What I want from SPECT

The physicians perspective

Nuclear Medicine, PET and Ultrasound
Liverpool Health Service

Don’t undervalue SPECT

- PET - Is it the future of Nuclear Medicine?
- SPECT still has a crucial role
  - Continued growth
  - Cost effective
  - Available

My ideal functional imaging system?

- The perfect tracer
- The perfect detection system
- Spatial information and anatomic correlates
- Widely available
- Low cost

SPECT as a functional imaging modality

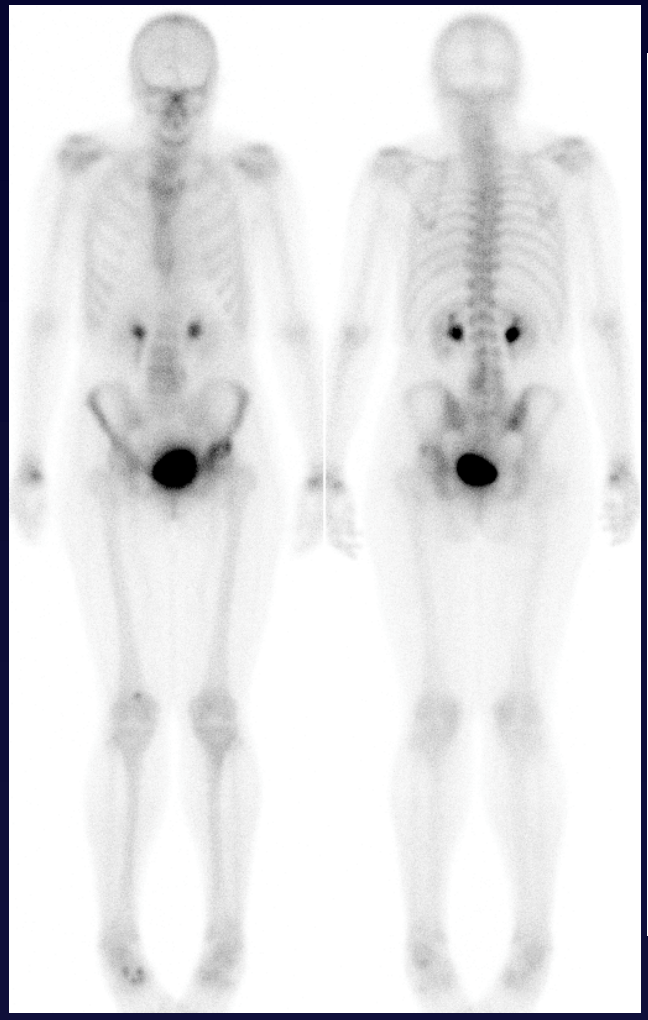
- What I like about SPECT?
- What more do I want from SPECT?
  - What pitfalls and problems need to be addressed?
  - What are the future possibilities?

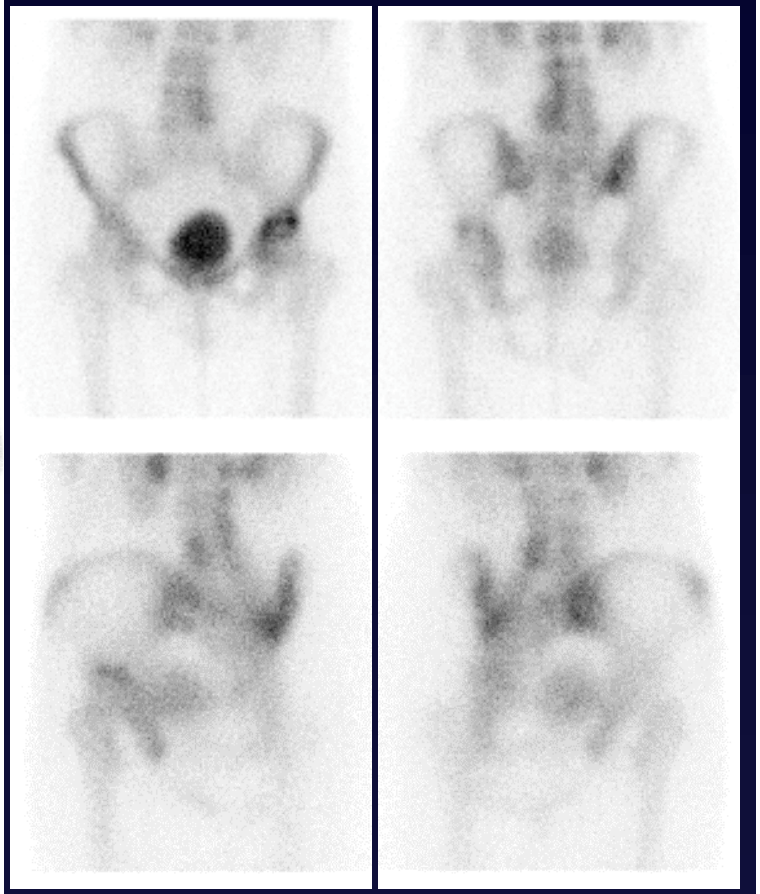
What I like about SPECT?

- Bone SPECT
  - 20 – 50% increased lesion detection
  - Greater detection of metastatic bone disease
    - Sensitivity 87% vs 74%
    - Specificity 91% vs 81%
      - Han et.al. Eur J Nucl Med 25:635-8; 1998.
  - More precise spatial localisation
    - E.g Facet arthropathy

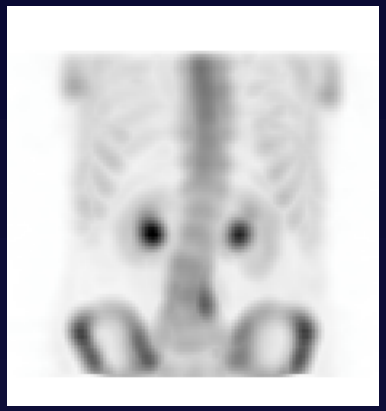
SPECT Example

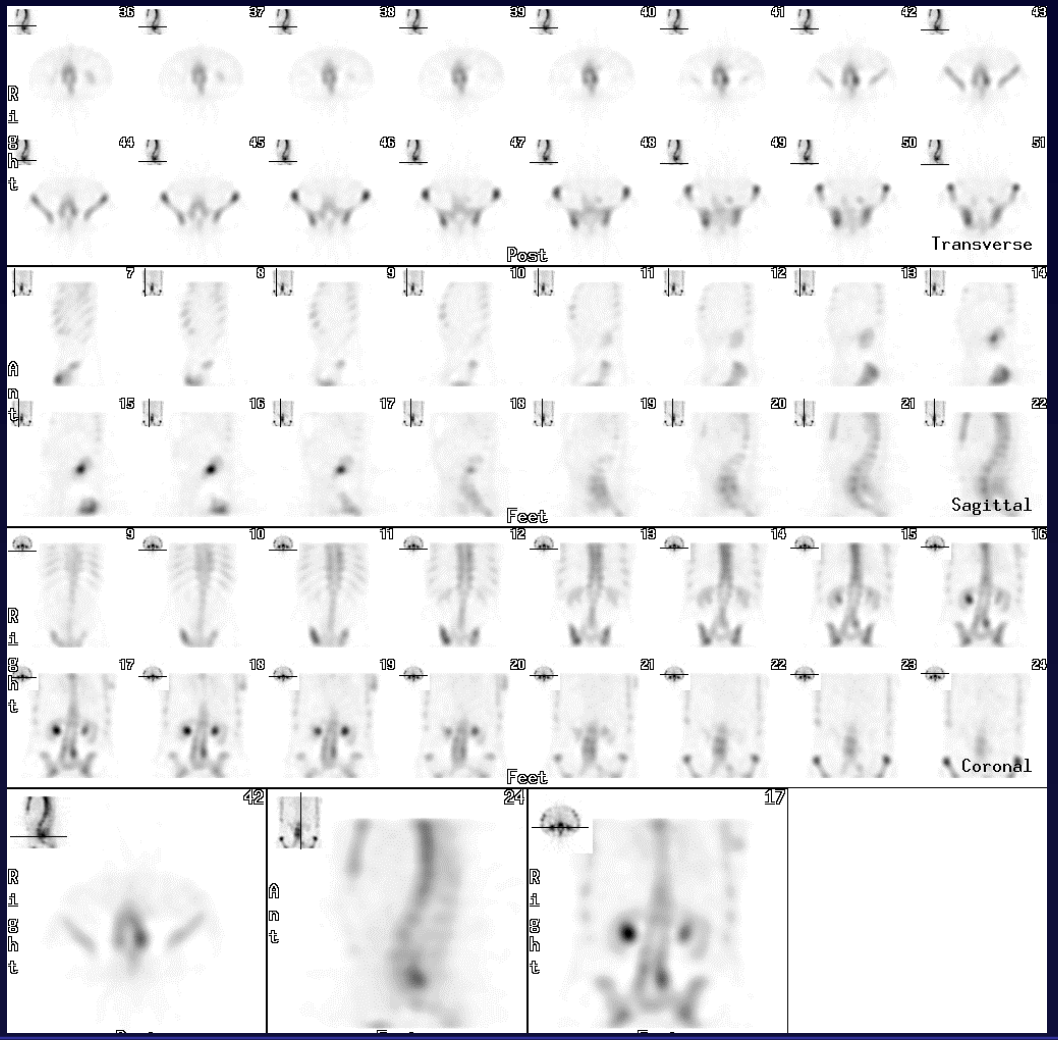
- 63 yo female
- Previous breast carcinoma
- Back pain





Bone SPECT Example





What I like about SPECT?

- MPI SPECT
  - Greater accuracy
  - Gated SPECT
  - Analytic packages
- Gallium
  - Greater sensitivity and specificity

What more do I want from SPECT?

- Solutions to existing pitfalls and problems
- New / evolving possibilities

Pitfalls and Problems with SPECT

Nuclear Medicine, PET and Ultrasound
Liverpool Health Service

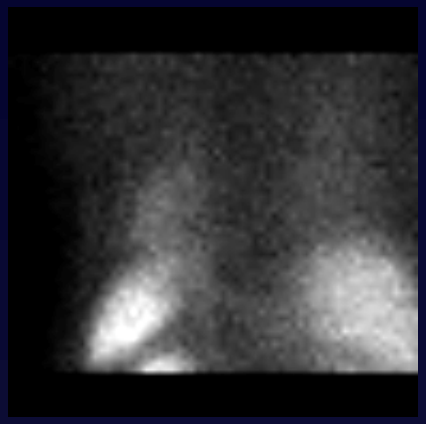
Pitfalls and problems with SPECT

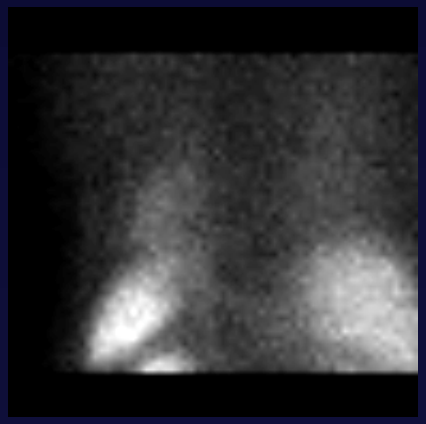
- Motion
- Attenuation
- Time of acquisition
- Adjacent high activity artefacts
- Dose

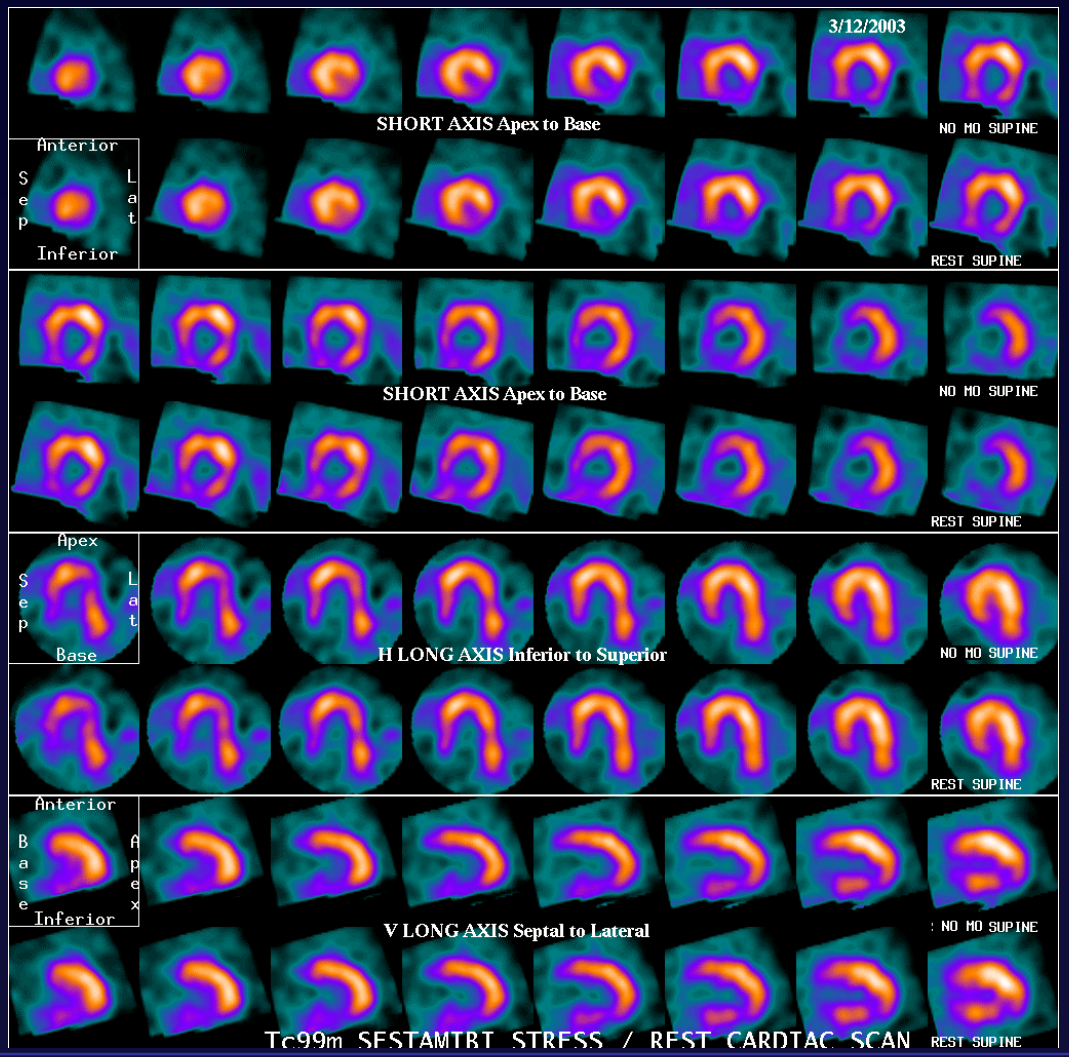
Motion Artefacts

- Common
- Potential for major diagnostic impact
- If in doubt re-acquire
- Motion correction algorithms?

70 yo male. Previous AMI. New chest pain







Motion artefacts

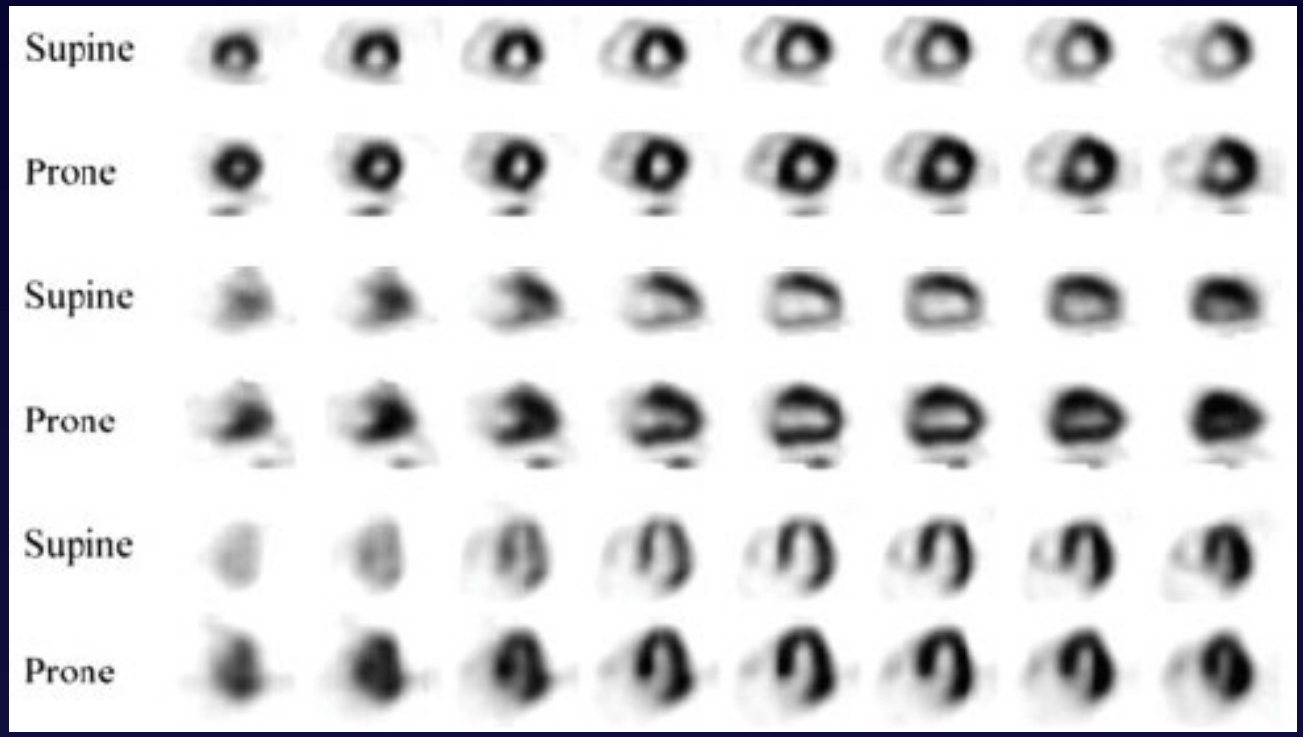
- Reliable implementations
  - Easy to apply
  - Correct real motion
- How do I know it has worked?
  - Difficult to assess

Attenuation artefacts

- Common
- Variety of causes
- Potential for major diagnostic impact

Diaphragmatic attenuation – prone imaging

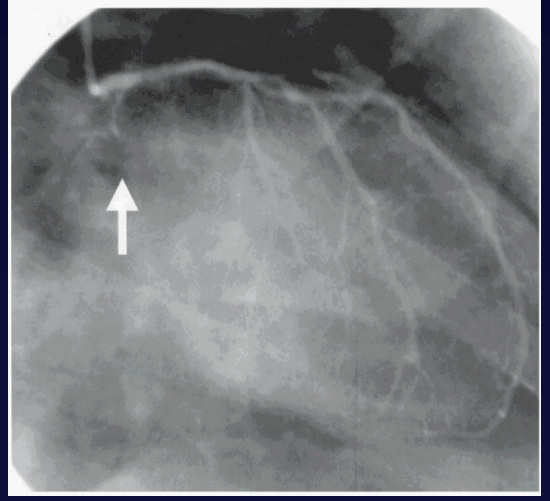
- 83 year old male, asymptomatic. Post stress images

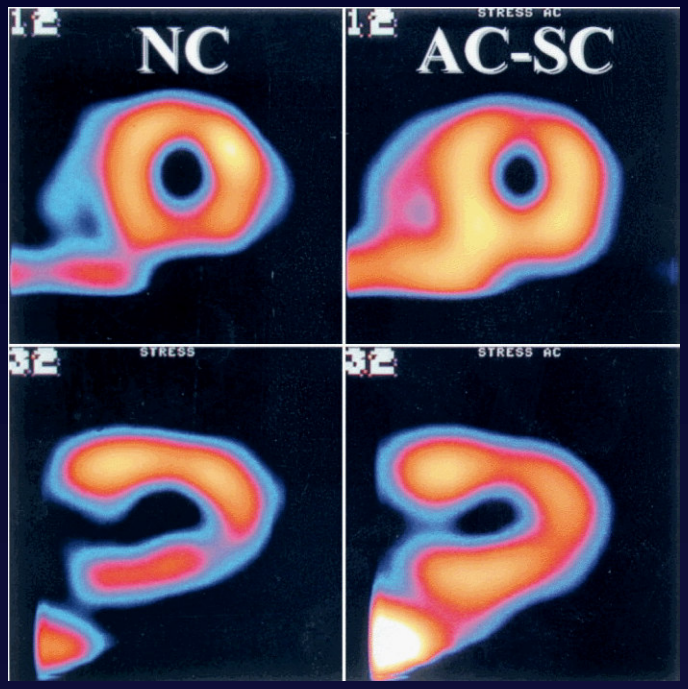


- Prognostically similar to normal supine imaging
  - Hayes SW et.al. J Nucl Med 2003; 44:1633–1640

Diaphragmatic attenuation – attenuation correction

(A)





	Sensitivity	Specificity
NC	92%	46%
AC-SC	76%	71%

Banzo I et.al Nucl Med Commun 2003; 24:995-1002

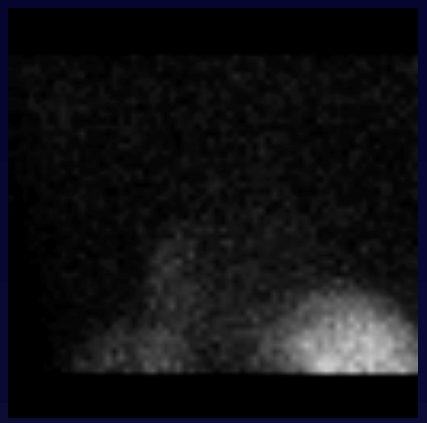
Attenuation artefacts

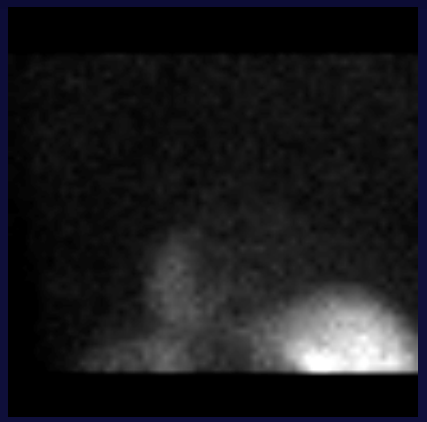
- Reliable fast cost effective attenuation correction
  - Attenuation correction
    - Cost
    - Validation
    - Quality control
  - Prone imaging
    - Simple
    - Time consuming

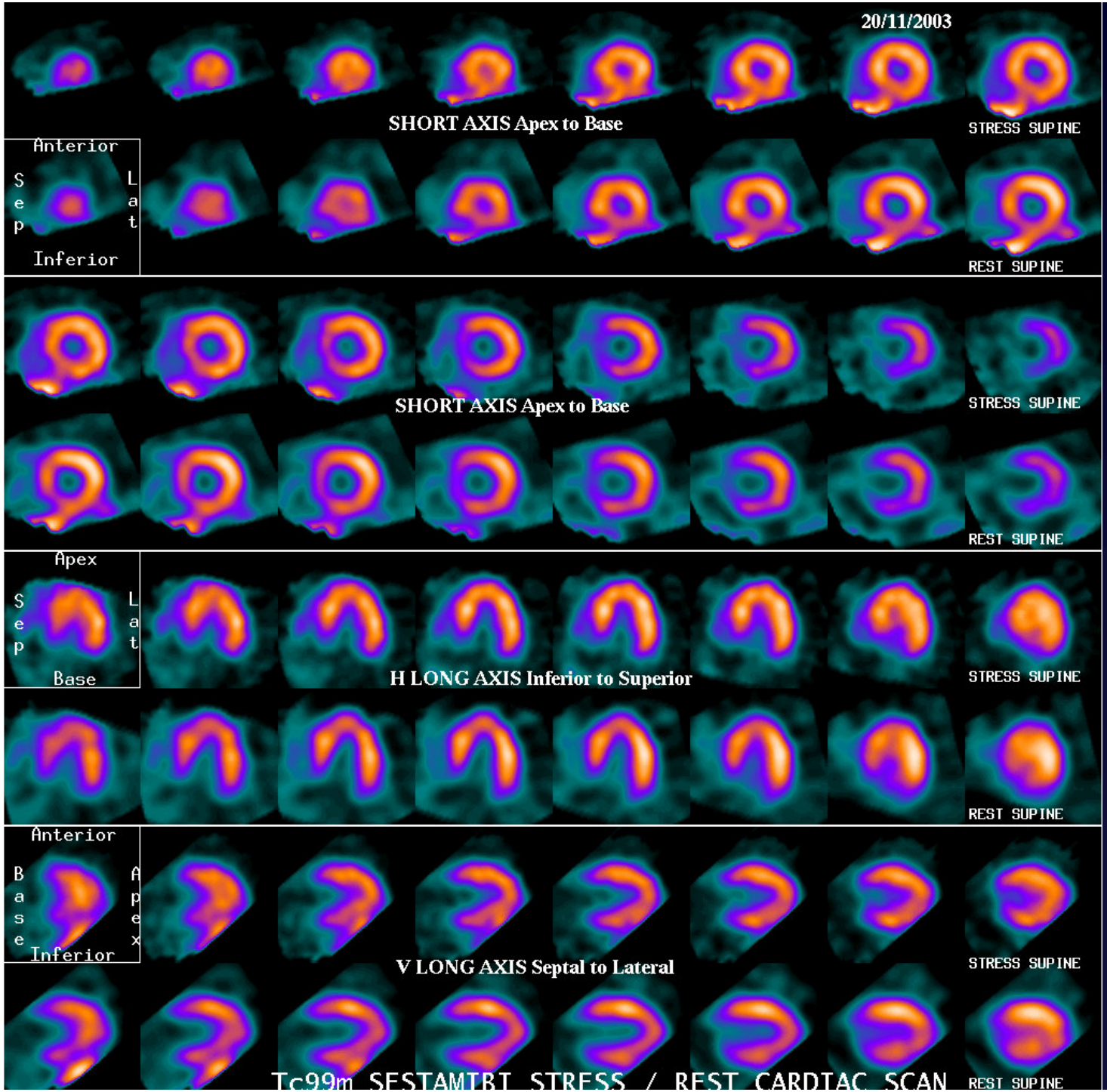
New / evolving possibilities with SPECT

Myocardial Perfusion Imaging – a case example

- 55 year old male.
- Chest pain
- Multiple cardiac risk factors







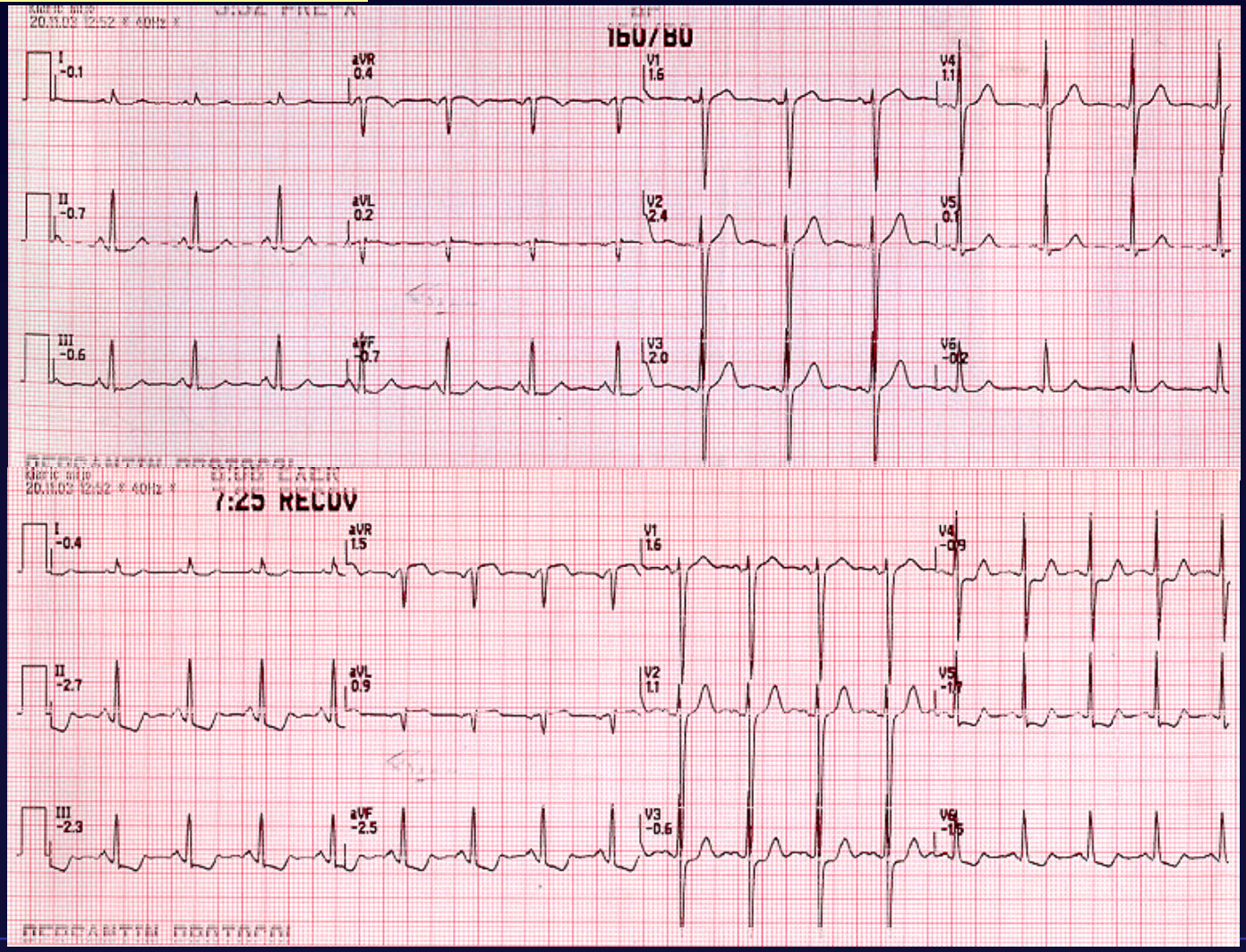
Rest LVEF=50%

Stress LVEF=51%

Dipyridamole Stress Findings

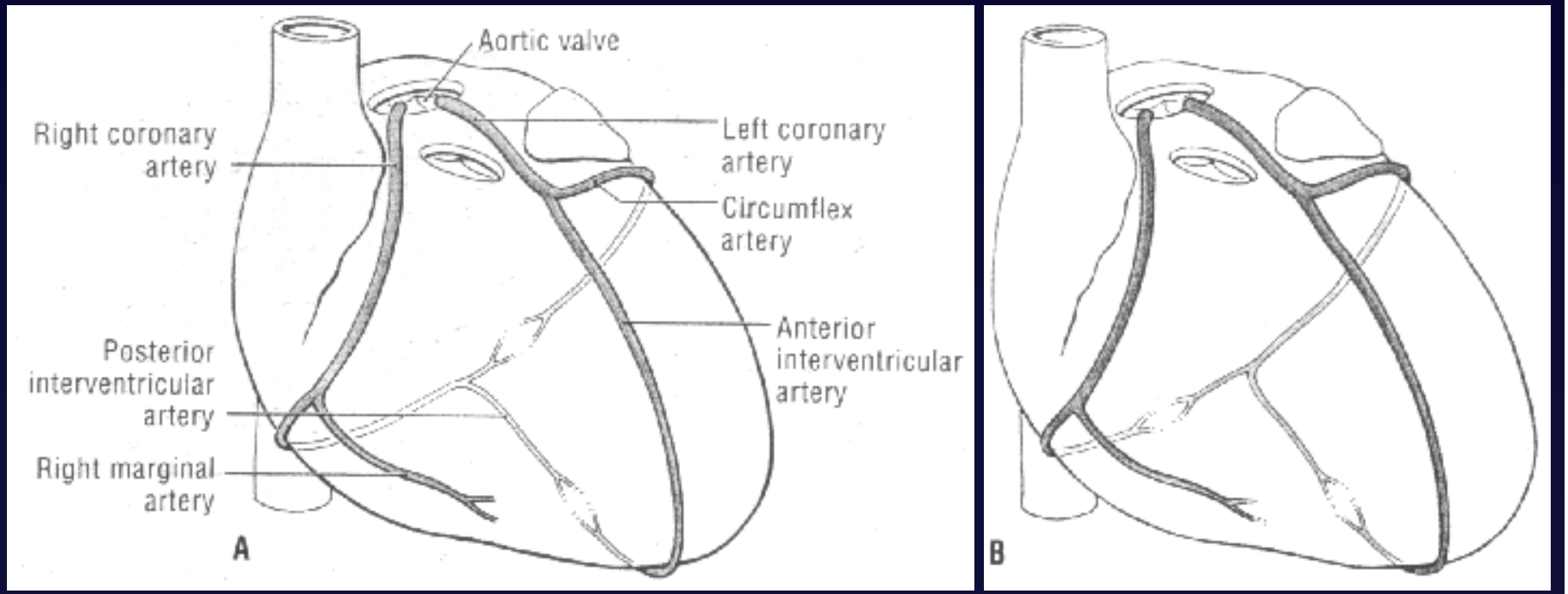
- 0.56mg/kg Dipyridamole infusion (4mins)
- Bruce 0 exercise augmentation
- Onset of chest pain during stress

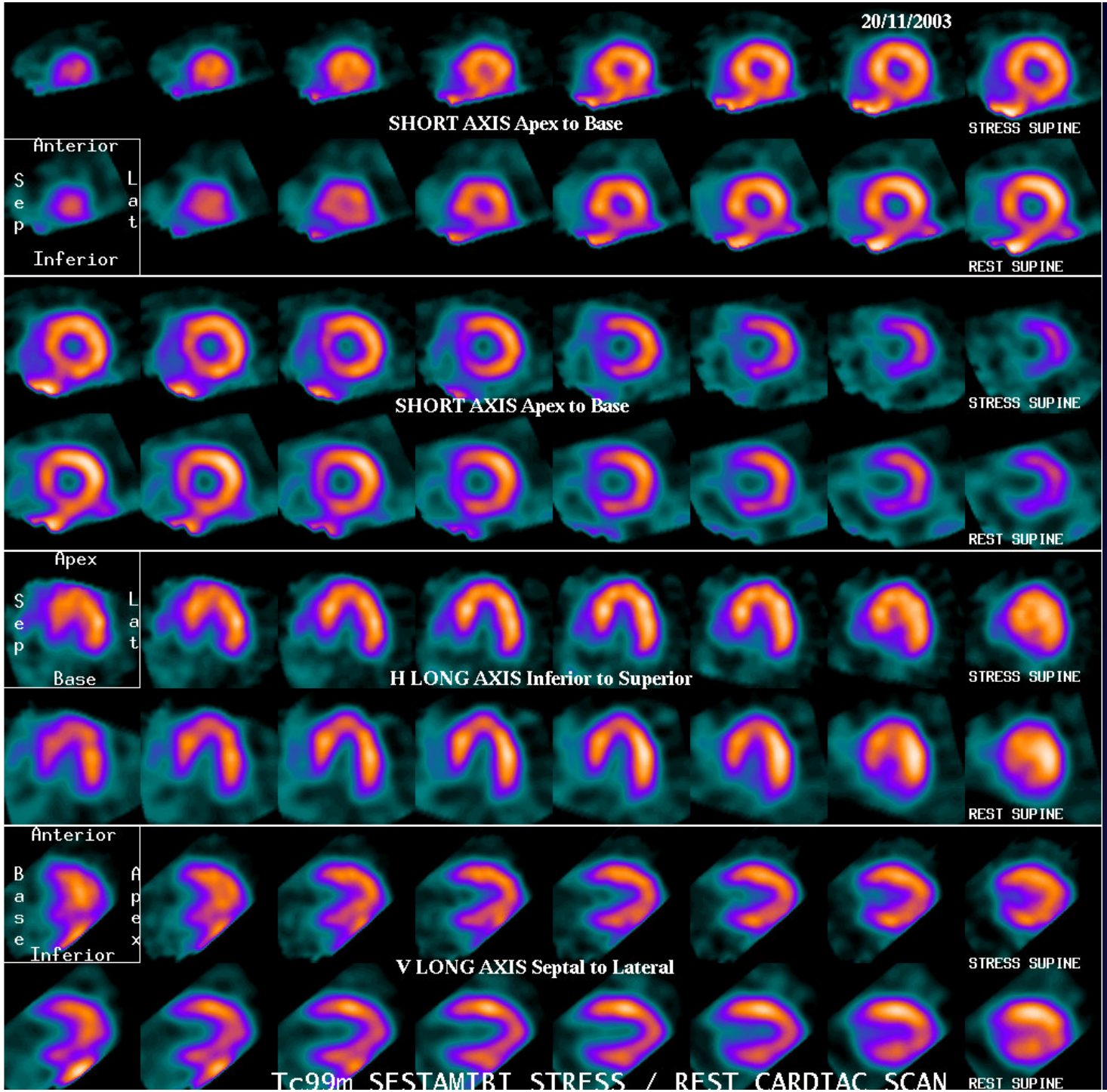
ECG Data


160/80
I -0.1
aVR 0.4
V1 1.6
V4 1.1
II -0.7
aVL 0.2
V2 2.4
V5 0.1
III -0.6
aVF -0.7
V3 2.0
V6 -0.2
7:25 RECOV
I -0.4
aVR 1.5
V1 1.6
V4 -0.9
II -2.7
aVL 0.9
V2 1.1
V5 -1.7
III -2.3
aVF -2.5
V3 -0.6
V6 -1.5

Angiographic Findings

- Left dominant coronary anatomy



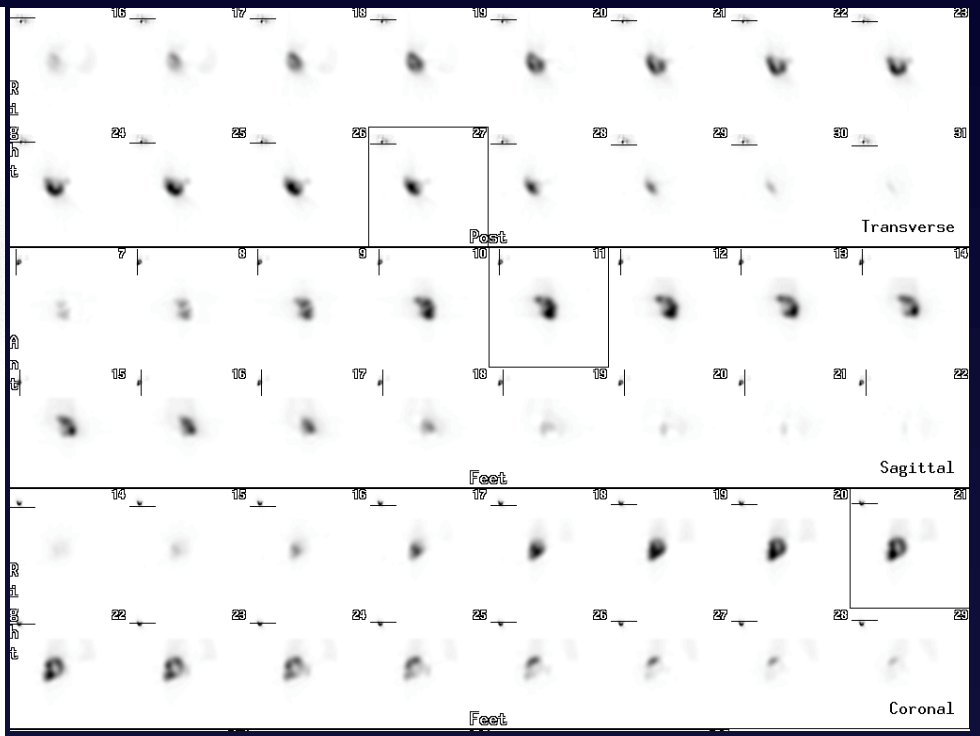


Rest LVEF=50%

Stress LVEF=51%

SPECT dosimetry

- 51 yo male HCC. Lipiodol therapy



SPECT dosimetry

- Individual tumour dose correlates with response
- I-131 tositumomab
- 20 patients follicular NHL
- All patients responded
- 77 individual tumour sites
  - PR 369 +/- 54 cGy
  - CR 720 +/- 80cGy
  - Trend toward significance

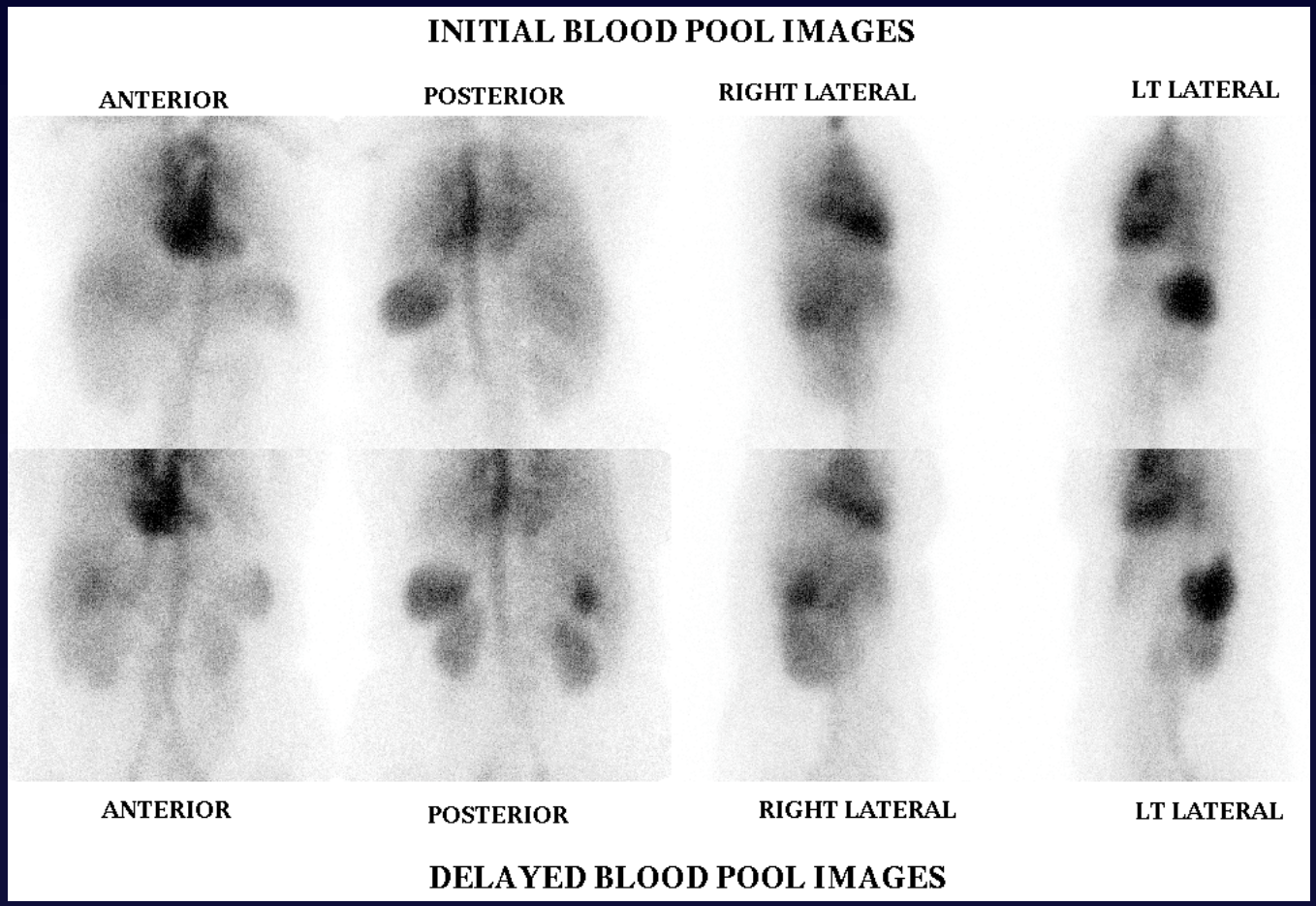
Koral KF et.al. Cancer Biother Radiopharm 2000; 15:301-3

SPECT: a static technique for dynamic processes

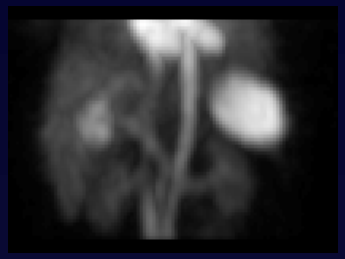
- Limited use of dynamic data with SPECT
  - MPI gated studies
  - Multiple time point SPECT

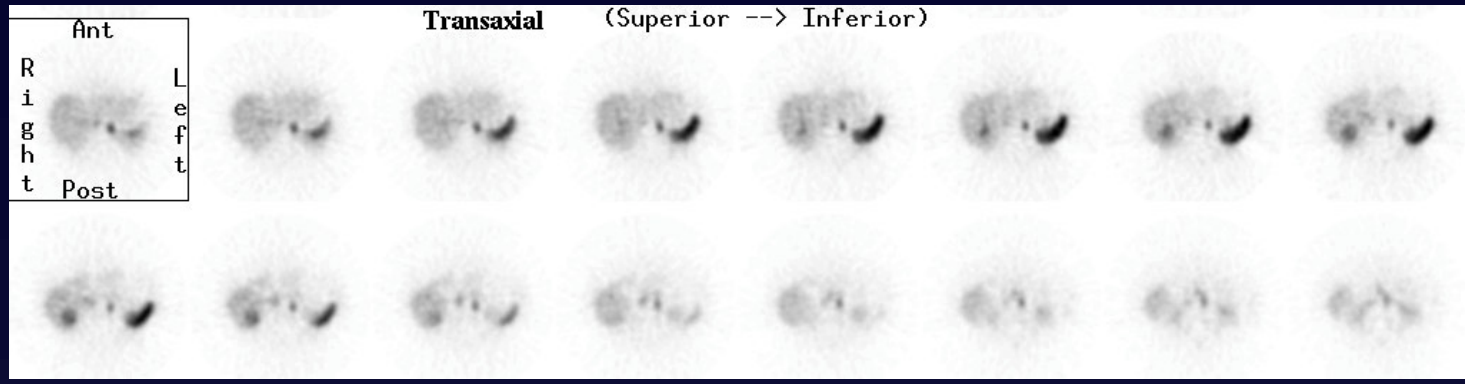
Haemangioma study - planar

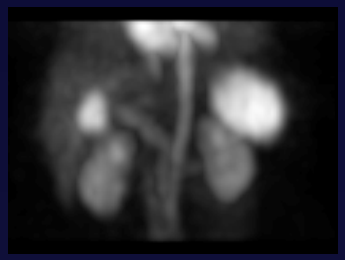
- 54 yo female. CT scan hepatic abnormality ?Haemangioma

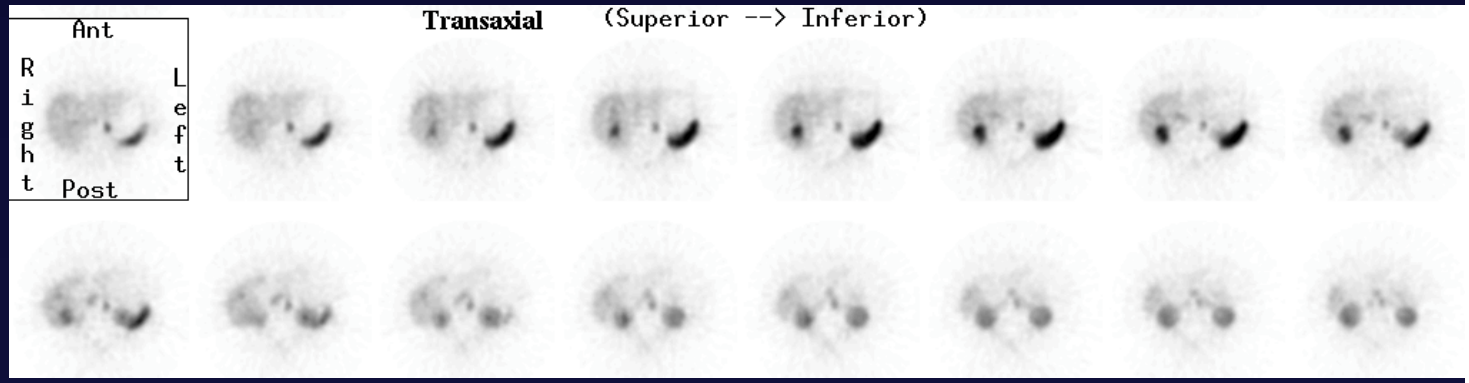


Haemangioma study - SPECT









Quantification / Dynamic SPECT

- Clinical SPECT is largely qualitative / static
- Quantification / Dynamic acquisition is potentially very clinically useful in
  - MPI
  - Drug uptake biodistribution
  - Washout
  - Dosimetry
- Potential to take some on some roles of PET

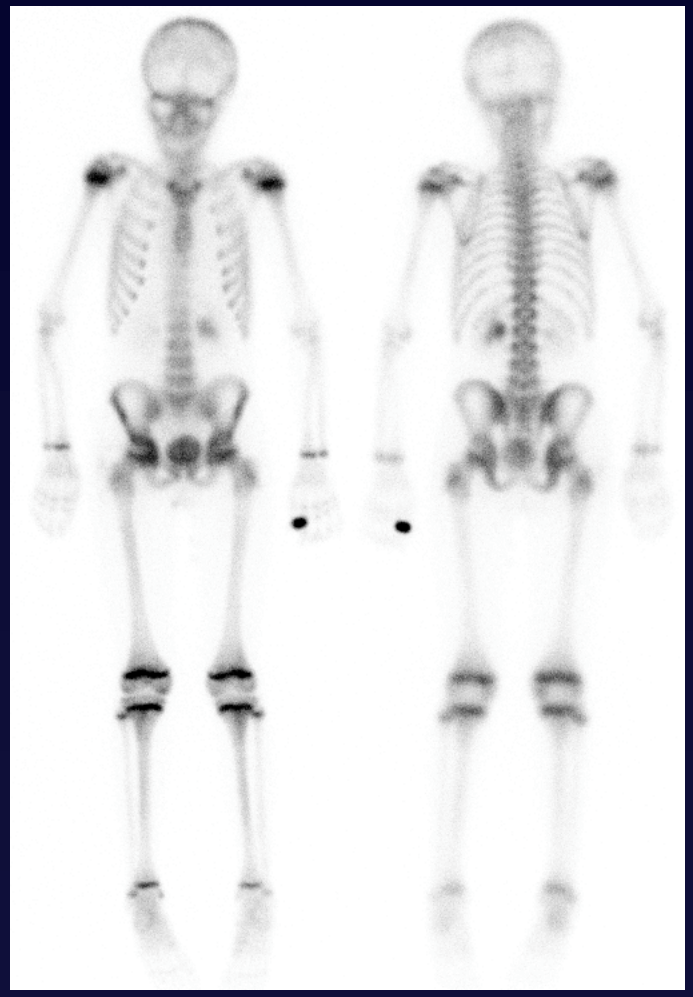
Anatomy poor function rich

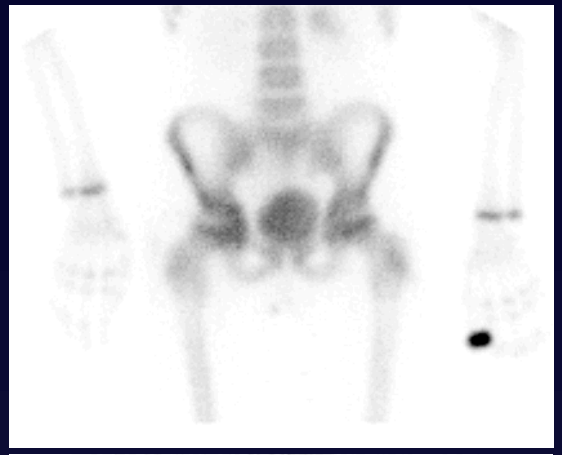
- Common criticism of Nuclear medicine in general
- Often able to visually correlate anatomic and functional imaging
- Vital for many roles
  - Surgery / biopsy planning
  - Radiotherapy planning

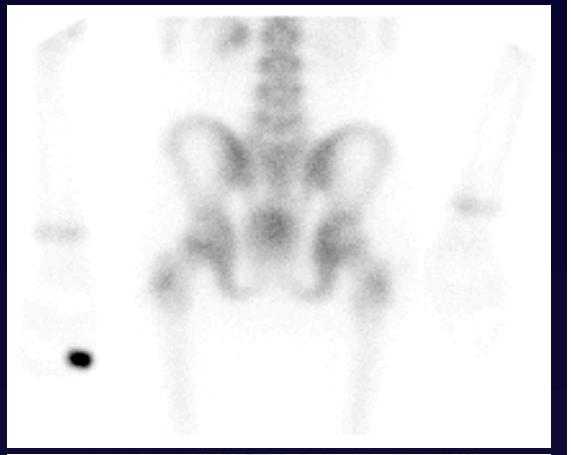
Enhancing resolution

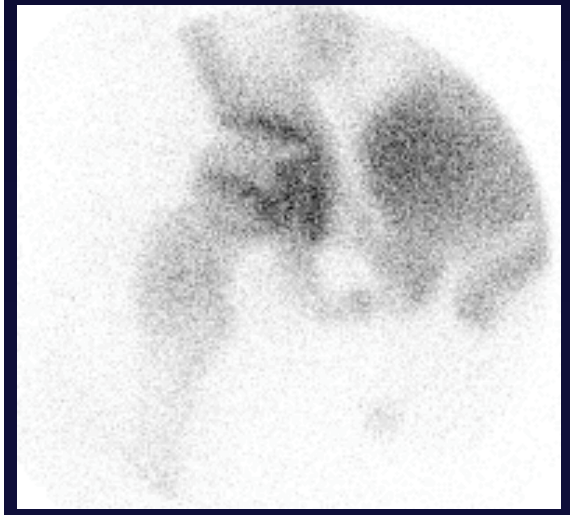
- 5 year old male
- Right septic arthritis
- ?Associated osteomyelitis

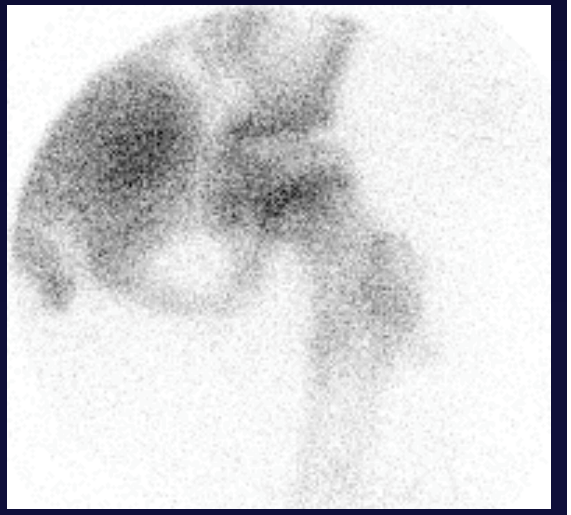
Bone scan







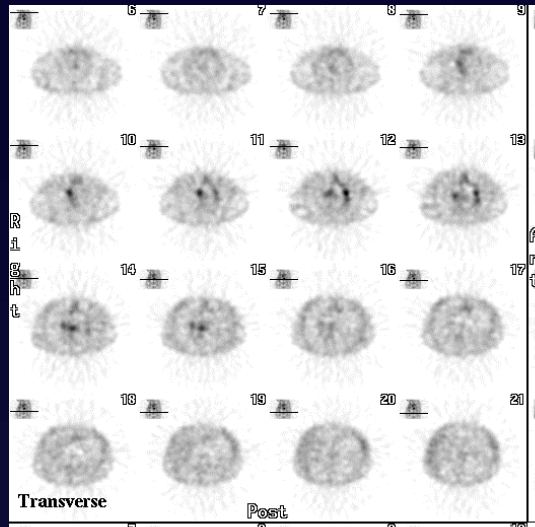


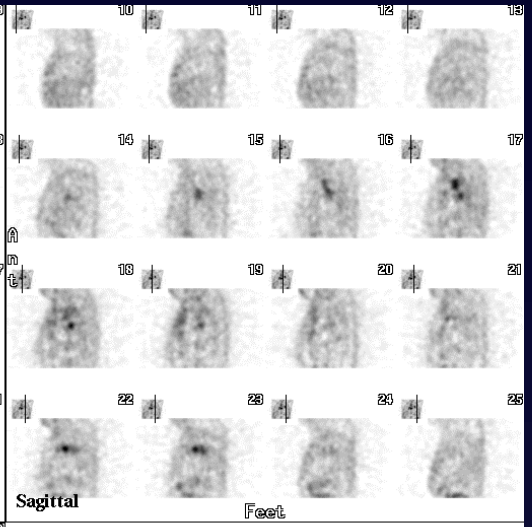


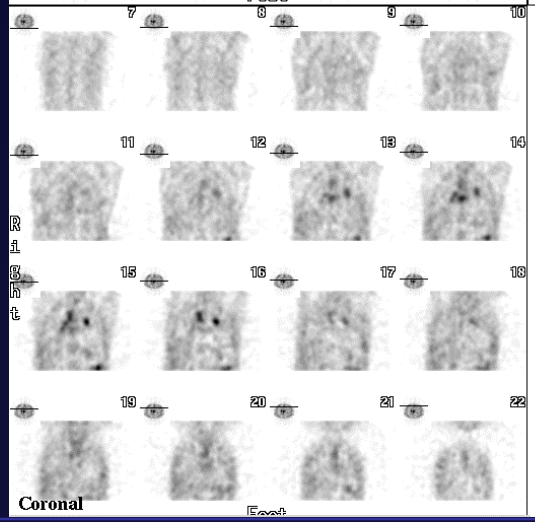
The importance of anatomy – multimodality imaging

- 76 year old male
- New onset fevers, renal impairment and elevated ESR
- ?Infection ?malignancy
- Multiple investigations
  - No cause found

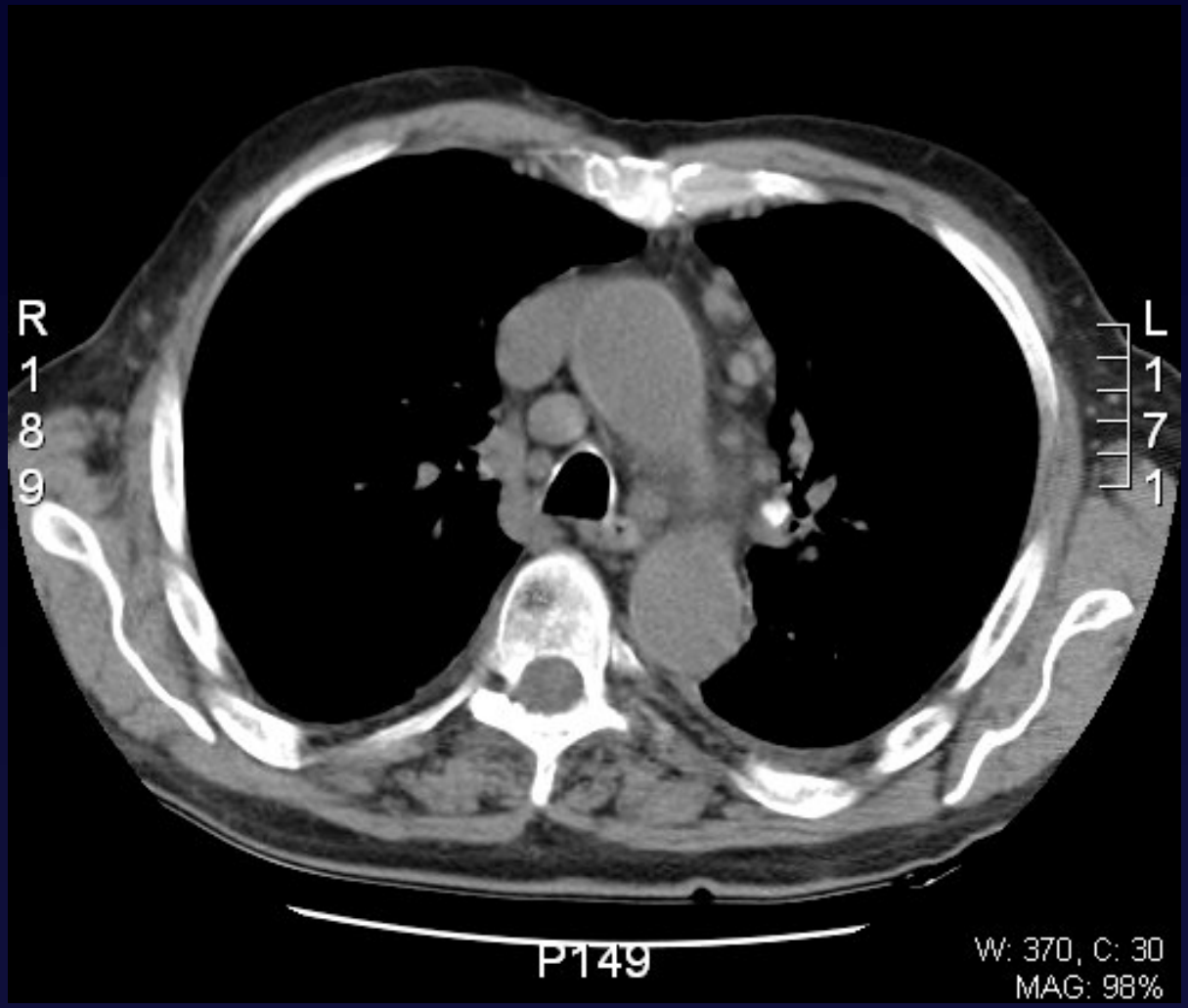
Gallium scan







CT scan



Final Diagnosis

Tuberculosis

Function – Anatomy fusion
What can SPECT learn from PET?

- PET data

What do I want from a functional imaging system?

- Existing systems already delivers significant benefits
- Persisting pitfalls and problems
- Volumetric quantitation
- Volumetric dynamic studies
- Speed
- Anatomy / Function fusion
- Low cost
- Widely available

Can SPECT deliver?

- ☑ Existing systems already delivers significant benefits
- ☐ Persisting pitfalls and problems
- ☐ Volumetric quantitation
- ☐ Volumetric dynamic studies
- ☐ Speed
- ☐ Anatomy / Function fusion
- ☑ Low cost
- ☑ Widely available

Can SPECT deliver?

The Future of SPECT

- An ideal functional imaging system
- PET vs SPECT?
  - Roles for both
  - Increasing availability vs increasing capability

My wish list

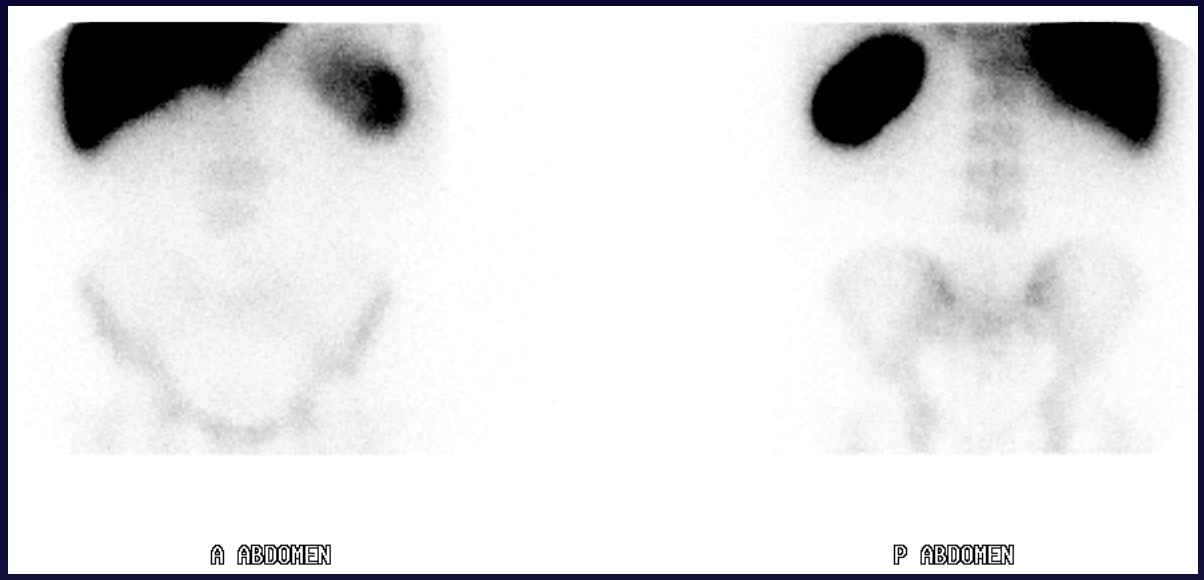
- Better techniques to address artefacts and a objective measure of the success / failure of these techniques in the individual patient
- Faster scanning times
- Larger FOV
- Higher resolution
  - Pinhole SPECT
- Quanitication
- Anatomy / functional correlation

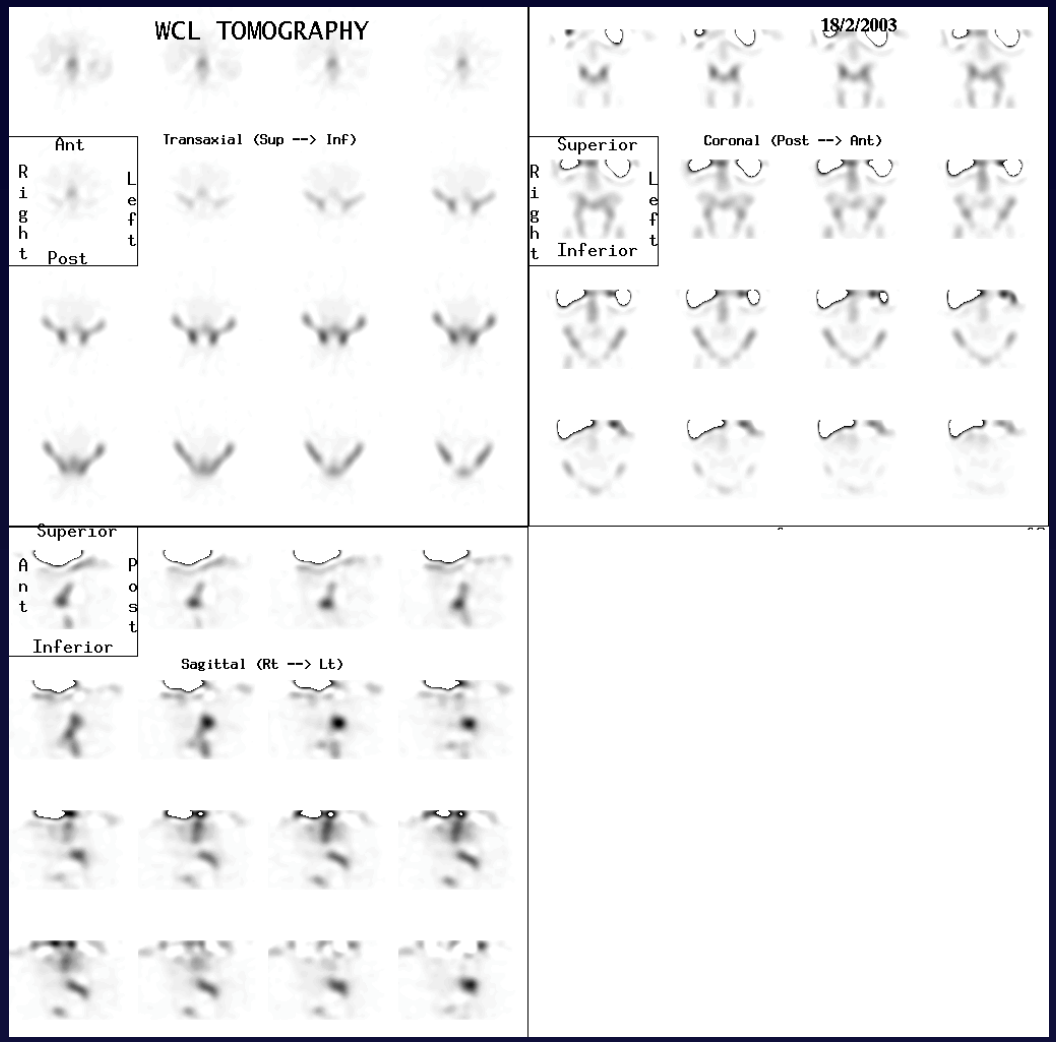
High Contrast areas

- Detection of small lesions adjacent to high activity normal areas
- Potential for major diagnostic impact

High contrast examples

- XX yo male ?infected AAA graft




WCL TOMOGRAPHY
18/2/2003
Transaxial (Sup --> Inf)
Ant
Right
Left
Post
Coronal (Post --> Ant)
Superior
Right
Left
Inferior
Superior
Ant
Post
Inferior
Sagittal (Rt --> Lt)