

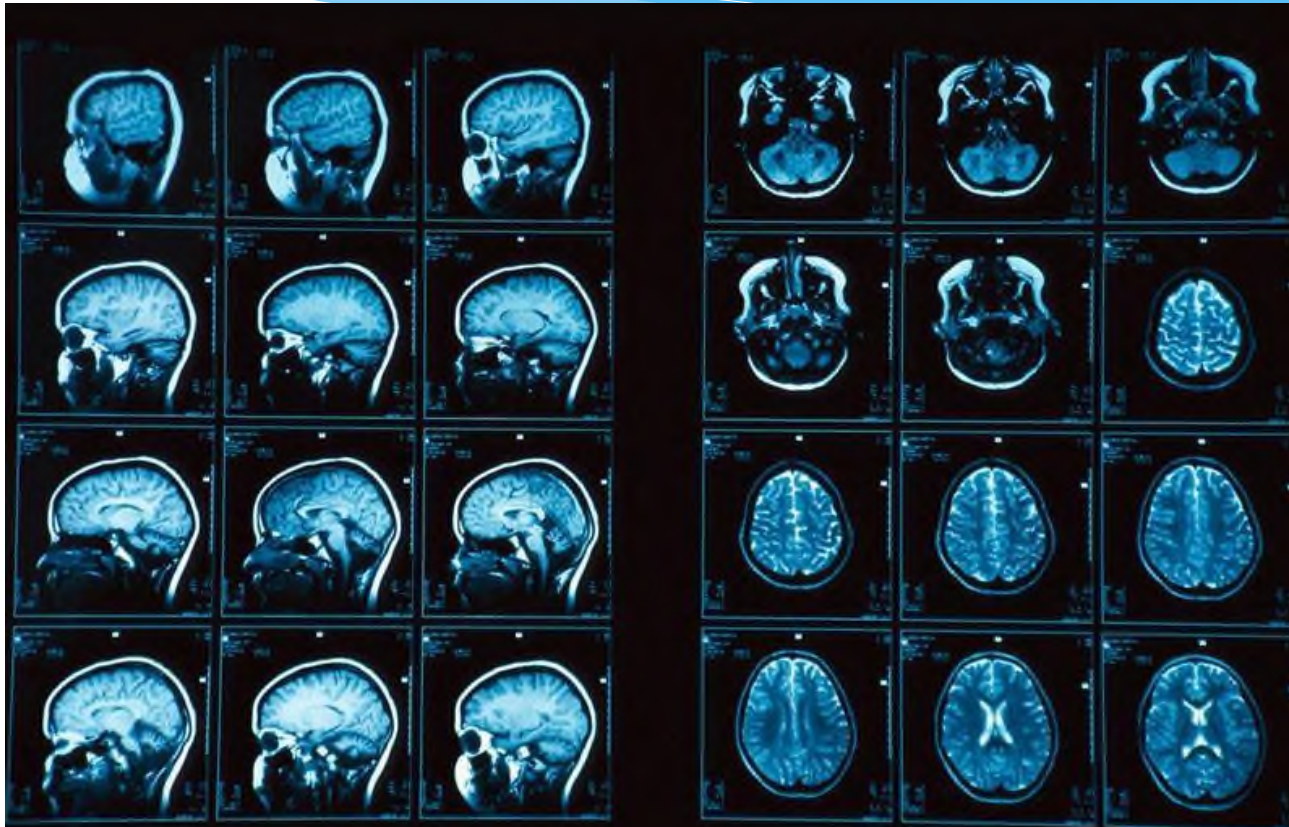
Lecture 3: Ultrasound, MRI and
radionuclide,

**Poltava State Medical
University**

**Department of oncology and
radiology**

**with radiation medicine
assistant Nestulia K.I.**

MAGNETIC RESONANCE IMAGING



MRI images of a human brain
Photograph by Ken Glaser/Corbis

INTRODUCTION

- On July 3, 1977, the first MRI exam was performed on a human being, five hours to produce one image.

"Indomitable

1982,

seconds

Definition

- **Magnetic resonance imaging (MRI)** or
Nuclear magnetic resonance imaging (NMRI),
Magnetic resonance tomography (MRT)

- MRI gives different information about structures in the body cannot be seen with an x-ray or computed tomography. MRI also may show

- Intensity
echo density

enance imaging (MRI) test is
neurologist. The

Structure of MRI Machine

- The basic design of an MRI machine resembles a cube, measuring 7 feet tall by 7 feet wide by 10 feet long from front to back.



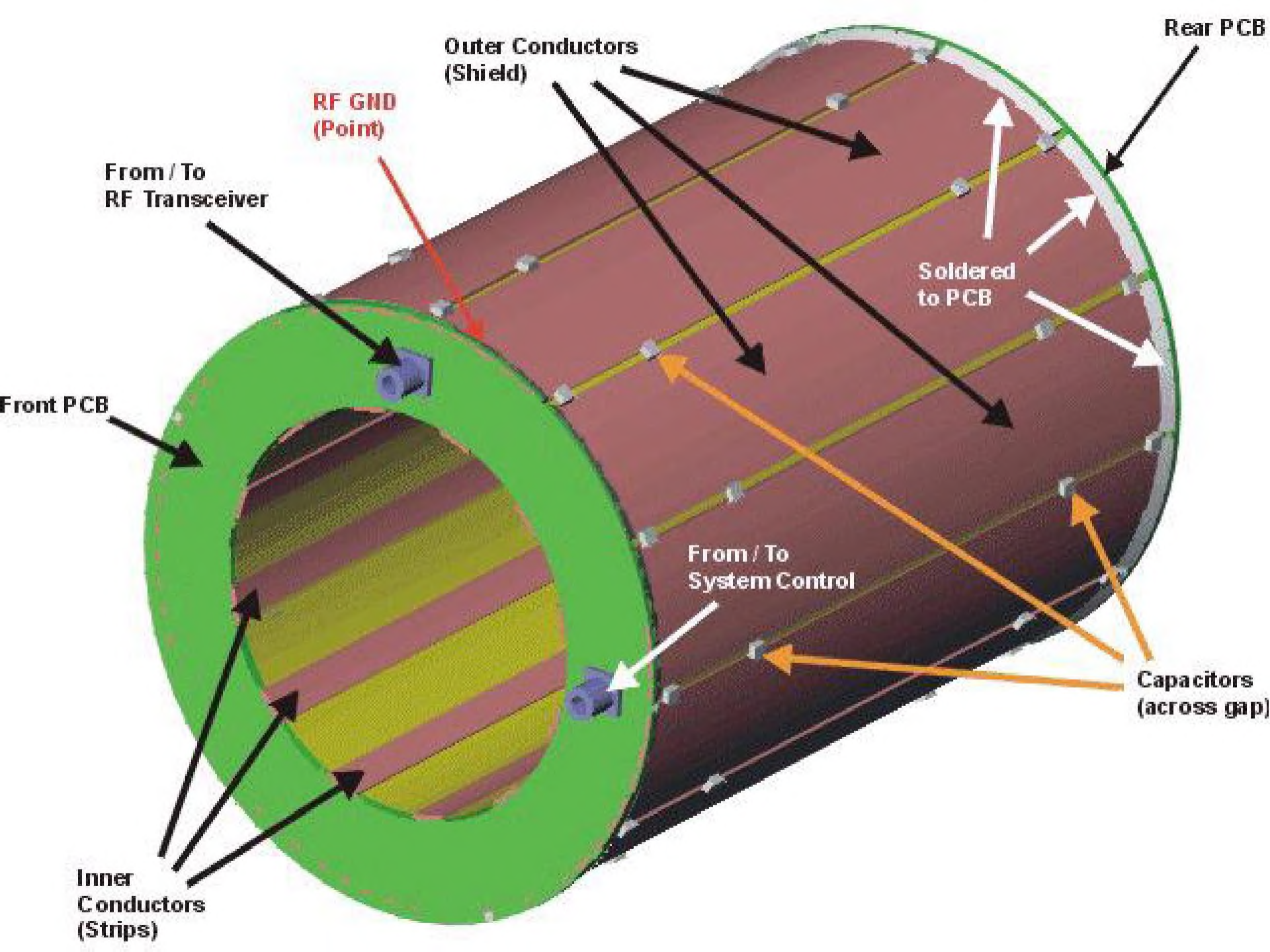
MRI MAGNET

three basic types of magnets used in

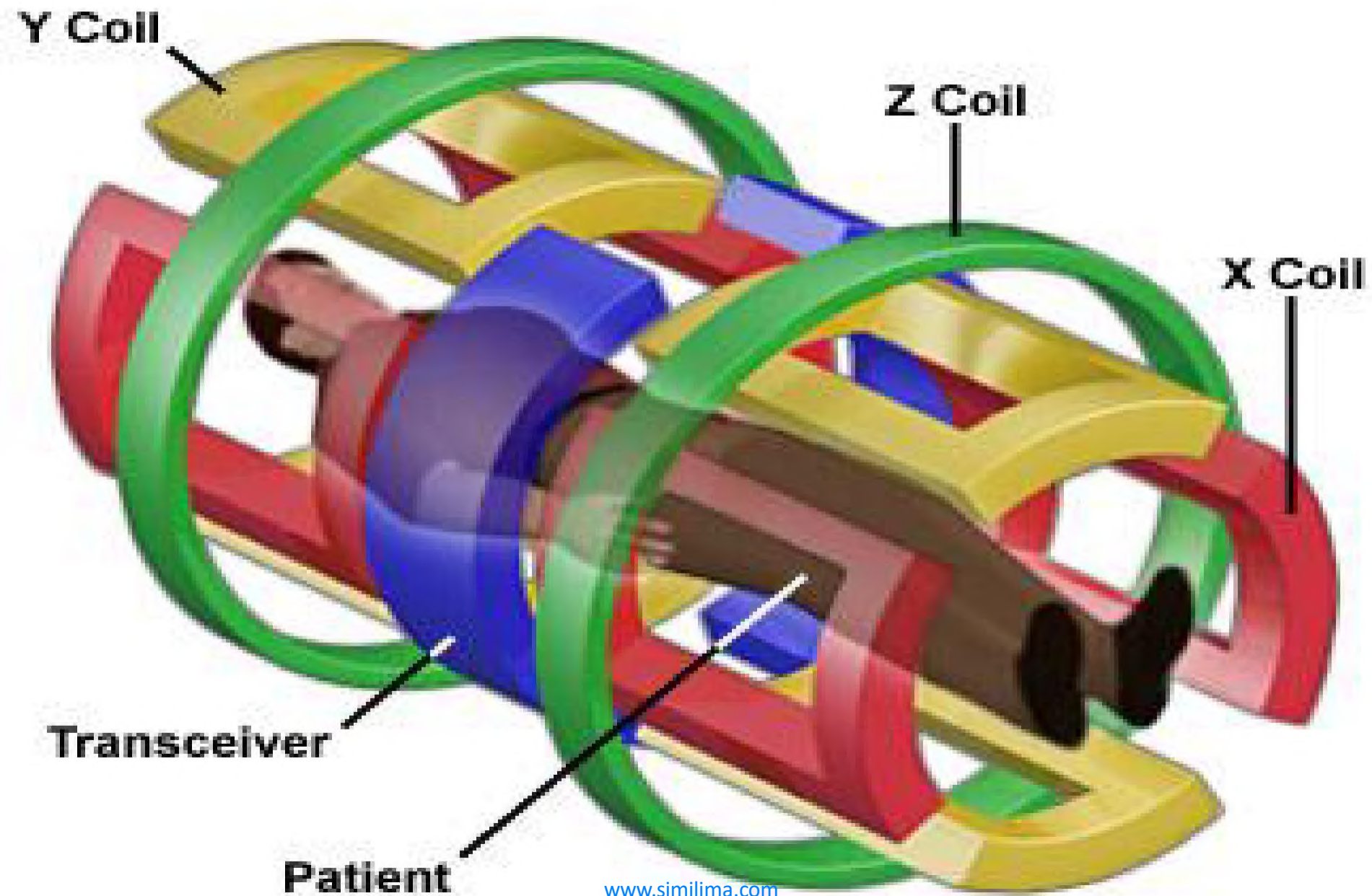
- **Resistive magnets**







MRI Scanner Gradient Magnets



permanent magnet's magnetic field is
full strength, so it

- **Superconducting magnets** are the most powerful type of magnet. The most powerful superconducting magnet is

PATIENT PREPARATION

Remove all metal objects (such as jewelry, watches, and aids)

- Patient need to take off all or most of clothes, depending on which area is examined.

• a gown to use during the

- During the test pt. will lie on back on a table that is part of the MRI scanner.
- Pt's head, chest, and arms may be held with restraints to keep them still.

feel nervous (**claustrophobic**)
which keeps pt. from

- **Inside the scanner** pt. will hear a fan and feel air moving. He may also hear tapping or snapping noises as the MRI scans are taken. He may be given headphones with music to listen to. It is important to hold

material is needed, the technologist
(IV) line in your

MRI test

30 to 60 minutes

no pain from the magnetic field
MRI test.

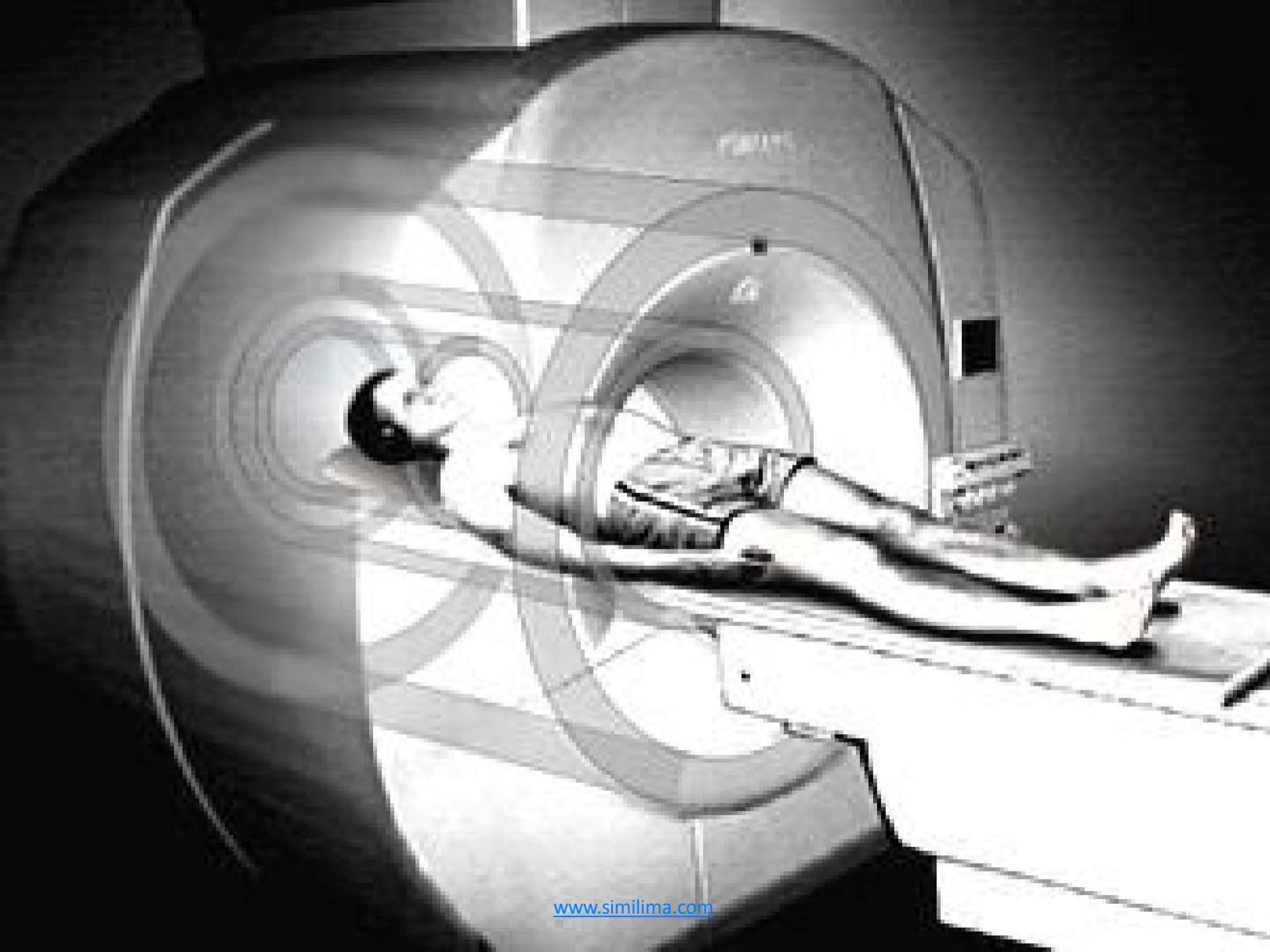
...t may feel:

...if he have

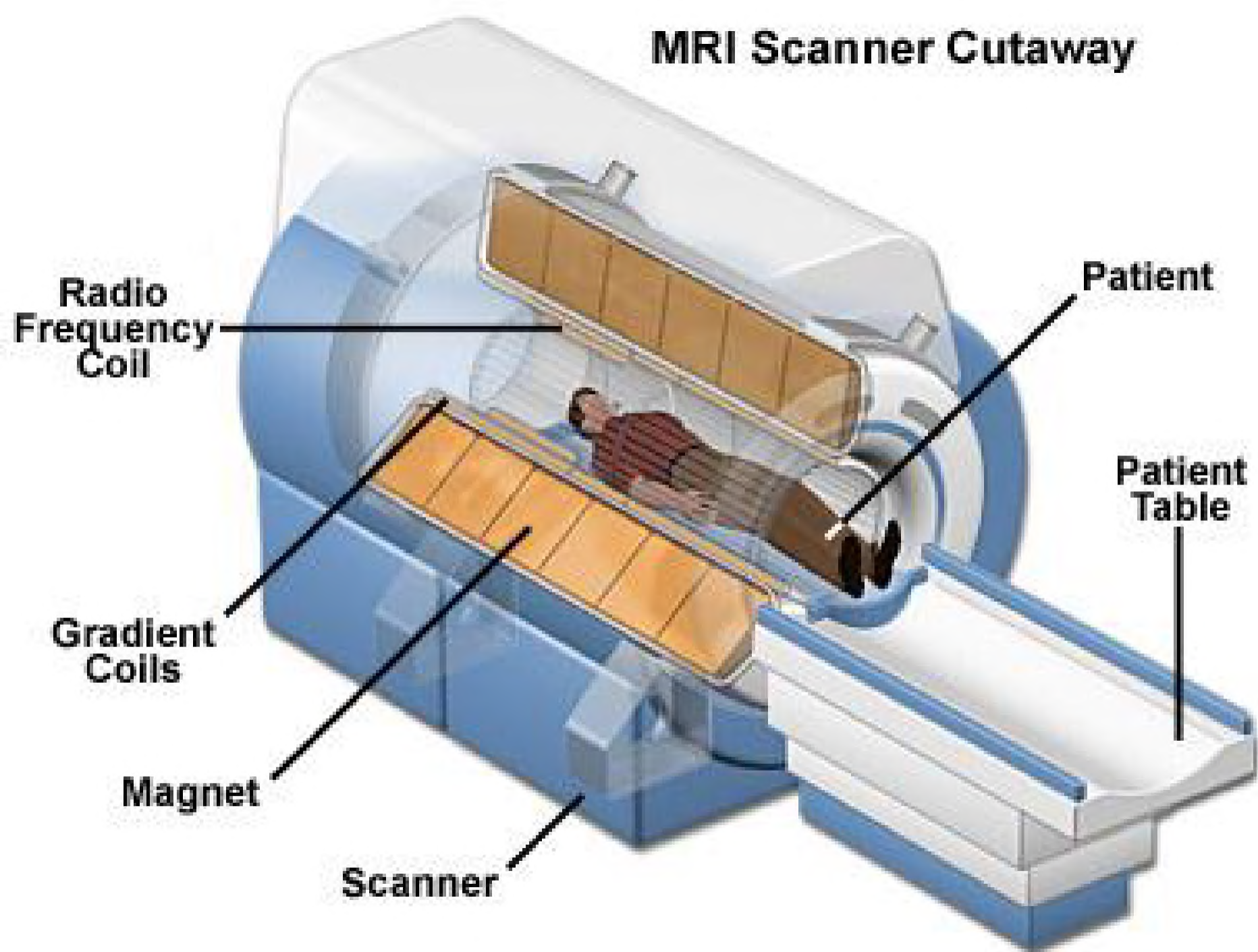
MECHANISM OF MRI

- The body is largely composed of water molecules. Each molecule has two hydrogen nuclei or protons. These are inside the powerful

... goes through the patient's
... up a 2-D or 3-D



MRI Scanner Cutaway

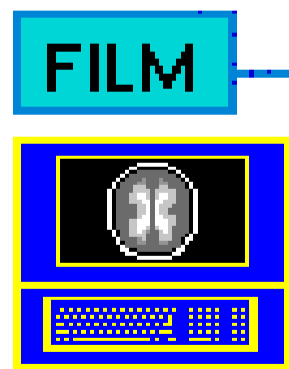


SHIELD

MAGNET
GRADIENT COILS
RF COIL



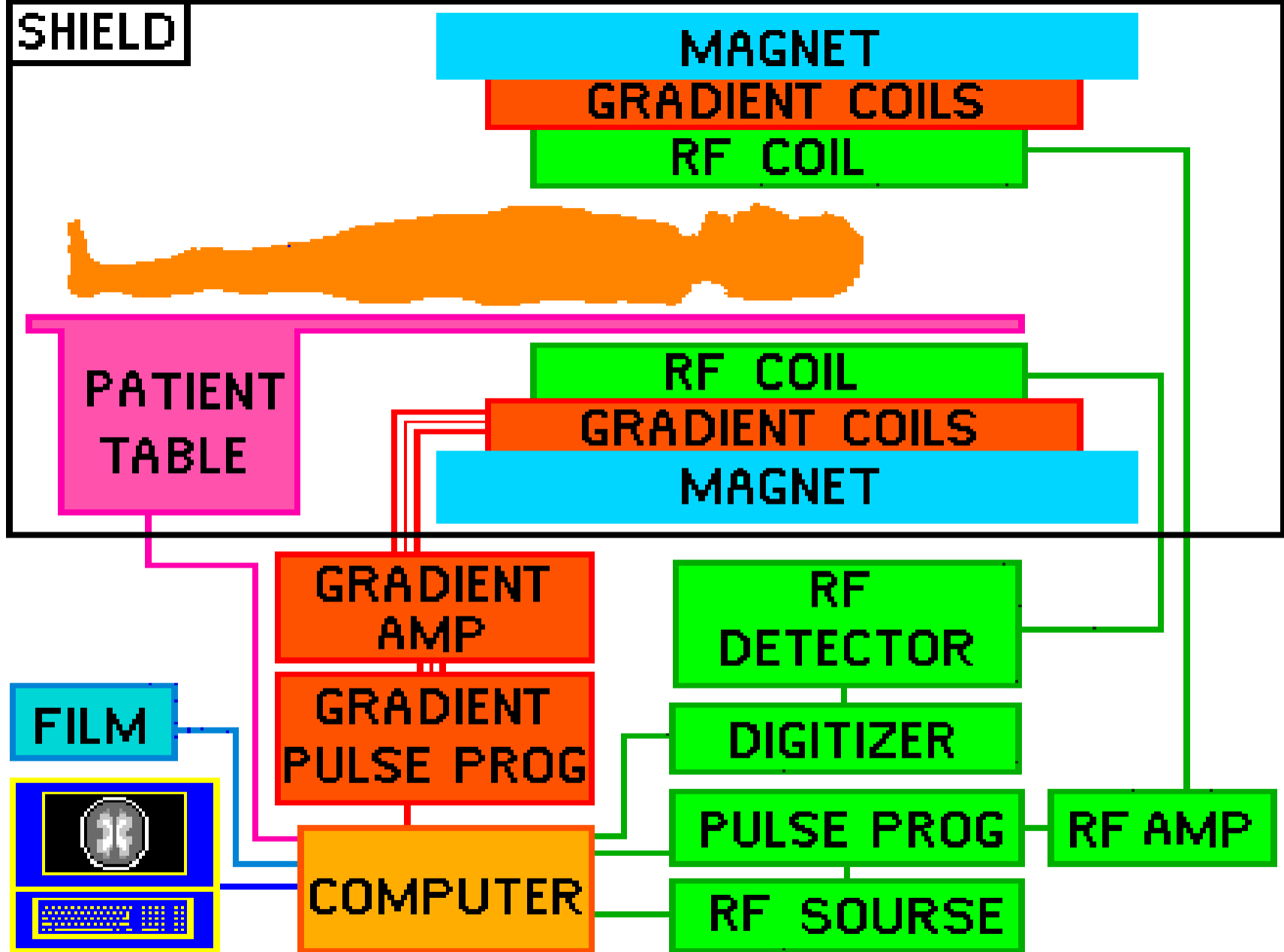
PATIENT TABLE
RF COIL
GRADIENT COILS
MAGNET



GRADIENT AMP
GRADIENT PULSE PROG
COMPUTER

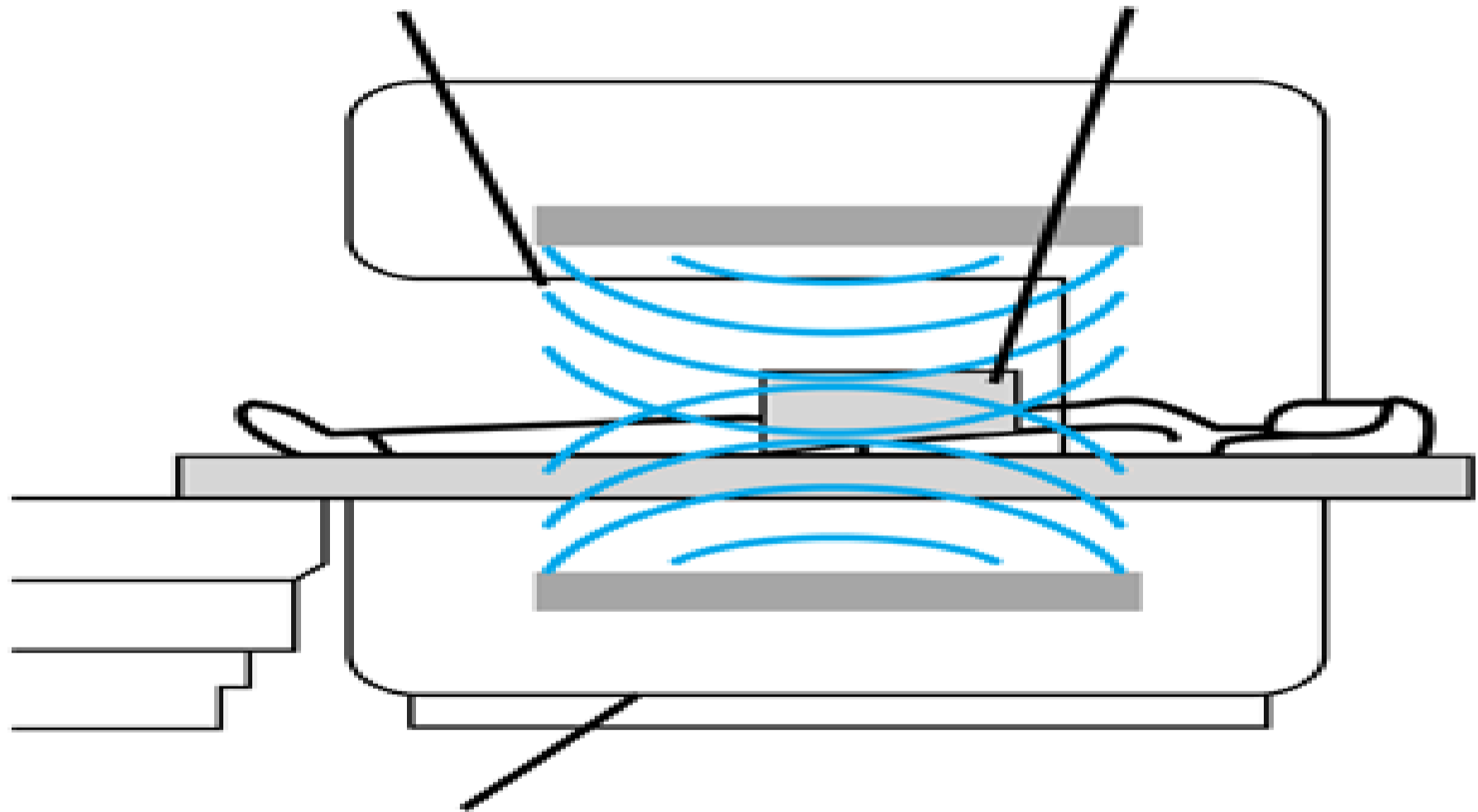
RF DETECTOR
DIGITIZER
PULSE PROG
RF SOURCE

RF AMP



2. Radio frequency waves are absorbed by the protons and then emitted as a signal.

3. A radio frequency coil picks up the signal and transmits it to the computer.



1. The magnetic field is used to align hydrogen protons in the body.

4. The computer processes the data and an image is generated.

Machine applies an RF (radio
frequency) specific only to

“Resonance” part of MRI.

forces them (only the one or two
million) to spin at

These are usually applied through a

At the same time, the three
the act. They are

think of "**slices.**" Think of a loaf of
thin as a few millimeters --

- When the RF pulse is turned off, the hydrogen protons begin to slowly return to their natural alignment within the magnetic field and release the absorbed energy. When they

“Imaging” part of MRI.

be constructed because the
turn to their

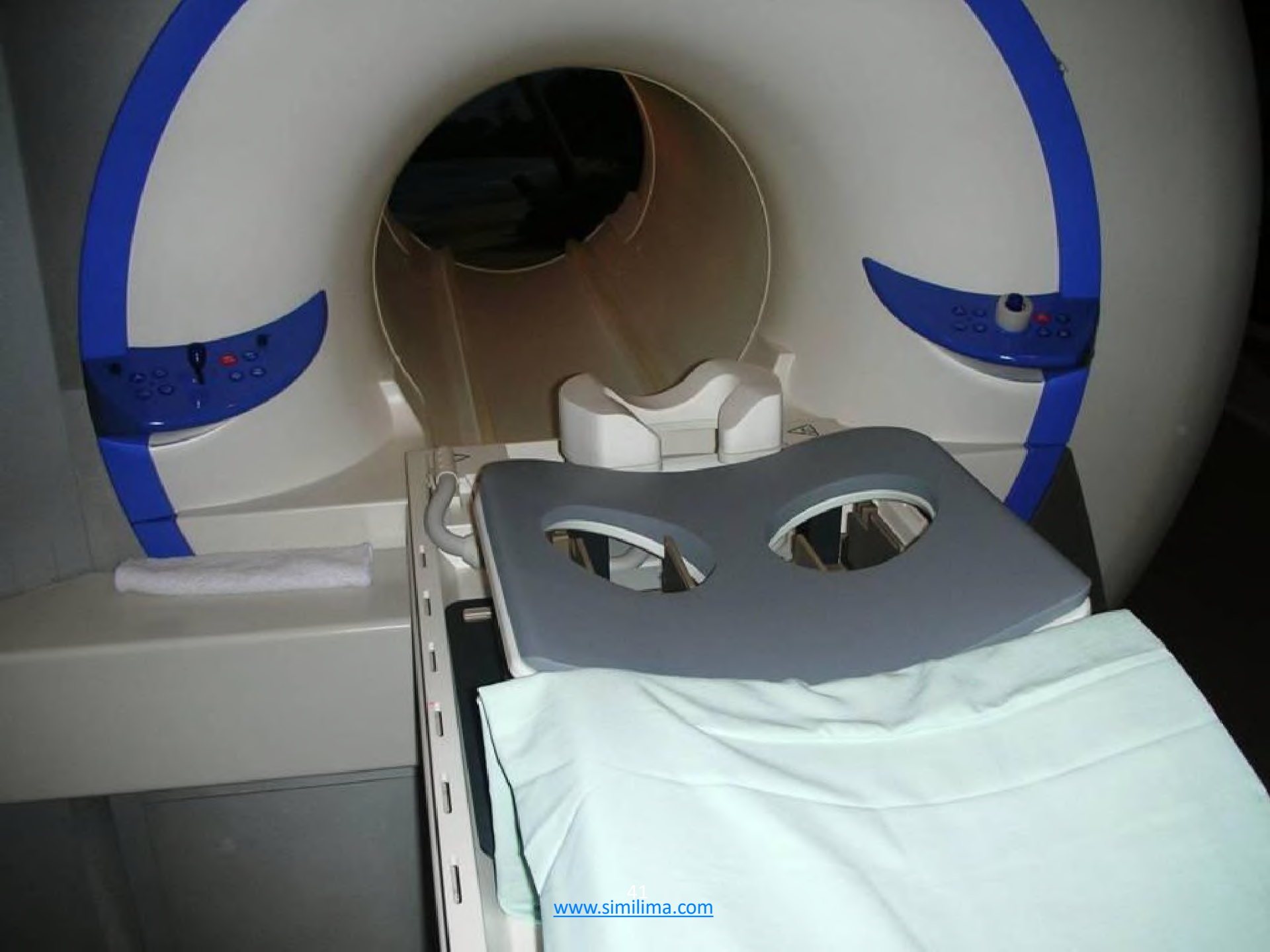
MRI SCANNERS

They vary in size and shape, and
different models have some

Open MRI

Closed MRI.













CT SCAN MACHINE



- Pictures from an MRI scan are digital images

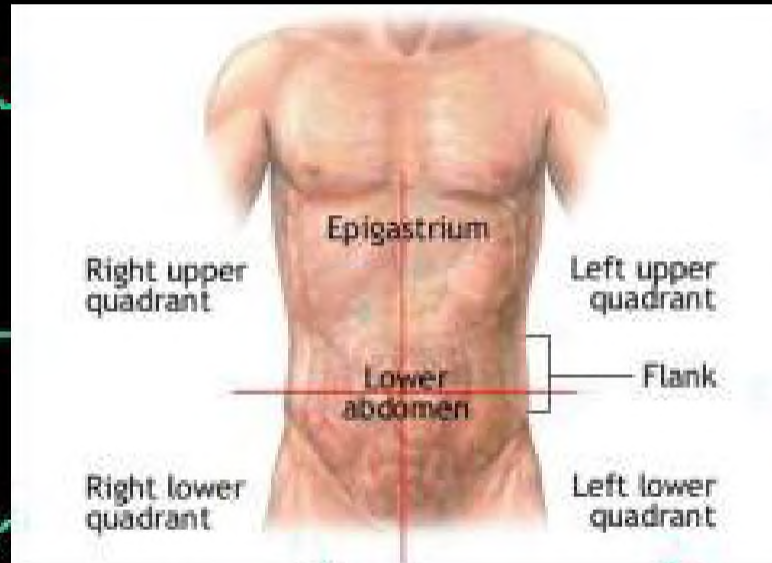
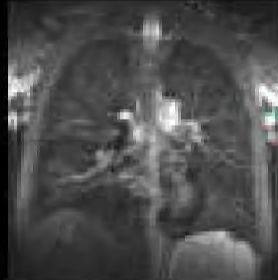
contrast material

APPLICATIONS

- Magnetic resonance imaging (MRI) is done for
This is used to find problems such as
tumors, bleeding, injury, bloodvessel diseases, or
infection.

Body MRI

TrueFISP Lung Imaging



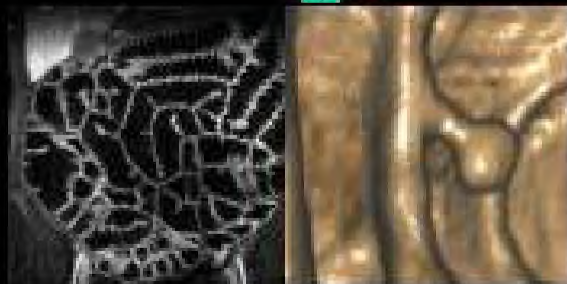
Free Breathing
(2D-PACE)



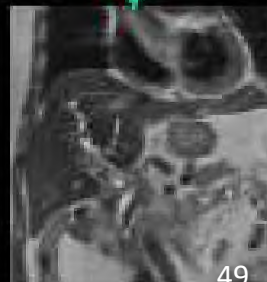
3D MRCP



3D-VIBE



MR-Colonography



HASTE



... and many more

- **Head. MRI** can look at the brain for tumors, an aneurysm, bleeding in the brain, nerve problems, and other problems, such as damage caused by a stroke. MRI can also find

- **Chest. MRI** can look at the heart, the valves, and coronary blood vessels. MRI can also find lung problems.

- **Blood vessels.** Using MRI to look at blood vessels and the flow of blood through them is called **magnetic resonance angiography (MRA)**. It finds problems of the arteries and veins, such as a blocked blood vessel, or the narrowing of a blood vessel (stenosis).

- **Abdomen and pelvis.** MRI

liver, gallbladder, pancreas, kidneys, and bladder. It is used to find tumors, bleeding, infection, and blockage in the uterus and ovaries. In men, it looks at the prostate.

- **Bones and joints.** MRI can check for problems of the bones and joints, such as arthritis problems with the temporomandibular joint bone marrow problems bone tumors cartilage problems torn ligaments or tendons or infection.

- **Spine.** MRI discs nerves of the spine spinal stenosis, disc bulges, and spinal tumors.

TYPES OF MRI SCANS

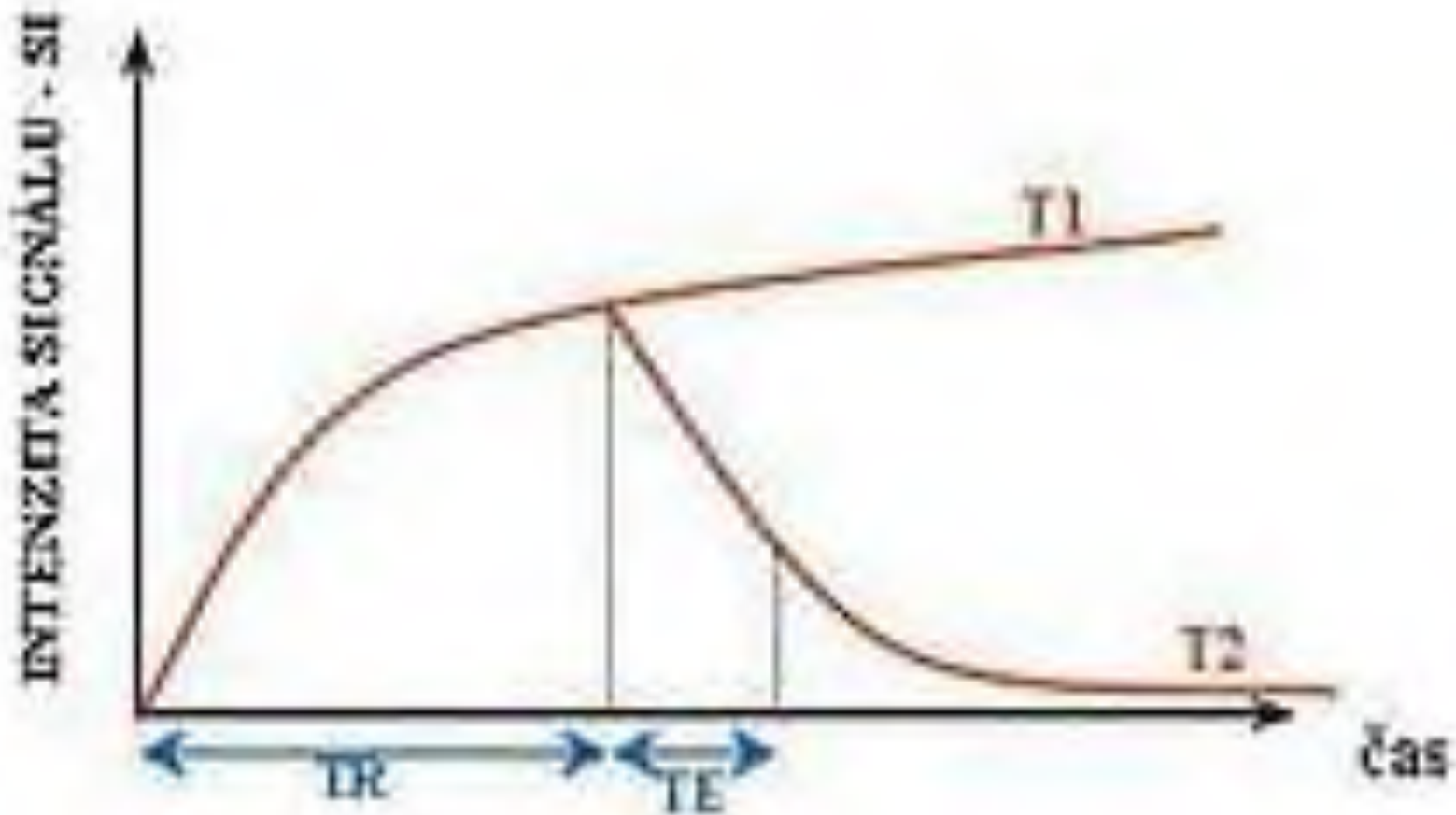
- 1. **Basic MRI scans**

T_1 -weighted MRI T_1 -weighted scans are a standard MRI scan used for distinguishing fat from water.

. **T_2 - weighted MRI**

edema

Effects of TR, TE, T1 and T2 on MR signal



- C . **T*2-weighted MRI2**

(pronounced "T 2 star") weighted scans use a gradient echo (GRE) sequence, with long T_E

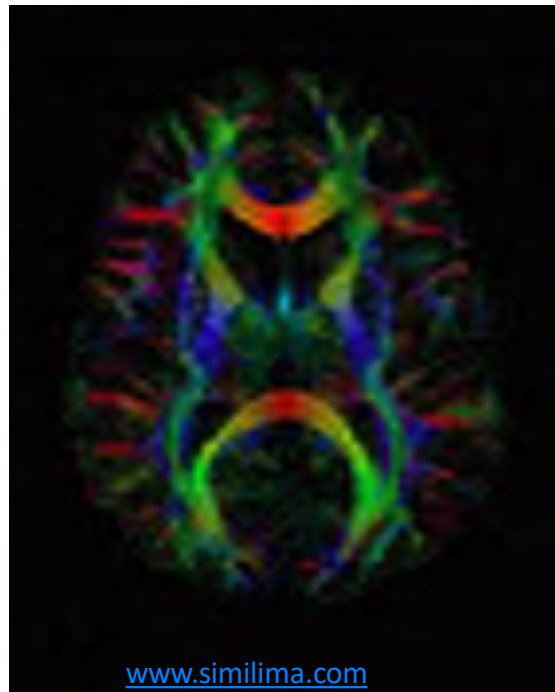
t-susceptibilit

Spin density weighted MRI

Proton density,

Specialized MRI scans

Diffusion MRI



- B. **Magnetization Transfer MRI**
- Magnetization transfer (MT) refers to the transfer of magnetization from free water protons to macromolecular protons. This is used in NMR and MRI.

Fluid attenuated inversion recovery (FLAIR)

- D. **Magnetic resonance angiography (MRA)**

Generates pictures of the arteries to evaluate them for stenosis (normal narrowing) or aneurysms (vessel bulge).



Magnetic resonance gated intracranial CSF dynamics (MR-GILD)



- F. **Magnetic resonance spectroscopy (MRS)**
is used to measure the levels of different metabolites in body tissues, to diagnose certain metabolic disorders, and those affecting the brain, and to provide metabolism.

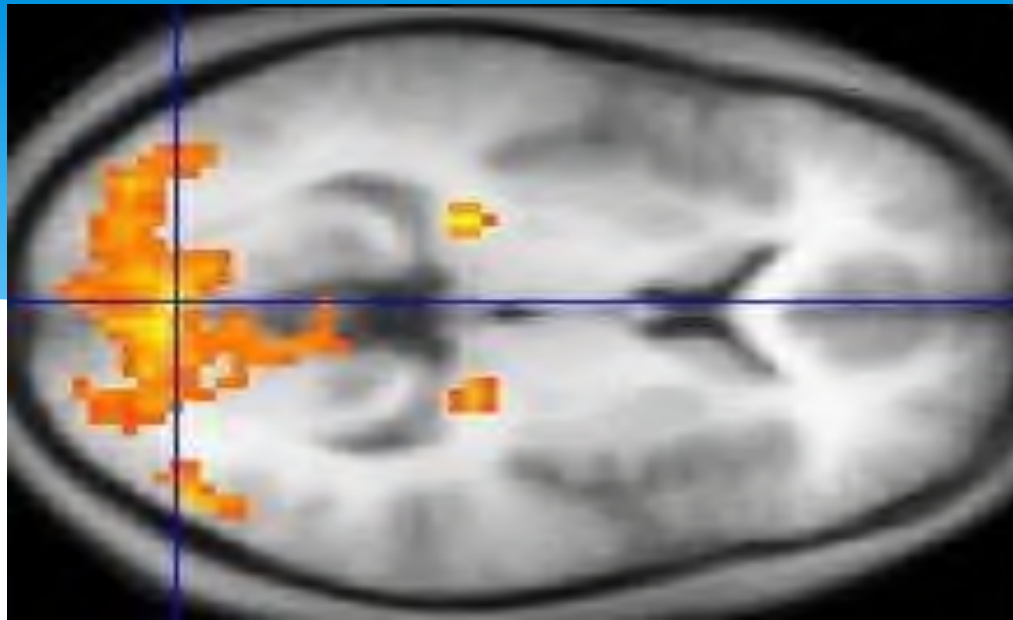
Functional MRI(fMRI)

neural

brain

[20]

blood-oxygen-level dependent



Real-time MRI.

Interventional MRI

the patient and

4. **Radiation therapy simulation**

to locate tumors within the body in preparation for
radiation therapy treatments.

patient is placed in

Current density imaging.(CDI)

tion from images to

**Magnetic resonance guided focused ultrasound
(MRgFUS)**

Multinuclear imaging

Imaged

imaging is primarily a research
potential applications

Solutions containing ^{13}C or
polarized ^{129}Xe

Susceptibility weighted imaging (SWI)

SWI is different from

to enhance the detection and
regular and

- E. **Other specialized MRI technique**

new methods and variants are often
when they are able to get

- T^*2 -weighted turbo spin-echo

- Double inversion recovery MRI

- Phase-sensitive inversion recovery MRI (PSIR-MRI), to improve imaging of

MP-RAGE

- Portable magnetic resonance instruments

After the Scan....

...may discuss initial results of the test. Complete

RISKS

Unknown harmful effects from the
use of MRI.

- Metal parts in the eyes can damage the retina.
Metal fragments in the eye, an

- An MRI can cause a burn with some patches. Be sure to tell your health care provider if you are wearing a patch.

CONTRAINDICATIONS OF MRI

- **Pregnancy.** An MRI test usually is not done during pregnancy. MRI may be done to get

ultrasound

Obesity

- **Allergic**

- Have a **pacemaker**, **artificial limb**, **any metal pins** **metal parts in the body** (especially in **metal heart valves** **metal clips in brain**, **metal implants in your ear** **tattooed eyeliner**, **other implanted or prosthetic medical device**

... or work around metal. This
... you have metal
fragments in your head, eyes, skin spine.

•

recent surgery on a blood vessel. In some
have the MRI

intrauterine device (IUD)

MRI Vs CT

- A **computed tomography (CT)** scanner uses **X-ionizing radiation**, to acquire its **images** for examining

- **MRI**
frequency(RF)

non-ionizing radio

- CT

enhanced by use of contrast agents
with high atomic number

iodine

barium.

MRI

gadolinium

paramagnetic
manganese.

- CT, uses only X-ray attenuation to generate

1. MPI scanners are able to
perform regional cross-

- MRI can generate cross-sectional **images in any plane** (including oblique planes).

limited to acquiring
axial (or near axial) plane

near-isotropic resolution

- For purposes of tumor detection and identification in the brain, MRI is generally superior.

solid tumors of the abdomen and chest, CT is often preferred due to less motion artifact

- MRI is also best suited for cases when a patient is to undergo the exam several times successively in the short term,

ADVANTAGES OF MRI

- MRI is a noninvasive imaging technique that does not expose the patient to radiation.

- **MRI has proven valuable in diagnosing a broad range of conditions** including cancer,

- MRI allows physicians to assess the biliary system non invasively and without contrast

DISADVANTAGES OF MRI

- High quality images are assured only if you are still while the images are captured or fused on

- **Breathing may cause artifacts** or image distortions, during MRI's of the chest, abdomen and pelvis. Bowel motion is another source of motion artifacts in abdomen and pelvic MRI studies.

pregnant women

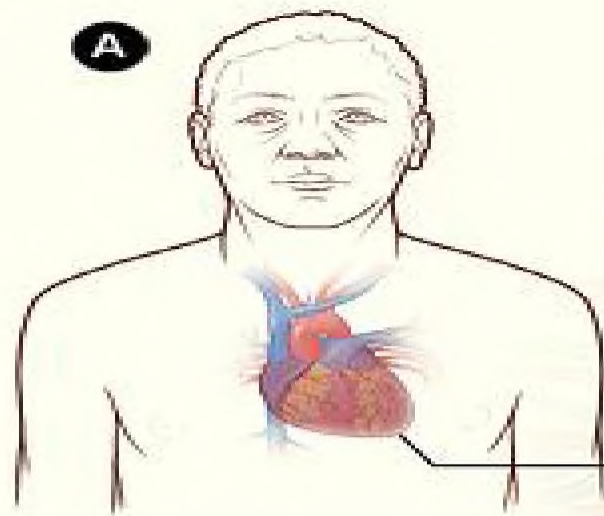
advised not

**no
and edema fluid.**

distinguish between cancer tissue

Future.....

developing newer MRI scanners
These new

A

Aorta

Location of
magnetic
resonance
imaging sectionLeft
ventricleRight
ventricle (RV)**B**

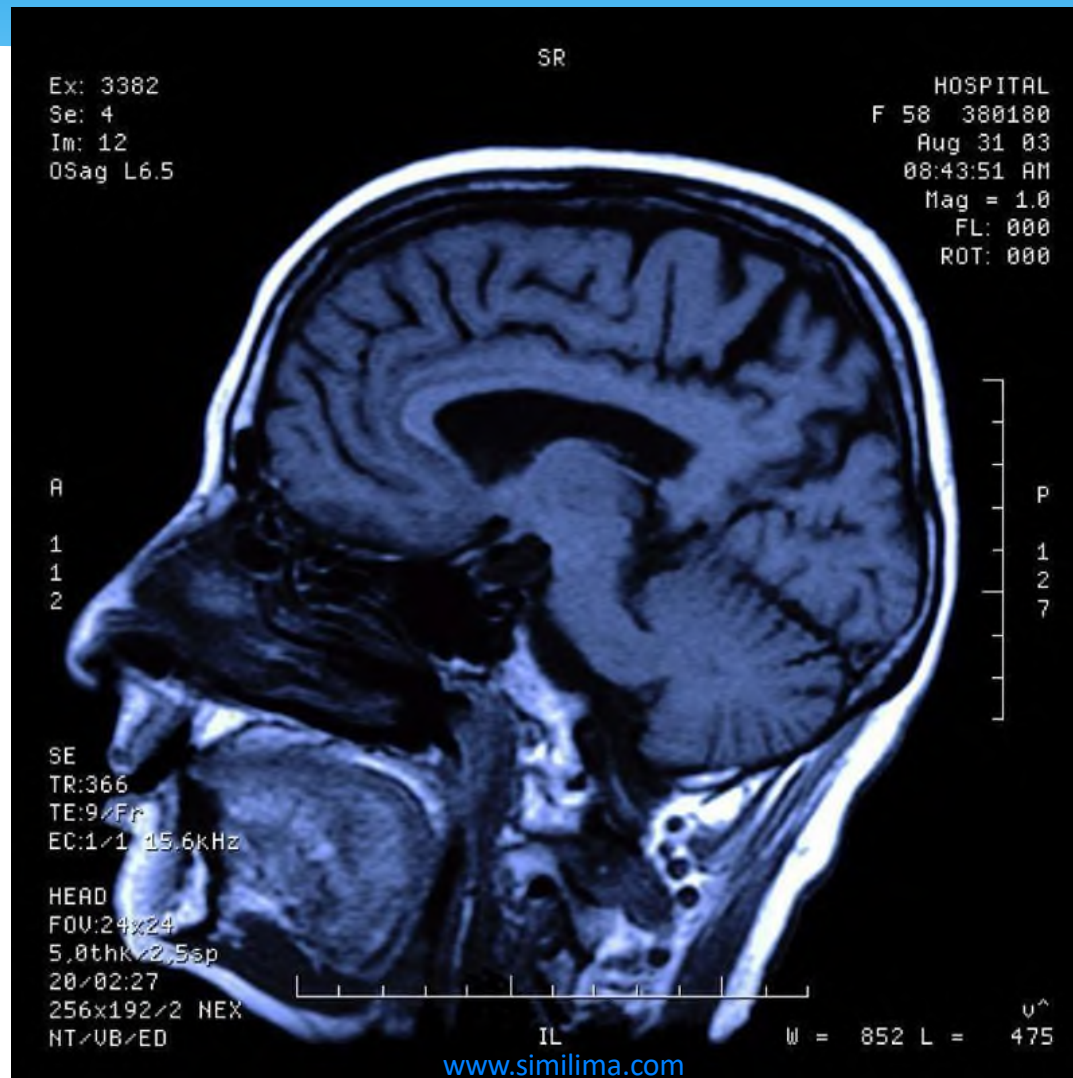
Aorta

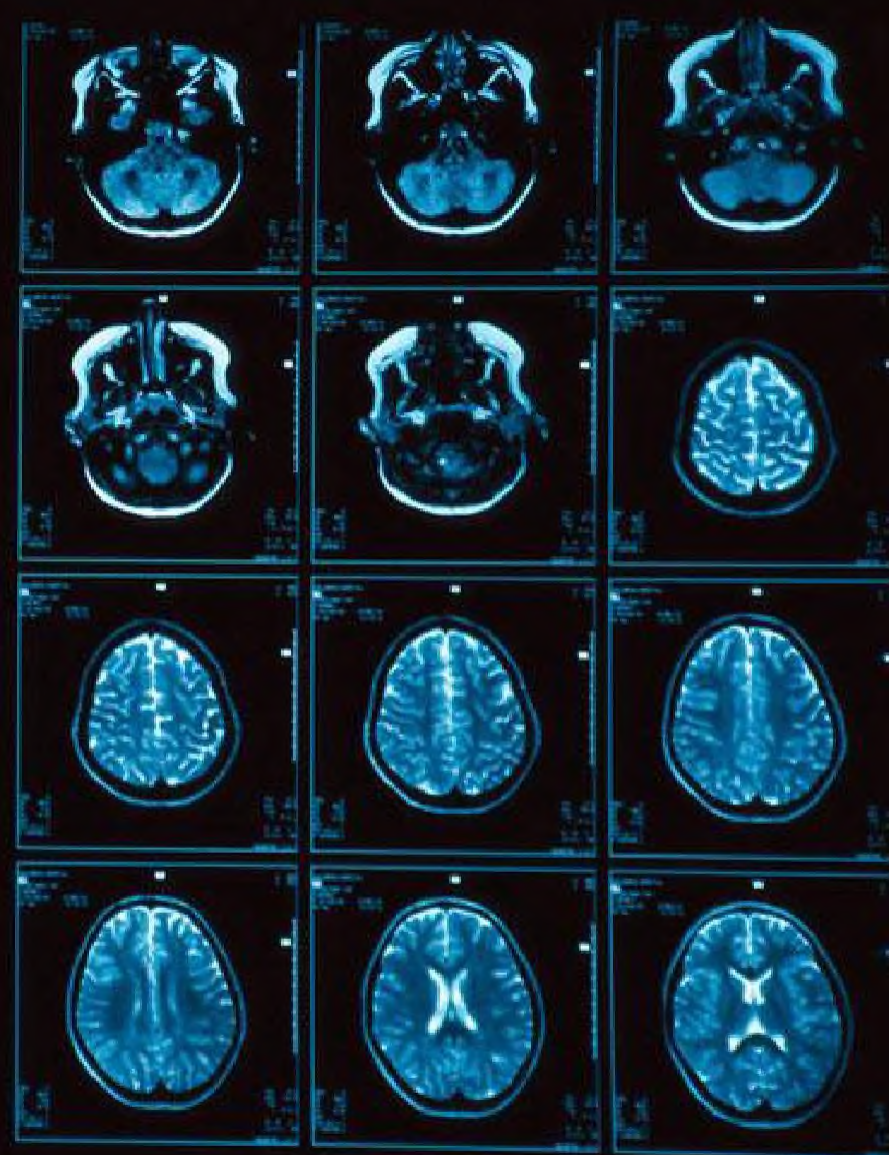
3D
angiogram
of heart

RV

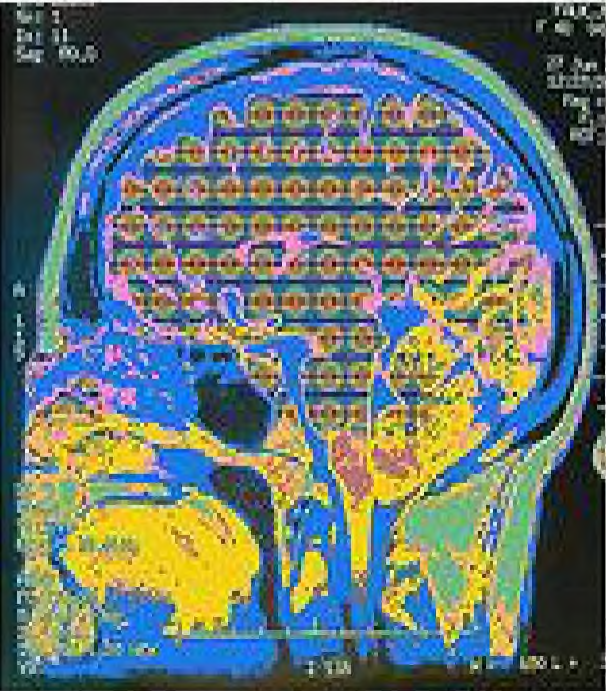
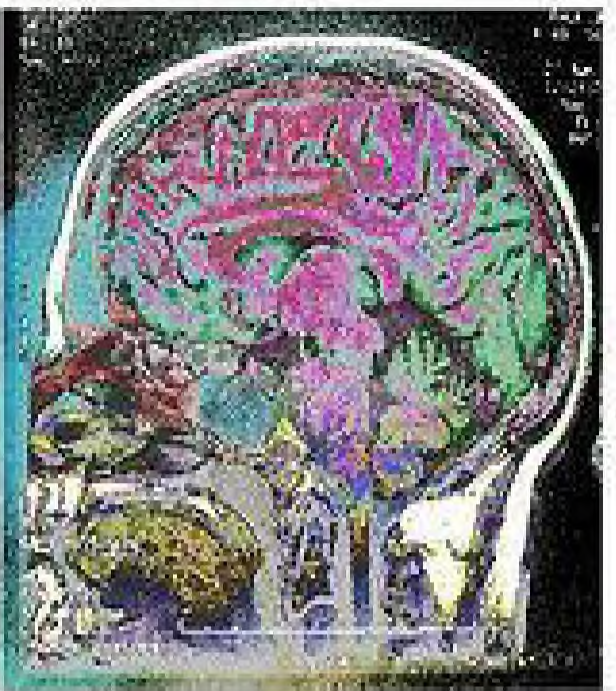
CNormal left
ventricleDamaged
left ventricle
from heart attackLeft ventricle not
receiving enough blood

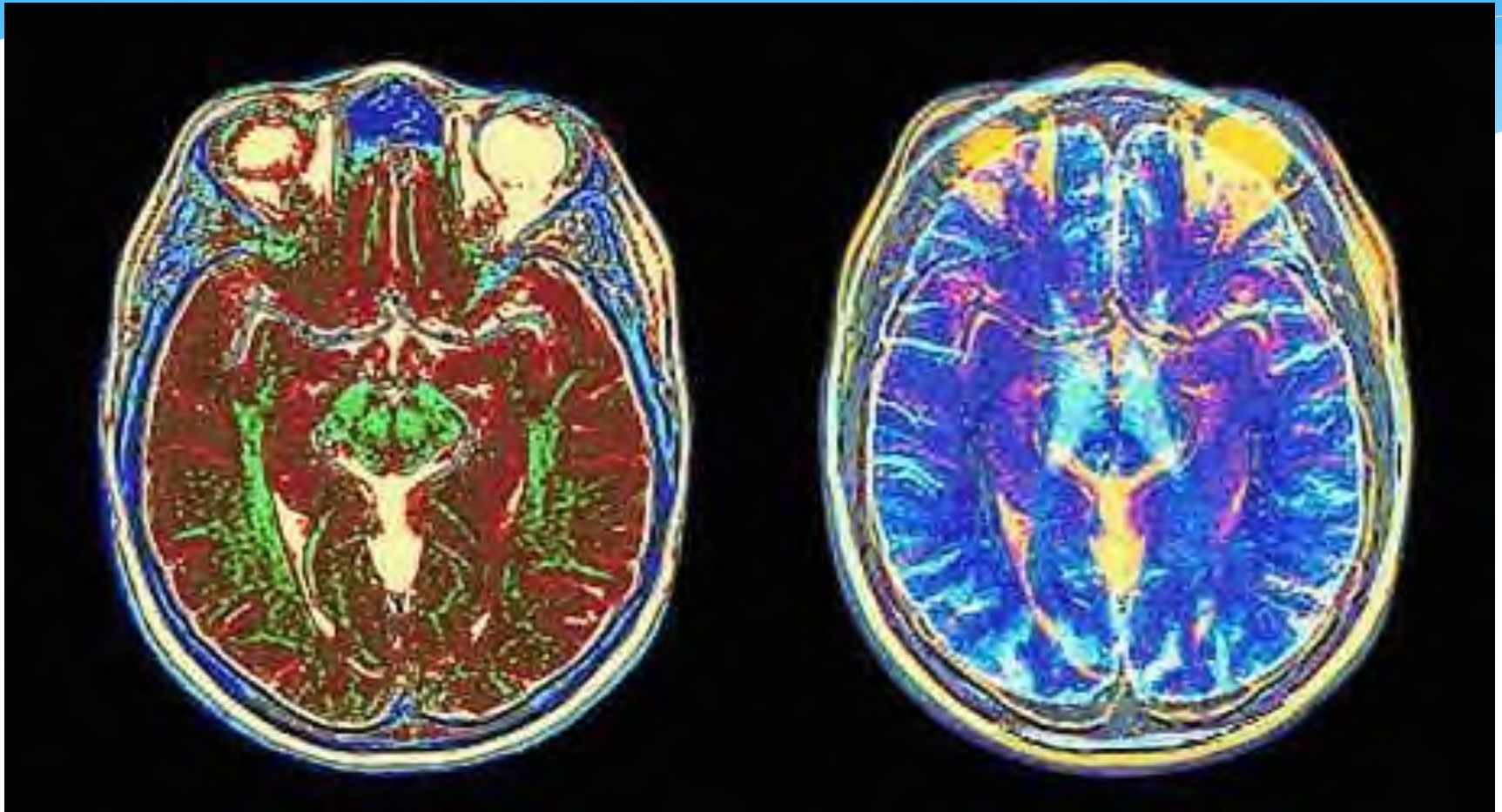
MRI BRAIN





MRI Images of a human brain
Photograph by Ken Glaser/Corbis





FULL BODY MRI

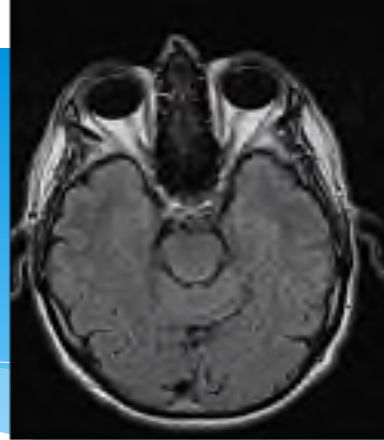


*The Zero Radiation**
Full Body MRI Scan

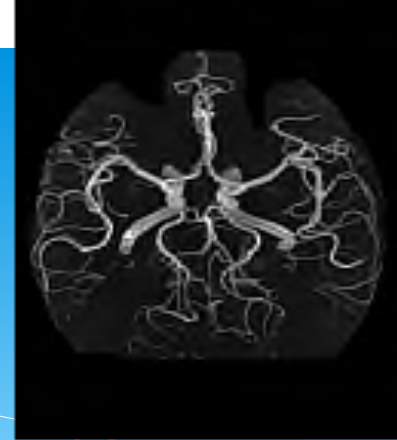


This comprehensive health screening allows our doctors to non-invasively examine the inside of the body in detail and look for early stages of disease.

*No x-ray radiation and no injections are involved.



Brain MRI



Brain MR/Angiography evaluates brain arteries & blood vessels.



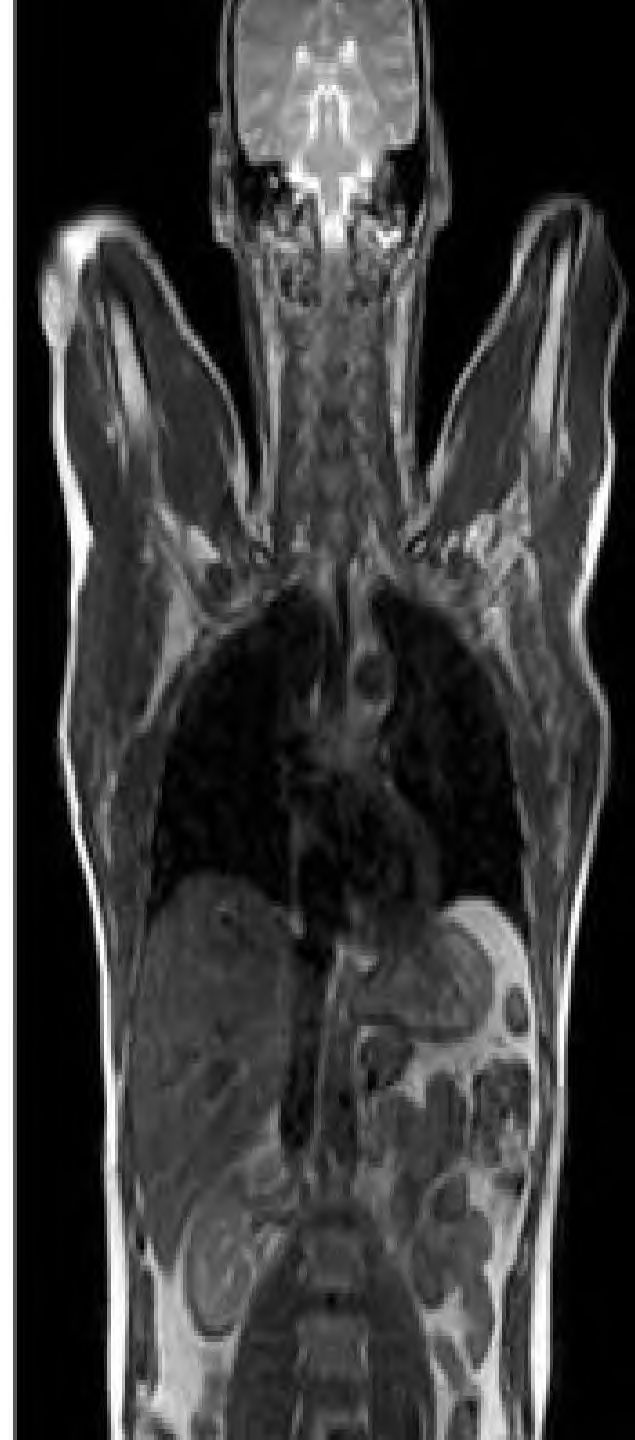
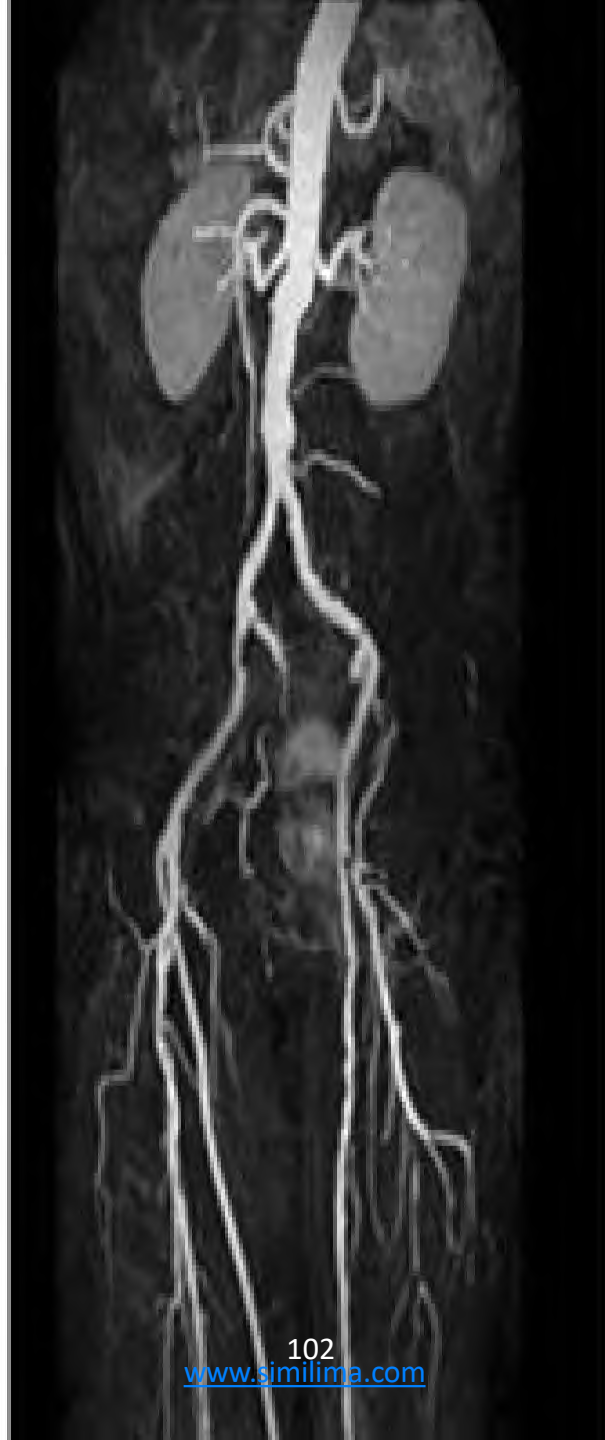
Vital organs of the neck, thorax, abdomen, pelvis, reproductive organs.



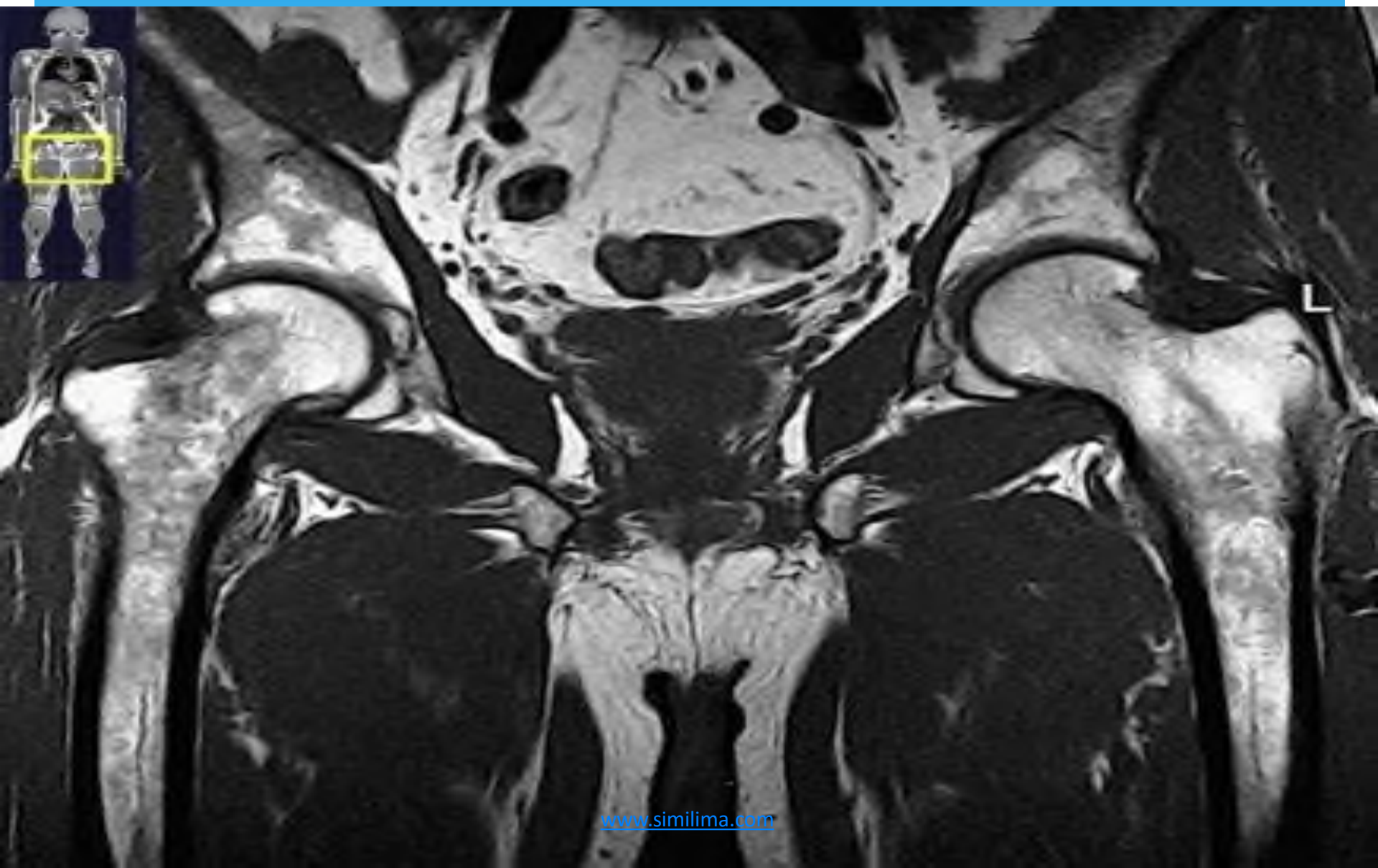
Lumbar spine, spinal cord, discs, hips.



Neck & Carotids MR Angiography



MRI PELVIS



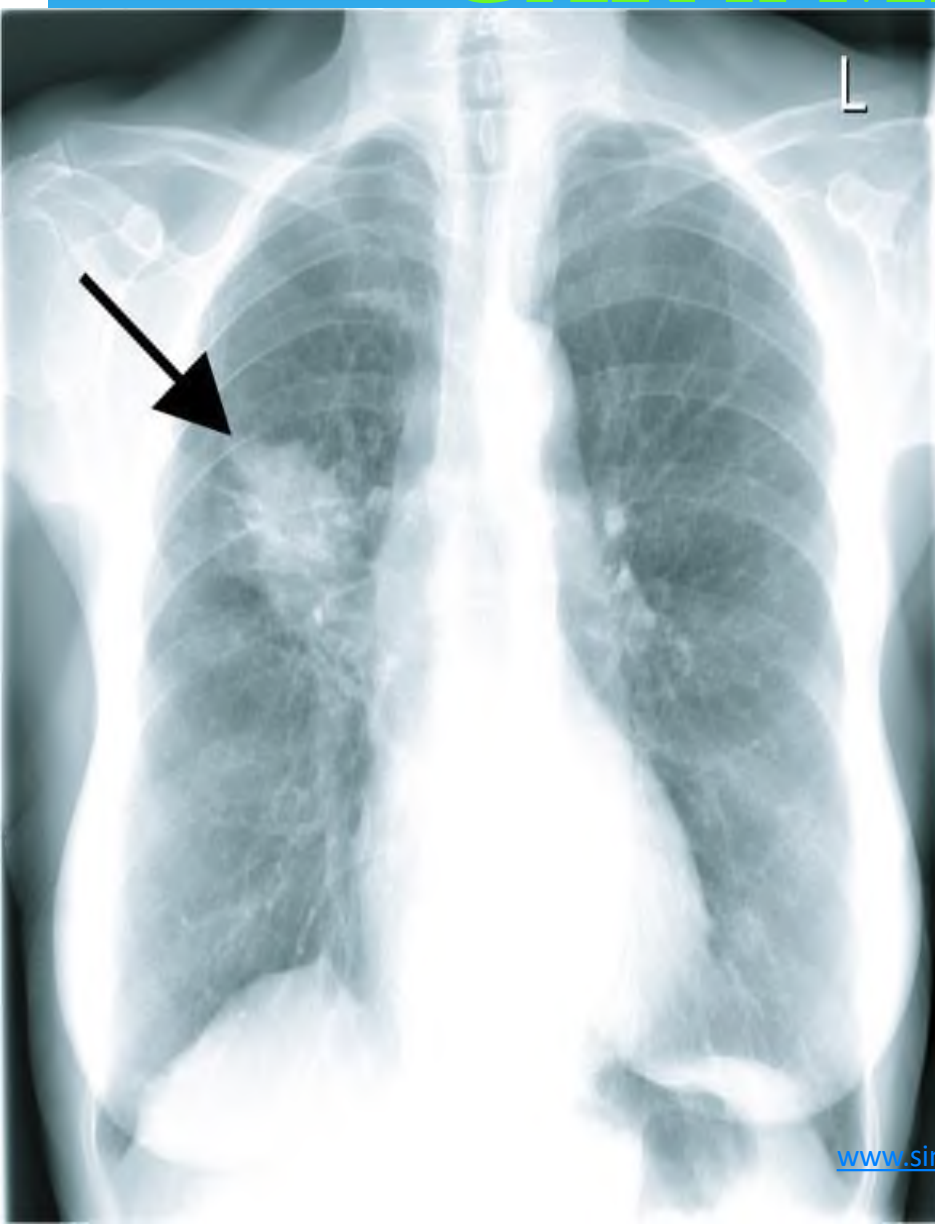
MRI WRIST JOINT



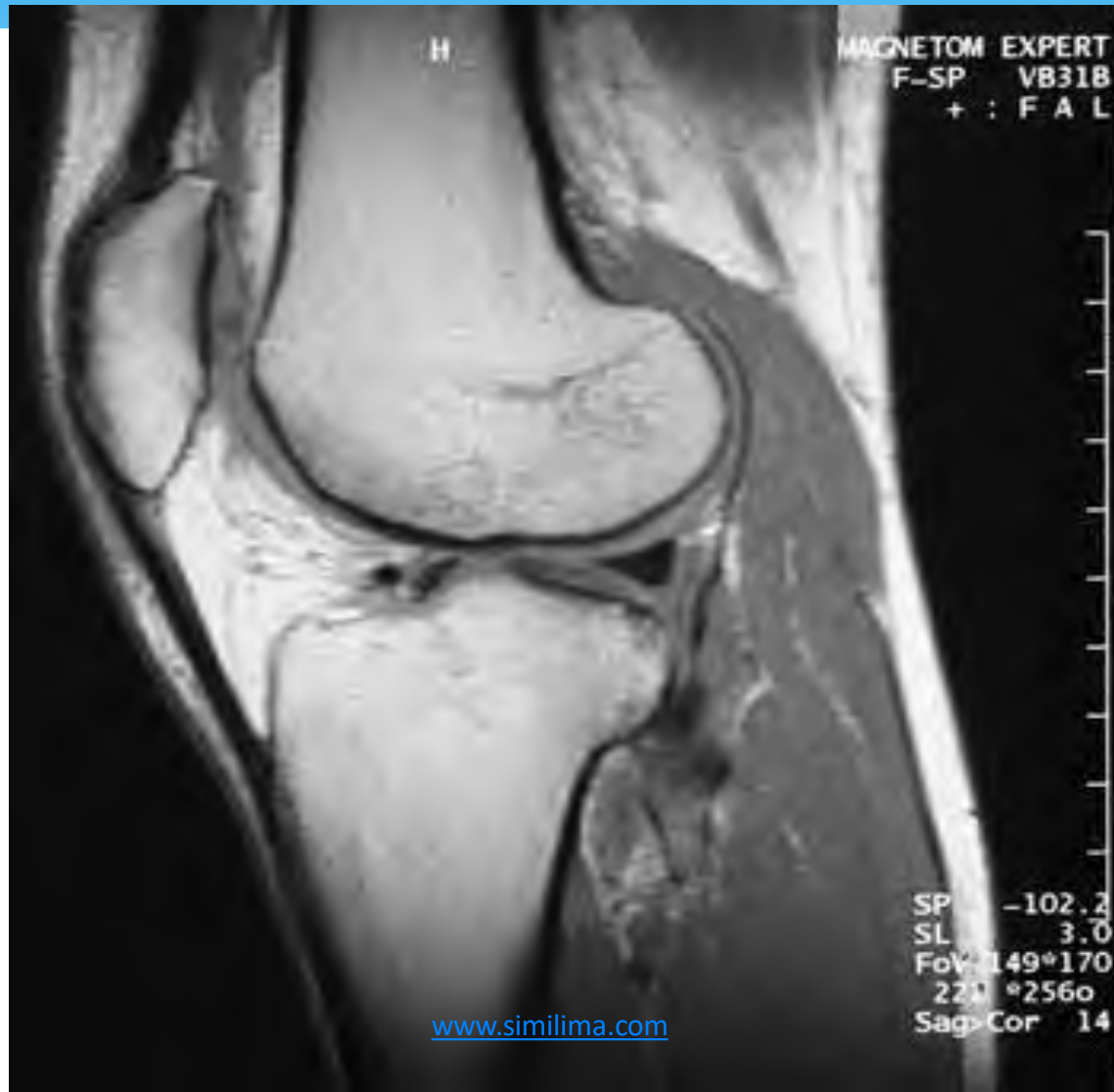
ROTATOR CUFF SHOULDER JOINT

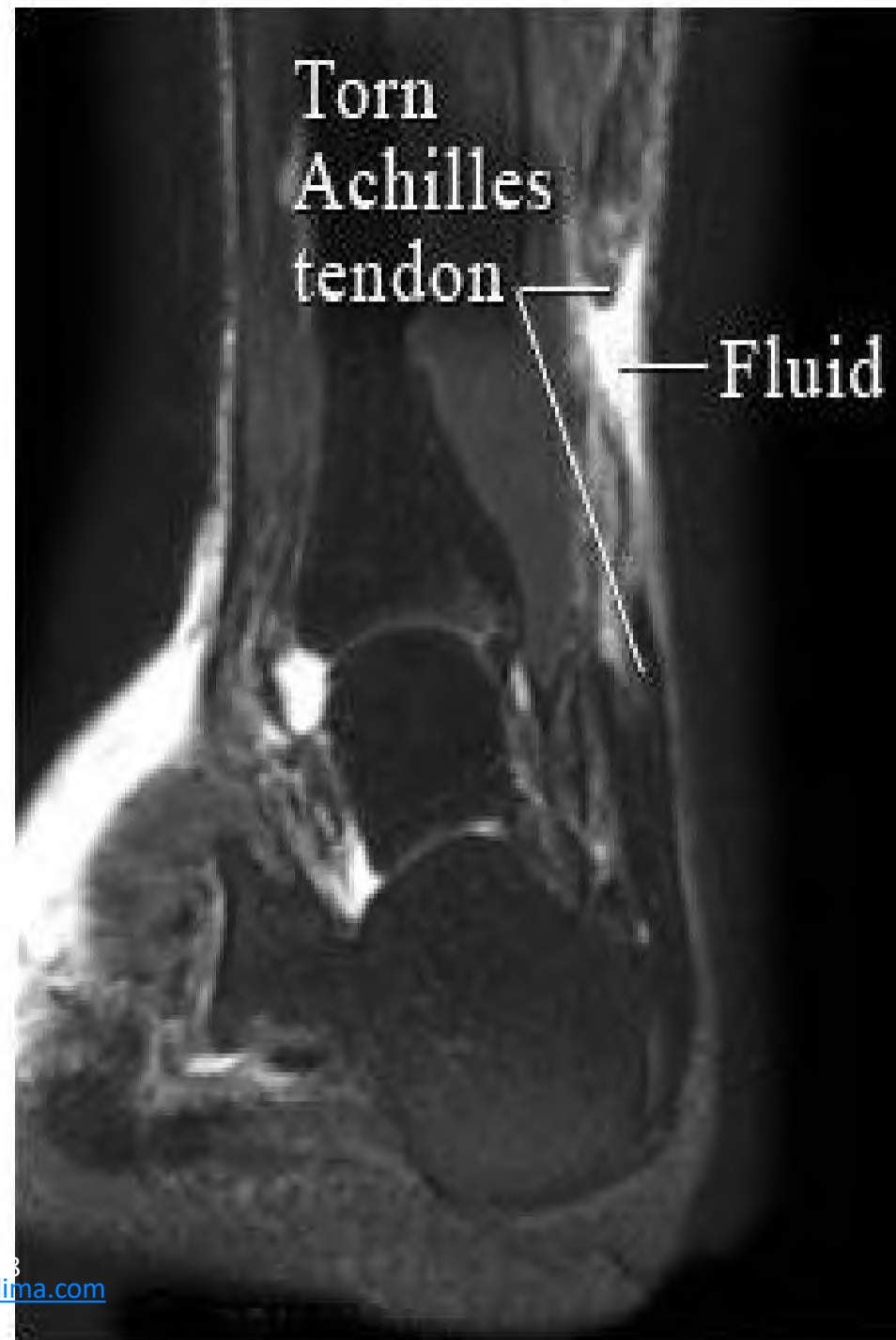


CXR n MRI CHEST

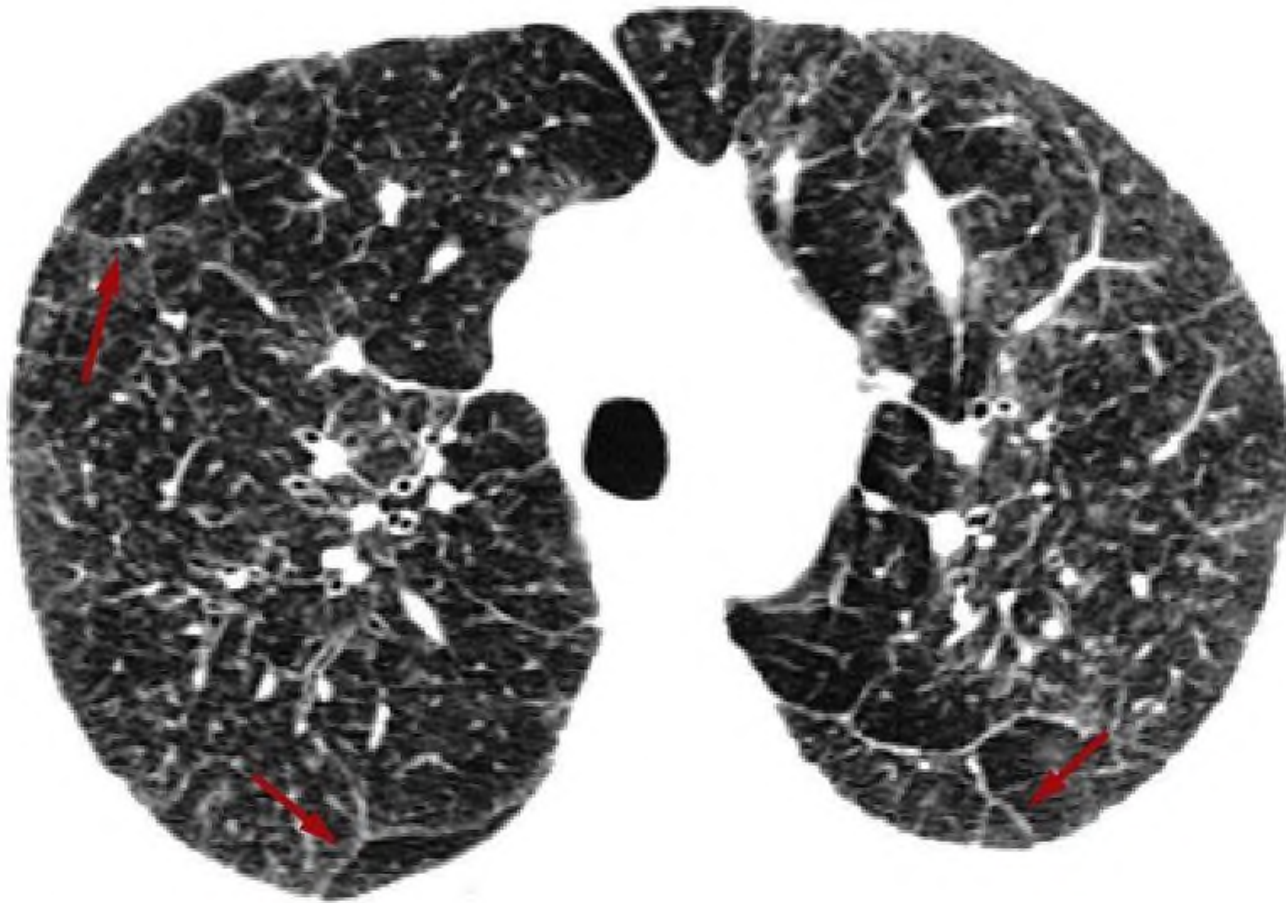


KNEE JOINT





Interlobular septal thickening is commonly seen in patients with interstitial lung disease.



RENAL MASS

Medscape®

www.medscape.com

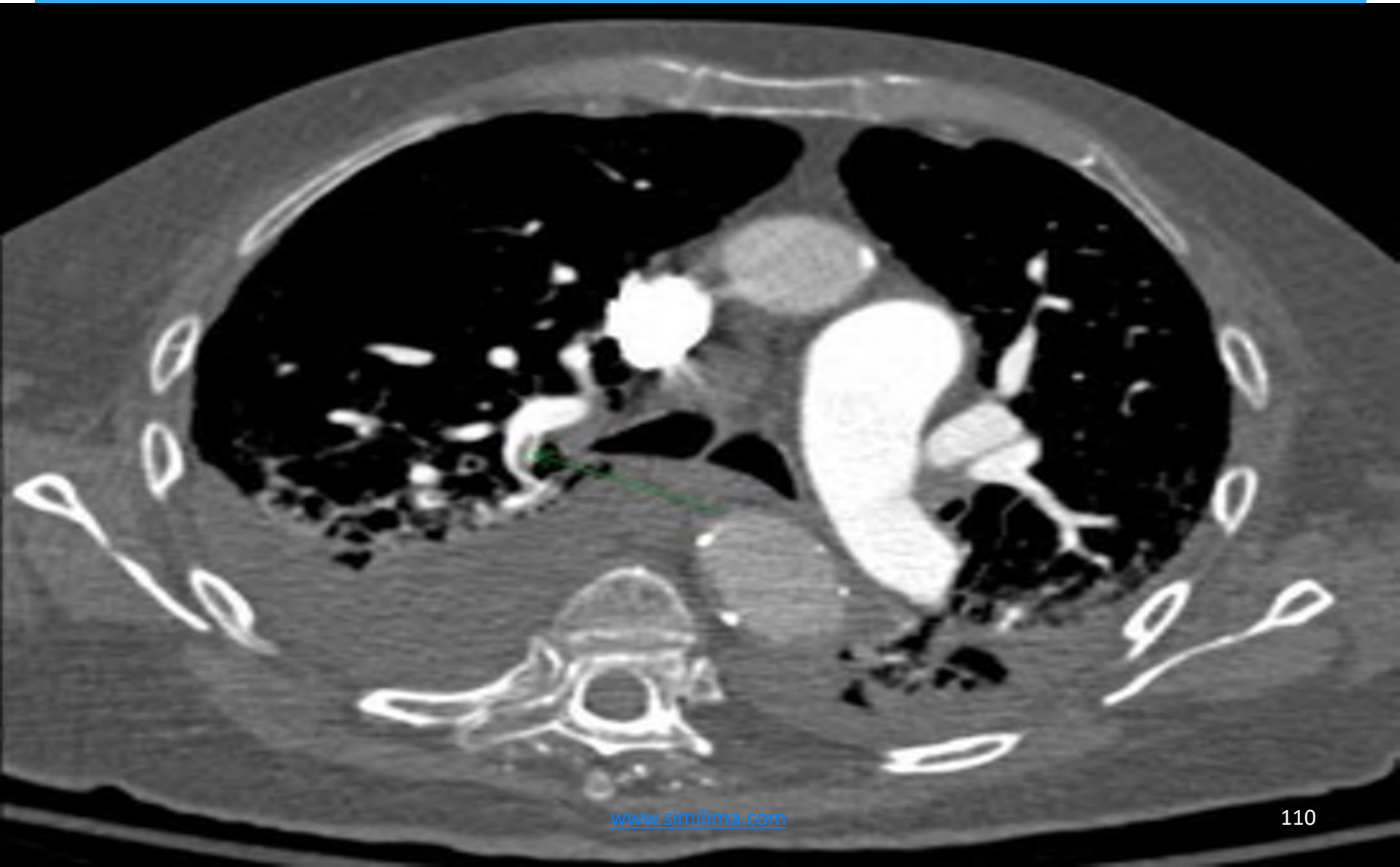
A



www.similima.com

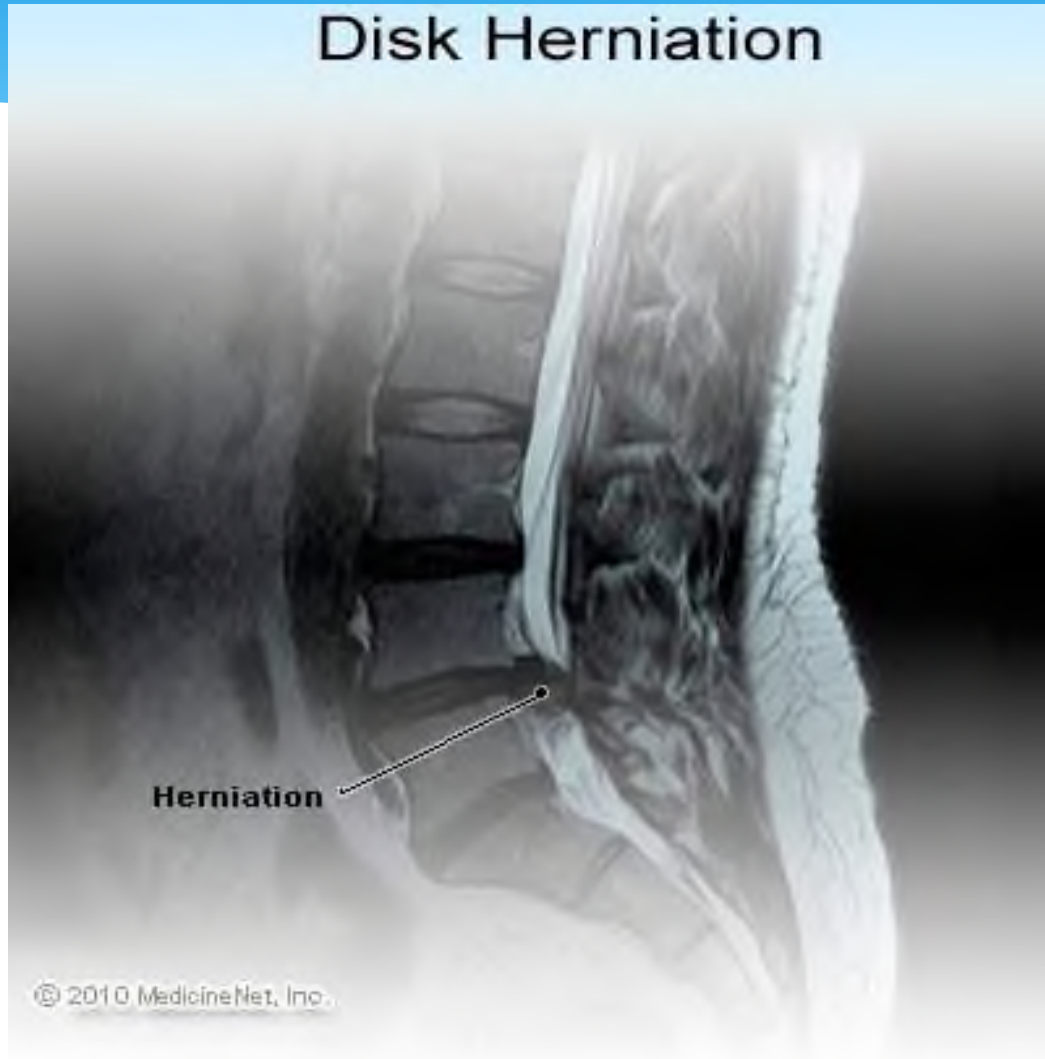
P

PULMONARY EMBOLI



Herniated disc between L4 and L5

Disk Herniation



Disk Herniation



Herniation

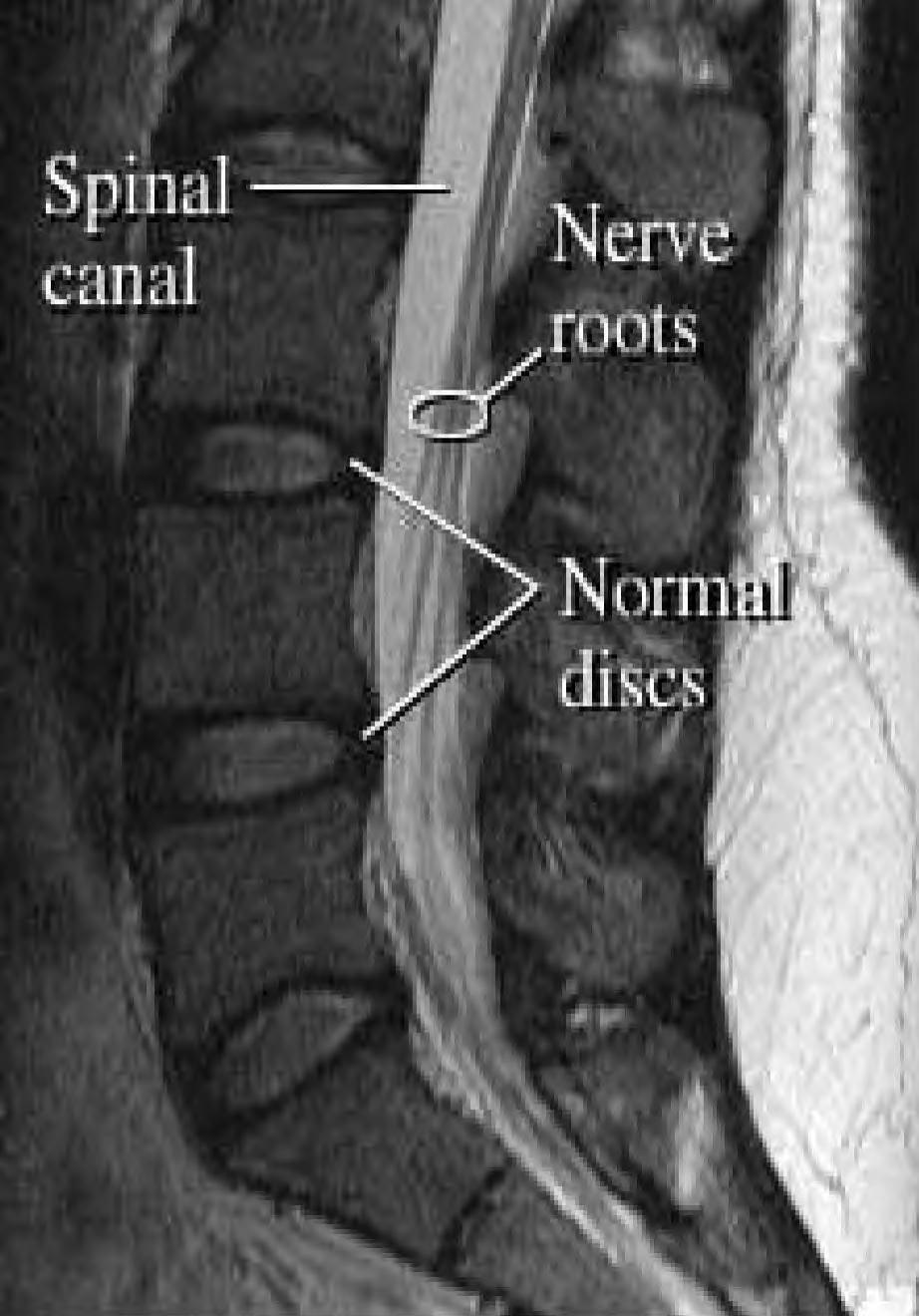


Figure 1

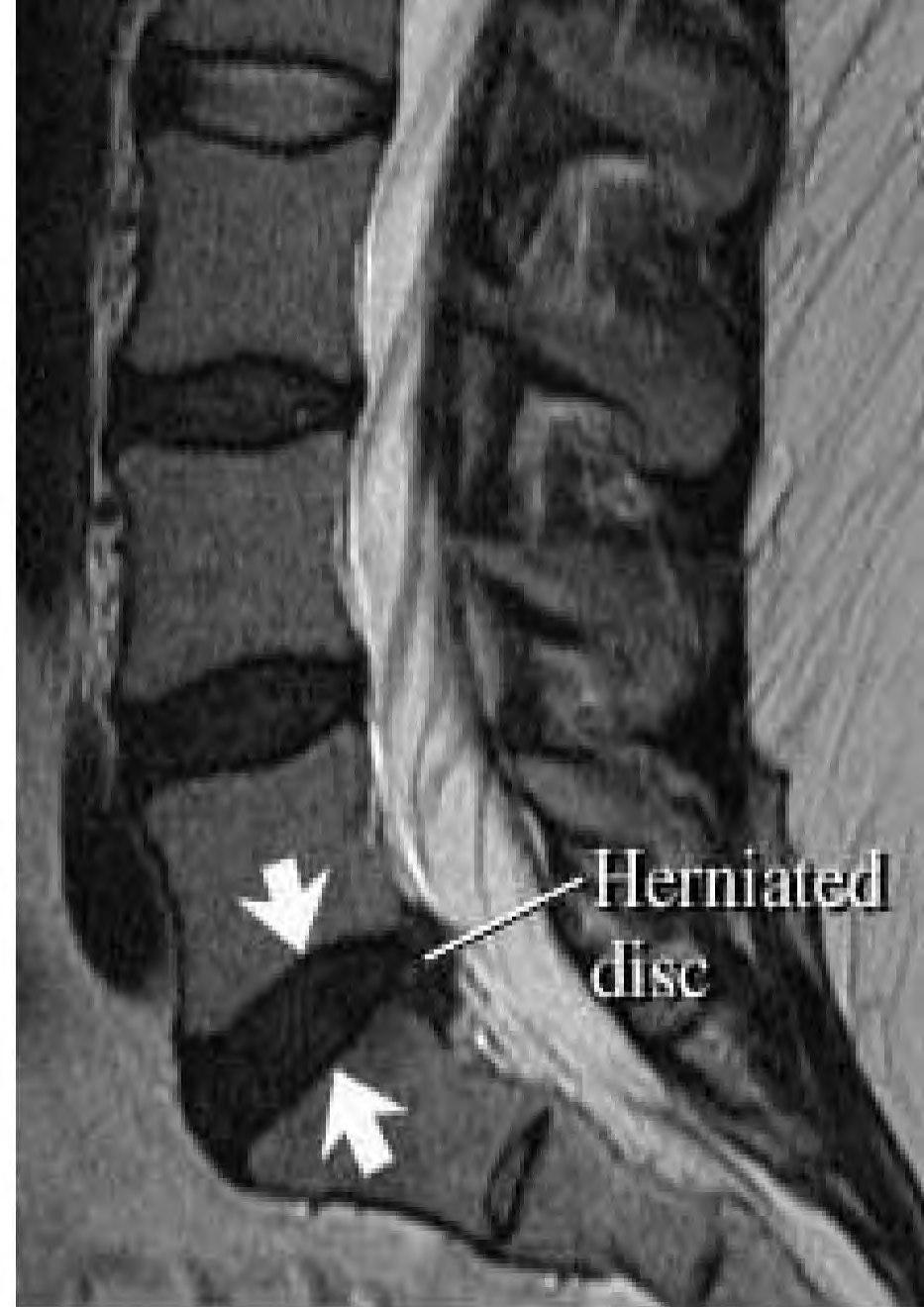
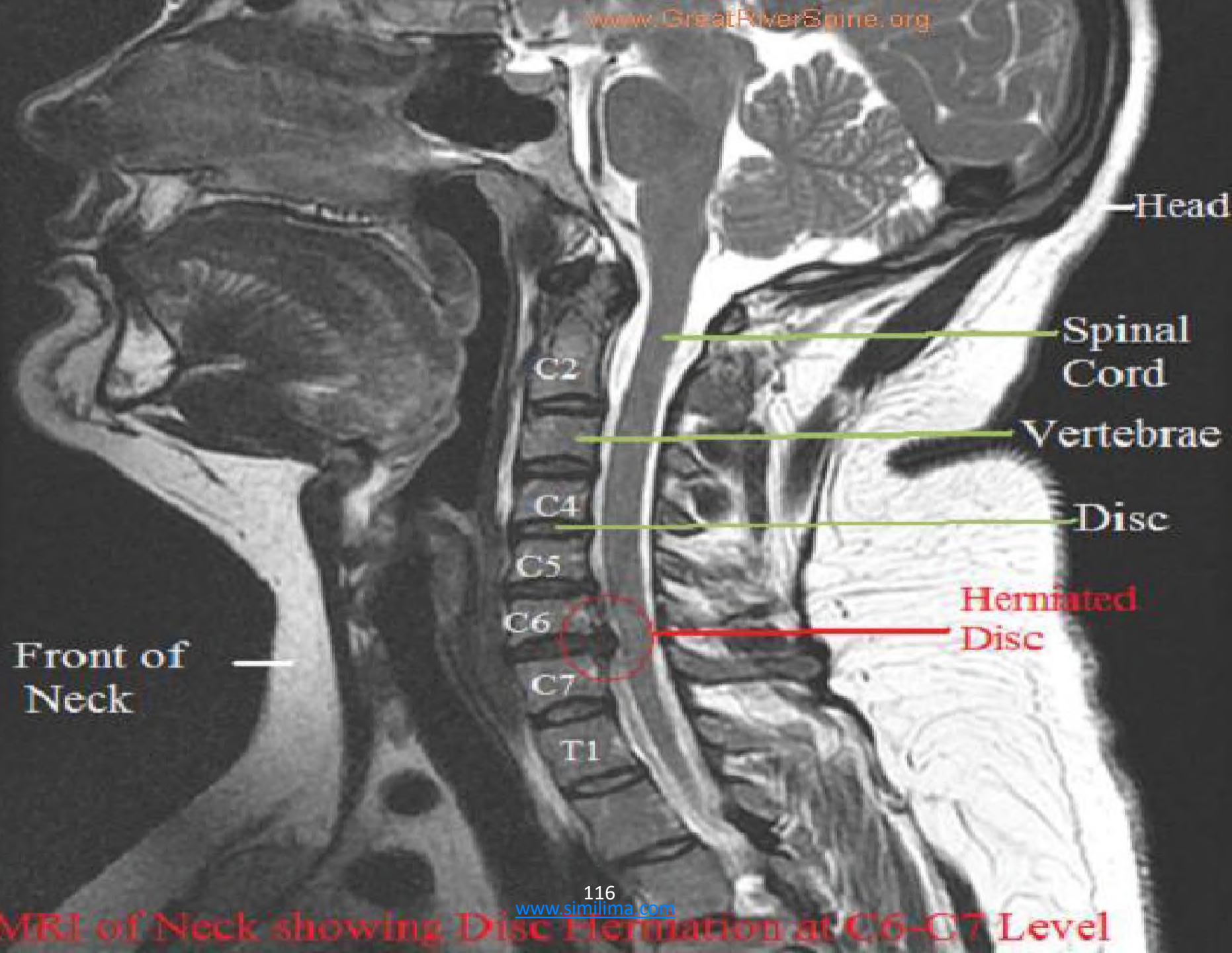


Figure 2

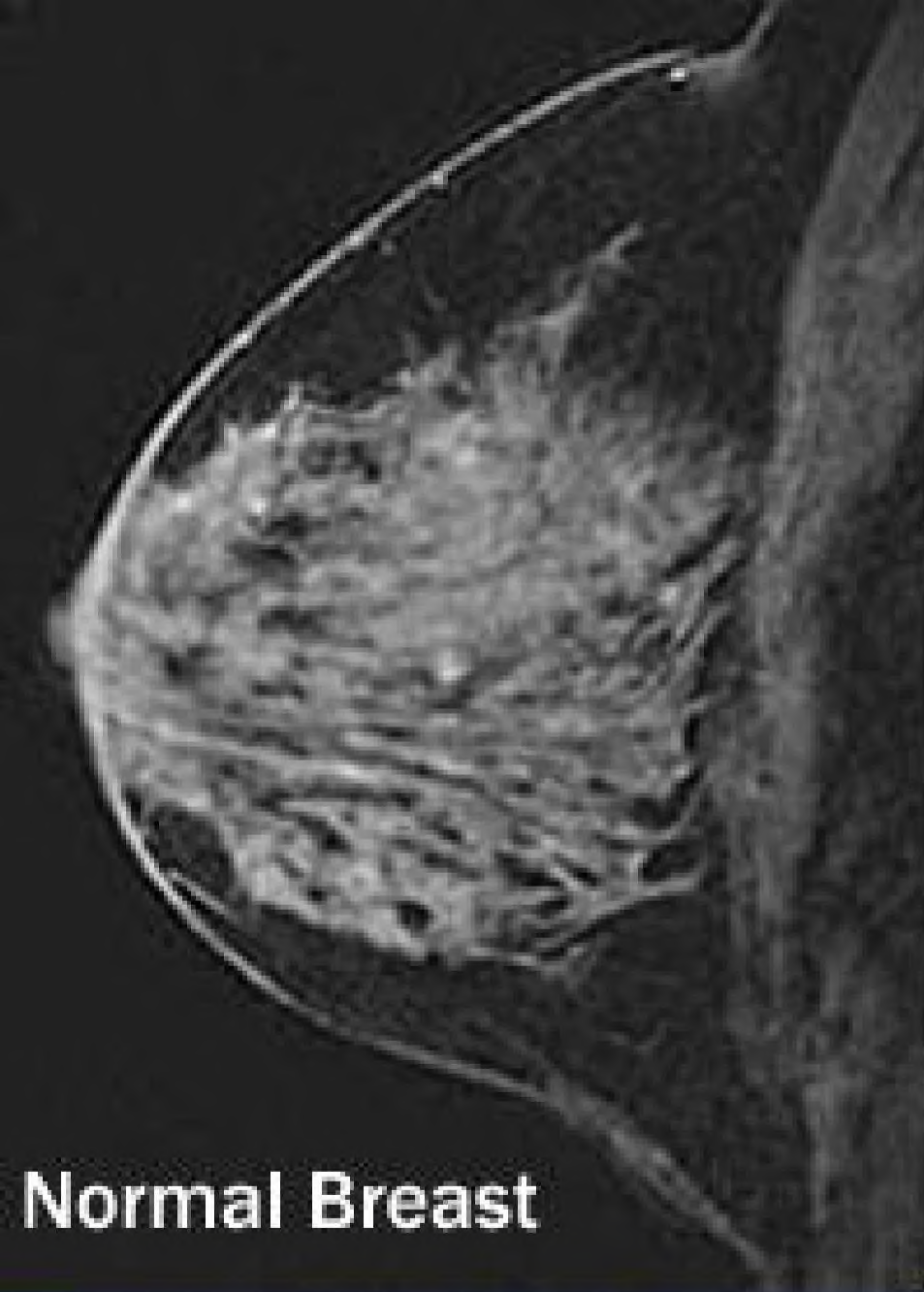


The tumor
is located
between
the 5th
and 6th
thoracic
vertebrae



MRI BREAST

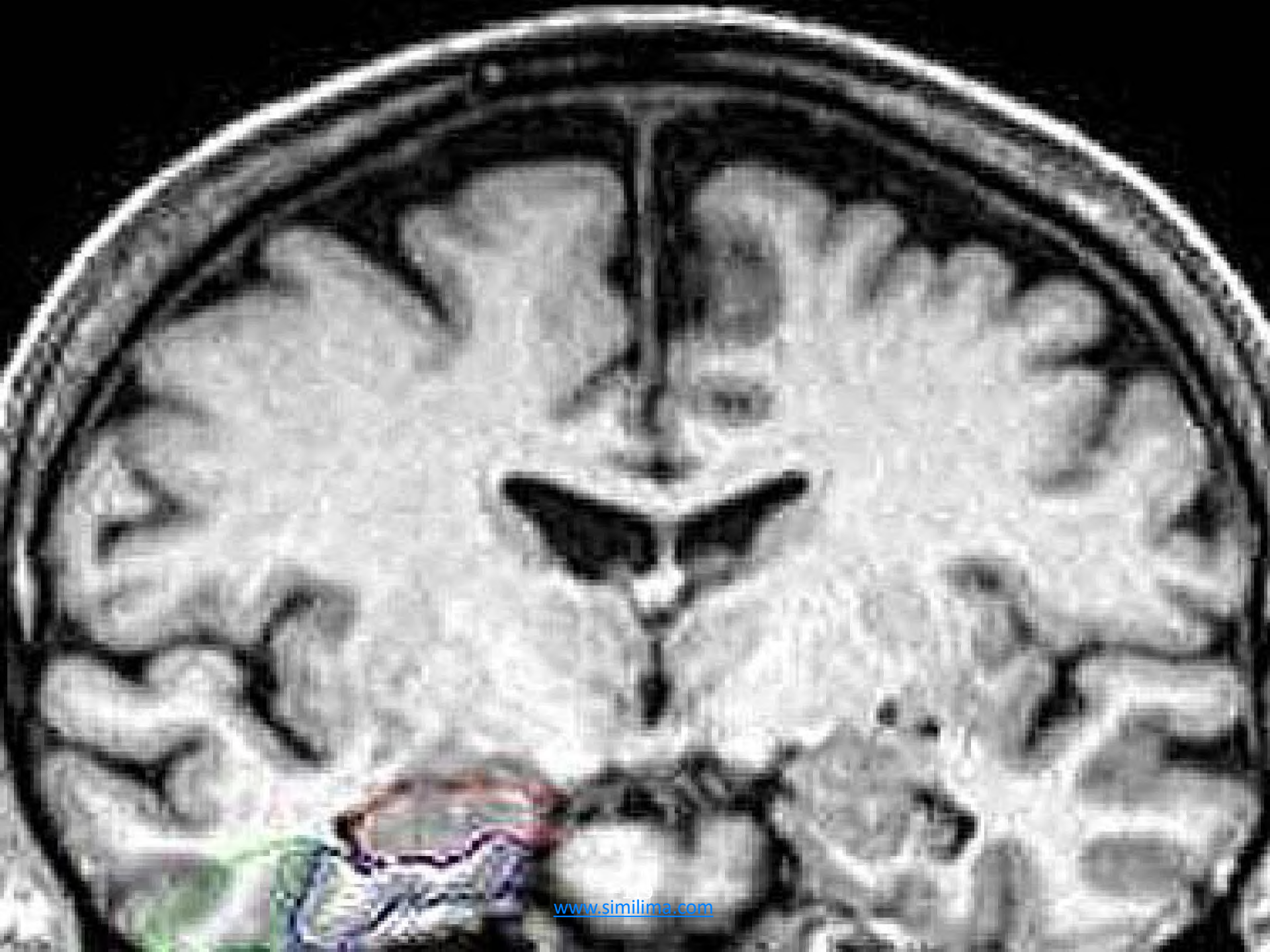




Normal Breast

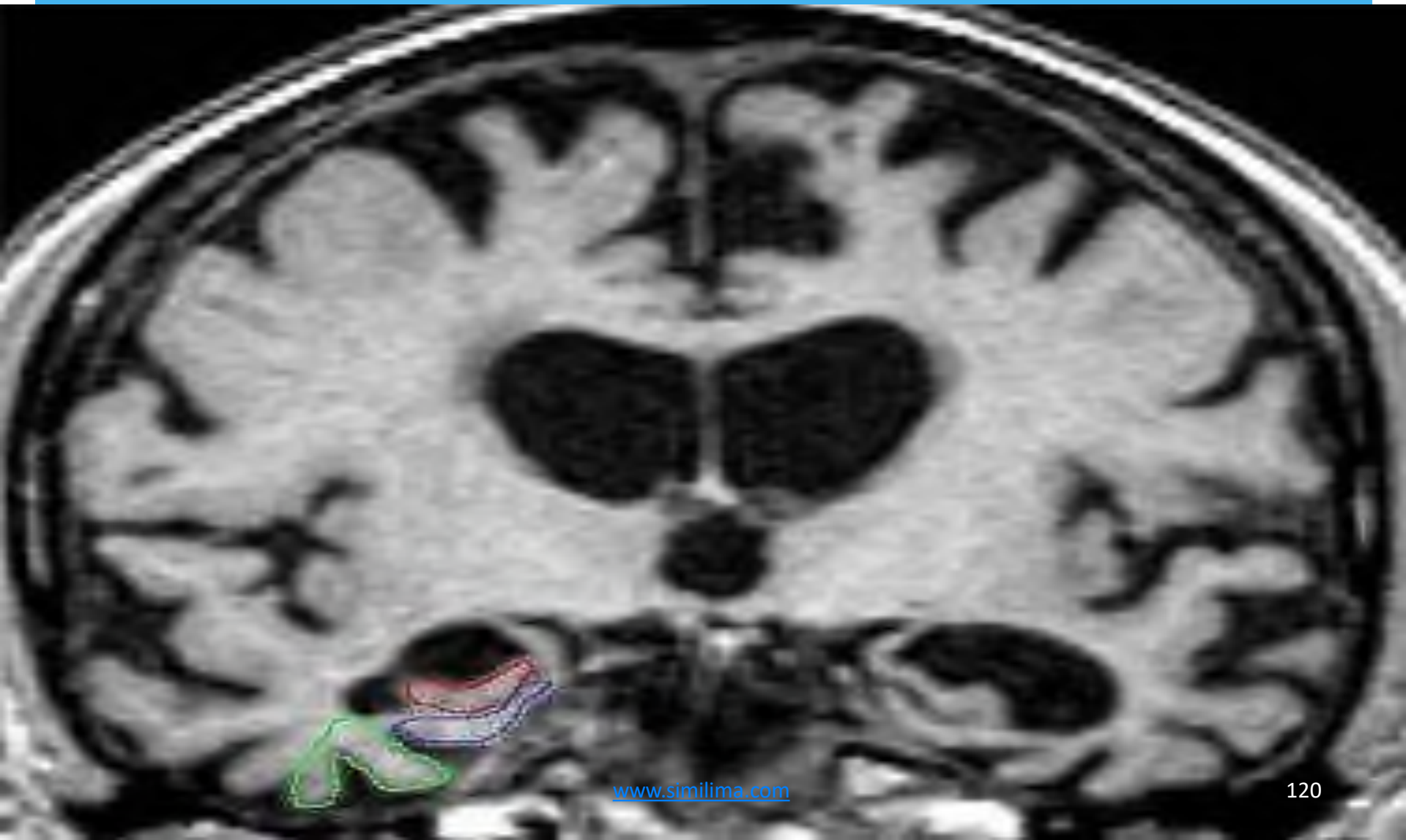


**Suspicious area that
could be cancer**

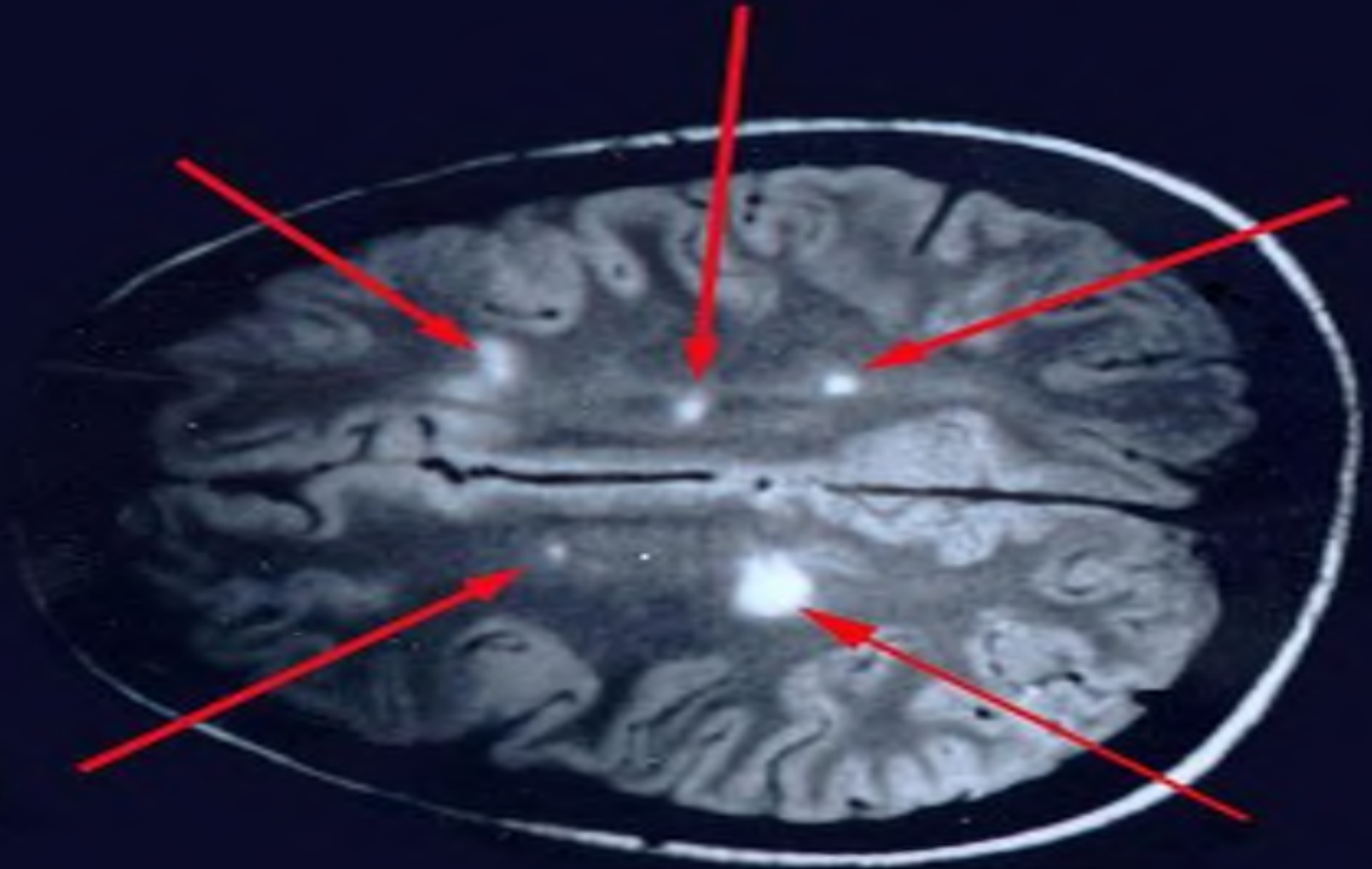


- The normal MRI brain scan above, showing no atrophy, depicts the three areas of interest in the brain's medial temporal lobe: hippocampus (outlined in red); entorhinal cortex (blue) and perirhinal cortex (green).

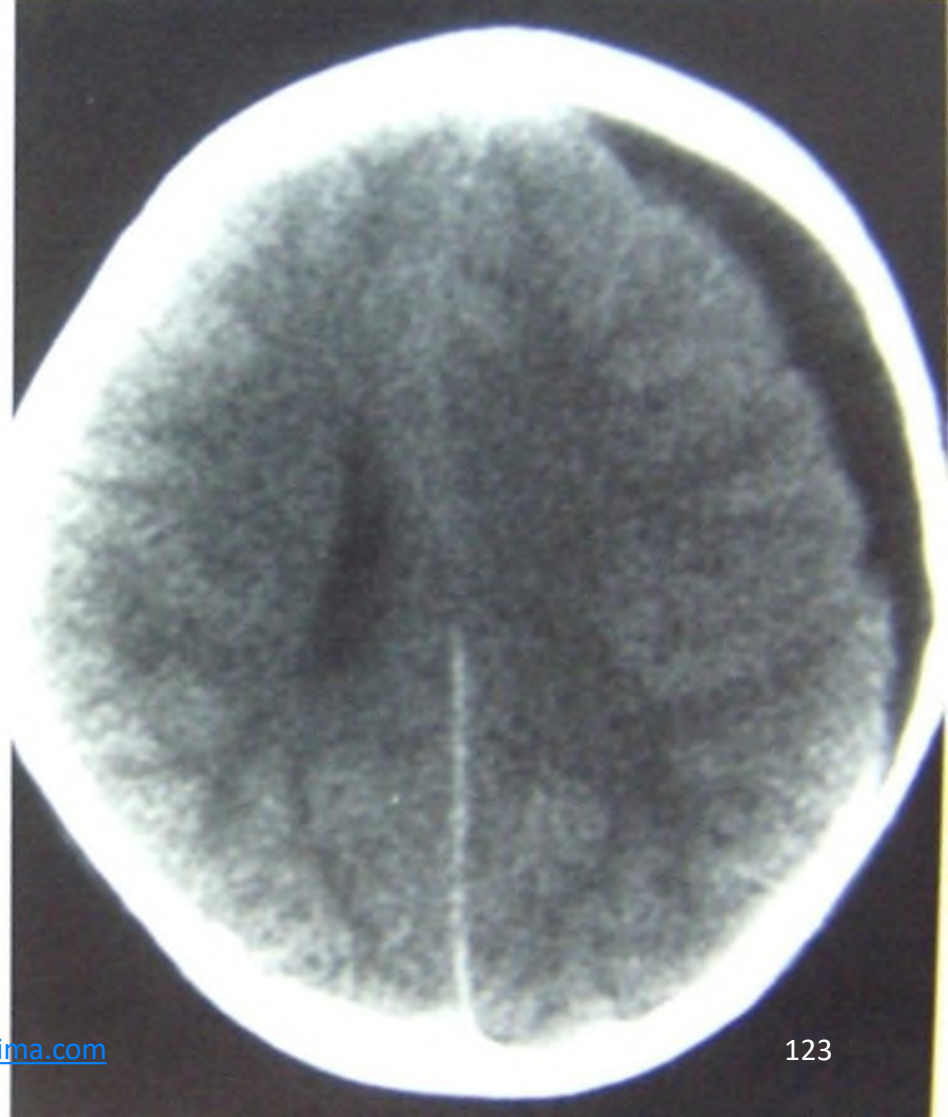
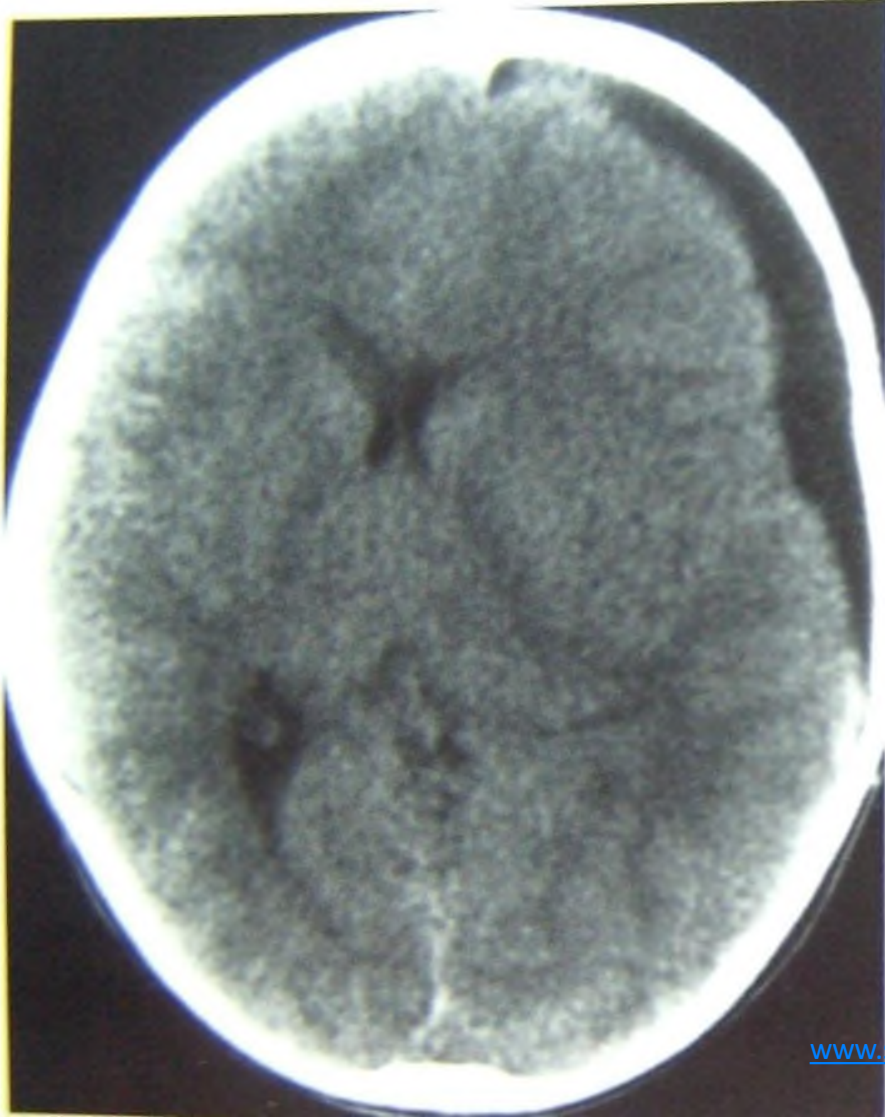
ALZHEIMER'S DISEASE



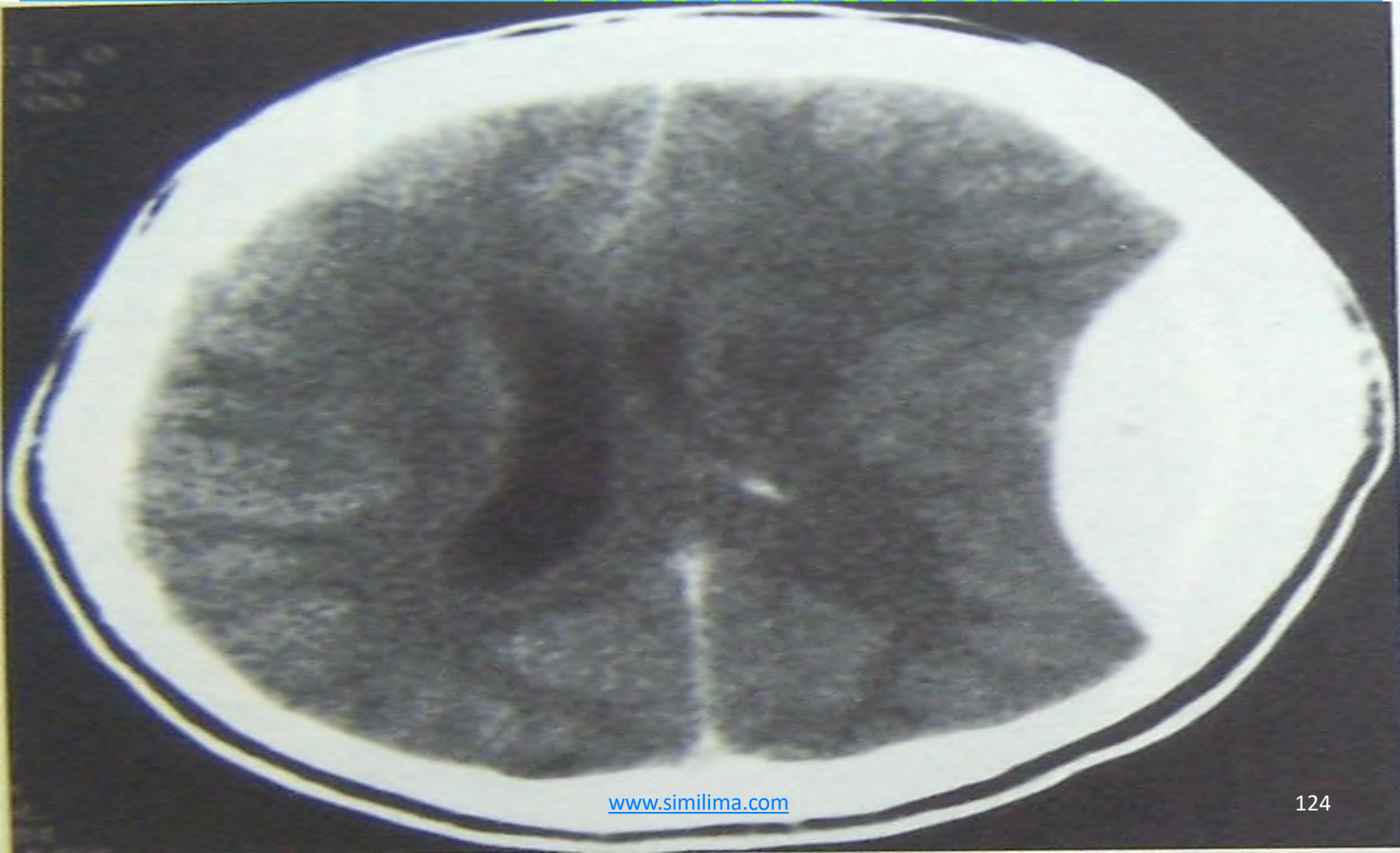
MULTIPLE SCLEROSIS



CHRONIC SUBDURAL HAEMATOMA



SUBACUTE EXTRADURAL HAEMATOMA



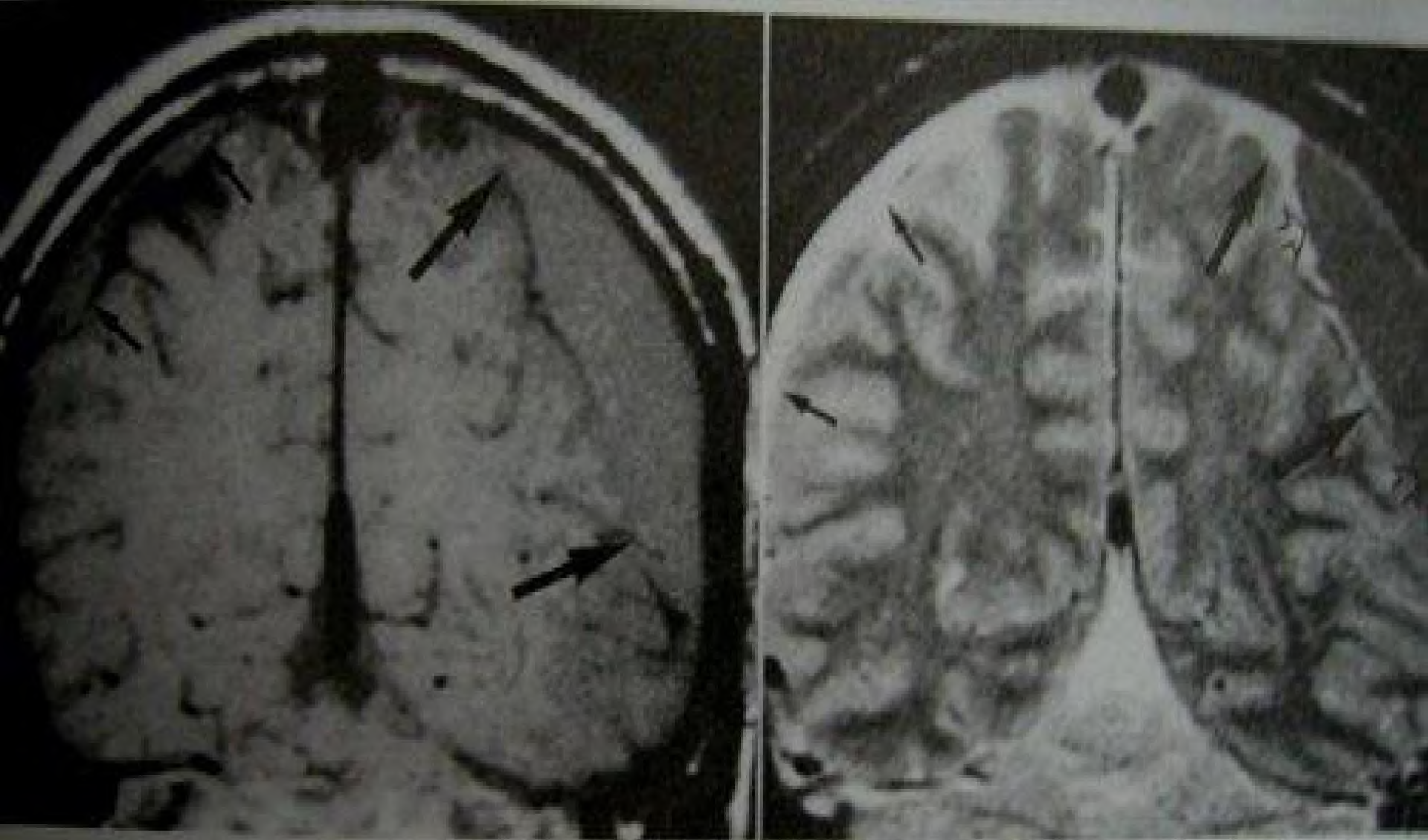
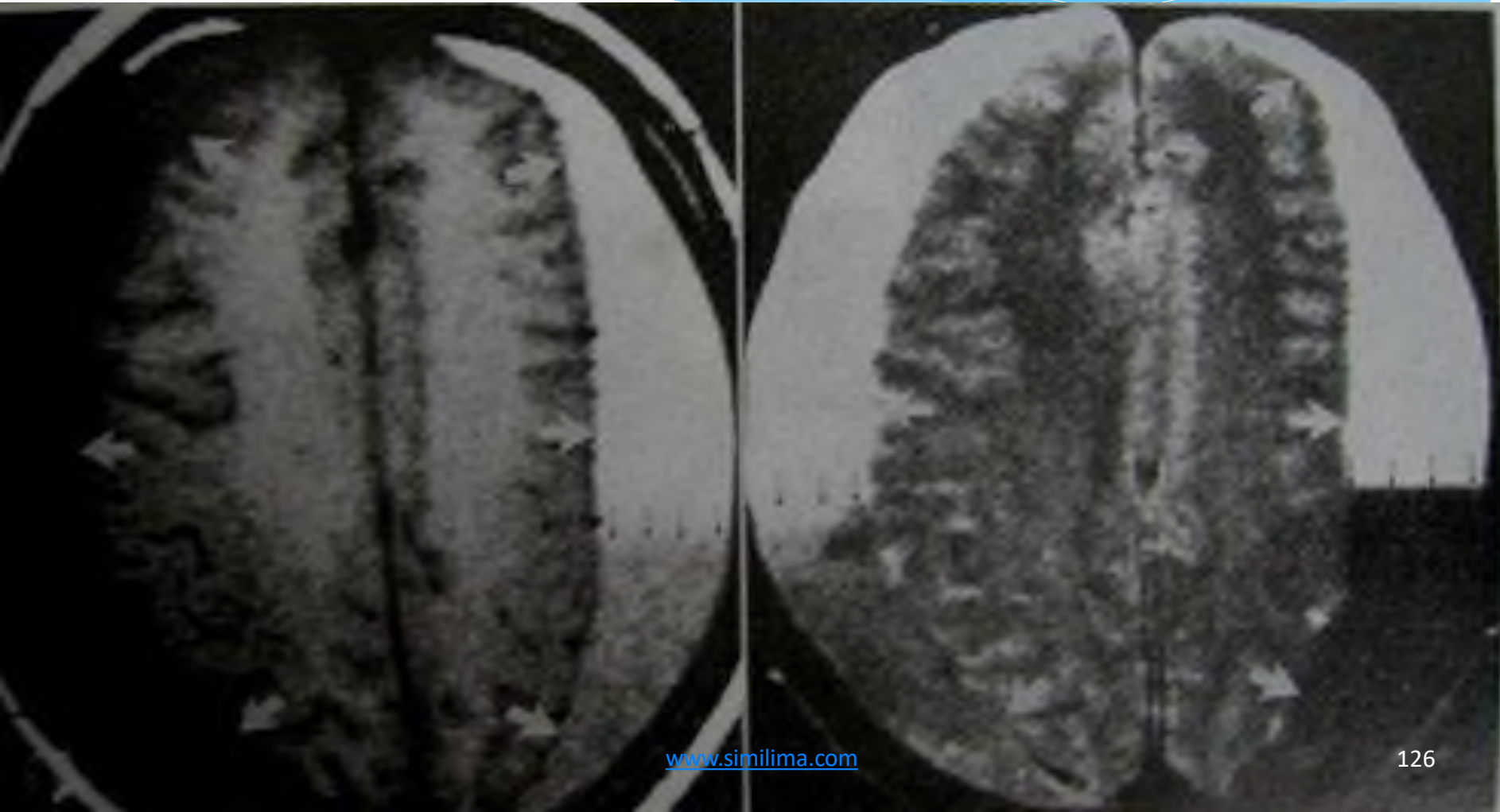
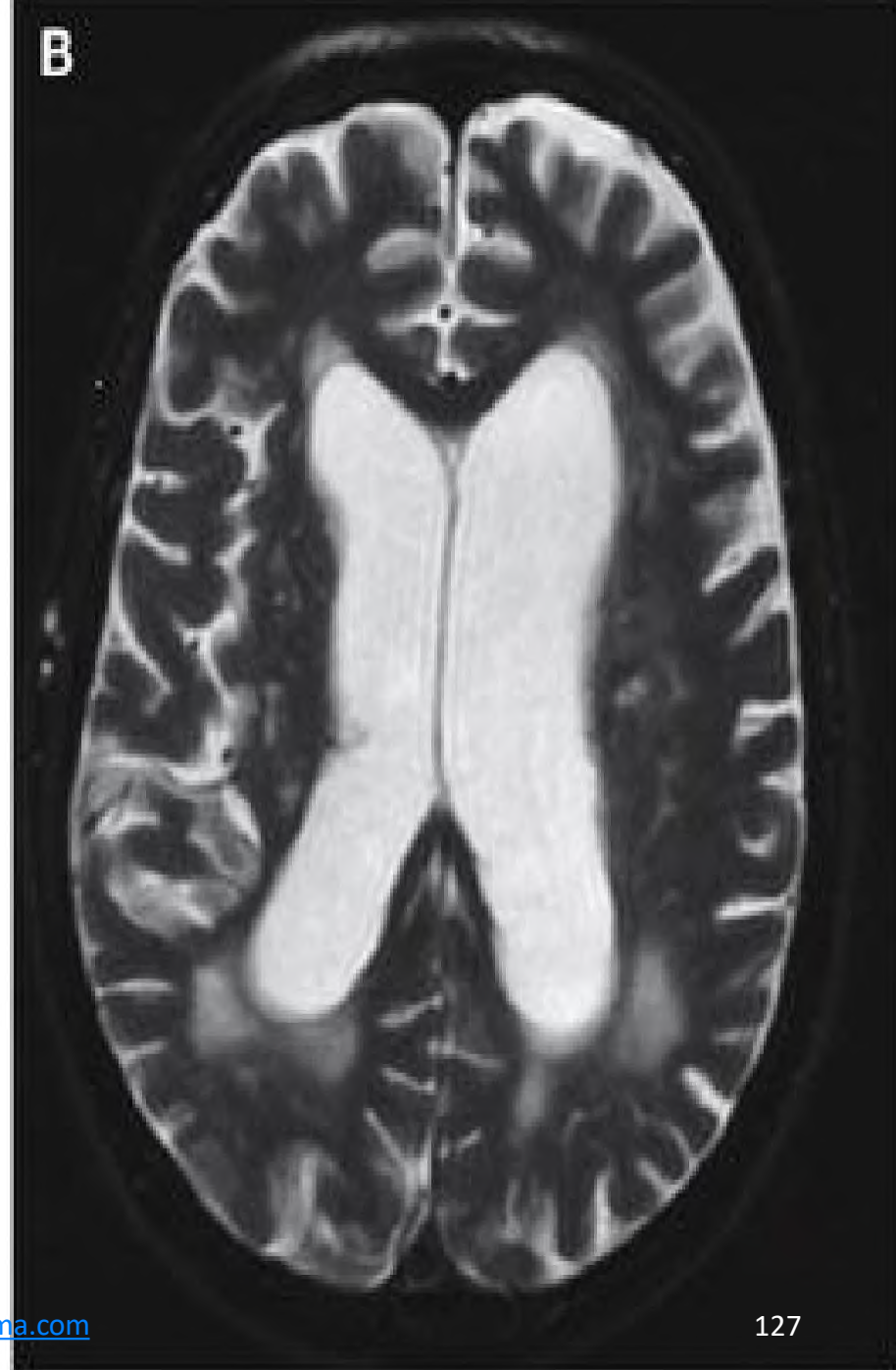


Fig. 8-20. Coronal T1- (A) and T2-weighted (B) MR scans show bilateral subdural hematomas. The crescentic right-sided collection (*small arrows*) is a chronic SDH. The left-sided chronic SDH (*large arrows*) contains a larger, lentiform subacute collection (*open arrows*).

Axial T1 & T2 WI shows large mixed age chronic SDH with fluid – fluid levels



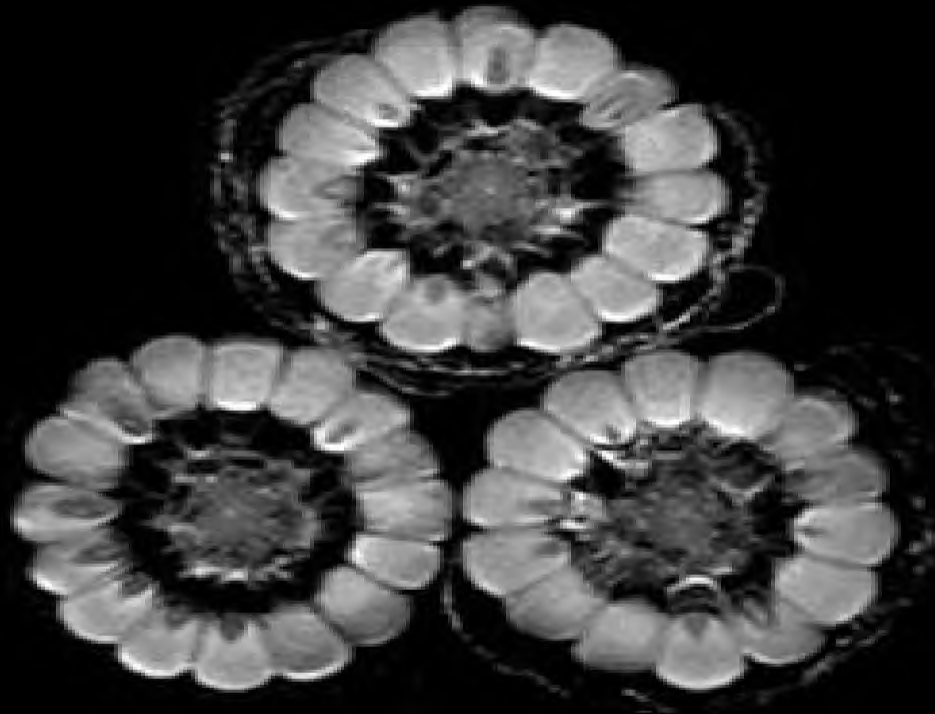
A**B**

A) Head CT scan demonstrating
an aneurysm without

"HE SEEMS CRANKY, BUT HIS HEART IS IN THE
RIGHT PLACE – WE GAVE HIM AN MRI TO
BE SURE."



Bales



Thank you....