The Clinical Landscape in Radiopharmacy – The Impact of Earlier Diagnosis

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Where does Nuclear Medicine fit in patient diagnosis?

- *Not usually first line*

  Other simpler investigations first

- *Radiation exposure*

  Justified

  Benefit vs risk assessment

- *But how do Nuclear Medicine diagnoses change things for patients?*

But how do radiopharmaceuticals work?

Radiopharmaceuticals are a combination of a

'Useful Molecule'

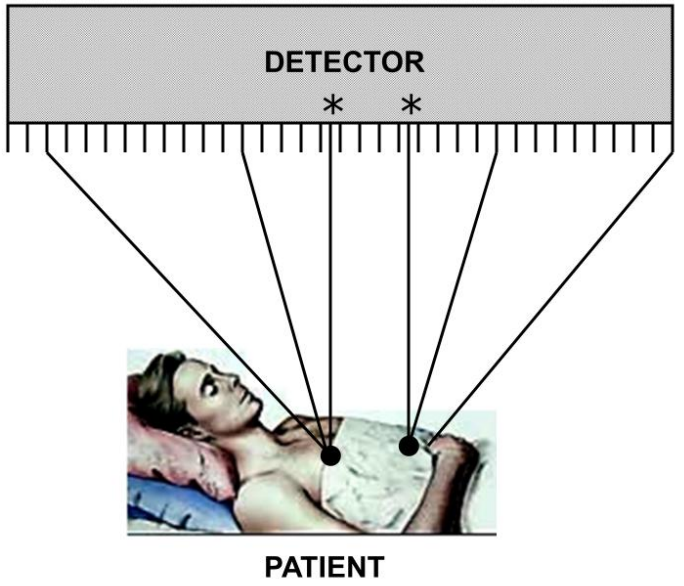
+

Radioactive isotope

Nuclear Medicine images function not anatomy

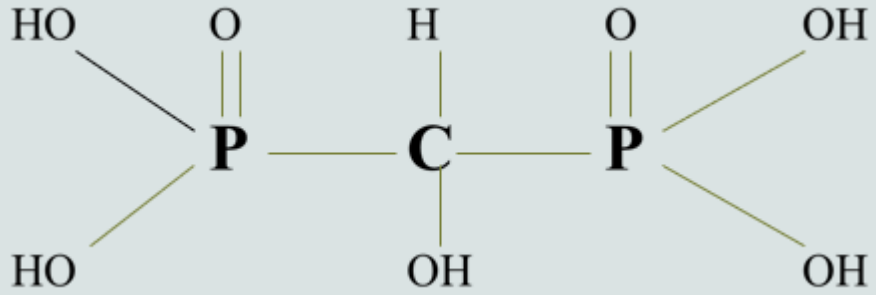
Main isotope: Technetium-99m

'Planar Imaging' 'SPECT Imaging'



Bone Scans

- One of the Common Nuclear Medicine tests

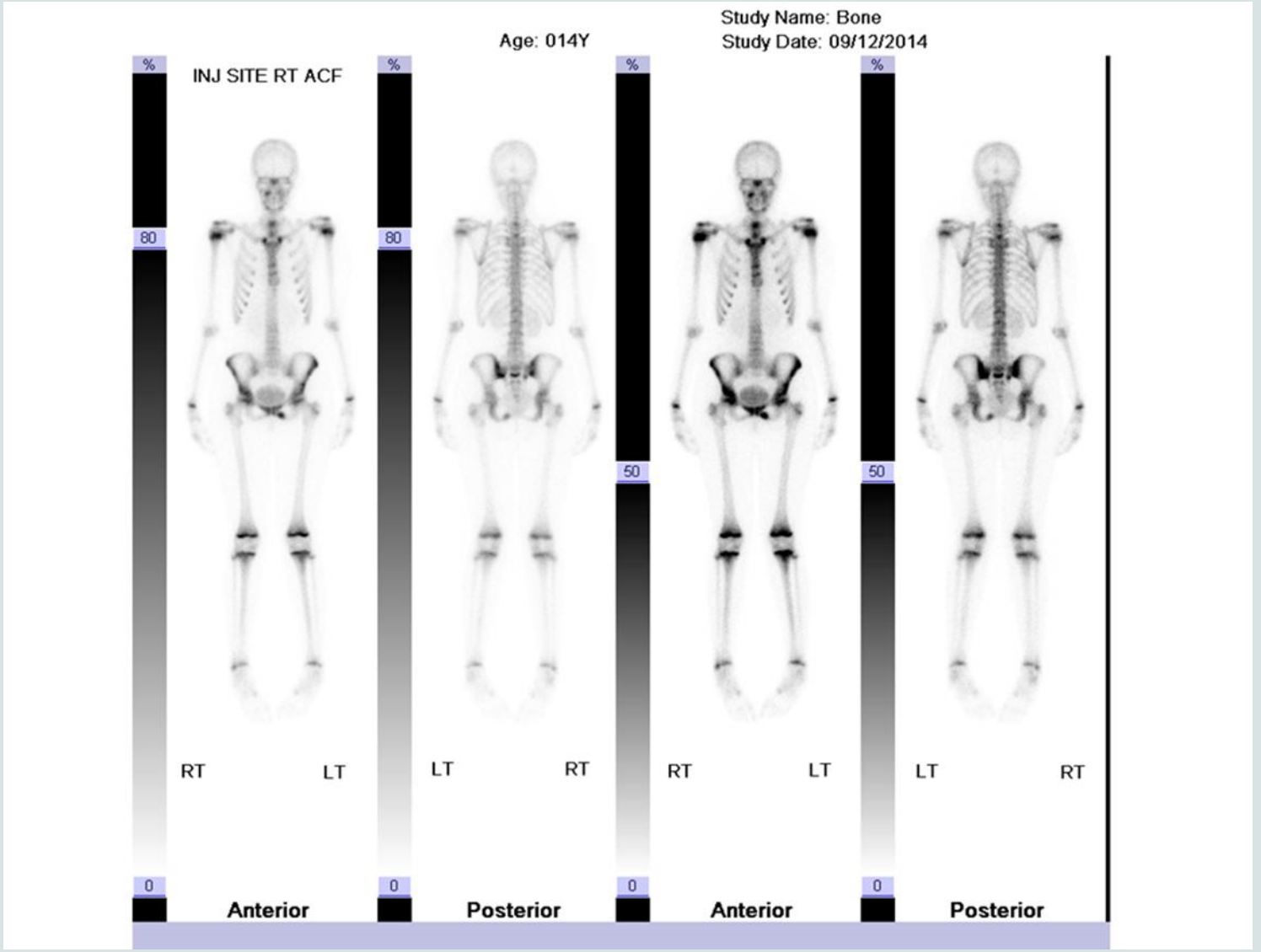


Used for identifying bone mets, usually 2° to Ca breast and prostate, , and diagnosis of Paget's, Osteomyelitis and stress fractures

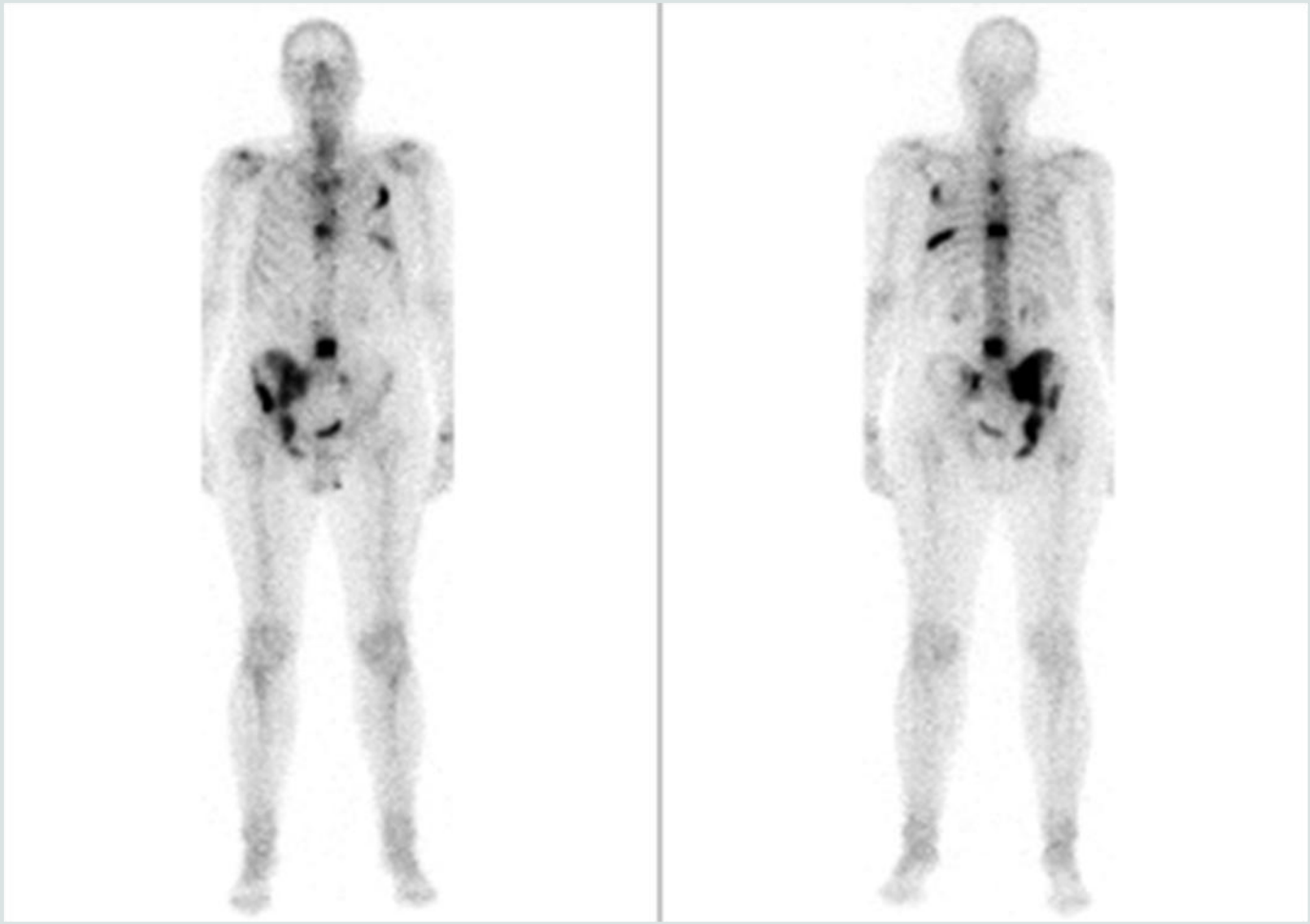
- Hydroxydiphosphonate diphosphonate (HDP)
- Patient is injected and scanned 2-3 hours later
- Binds to hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$ – particularly at sites of osteoblastic activity
- Greater the bone turnover, greater uptake
- Can detect changes before change in bone density

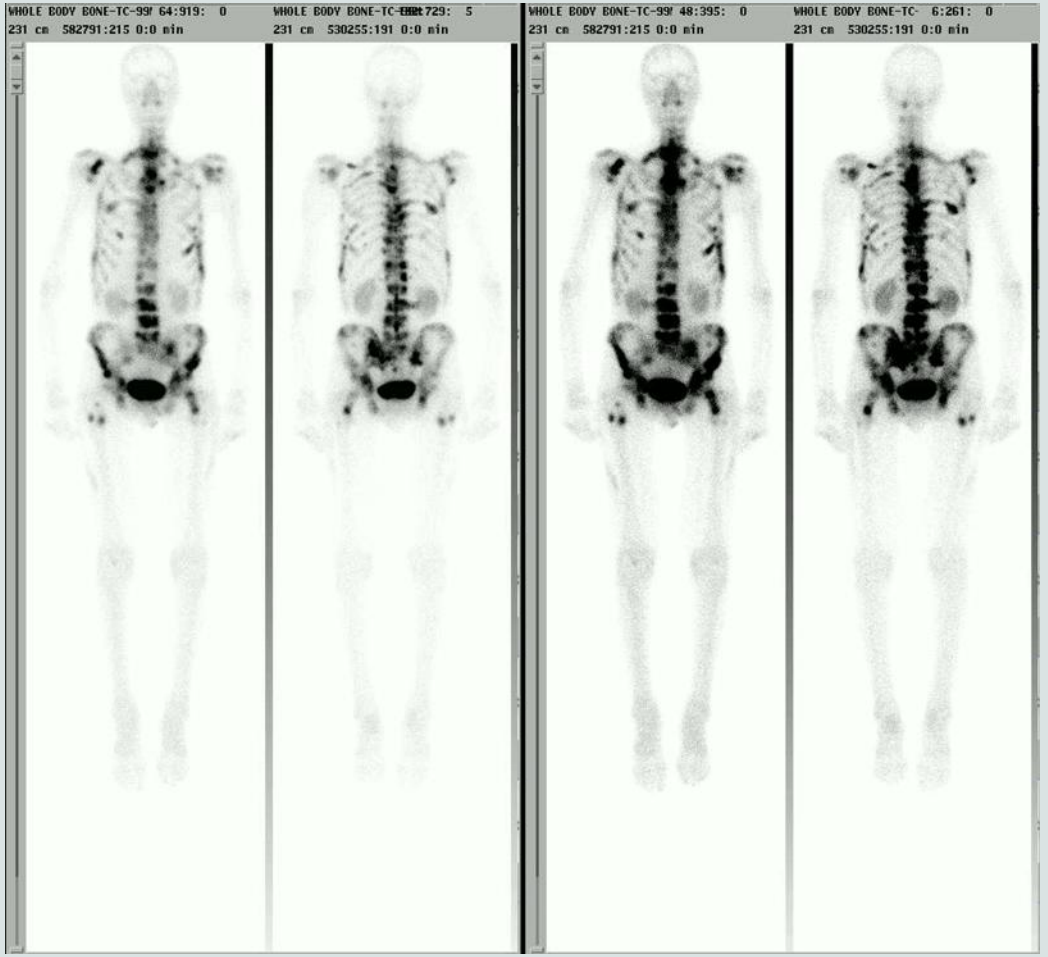
Normal adult bone scan

Normal bone scan paediatric, aged 14 years



Most common indication for bone scan is to assess bone metastases usually 2o to Ca breast and prostate





Impact of early diagnosis

- Cancer diagnosis already in place
- Important for staging
- Prostate cancer may be ‘curable’ if no spread
- Assessing treatment response
- May help with symptom management

Diagnostic applications: Respiratory system
The 'VQ' Scan

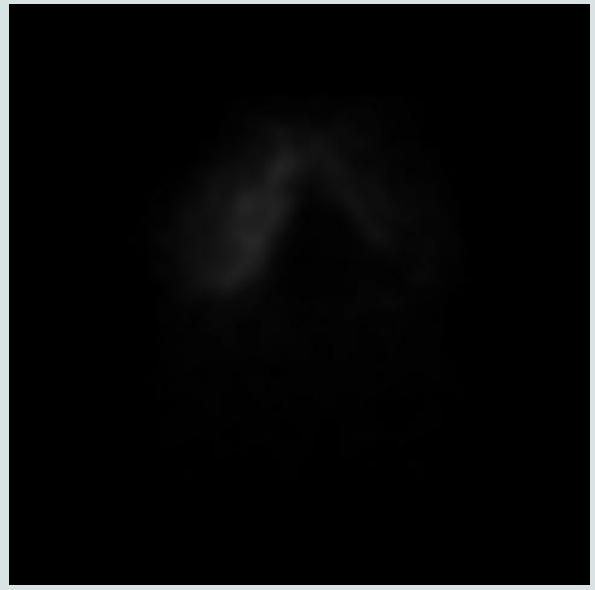
- Lung perfusion imaging performed by IV injection of ^{99m}Tc MAA (macroaggregates of albumin typically 30-50μm)
- Particles lodge in the terminal arterio-capillary bed
- Images which show areas of reduced uptake could be caused by PE

- Lung ventilation carried out in conjunction with perfusion
- ^{81m}Kr or ^{99m}Tc Technegas may be used
- Vent and perfusion scans compared – mismatch is indicative of PE

Perfusion scan:

Albumin is trapped in the pulmonary capillaries to assess blood supply.

Perf

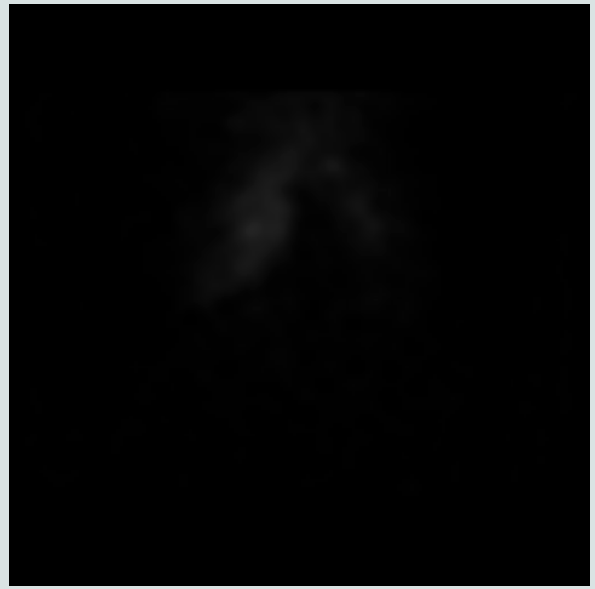


Concurrently breathe in Krypton-81m gas

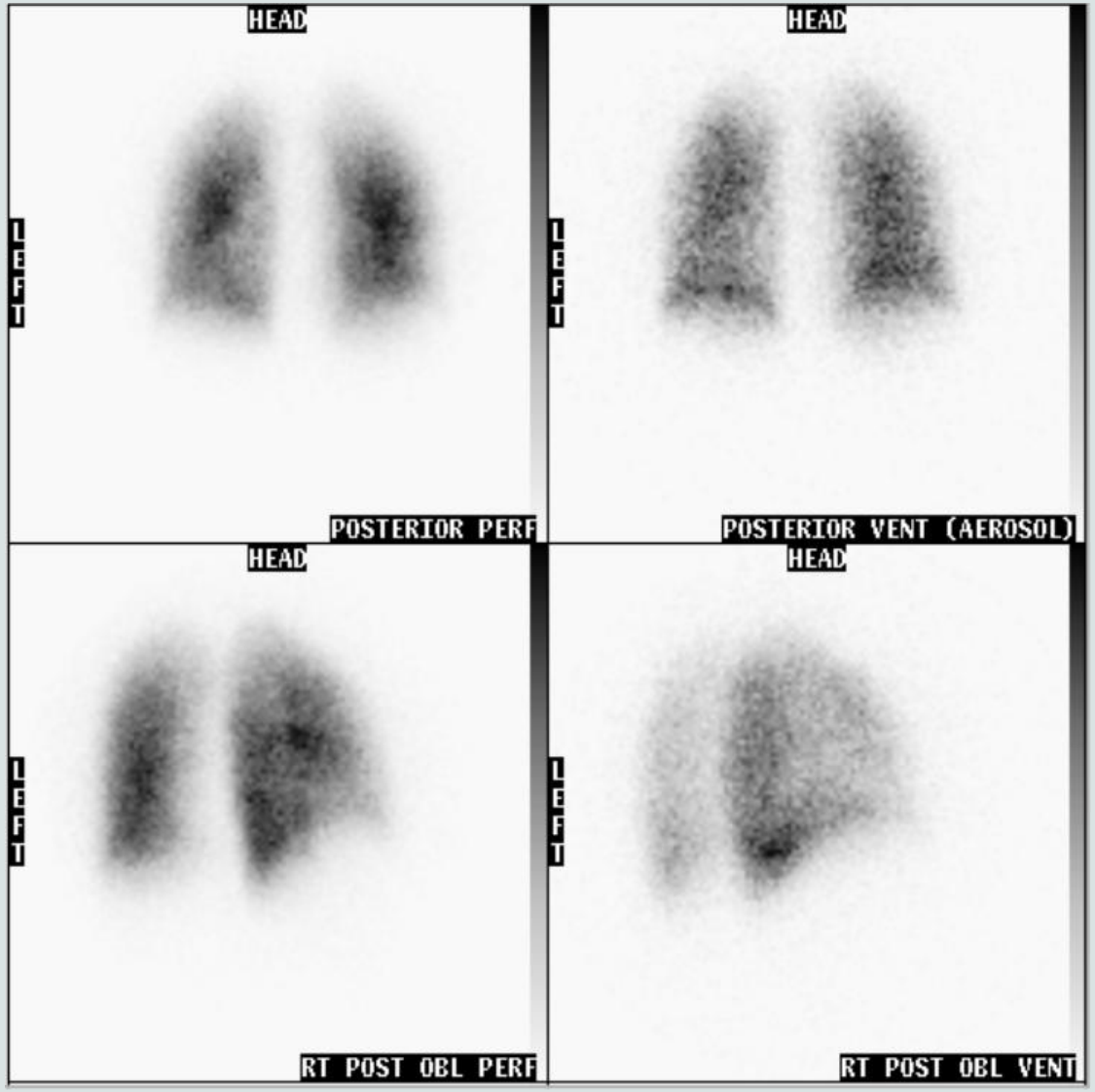
Scan straight away

20 minute acquisition

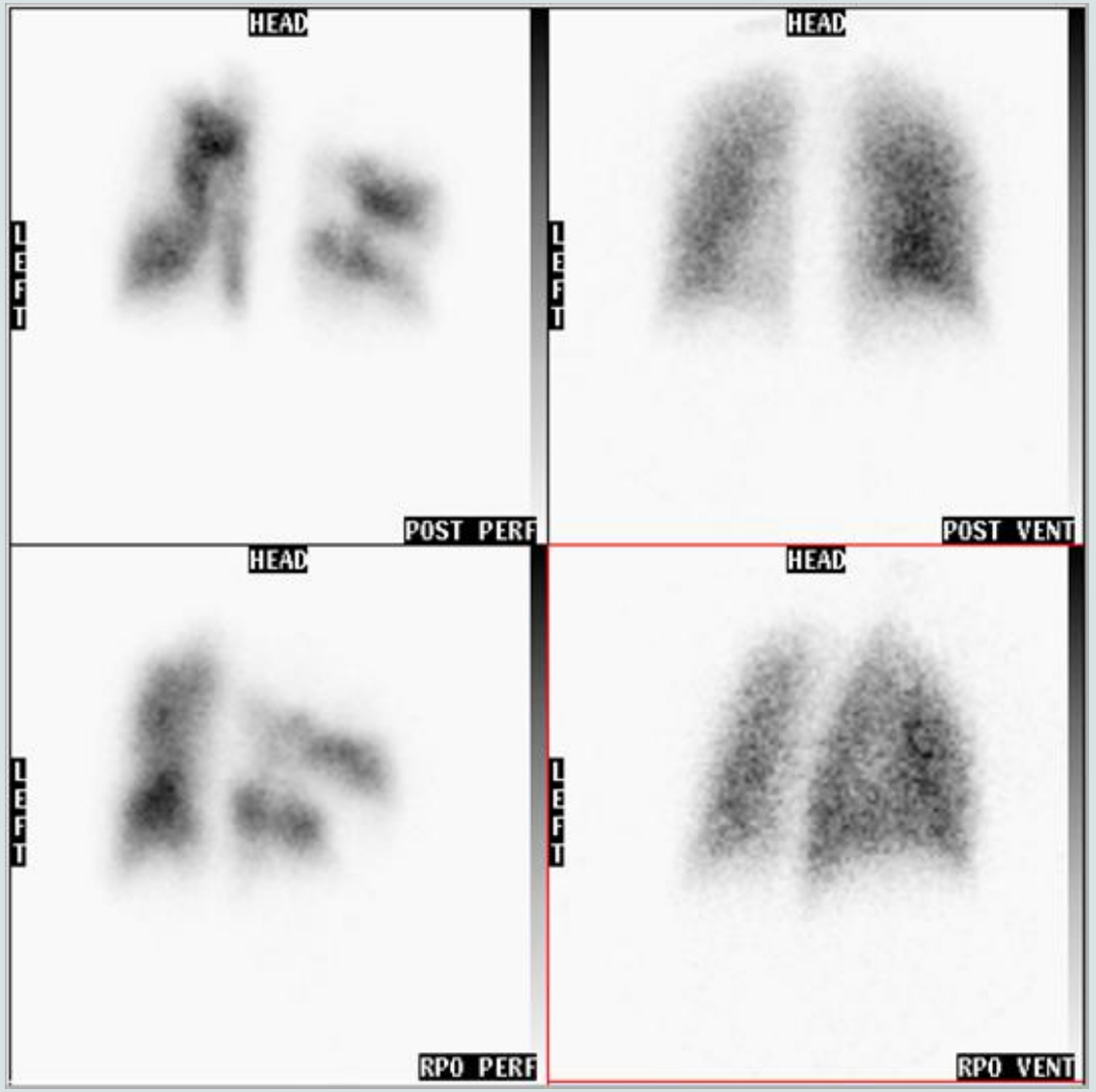
Vent



Normal Lung scan



Abnormal Lung scan

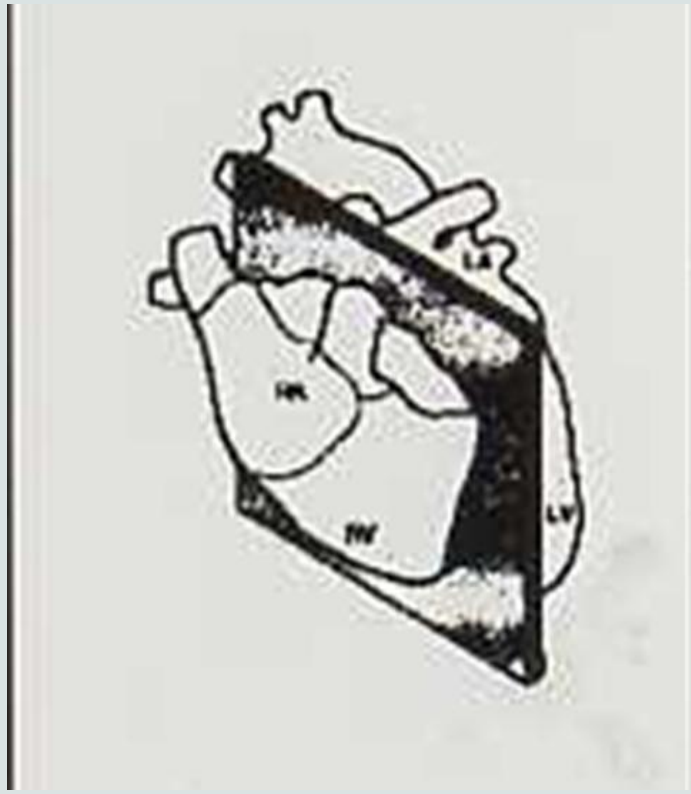


Cardiovascular System: Myocardial Perfusion Imaging (MPI)

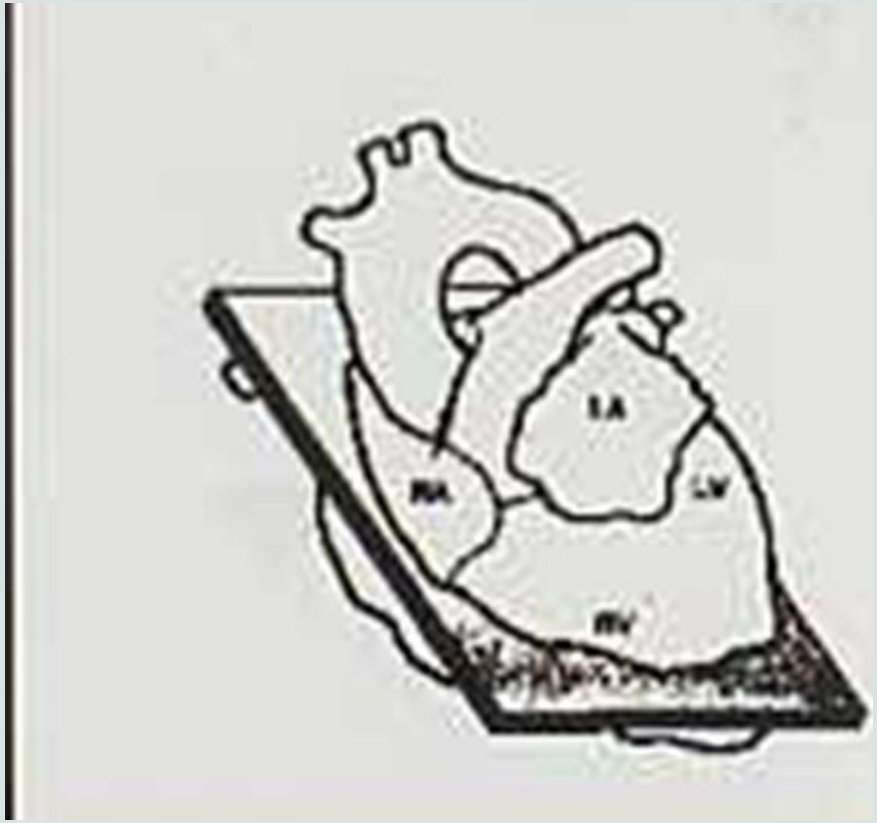
- Patients undergo MPI in 2 parts
- Heart stressed by exercise or pharmacologically using adenosine or dobutamine
- Heart imaged at rest
- Comparison of two studies provides the diagnosis

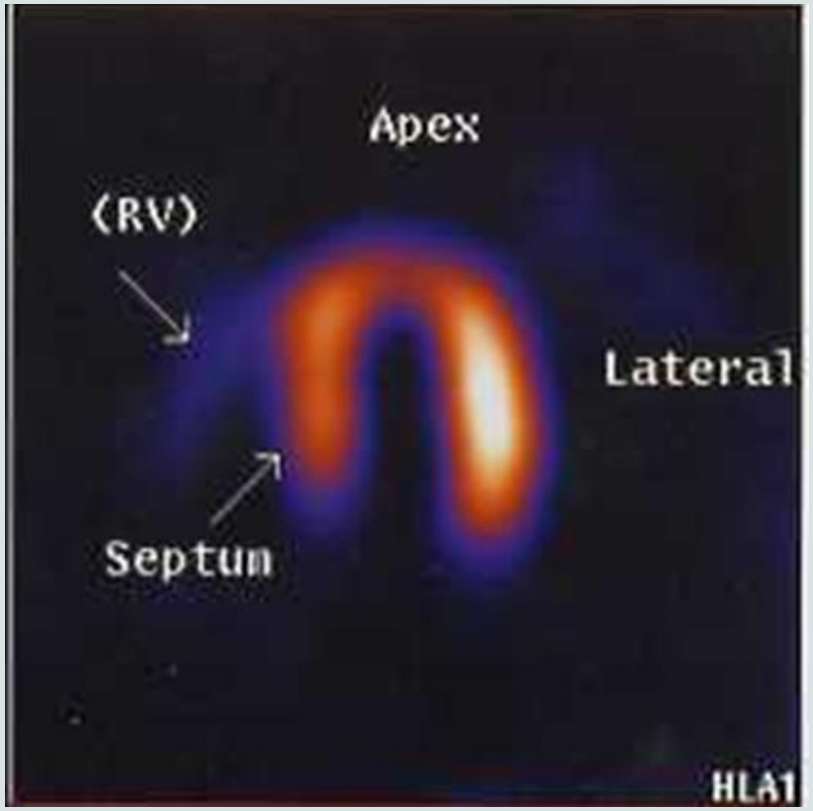
MPI slices – Short Axis (SA)

MPI slices - Vertical Long Axis (VLA)

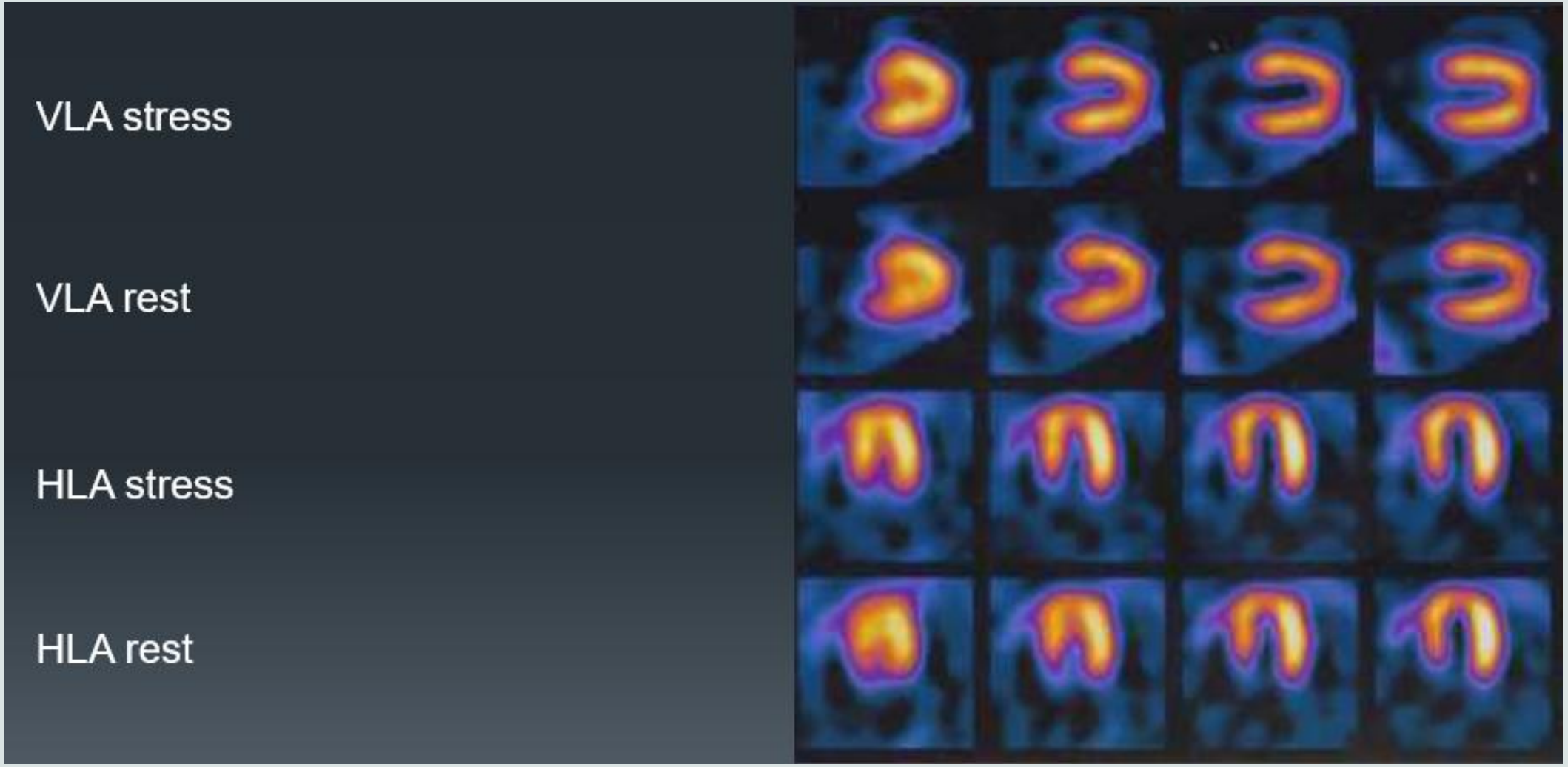


MPI slices - Horizontal Long Axis (HLA)

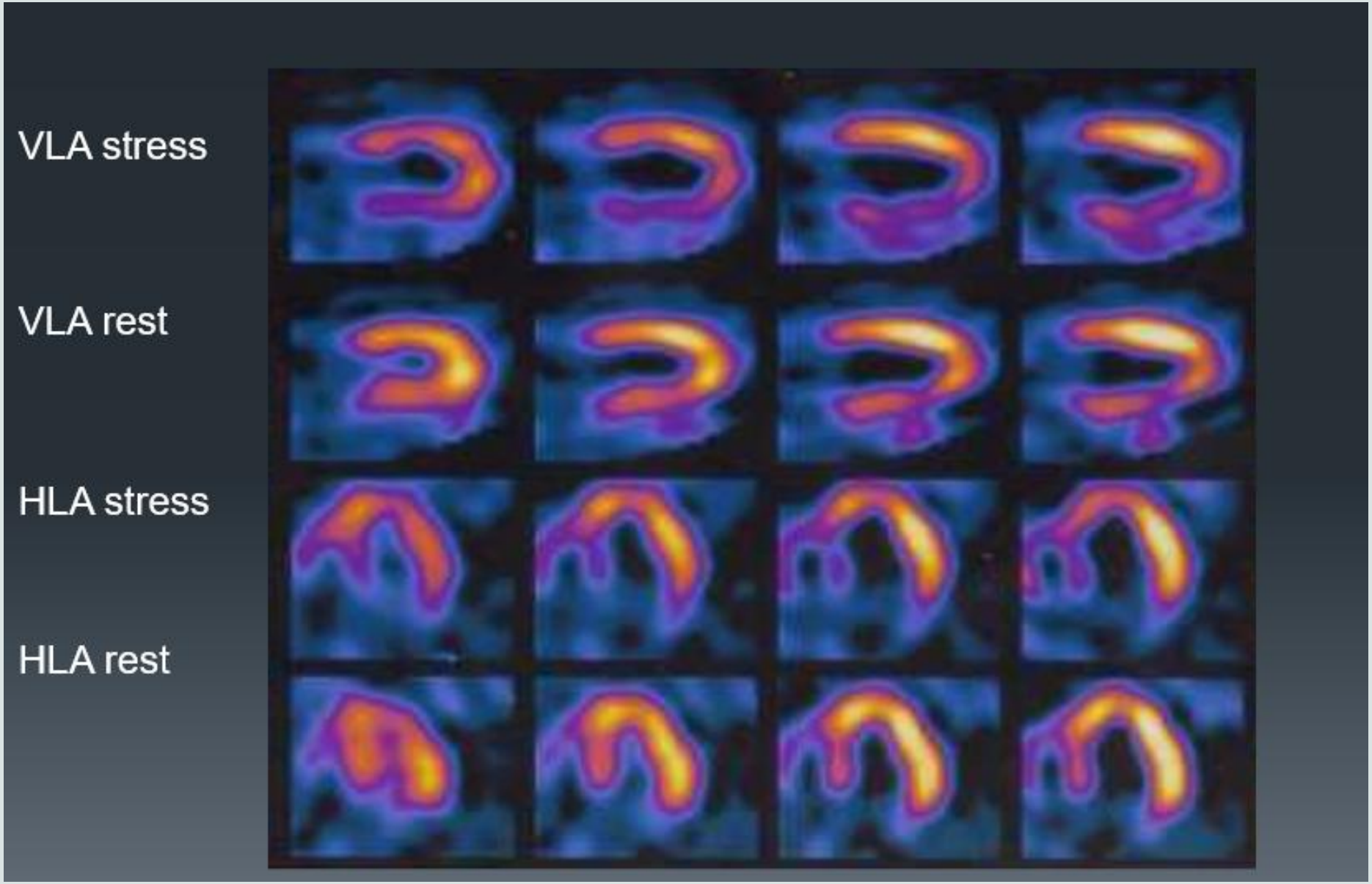




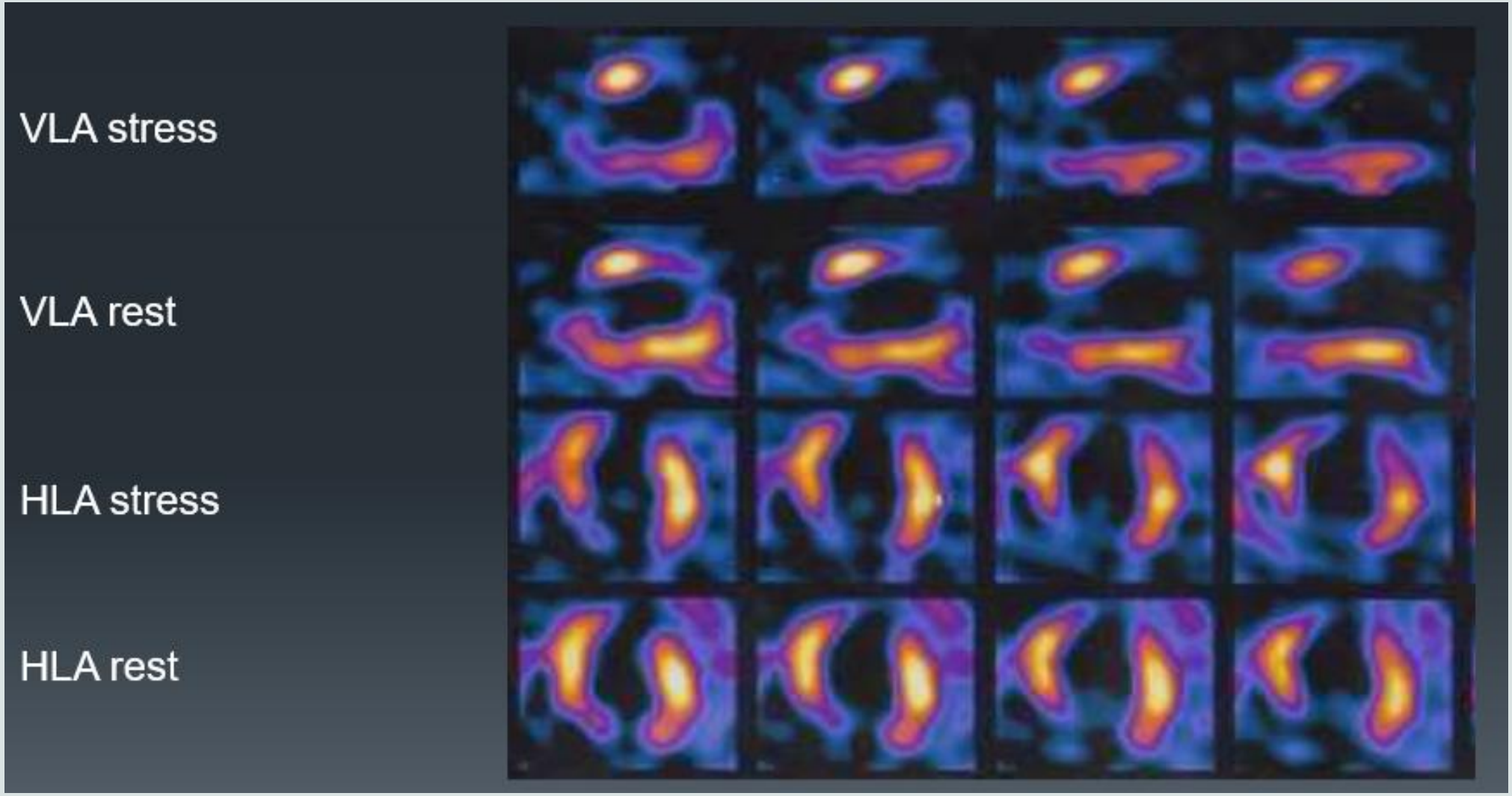
Normal MPI



MPI showing ischaemia



MPI showing fixed defect



Benefits of early diagnosis

- Typical picture – patient presents with chest pain
- MPI scan can differentiate between panic attacks, thickening of arteries, infarction
- MPI scan informs treatment –

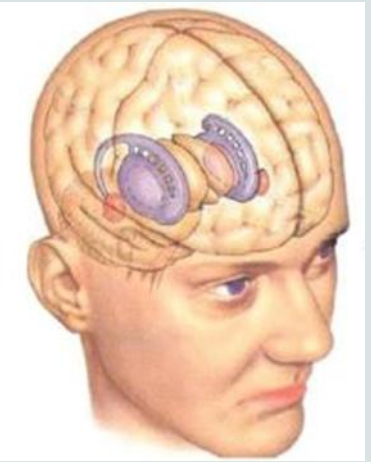
  Home

  Further intervention – e.g. Stent

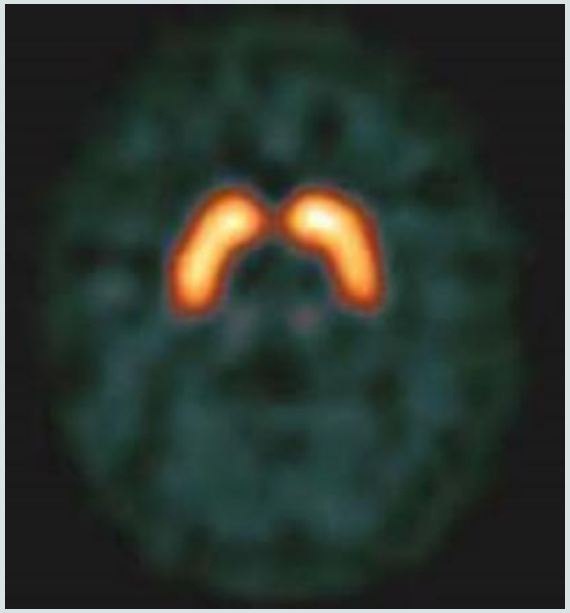
  Surgery

Brain scanning: tests for Parkinsons Disease

- I-123 DaTSCAN accumulates in the Striata of the brain, used to co-ordinate movement.
- Scan 3 hours later.
- 30 minute acquisition. Claustrophobic!



Normal DaTSCAN



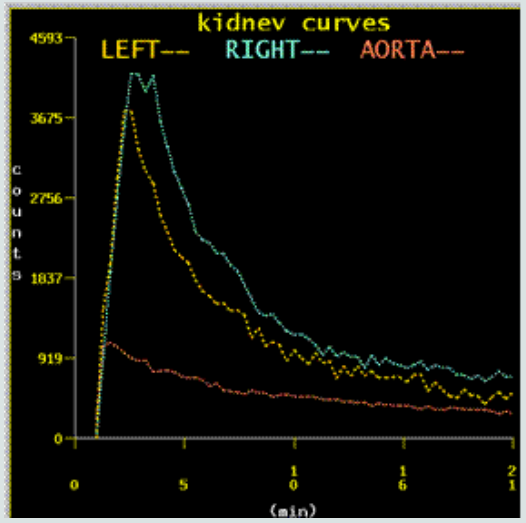
Abnormal DaTSCAN

BUT… Drug interactions!

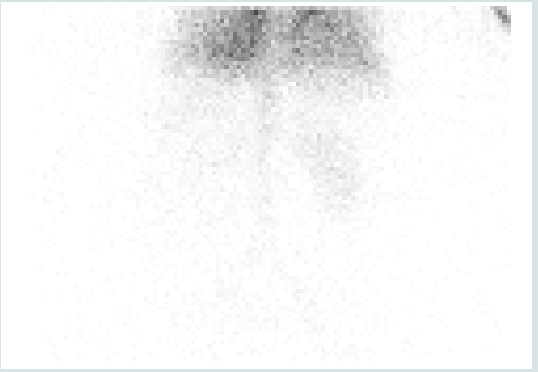
Renal Scanning: Dynamic Kidney Scan 'Renogram' to see if Kidneys are functioning

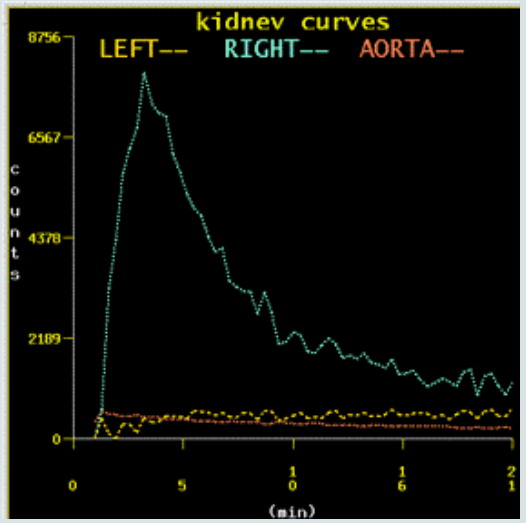
- Inject 80 MBq of Tc99m-MAG3
- Absorbed and excreted by kidneys to Bladder
- Scan immediately
- 20 minute acquisition

NORMAL

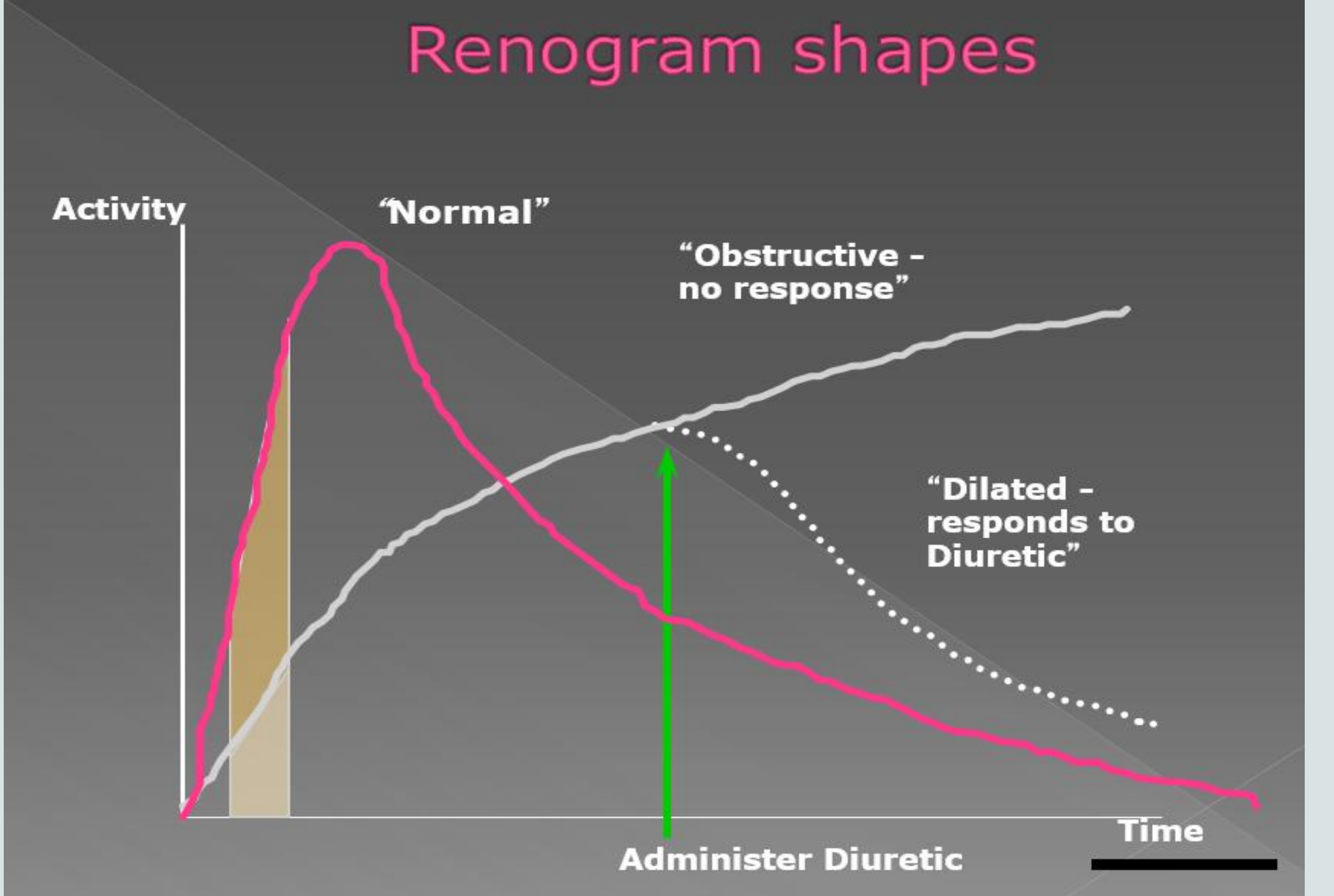


ABNORMAL





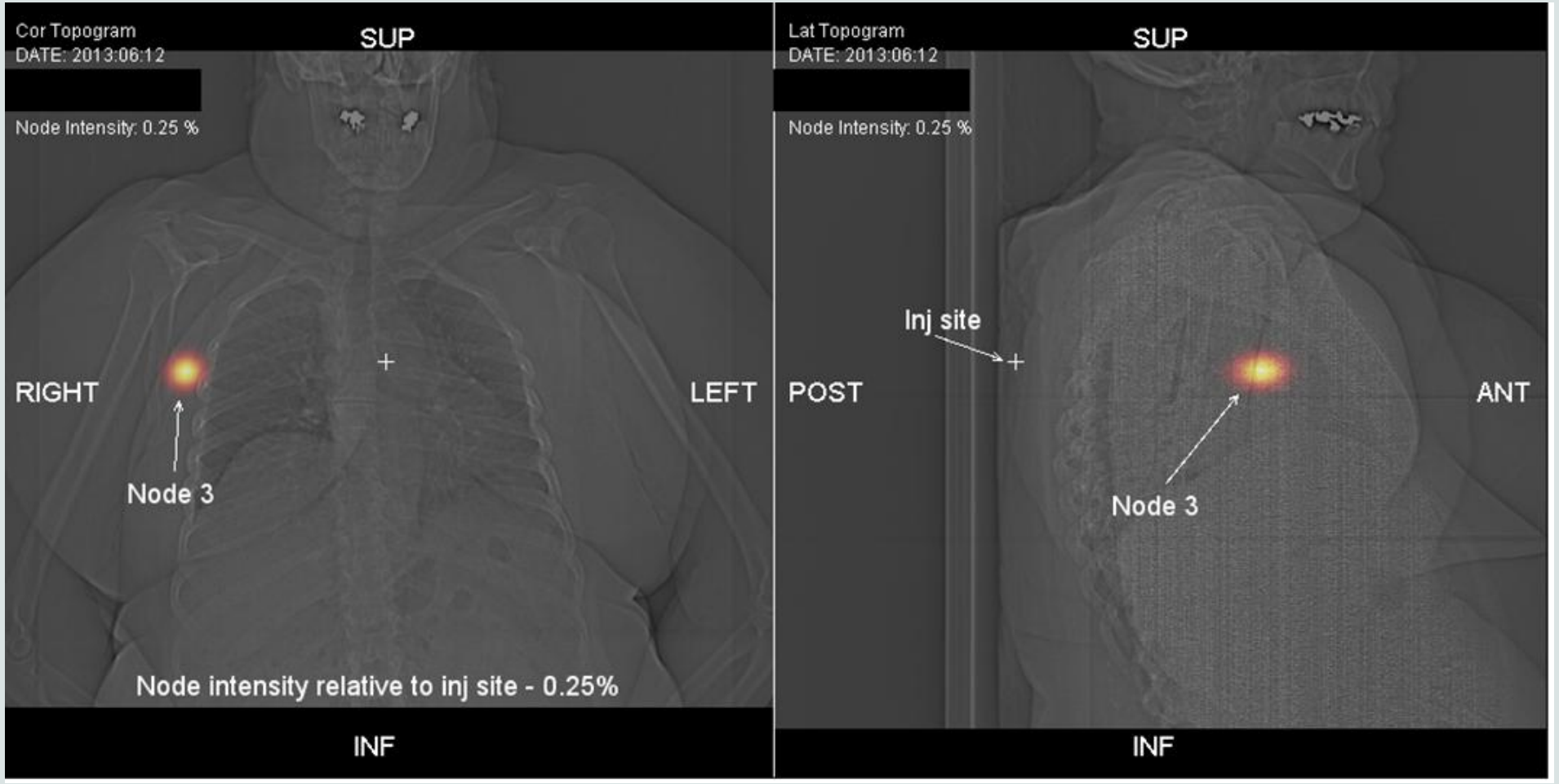
Renogram shapes



What do we learn from this?

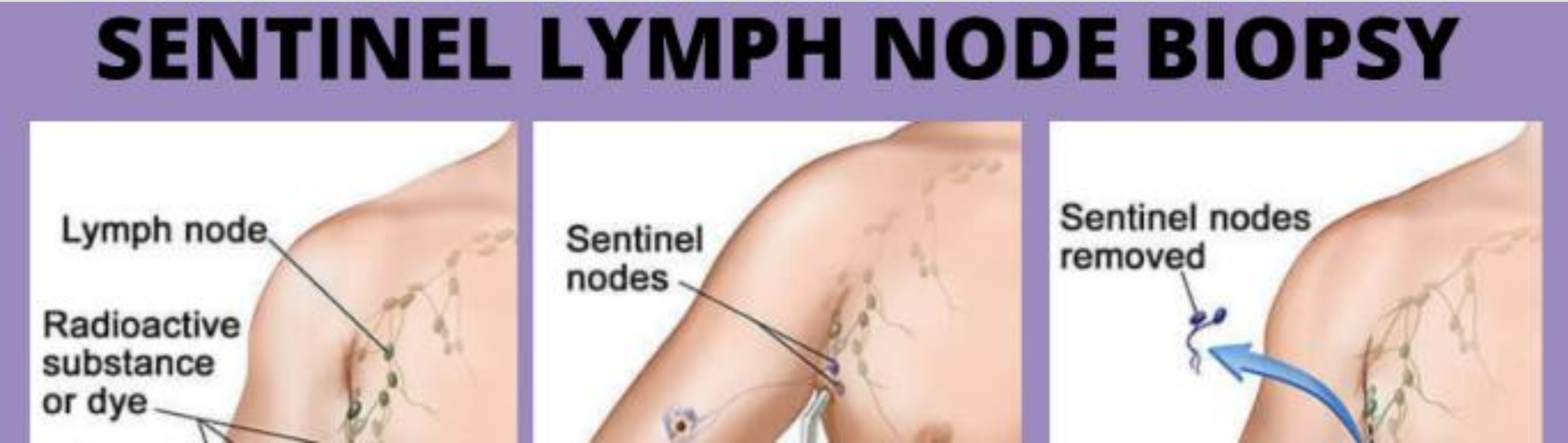
- Identification of obstruction
- Diagnosis of renal hypertension
- Looks at the kidneys individually
- Pre-operative assessment for kidney removal

Sentinel Lymph Node: breast cancer

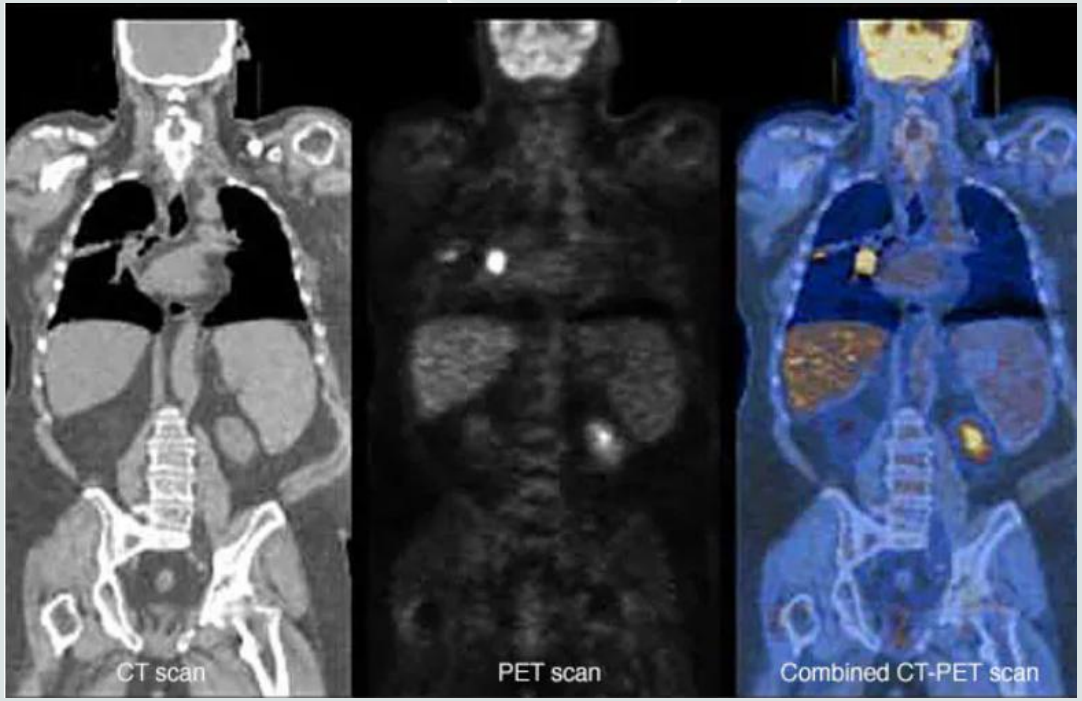


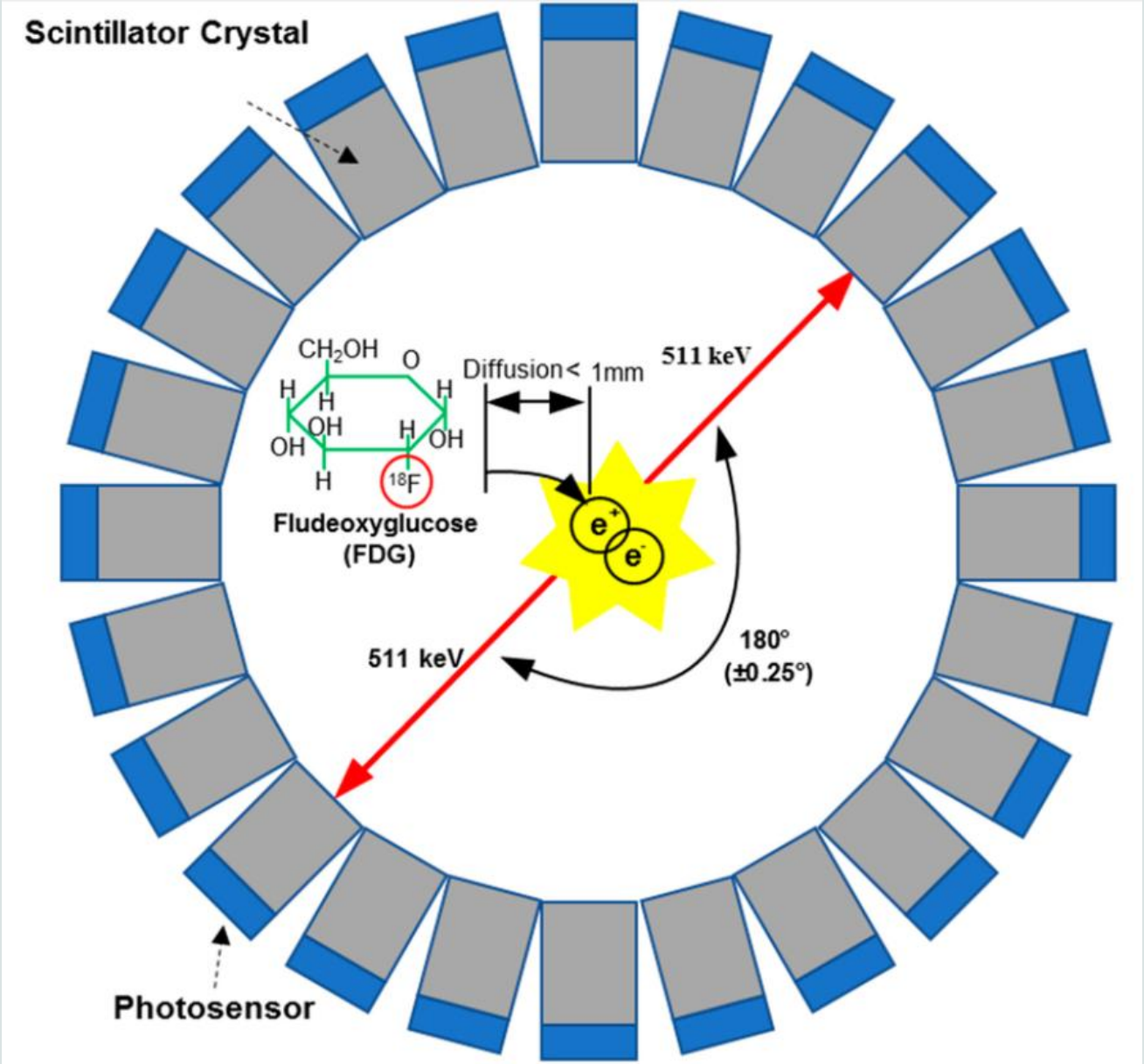
Benefits

- More accurate cancer staging
- Avoids excessive lymph node removal
- Faster recovery
- Fewer long-term side effects, e.g. lymphoedema



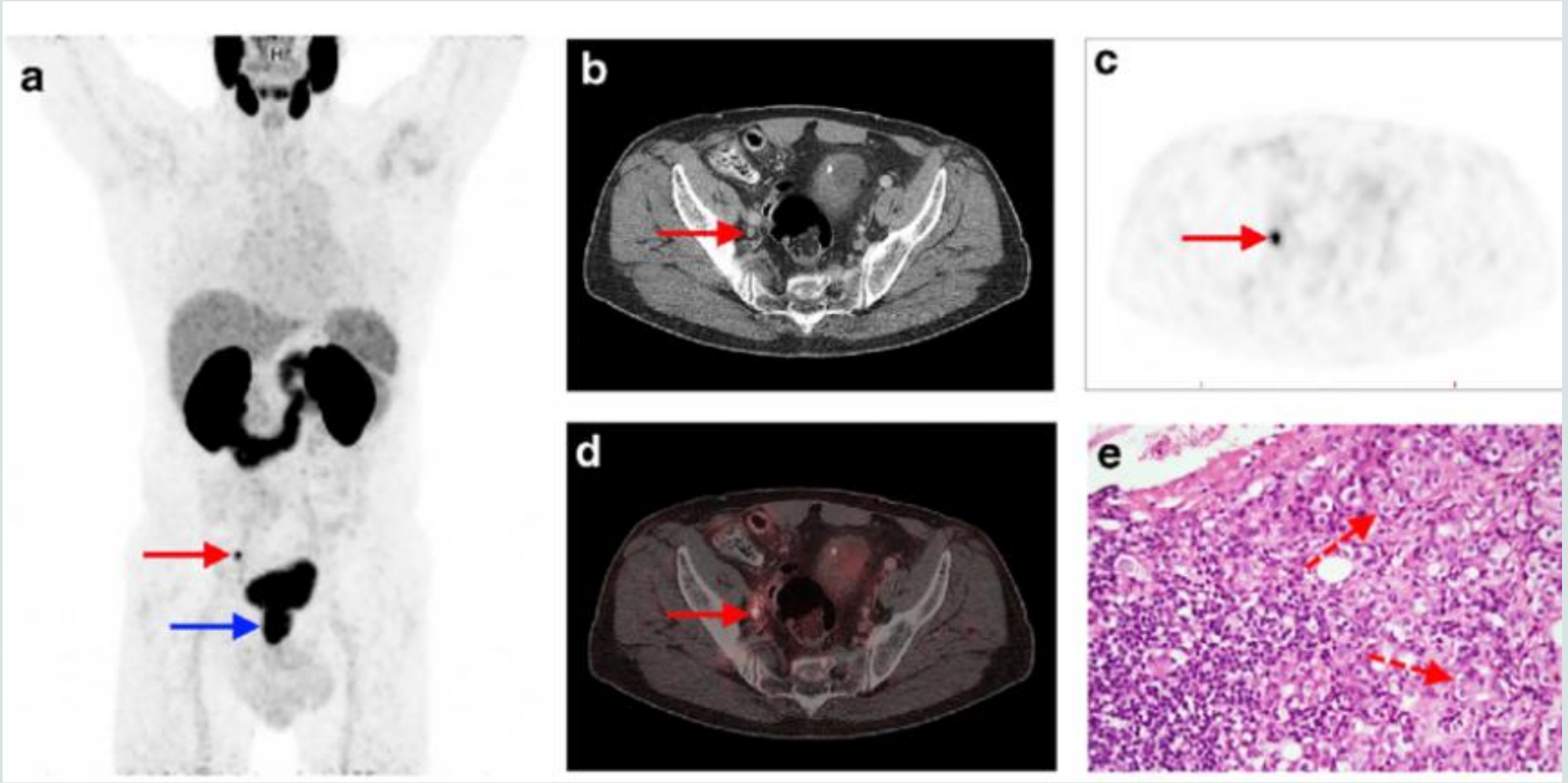
Introducing PET CT (Positron Emission Tomography) Imaging





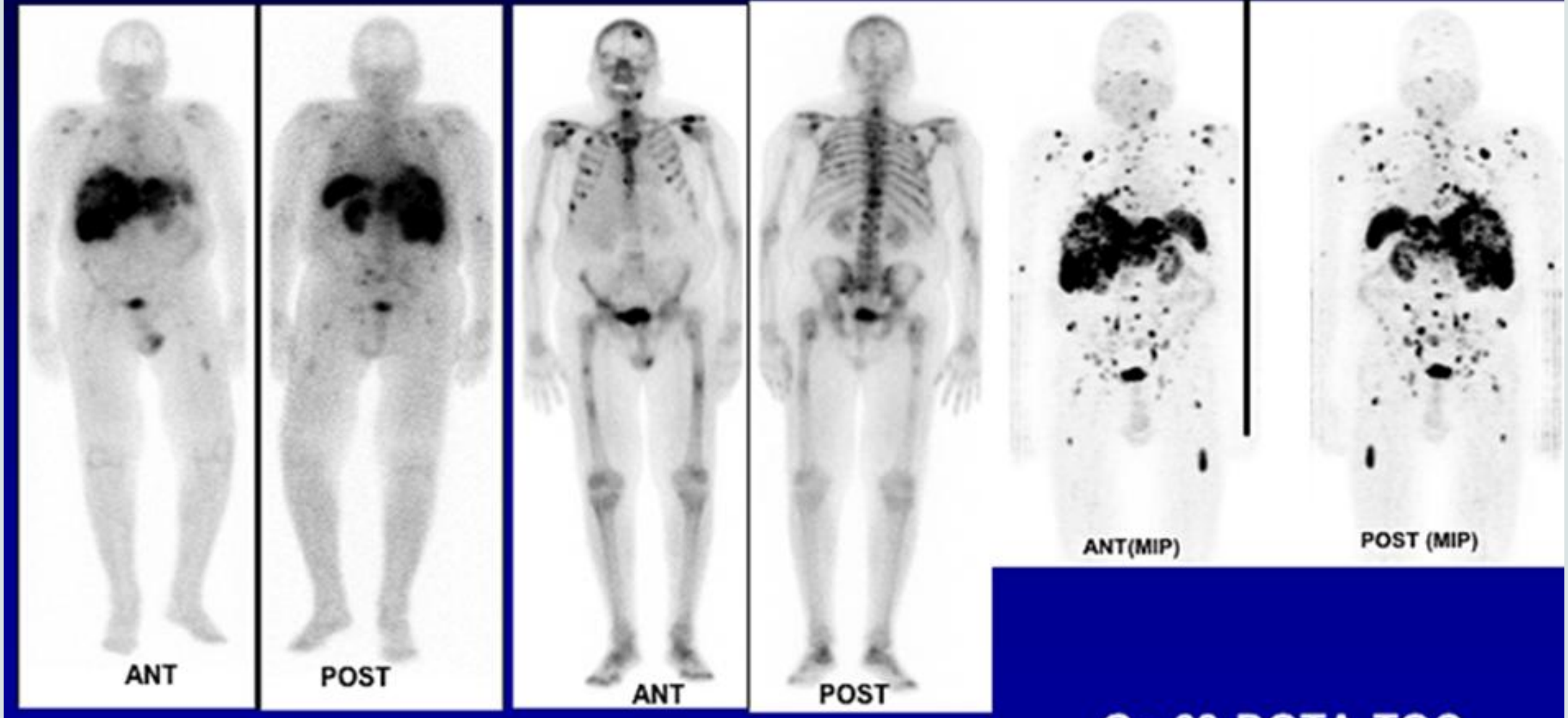
The basic principle of a positron emission tomography (PET) system: A PET detector ring detects a pair of gamma photons with an energy of 511 keV (red arrows) which results from the annihilation of an electron with a positron emitted by the radiotracer (FDG).

68Gallium PET imaging for prostate cancer



Sensitivity – OctreoScan vs. Ga-68 SMS PET

Metastasizing bronchus carcinoid



Thanks for Listening ☺