Infection and inflammation

John Buscombe

Infection and inflammation

- The two cannot be separated by bone scanning
- Sensitive but not specific
- Two or three phase bone scan may help
- Infection
  - Spontaneous
  - Malunion of fracture
  - Around prosthetic joints

Imaging infection

- Three phase bone scan
  - Arterial phase, 1 sec frames 30-60 secs
  - Looks at increased blood flow
  - Blood pool phase looks at cap dilatation
  - Images 2-5 mins
  - Static phase looks bone metabolism
  - Sensitive but poor specificity
  - Very good for vertebral OM/discitis
  - May not need first phase

3 phase bone scan

Disease	Dynamic	Static
Osteomyelitis	Pos	Pos
Cellulitis	Pos	Neg
Non infected Bone	Neg	Pos

False positives in 3 phase bone

- Recent but treated infection
- Fracture
- Non-infected malunion
- Inflammatory arthritis
  - Look for synovial uptake
  - Could be septic arthritis

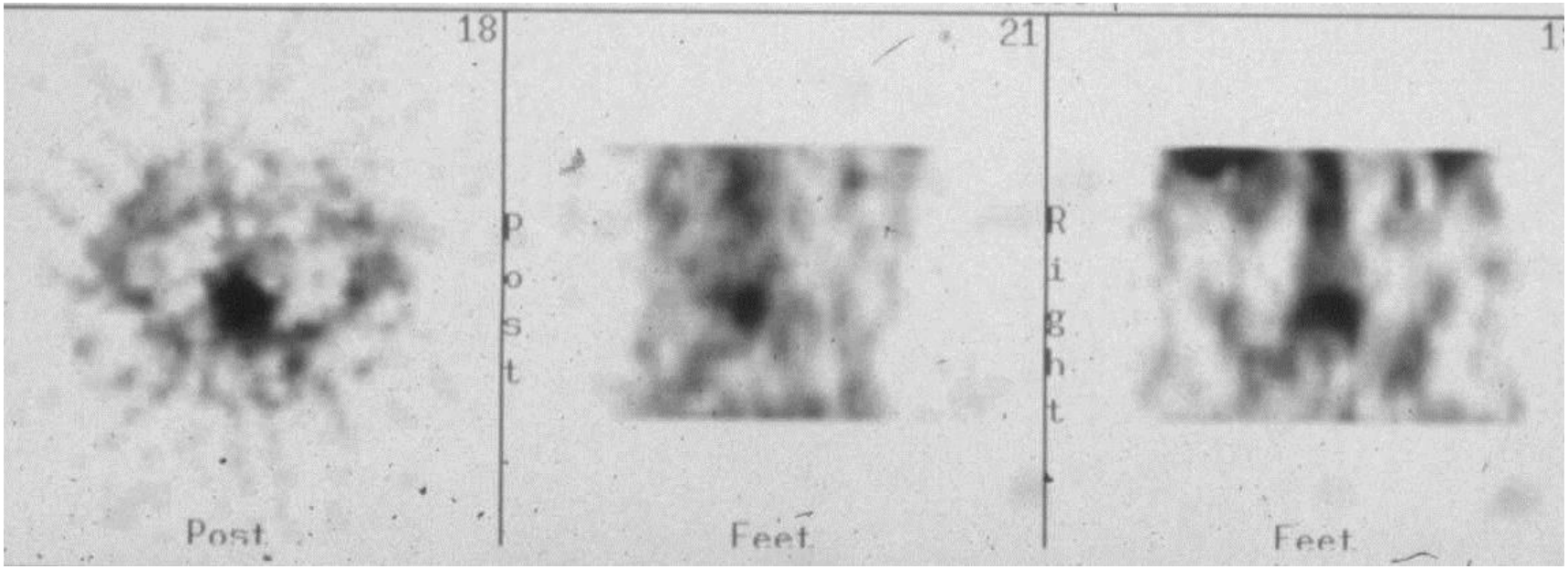
Need for more specific agents

- Ga-67 may have uptake in fractures, low grade uptake in normal bone and BM
- Labelled WBCs High sensitivity and specificity, not good in vertebral infection
- HIG Ok for arms and legs
- AGAB generally good
- PET non-specific but excellent localisation
- Prosthetic joint may be different
- Charcot’s joints difficult

Ga-67 in bones

- Will be very sensitive
- Problem with imaging as counts can be low in periphery
- Imaging out to 7 days possible
- Some uptake in metabolically active bones
- May be best for vertebral infections
- SPECT possible

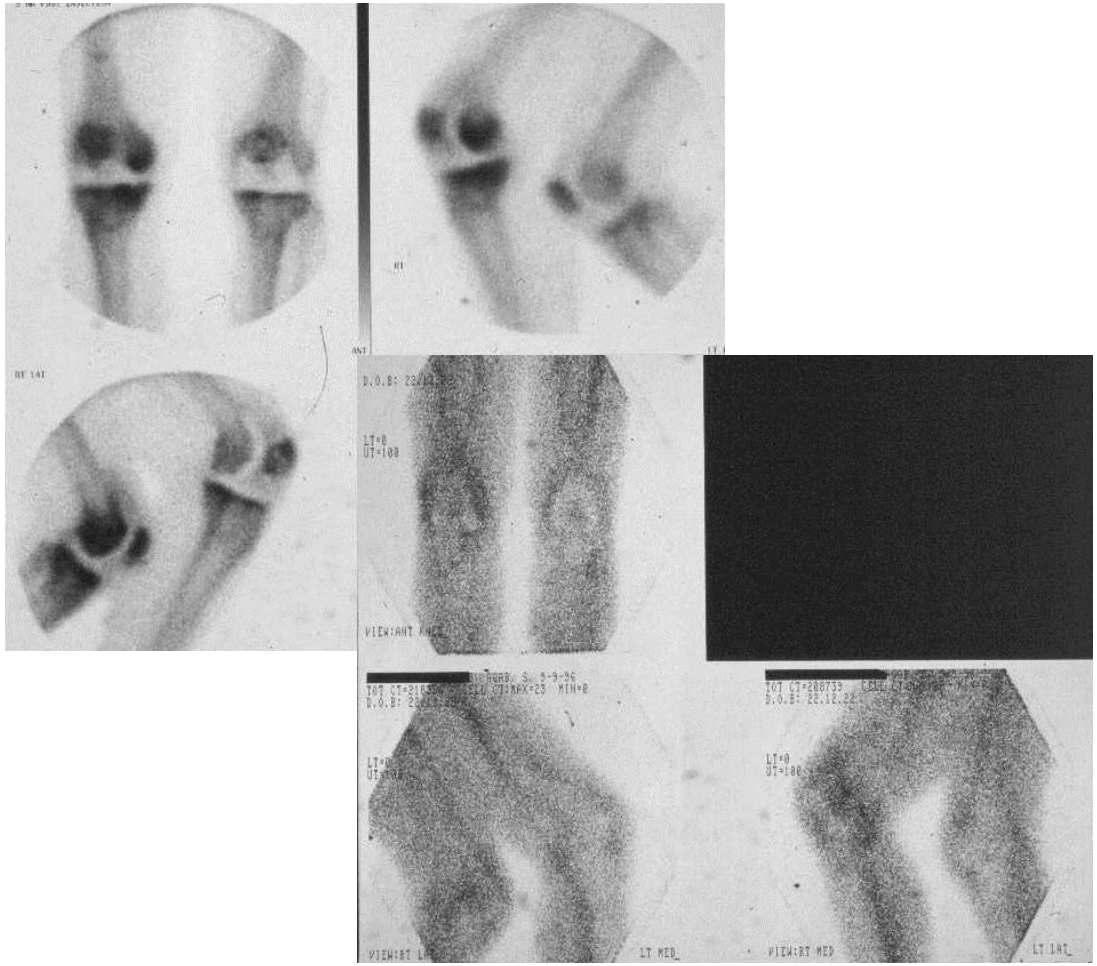
Ga-67 in E.coli spinal OM



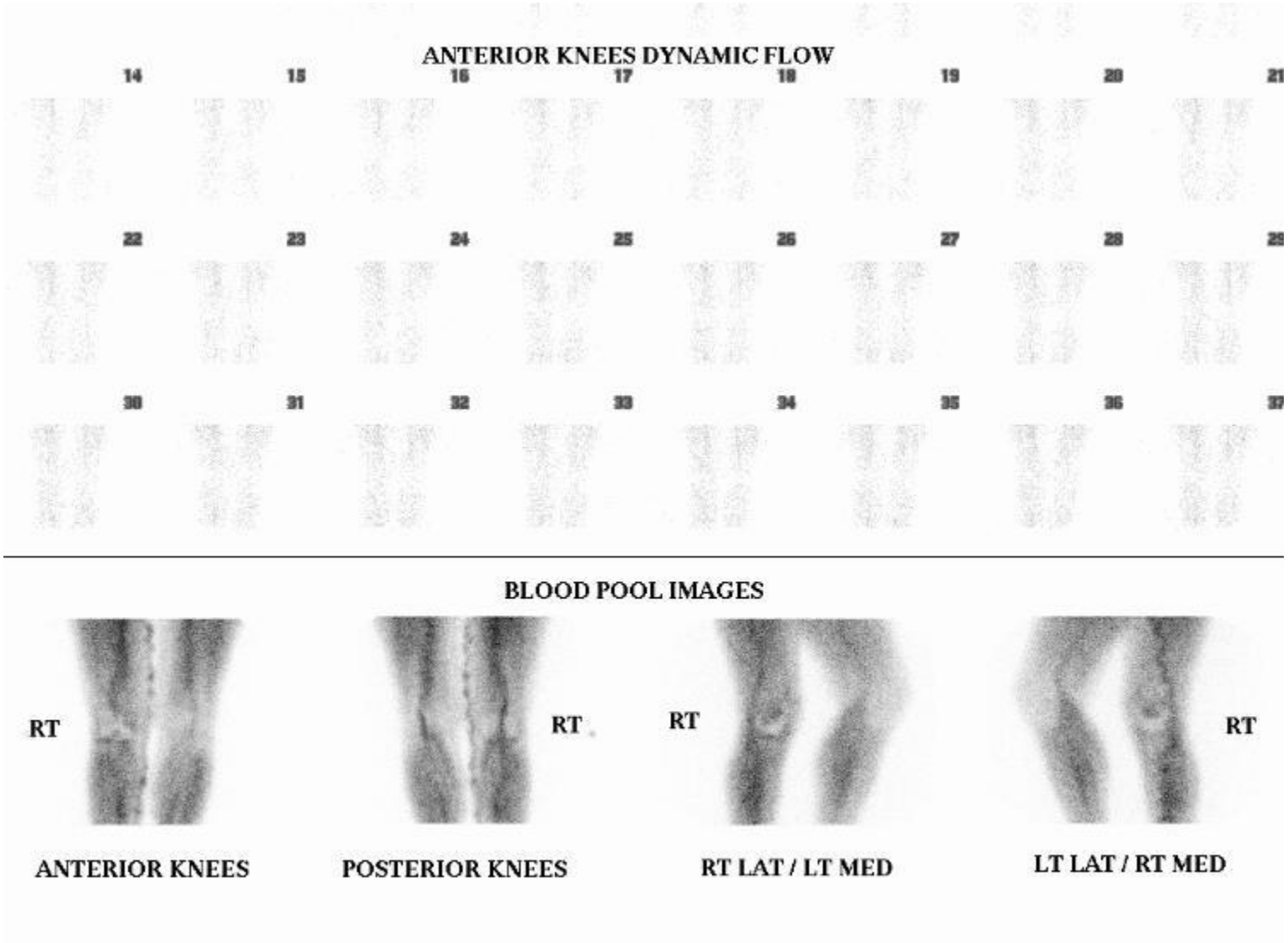
Prosthetic joints

- Need to exclude infection
- Radiology little help
- CT and MRI affected by metal inplant and cement
- Bone scan negative means infection unlikely
- Knee different from hip
- Cemented different from uncemented

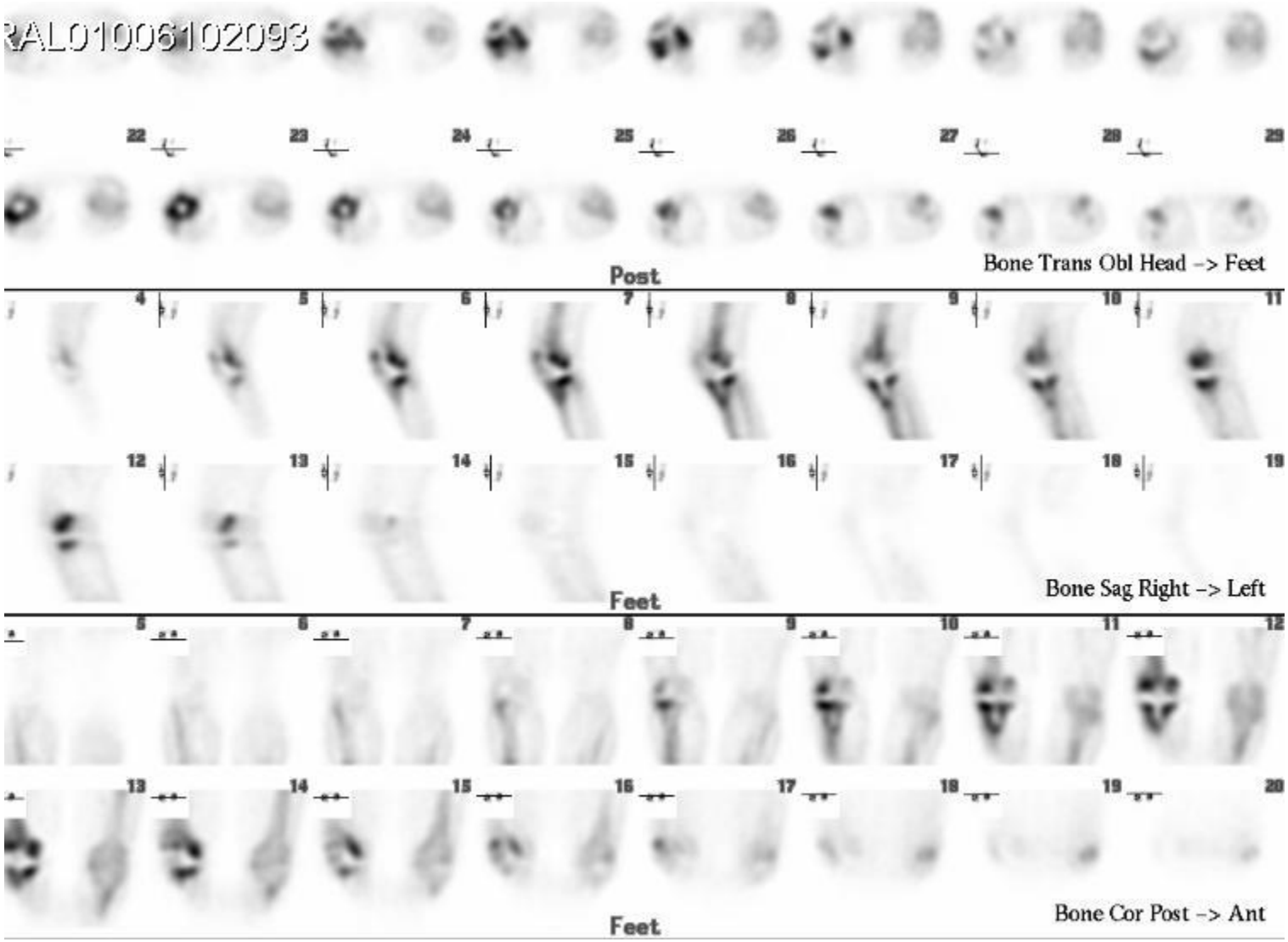
?infected knee or synovitis



? Infected TKR

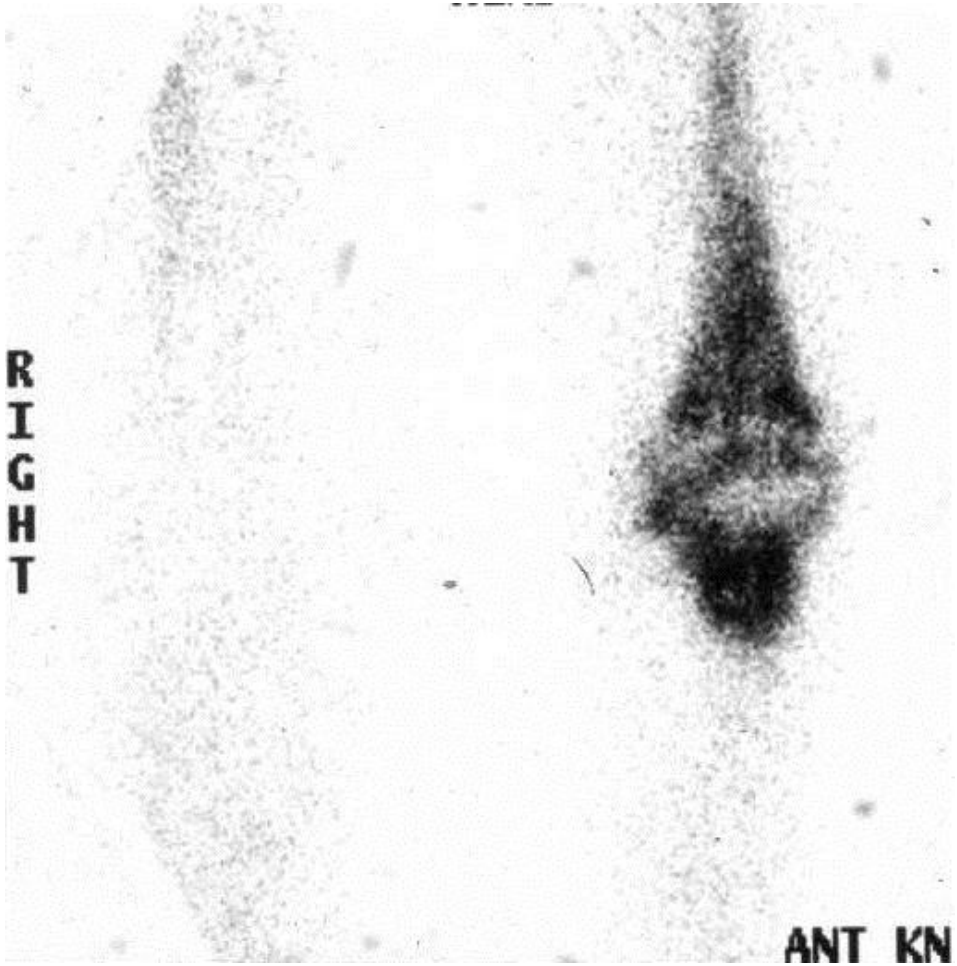


?infected TKR-SPECT

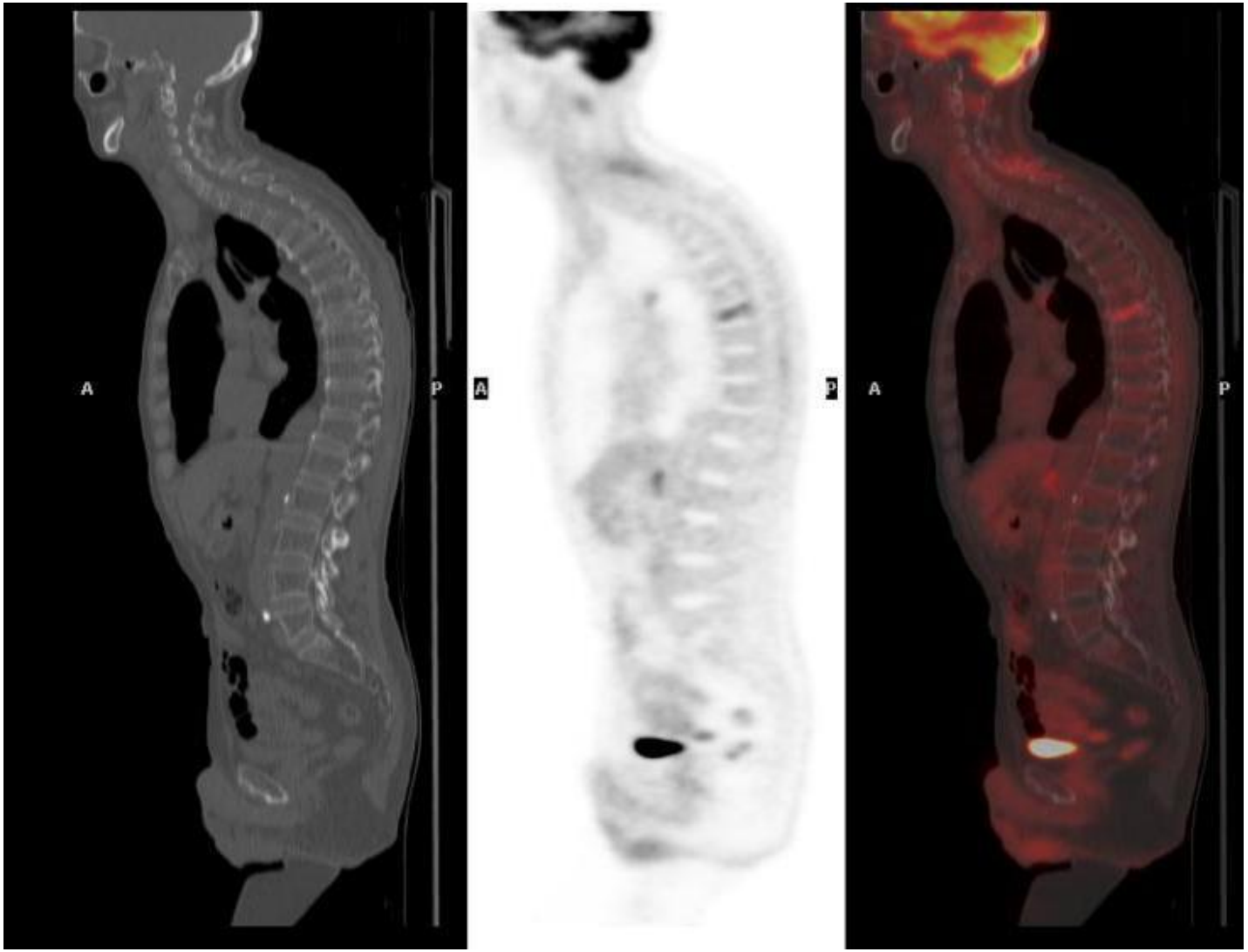


Ga-67 in infected TKR

Infected knee
Tc-99m HMPAO WBCs



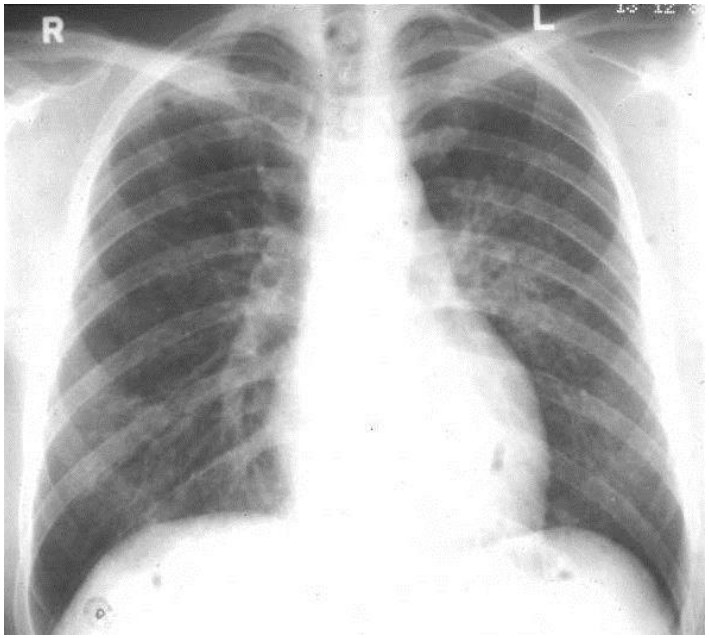
Spinal TB and Pott's

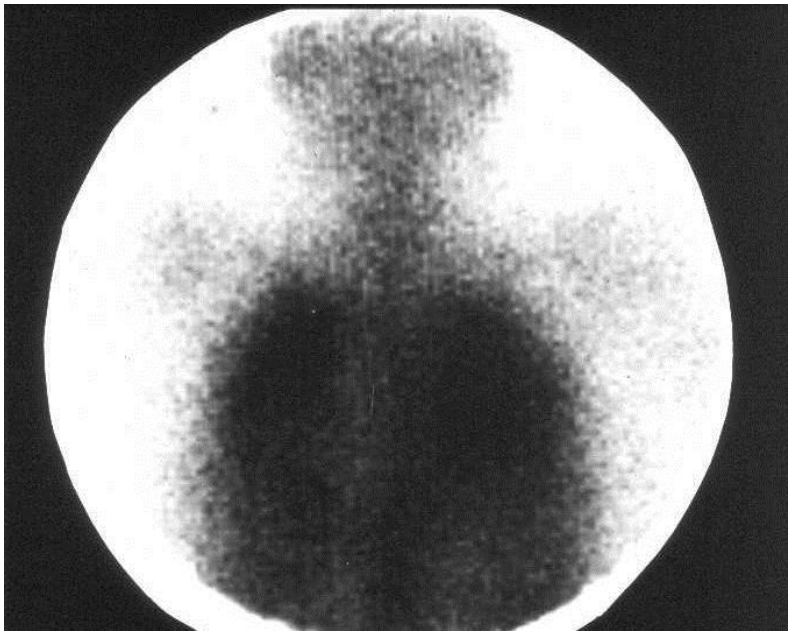


Chest Ga-67

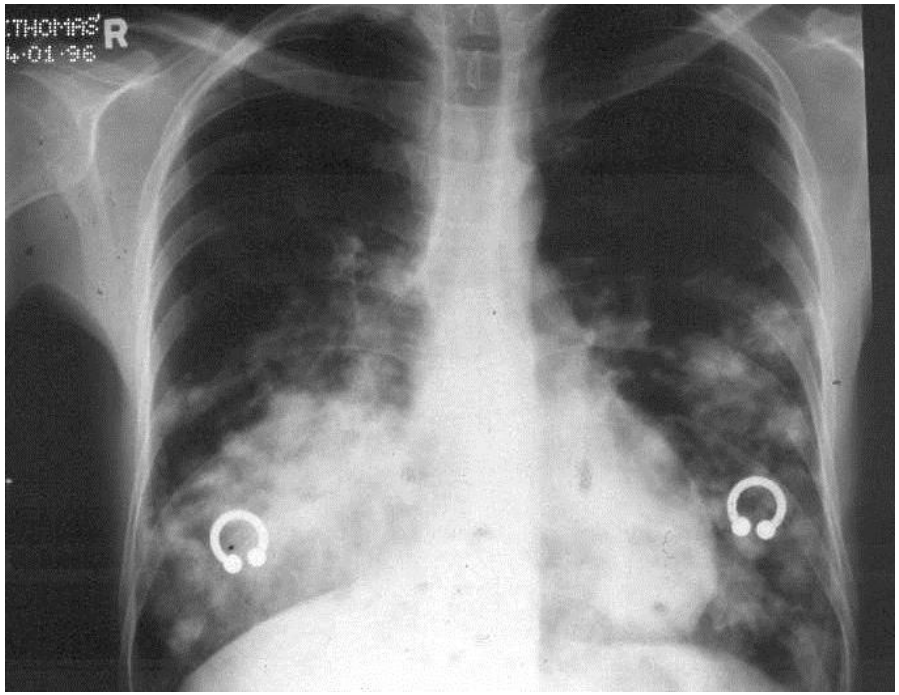
- Maybe most commonly used test
- Does not depend on WBC function
- May be best in TB
- However uptake non-specific
- In HIV Bowel uptake very intense-no pathology
- May be looking at more than one pathology

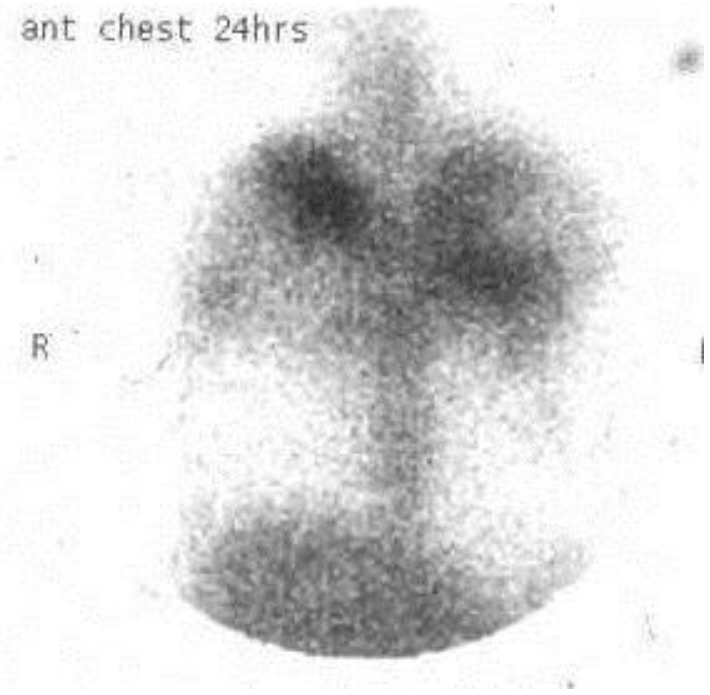
Ga-67 in AIDS



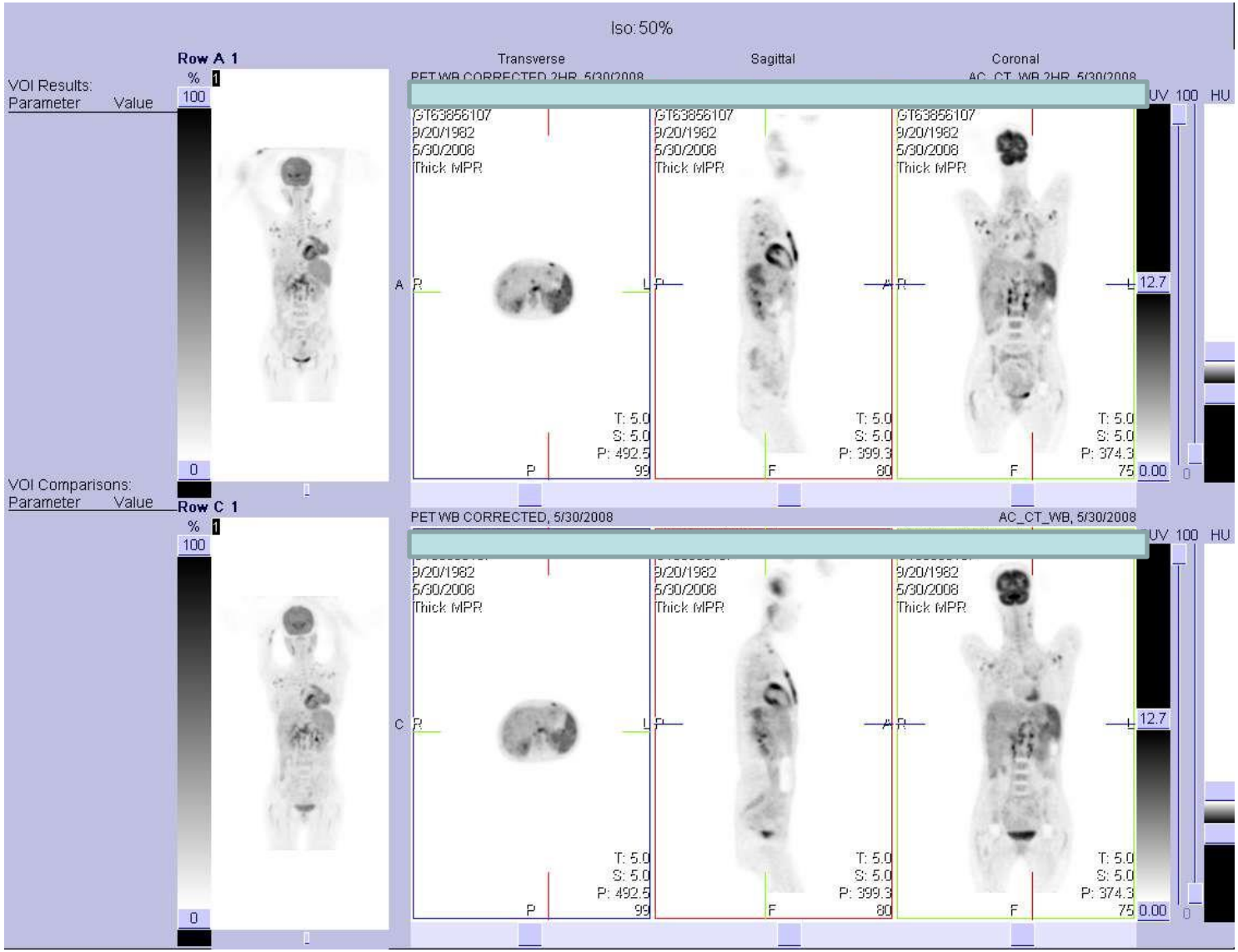


Ga-67 in PCP and KS



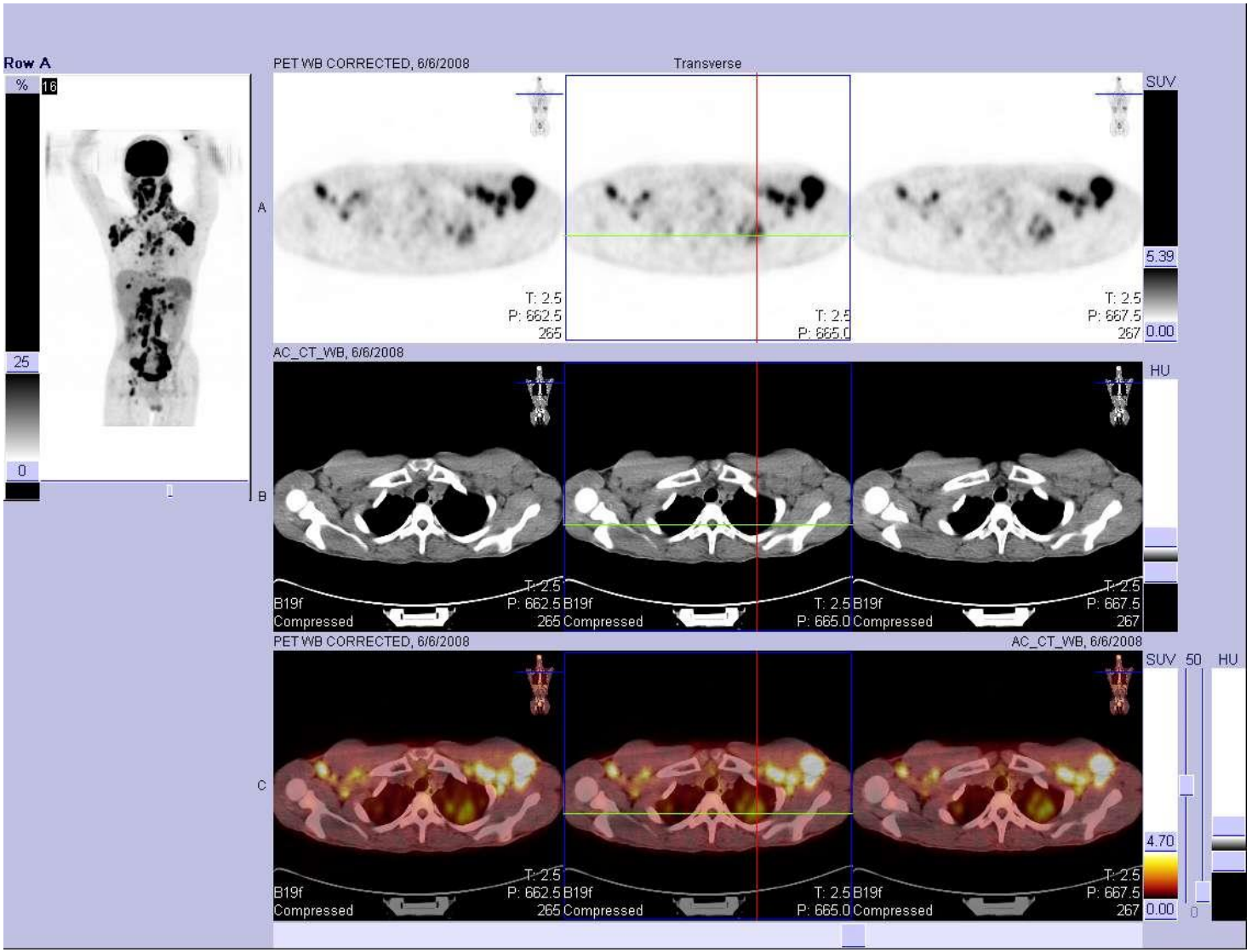


Dual Time F-18 FDG Imaging



M. Sathekge Steve Biko Hospital

F-18 FDG PET-CT



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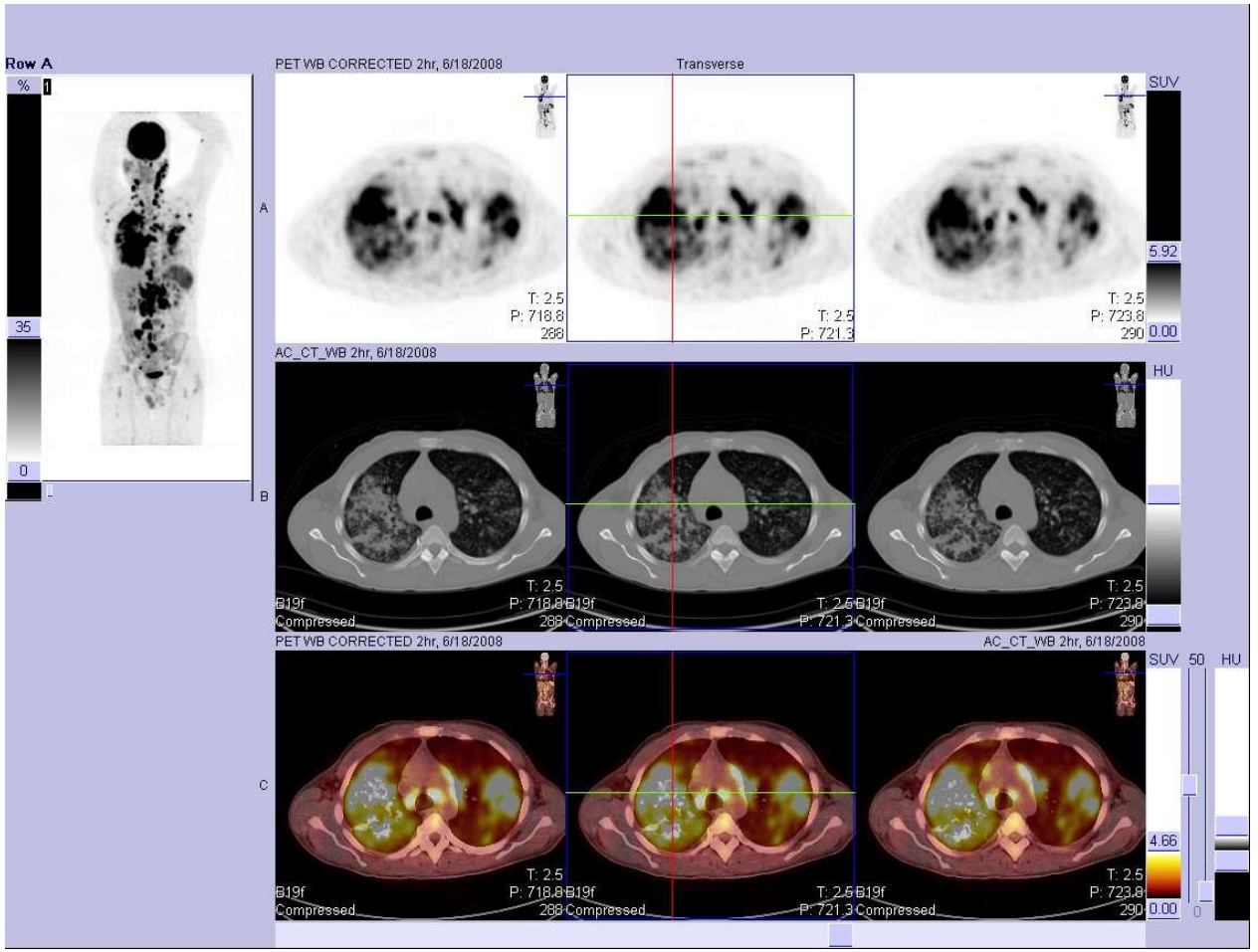
F-18 FDG in TB



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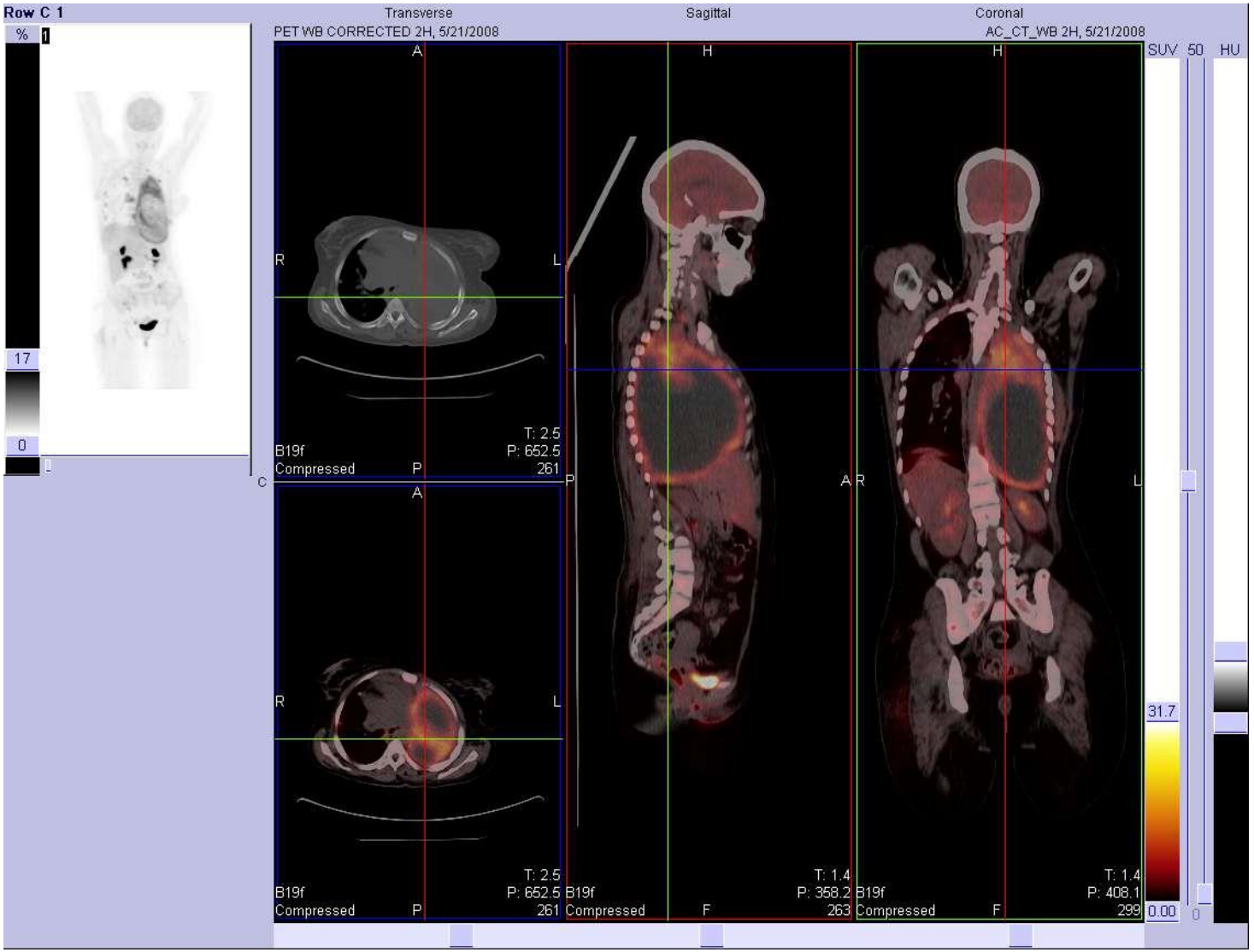
F-18 FDG lung abcess



M. Sathekge Steve Biko Hospital

Inflammatory bowel disease

- Still probably underused
- Can be used to aid establishing diagnosis
- Esp small bowel Crohn’s
- Mostly used for follow-up
  - ?post op adhesions or reactivated IBD

IBD-agents

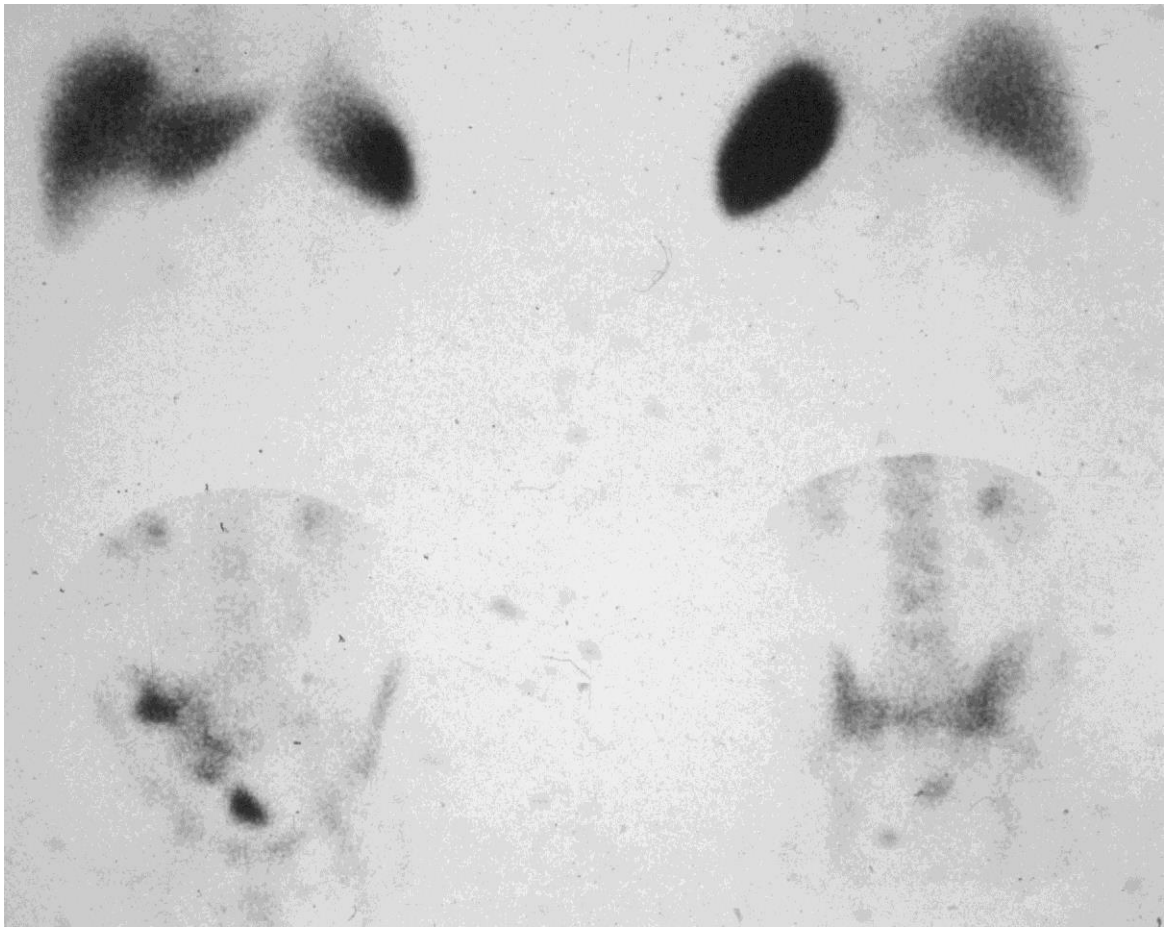
- Ga-67
  - Too non specific
- In-111
  - High sensitivity and specificity imaging at 4 & 24 hours, quantifiable
- Tc-99m HMPAO
  - High sensitivty and specificity, imaging 1 & 3 hours, semi quantifiable
- Best of the rest
  - Antibodies not proven maybe Tc-99m Il2

The big battle

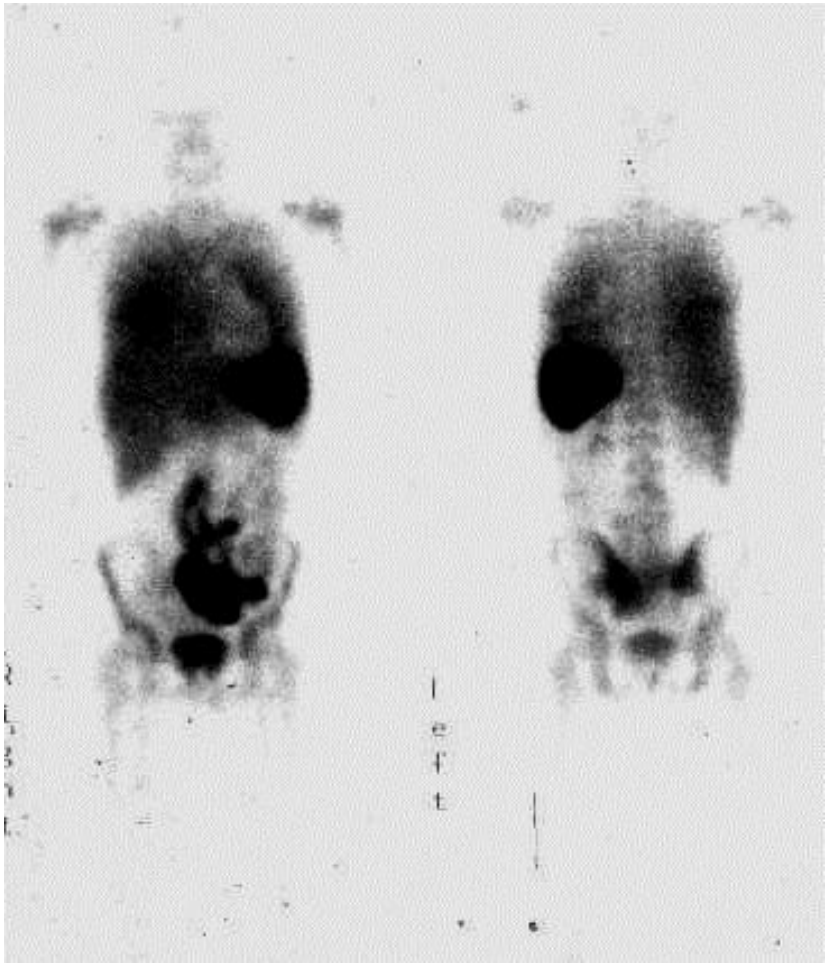
- In-111 WBC
- High accuracy
- NO bowel activity
- Years of experience
- Faecal In-111 activity over 48 hours quantifies disease activity

- Tc-99m HMPAO
- High accuracy
- Imaging 1 & 3 hours
- Low dosimetry
- Semiquantification possible
- Years of experience

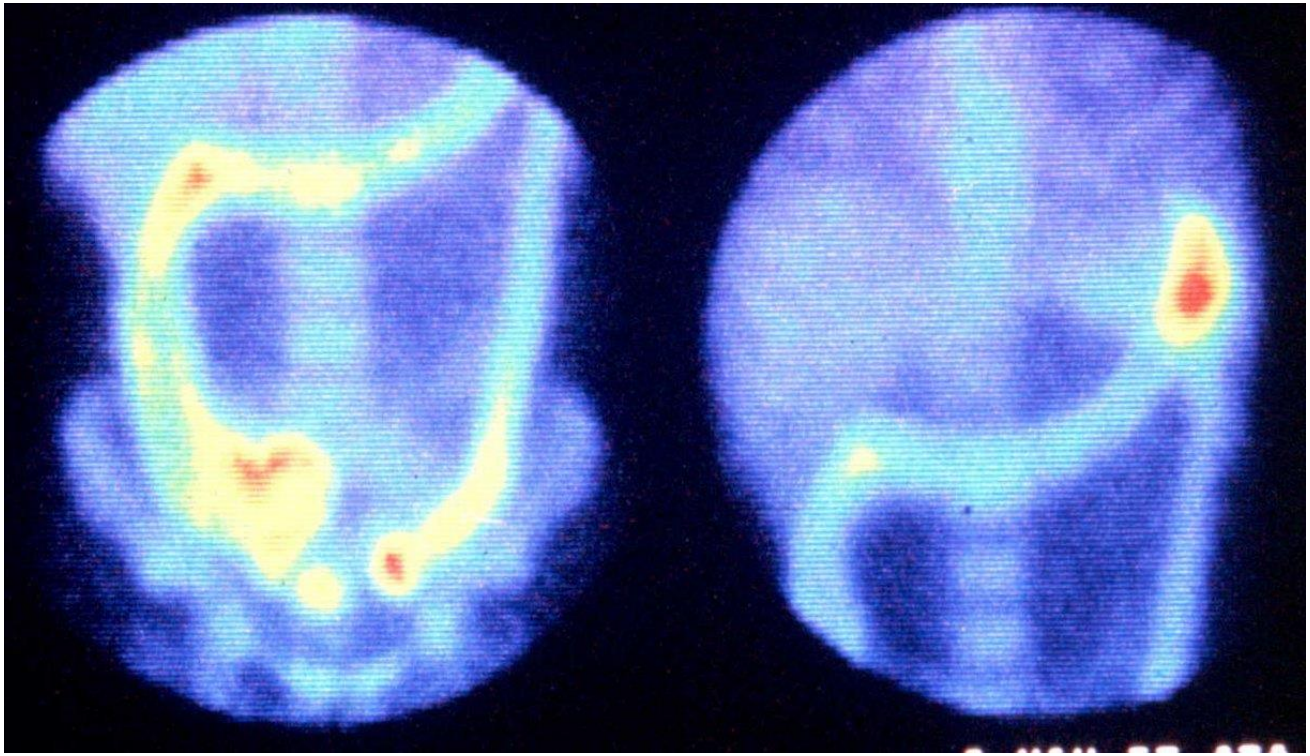
In-111 WBC in IBD



Small bowel Crohn's



Tc-99m HMPAO WBC in UC



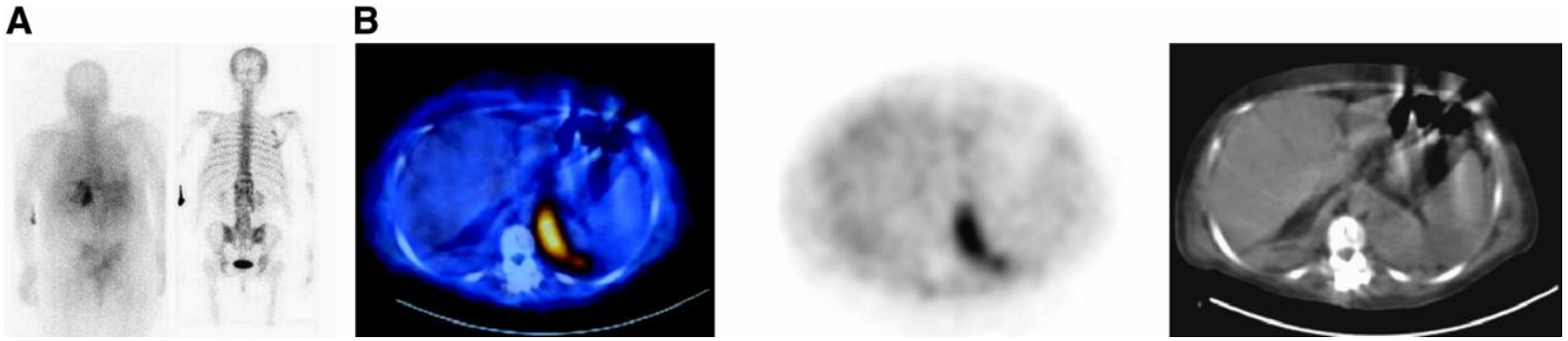
IBD-special cases

- With Tc-99m HMPAO WBCs
- Later imaging will find Crohn's abscess
  - Activity in bowel moves, abscess does not image up to 24 hours
- Pelvic disease
  - Do squat/outlet view
- Connecting abscess
  - Focal area of uptake adjacent to bowel that then decreases or disappears

PUO SPECT-CT

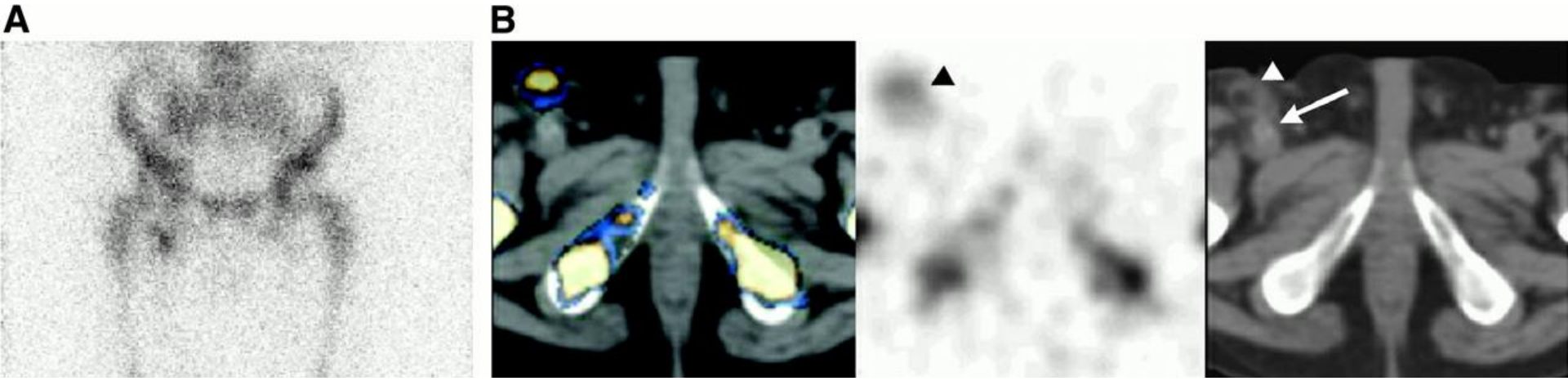
- Roach et al 2006 NMC
- Looked at 50 scans including bone and Ga-67 SPECT-CT
- 16% of patients had minor change 11% major change c/w SPECT alone
- Almost all to do with localisation and improved specificity
- Specificity itself improved by 26%

Bar-Shalom et al JNM 2006



SPECT/CT for suspected bone infection on GS. A 56-y-old woman presented with fever, low back pain, and infected scar 1 mo after spinal surgery and was referred for GS for suspected vertebral osteomyelitis. (A) Planar posterior whole-body GS image (left) shows prominent abnormal uptake in left lower back, corresponding in part to regions of increased irregular uptake seen on planar posterior whole-body ^{99m}Tc-MDP image (right) along operated vertebrae. (B) Transaxial GS SPECT/CT image (left) localizes abnormal uptake on GS (center) to paravertebral soft-tissue abscess seen on corresponding CT image (right), thus defining soft-tissue infection without osteomyelitis. There was no evidence of vertebral osteomyelitis on follow-up CT 4 wk later

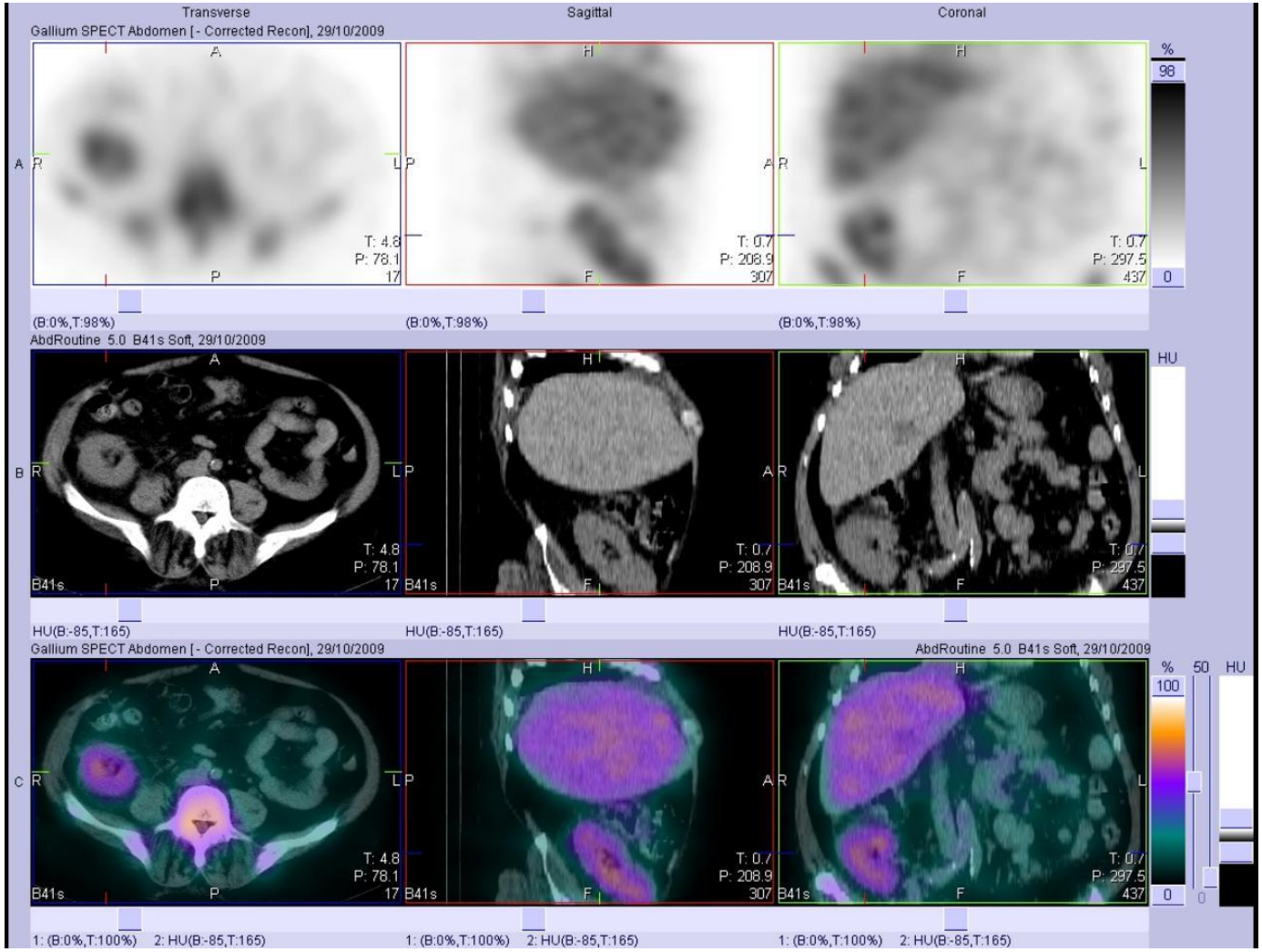
WBC SPECT-CT showing an infected iliac graft Bar Shalom et et JNM 2006 48% more accurate than planar WBC imaging



Specific results for infection

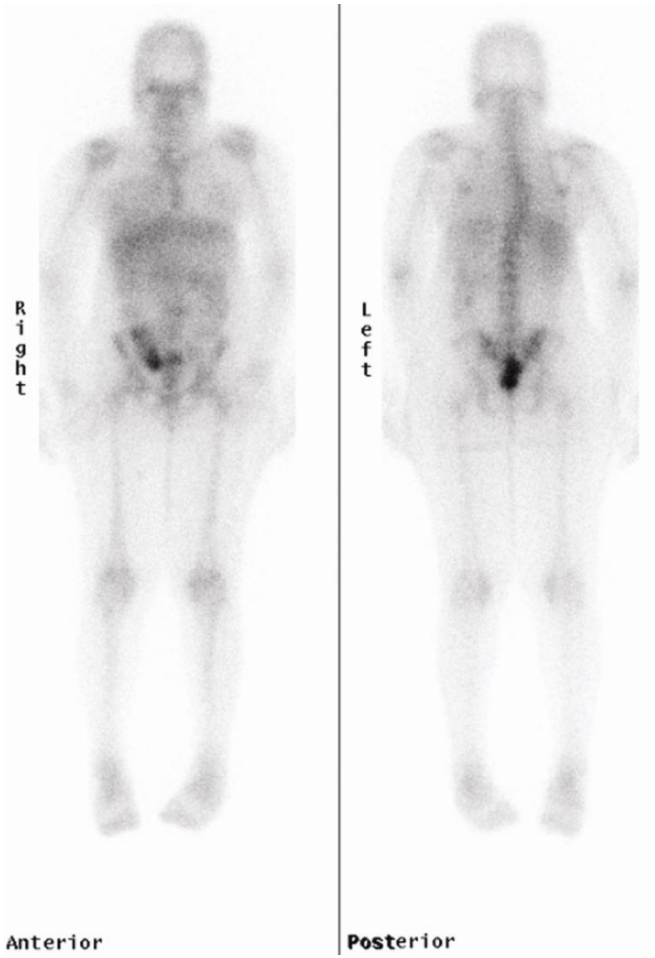
- Inquie et al J Comp Assist Tom 2007
- 16 patients (11 In-111 WBC and 6 Ga--67)
- SPECT/CT images yielded "added value" for anatomical localization in 65%, diagnostic confidence in 71%, and altered interpretations in 47% of cases

Ga-67 in infected Tx

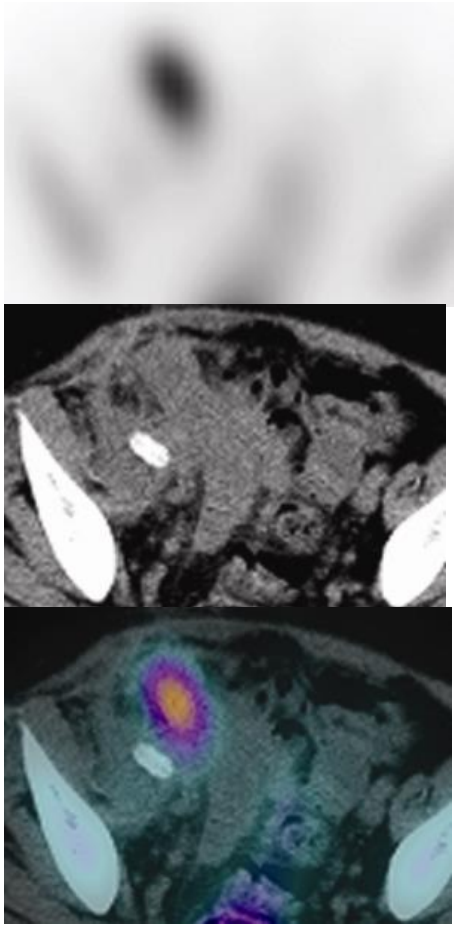


Nowosinska CNM in press 2013

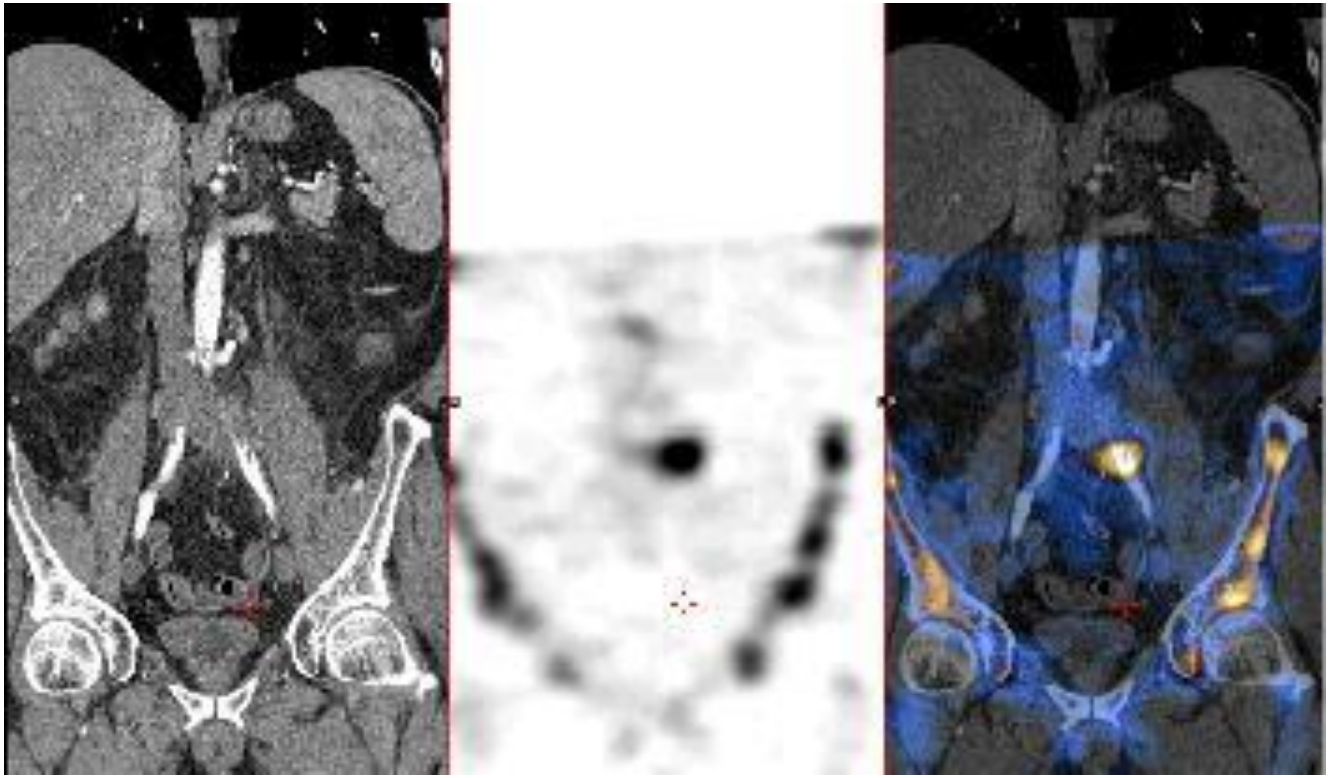
Patient with Ga-67 SPECT-CT



Patient with infected renal transplant SPECT-CT confirms uptake in peri-nephric fat



In-111 WBC in iliac A mycotic aneurysm



PET in FUO

- Blockmans et al Clin Infect Dis
- Leuvan department
- 58 patients with FUO studies, final diagnosis in 38
- 40% of scans unhelpful in diagnosis
- Results similar to those from Ga-67 in 40 patients studied with both scans only helpful in 42% for each tracer

PET and FUO

- Bleeker-Rovers et al EJNMMI 2004
- Nijmegen group
- 35 patients with FUO imaged
- Diagnosis conformed in 19
- 37% of scans clinically useful
- 65% of the positive scans clinically useful
- PPV 87%, NPV 95%

PET vs In-111 WBC

- Kjaer et al EJNMMI 2004
- Copenhagen group
- 19 patients had In-111 WBC and F-18 FDG
- FDG counted as useful if found infection or malignancy (WBC infection)

Image from Blockmans et al

Showing F-18 FDG uptake in spinal TB

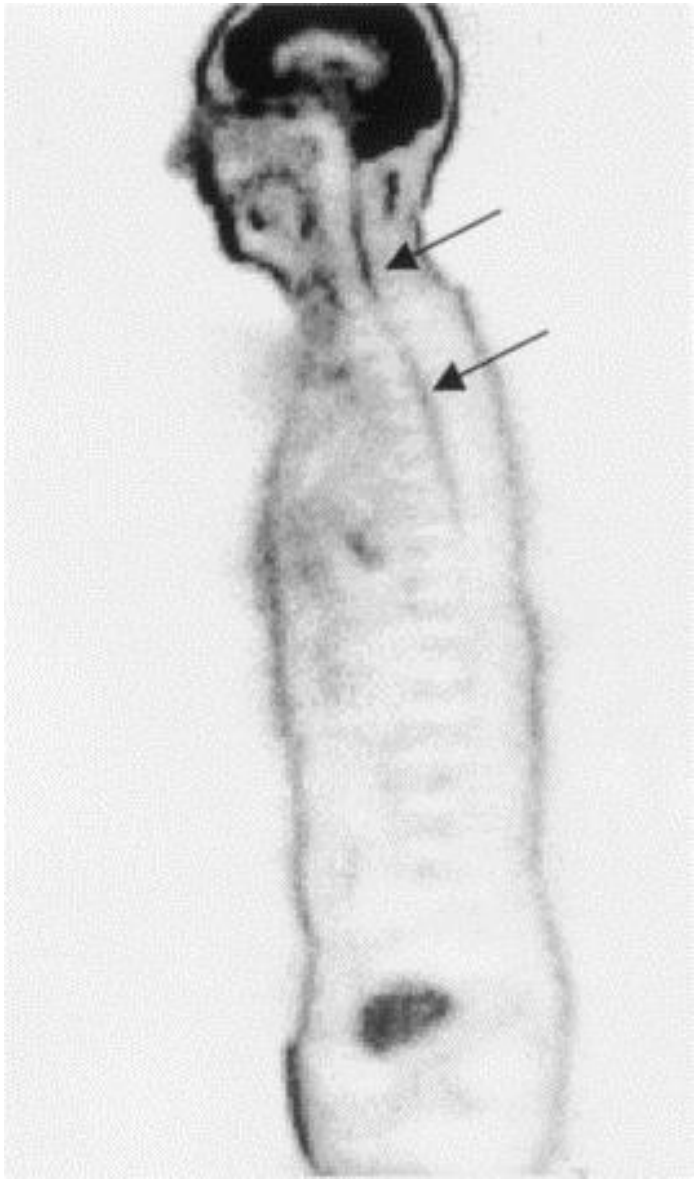
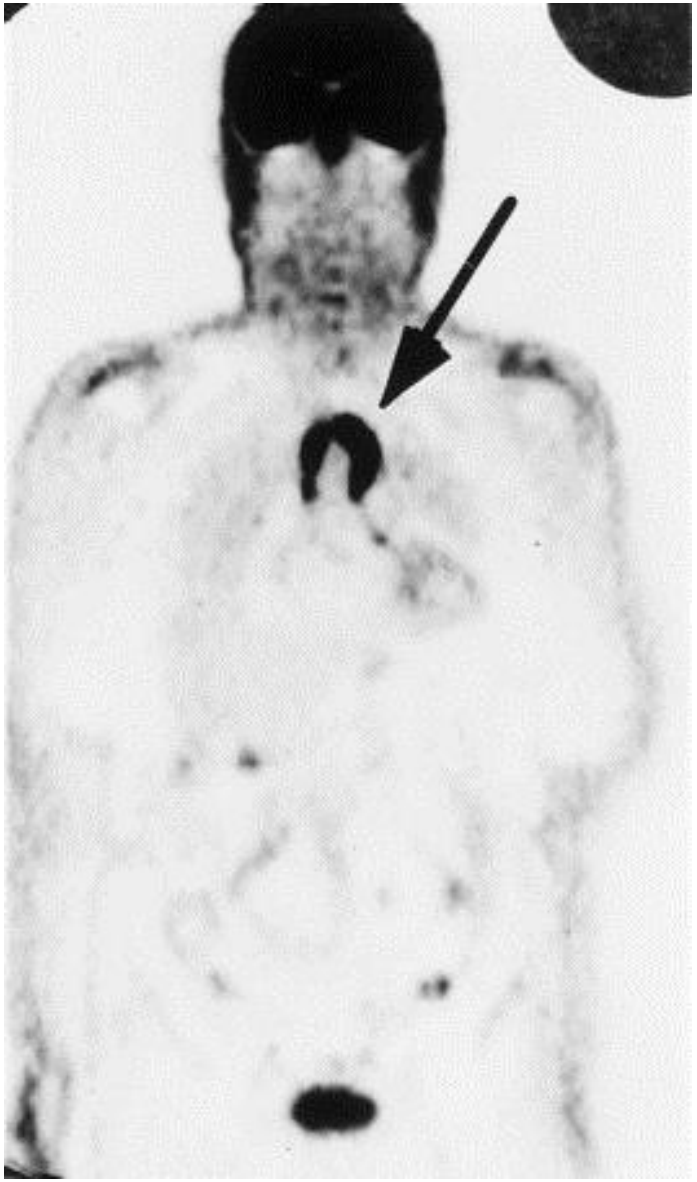
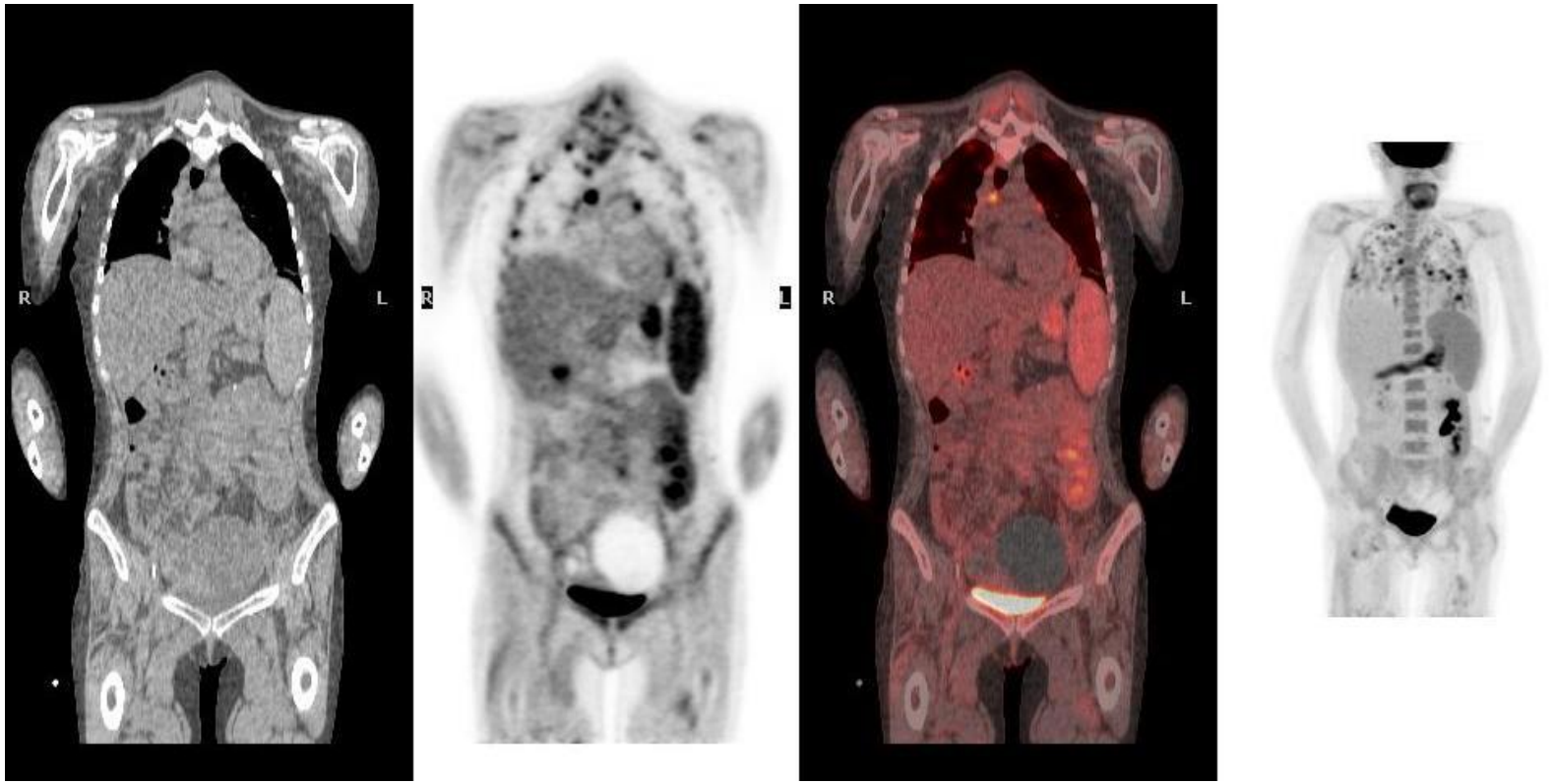


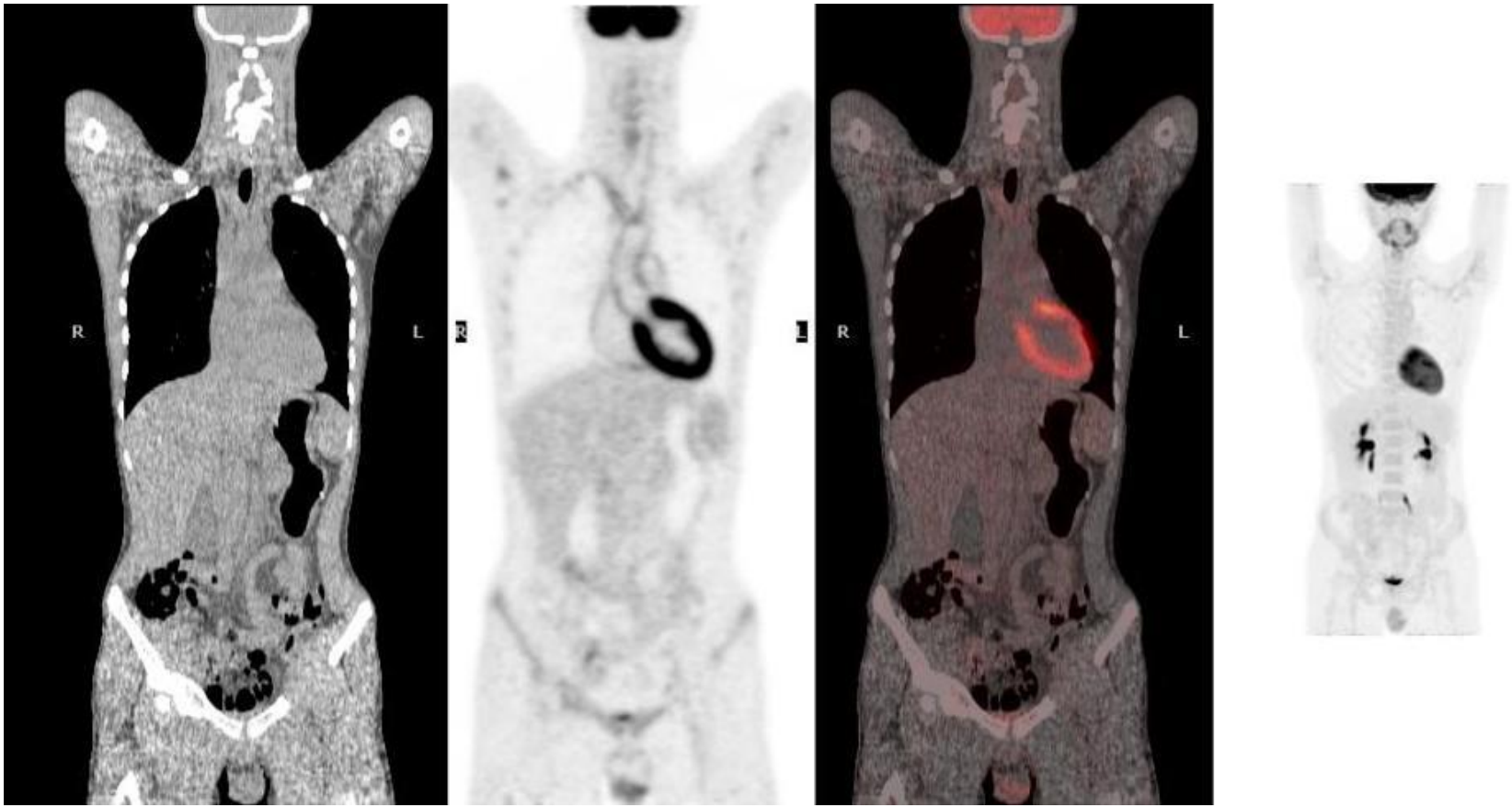
Image from Blockmans et al Showing F-18 FDG uptake in infective aortitis



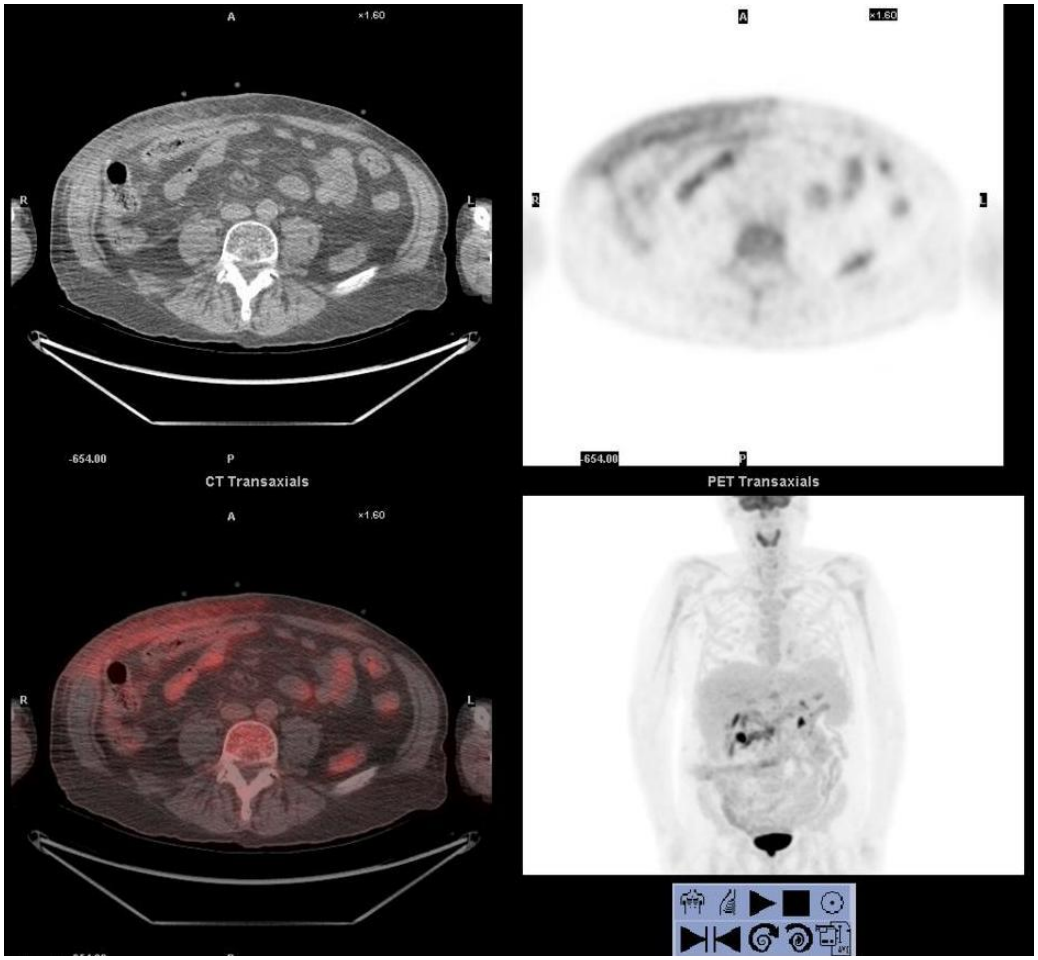
Cyptococcus in patient with HD treated with Chemo



Giant cell arteritis



Peritonitis



FDG PET in inflammation

- Increasing use in non infected inflammation
- Quantifying uptake can monitor progress
- Able to look at burden of inflammation
- Some special cases
  - Cardiac sarcoid
  - RA on peripheral joints

Sarcoid

- Disseminated inflammatory disease
- Characterised by granuloma
- Various patterns
  - Salivary/lacrimal glands
  - Lymph nodes
  - CNS
  - Skin
  - Joint
  - Pulmonary- the most dangerous

Imaging in sarcoid

- Normally diagnosis clinical followed by biopsy
- 50% of patients have raised serum ACE
- If lymph nodes involved may see symmetrical enlarged mediastinal/hilar nodes the lambda pattern
- Since 1966 Ga-67 citrate used
  - Not very trendy
  - High radiation dose

Ga-67 in sarcoid

Panda sign, lacrimal and salivary glands

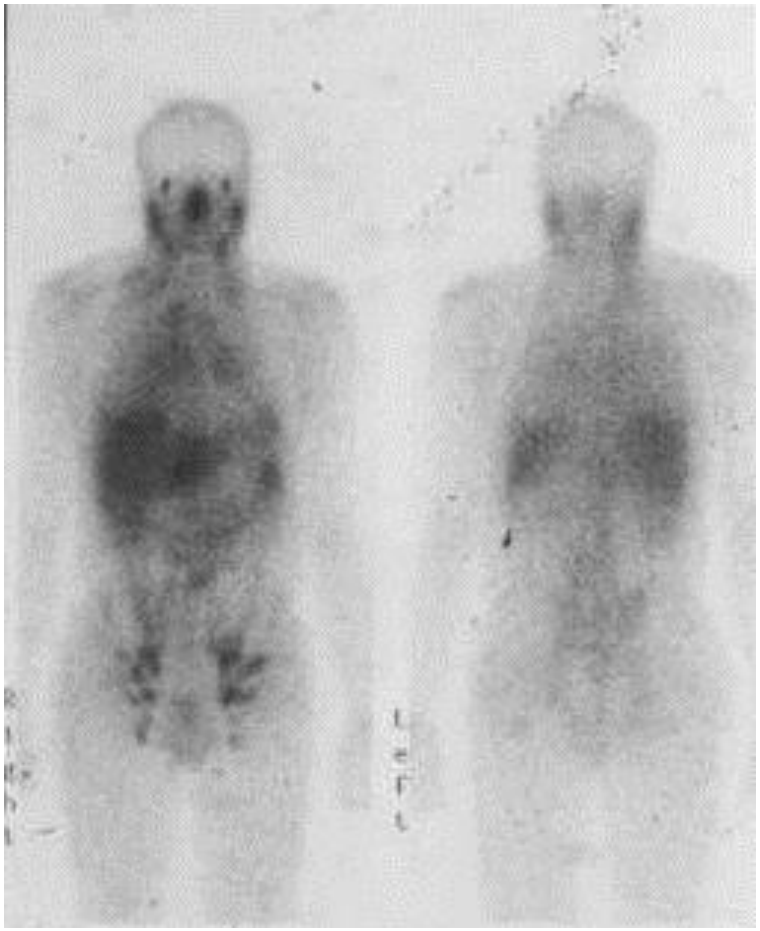
Lamba sign mediastinum and hilar nodes

Diffuse lung uptake

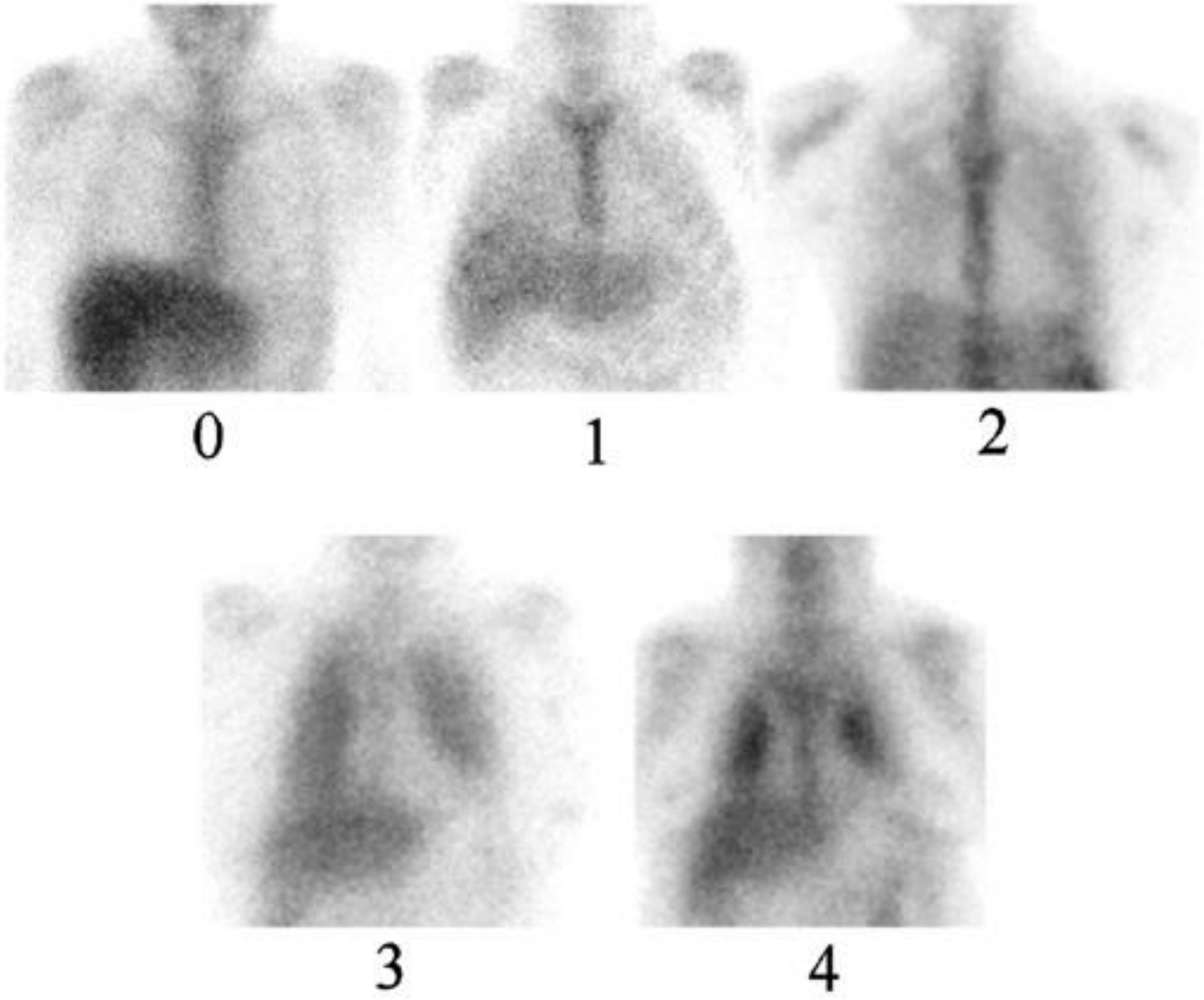
Lymphadanopathy (symmetrical)

Joints

Liver-diffuse



Bitran grading in sarcoid-Ga-67

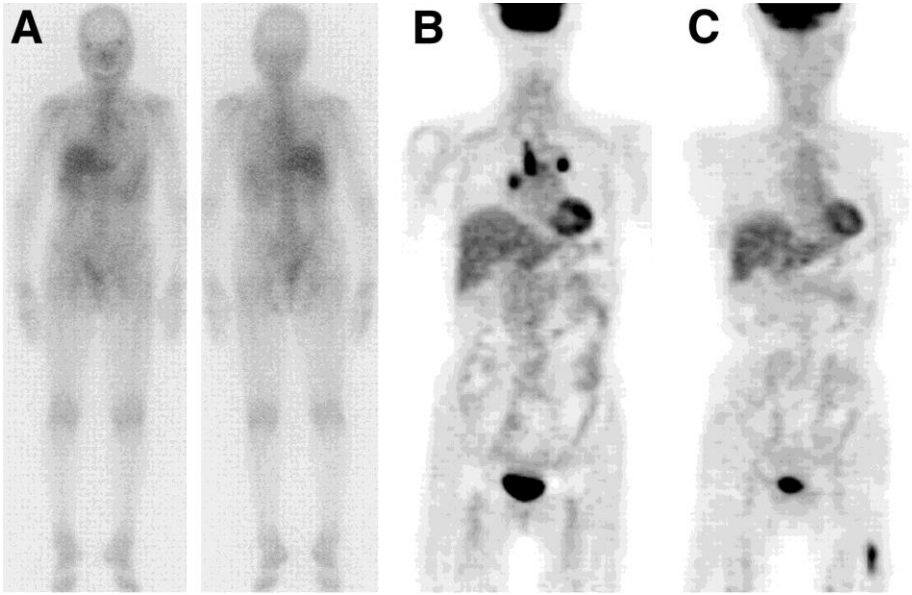


Use of F-18 FDG

- Lymphocytes very FDG avid
- Much improved resolution
- Lower radiation dose (5mSv vs 18mSv)
- Confirm sites of active disease esp in the abdomen
- Quantify uptake which may be useful in treatment monitoring

FDG vs Ga-67

- Nishiyama et el JNM 2006
- 18 sarcoid patients imaged with Ga-67 and FDG.
- Pulmonary disease Ga-67 81%, FDG 100% - mean SUVmax 7
- Extra-pulmonary disease Ga 48%, FDG 90% mean SUVmax 5



A= Ga-67
B= F-18 FDG
C= F-18 FDG post therapy

Using FDG to monitor therapy

- Sobic-Saronovic, Clin Nucl Med 2013
- 30 patients imaged before and after steroids for active sarcoid
- Observed reduction in sites and intensity of activity
- Correlated well with clinical symptoms
- SUVmax 8.5 to 4.9 ($p<0.05$)
- Serum ACE did not predict response

Cardiac sarcoid

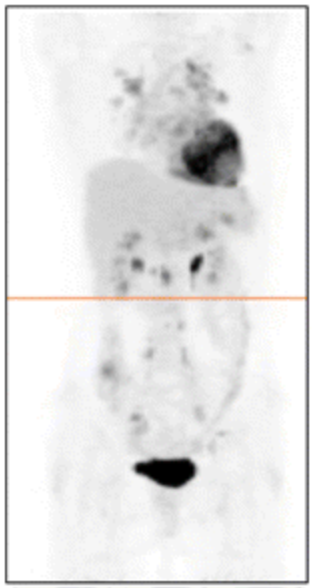
- Cardiac sarcoid may occur with other sites or be isolated
- Can result in heart failure and arrythmias
- Cause of unexpected cardiac death
- Recently a growing role for cardiac F-18 FDG
- Has been proposed both for diagnosis and to monitor any response to therapy

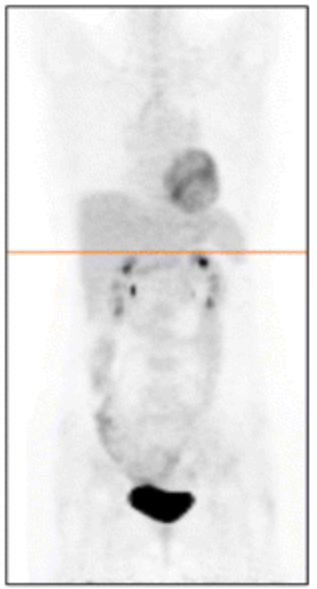
Imaging cardiac sarcoid

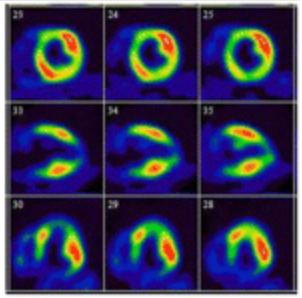
- Patient preparation vital
- Patient need 24hrs high fat/low carbohydrate diet
- IHD should be excluded by MIBI/Rb-82
- Images should be gated
- No myocardial uptake or diffuse uptake normal.
- Focal uptake is cardiac sarcoid

Before Tx steroids

After







Review of FDG in cardiac sarcoid

- Youssef et al JNM 2012
- Systematic review of 7 studies of FDG in cardiac sarcoid
- 164 patients with sarcoid scanned 50% had cardiac involvement
- Sensitivity of FDG 89% (95% CI 76-06%)
- Specificity of FDG 78% (95% CI 68-86%)

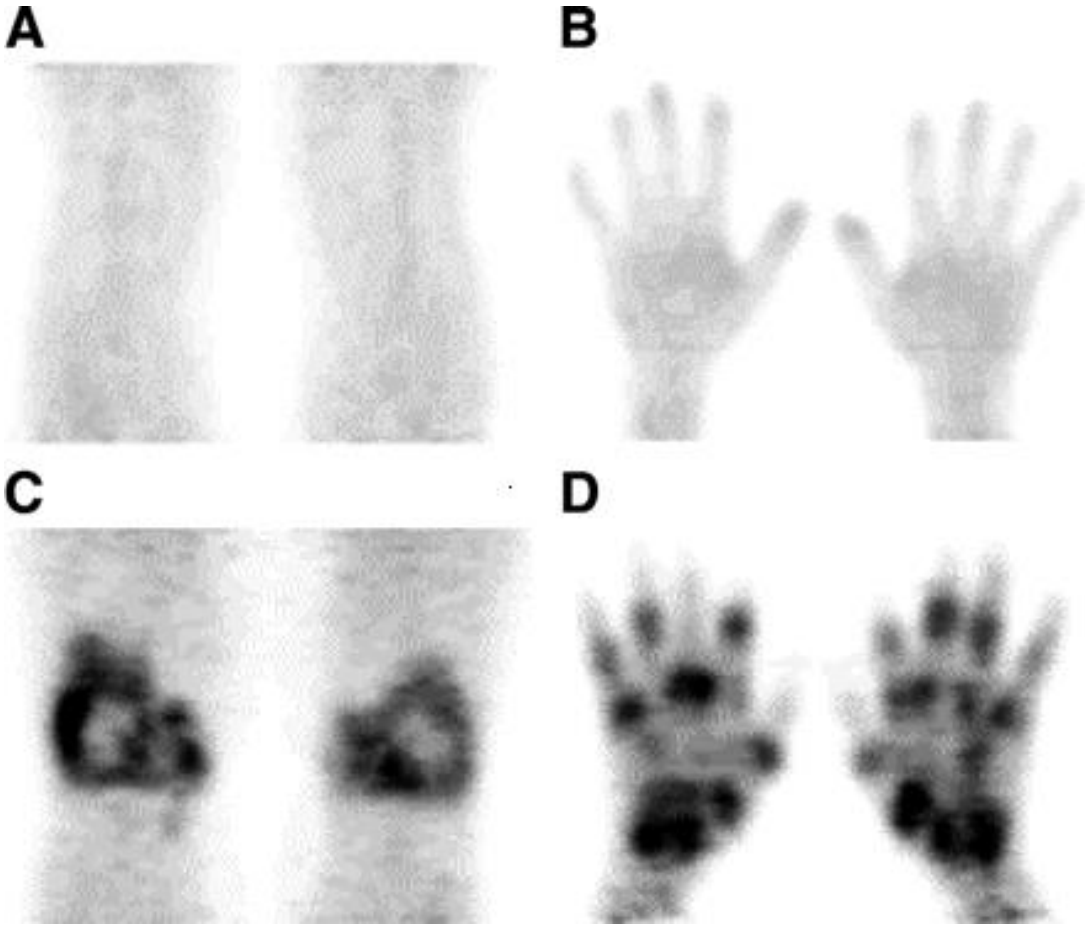
Using FDG in RA

- Beckers et al JNM 2004
- 21 patients with active RA
- FDG imaging with views of knees and hands
- FDG positive in 68% joints though 75% of joints swollen and 79% painful
- Good correlation with increased blood flow on Doppler ultrasound

FDG uptake in RA
Beckers et al JNM 2004

Normal

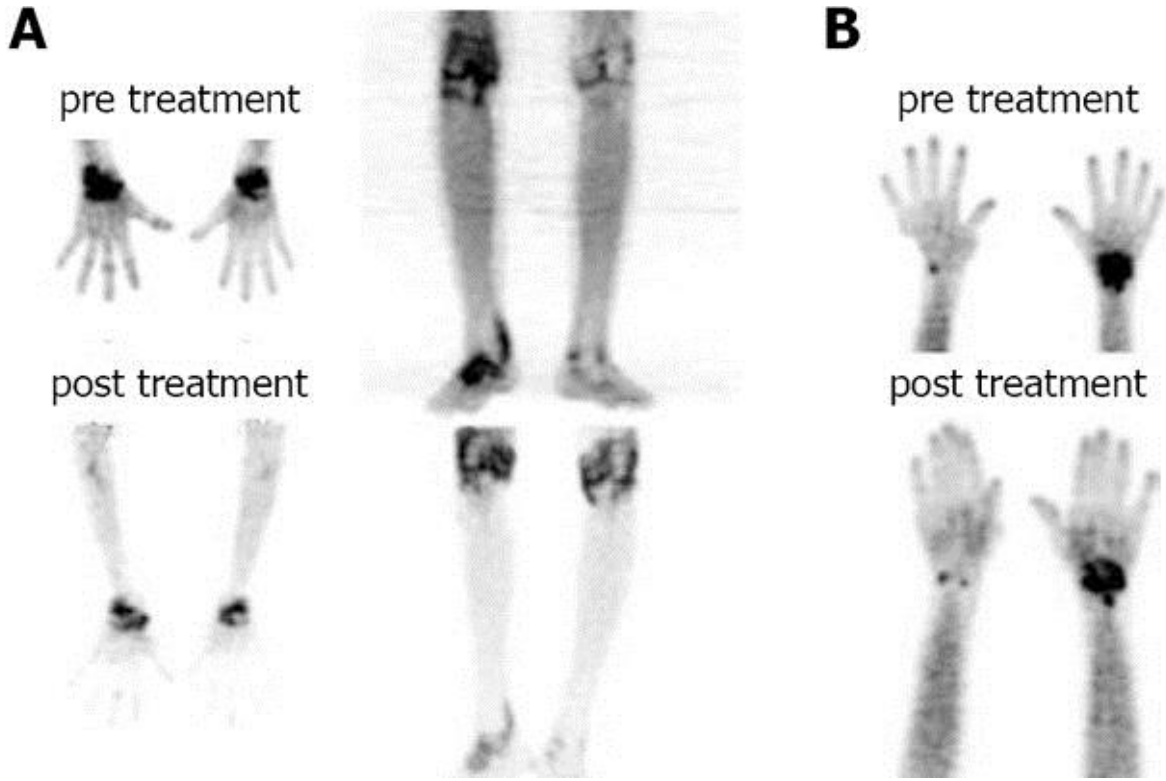
Patient with RA



Monitoring response

- Vijavant et al WJR 2012. 17 newly diagnosed RA and 11 newly diagnosed sero-neg arthropathy
- Good correlation between symptoms and sites of increased uptake of FDG
- Change in SUVmax correlated well with clinical response and change in CRP

FDG before and after Tx
Vijavant et al WJR 2012



RA and PET in 2004-stll true 2013

- However, much work remains to be done to gain more detailed information and to clarify the impact of ^{18}F-FDG PET on diagnosis and therapy of RA, in comparison with state-of-the-art MRI, ultrasound, and three-phase bone scanning. Eventually, we may be able to define indications for ^{18}F-FDG PET to improve and adjust RA management.-*Wilfred Brenner*