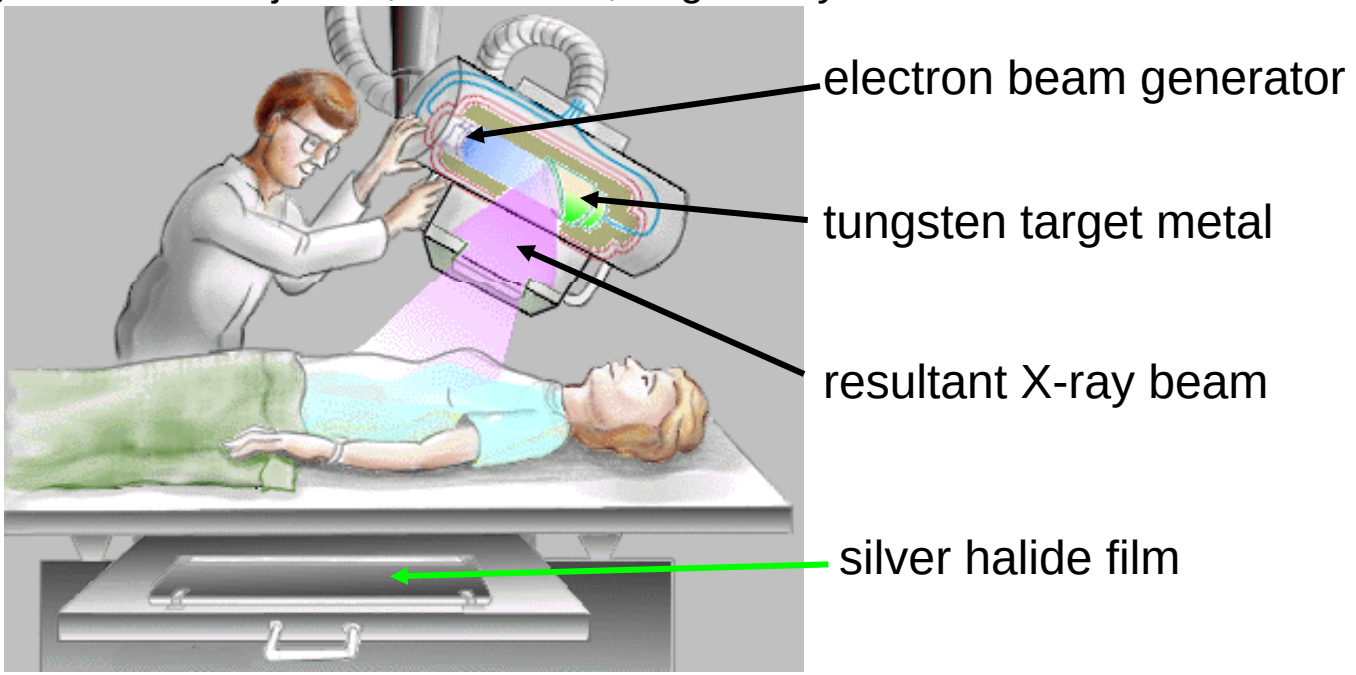
X- Rays

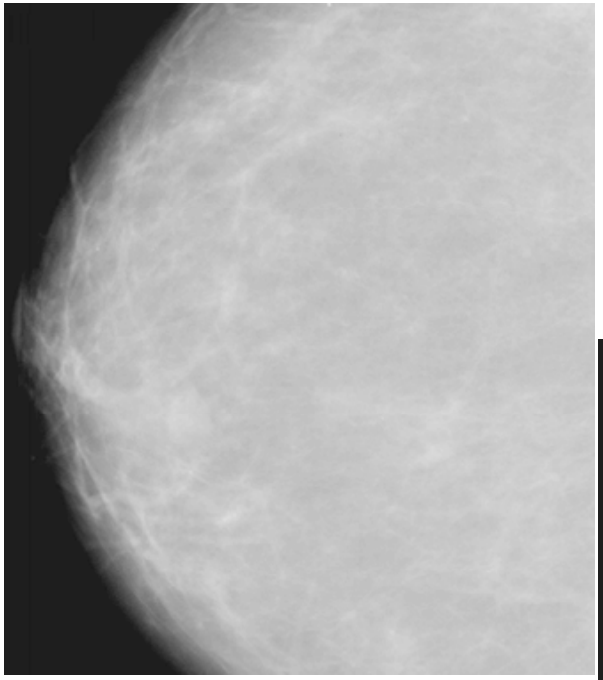
- **X-rays are generated from the interaction of accelerated e^-'s & a target metal (tungsten)**
- **Patient is placed between X-ray tube and silver halide film**
- **X-rays passed through the body are absorbed in direct proportion to tissue density**
- **X-rays penetrating the body strike the silver halide film and turn it dark**
  - The more x-rays that penetrate, the darker the area inscribed on the film
- **Bones & metal absorb or reflect X-rays ➞ inscribed film is "lighter" or "more white"**
- **Soft tissues allow more X-rays to penetrate ➞ inscribed film is "darker"**
- **Visualizing tissues of similar density can be enhanced using "contrast agents"**
  - Contrast agents: dense fluids containing elements of high atomic number (barium, iodine)
  - Contrast agents absorbs more photons than the surrounding tissue ➞ cavity appears lighter
  - These contrast agents can be injected, swallowed, or given by enema



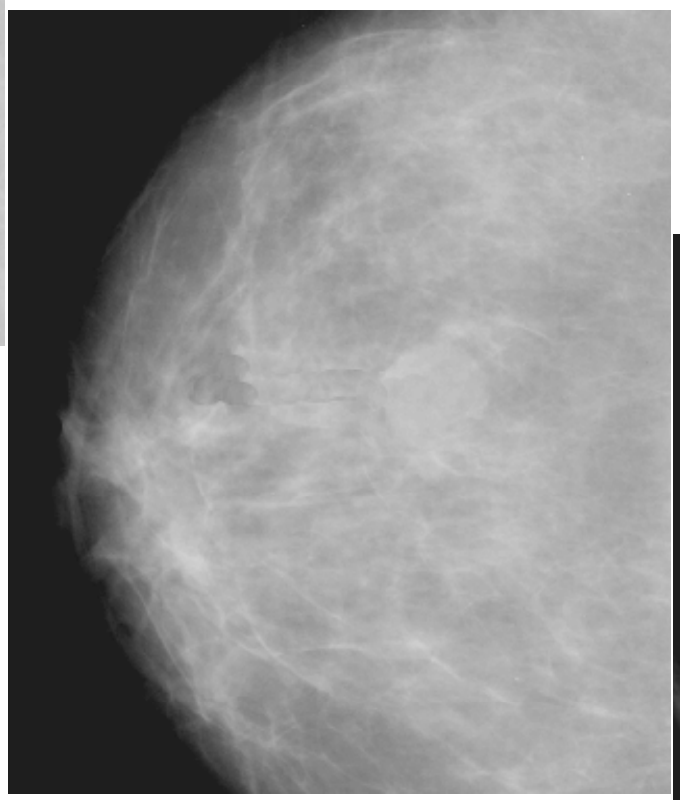
X-ray View of a Gunshot Wound (Bullet has split into fragments)

X-Ray Mammography

For Emma…..
We Will Always Remember !!

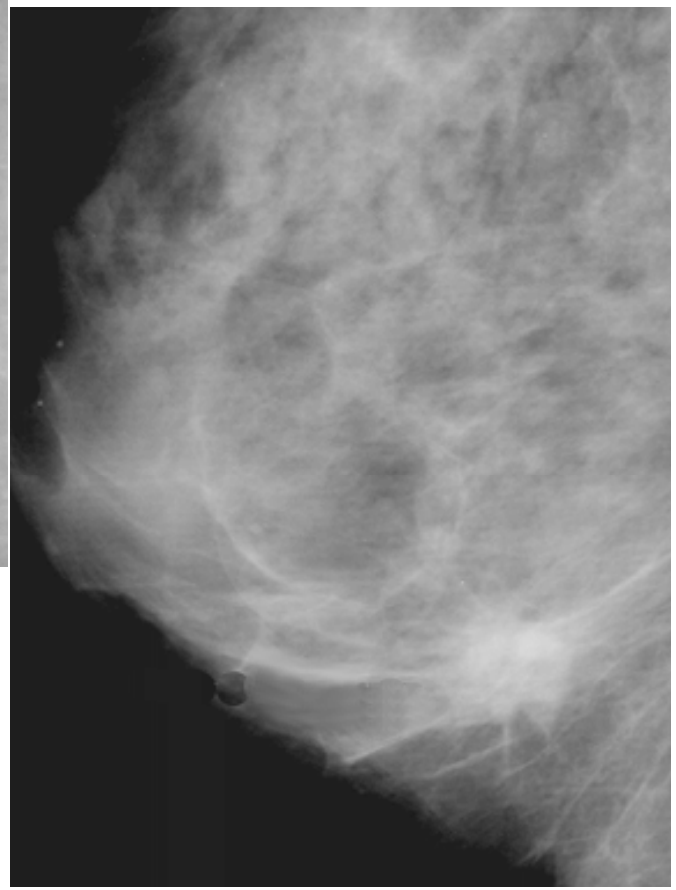


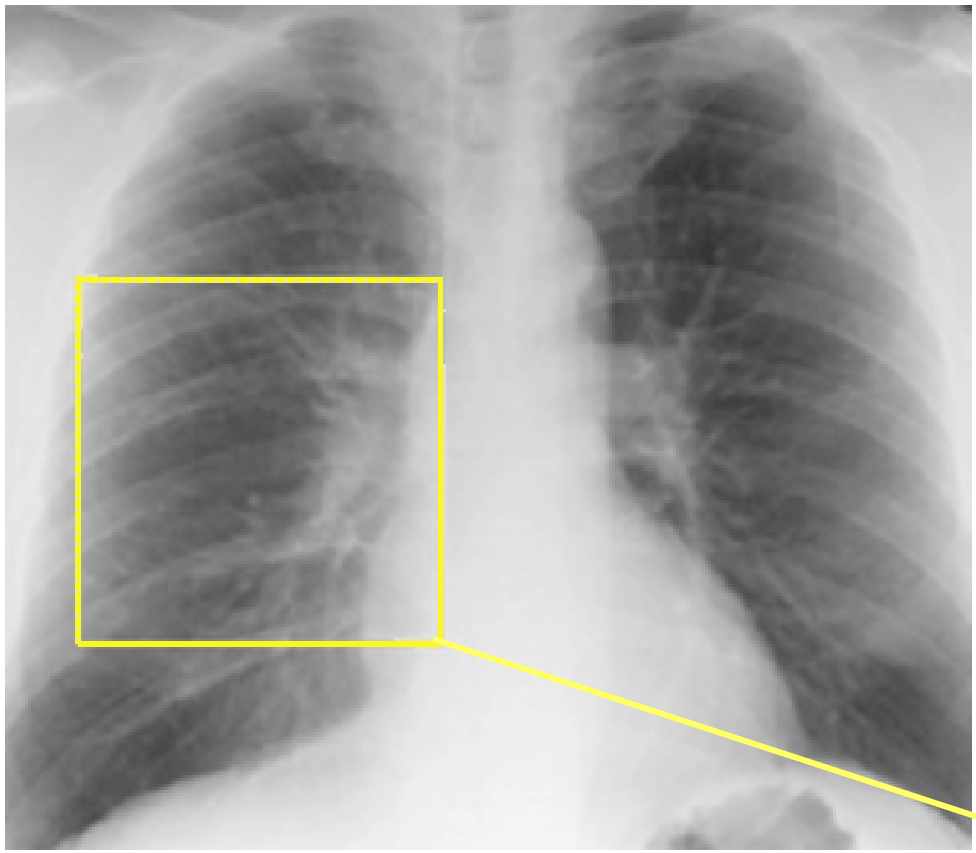
Normal Breast



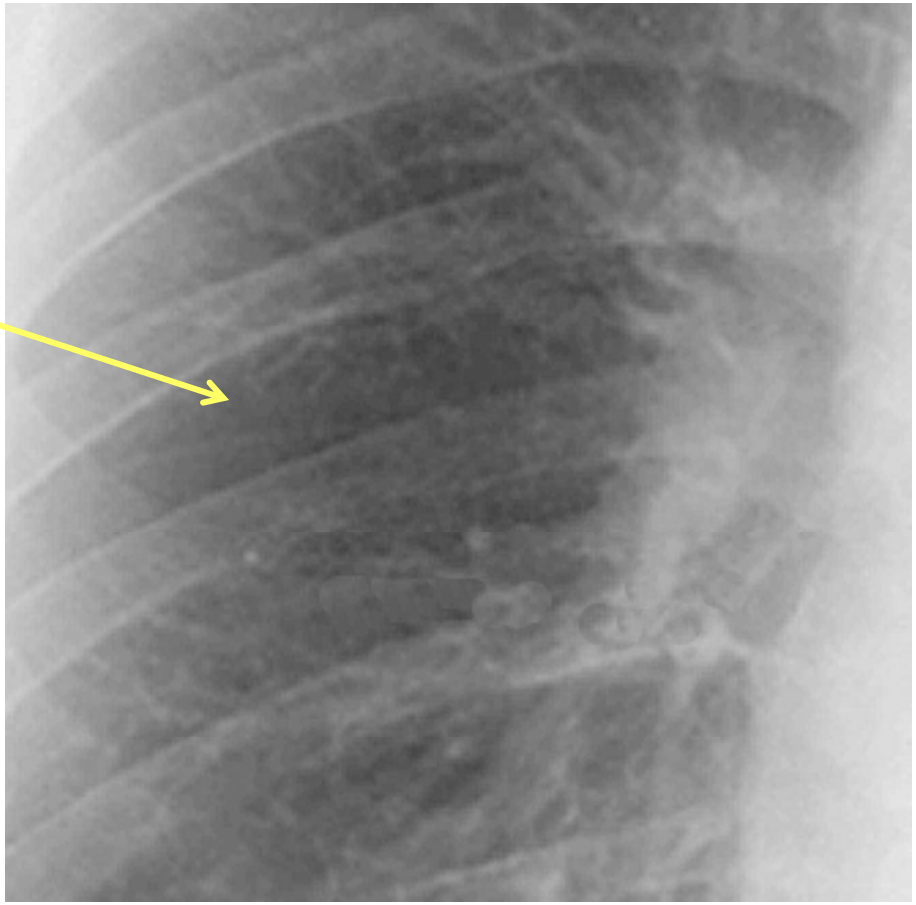
Breast with Cysts and Fibrotic Changes

Breast Cancer !



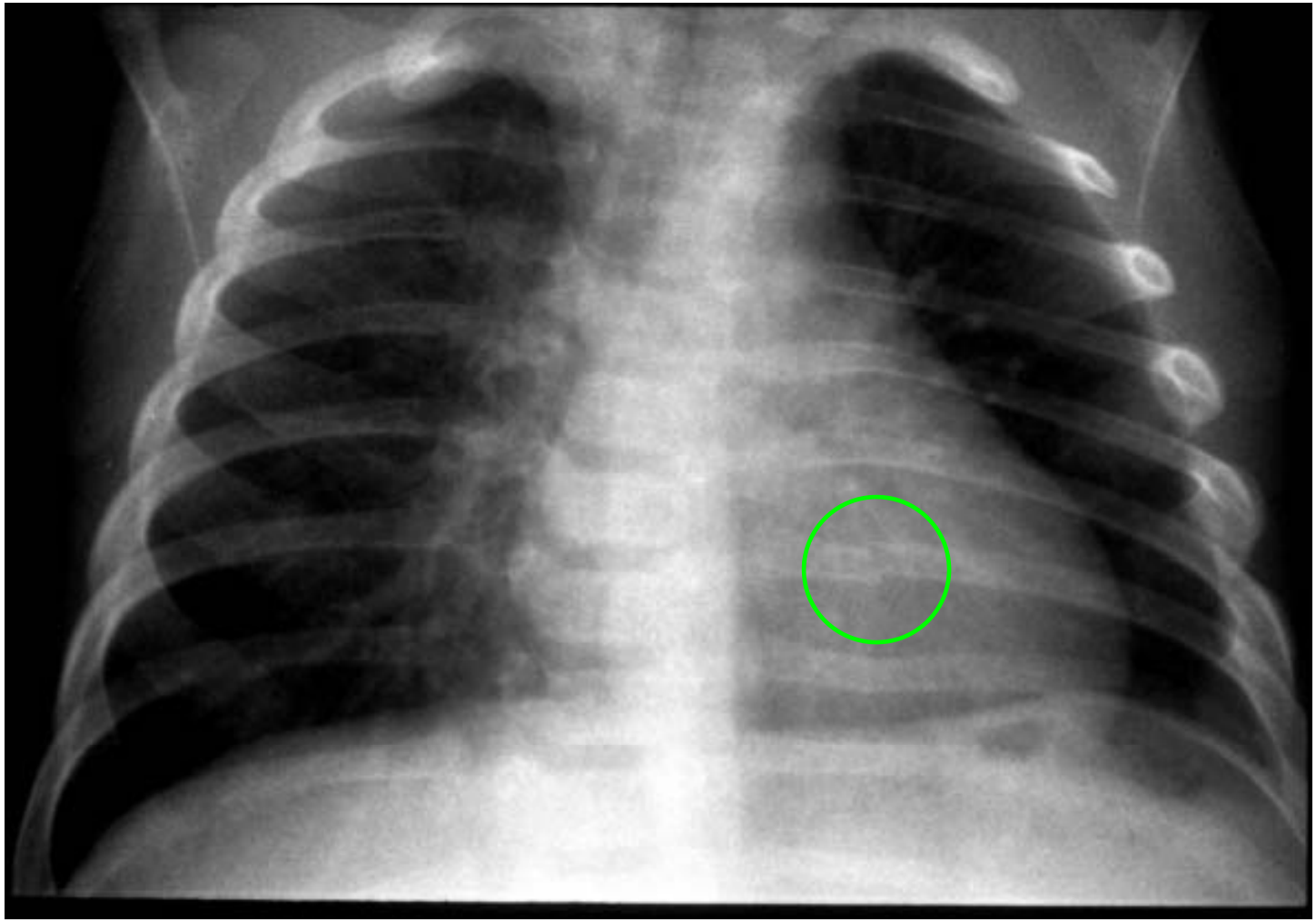


Classic X-ray view of “Lung Infiltrates” caused by Pneumonia. Notice the increased “whiteness” close to the sternum



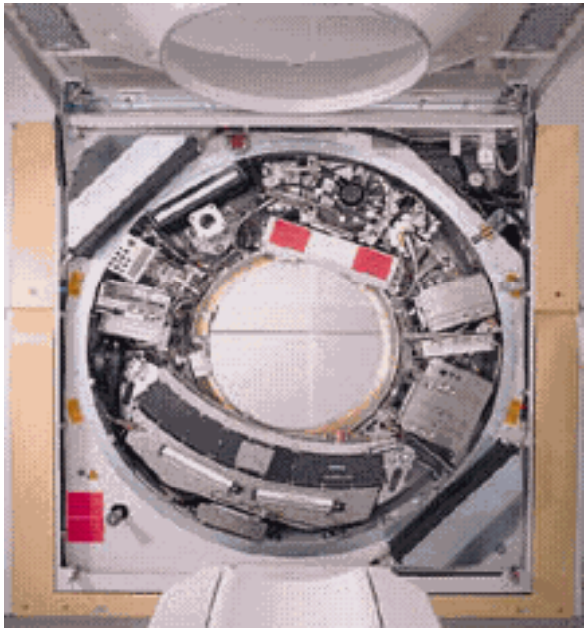
X-ray view of broken ribs in an infant ….

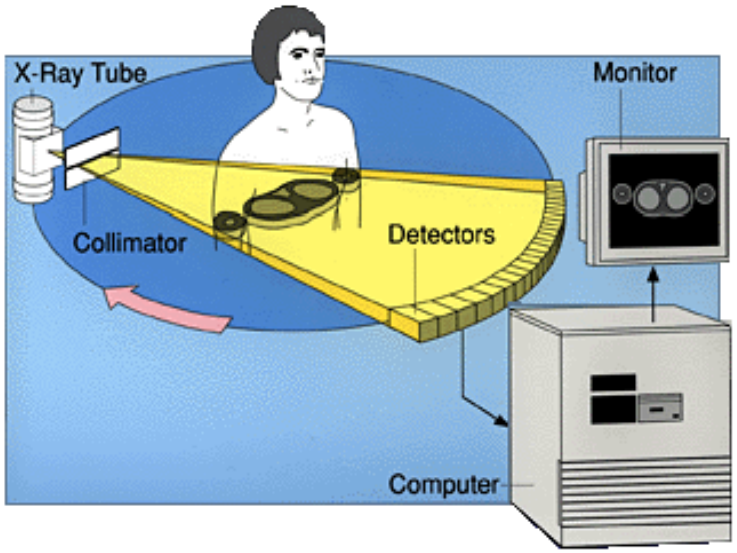
……caused by child abuse. Specifically, by holding the baby by the chest and shaking him violently.



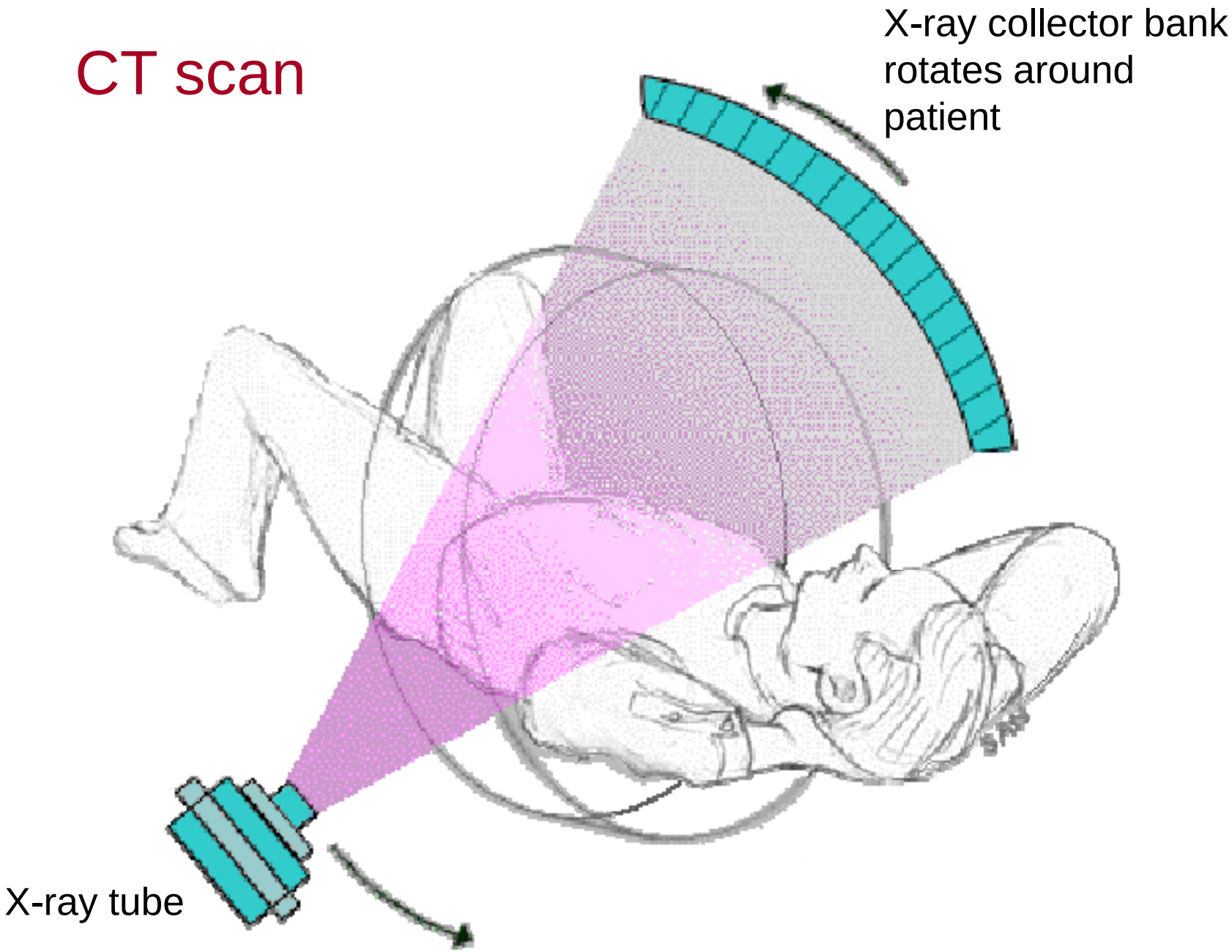
Computed Tomography (“CT Scan” or “Cat Scan”)

- The scanner device incorporates a moving table & a revolving X-ray tube
  - The table moves the patient back and forth through the revolving X-ray emissions
  - The X-ray emitter moves (revolves) in a 360^{o} arc around the patient
- Instead of film, the CT scanner collects emitted X-rays via a collector
  - This collector is called a SCINTILLATOR
- Scintillator transforms X-ray’s into a proportionally strong electric current
- The electric current is then converted into a number of images (“slices”)
  - Contrast dyes may be used for image enhancement
- Tool of choice for most stroke cases

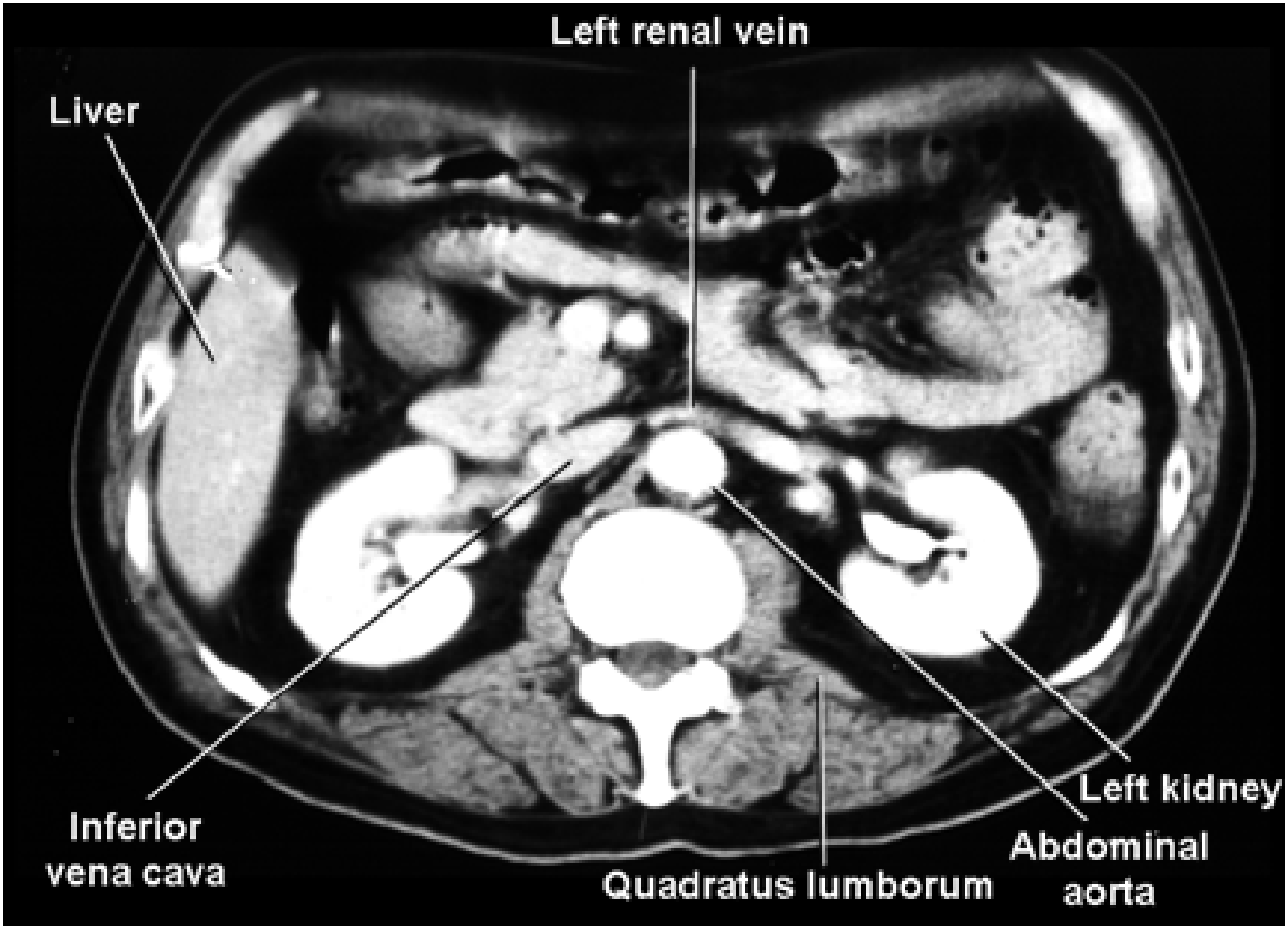




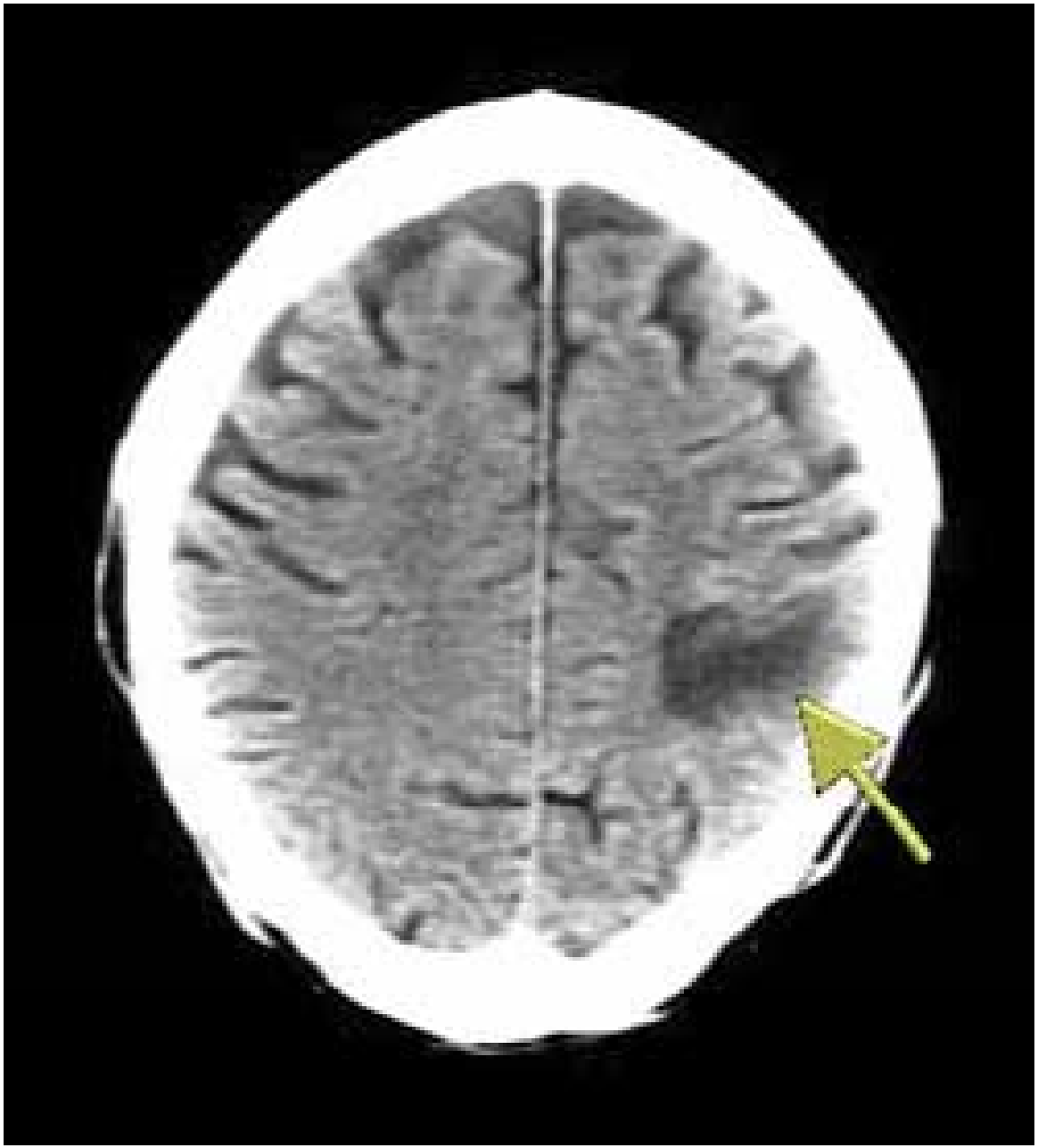
CT scan



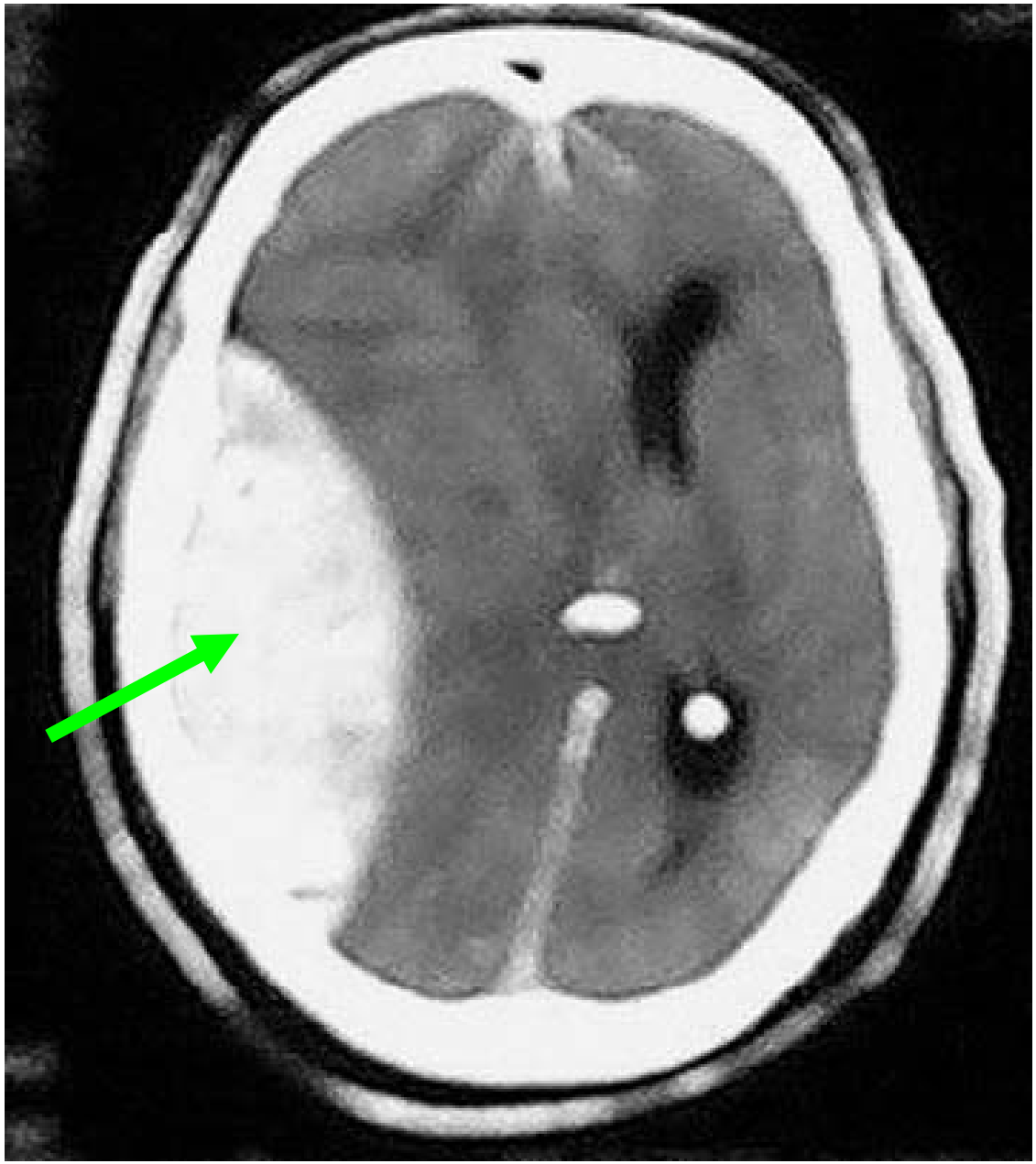
Normal CT scan (abdominal slice)



CT scan of ischemic stroke (gold arrow)



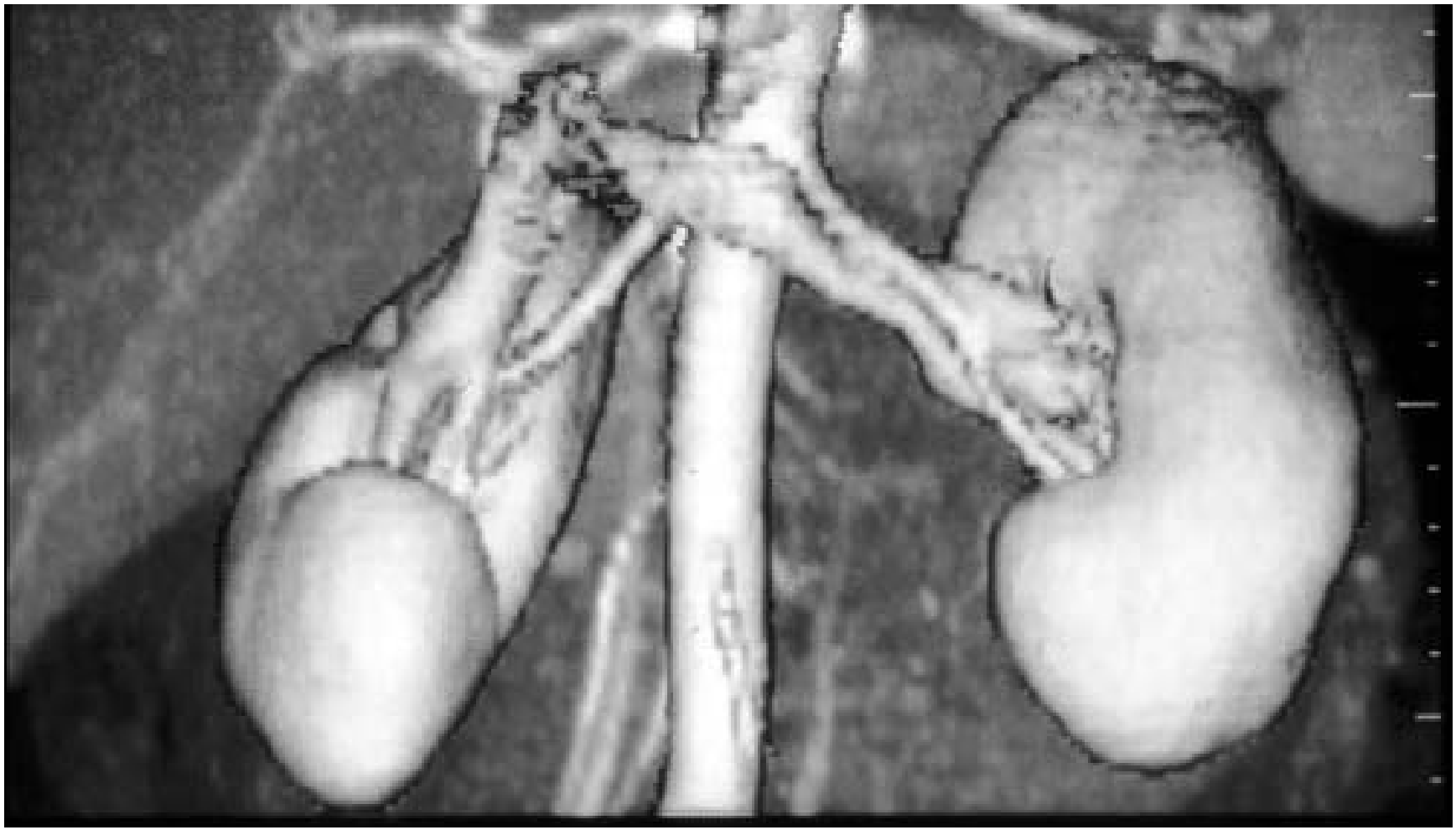
CT scan of Subdural Hematoma (Green Arrow)



CT scan color enhancement

Purple area denotes destruction of normal brain tissue which is colored green

3-dimensional modeling using CT scan



Magnetic Resonance Imaging

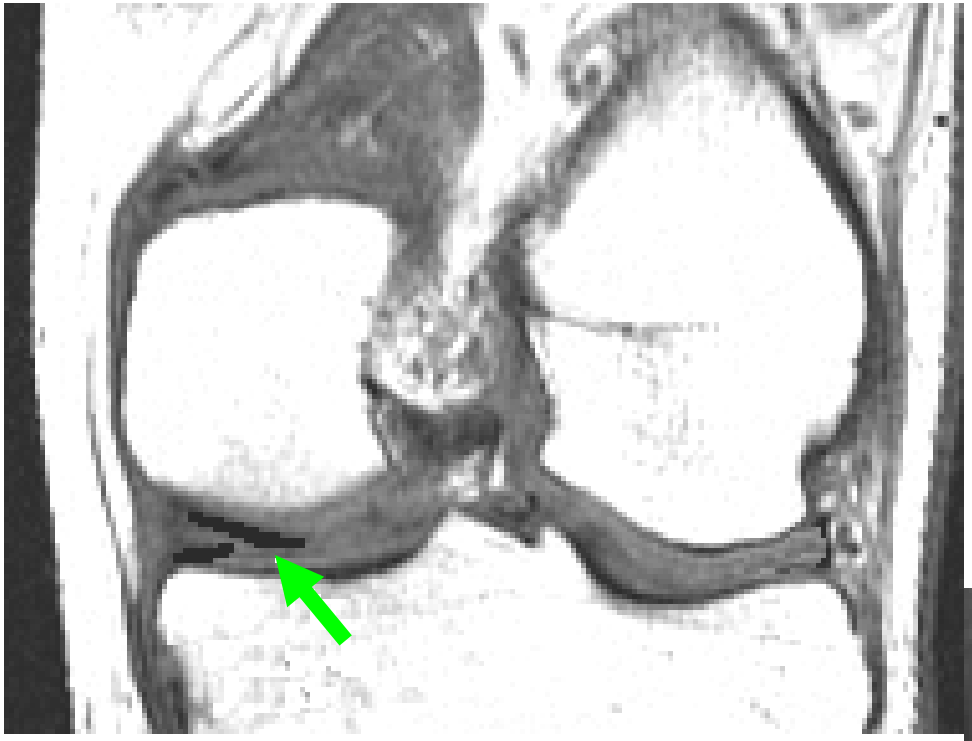
- Magnetic nuclei are abundant in the human body (H,C,Na,P,K) and spin randomly
  - Since most of the body is H_2O, the Hydrogen nucleus is especially prevalent
- Patient is placed in a static magnetic field
- Magnetized protons (spinning H nuclei) in the patient align in this field like compass needles
- Radio frequency (RF) pulses then bombard the magnitized nuclei causing them to flip around
  - The nuclei absorb the RF energy and enter an excited state
- When the magnet is turned off, excited nuclei return to normal state & give off RF energy
  - The energy given off reflect the number of protons in a “slice” of tissue
- Different tissues absorb & give off different amounts of RF energy (different resonances)
- The RF energy given off is picked up by the receiver coil & transformed into images
- MRI offers the greatest “contrast” in tissue imaging technology (knee, ankle diagnosis)
- cost: about $1450 - $2000
- time: 30 minutes - 2 hours, depending on the type of study being done

Closed (traditional) MRI scanner

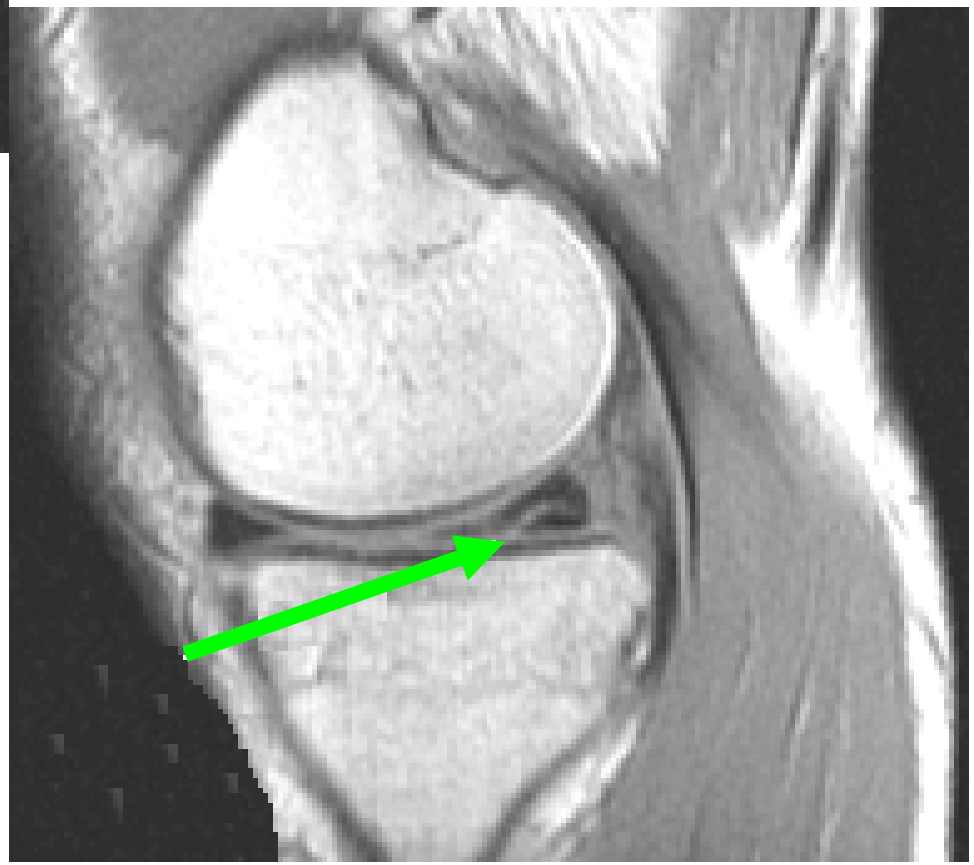
Open MRI

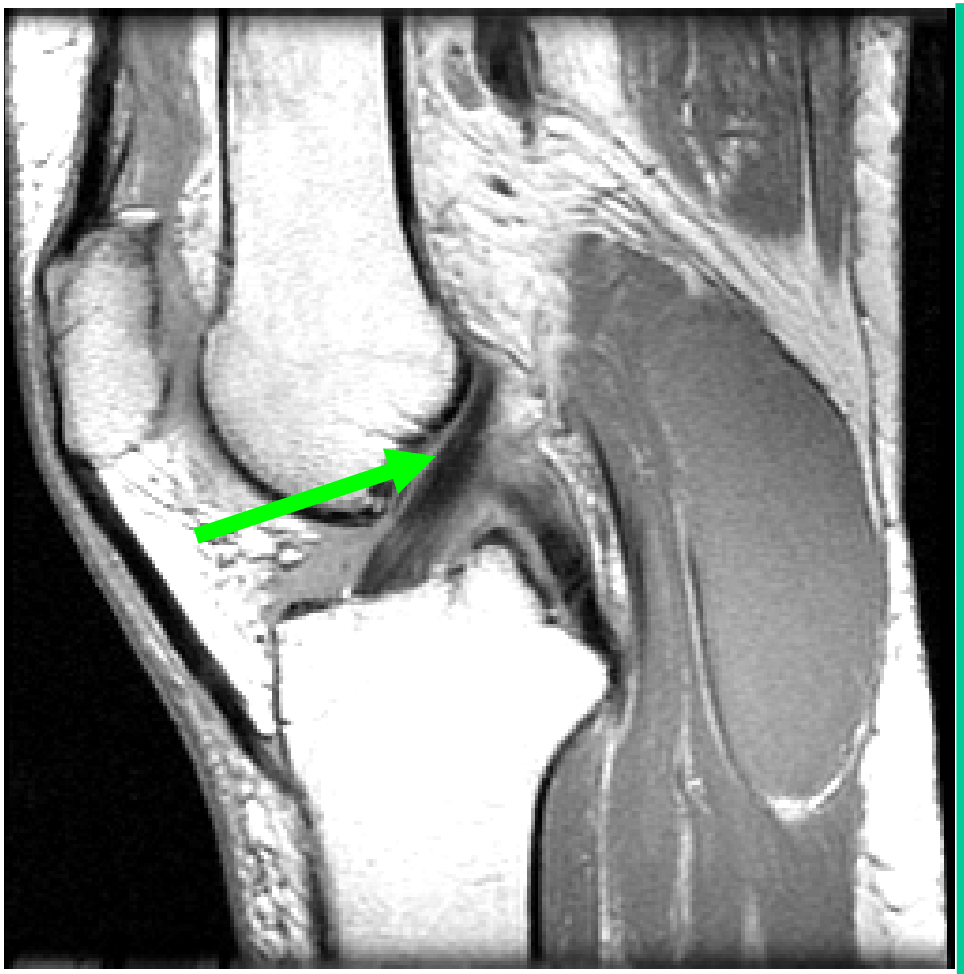
Magnetic Resonance Imaging
tissues composition & signal intensity

Tissue	Signal Intensity T1	Signal Intensity T2
Fat	high (whitish)	intermediate
Muscle	intermediate (gray)	intermediate
Hyaline Cartilage	intermediate	intermediate - low (dull gray)
Ligaments & Tendons	low (dark gray)	low
Cortical Bone	low	low
Granulation Tissue	intermediate	high
Fibrous Tissue	low	low
Hemorrhage / Edema	high - intermediate	high
Immature Scar	intermediate - low	low to high
Mature Scar	low	low



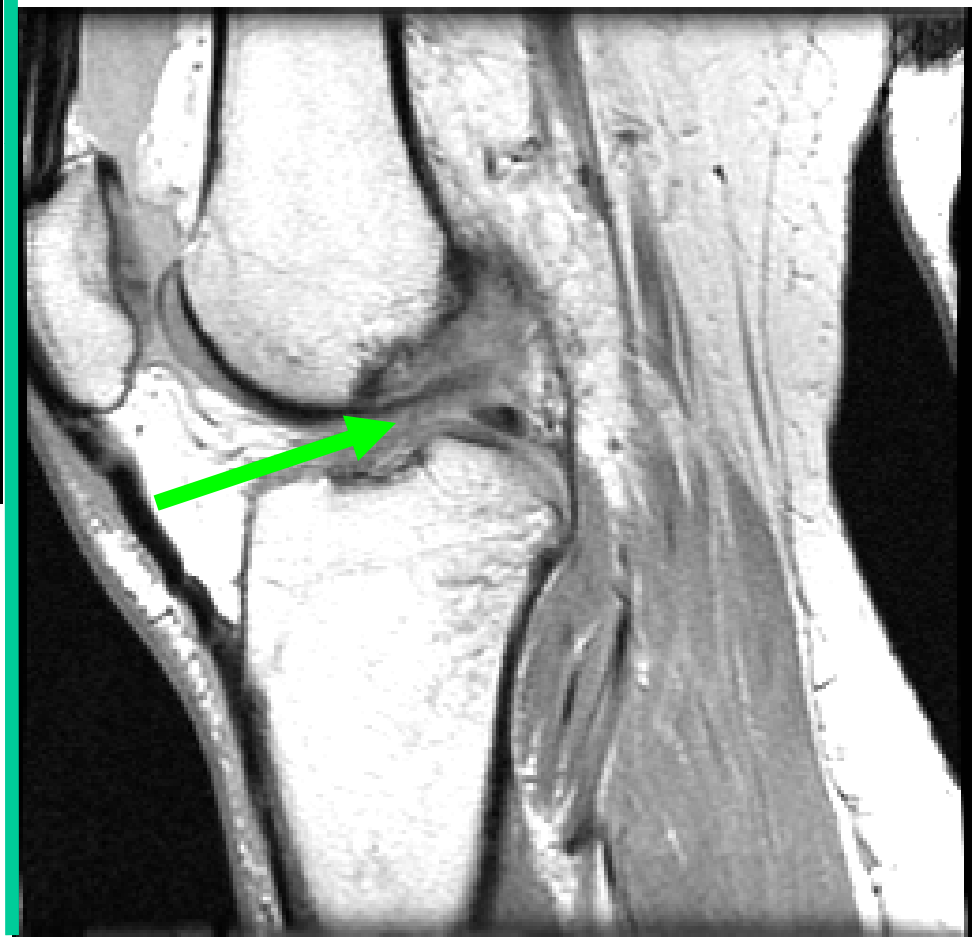
Significant meniscus tears (indicated by the green arrows) in frontal (left) and the sagital (below) planes



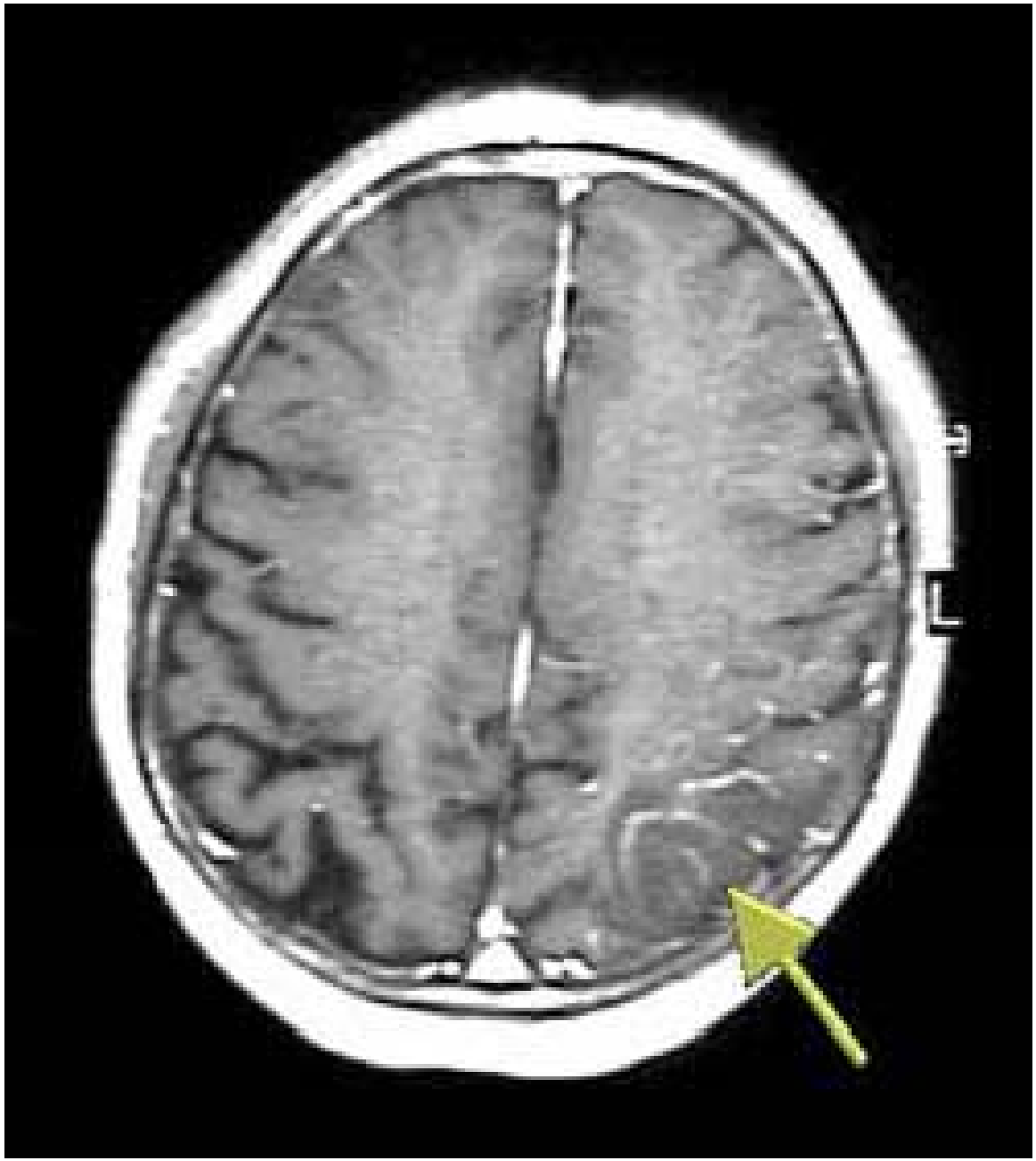


Normal ACL
(note “darker” region indicating normality)

Grade 3 ACL tear
(note “lighter” region where the “darker” region used to be. This indicates tissue disruption and associated fluid buildup)



MRI view of the same Ischemic Stroke seen in slide 8



Bone Scan

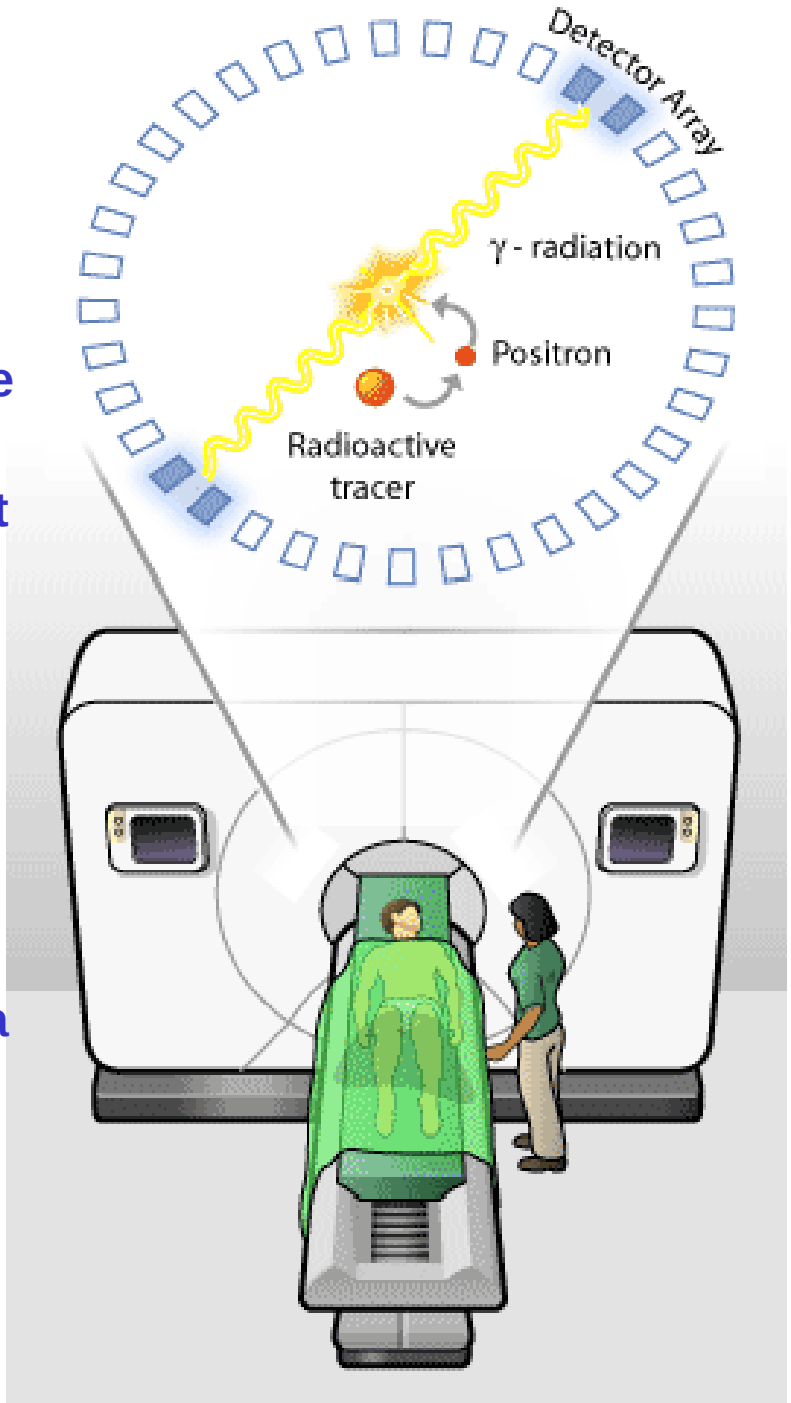
- Measures the rate of bone formation
  - Any disease that injures bone will cause new bone to form
  - This process is a very sensitive measure of bone disease processes
    - Often used for detecting cancer mets (breast, prostate), fractures, & infection
    - Can be used to detect avascular necrosis of bone
- Procedure is done by injecting a technetium labeled phosphate (raidioactive)
  - Pictures are taken using a gamma camera……
    - Immediately after injection, 3 hours post injection, & 24 hour post injection
  - Dose of radiation is small
  - Takes about an hour to complete

Bone Scan of Non-malignant Osteoid Bone Tumor

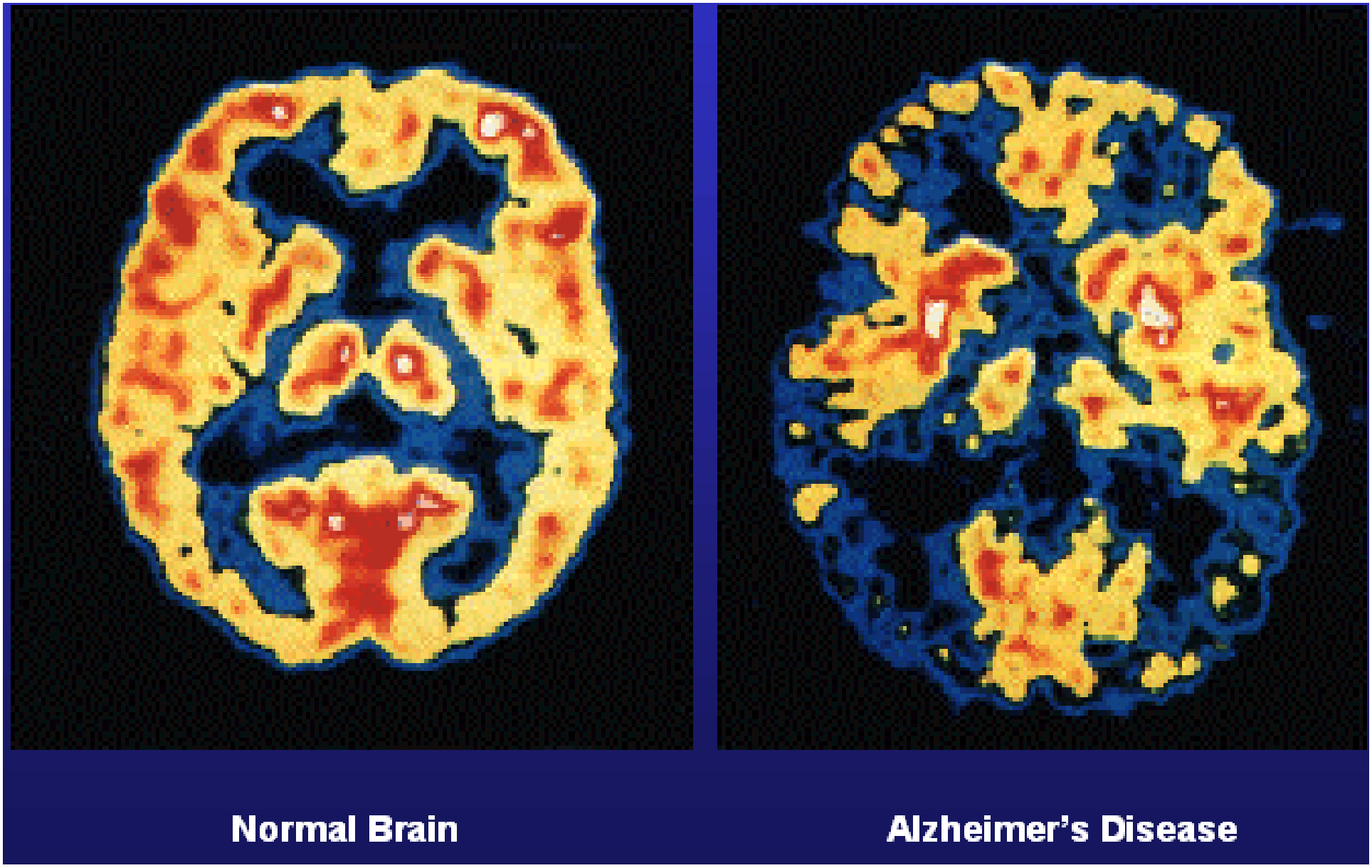
"hot spot" indicating ↑ uptake of isotope in right femur

Positron Emission Tomography (PET) Scan

- Device measures metabolism via the decay of radioactive tracers in tissues with higher than normal metabolic activity (such as cancer)
  - Patient is injected with FluorDeoxyGlucose
    - Glucose bound to Fluorine 18 (radioactive)
  - Diseased organs & tissues process FDG at a higher rate than normal tissues making FDG concentration higher in diseased tissue
  - Positrons are emitted by FDG and collide with electrons, emitting γ radiation
  - Radiation picked up by γ camera
  - Computer reconstructs the radioactivity into 3 dimensional images of organ or area with higher than normal FDP uptake
- Procedure performed as outpatient
- Takes about 2 hours
- Results available to physician within 48 hours



PET scan showing Alzheimers's Disease



PET Scan showing Non Hodgkins Lymphoma (Green Arrows) before & after 6 months of chemotherapy

Dual Energy X-ray Absoprtometry (DXA or DEXA)

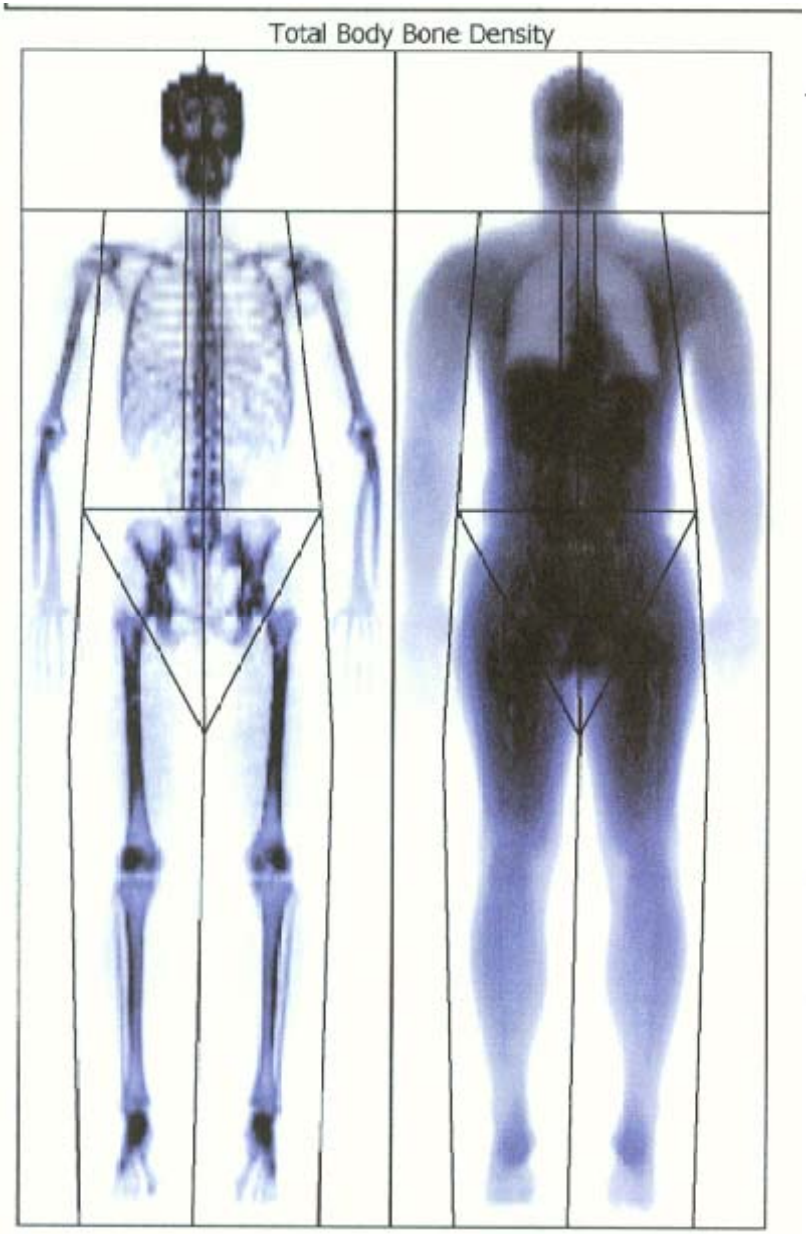
- Used to test for bone mineral density (BMD) ie. Osteoperosis
  - Thin X-ray beam is passed through the hip and lower spine regions
  - Computer calculates how much X-ray energy is absorbed by the bones
    - Computer compares results with an average 20 year old (T-score) and an average age, race and gender peer (Z-score)
    - Results are plotted on a norm graph and given to the radiologist

Dual Energy X-ray Absoprtometry (DXA or DEXA)

GE LUNAR Prodigy DEXA...in the
Applied Exercise Science Lab

Our new toy!

DEXA Output

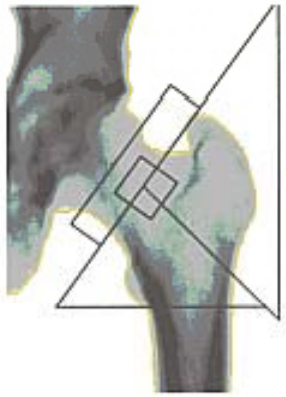


University Medical Associates

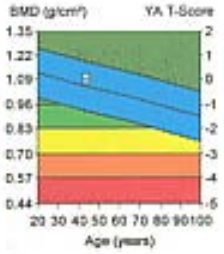
1303 D'Antignac Street
Augusta, GA 30901

DUALFEMUR BONE DENSITY

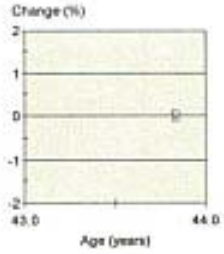
Facility ID:		Measured:	09/16/1999	1:57:13 PM (2.05)
Birth Date:	43.8 (years)	Analyzed:	09/16/1999	1:57:50 PM (2.05)
70.0 in. 175.0 lbs. White Male		Printed:	04/27/2001	2:41:26 PM (2.15)
Physician:				



Reference: Total



Trend: Total



Region	BMD [1] (g/cm²)	Young-Adult [2] T-Score	Age-Matched [3] Z-Score
Neck	0.909	-1.2	-0.9
Wards	0.836	-1.0	-0.4
Troch	0.968	0.3	0.5
Shaft	1.286	-	-
Total	1.088	0.0	0.3

Region	Measured Date	BMD [1] (g/cm²)	Change (%)	Age (years)
Total	09/16/1999	1.088	0.0	43.8

COMMENTS:

Image not for diagnosis

76:3.00:50.00:12.0 0.00:11.70 0.60x1.05 14.9%Fat=20.6%
0.00 0.00 0.00 0.00 0.00
Neck Angle (deg) = 54

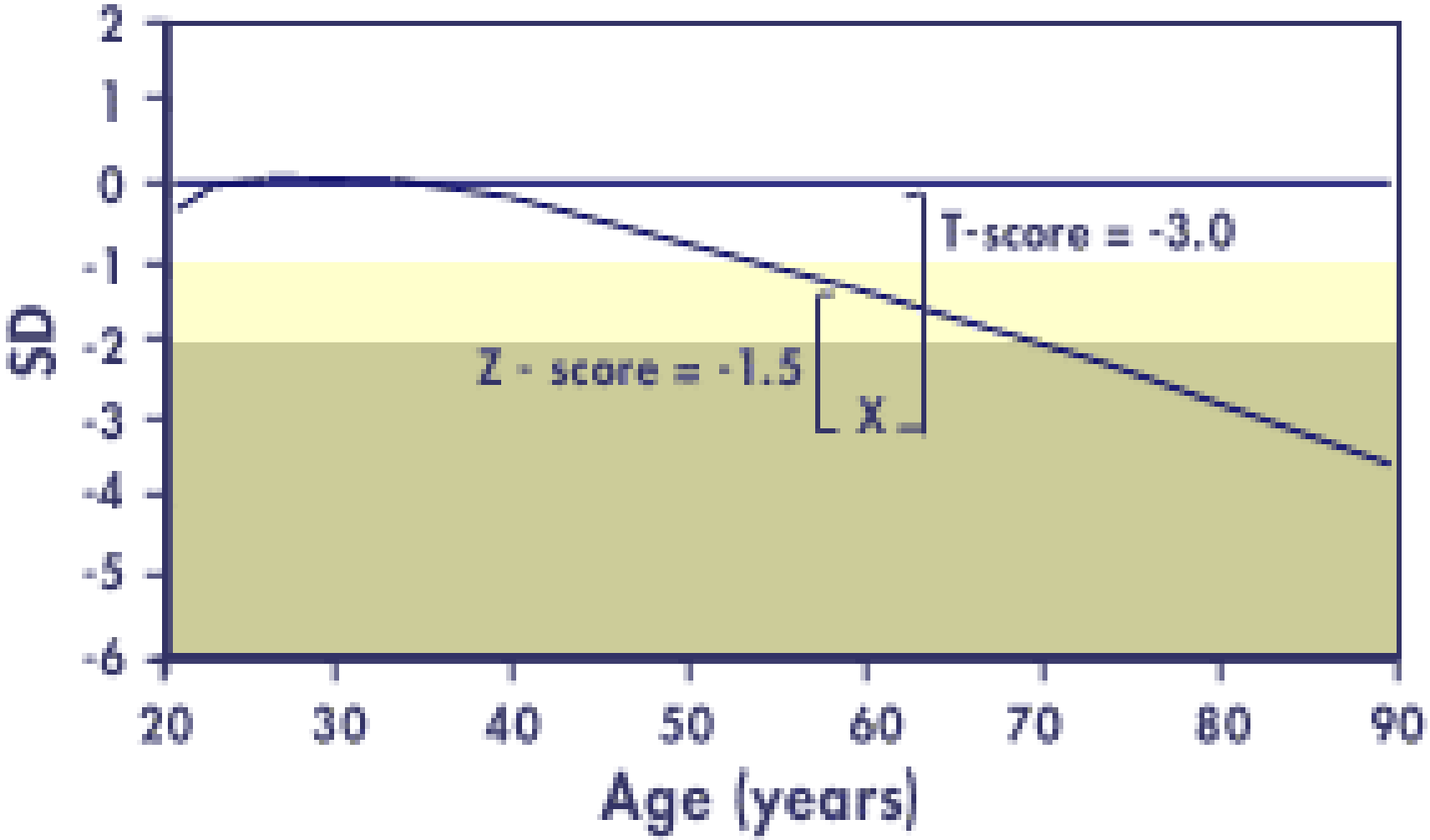
1 - Statistically 68% of repeat scans fall within 1SD (± 0.020 g/cm² for Total)
2 - USA, Femur Reference Population, Ages 20-40
3 - Matched for Age, Weight (males 25-100 Kg), Ethnic
11 - WHO has defined for white women that >-1.0 SD = normal; -1.0 to -2.5 SD = osteopenia; <-2.5 SD = osteoporosis

LUNAR Prodigy 10241

DEXA Standards

T-score (sd's) (WHO standard reference)	Fracture Risk	Medical Action
Normal Test: T > -1.0	**Low**	Lifestyle advice
⬇Bone Mass: T -1.0 to -2.5 (Possible Osteopenia)	**Above Average**	Lifestyle advice, HRT in women 50 – 60 , Calcium and Vitamin D supplementation
Osteoperosis: T < -2.5	**High**	All of above plus consider Bisphosphonate Drugs (FOSOMAX, ACTINEL….)
Established Osteoporosis plus the occurrence of one or more fractures	**Very High**	All of above plus consider possible pain control and referral to specialist

DEXA Report Graph: 60 yr old female



Color enhanced DEXA Scan: T-score: -1.8

The more dense regions are red/orange/yellow