OPEN MRI

- - Open sides with top & bottom magnets.
- - Comfortable for claustrophobic or obese patients.
- - Limitation: Lower magnetic field strength and resolution.

WIDE-BORE / SHORT-BORE MRI

- - Wider opening compared to closed MRI.
- - Compromise between comfort and imaging strength.
- - Suitable for larger patients.

PORTABLE / LOW-FIELD MRI

- - Compact, mobile MRI units.
- - Field strength often $<0.1\text{T}$.
- - Useful in ICU and emergency settings.
- - Limitation: Low resolution.

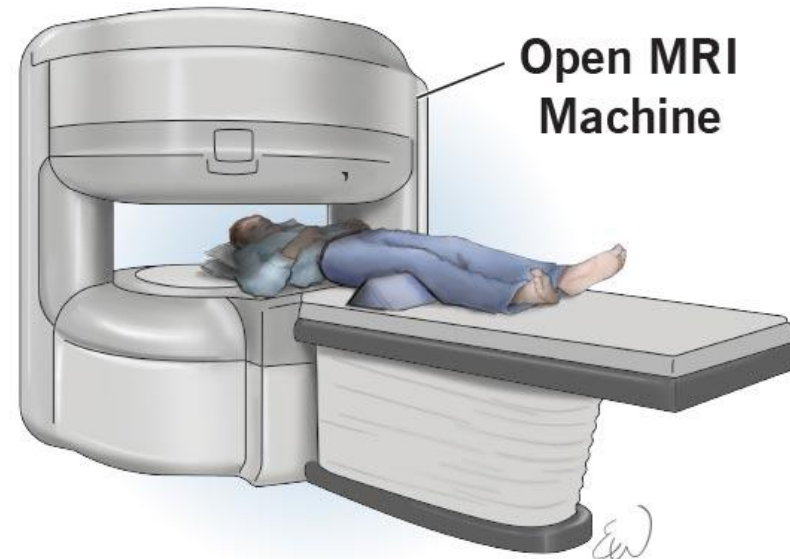
SPECIALIZED MRI TECHNIQUES

- - Functional MRI (fMRI): Brain activity mapping.
- - Diffusion Tensor Imaging (DTI): White matter tracts.
- - MR Spectroscopy (MRS): Chemical/metabolic info.
- - Cardiac & Interventional MRI.

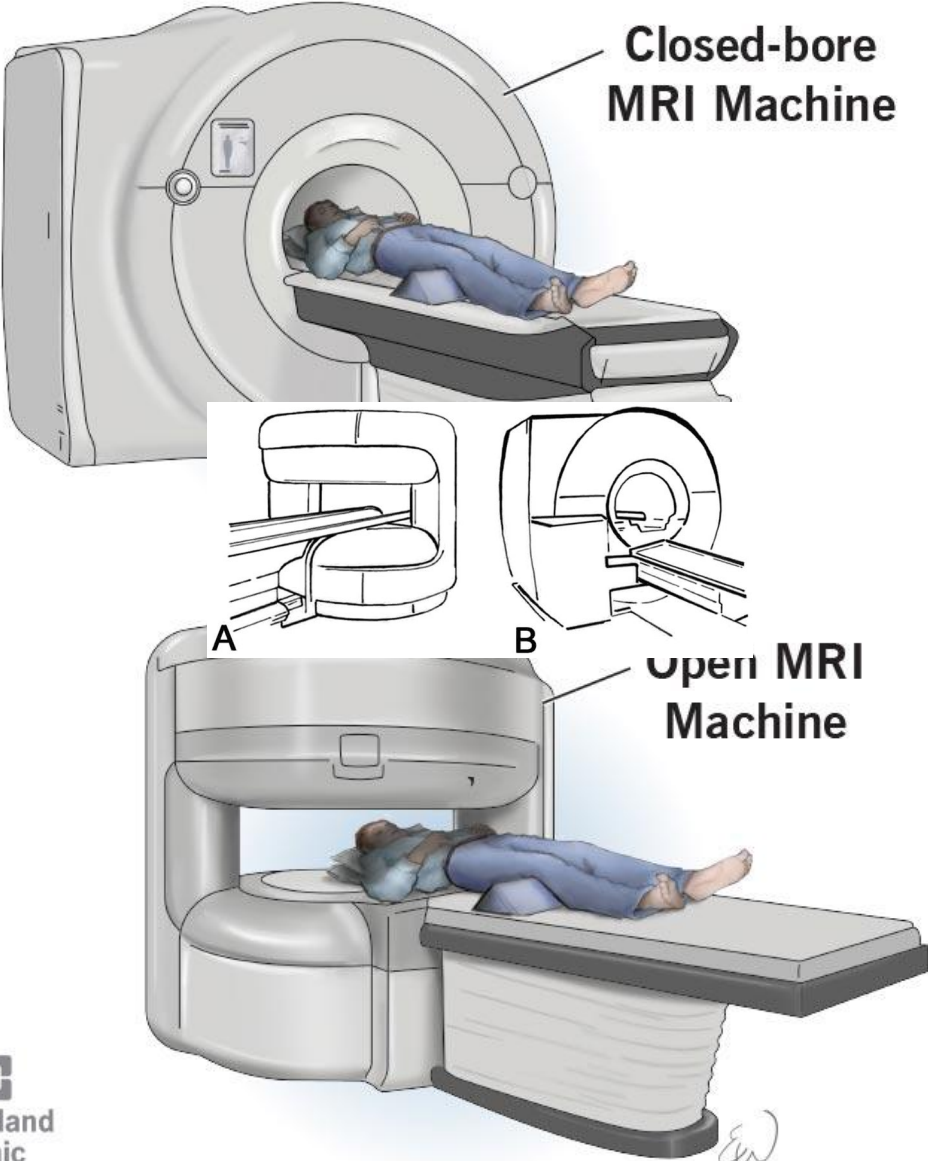
COMPARISON OF MRI TYPES

- Closed MRI: High quality, less comfortable.
- Open MRI: Comfortable, lower resolution.
- Wide-Bore MRI: Balanced option.
- Portable MRI: Emergency use, low detail.

MRI



MRI





MRI

Closed

Widely available

Can diagnose more problems

Scan may be quicker

Higher-quality imaging

Can scan all areas of a body

Open

Quieter

Suits larger people

Suits those with mobility issues

Child-friendly

Less anxiety and claustrophobia

Fewer image artifacts

SUMMARY & TAKEAWAYS

- - MRI types vary by field strength and design.
- - Tradeoff: Comfort vs. Image quality.
- - Closed MRI = best detail.
- - Open/Wide MRI = patient comfort.
- - Portable MRI = emergency convenience.
- - Future: Ultra-high field and advanced open designs.

Any questions?

*Thank
You*