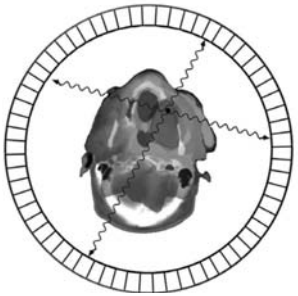
Syrian Private University
Faculty of Dentistry
Department of Oral Medicine

MR imaging
Nuclear imaging



Lecture 6

IMAD BRINJIKJI

MRI

- Large magnet (0.25 – 11 T).
- Radiofrequency pulse.

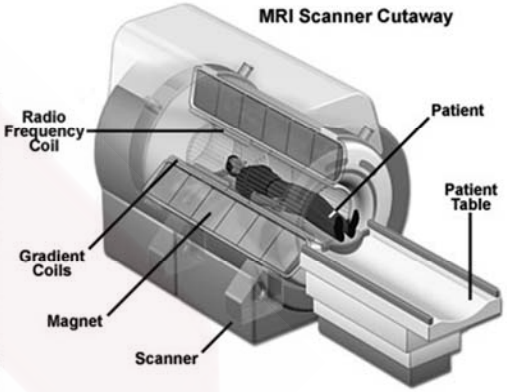


Image formation in MRI

The patient is placed within a large magnet.

↓

This magnetic field causes the nuclei of hydrogen (in particular) to align with the magnetic field.

↓

The scanner directs a radiofrequency (RF) pulse into the patient.

Image formation in MRI

Some hydrogen nuclei absorb energy (resonate).

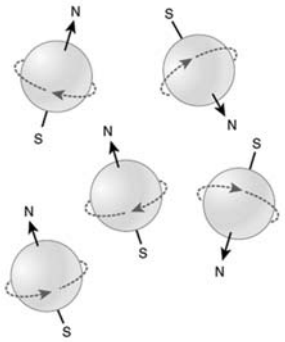
↓

When the RF pulse is turned off, the stored energy is released from the body and detected as a signal in a coil in the scanner.

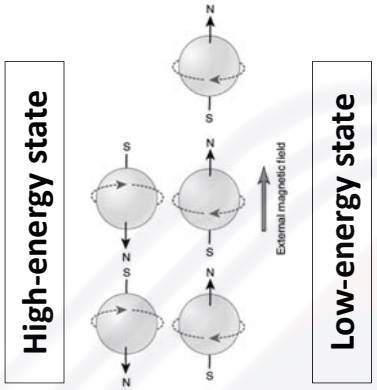
↓

This signal is used to construct the MR image.

Image formation in MRI



Hydrogen nuclei normally have randomly oriented dipoles (no net magnetic vector).

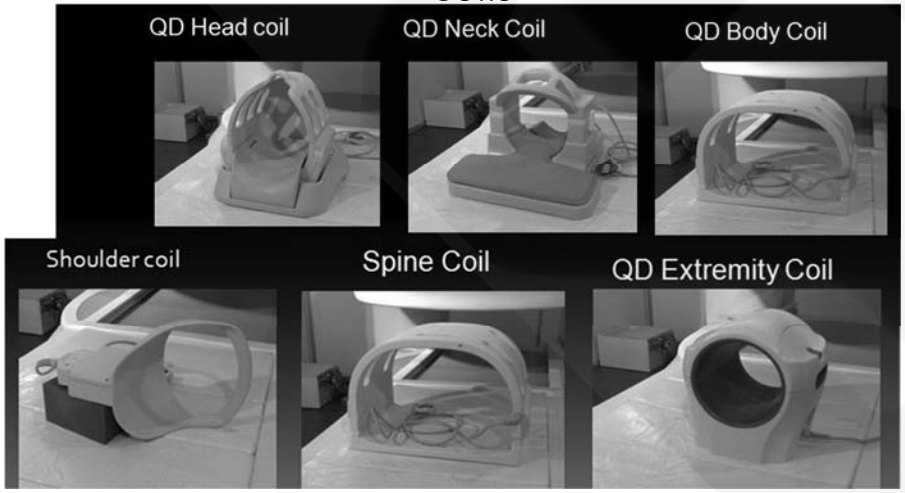


In an external magnetic field, hydrogen nuclei are aligned parallel (low) or anti-parallel (high) to the magnetic field.

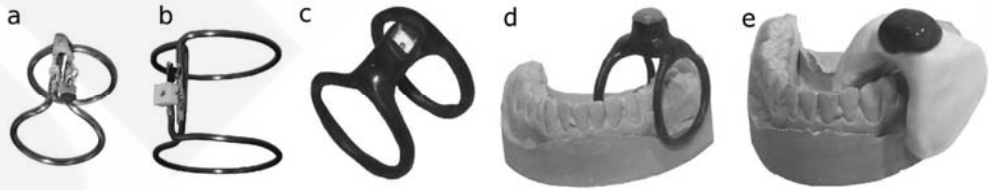
Image formation in MRI

- Nuclei can be made to undergo from low- to high-energy state by absorbing energy (using radio waves).
- When the radiofrequency pulse is turned off, the nuclei returns to the lower energy state and release the absorbed energy.

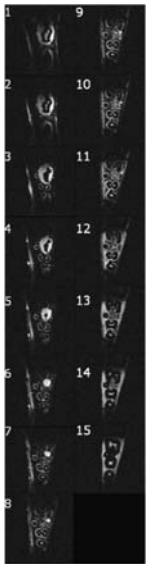
Coils

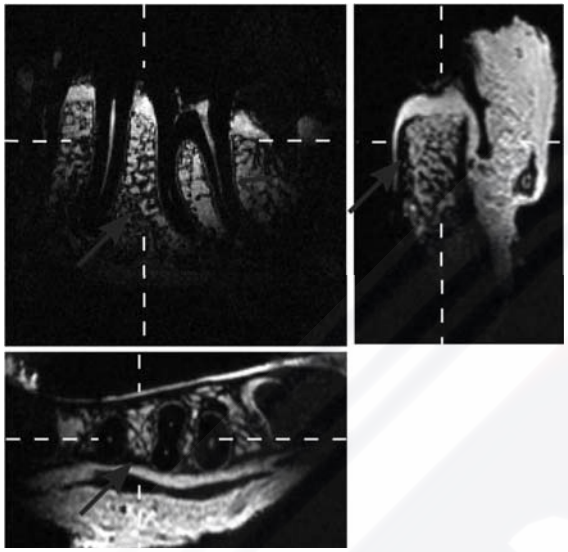


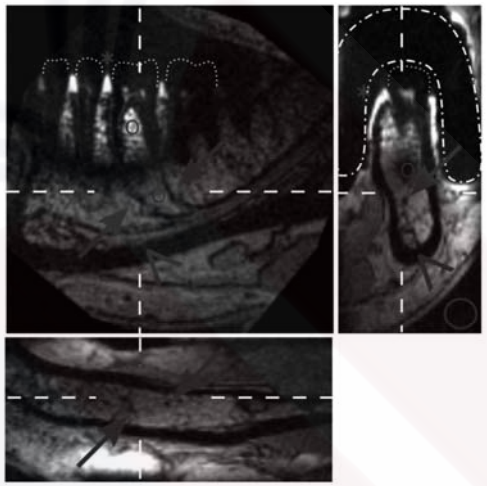
Recently, an intraoral MRI was introduced

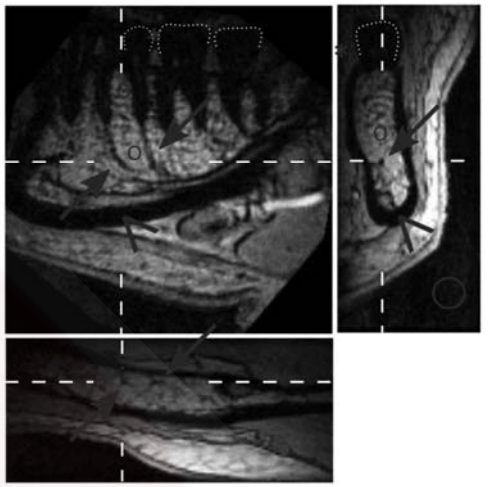


Intraoral coils









MR images

- The higher the concentration of hydrogen nuclei of loosely bound hydrogen atoms, the more intense the recovered signal, and the brighter the corresponding part of the MR image.

- Low signal = Black.
- High signal = White.

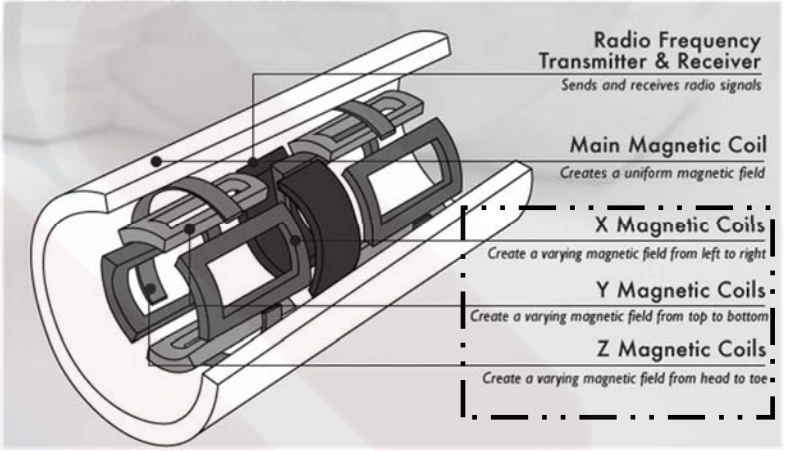
MR images

- Tightly bound hydrogen atoms (such as those in the calcified tissues), do not align themselves with the external magnetic field and produce only a weak signal.
- Loosely bound or mobile hydrogen atoms (such as those in soft tissues and liquids), produce a detectable signal at the end of the RF pulse.

Characteristic of MRI

- **Non-invasive imaging technique (using non-ionizing radiation).**
- **The higher the magnet strength, the higher the resolution.**
- **High-quality images of soft tissue resolution in any imaging plane.**
- **High cost.**
- **Long scan time.**
- **The metals distort the image.**

MR images



Time-sequences in MR images

There are many time-sequences in MRI image.

T1W
T2W
Post-Gd images
STIR
FLAIR

PDW
DWI
ADC
fMRI
BOLD
…….

T1 images

High fluid content (CSF)
↓
Black

High fat content (bone marrow)
↓
White

- T1-weighted images are more commonly used to demonstrate anatomy.

T2 images

Long T2 times (White)
e.g. Water (CSF)

Short T2 times (Black)
e.g. Fibrous tissue

T2 images are commonly used for identifying pathology.

Post-Gd images

Gadolinium is not imaged itself, but rather it shortens the T1 relaxation times of enhancing tissues, making them appear brighter.

Tissues that enhance include normal tissues, such as vessels with slow-flowing blood, sinus mucosa, and muscle.

Pathologic tissues often enhance allowing them to be better differentiated from surrounding normal tissue.

MR images

For maxillofacial imaging

T1 images.

T1 images post-Gd administration.

T2 images.

STIR (fat suppression).

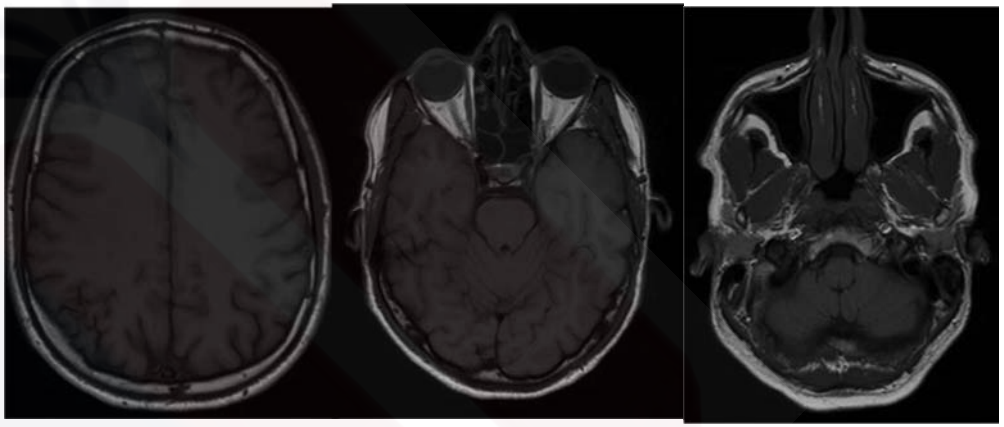
MR images

Anatomy/ Lesion	T1	T2
Mucosal thickness	Intermediate	High
Cyst	Low	High
Serum	Low	High
Flowing blood	Low	Low

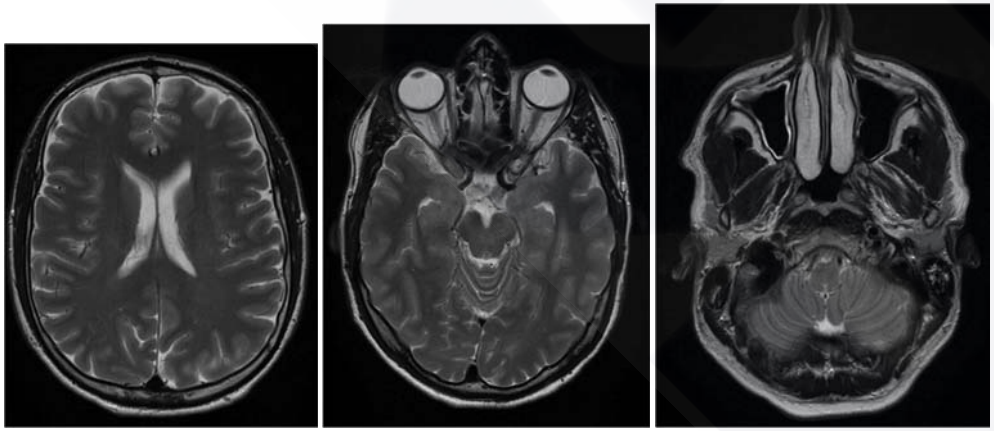
MR images

Anatomy/ Lesion	T1	T2
Foreign body	Low	Low
Polyp	Low	Very high
Mucocele	High	High
Compact bone	Low	Low

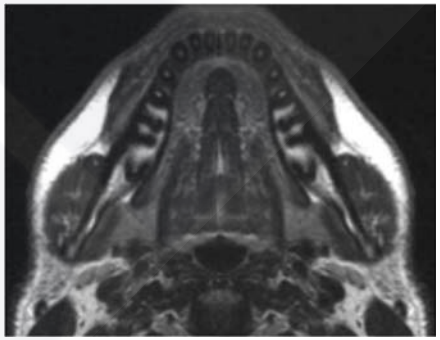
T1



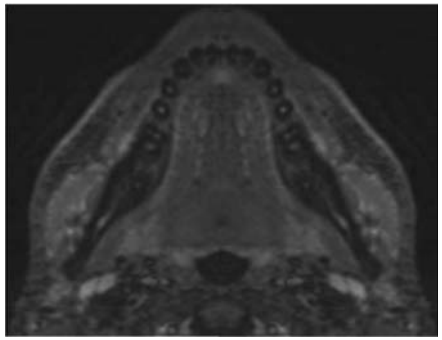
T2



STIR (T2 with fat suppression)

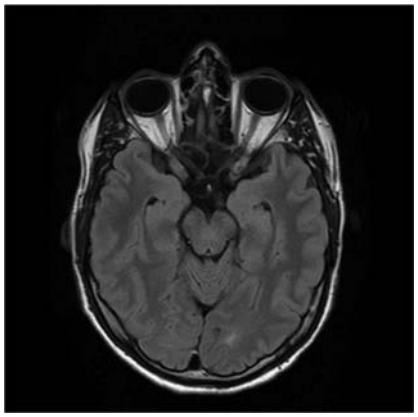


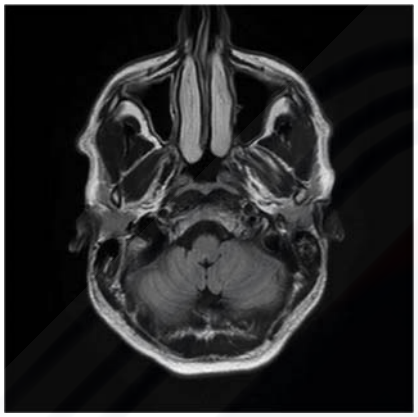
T2



STIR

T2 FLAIR





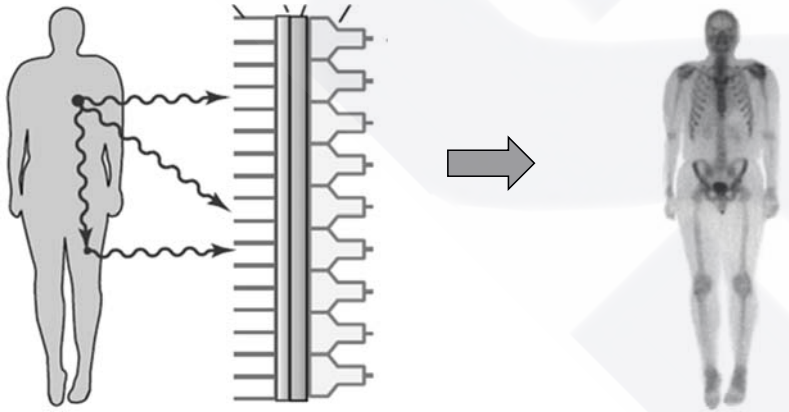
Nuclear medicine

Gamma camera (Scintigraphy) | **SPECT SPECT/CT** | **PET PET/CT**

γ-ray/ positron (inter-act to produce γ-ray).

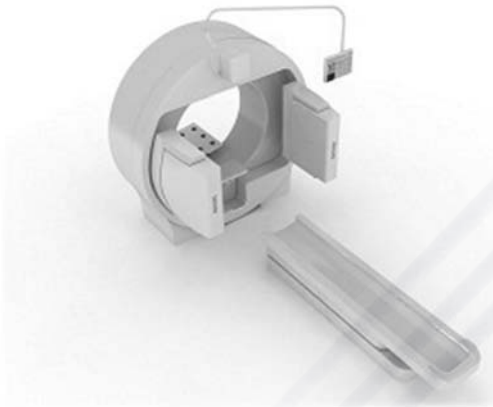
Tc is the most commonly used element for bone scanning.

Gamma camera (Scintigraphy)



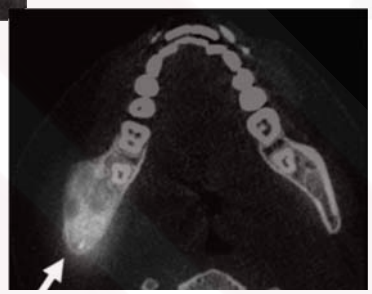
Gamma camera (Scintigraphy)

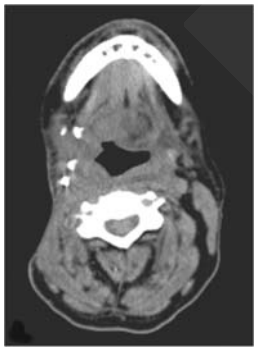
SPECT/ CT



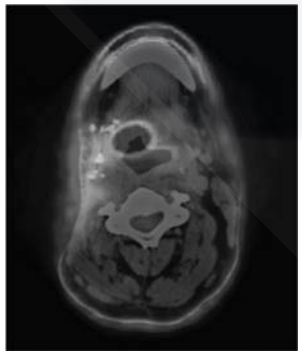
SPECT/CT

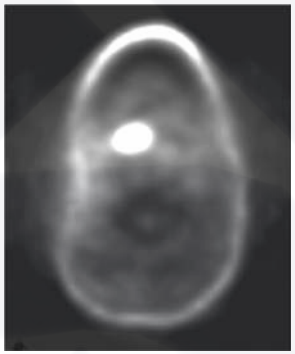
+





PET/CT





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