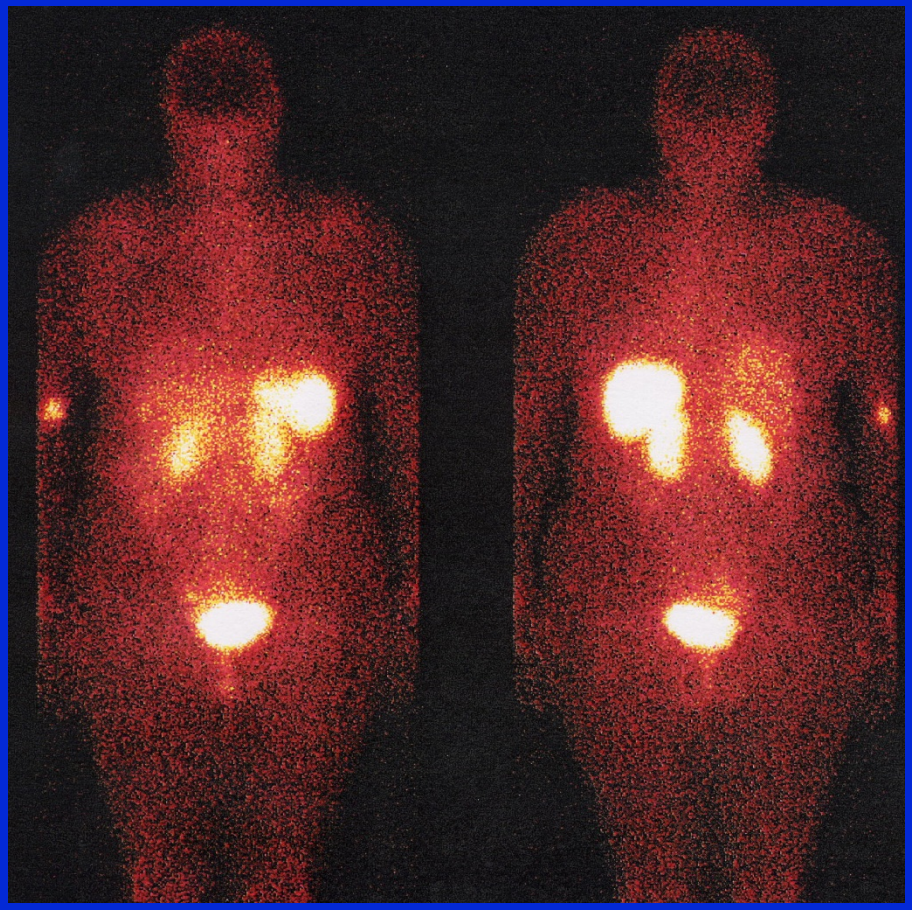
SPECT/SPECT-CT in tumour

J.R.Buscombe

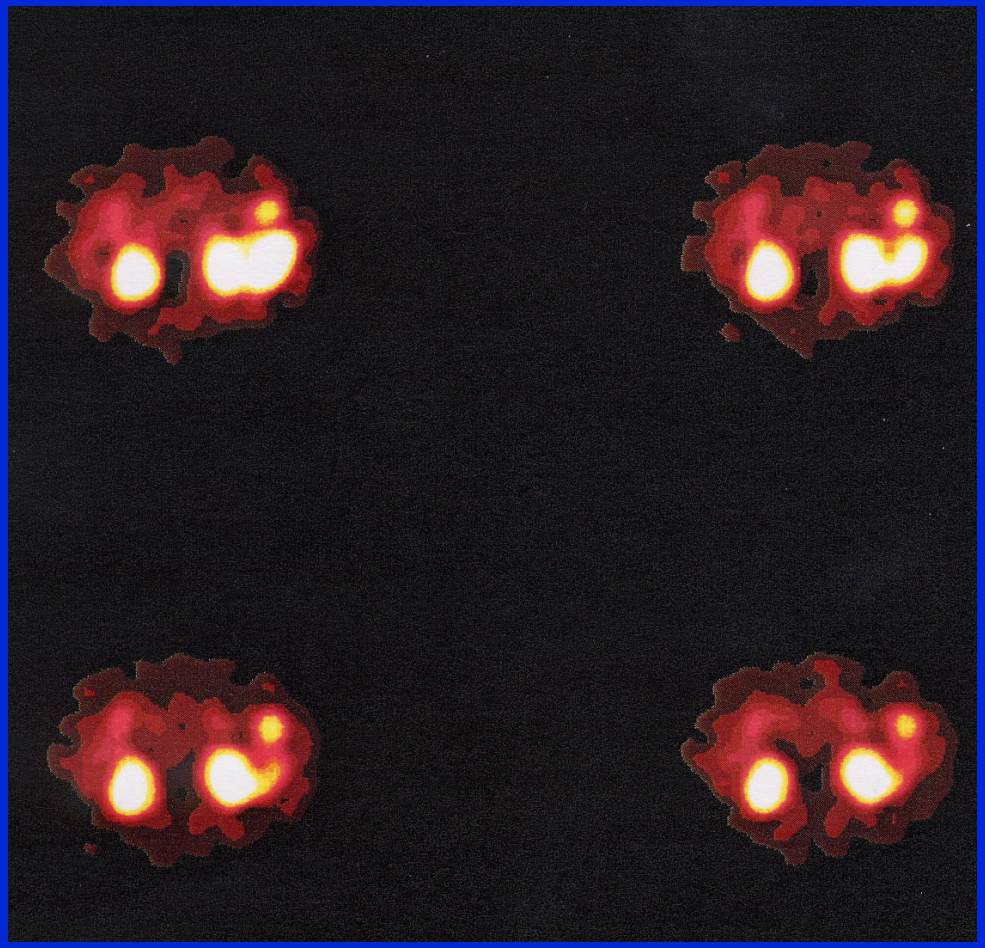
Why SPECT

- Increases contrast between target tissue and background
- Separates overlying structures
- May allow better localisation (esp SPECT-CT)
- However spatial resolution worse

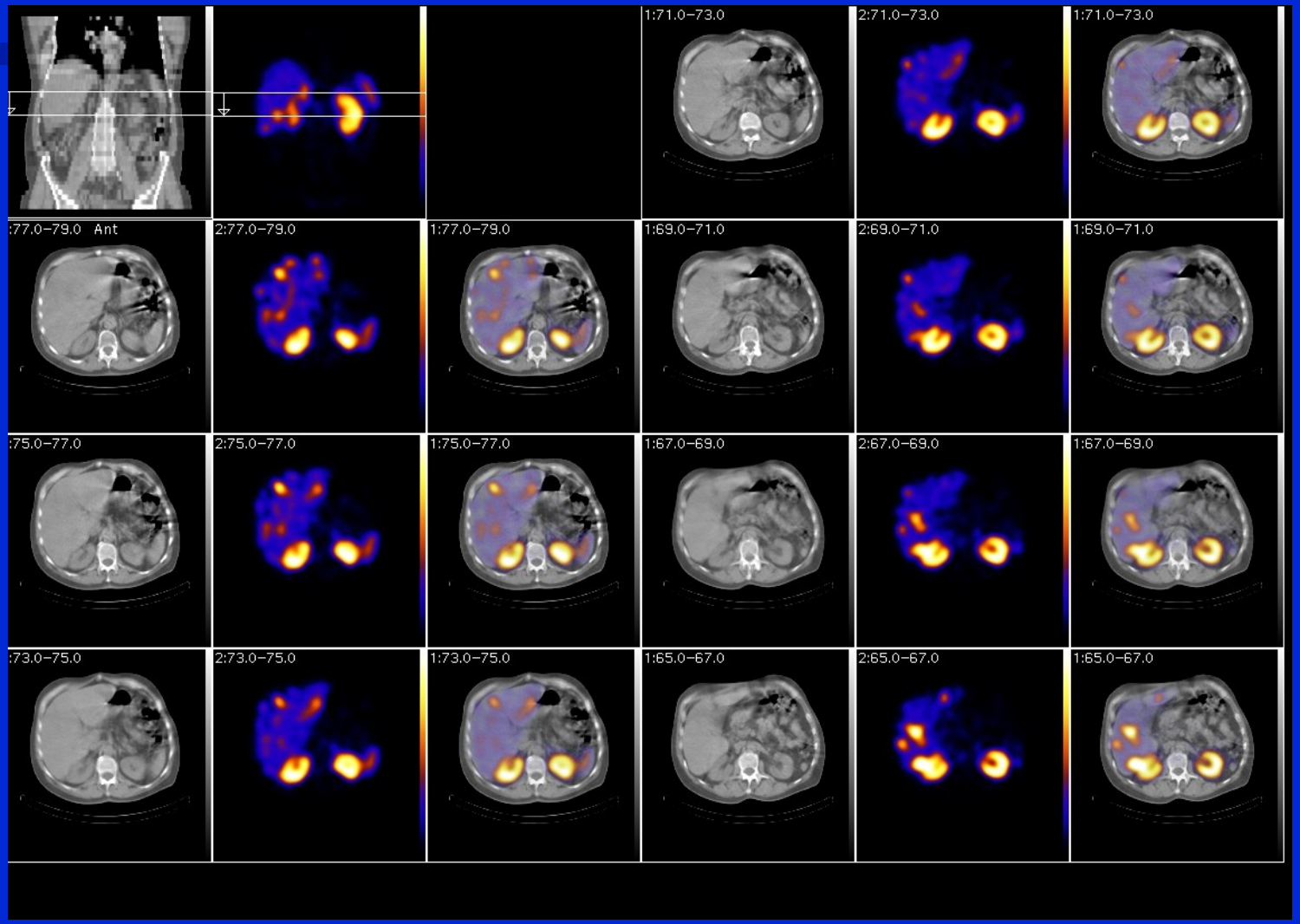
Planar In-111 pentreotide imaging

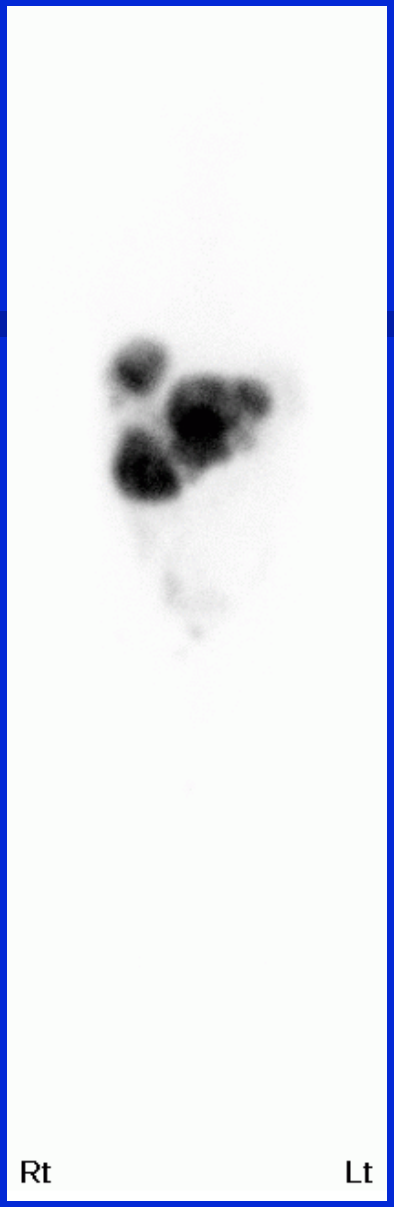


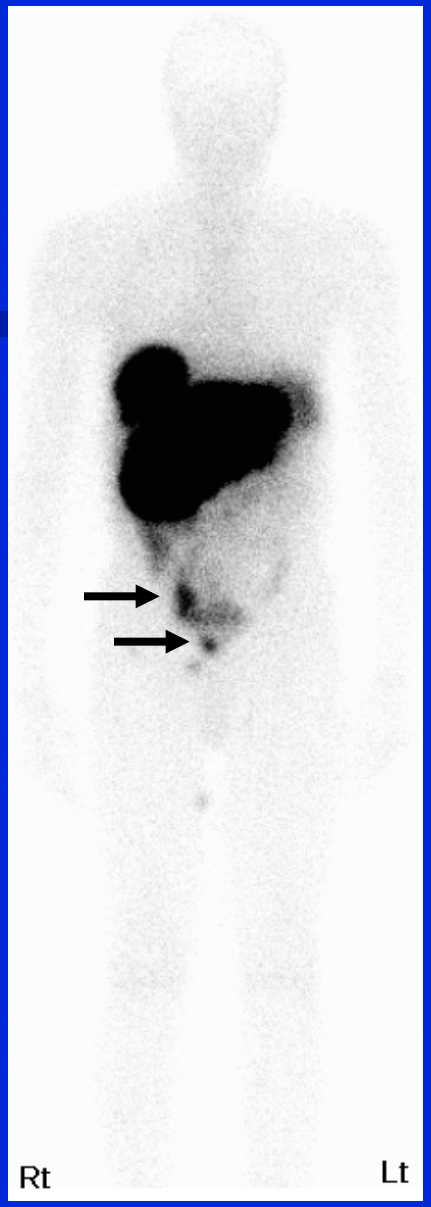
In-111 pentetreotide SPECT shows tumour in front of spleen

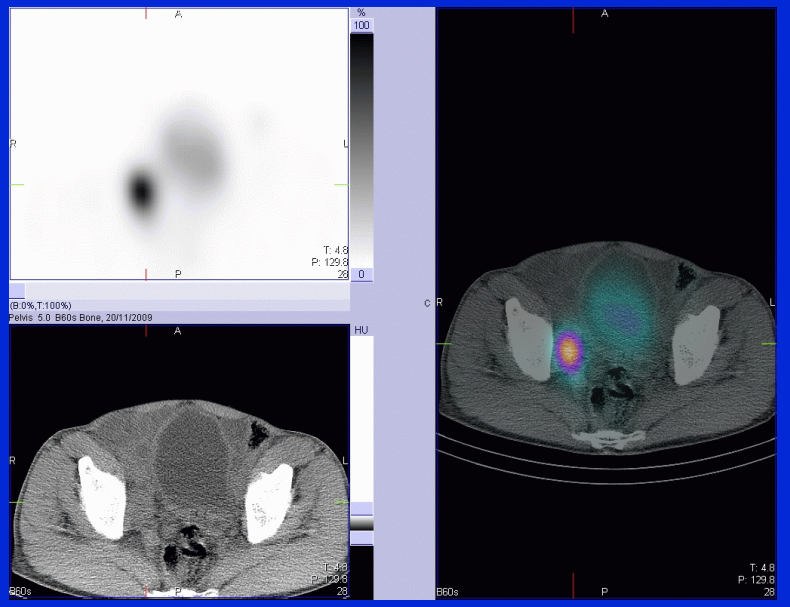


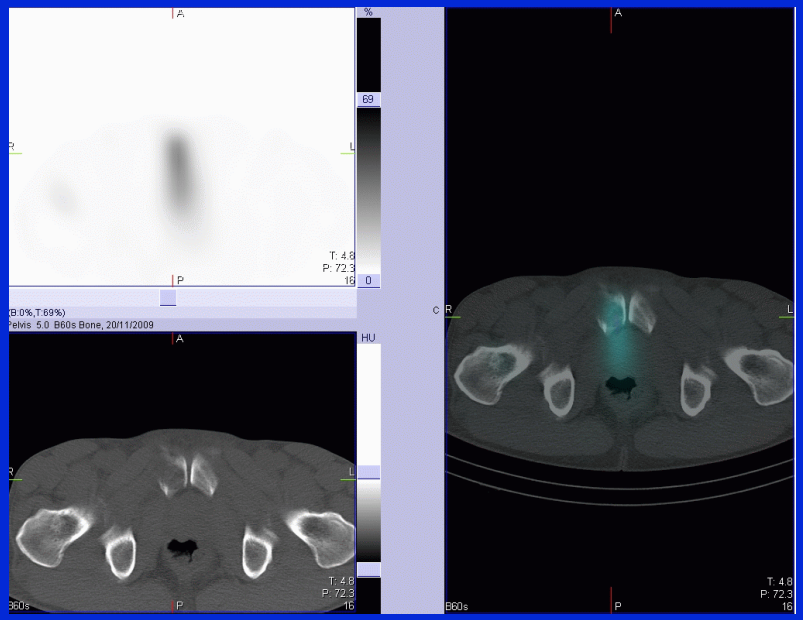
Registered CT-SPECT image









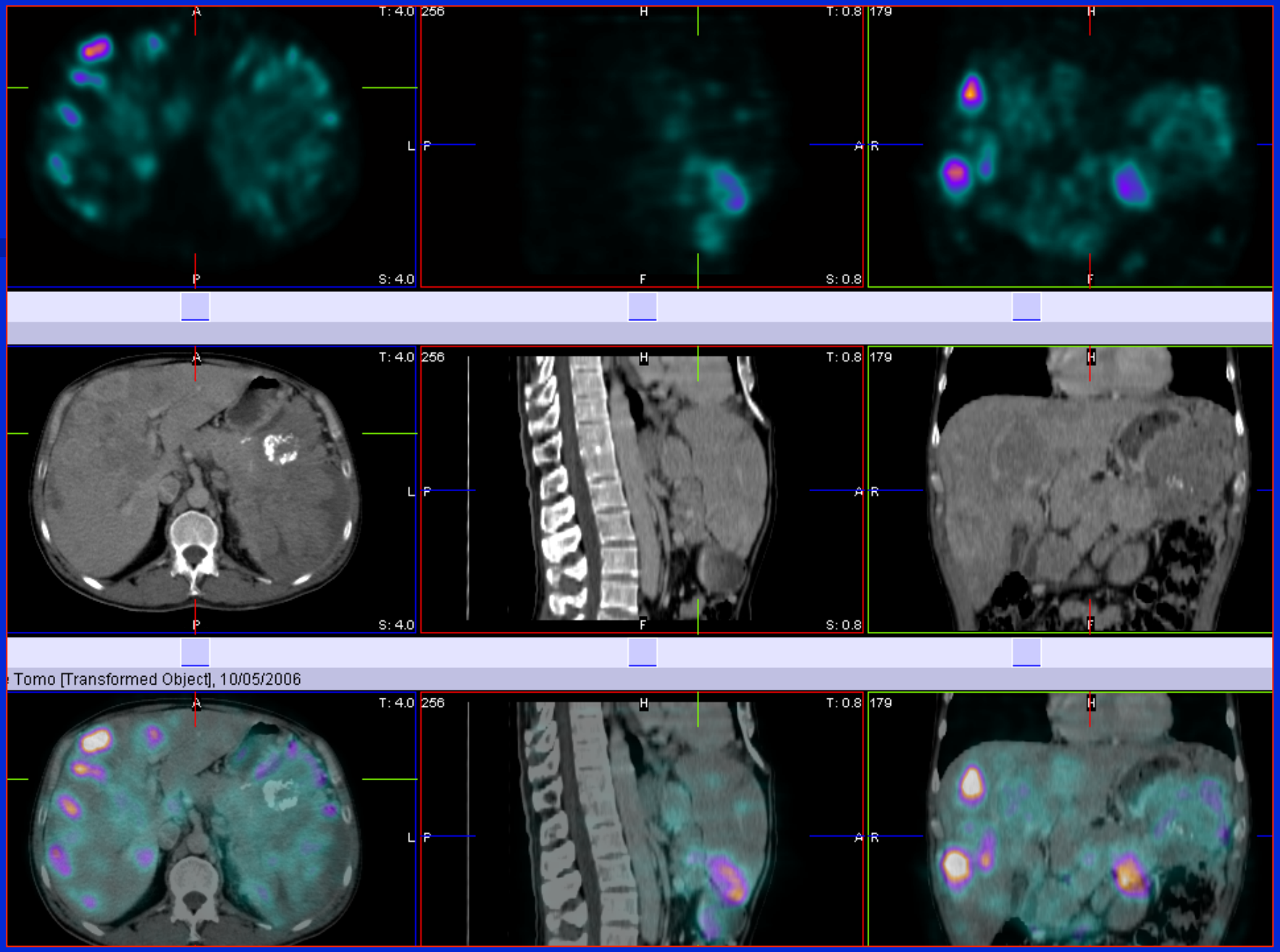


SPECT/CT: improved localisation with hybrid imaging

Courtesy of Dr Navalkissoor

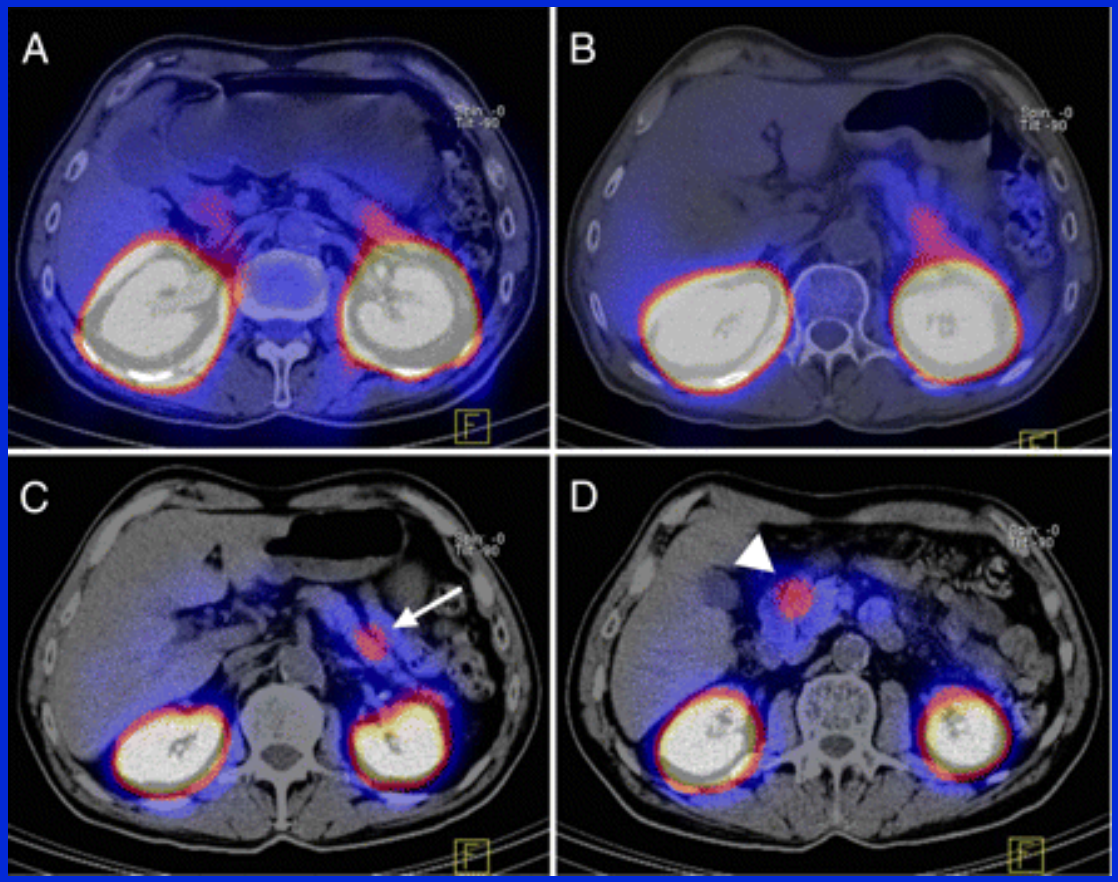
Tc-99m HYNIC TATE

- Based on octreotate
- Tc-99m linked via nicotinic acid linker
- Increased uptake in SSR2 positive tumours
- Much cheaper
- Lower radiation dose
- Development restricted by ECTD
- Available from Poland



Foregut, pancreas – non-secretor, NECLM (WHO 2)

In-111 GLP in 2 pancreatic tumours Christ et al JNM 2010



SPECT and SPECT-CT in oncology

- Breast-scintimammography
- Lungs depreotide, MIBI
- Head and neck MIBI
- Colon CEA scan
- Prostate prostoscinct
- I-131 SPECT-CT

Scintimammography

- Method uses a radiopharmacauetical Tc-99m MIBI/TF/MDP
- This had preferential uptake for tissues with higher metabolic rate
- Includes many cancers such as breast
- Imaging techniques optimised (by Diggles & Khalkhali) – use of early prone lateral images

What about SPECT?

- How should it be done?
- Prone or supine?
- What timings?
- Does it improve accuracy?
- Will it aid localisation?

SPECT or planar

Author (n)	Sens pl	Spec pl	Sens tom	Spec tom
Danielson (26)	85%	88%	61%	64%
Schillaci (63)	85%	91%	92%	85%
Aziz (150)	87%	85%	95%	84%
Spanu (93)	46%	-	86%	-
Myskivecek (310)	82%	91%	92%	91%

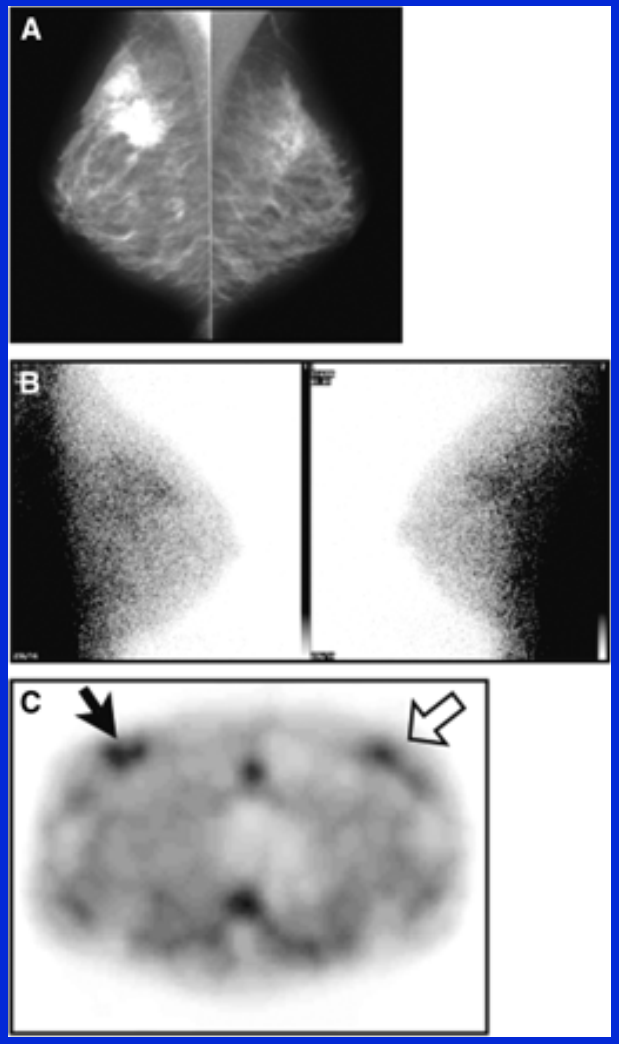
When was SPECT good

- Prone imaging appeared to be better than supine
- Some authors found back-projection better than iterative as it avoids low angle scatter off the skin
- Small <10mm lesions best seen with SPECT
- Axillary nodes seen much better with SPECT
- SPECT-CT may help localisation

Planar vs SPECT

Supine SPECT
bilateral breast cancer
better seen o n SPECT

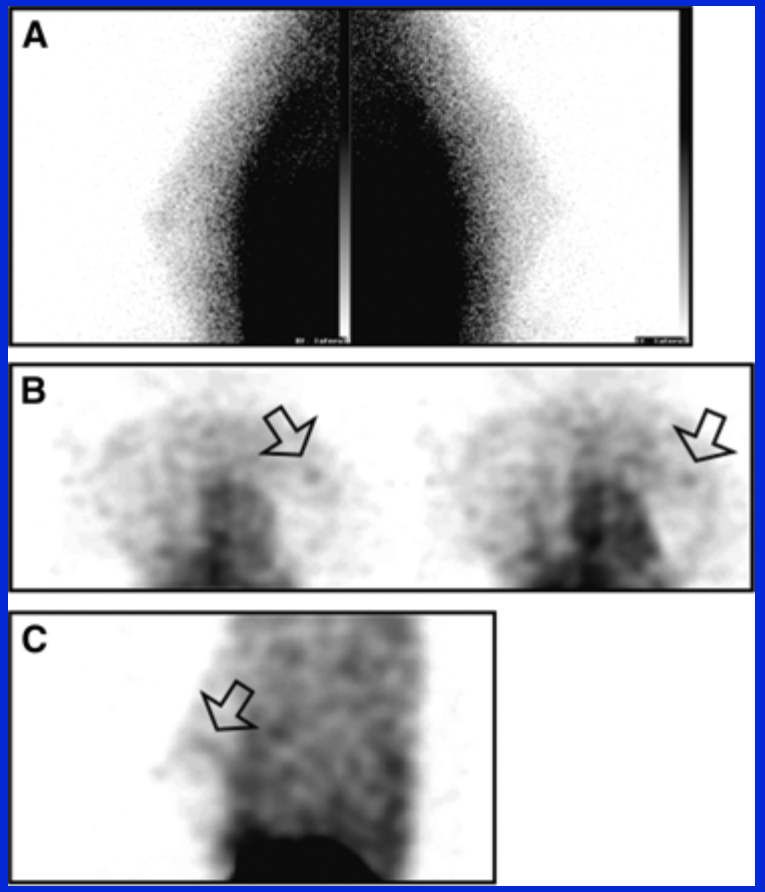
Matheiue et al Namur
Belgium



Planar vs SPECT

Small 5mm invasive ductal caricnoma negative on planar scintimammography but positive on SPECT

Matheiue et al
Namur Belgium



Imaging in head and neck cancers

- Most centres use ultrasound or CT
- MRI may be of particular use because of its ability to see in more than one plane
- Most of the time however the essential point is whether or not it is possible to identify
  - 1) extent of primary
  - 2) lymph node extension

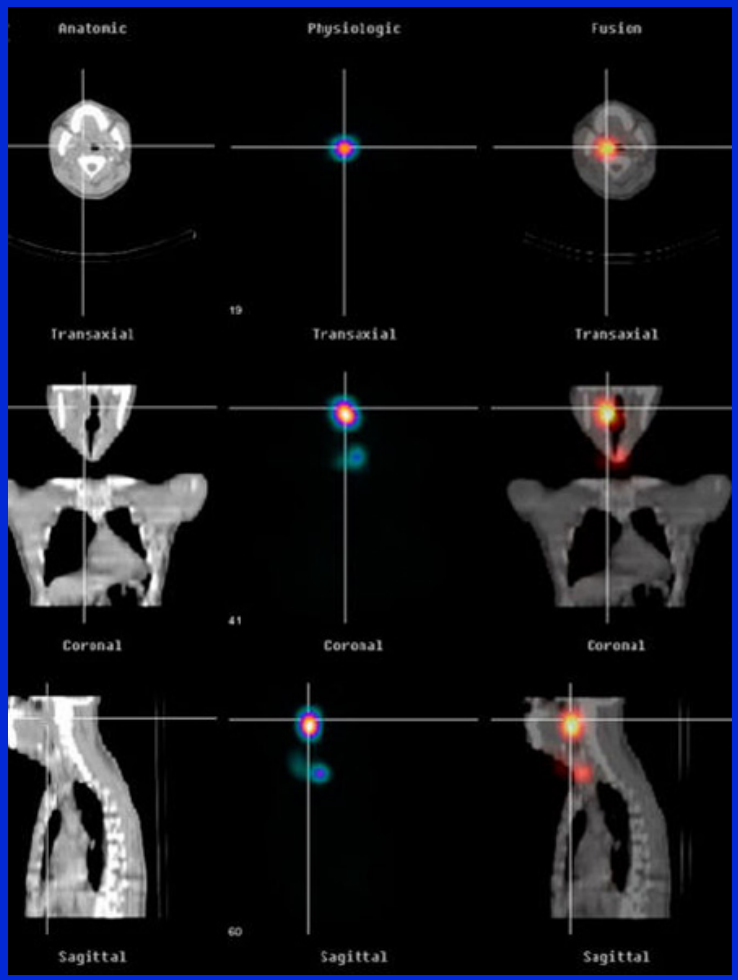
Methods used in head and neck cancers

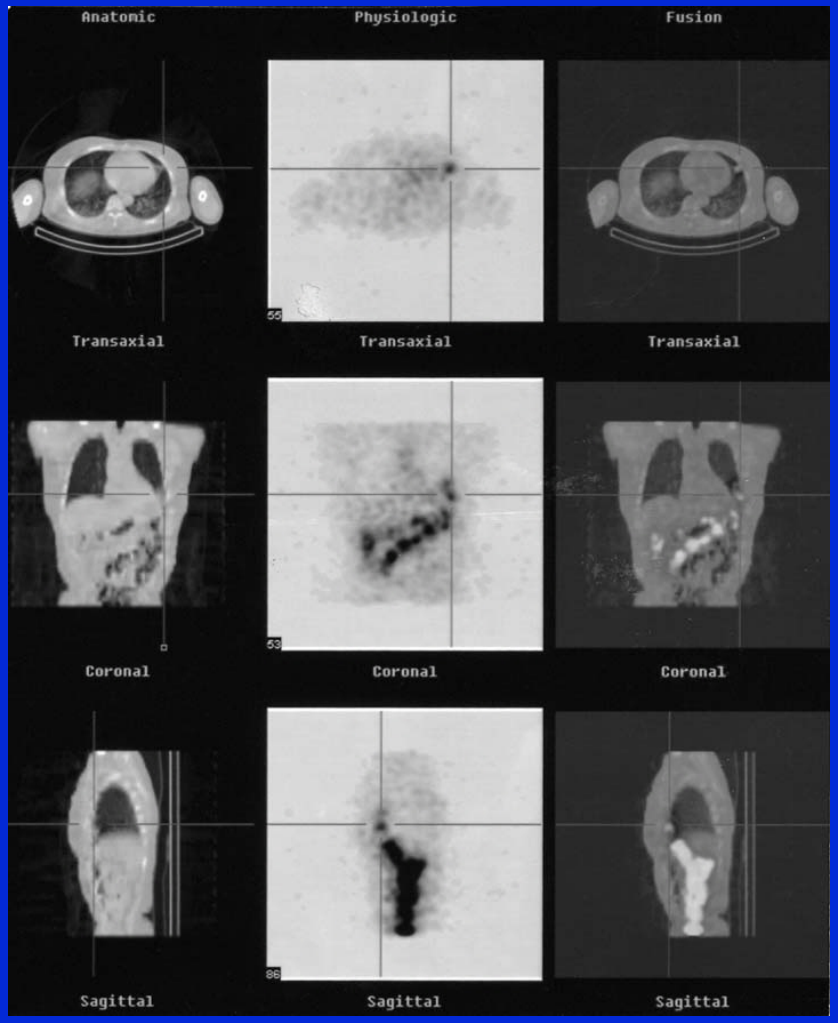
- I-123/I-131 in thyroid cancer
- Bone scintigraphy
- Tl-201
- Tc-99m MIBI/TF
- In-111 octreotide/MIBG
- PET

In thyroid cancer

- Can use I-123/I-132 SPECT to localise lymph node disease in neck
- SPECT-CT will help localisation
- Tc-99m MIBI/TF may also be useful (esp if Thyroglobulin increased but I-123/I-131 scan negative
- Also somatostatin imaging

I-131 SPECT-CT Barts

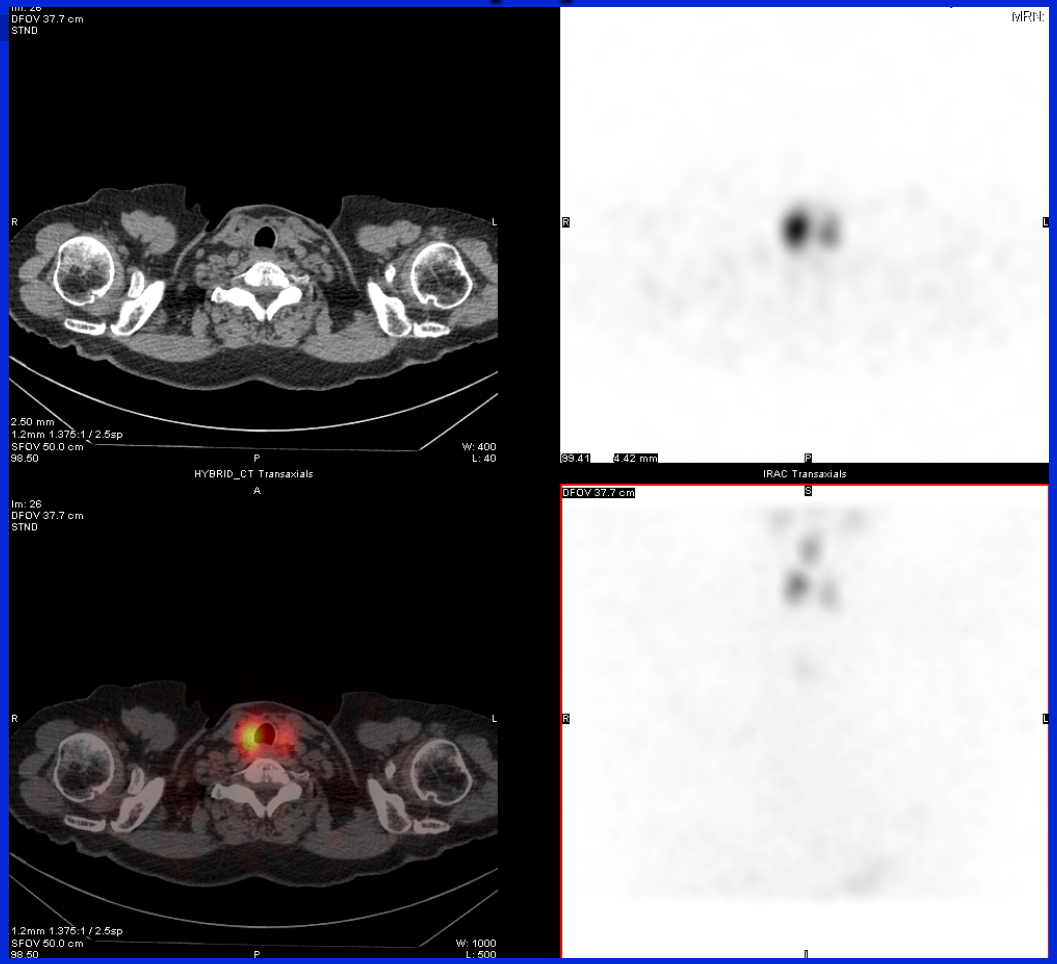




I-131 SPECT-CT post therapy

- Wong et al AJR 2010
- 48 patients with DTC had I-131 SPECT-CT of neck and chest as part of therapy with I-131
- 19 patients SPECT-CT different results than planar – most show physiological uptake eg oesophagus
- In stage 3 patients 4/8 increased number of mets found

Post I-131 therapy



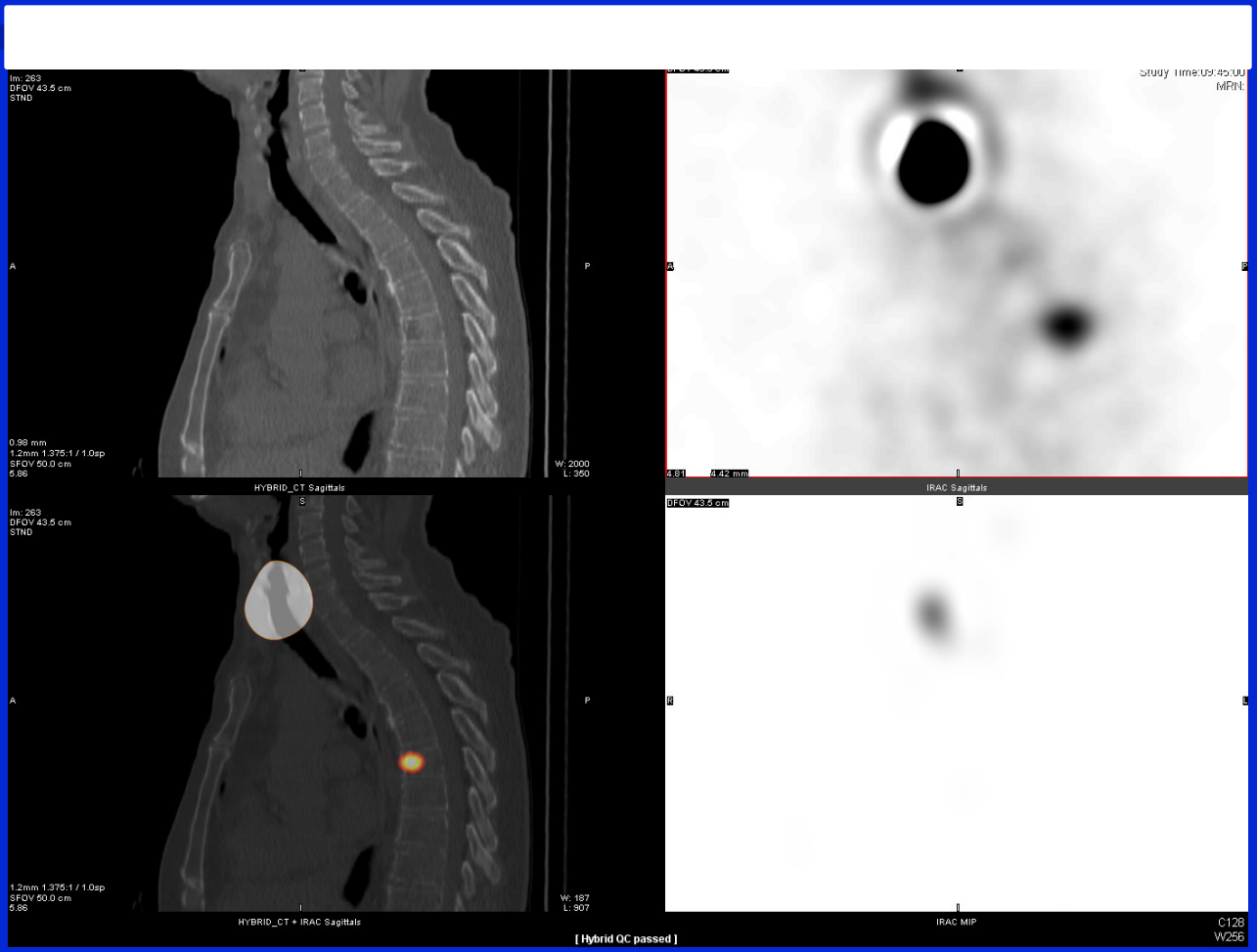
Post therapy I-131 planar

4 days post treatment
3.7GBq I-131

Whole body images

Where is uptake in neck

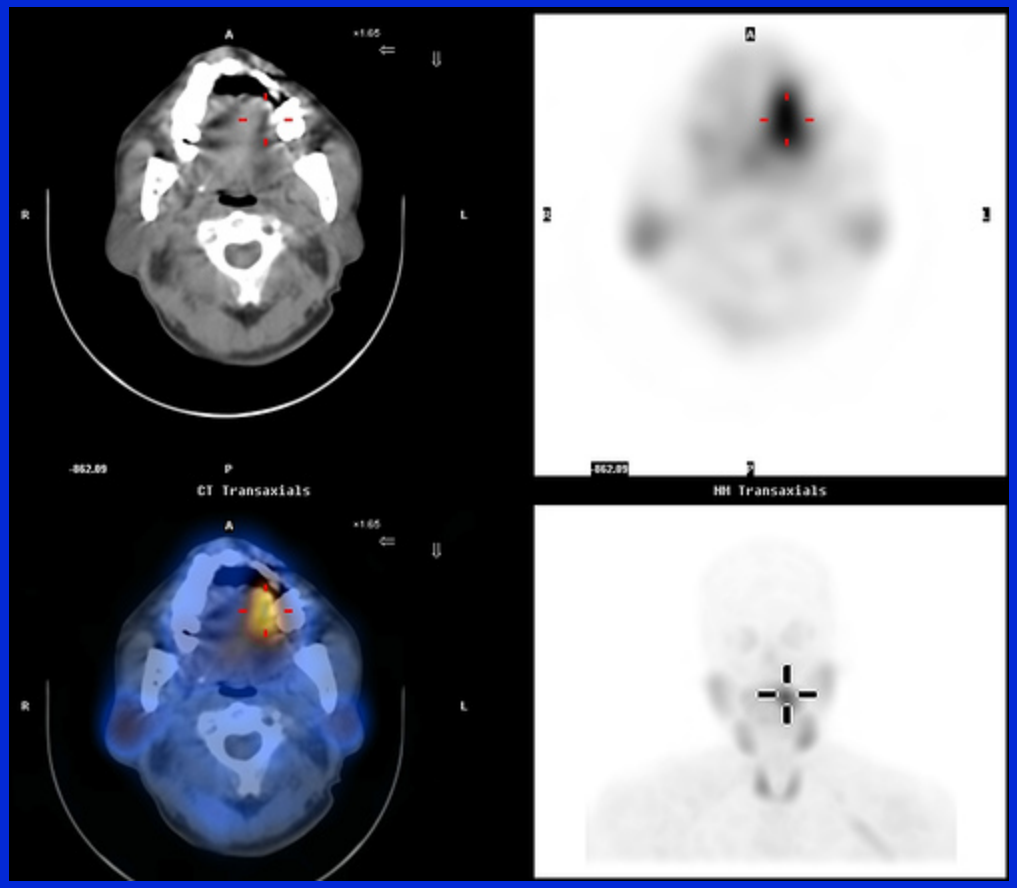
Therefore SPECT-CT used



Tl-201

- For many years used a tumour agent
- Activity is secondary to tumour metabolism
- However uptake into salivary gland tissue may complicate imaging
- SPECT needed
- Early imaging recommended

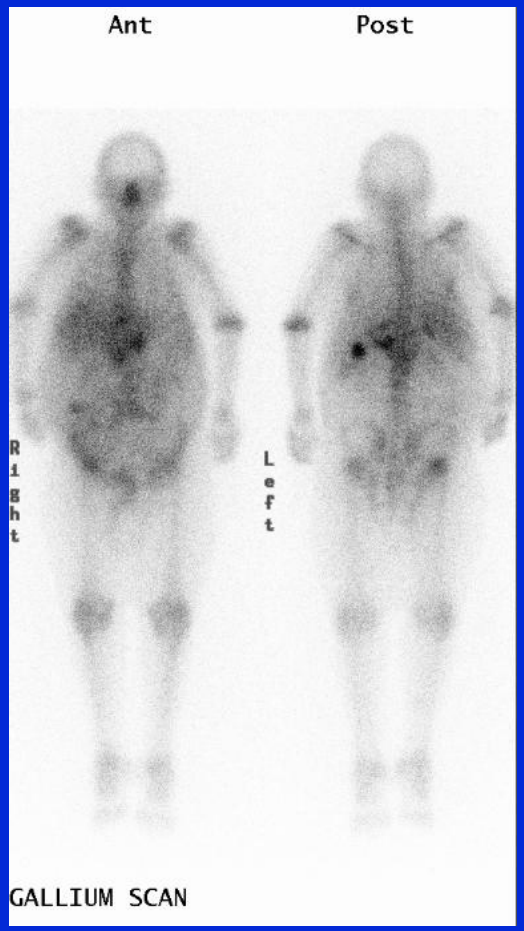
SPECT-CT Tl-201 in tongue cancer Taipei Uni Hospital

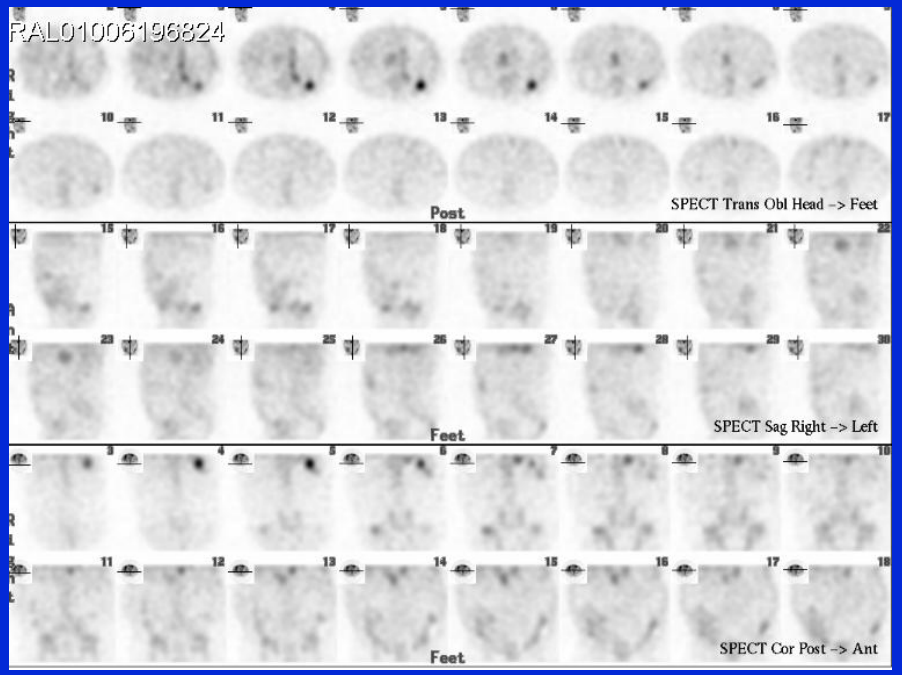


Which of the following agents can image lymphoma?

- Ga-67 citrate
- Tl-201
- Tc-99m MIBI
- Tc-99m tetrofosmin
- Tc-99m EDDA HYNIC octreotate
- Tc-99m DMSA (V)

Lymphoma with Ga-67 citrate



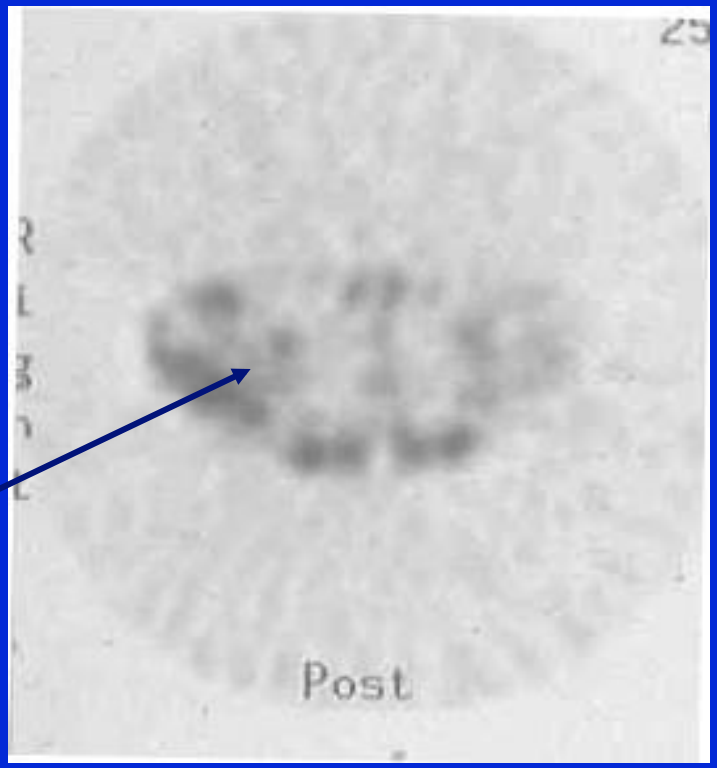


Lung tumours

- Often seen as best with PET
- However what happens if you have no PET scanner
- Your Pet scanner is broken
- You have a mixture of infection and tumour – both take up F-18 FDG
- Need more specific tumour imaging
  - Tc-99m MIBI/TF
  - Tl-201 (for KS)
  - Tc-99m depreotide

Patient with raised PTH

- Image formed as part of parathyroid study with Tc-99m MIBI-chest SPECT

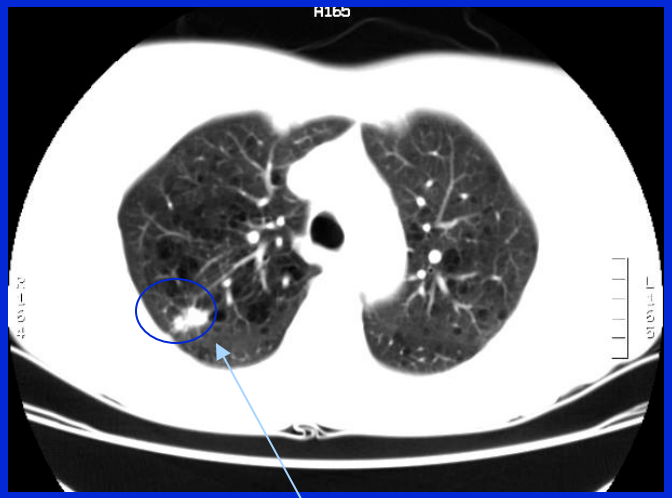


Tc-99m depreotide-NeoSpect

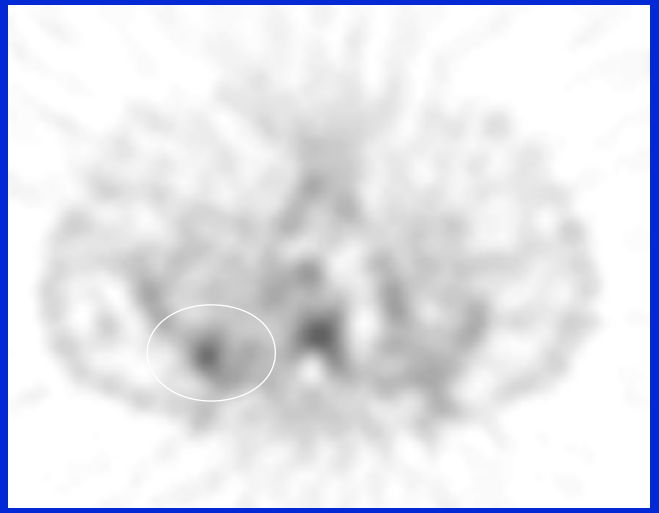
- New agent available from CISbio
- Able to identify NSLC
- Can be used to characterise pulmonary nodules seen on CXR/CT
- Uses Tc-99m label-does not need a PET machine-more cost efficient
- May prevent lung biopsy

62 year old female smoker

- Remote smoking h/o (30 pack year)
- Abnormal chest X-ray examination
- CT with SPN in right upper lobe
- Pathology 15mm moderatley differentiated
- Adeno Ca
- Surgery single lesion-no nodes

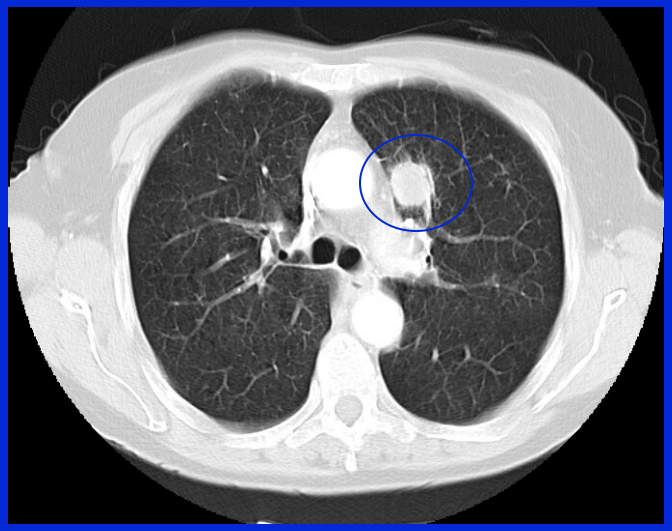


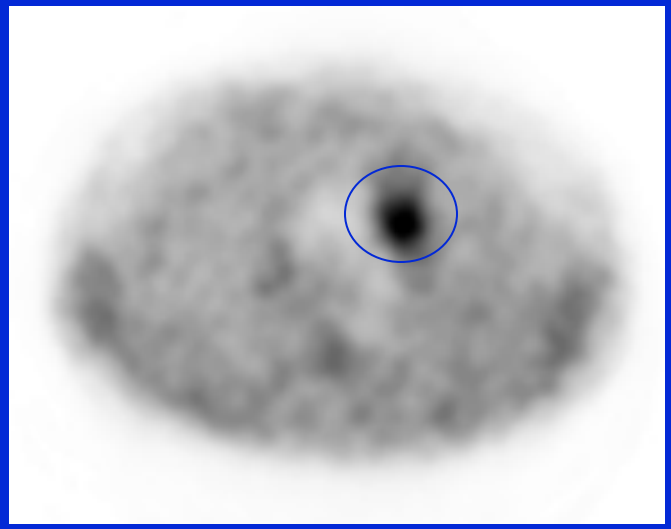
Spiculated lesion with pleural retraction



45 year old female smoker

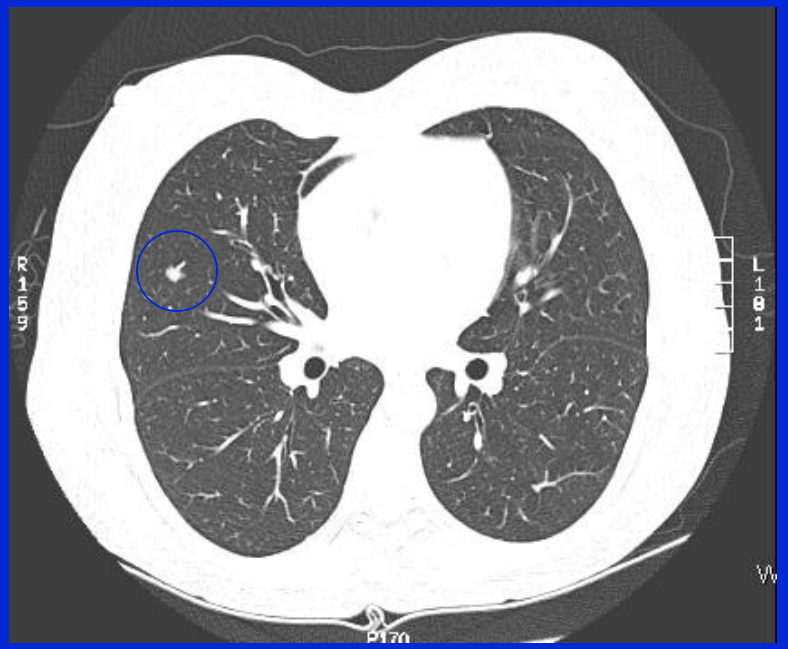
- Remote 30 year history of smoking
- Chest CT showing SPN in left upper lobe
- CT not typical of Ca-no nodes (prob 75%)
- Positive NeoSpect
- 23mm T1 well diff AdenoCa removed-no nodes

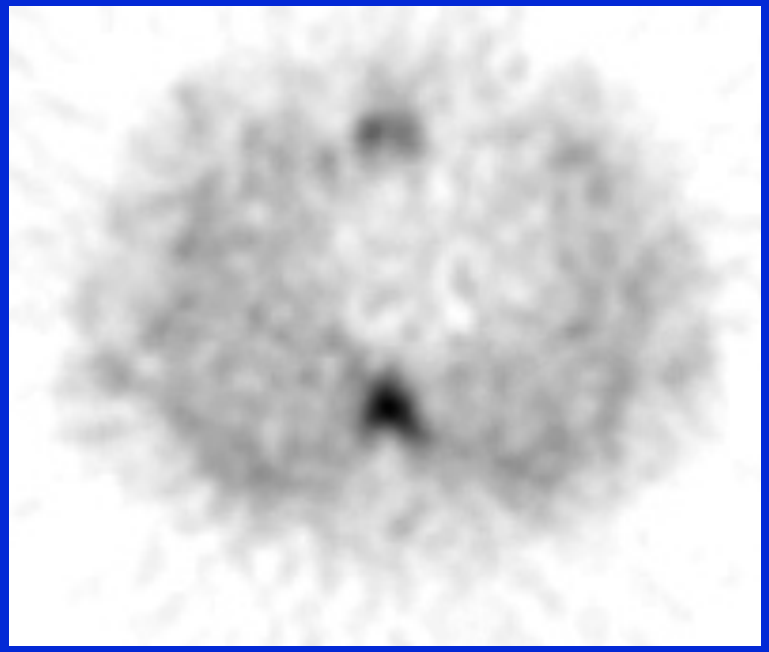




46 year old male smoker

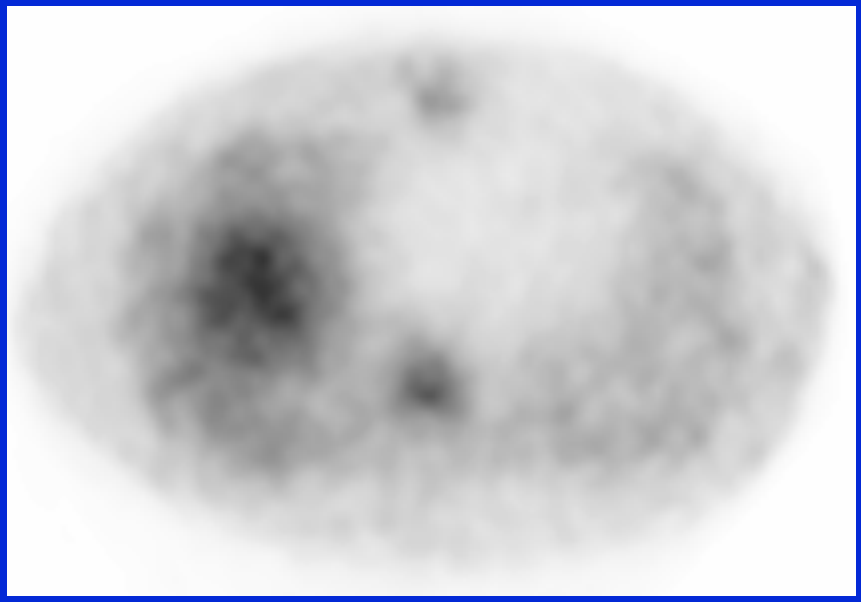
- 40 pack years
- Abnormal CT with SPN
- Equivocal characteristics
- Negative on Tc-99m NeoSPECT
- No change on CT over 2 years





39 year old smoker screening EBCT

- 39 years old remote smoker (39 pack years)
- Lives in Northern Georgia, USA (area endemic for histoplasmosis)
- Asymptomatic
- Abnormal EBCT
- Negative NeoSPECT
- Responded to appropriate treatment



Efficacy of NeoSpect™ in normal clinical setting:

(NeoSpect scan read in presence of the chest x-ray)

^{99m}Tc-depreotide and Chest X-ray	Histology: Pos	Histology: Neg
Pos	TP **75%** (n=85)	FP **6%** (n=7)
Neg	FN **2.6%** (n=3)	TN **16%** (n=19)

TP = true positive
FP = false positive
FN = false negative
TN = true negative

n=114

Sensitivity = 97%
Specificity = 73%
Agreement rate = 91%

Blum J et a. A Multicenter Trial with a Somatostatin Analog 99mTc Depreotide in the Evaluation of Solitary Pulmonary Nodules. Chest 2000;117:1232-38

Prostoscinct

- Directed to Prostatic Specific Antigen (PSA)
- Labelled with In-111 via DTPA
- Can identify Ca prostate primary and mets
- Needs much image manipulation and SPECT
- Used in the USA

Why Do we need it

- The treatment of prostate cancer is either curative or palliative
- If an MRI shows local invasion or a bone scan metastases then patient can only have palliative treatment
- Problem pelvic nodes may not be fully characterised by MRI
- F-18 FDG PET does not work in prostate cancer

In-111 Capromab pentride

- Proper name for Prostascinct
- Up to 150MBq injected (300 MBq in USA)
- Imaging can take place over 72 hours
- Need to consider catheter, frequent voiding
- SPECT imaging always useful
- New work with PET-CT

Prostascint

- Up to 95% of all studies find relevant lymph nodes, though in some studies sensitivity drops to 60%
- Compares to 4% CT and 15% for MRI
- Some cross reactivity with lymphoma noted!
- Better for nodes than bone metastases

Prostascint study

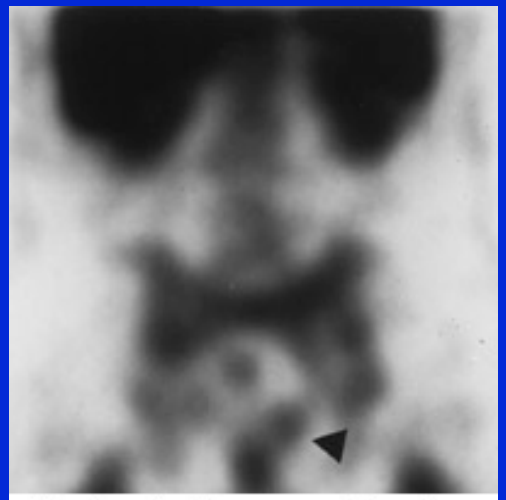


Fig 1. — Radioimmunoscintigraphy showing a coronal SPECT image of the abdomen and pelvis in a patient recently diagnosed with prostate cancer at relatively high risk for metastasis (PSA 34, Gleason score 7). Abnormal uptake (arrow) was confirmed to be metastasis on laparoscopic pelvic lymph node dissection.

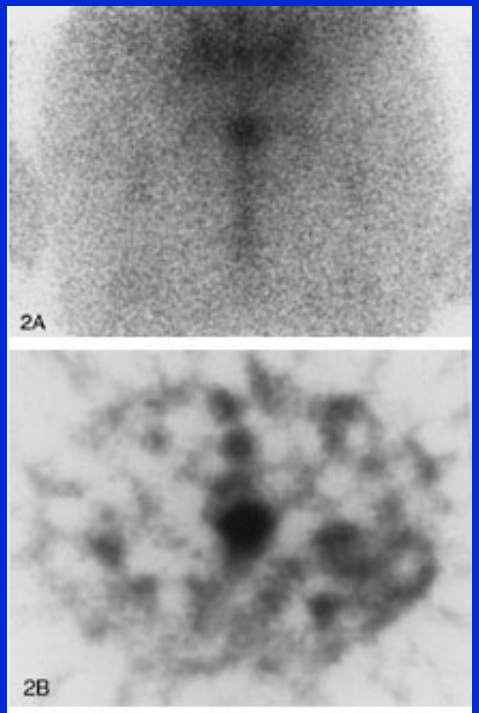
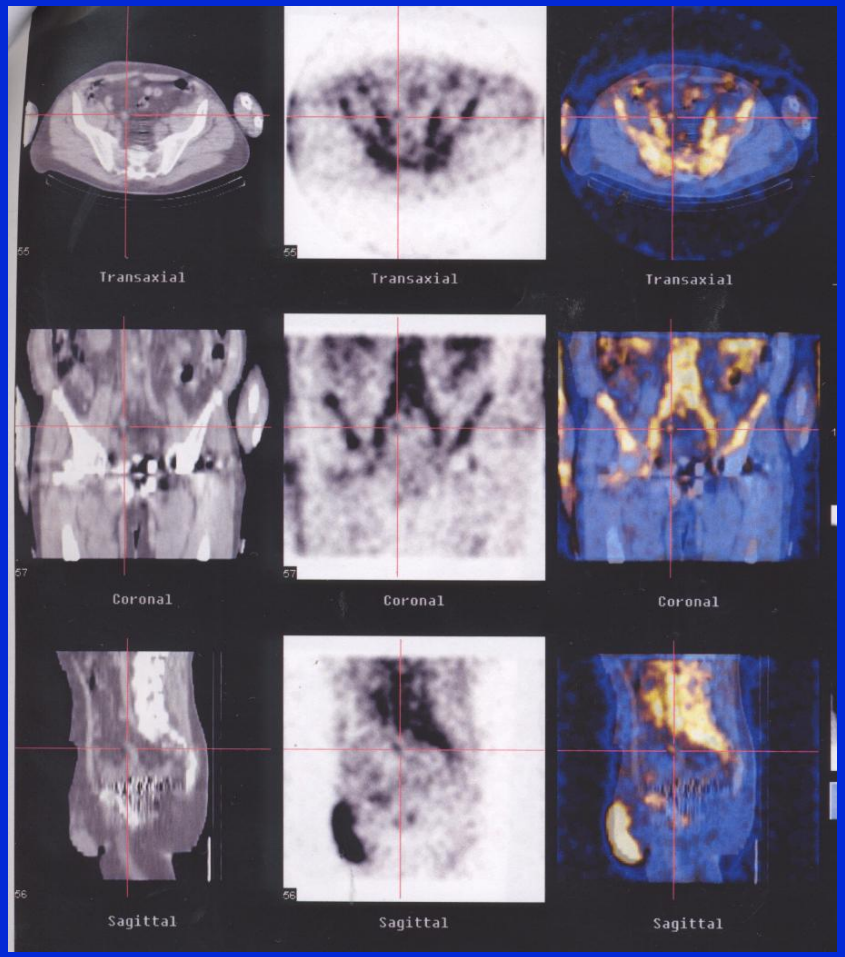


Fig 2A-2B. — (A) Planar and (B) SPECT of the pelvis demonstrating increased radioimmunoscintigraphic uptake in area of previous prostatectomy in a patient with rising PSA.

Manayak et al Cancer Control 1998

Hawkeye SPECT-CT image Barts



CEAscan

- Like leucoscan and engineered Fab'_2 murine antibody labelled with Tc-99m
- Directed against CEA (carcinogenic embryonic antigen)
- Used in Ca Colon, Ca Rectum
- Some new work on Ca Breast and Ca Pancreas
- Available in UK

CEAScan in the age of PET

- Does not need a PET scanner
- More specific less uptake in other pathologies
- Work in mucinous colon cancer where PET often negative
- May work on Ca pancreas, Ca breast and NSCLC
- Not blocked by circulating CEA

CEAscan in Ca colon

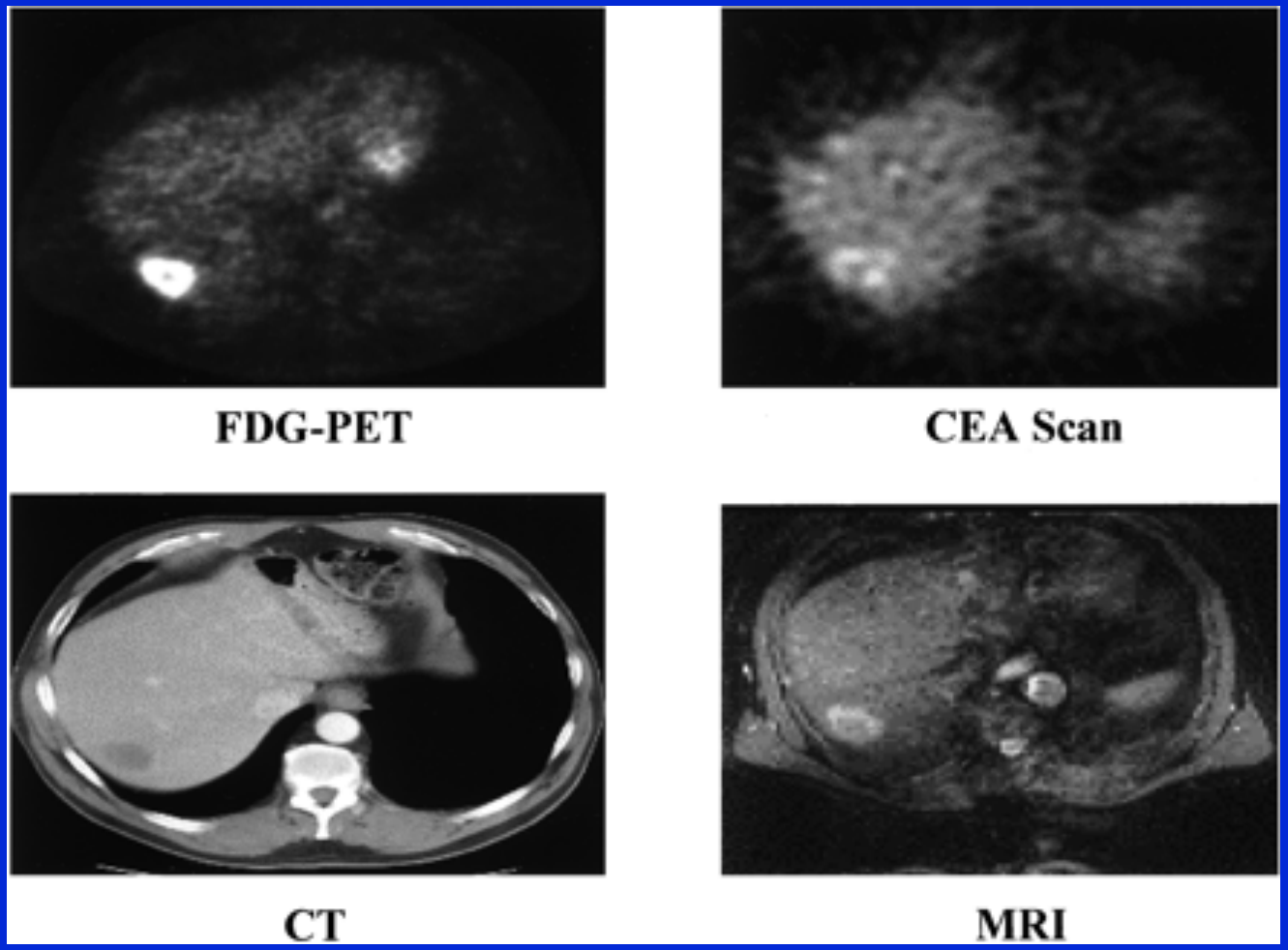
F-18 FDG PET
negative

Tc-99m CEAscan
positive

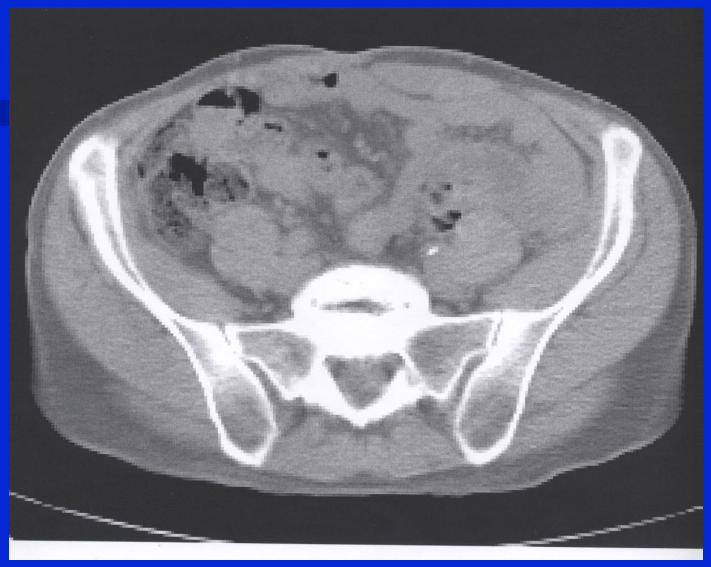
Imaging with CEA scan

- Can give up to 1000 MBq
- Tc-99m Fab' murine antibody
- HAMA rate small
- Planar and SPECT imaging at 1 and 4-6 hours
- May need to consider catheter/squat views
- Correlation with CT useful
- Again will benefit from SECT-CT

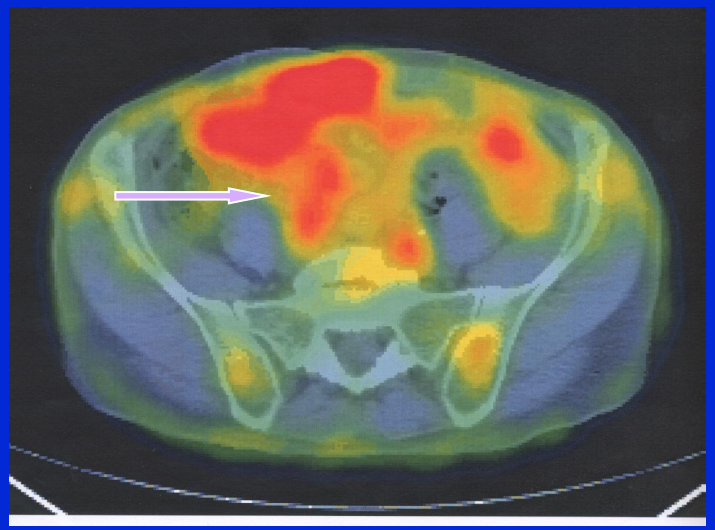
PET and CEA Scan (Libutti et al)



CEAscan in Ca colon



F-18 FDG PET negative, CT unhelpful

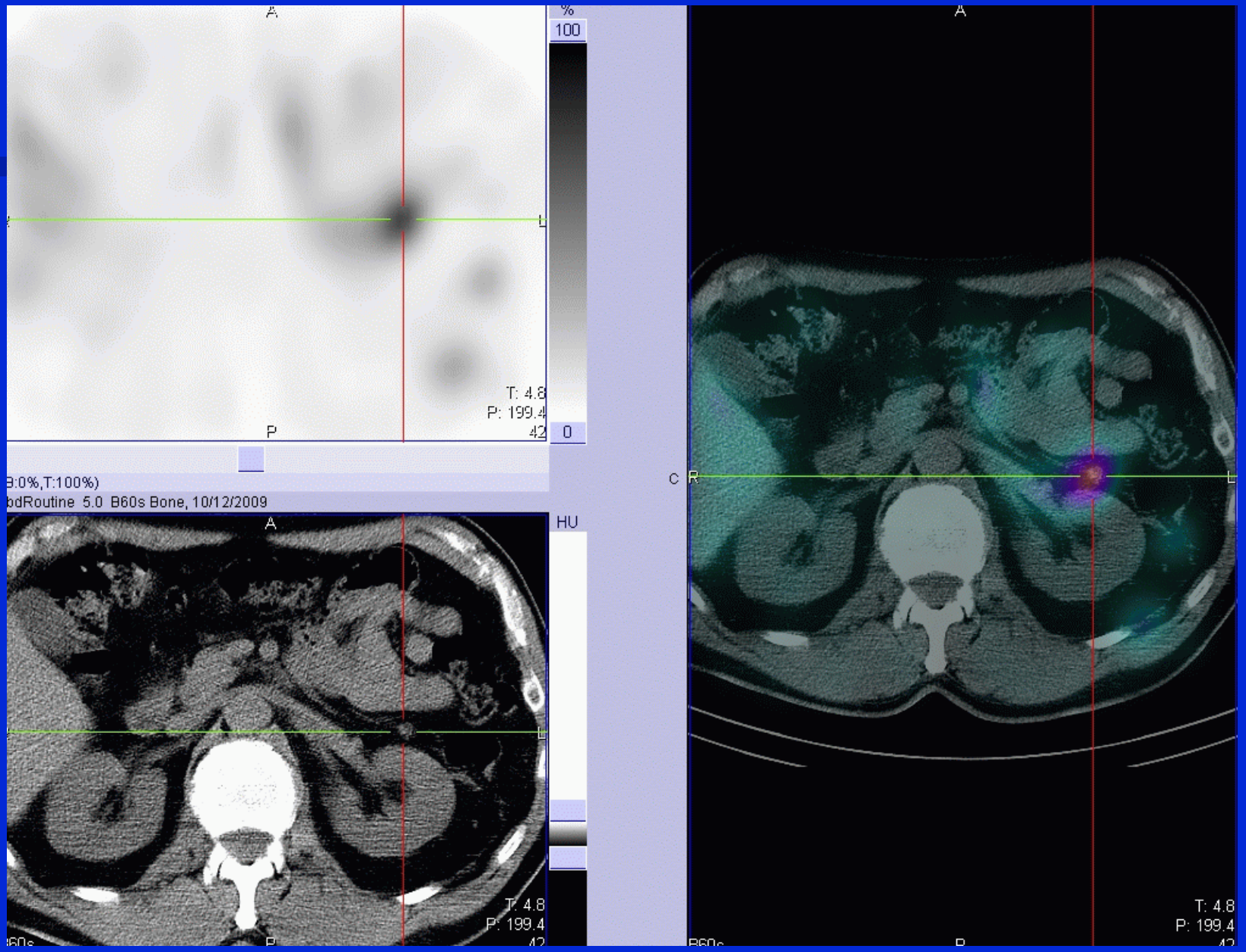


Tc-99m CEAscan positive in mesenteric lymph node and small bowel

I-123 mIBG

- SPECT imaging
- For MCT head and neck SPECT
- For NETs/pheo/neuroblastoma liver and upper abdomen
- Or SPECT-CT

Malignant Pheochromocytoma



Summary

- Single photon is not dead
- Pictures may not be so pretty but there is almost no tumour that cannot be imaged by use of single photon agents
- SPECT and SPECT-CT have helped increase the range of tumours that can be imaged
- New agents like Tc-techtate may help