

Medical Imaging

Physics Applied to Medicine

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Medical Imaging...

- is the creation of a diagnostic picture, either structural or functional, of the body
- is a good example of how basic science can benefit society through applied science
- has a variety of *modalities*
- uses high energy waves/particles (photons), radio waves, and sound

Nuclear medicine

- A radioactive substance is introduced into the body
- The radiation released is detected as a function of position
- Detection of brain function, blood supply, detection of cancer (metastasis)
- Provides functional imaging
- Takes a very long time to create an image, poor image detail, very invasive

Scintillation detectors and “Gamma cameras”

- A scintillation detector is a radiation detector that is scanned over the patient to create an image in nuclear medicine
- Based on a photo-multiplier tube behind a *collimator* and a *scintillation material*
- A gamma camera has many detectors working together and can make a picture without scanning

PET scanner

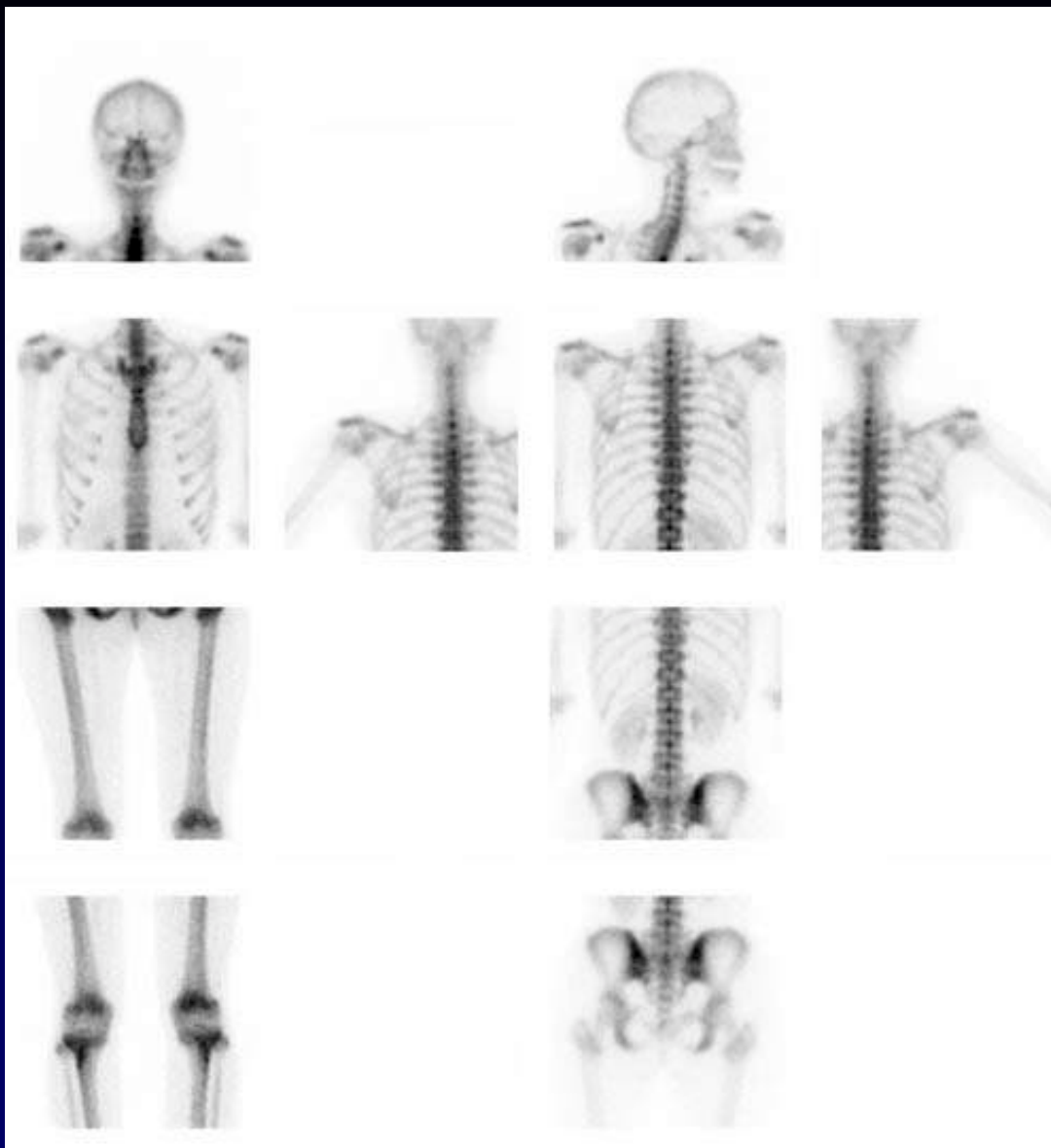


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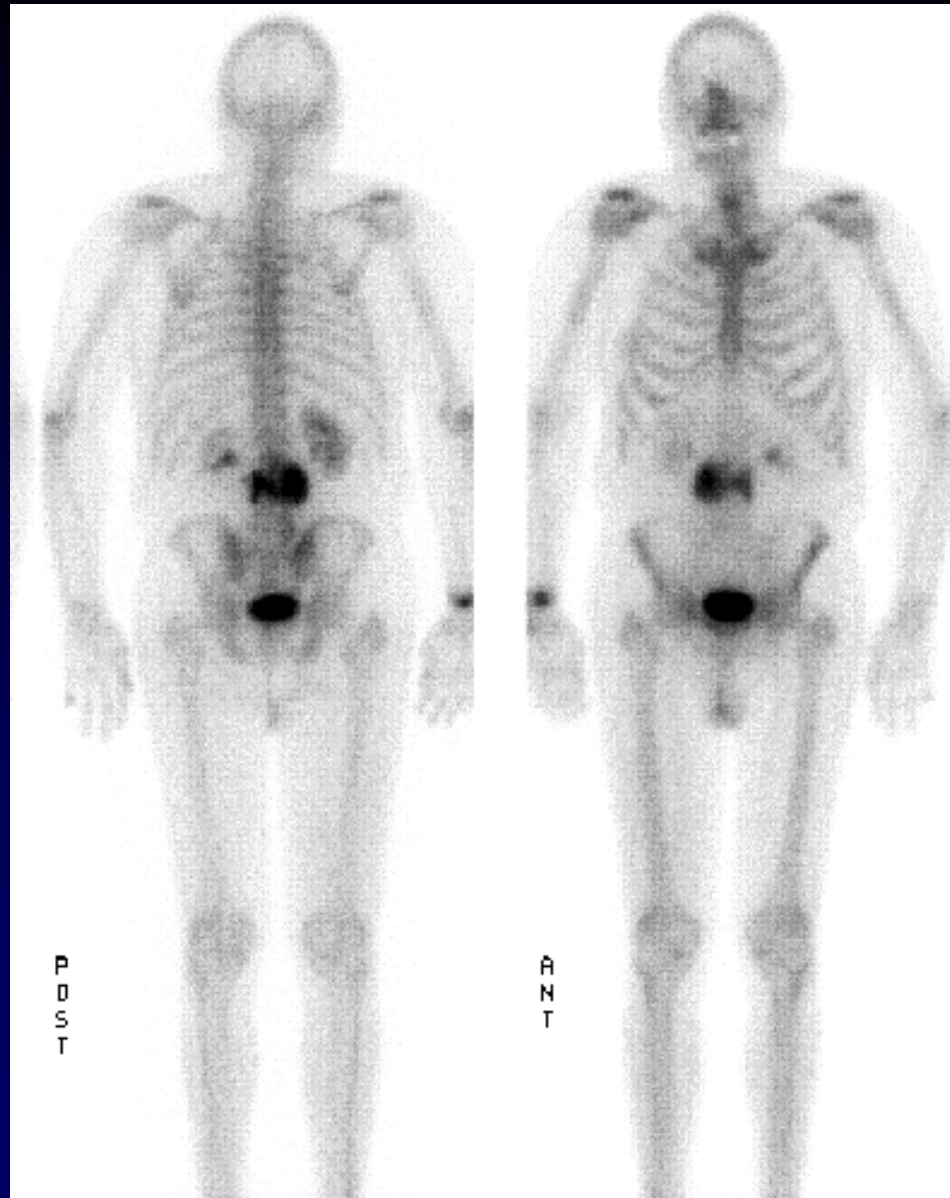
Orthogonal gamma camera scanner



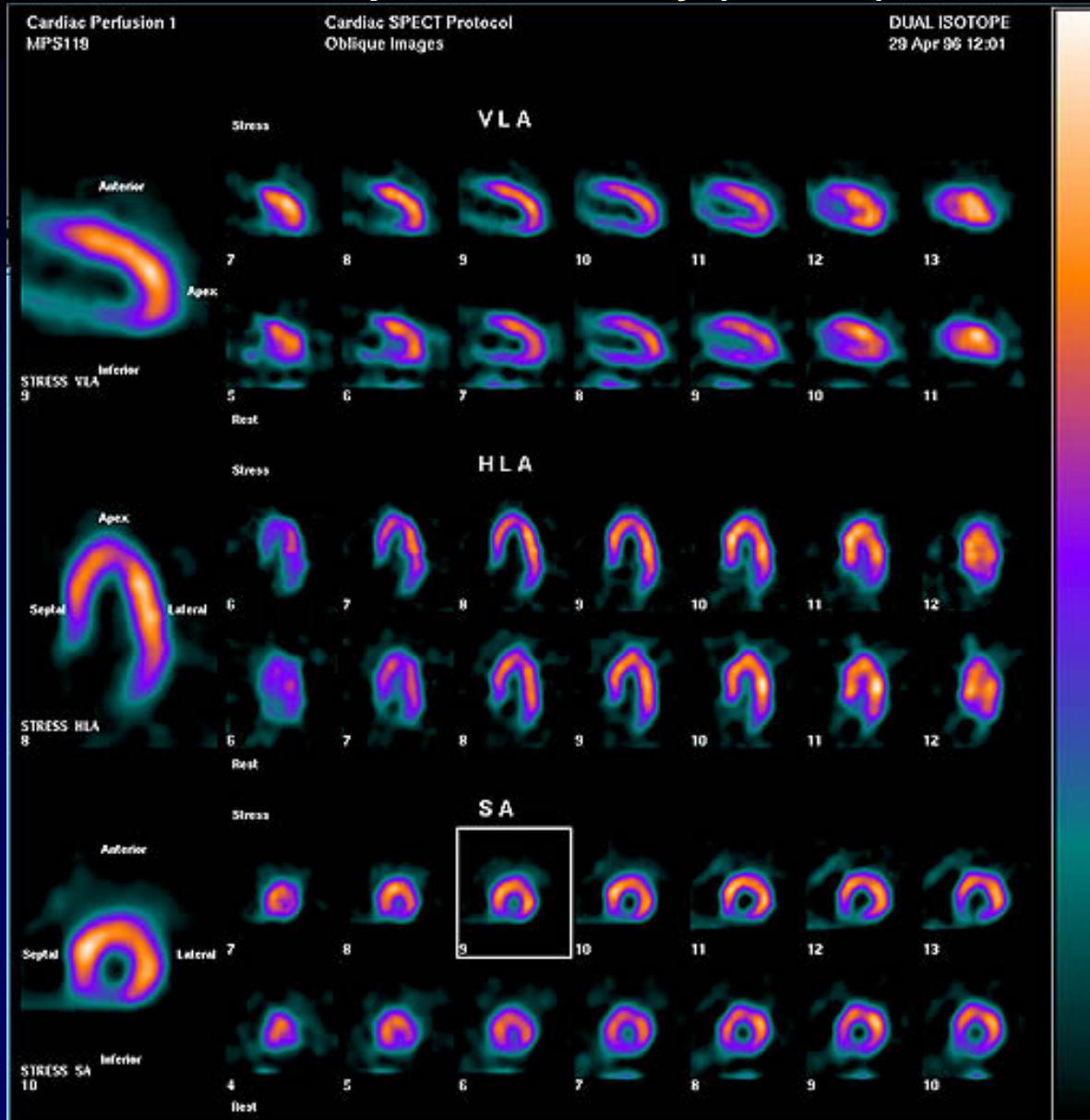
Normal bone scan



Radiation induced osteosarcoma of lumbar spine



Cardiac perfusion study (SPECT)



X-ray

- High-energy photons are transmitted through the body and collected on film or with a digital camera
- Images the shadow cast by the parts of the body
- Soft- and hard-tissue imaging throughout the body
- Inexpensive, easy to compare among hospitals
- Harmful radiation, images can be ambiguous due to overlapping shadows

Conventional X-ray machine, table type



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Fractured orthopedic hardware



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University of Washington Department of Radiology

Enchondroma of the left first metacarpal



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University of Washington Department of Radiology

Renal cell carcinoma with metastasis to right proximal tibia



T1-weighted sagittal section



X-ray CT

- X-ray imaging applied in 2 or 3 dimensions
- *Tomographic* soft- and hard-tissue imaging throughout the body
- Overcomes some limitations of conventional X-ray, off-line manipulation possible
- Large radiation dose, expensive

X-ray CT scanner



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Normal skull

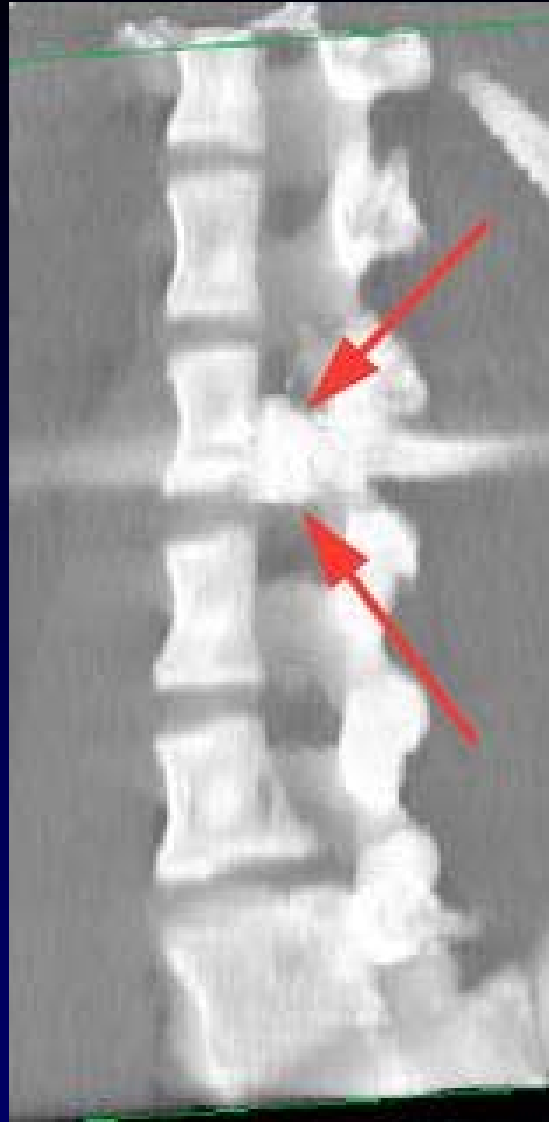
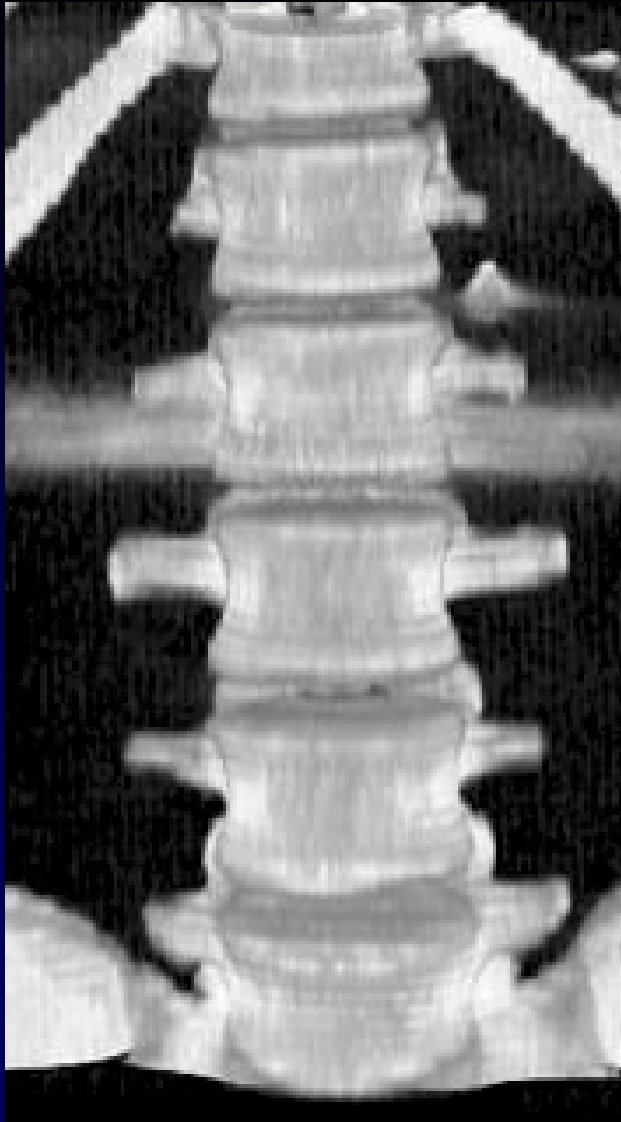


Missing pectoral muscle



© 1999,2000 Elliot Fishman, MD
Department of Radiology, Johns Hopkins University

Gunshot victim with bullet lodged in spine



Parosteal osteosarcoma



Ultrasound

- High-frequency sound is transmitted into the body
- Images echoes from structures within the body
- Soft-tissue and blood-flow imaging throughout the body
- No harmful radiation used, inexpensive, portable, real-time blood flow imaging
- Less image detail than other methods, cannot penetrate bone and air, inconsistent results among hospitals



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BME ultrasound lab

Features a Siemens
ultrasound scanner
connected to computers

Research in better ways
of imaging with
ultrasound



HDI
5000

TTH GEN DIV

C5-2 Abd/General

TIs 0.4 MI 1.1
Fr #235 14.7cm

Map 3
150dB/C3
Persist Med
Fr Rate Med
2D Opt:Gen

ATL



Courtesy of
S. Wilson, MD
P. Burni, PhD
U of Toronto

MULTIPLE LIVER MASSES

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SIEMENS

5.0HDPL40/5.53
MI 0.7

Abdomen
63%
24dB RS4
12.0cm 9fps



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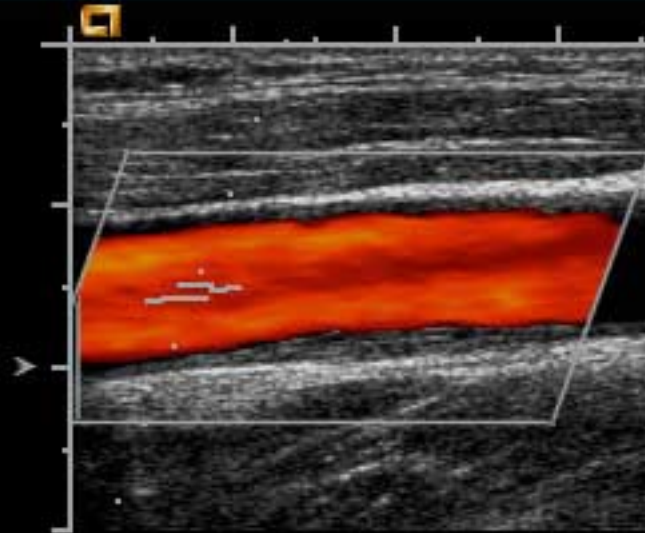


.20



.20

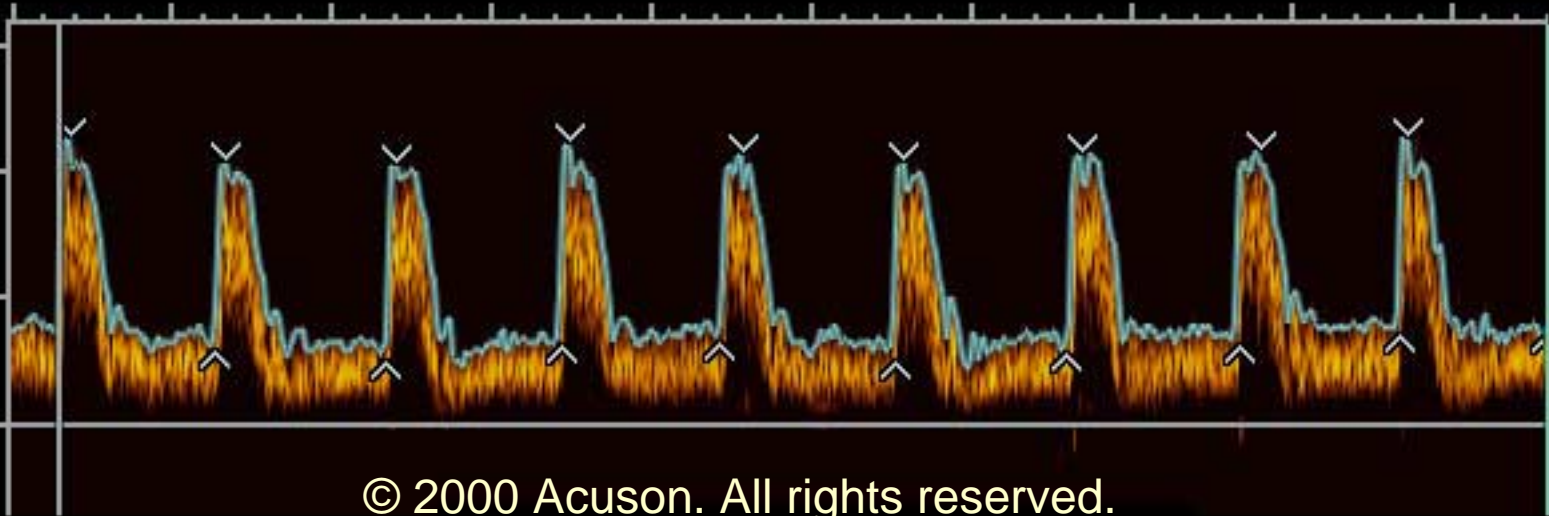
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Min = 0.13m/s
Angle = 59°
HR = 58bpm



8L5

.60

m/s



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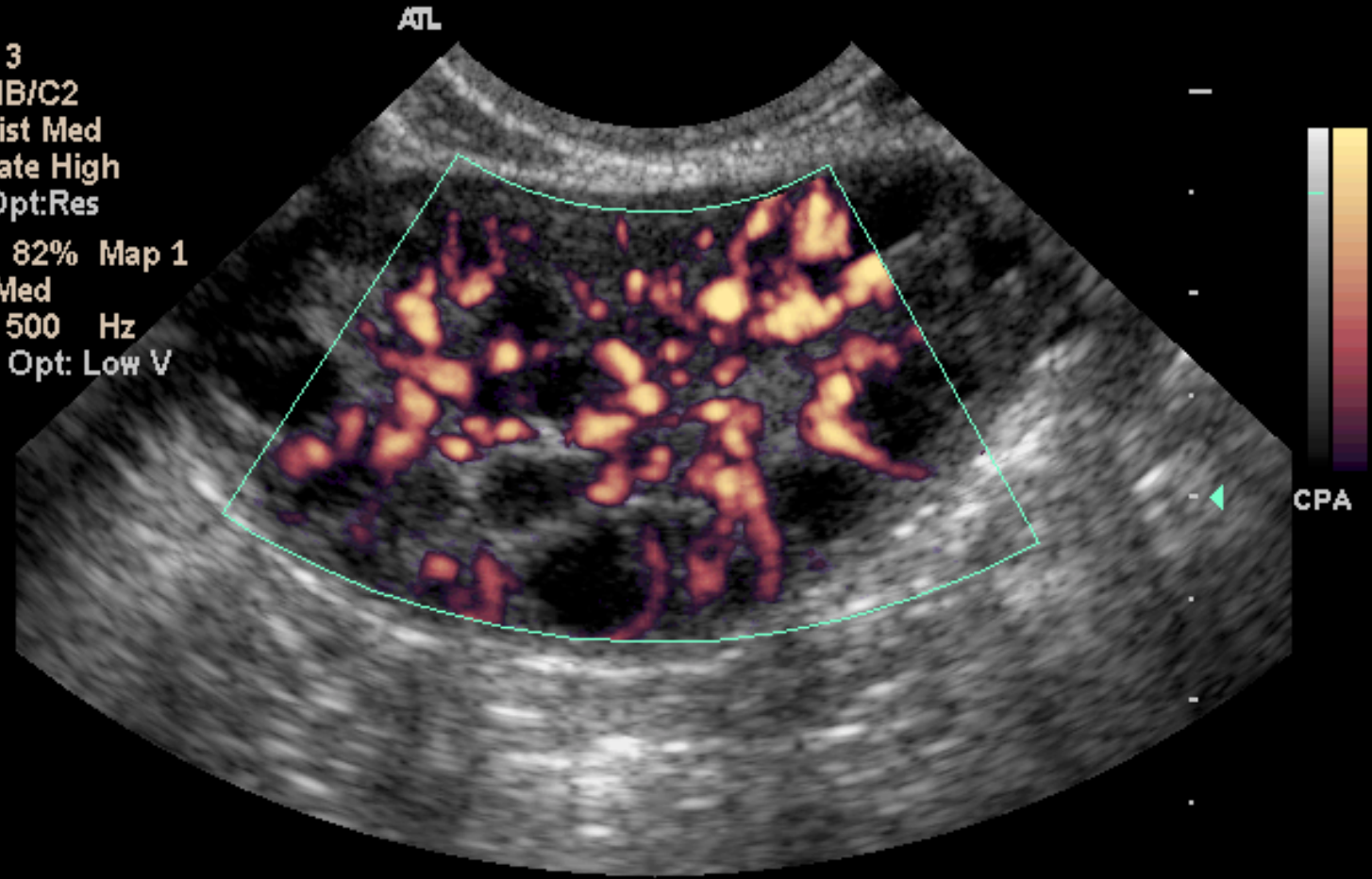
HDI
5000

C8-4v Gyn/Fert/Pel

12:05:24 pm

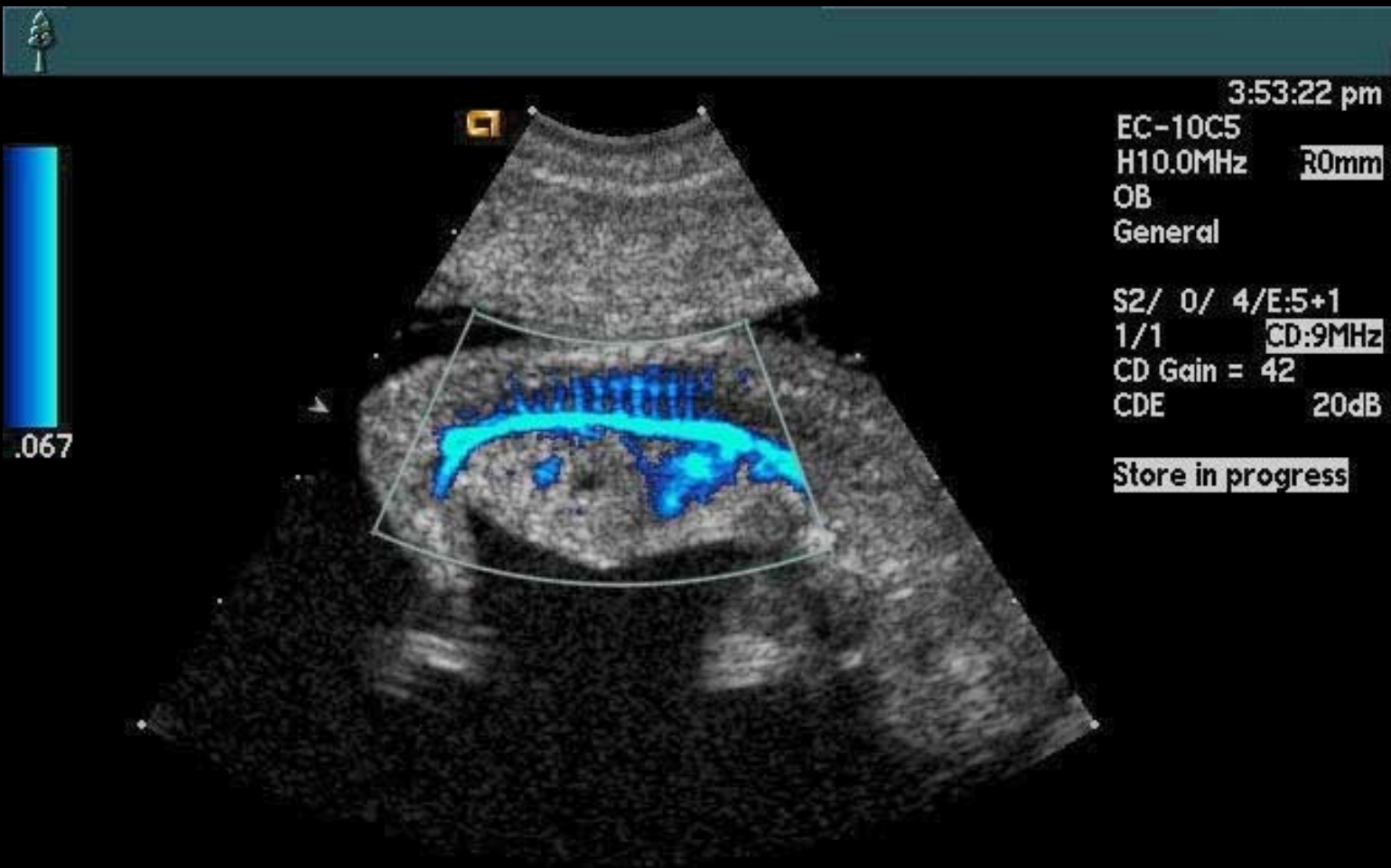
TIs 0.5 MI 0.9
Fr #157 3.9 cm

Map 3
150dB/C2
Persist Med
Fr Rate High
2D Opt:Res
CPA 82% Map 1
WF Med
PRF 500 Hz
Flow Opt: Low V



OVARIAN VASCULATURE

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HDI
5000

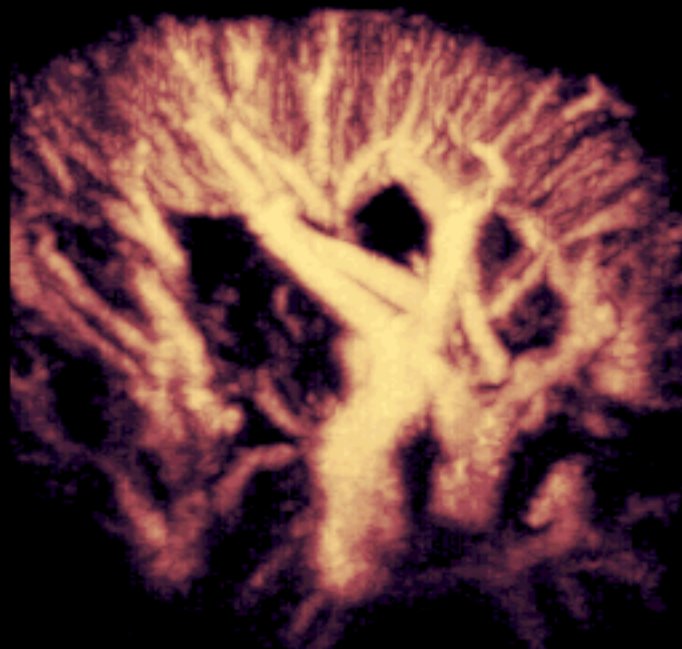
MILTON S. HERSHEY MED CT L12-5 50 PVasc/Ven

2:34:50 pm

TIs 0.1 MI 0.6

Fr #8

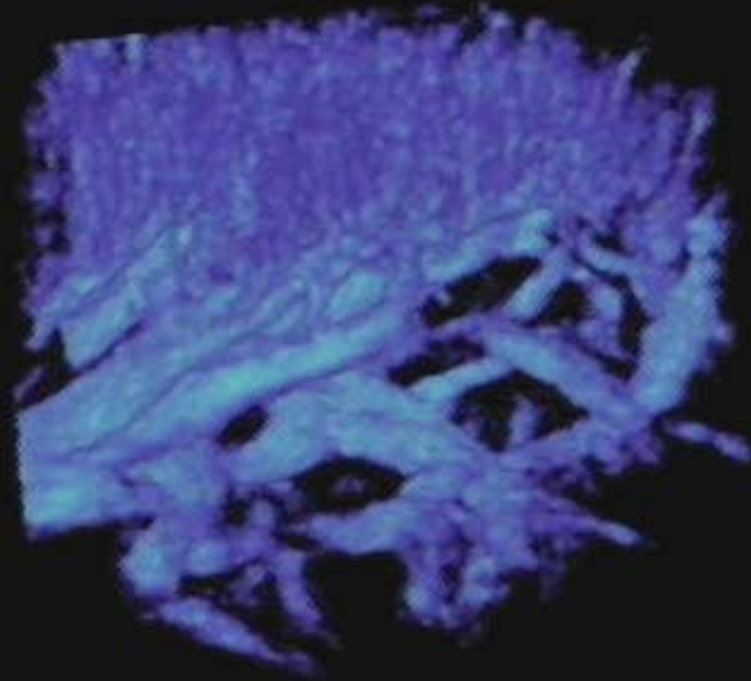
Map 2
150dB/C 3
Persist Med
2D Opt:Gen
CPA 79% Map 1
WF Med
PRF 1000 Hz
Flow Opt: Med V



RENAL TRANSPLANT
3D COLOR POWER ANGIO

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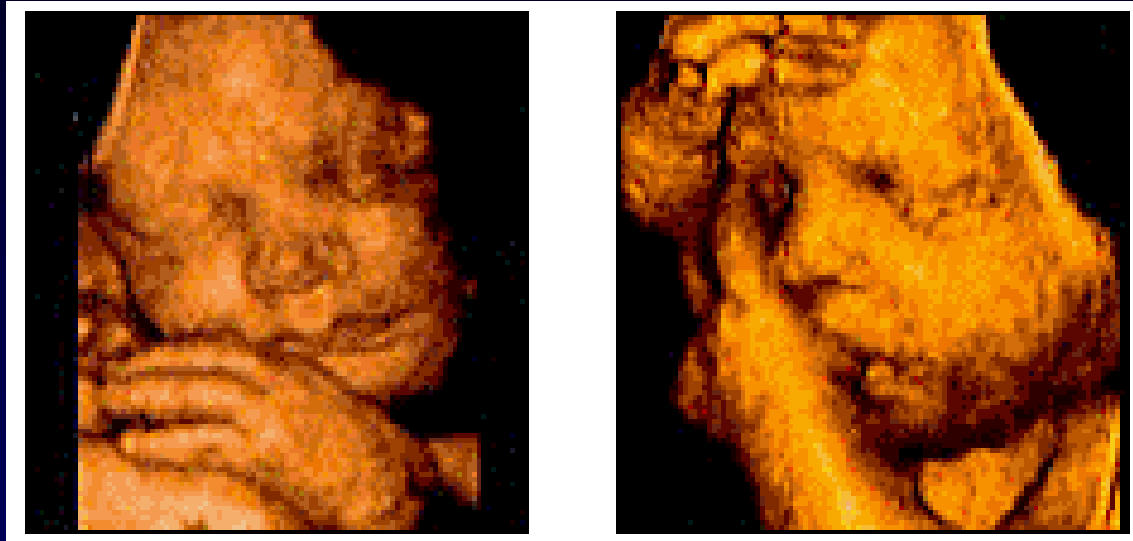
ADVANCED



RENAL VASCULATURE

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3D Ultrasound



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- Various applications are under investigation
 - Obstetric, guided biopsy, cardiac

Magnetic resonance imaging (MRI)

- Atoms in the subject are aligned within a strong magnetic field and probed with radio waves
- Images radio signature of different types of tissues
- Tomographic and functional soft- and hard-tissue and blood-flow imaging throughout the body
- No harmful radiation used, off-line manipulation possible
- Takes a long time to create an image, claustrophobic, no metal allowed, expensive

MRI scanner



**Steven H. Brick, M.D., Drs. Groover,
Christie & Merritt, P.C.**

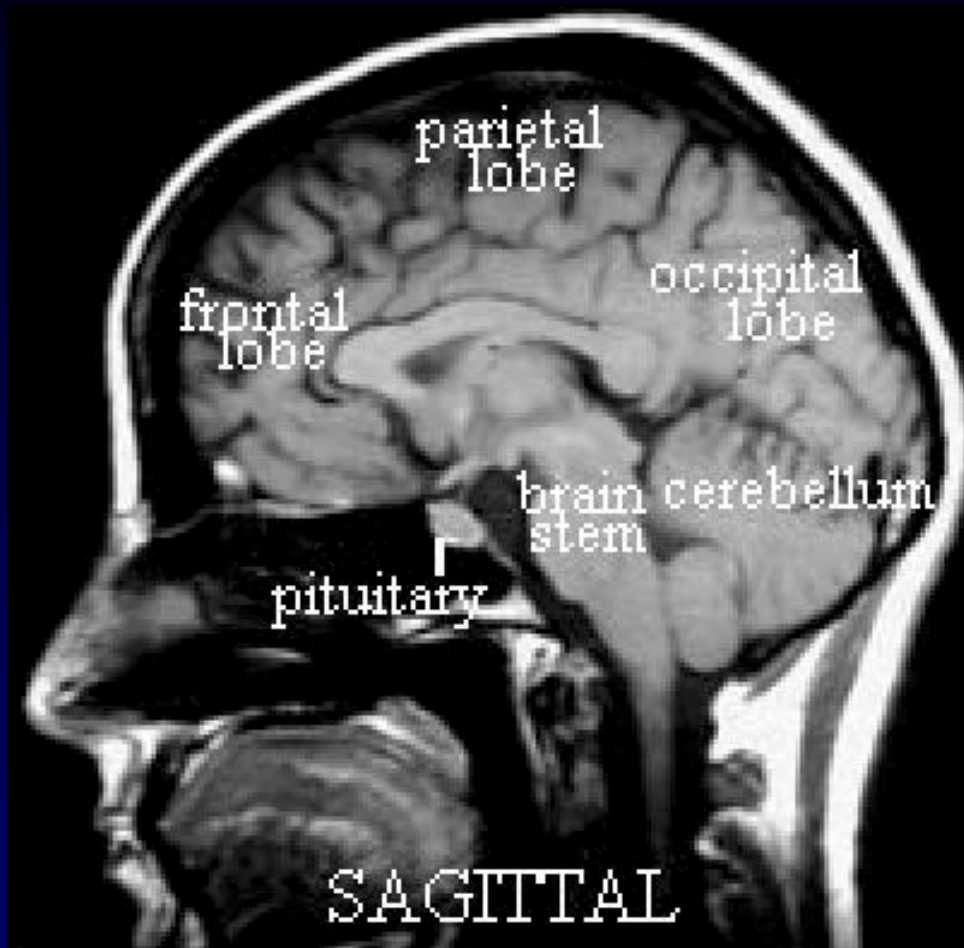
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Open core MRI scanner

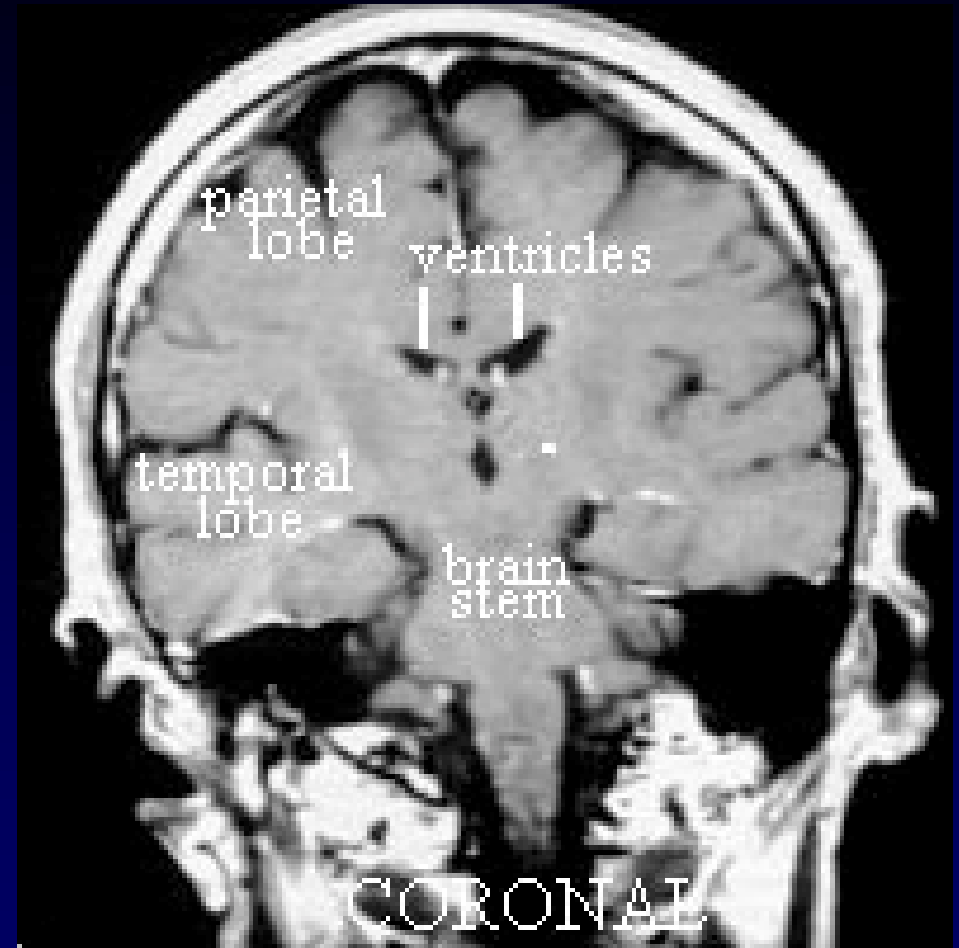


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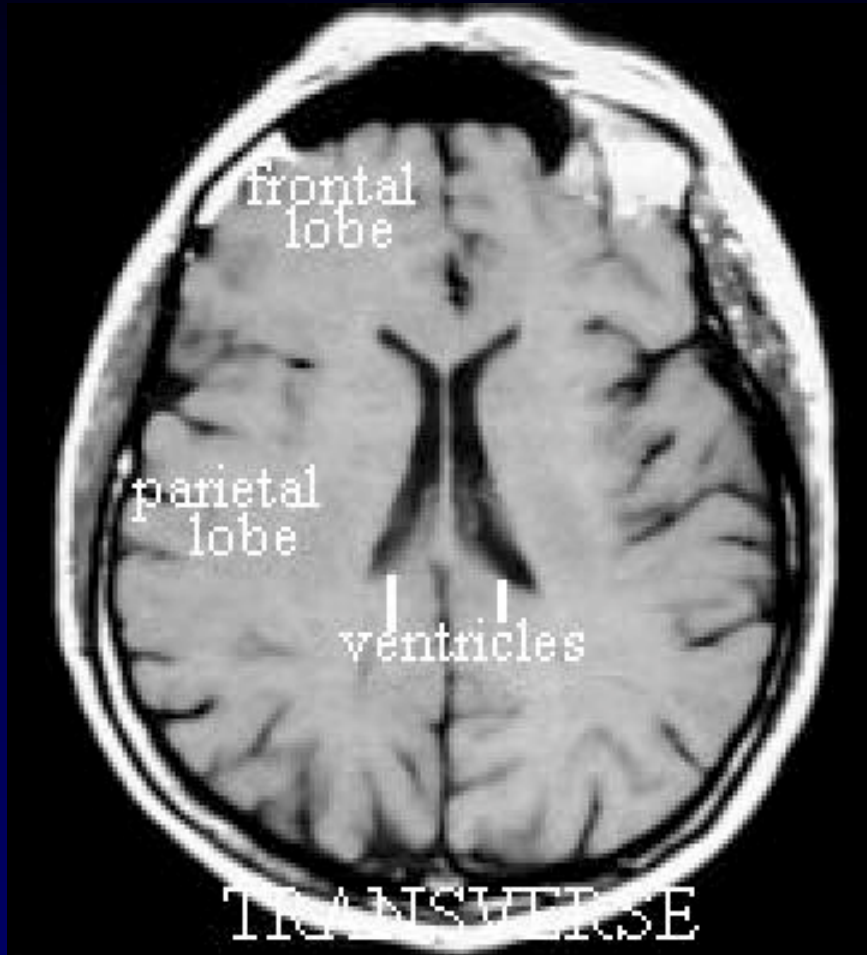
Sagittal brain section



Coronal brain section



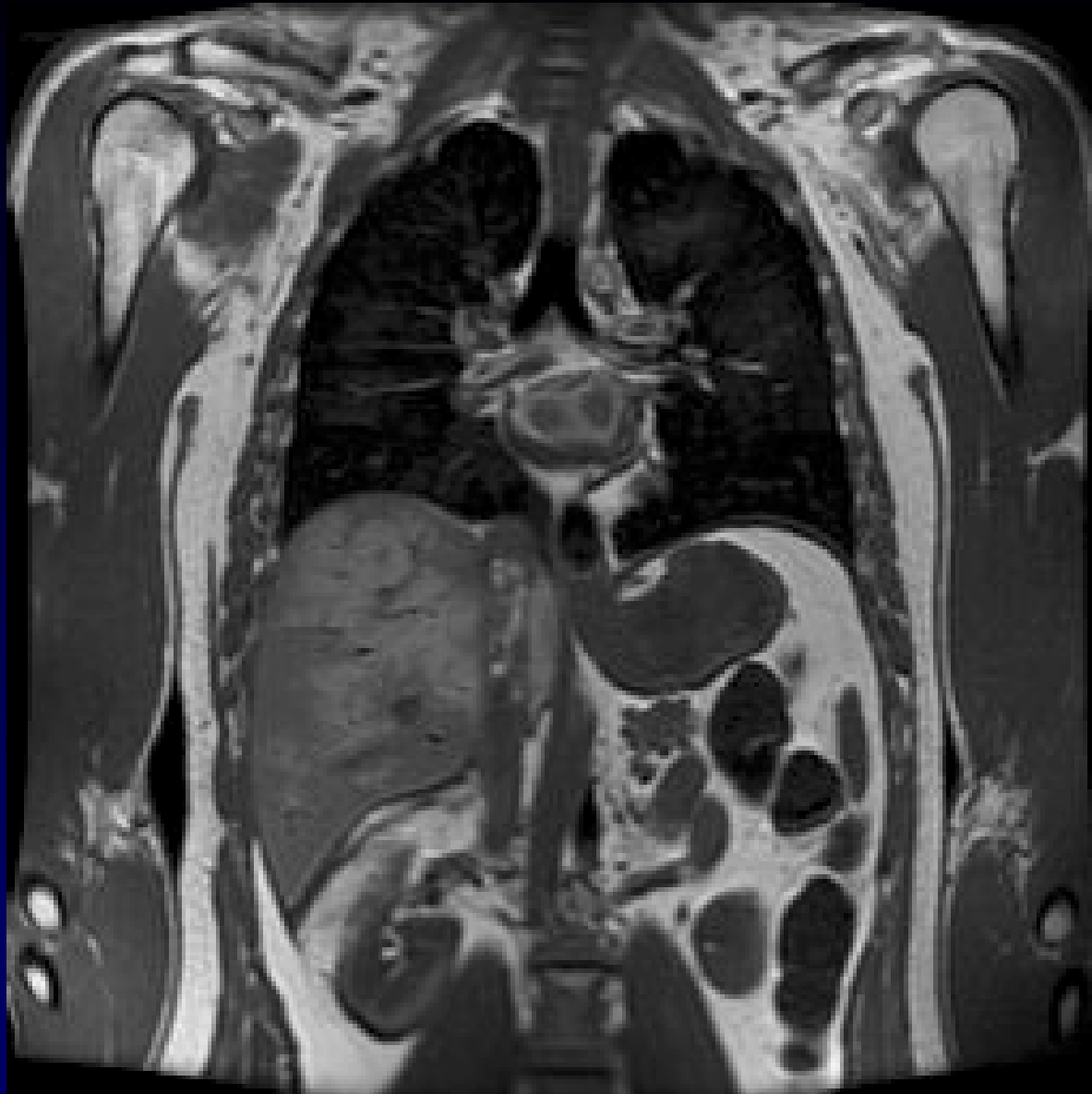
Transverse brain section



Transverse brain MRA: circle of Willis



Coronal torso section



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