My Radiologist says . . .

The Role of Radiology
in
Cancer Diagnosis and Treatment

Dr. Richard Wasley November 12, 2014

Role of Radiology in Cancer Diagnosis and Treatment

1) Understand what types of tests are available, what they can and cannot do and what the patient can expect when having them.

2) How Radiology can be helpful in cancer care.

3) Specific examples – screening and diagnosis

Radiology Tests available

- X-ray
- Ultrasound
- Computed Tomography
- MRI
- PET
- Angiography and nuclear medicine
- Fluoroscopy

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X ray - strengths

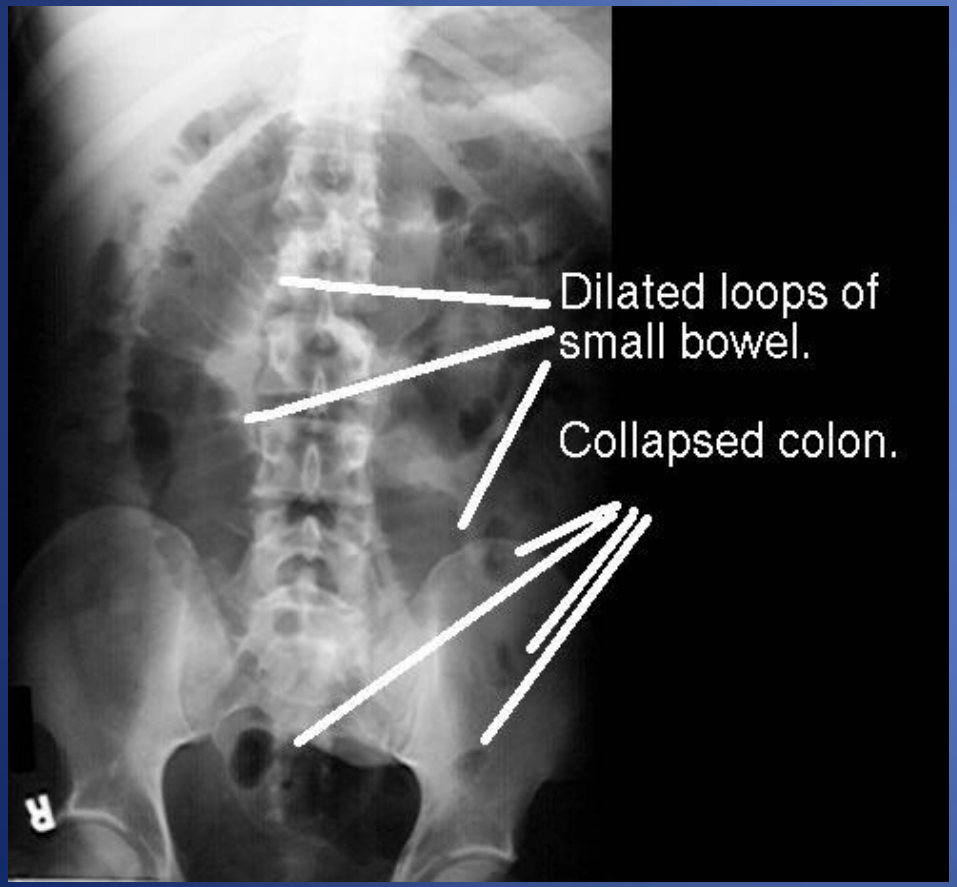
- Often a very good first test in many scenarios
  - Cancer patients can have:
    - Bowel obstruction
    - Pneumonia
    - Complications of treatment
  - Inexpensive, rapid, always available

X ray - strengths

- Cancer patients can have fragile bones

X ray – strengths
Small Bowel Obstruction

Supine positioning



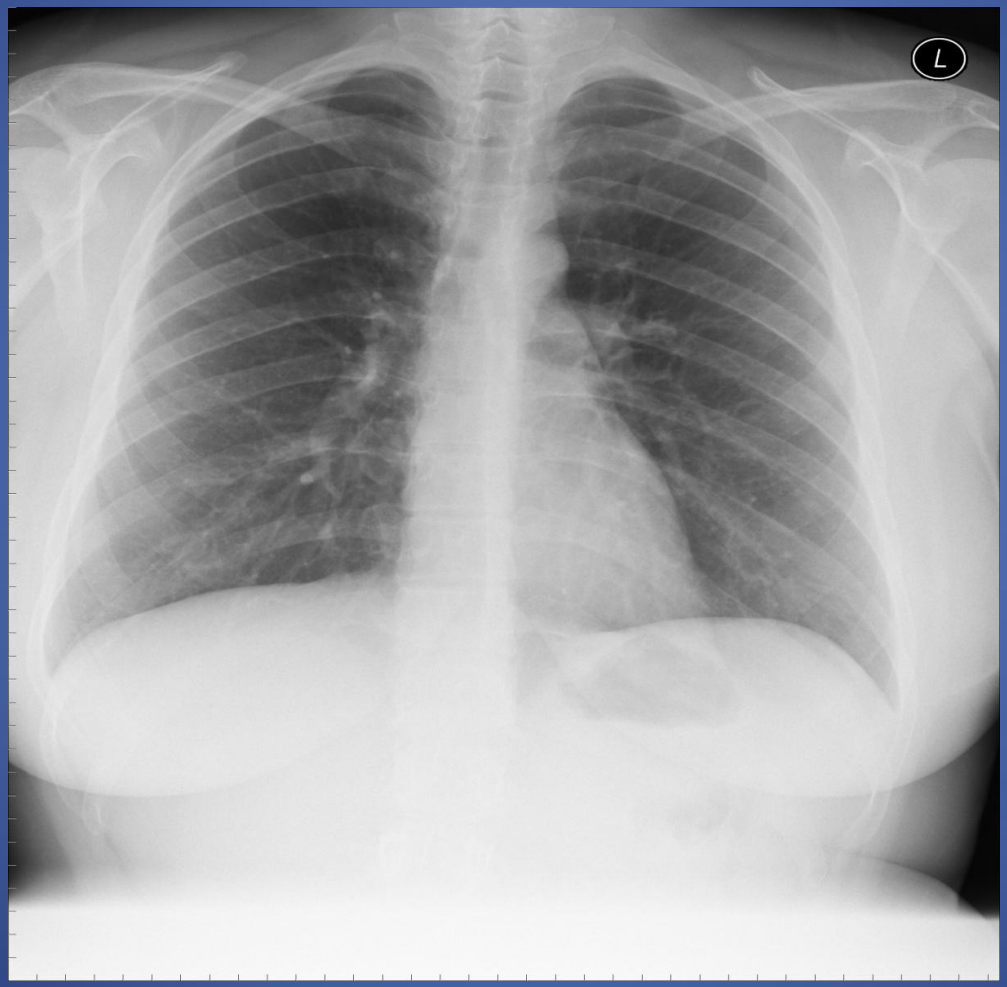
Upright positioning

X ray – strengths
- a good “overview”

X ray - limitations

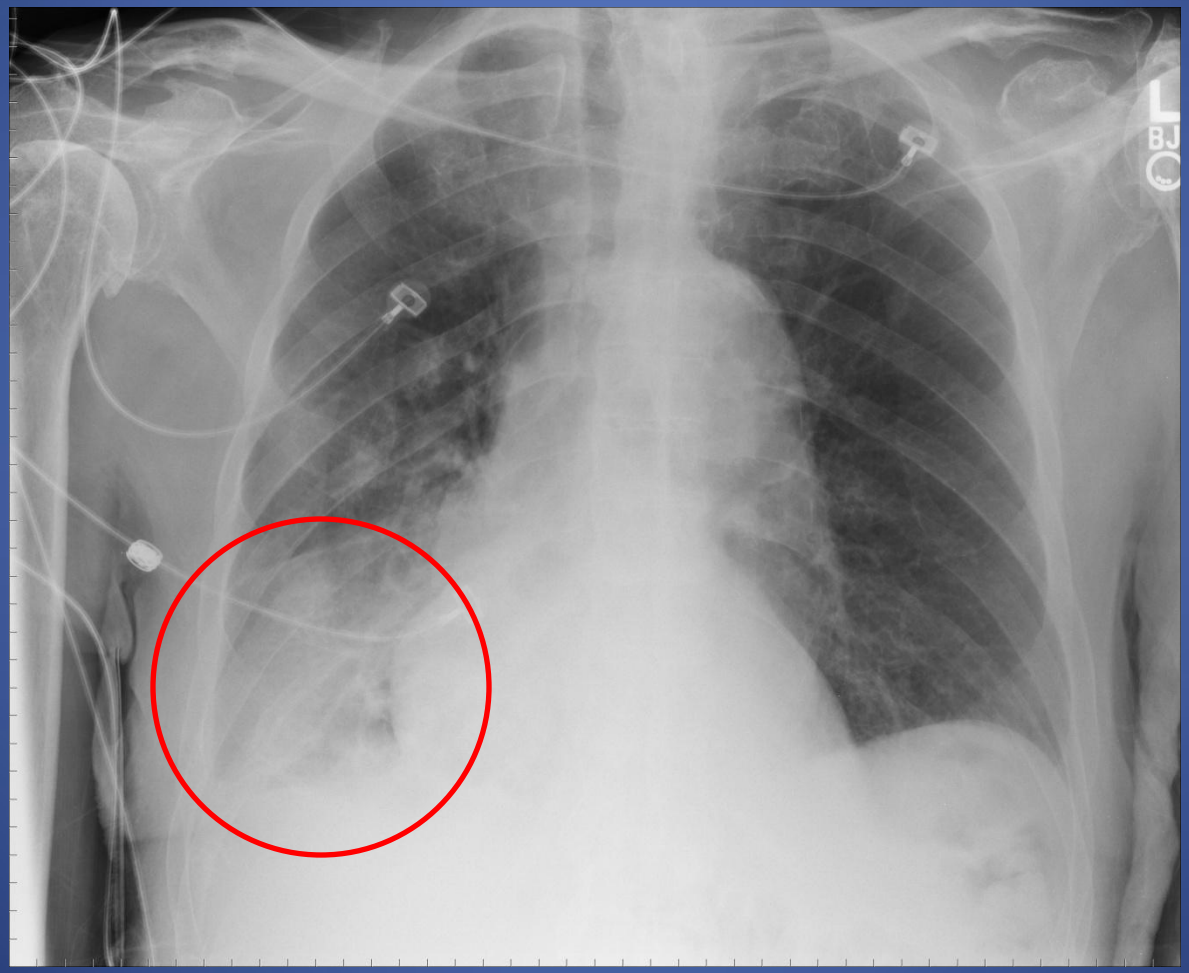
- Good for bones and air filled structures
  - Lung and bowel are air filled
- Very limited in assessing soft tissue
  - Unfortunately most cancers are soft tissue density
- 2D image of 3D structures

X ray - limitations



Normal chest xray

X ray - limitations



Probable pneumonia

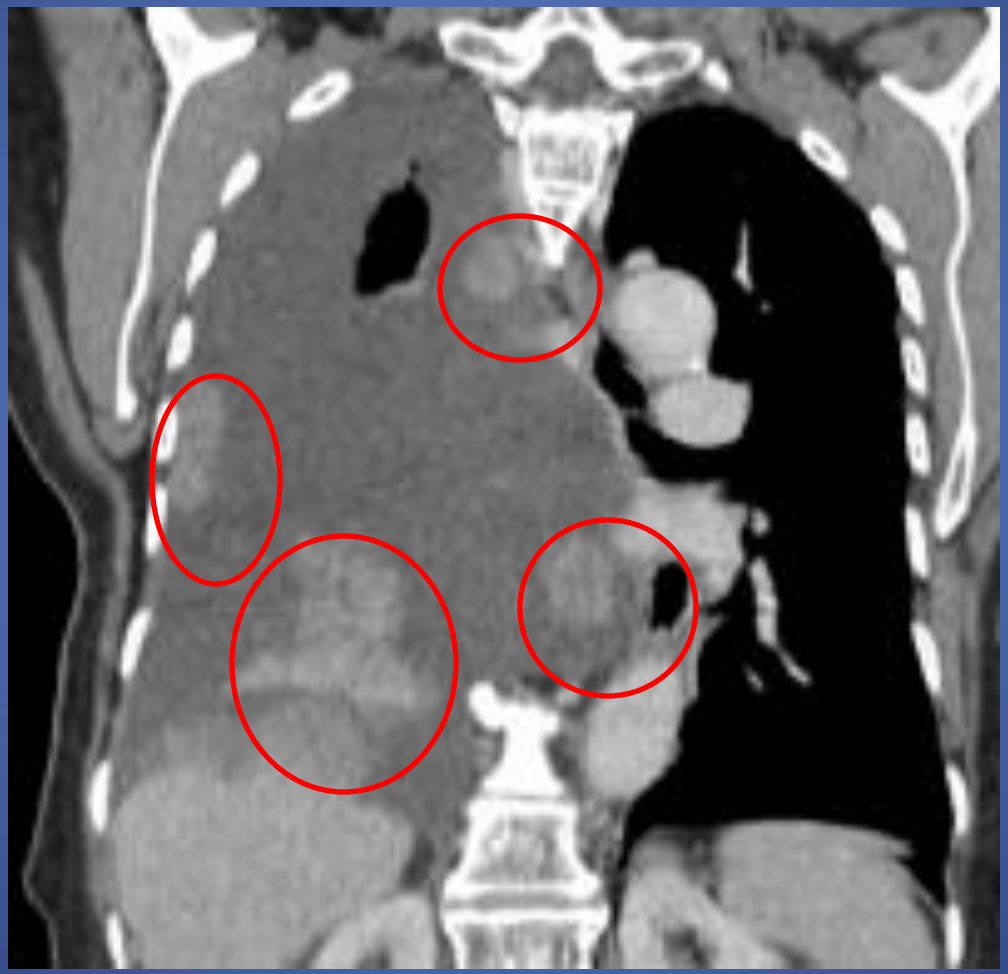
X ray – limitations

Pleurisy?

Pneumonia?

Cancer?

X ray - limitations

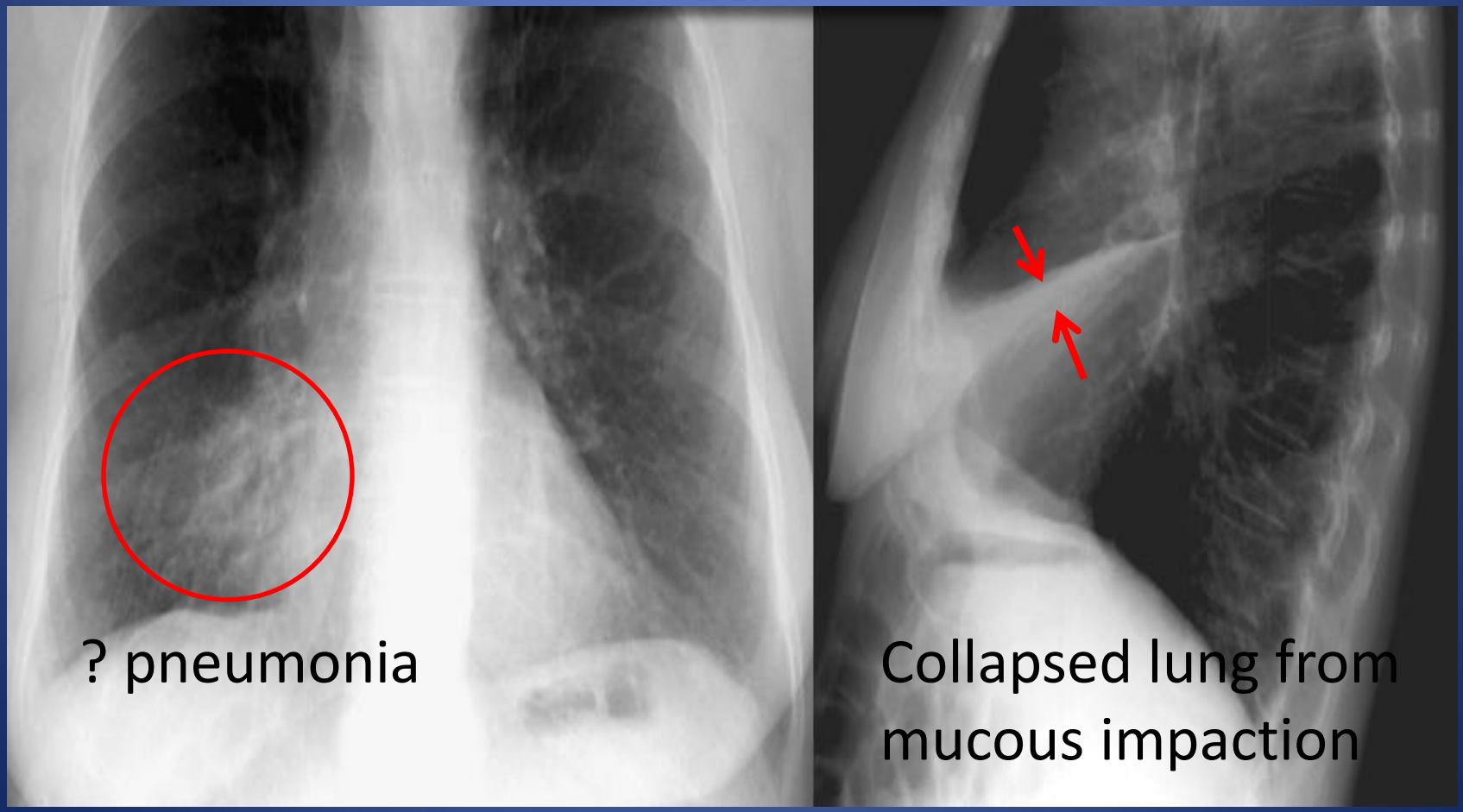


CT scan image

X ray – limitations
2D image of 3D structure

Front view

Side view



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Ultrasound

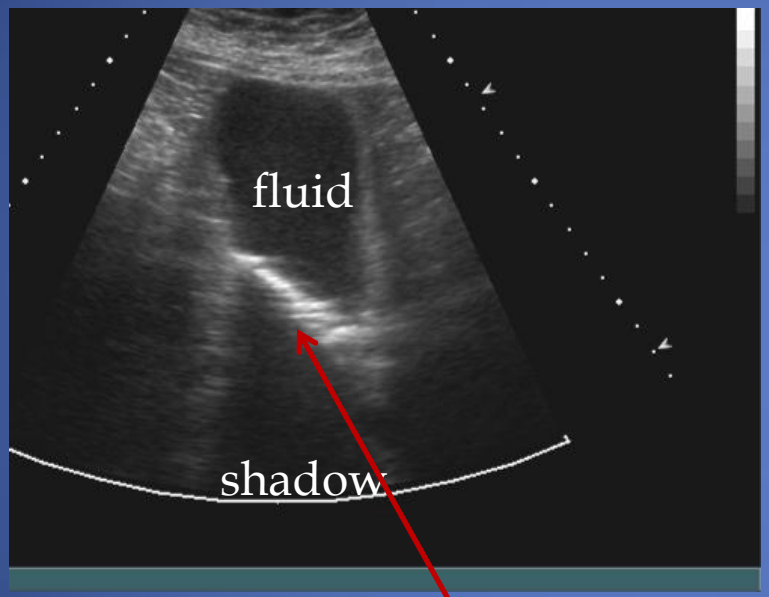
- strengths

  - Good for fluid filled structures
    - Gallbladder, kidneys and urinary bladder
    - Fluid in the abdomen or around lungs
  - Cheap, accurate, reliable and safe

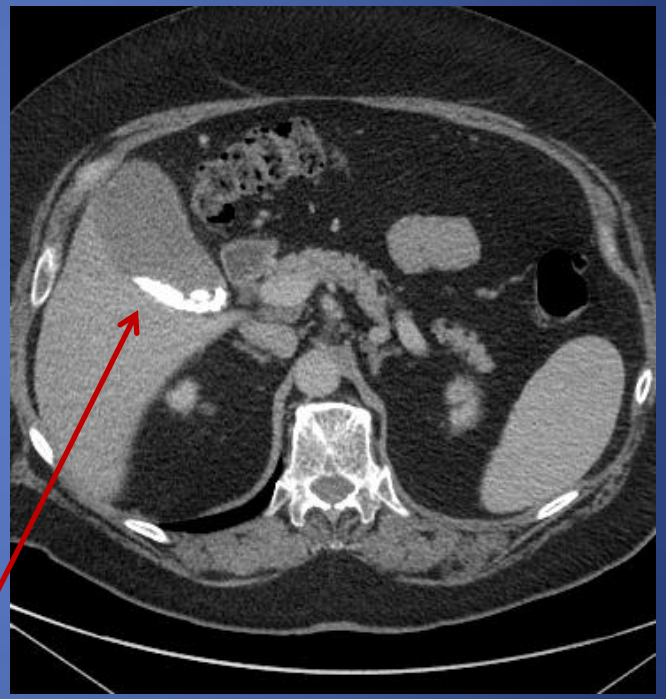
- weaknesses

  - Cannot see too deep, through air or through bone. Beam reflects off fat.
  - Not good for bowel, lungs or bone cancer

Ultrasound of biliary tract



Ultrasound



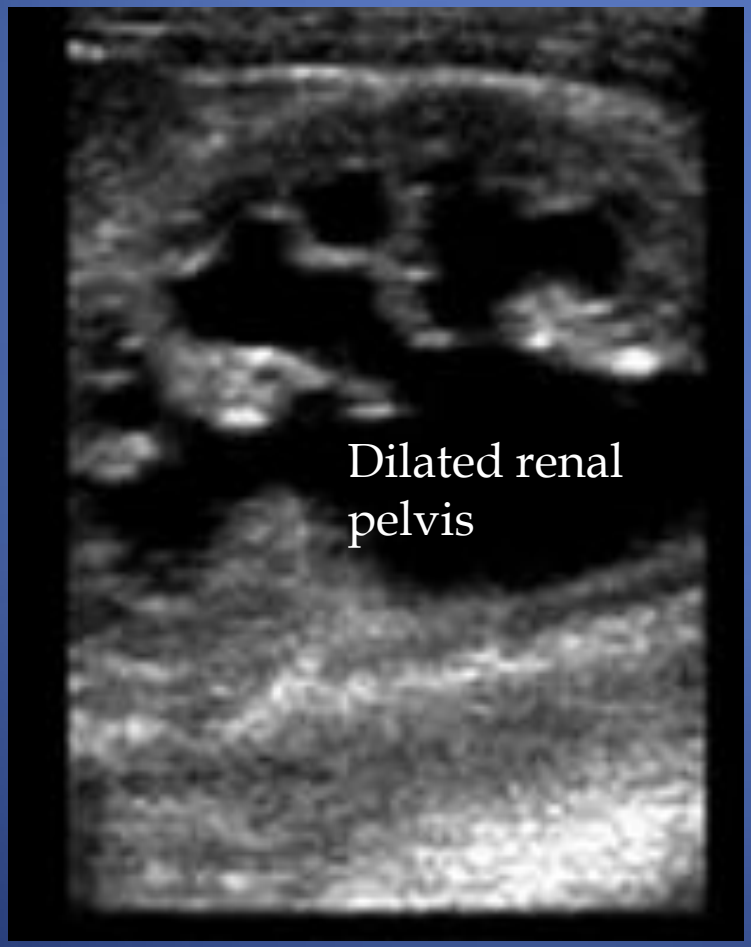
stones

CT scan

Ultrasound

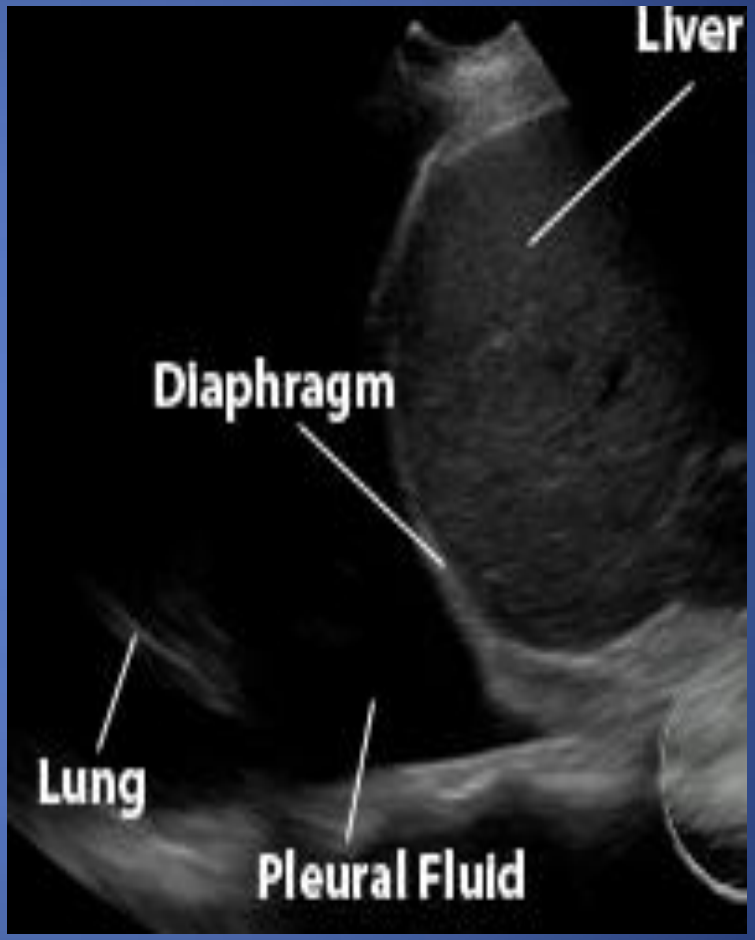
Ultrasound of kidney

- Hydronephrosis (dilated kidney and ureter)



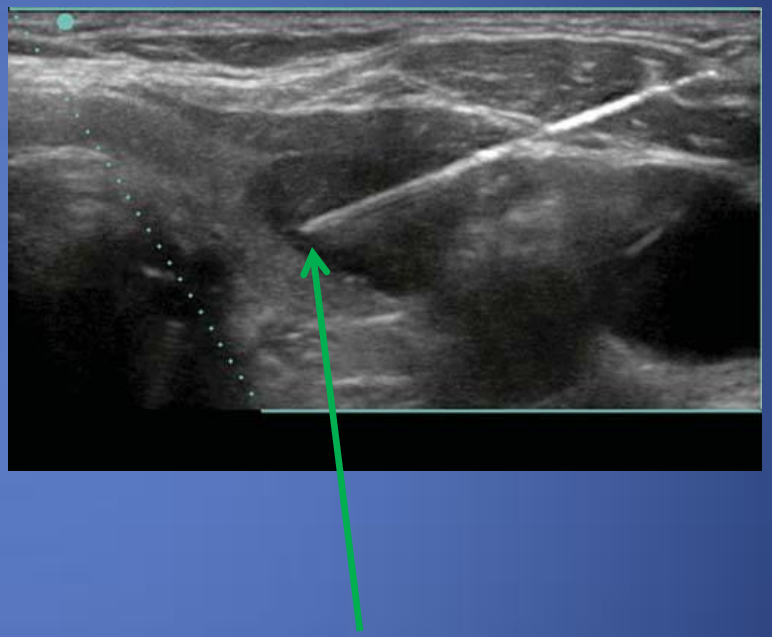
Ultrasound of fluid

Fluid in belly



Fluid around lung

Ultrasound to guide biopsy



Needle in thyroid

Ultrasound - babies

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Computed Tomography (CAT scan)

- One of the primary cancer diagnostic tools.
- Uses xrays to create images that look like “slices” through the body – in any direction.
- Accurate measurements can be used to measure cancer deposits and evaluate response to treatment.

Computed Tomography (CAT scan)

CT scanning - How it's done

- Patient moves continuously
- Xray continuously rotates
- Very fast - in a single breath hold

CT scanning
- very good at imaging all soft tissue

- evaluate fluid, bones, lungs and organs

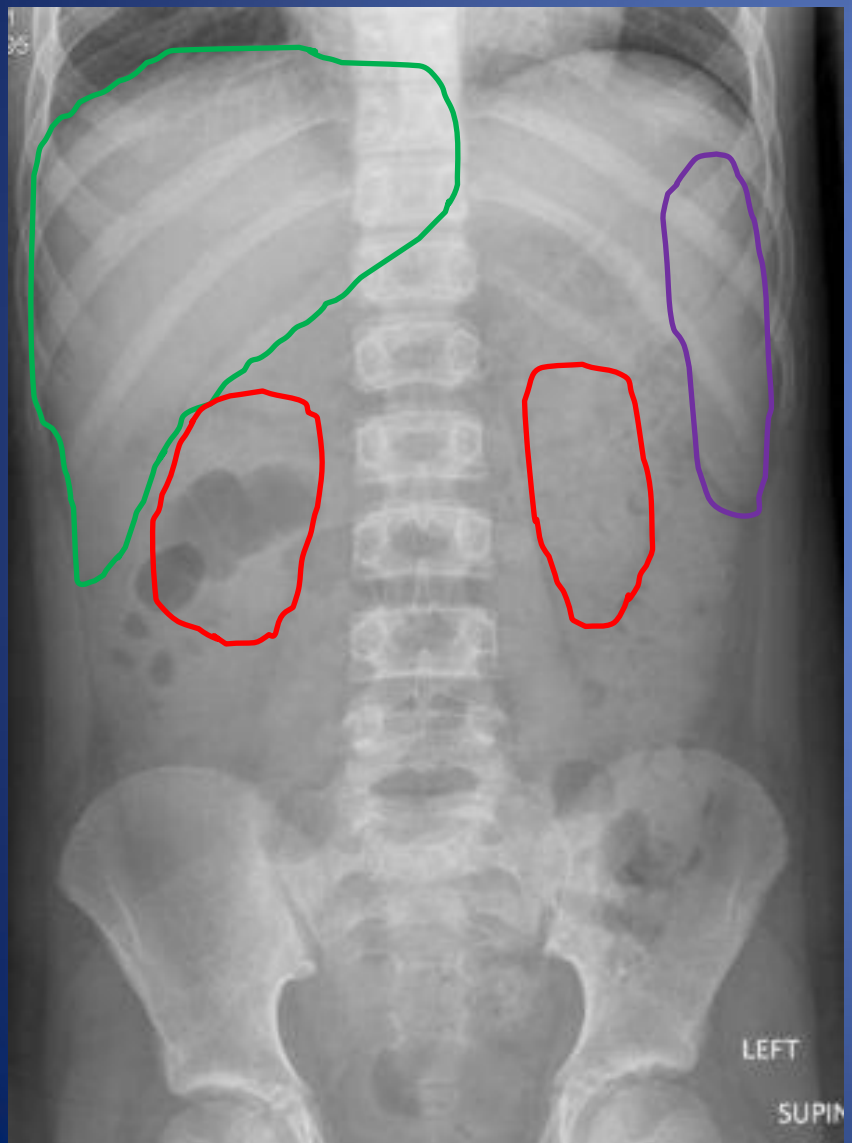
  - if use intravenous contrast, we can see vascular supply to tumors.

- accurate measurement, reproducible images and can be compared with CT from other hospitals and imaging centers.

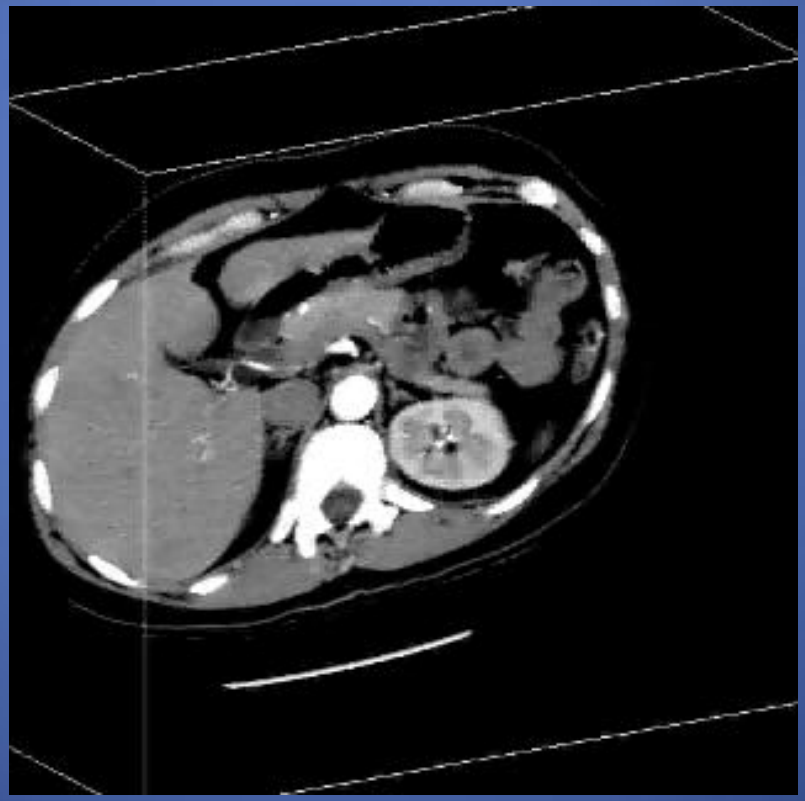
CT - limitations

- Uses radiation so may not be appropriate for children, women of childbearing age or for those who require multiple serial CT for cancer follow-up.
- While good for soft tissue, sometimes MRI is better, especially bone, breast or brain tumors.

CT – detail imaging



CT – multiplanar imaging you get a lot of images



CT – multiplanar imaging
3 dimensional image of the body

CT scan of whole body

Can look at any “slice”

CT – multiplanar imaging
Select what you want to visualize

Abdominal vessels

Kidney vessels only

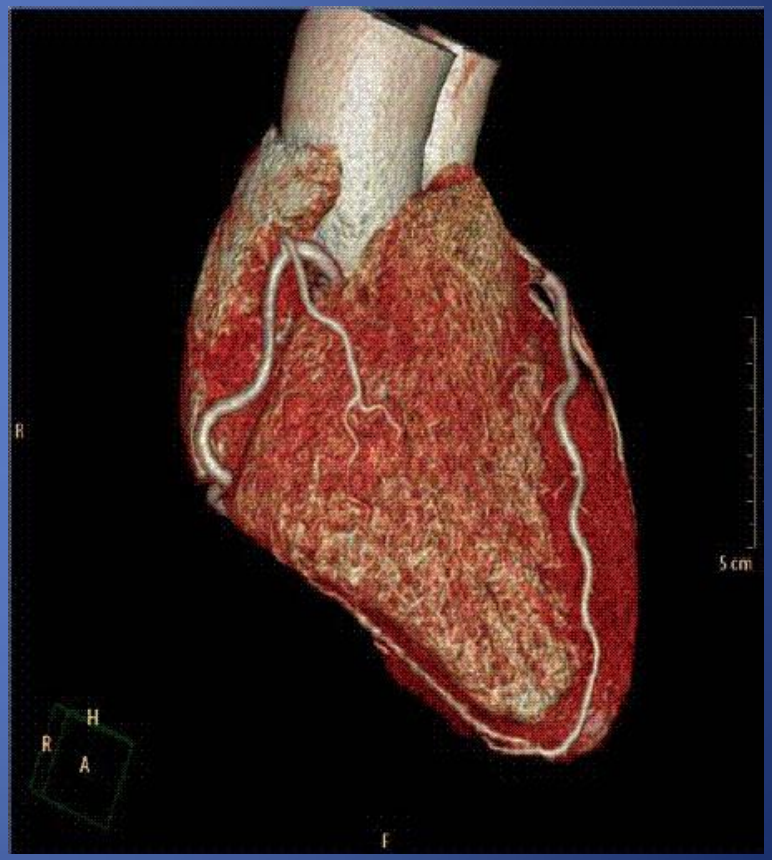
CT – multiplanar imaging
Select what you want to visualize

Spine

Colon

CT – multiplanar imaging
Select what you want to visualize

Chest vessels



Just the heart

CT scan imaging
- Cancer detection

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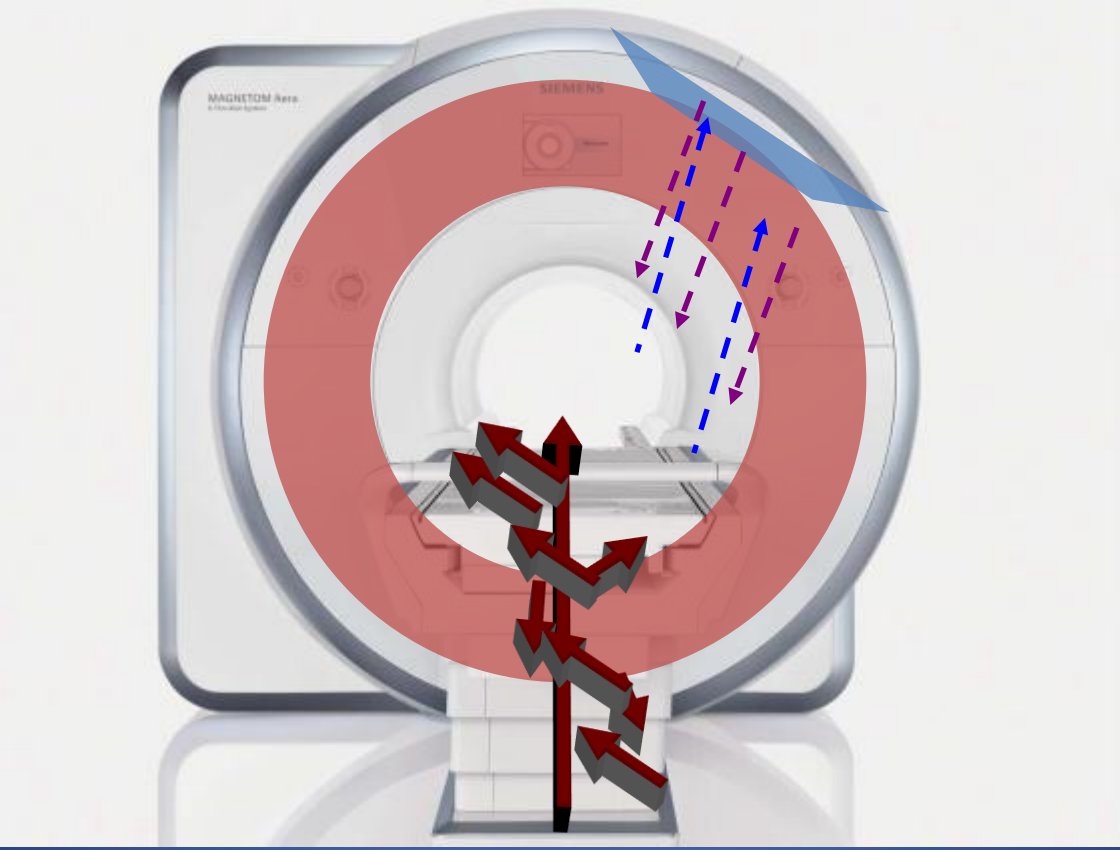
The MRI Scanner

How does MR work?



MR Safety

- You must be screened before you can enter the magnet, or even the room with the magnet
- All implanted devices must be looked up for MR compatibility
- Most pacemakers and cochlear implants are not safe
- The magnet is always on!

The magnet is always on!

The magnet is always on!

MRI
-advantages

- Uses no radiation to generate images.
- Radiowaves in a big magnet makes an image.
- While CT more versatile, MRI has specific advantages

CT versus MRI

Computed Tomography

- Fast (seconds)
- Readily available (24/7)
- Measures attenuation (density)
- Uses ionizing radiation

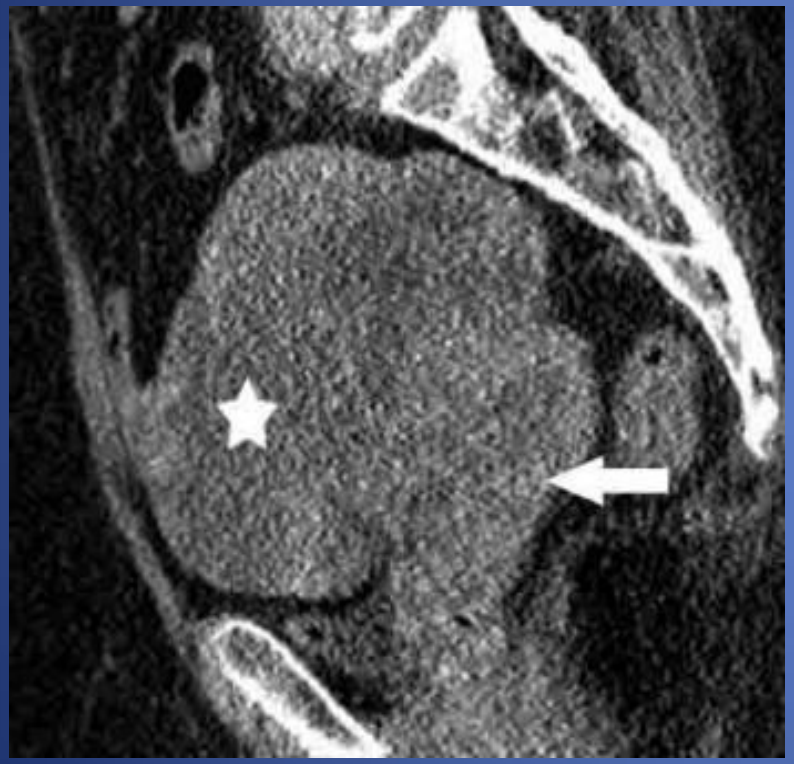
Magnetic Resonance Imaging

- Slow (minutes)
- Not as available
- Measure lots of different properties
- Uses magnetic fields and radio waves

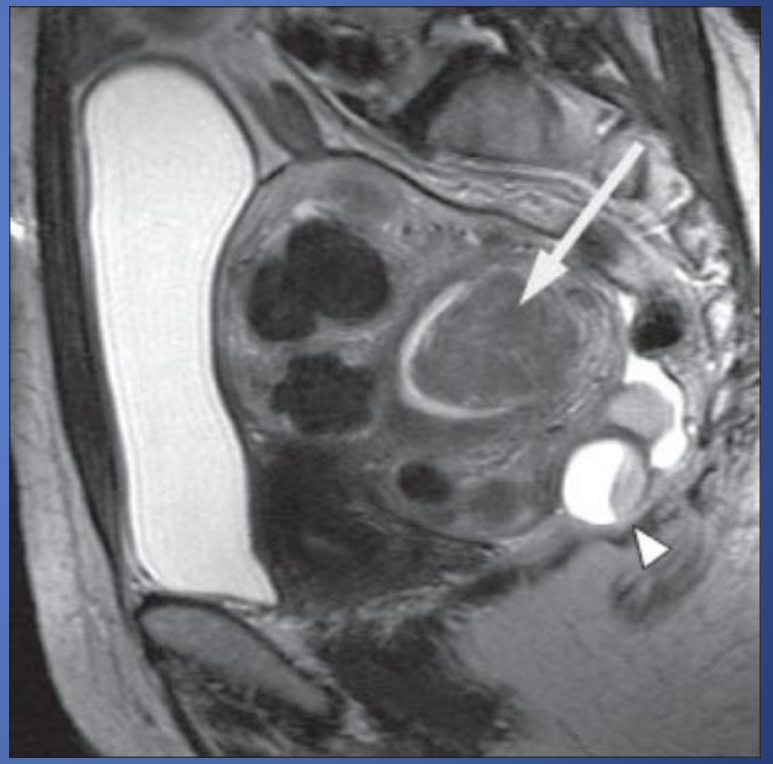
MRI vs CT

- MRI can be better for bone cancer diagnosis and treatment response, especially spine or joints.
- Better at defining and characterizing soft tissue tumors, some liver or pancreas tumors.
- Very good for gynecologic (uterus and ovarian) issues.
- Best for brain and spinal cord imaging of cancers vs CT.

MRI vs CT

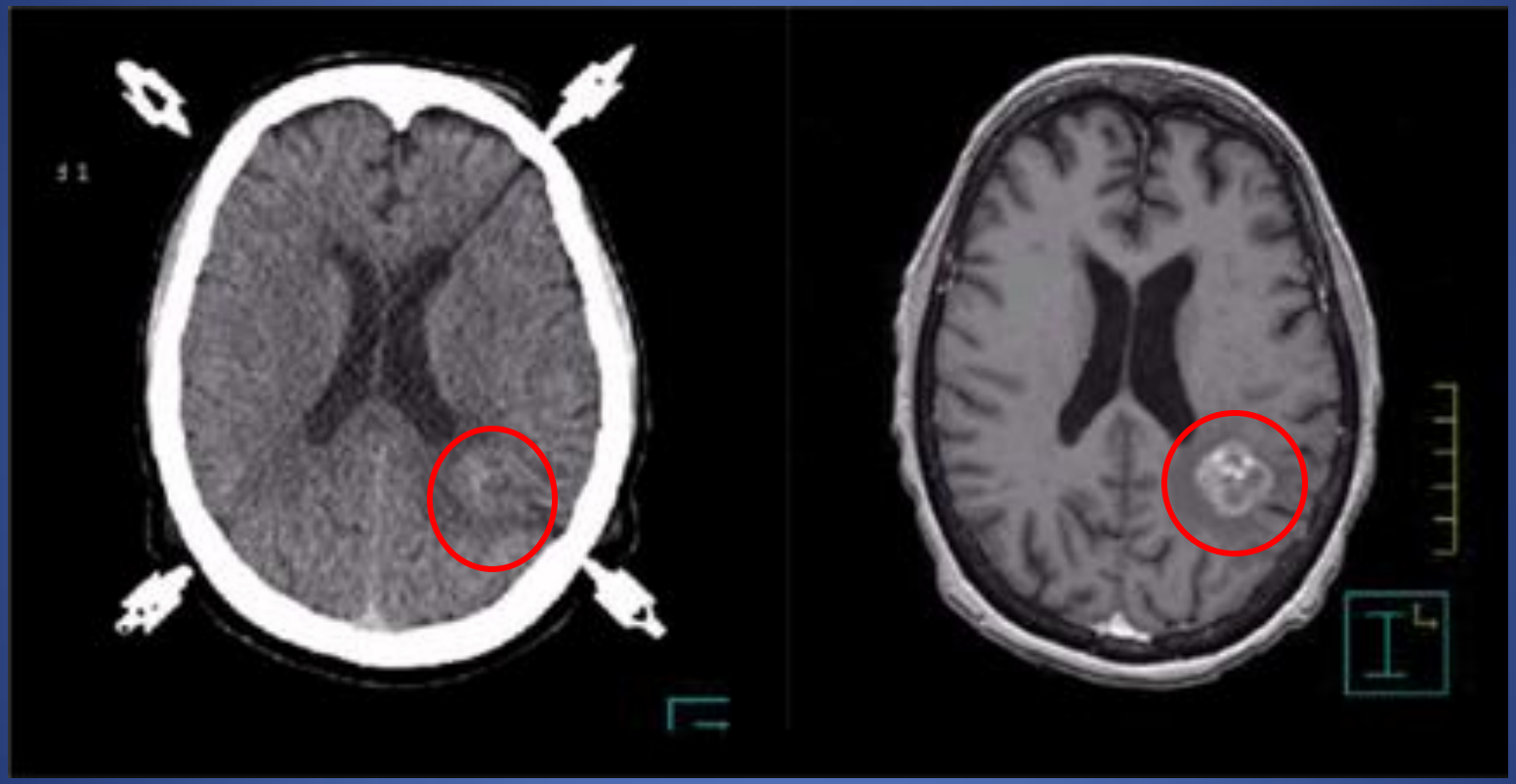


CT shows enlarged uterus



MRI with better detail

MRI vs CT



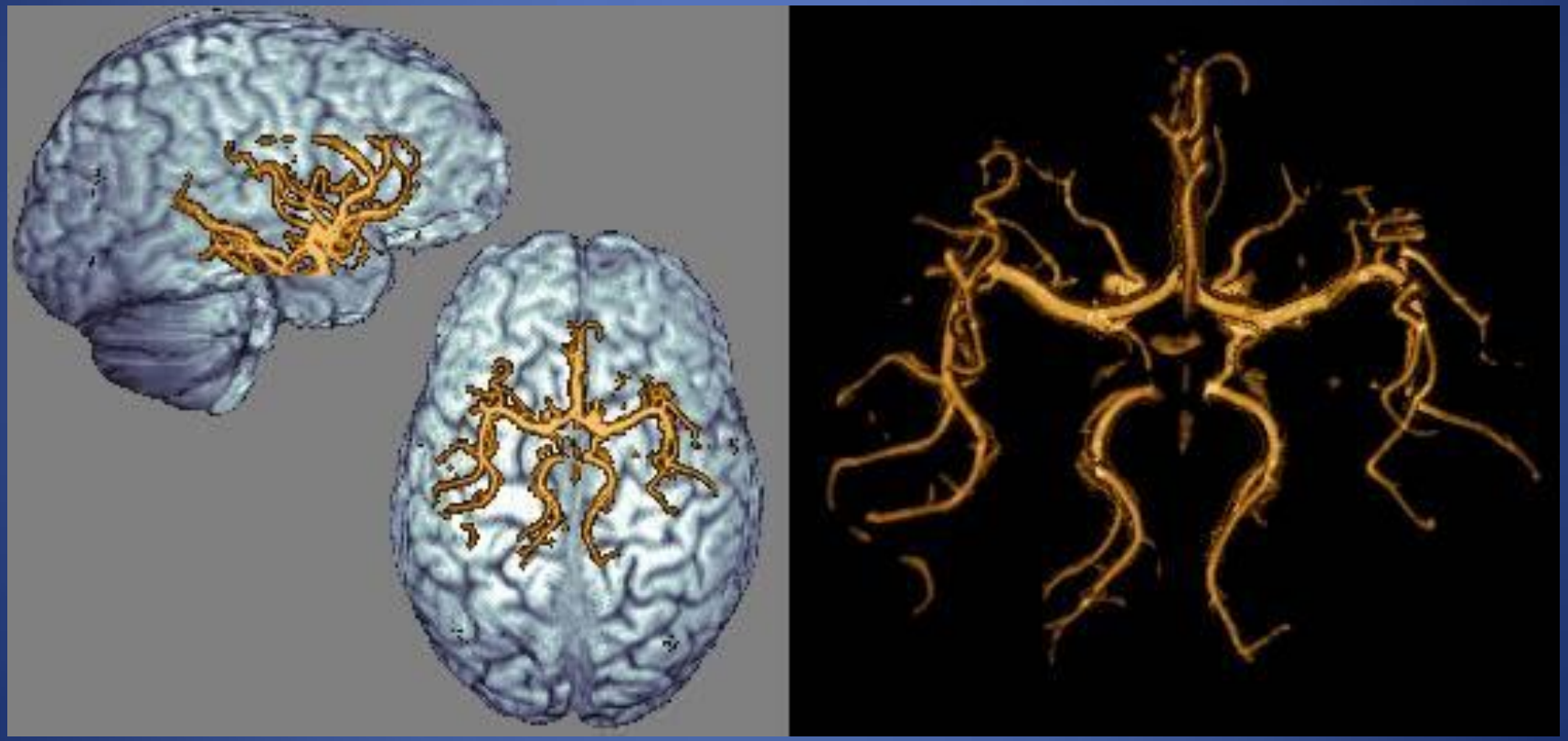
CT shows subtle mass

MRI with better detail

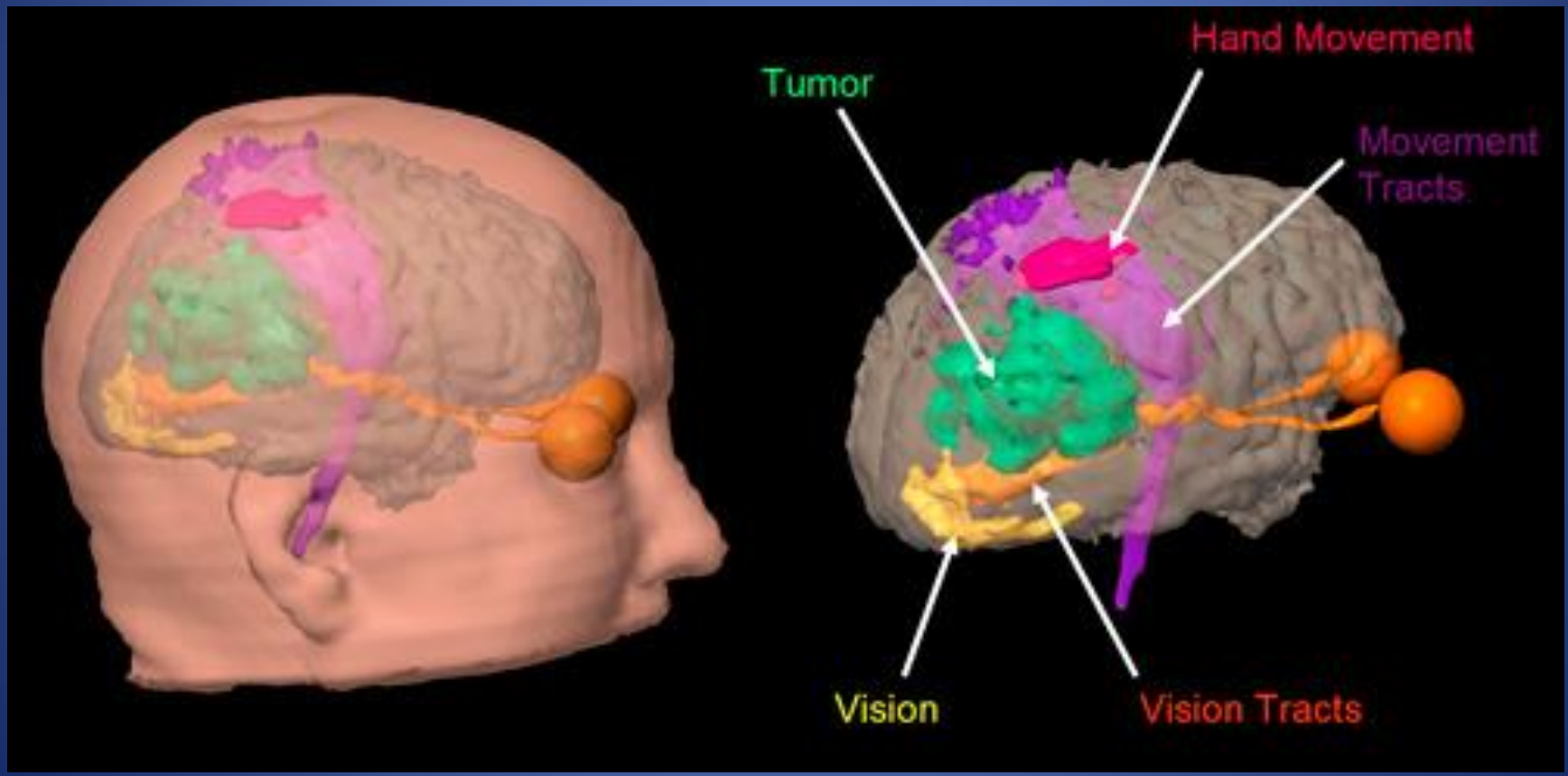
MRI vs CT

Some areas are difficult to see on CT

MRI 3D image



MRI 3D image
- pre surgical mapping



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PET

- Combines both anatomic detail with cellular activity – it shows exactly where cancer is lurking.

- Used to stage cancer. Can accurately assess response to treatment, progression or remission.

PET Scanner

PET scan technique

- All actively growing cells require glucose sugar as energy.
- Glucose tagged with a marker is injected intravenously. Whole body is scanned.
- Active cells using the glucose can be imaged.

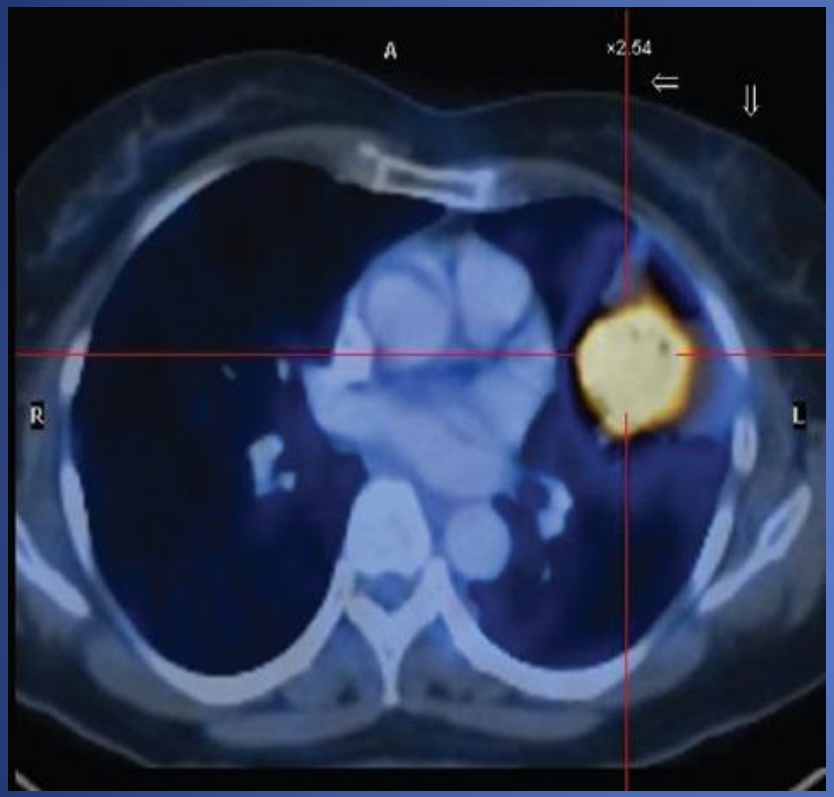
PET images

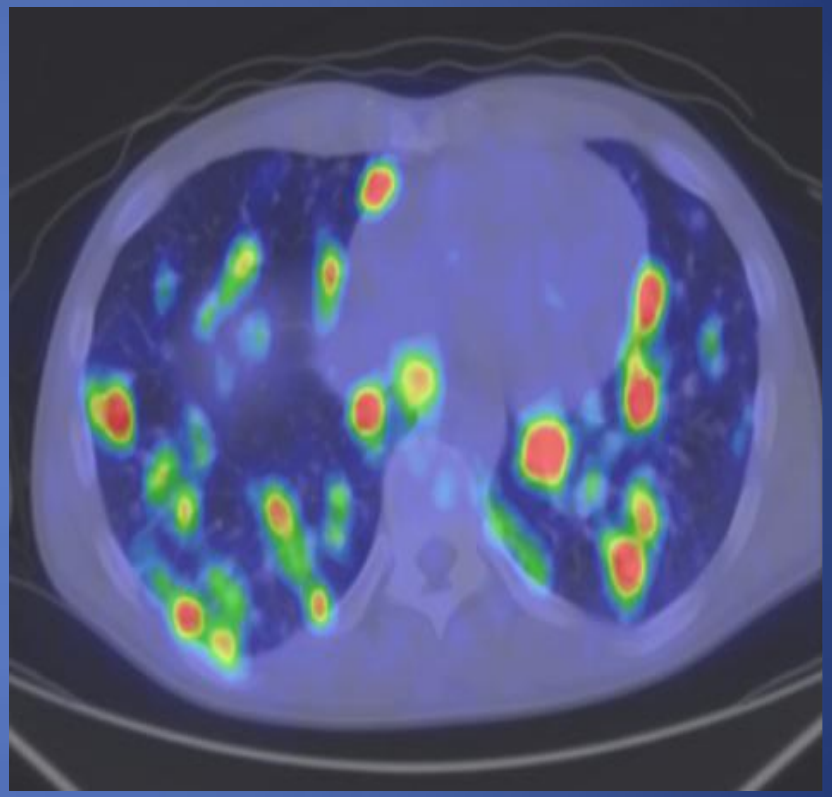
- Normal to see
  - Brain
  - heart

PET images

- Cancer is conspicuous

PET detects all areas of involvement



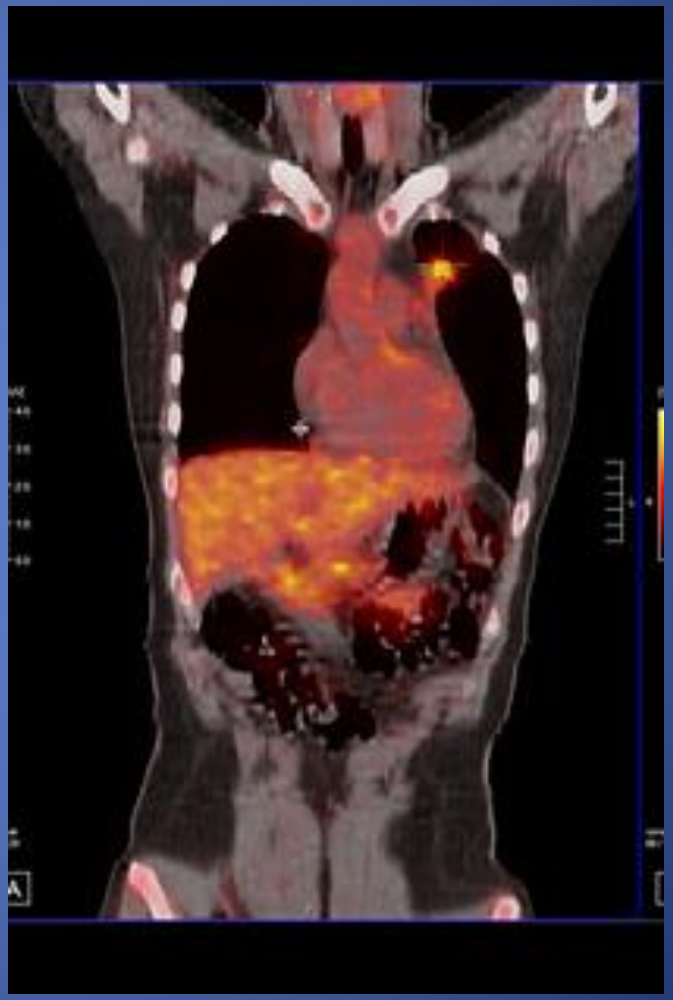


One large lesion

Or several small ones

PET assesses response to therapy

At initial diagnosis

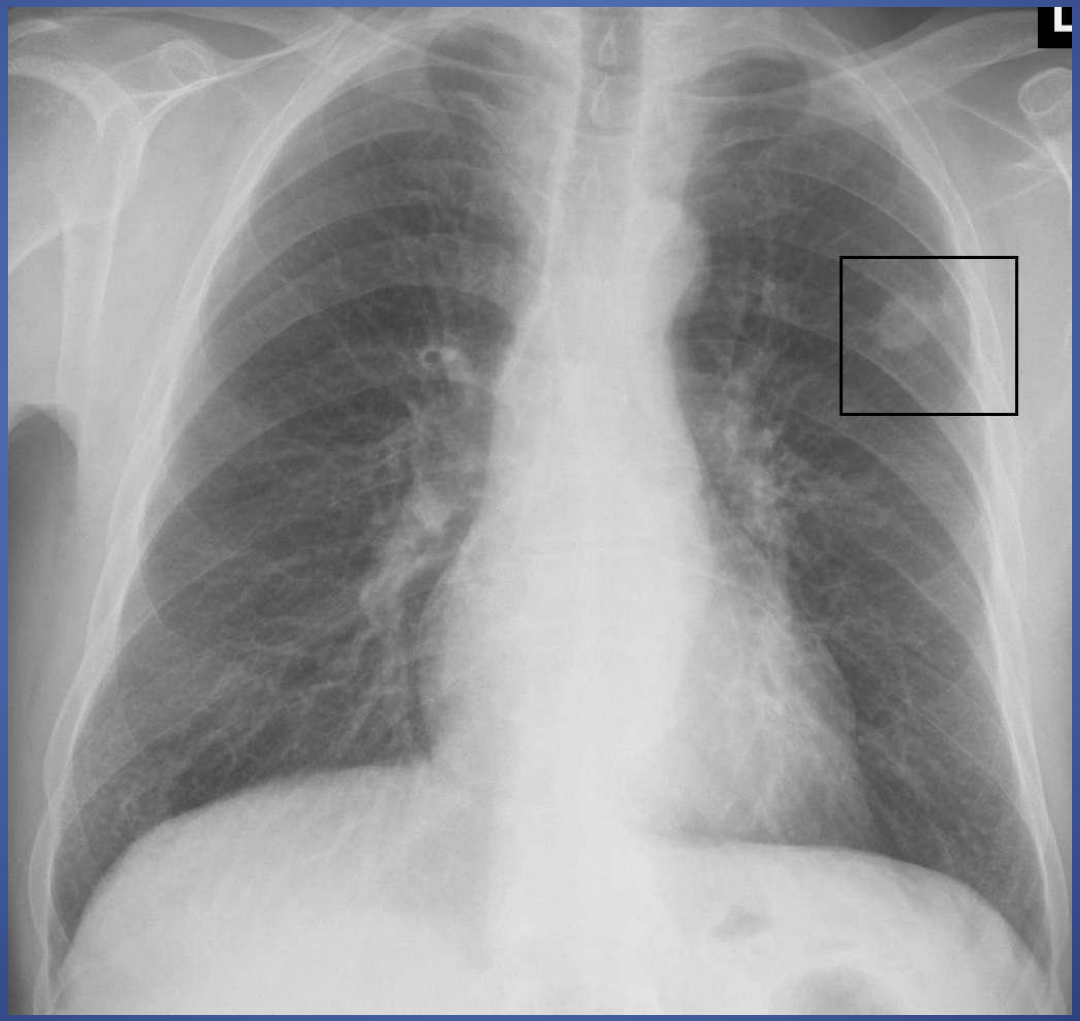


After 3 months of chemotherapy

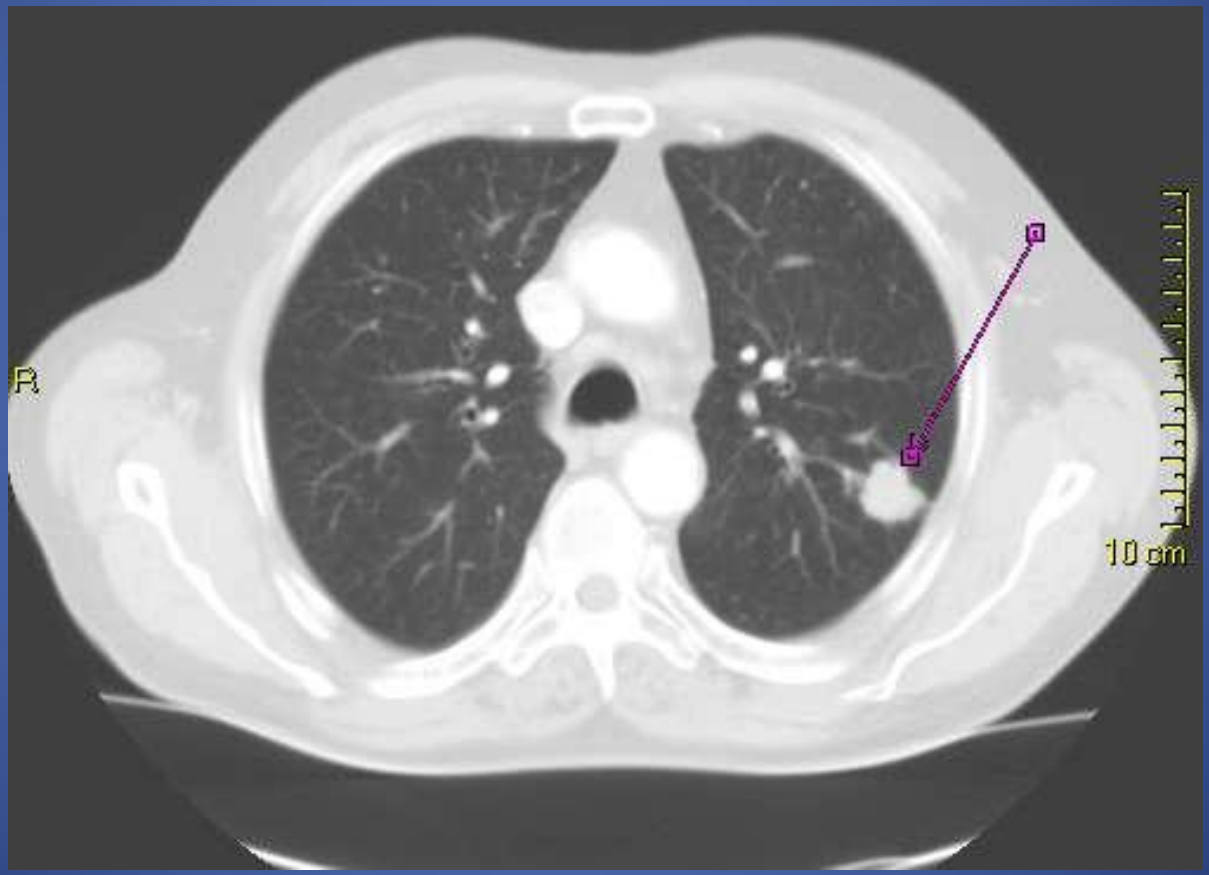
Radiology Tests available -how does it all fit together?

- X-ray
- Ultrasound
- Computed Tomography
- MRI
- PET

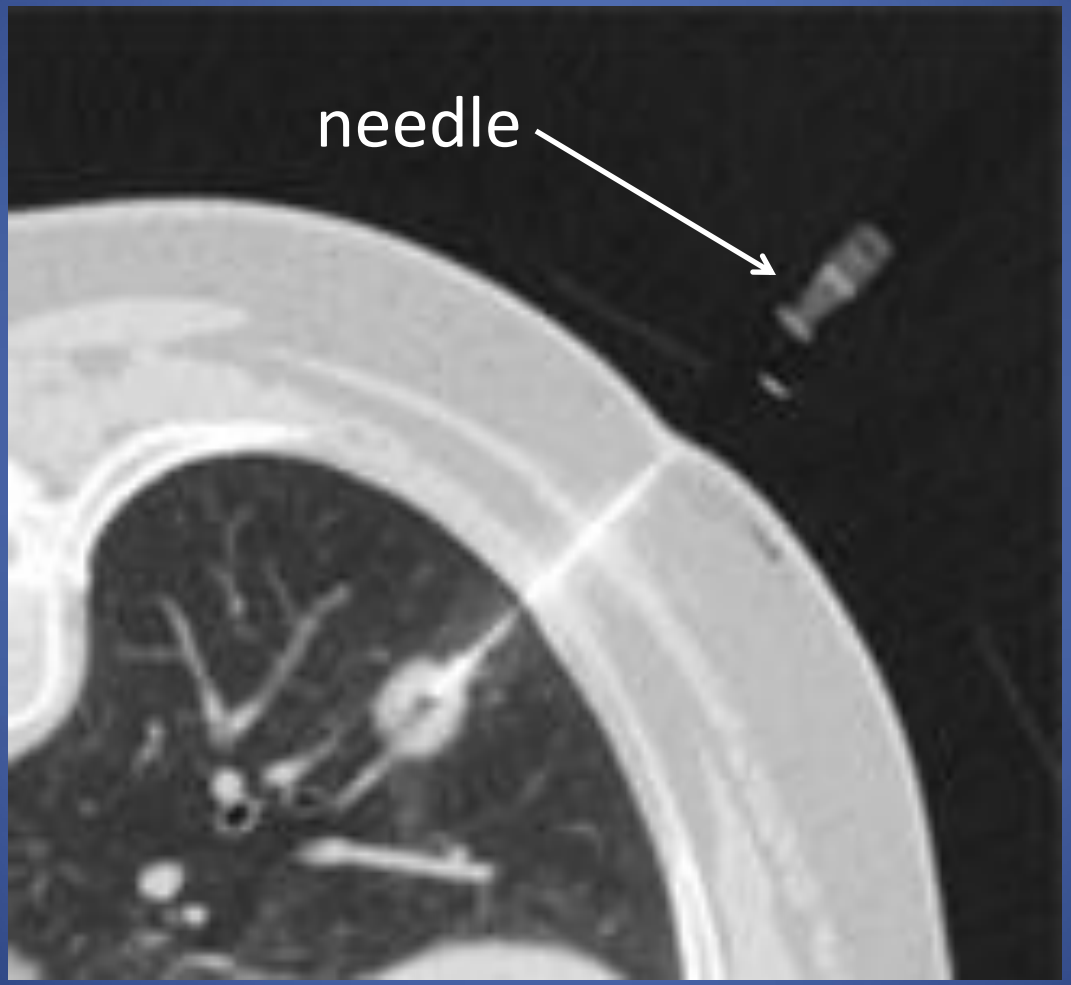
Lung Cancer detection



Lung Cancer CT

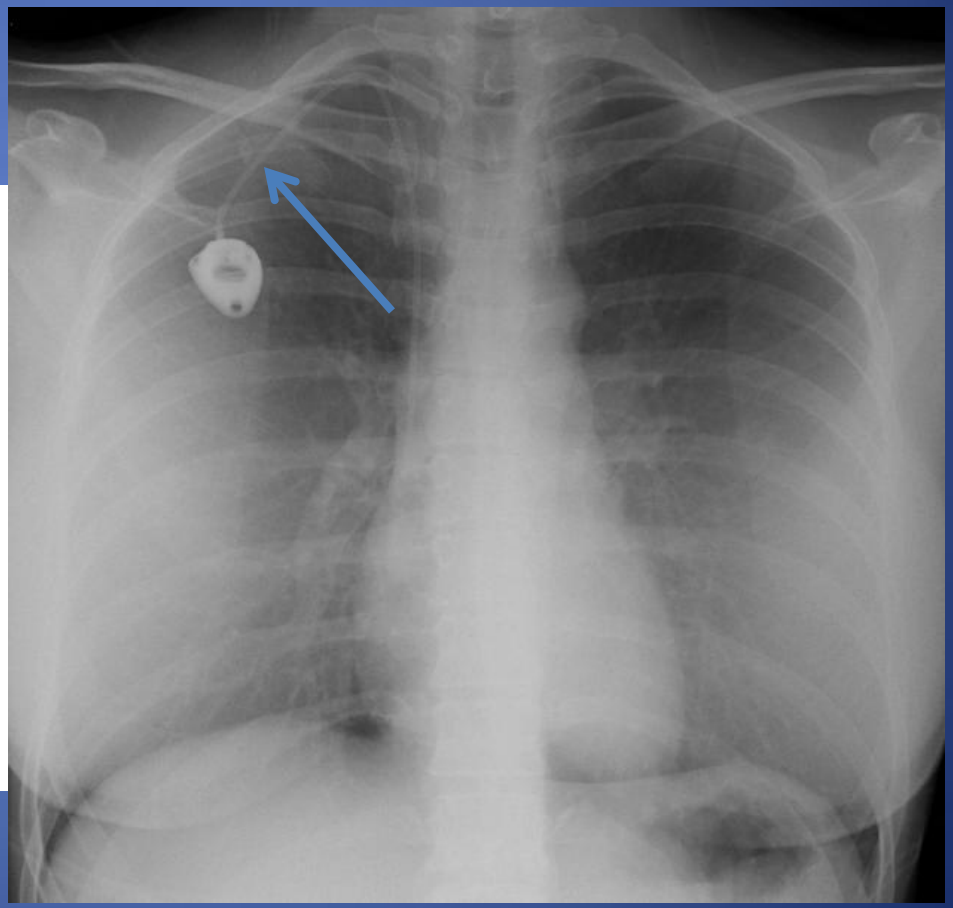


Lung Cancer diagnosis

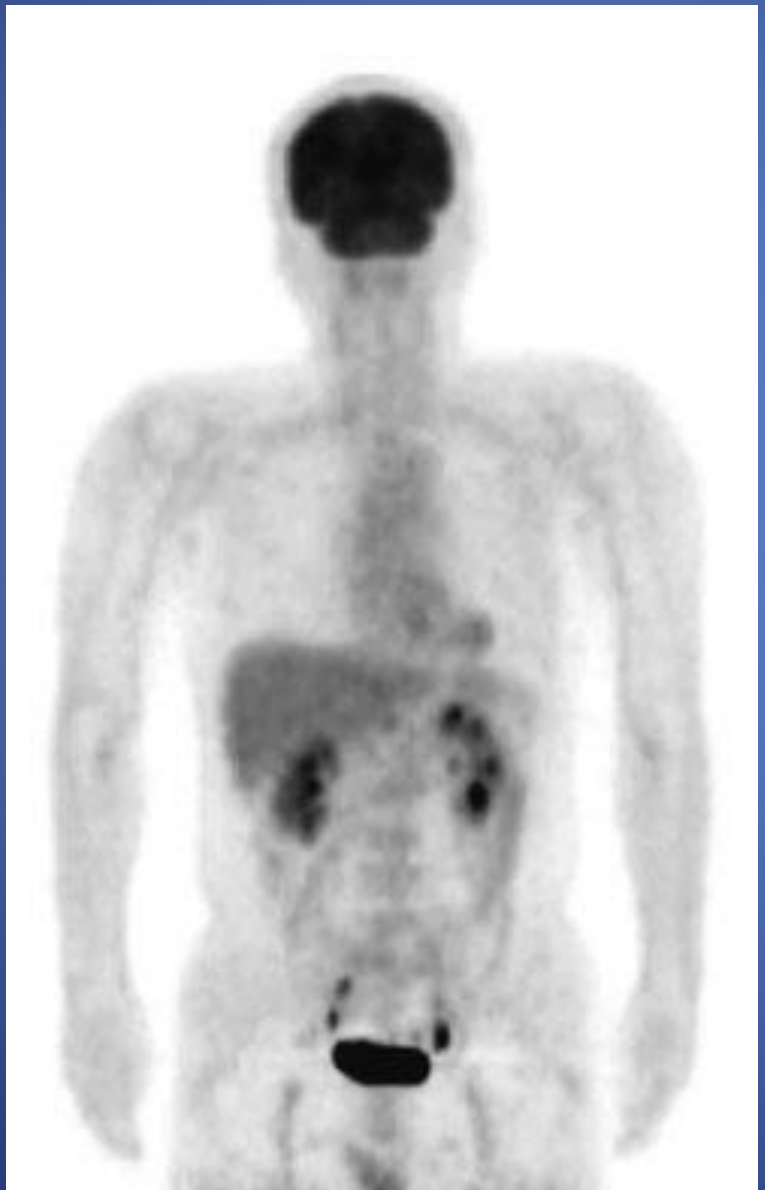


Lung Cancer staging with PET

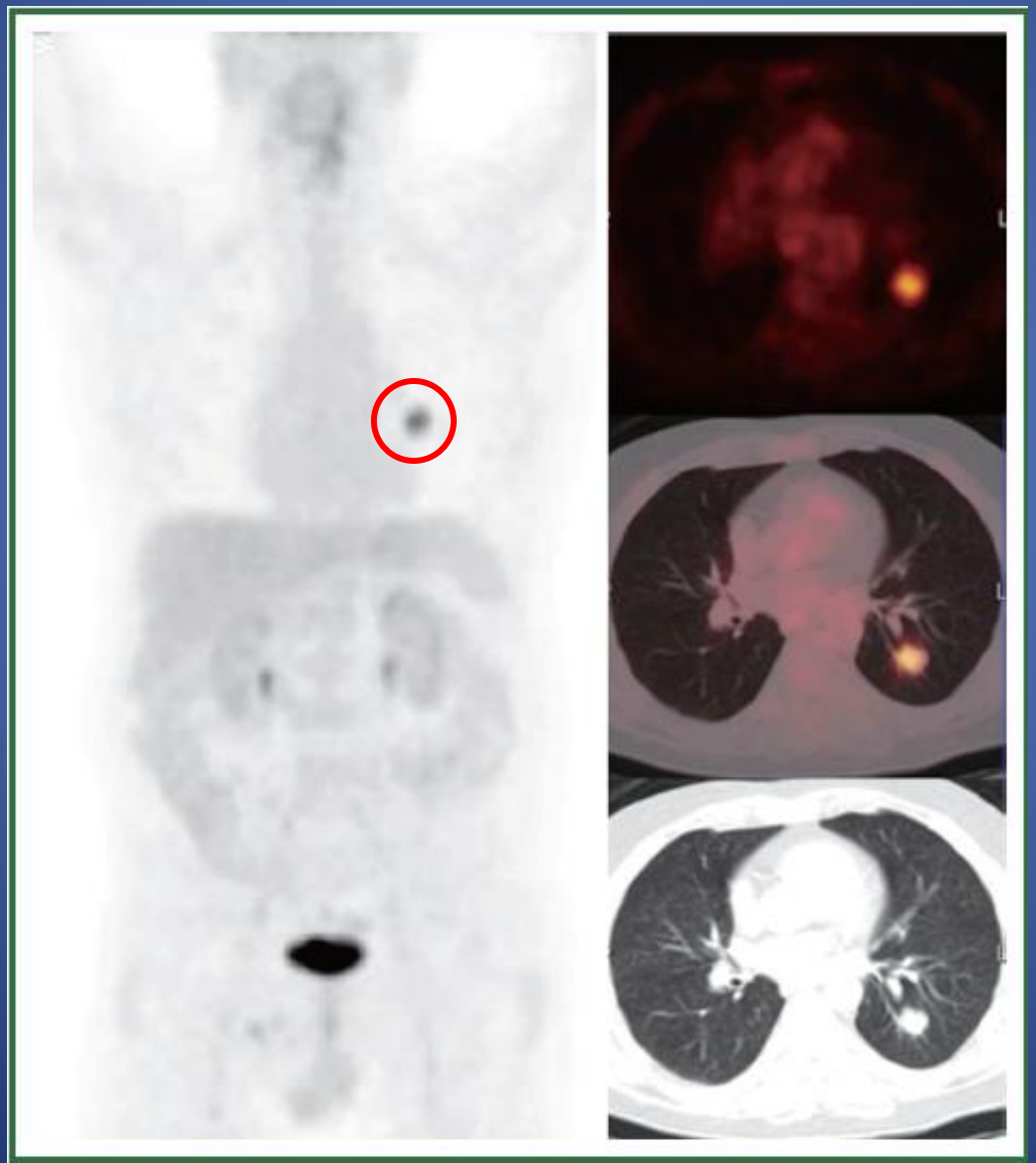
Infusion port placed for chemotherapy



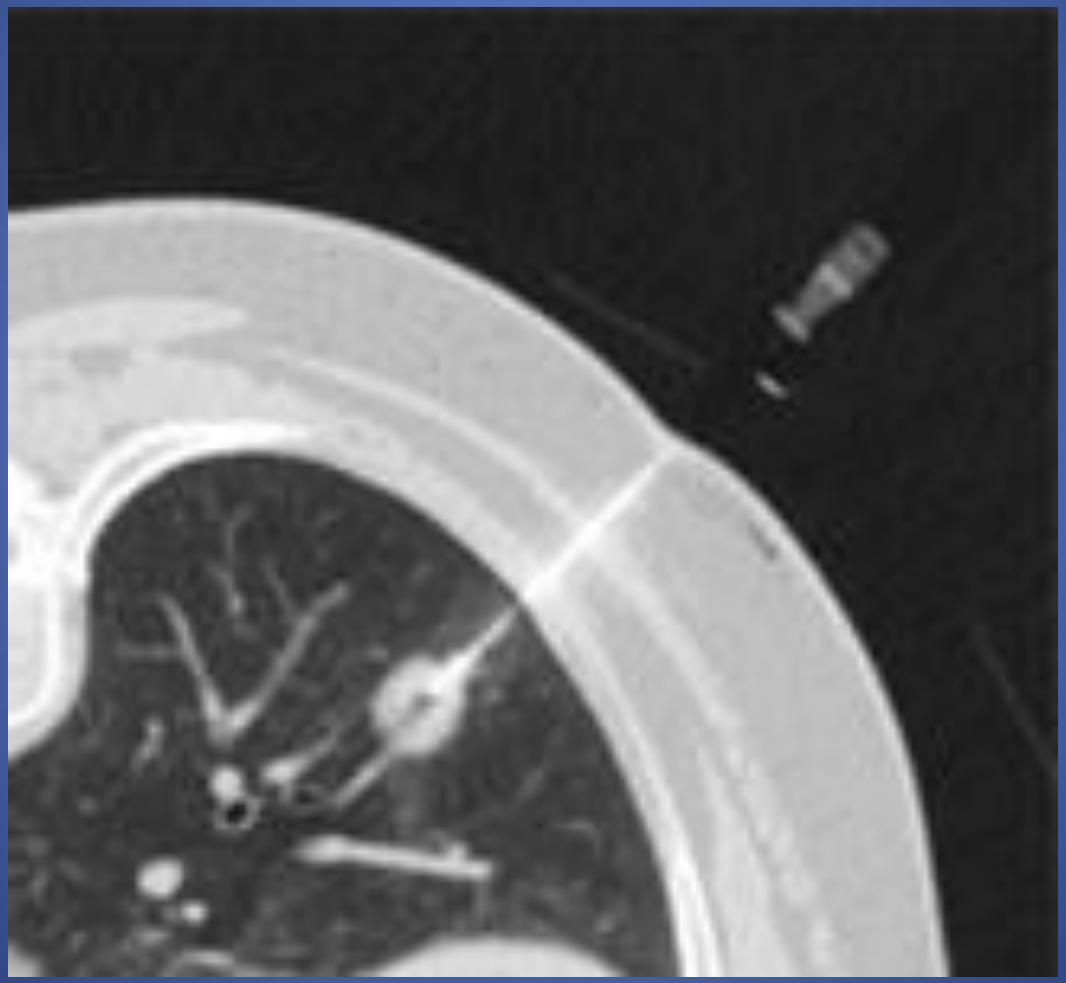
Lung Cancer chemotherapy



Lung Cancer recurrence



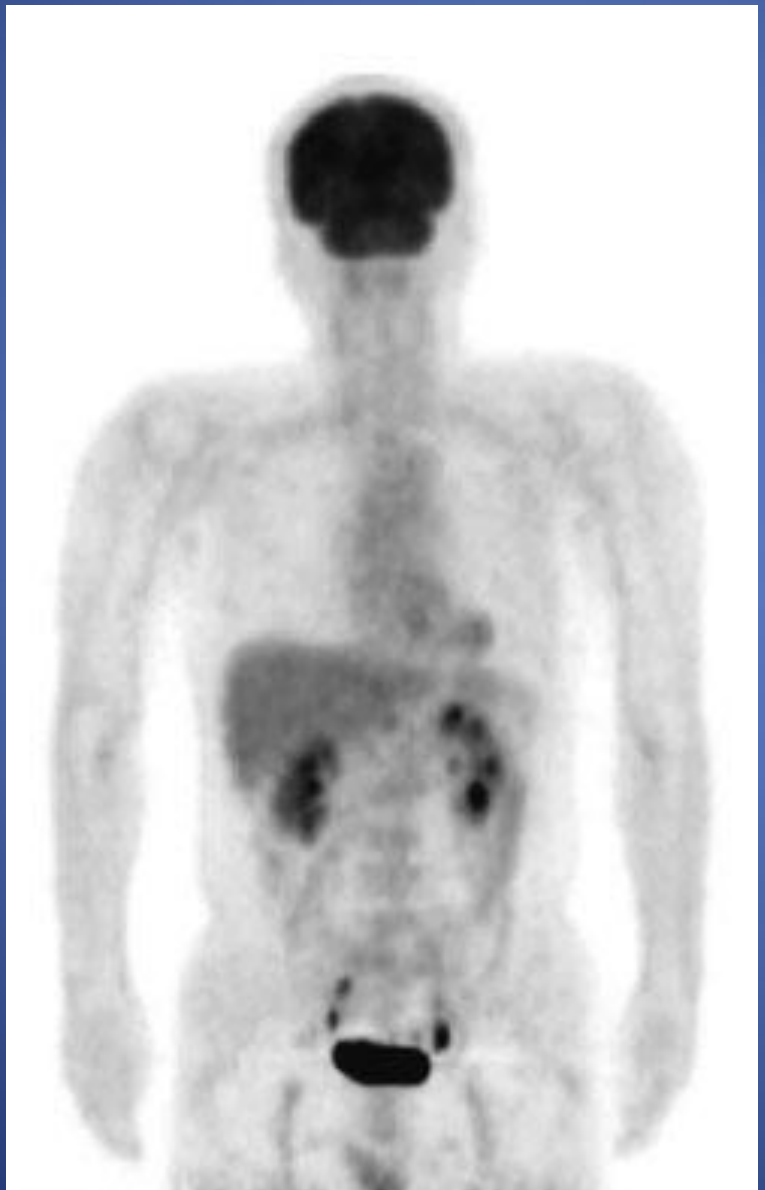
CT “gold seed” placement



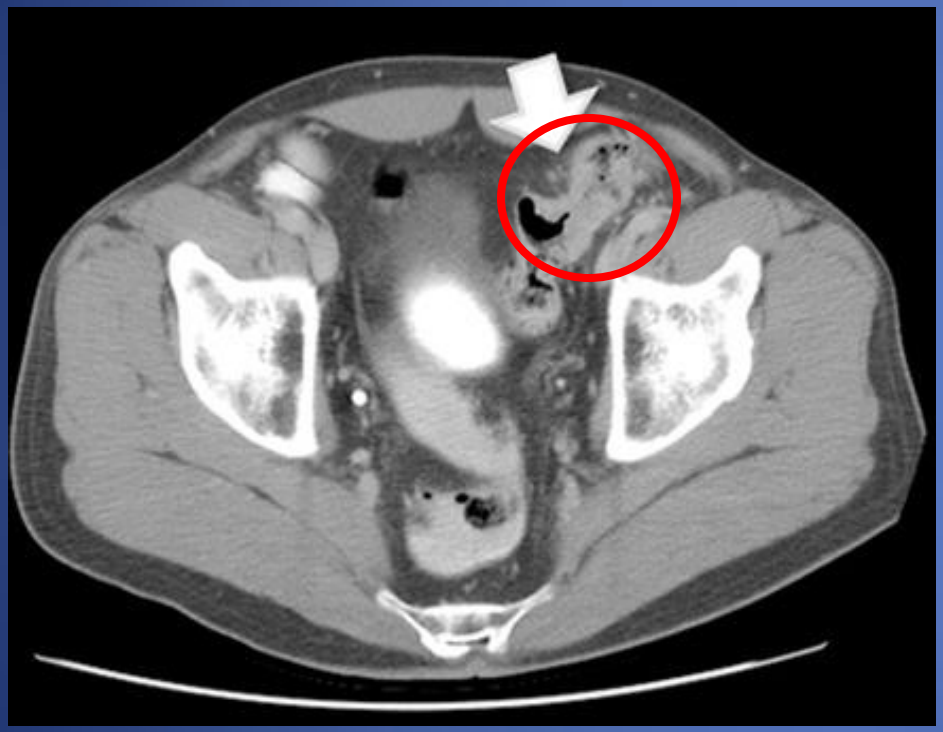
Gold seeds

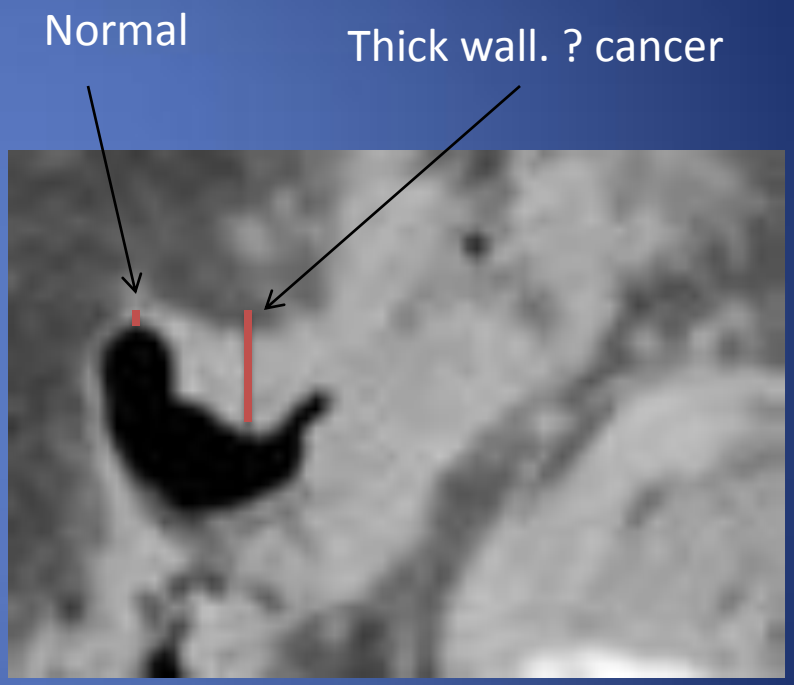
Gold seeds in position for Cyberknife

Lung Cancer remission



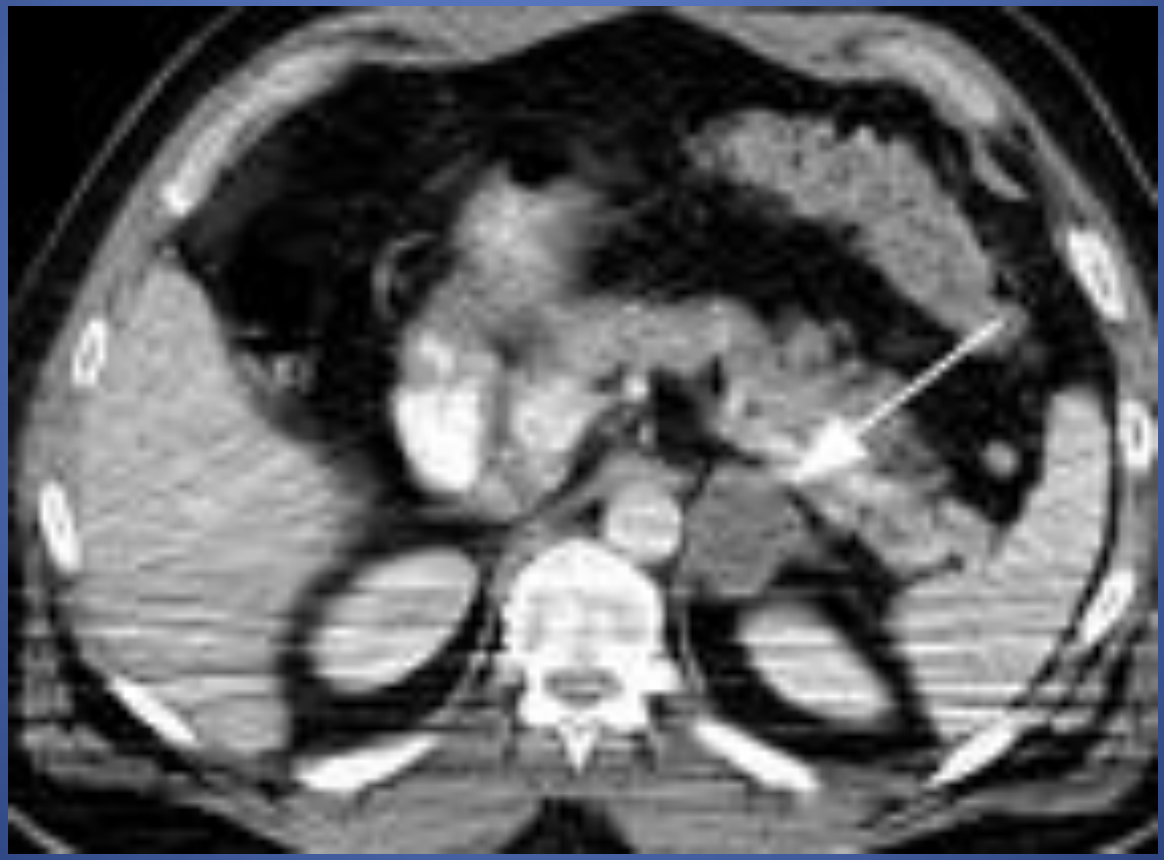
Colon Cancer



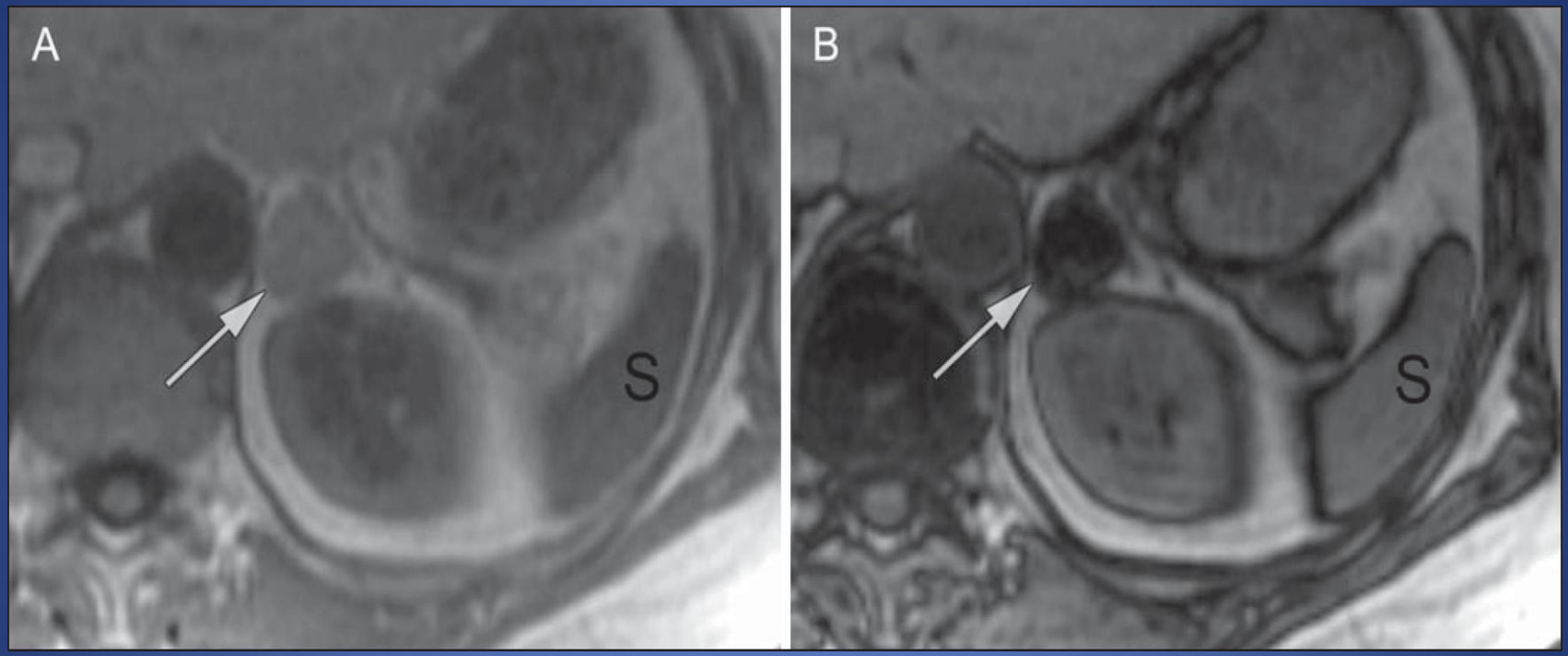


Sigmoid colon “thickening”

CT incidental adrenal nodule



MRI characterization of adrenal nodule



In phase imaging

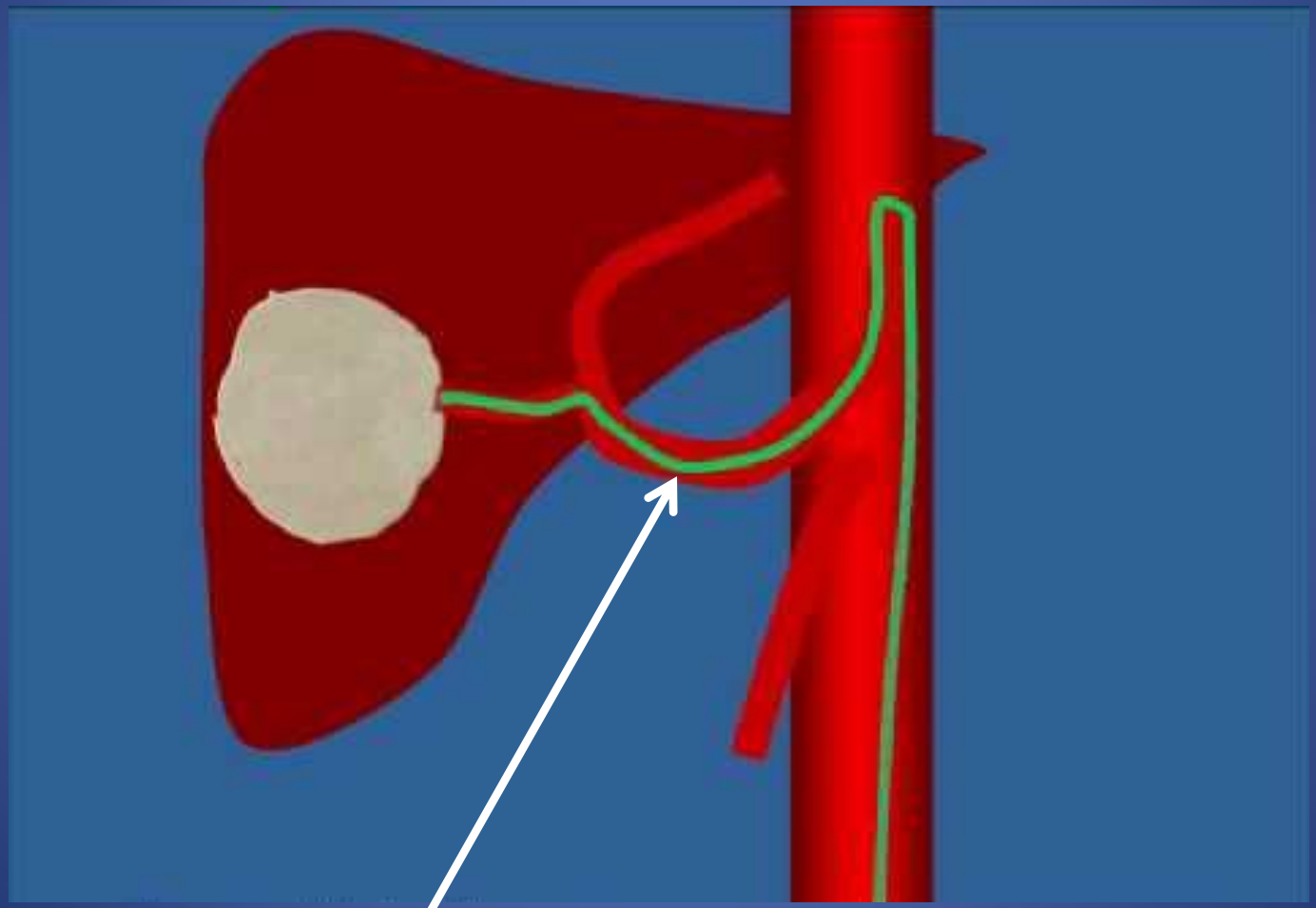
out of phase (“fat”)

Spread to liver

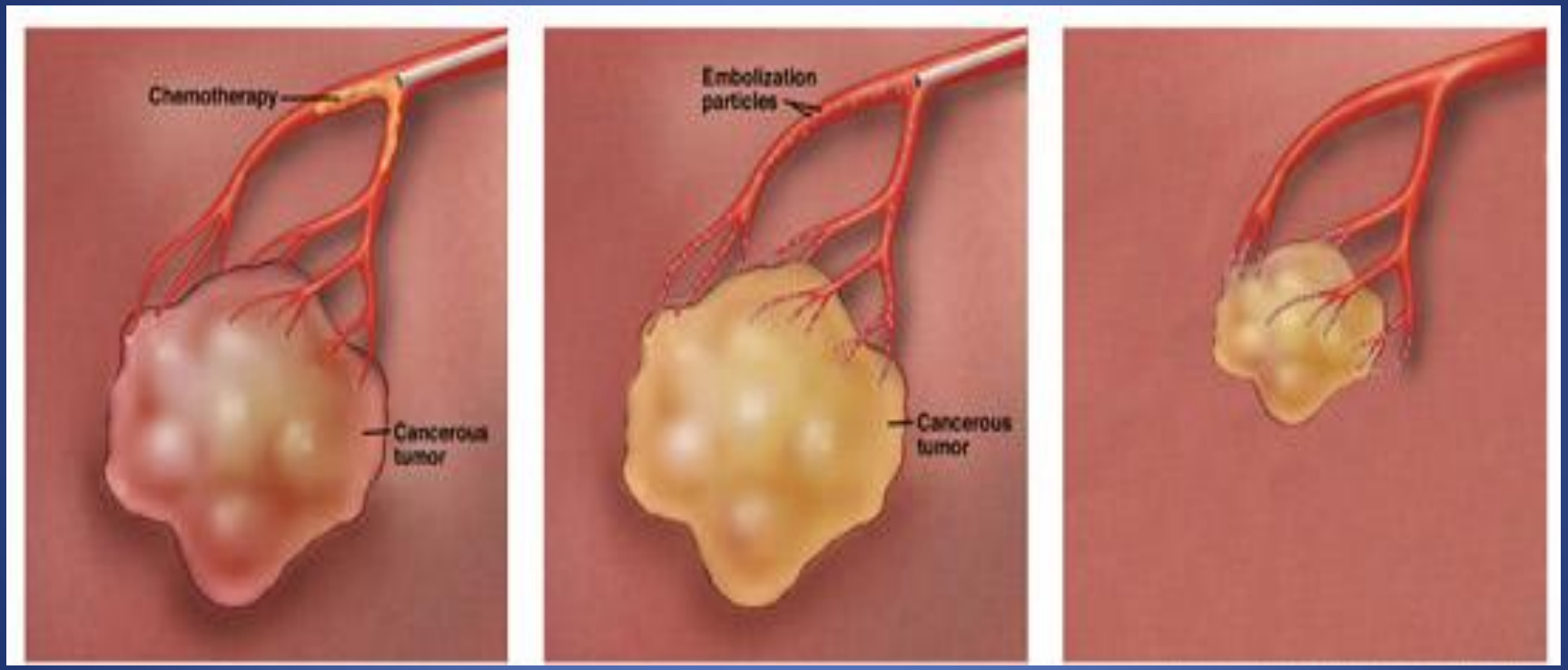
PET scan

CT scan

Chemo-embolization of liver cancer



Chemo-embolization of liver cancer



Screening studies

- Colon
- Lung
- Breast

Screening studies

- Colon
- Lung
- Breast

Screening studies

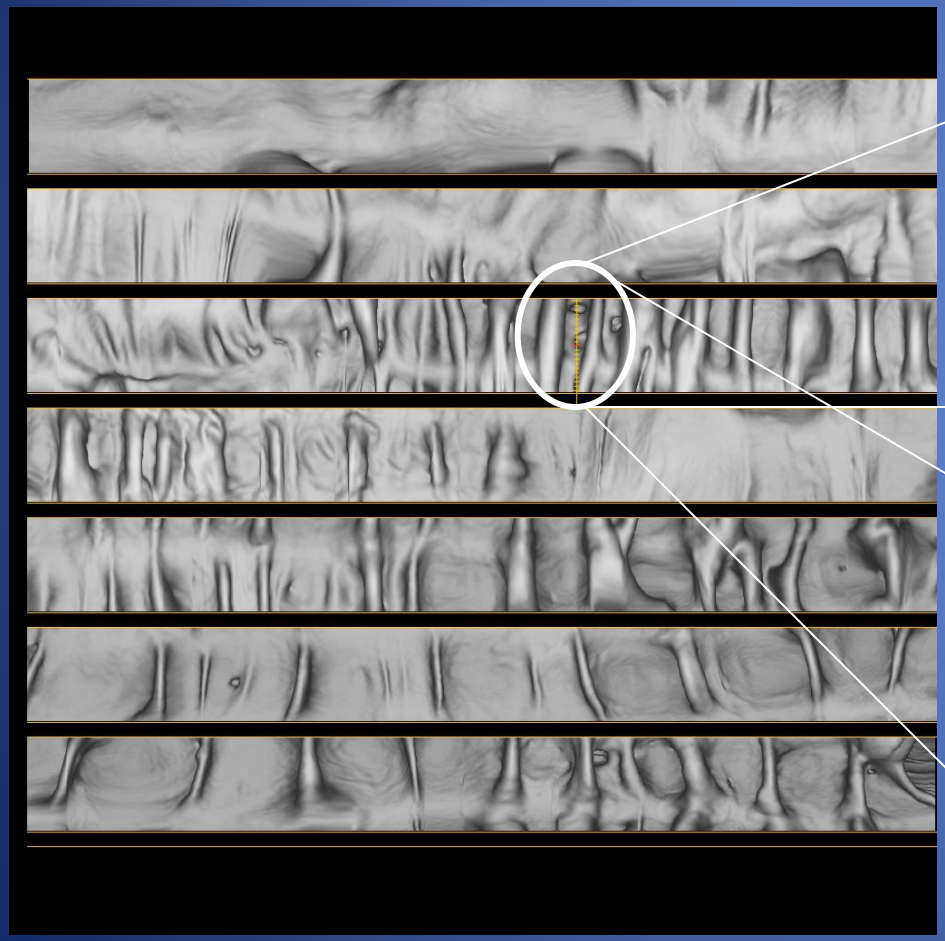
- Colon

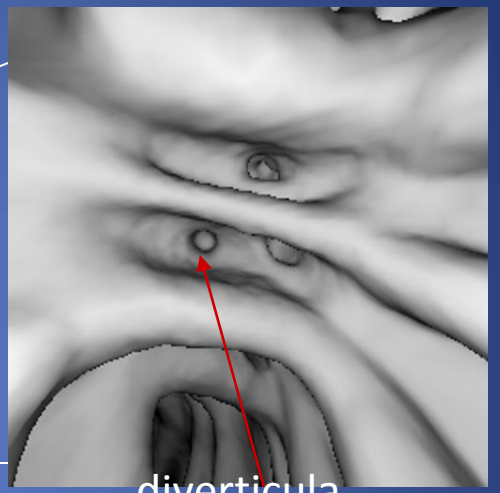
Screening studies save lives -"Virtual" Colonoscopy

Image generated from a CT scan of the belly.

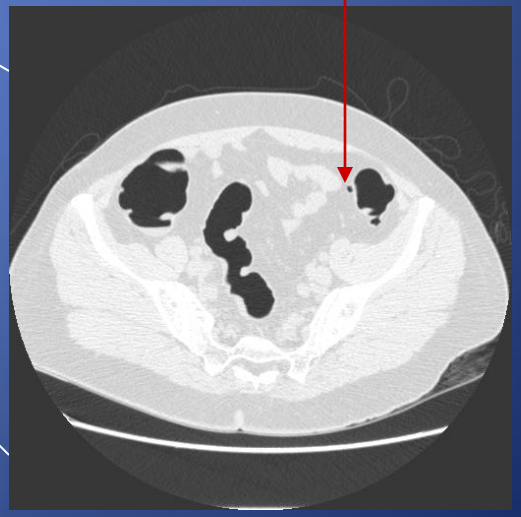
Virtual Colonoscopy

Virtual dissection

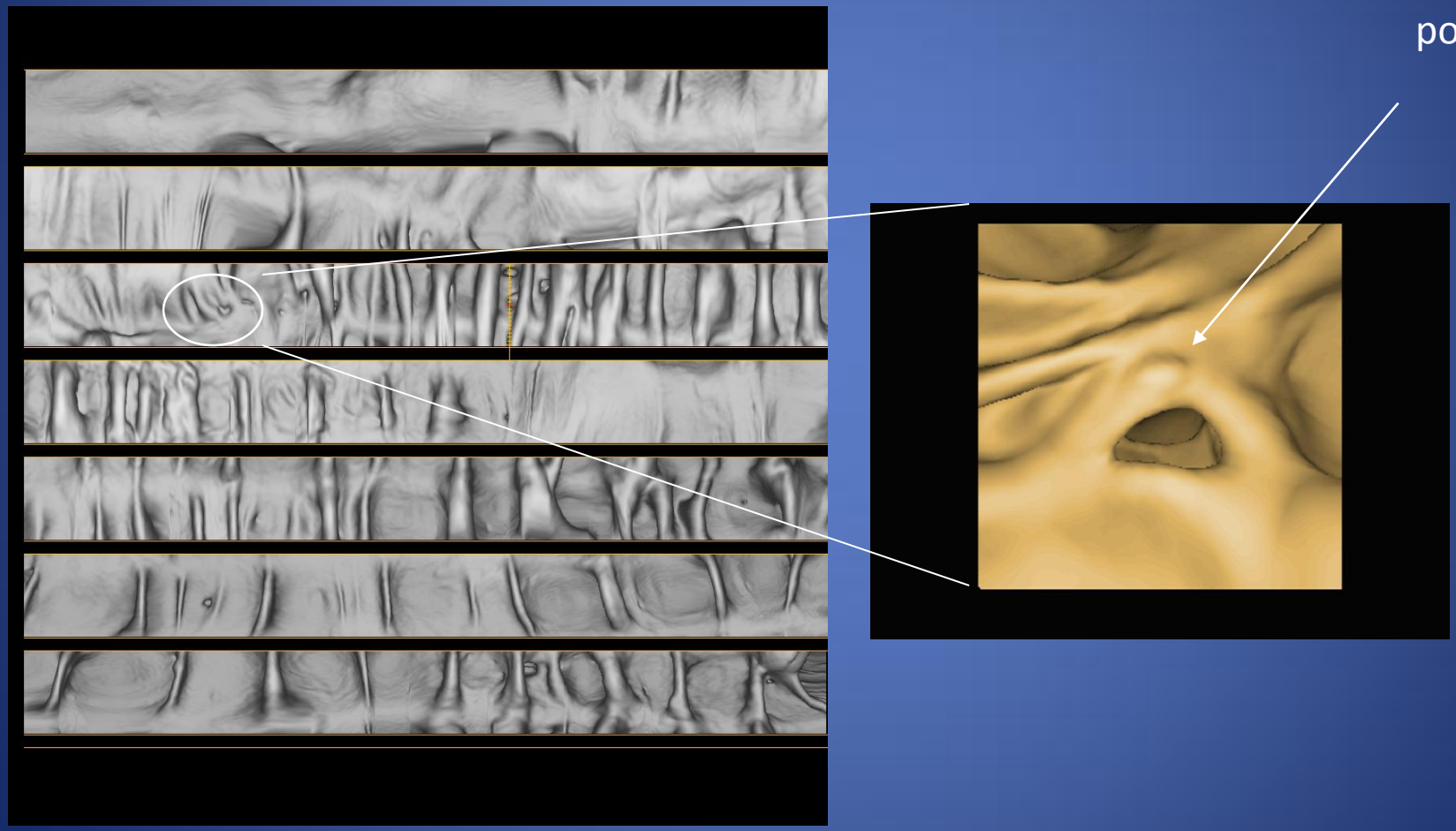




diverticula



Virtual Colonoscopy



Screening studies

- Lung

Screening studies save lives -CT lung screening

- 20% decrease in lung CA mortality with only 3 annual screenings.
- Very low dose technique, similar to diagnostic mammogram.

CT Lung Screening

Who should we screen?

- >= 50 years old.

- >=30 pack years smoking OR
  >=20 pack years and one additional risk factor (COPD, asbestos, family history, etc).

- Still smoking or quit < 15 years ago.

CT Lung Screening

How do we screen?

- Very low dose protocol
  - Radiation usage similar to mammogram
    - Detects lung nodules
    - Relatively noisy images.
  - Designed to only view lungs.
  - ASIR technology.

CT Lung Screening
- What do we do with a “positive screen”?

- Based on size, growth and appearance.
- Small nodules are very common.
  - About 30% of all screening studies have at least one nodule.
- Nodules <=4mm have <<1% statistical chance of malignancy.
- Nodules <8mm are also likely benign especially if no growth. Basis for followup CT.

QUESTIONS?