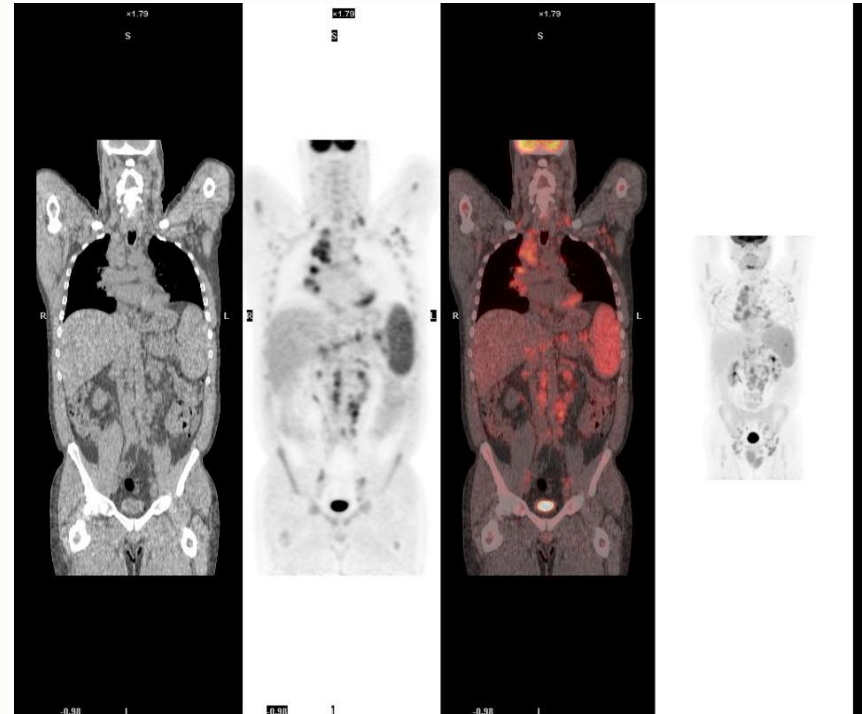


PET in vascular inflammation and atheroma

Dr John Buscombe

Use of PET

- Concentrated on Oncology
- Use of F-18 FDG as most common agent
- Basis of acceptance oncology
- Basis of UK programme for PET provision 2008-15



F-18 FDG PET-CT showing uptake in NHL

FDG PET in the CVS

- F-18 FDG used in imaging cancer for 25 years
- Since the earliest days of PET uptake seen in vasculature
- Often seen as annoying artefact
- Then in early 2000s F-18 FDG started to be used to look for inflammation
- This included identification of vasculitis

Patient with renal cell cancer

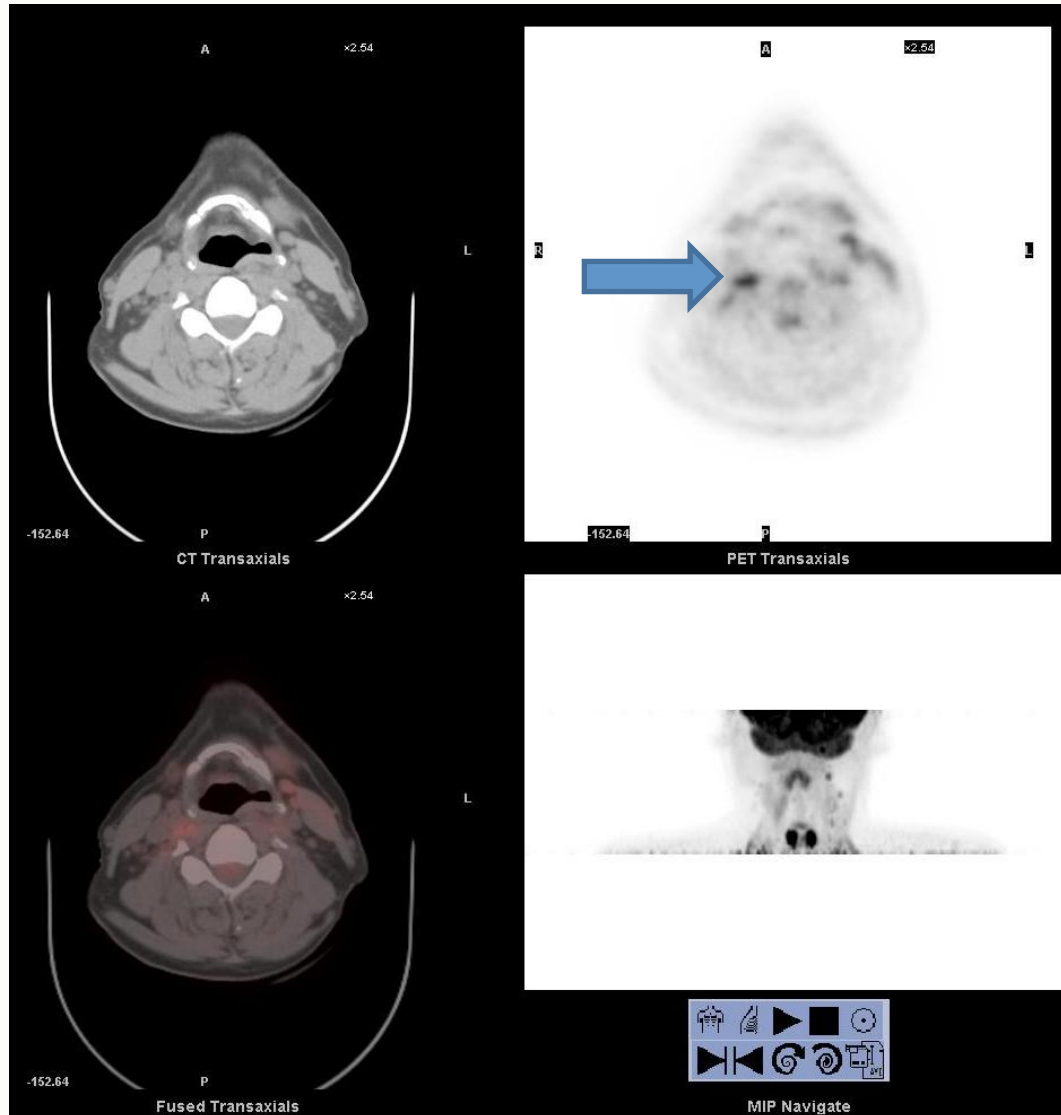
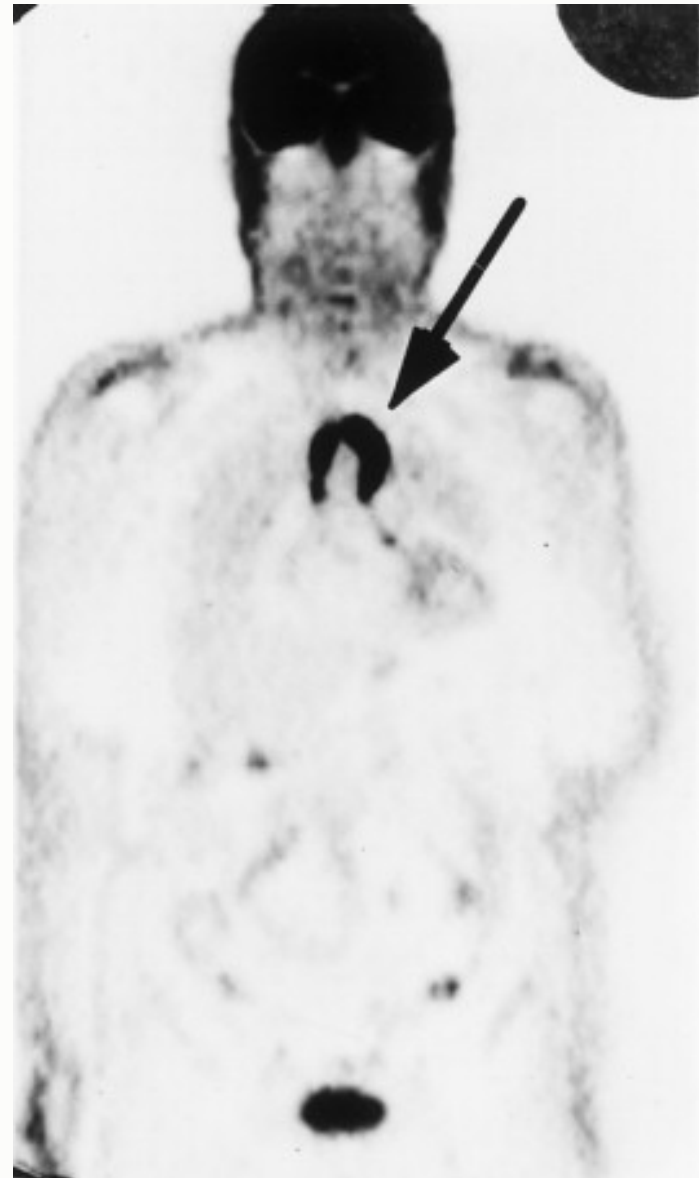


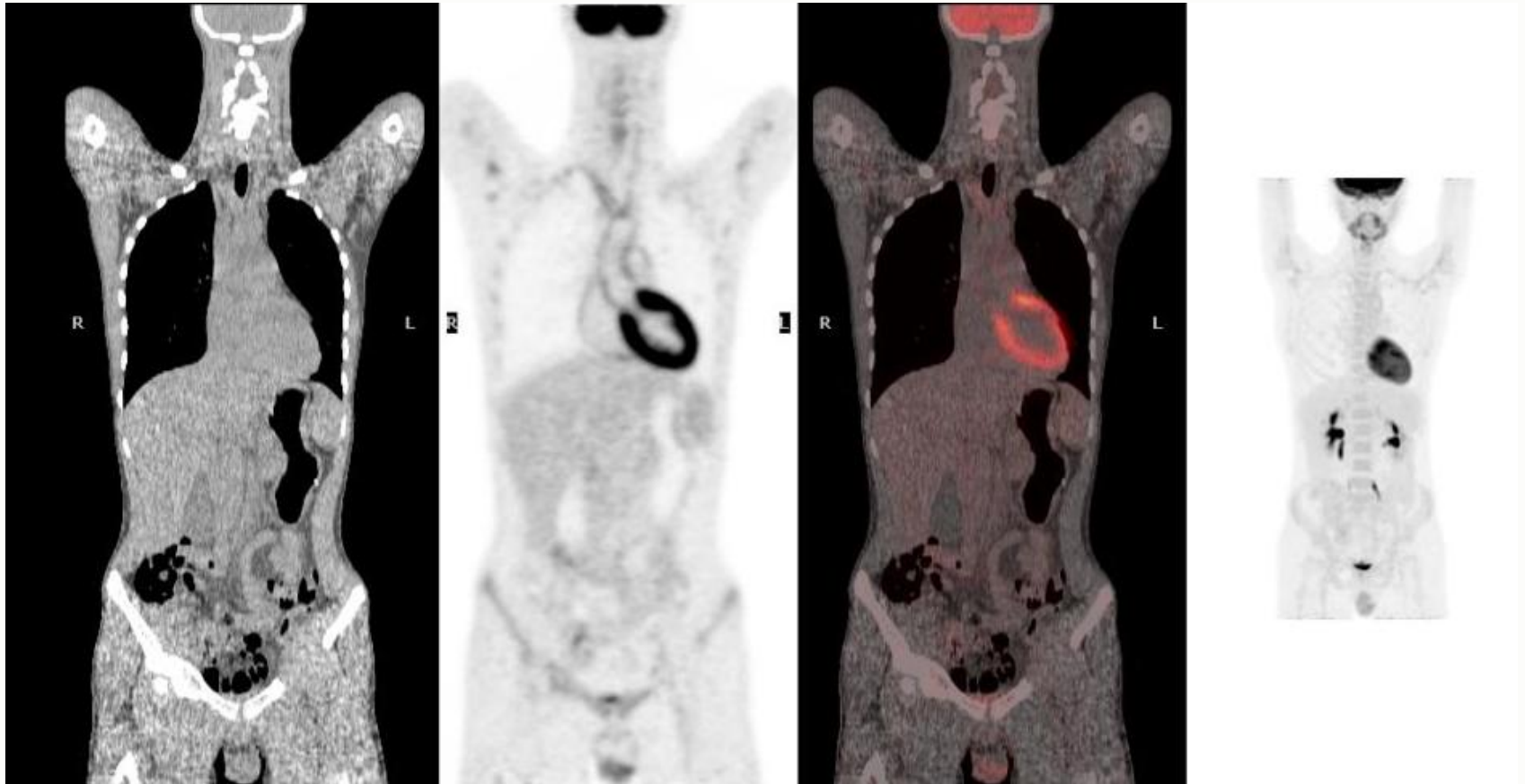
Image from
Blockmans
et al JNM
2002
Showing
F-18 FDG
uptake in
infective
aortitis



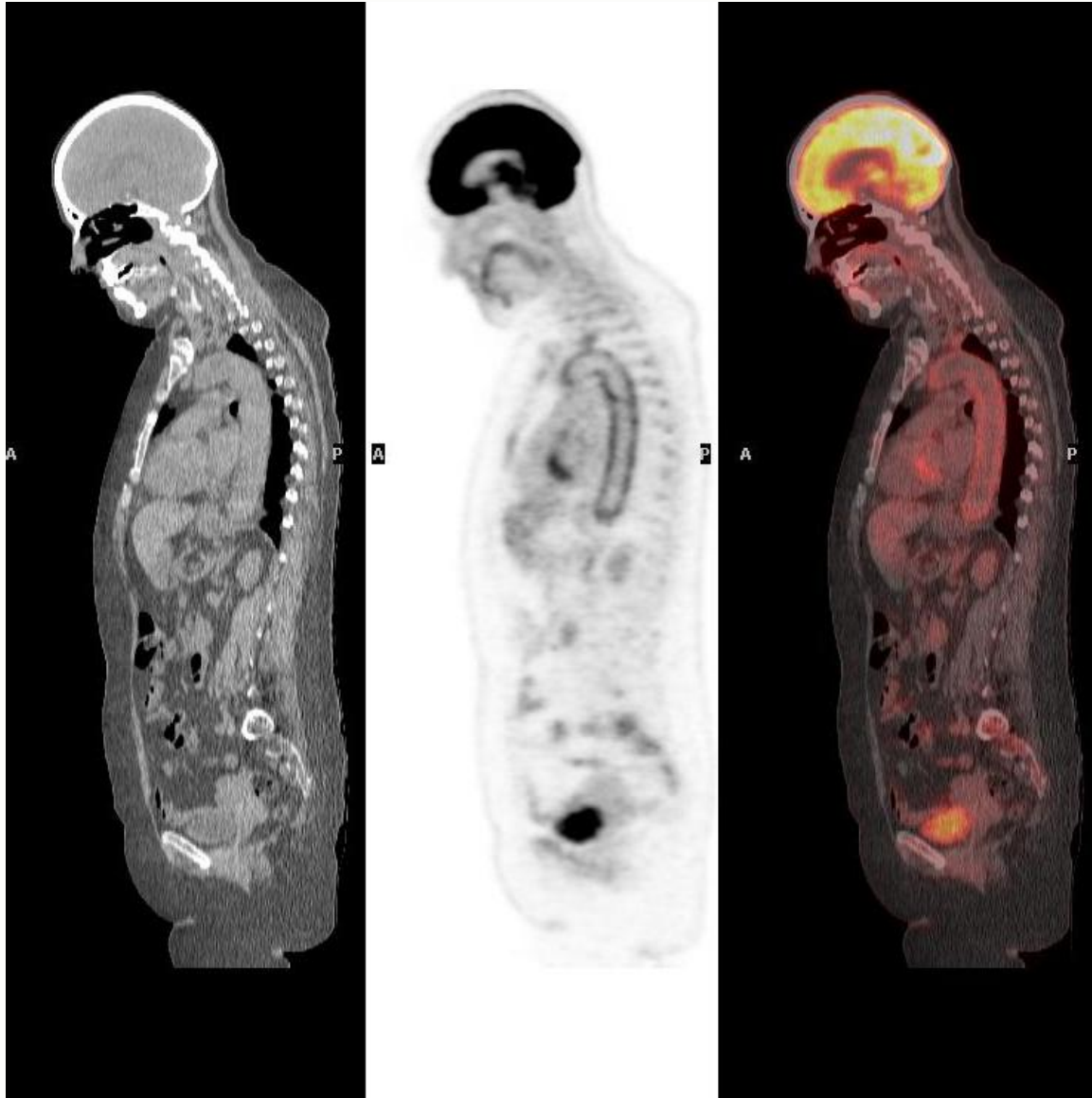
F-18 FDG in vasculitis

- Walter et al EJNMMI 2005 used F-18 FDG imaging in 26 patients with giant cell arteritis
- Good correlation with wall thickness on CT, ESR and CRP
- Papathanasiou et al from UCL BJR imaged 16 patients with GCA before and after their first dose of steroids
- Mean SUVmax dropped from 3.38 to 2.32 with treatment

Giant cell arteritis

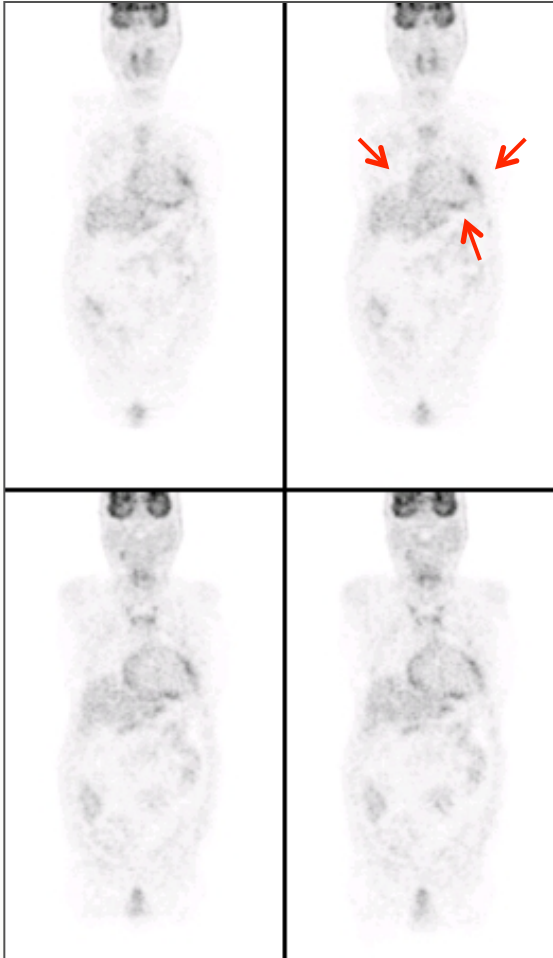


Aortitis



FDG Imaging in Infection

Pericarditis



M, 79, FUO

Linear FDG uptake around the contour of the heart,
localized by PET/CT to the pericardium

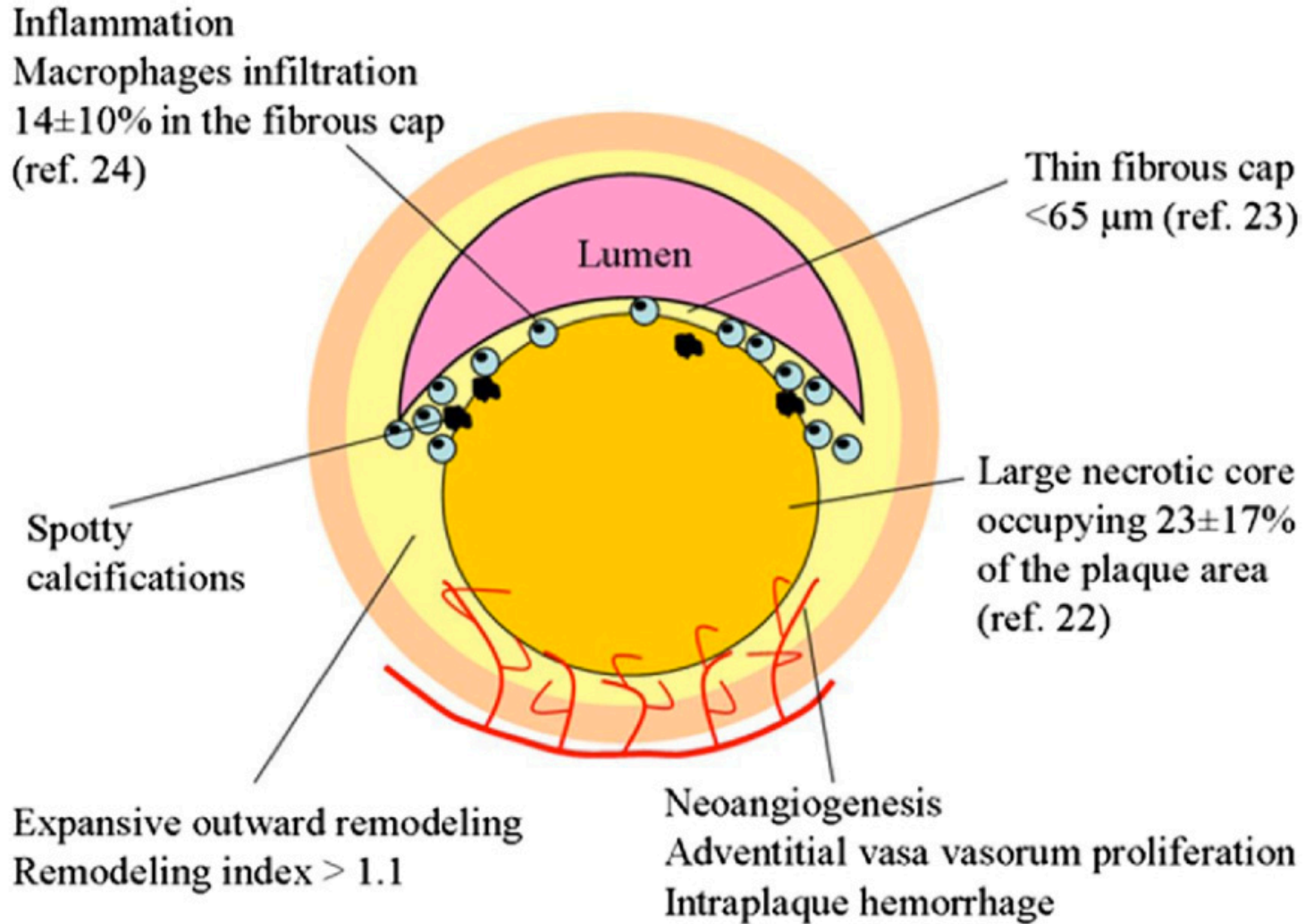
Idiopathic pericarditis

Treated with NSAID with good response

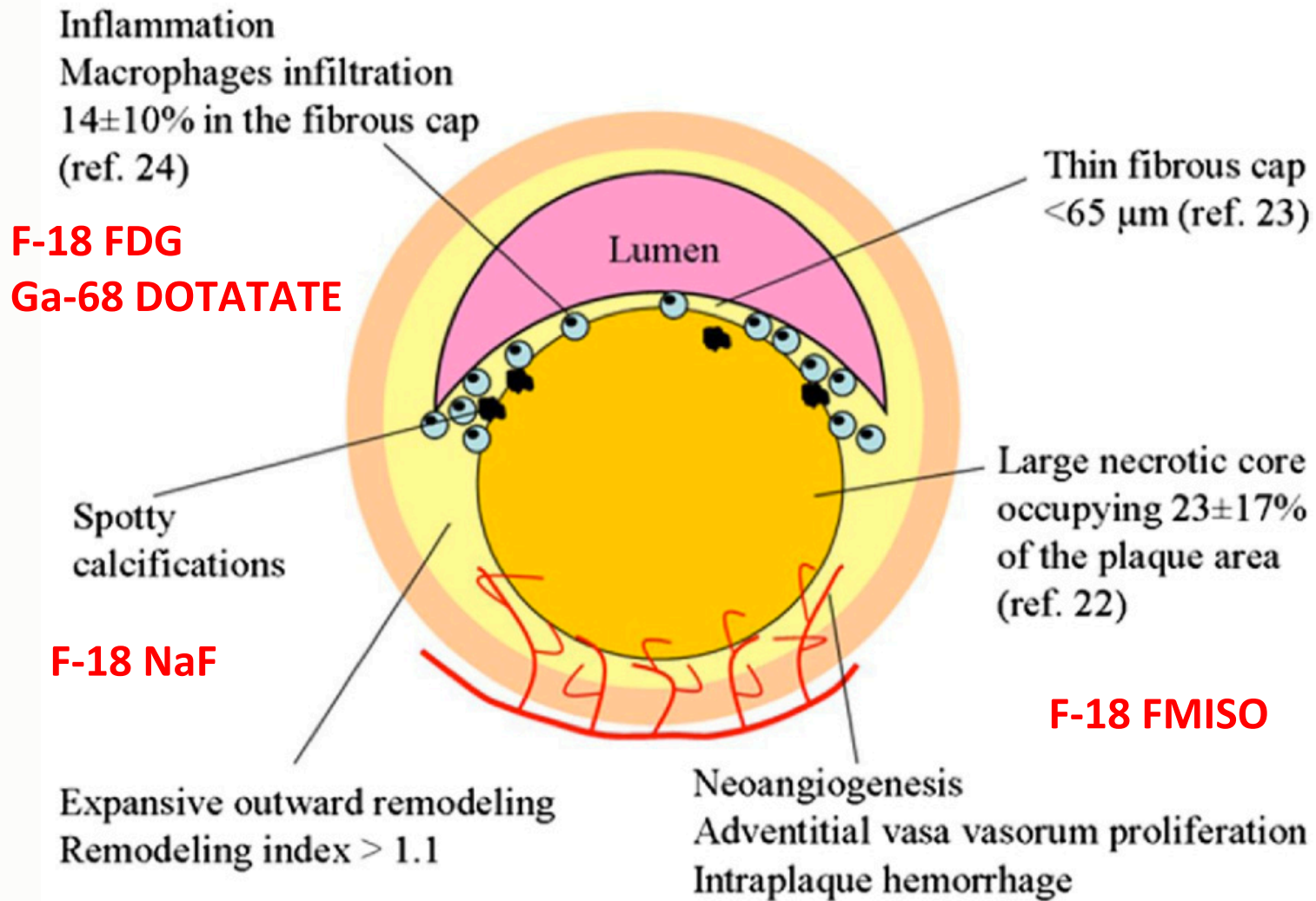
However what about atheroma

- Atheromatous CVS disease kills more people than cancer
- Increases with age so will be growing problem with our aging population.
- Cancer imaging moving beyond F-18 FDG to new agents can these techniques contribute to imaging CVS disease

What is a high-risk plaque?

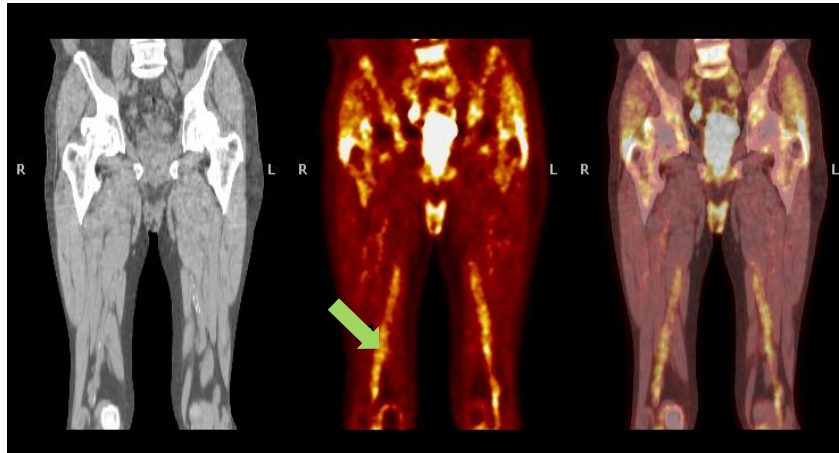


What is a high-risk plaque?

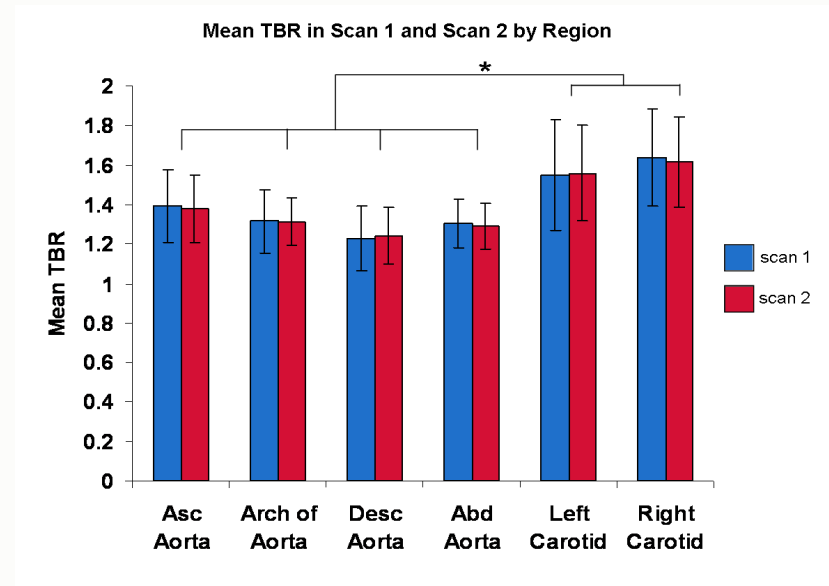
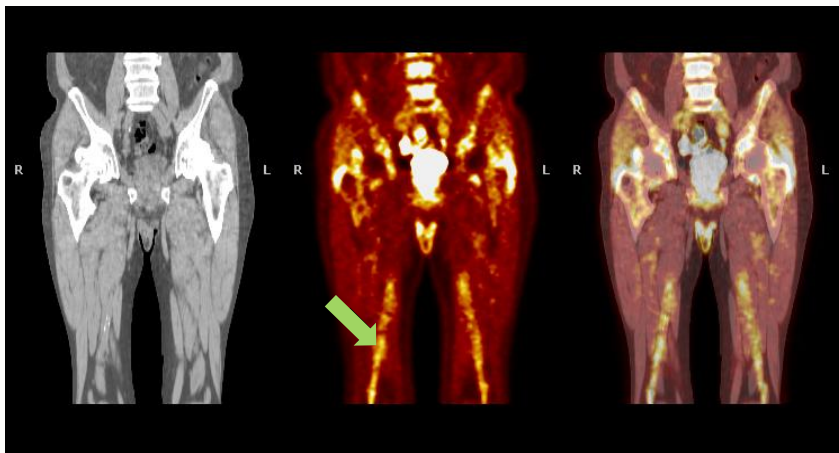


Arterial FDG Signal Is **Reproducible**

Day 1



Day 14

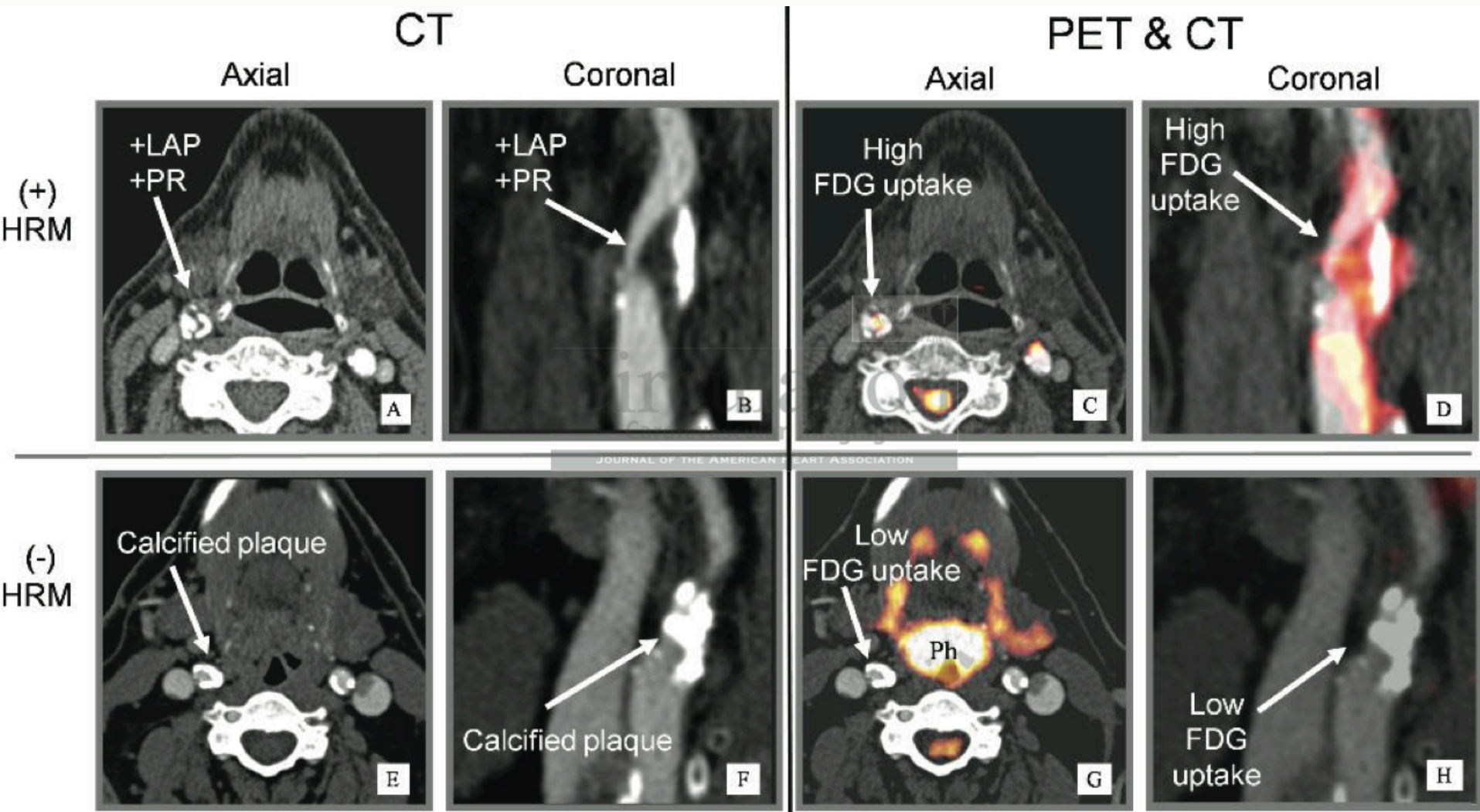


Rudd et al Circ CV Imag 2009

- Looked at 41 patients with known cardiovascular disease or multiple risk factors
- F-18 FDG imaging compared to intra-vascular contrast
- Found there was a clear correlation between F-18 FDG uptake patients with atherosclerosis
- Noted inflammation and calcification rarely overlapped.

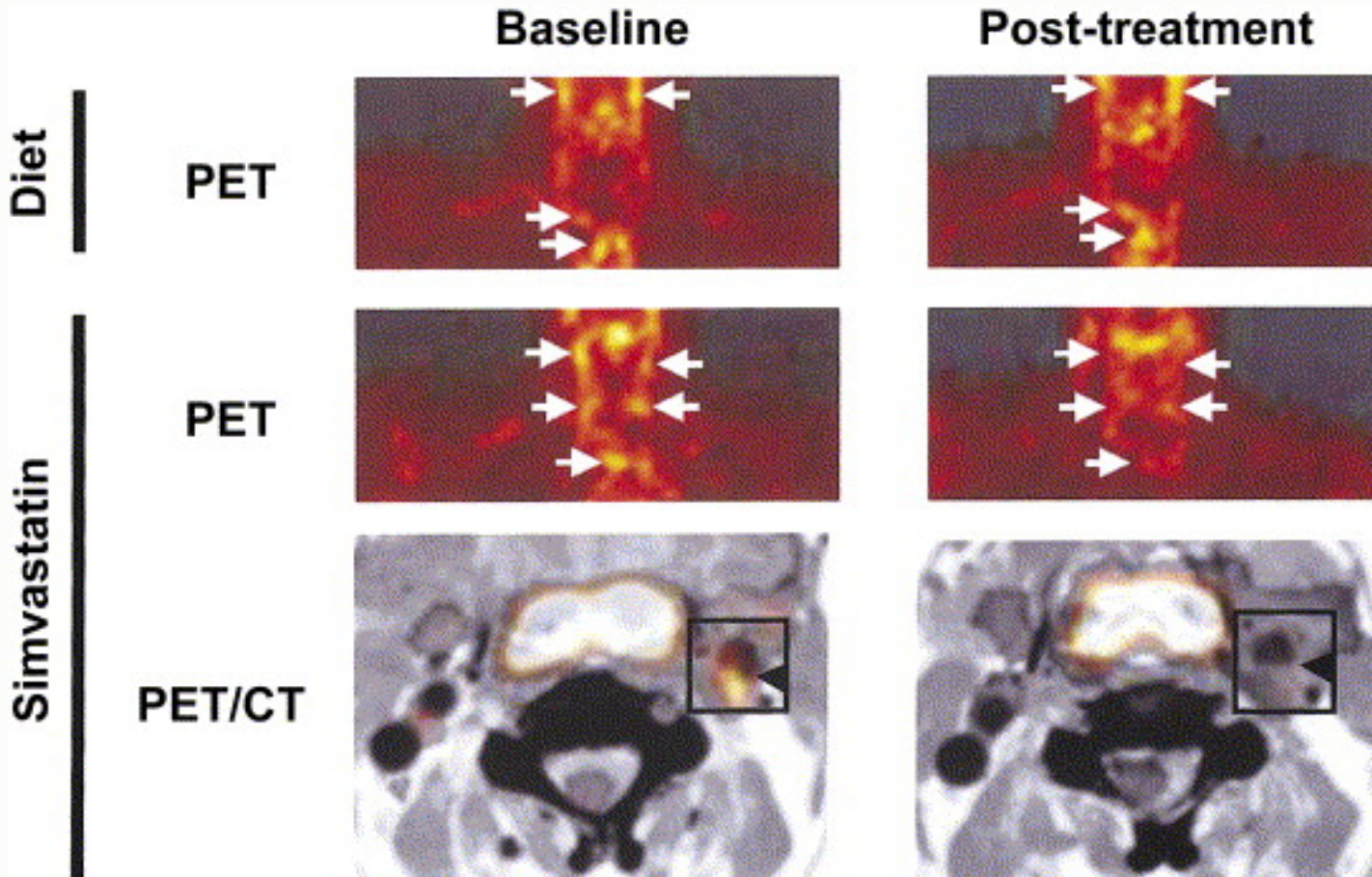
Bucerius et al JACC 2011

- F-18 FDG images in 82 patients with established CAD
- 67% patients had $TBR > 1.7$, 23% had $TBR > 2.4$
- Reverse analysis found correlation of FDG uptake and the following;
 - High BMI
 - Smoking
 - Hypertension



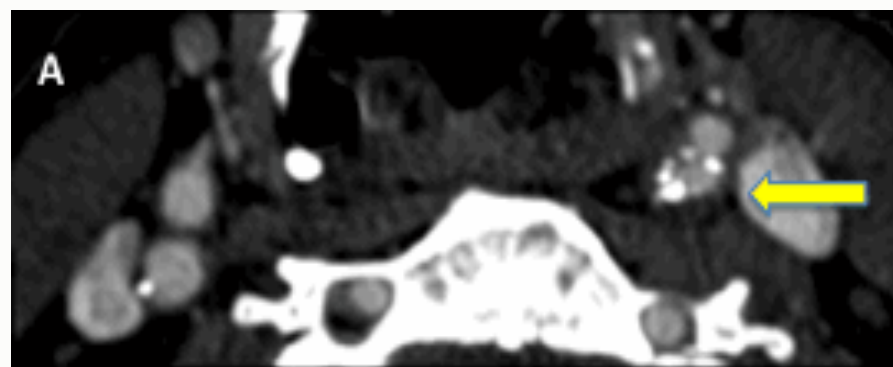
JOURNAL OF THE AMERICAN HEART ASSOCIATION

Response To Therapy: Simvastatin Treatment Study



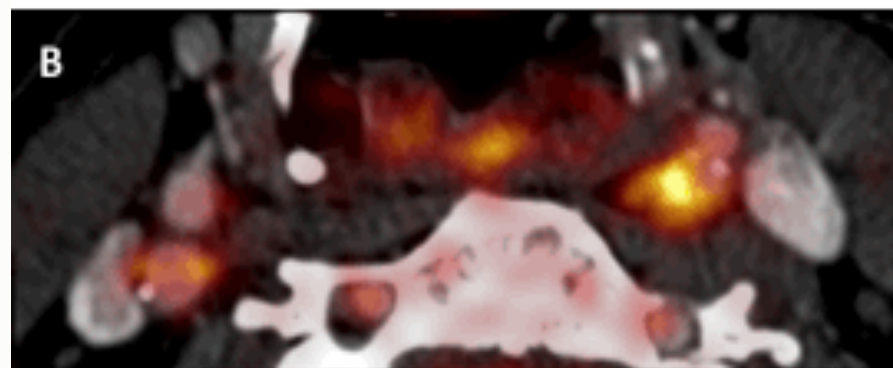
Joshi et al AHA 2013

- Looked at 15 patients with recent atheroma
- Looked at inflammation with F-18 FDG
- Looked at hypoxia with F-18 FMISO
- FMISO and FDG uptake correlated positively ($r^2=0.38$; $p<0.001$).
- Median carotid arterial TBR was 1.79 (IQR 1.33-2.25) for FDG.
- Mean FMISO TBR was 1.06 ± 0.07 . FMISO uptake, but not FDG was higher in culprit plaques than asymptomatic lesions (1.11 ± 0.08 vs. 1.04 ± 0.06 ; $p<0.05$).

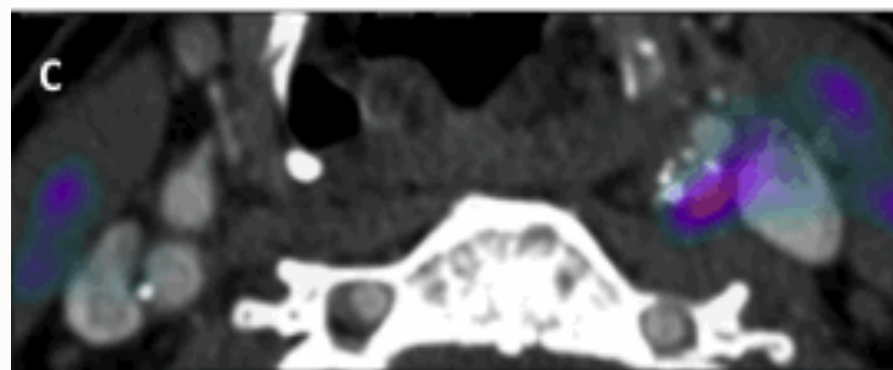


PET/CT imaging of a culprit left carotid artery stenosis.

A: CT angiography. Transaxial slice through a stenosis in the left internal carotid artery (yellow arrow).



B: Fused FDG PET/CTa image at same location with intense uptake in the culprit lesion.

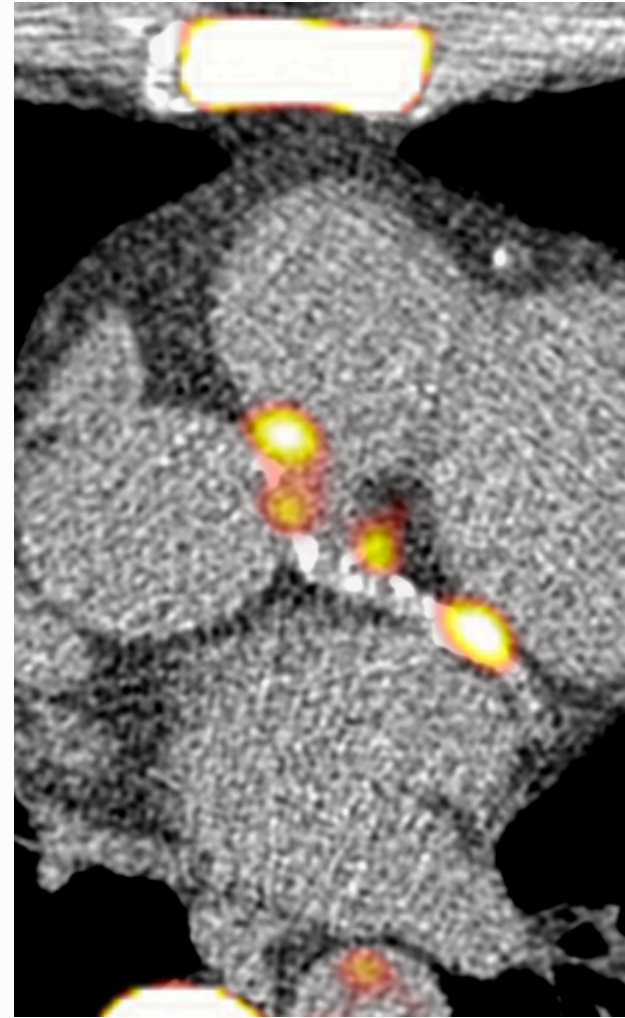
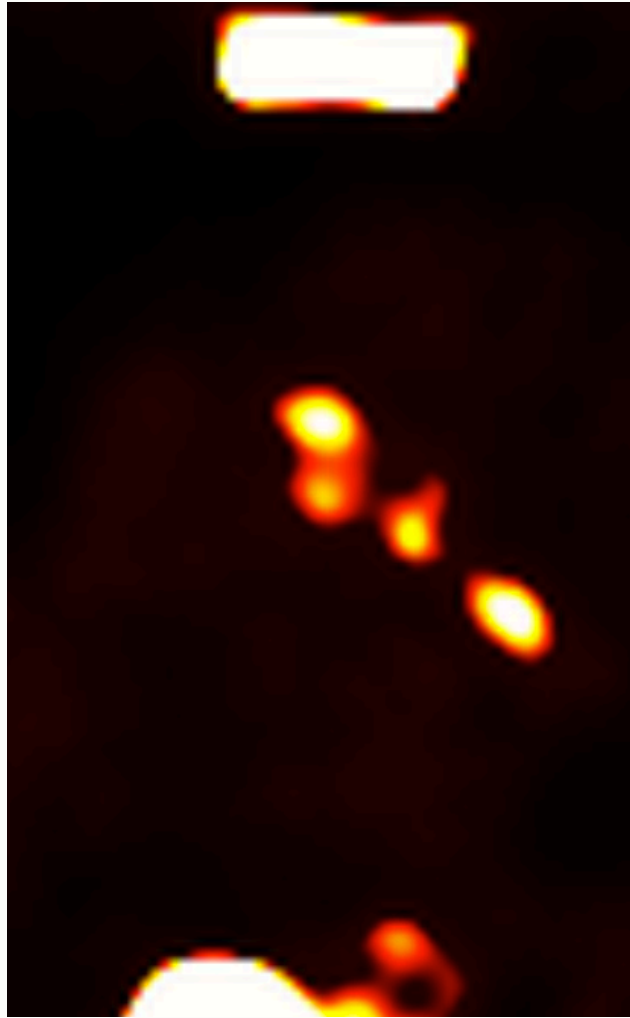


C: Fused FMISO PET/CTa with corresponding uptake indicative of intraplaque hypoxia.

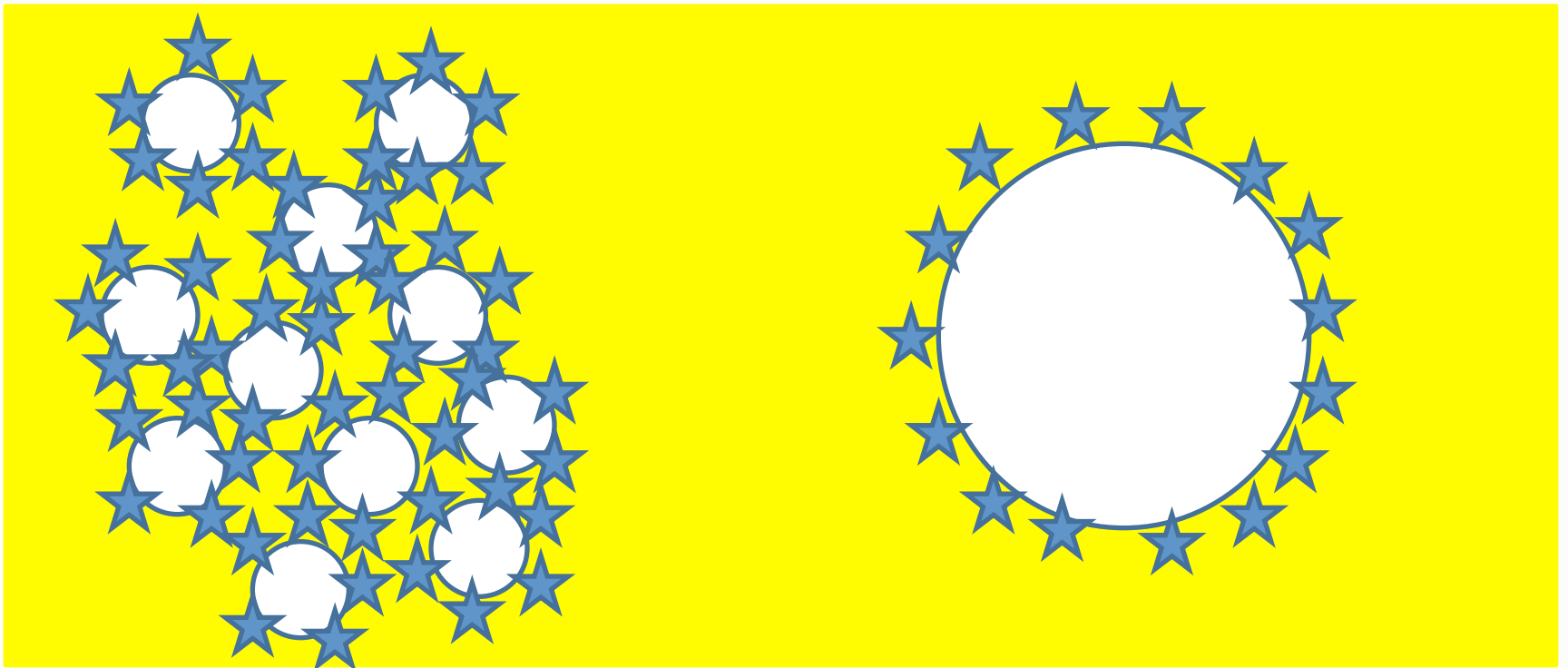
What about the heart

- Tracers such as F-18 FDG have uptake in normal myocardium making imaging of the heart difficult
- Recent innovation include:
 - “Time of flight” improves sensitivities near centre of field of view
 - Gating reduces blurring due to heart movement
 - Sharp IR helps to reduce blurring due to scatter
 - Non FDG tracers look at other aspects of atheroma

NaF Uptake in Coronary Atheroma looks at active calcification



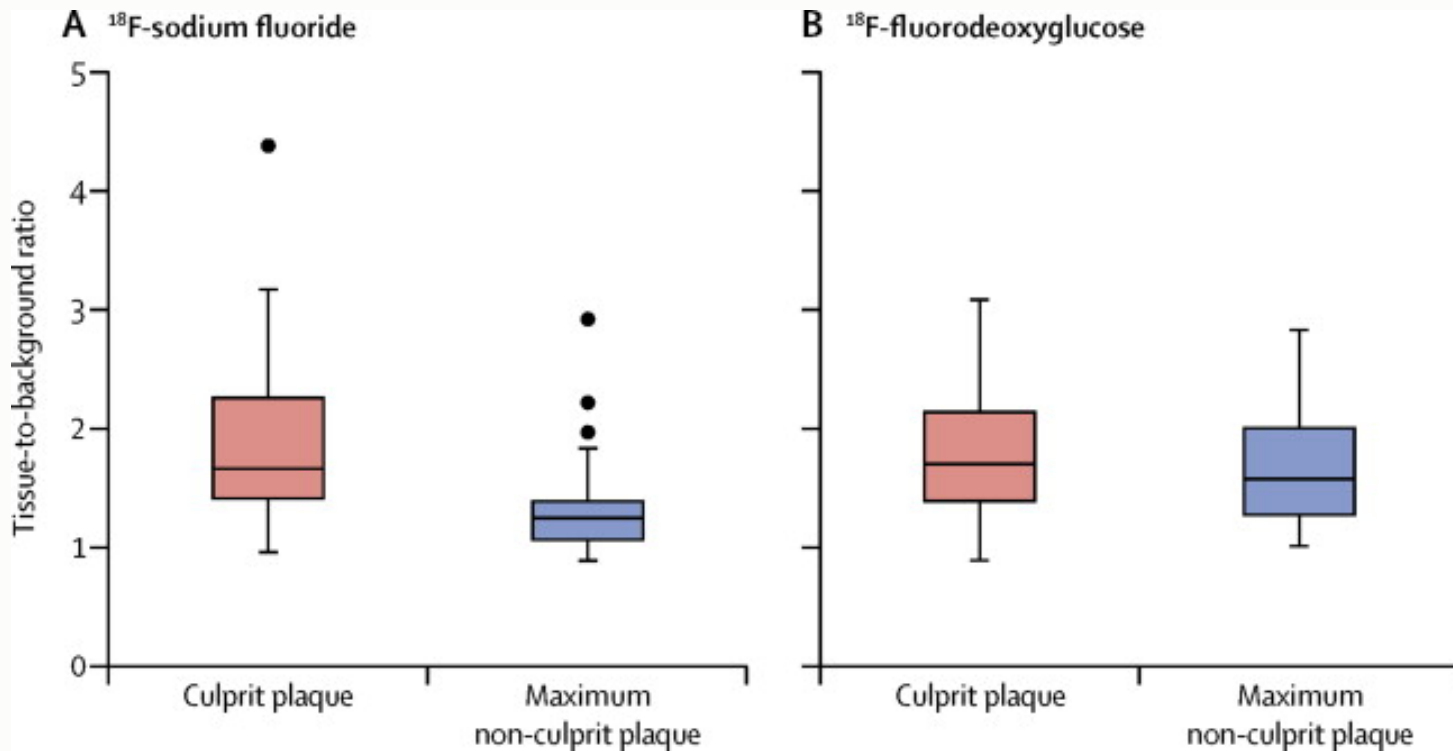
NaF uptake in micro-calcifications



F-18 NaF and high risk plaque

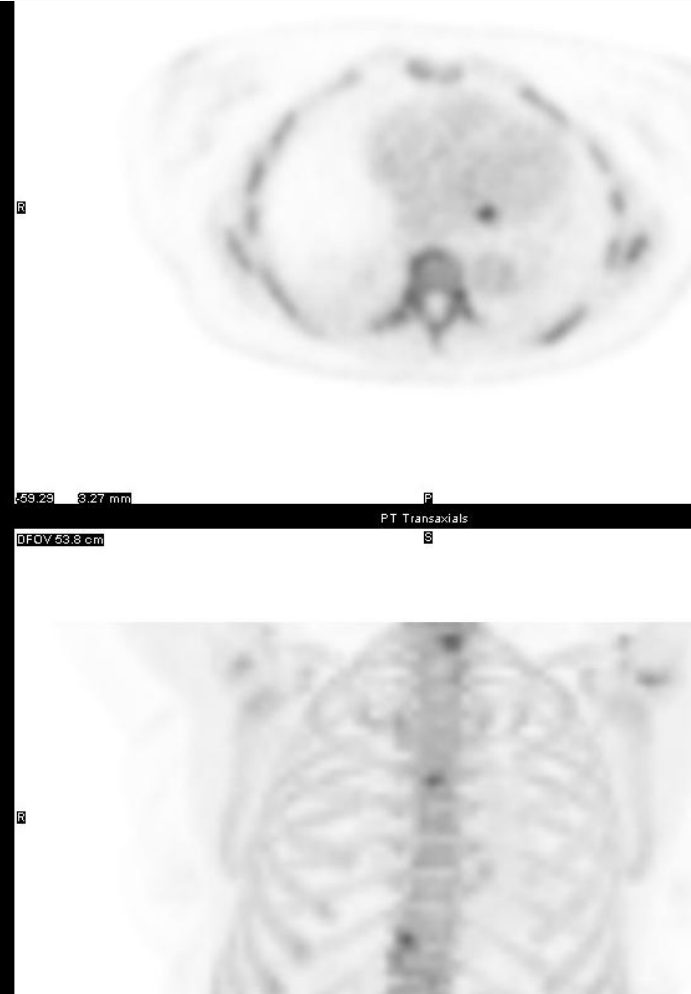
- Joshi et al Lancet 2013
- Two centre prospective trial
- 40 patients with MI and 40 stable angina
- All imaged with F-18 FDG and F-18 NaF
- F-18 FDG imaging not helpful
- F-18 NaF uptake had a high degree of correlation with culprit plaque

Joshi et al Lancet 2013



^{18}F -fluoride and ^{18}F -fluorodeoxyglucose uptake in patients with myocardial infarction
 ^{18}F -fluoride activity (maximum tissue-to-background ratio) was increased in the culprit plaque (red) compared with the maximum uptake in any of the non-culprit plaques (blue).
By contrast, there was no difference in the activity of ^{18}F -fluorodeoxyglucose between these regions

F-18 NaF in new coronary atheroma



Conclusions

- Area of exciting research
- Many more patients die of stroke and MI than cancer
- It is clear the inflamed hypoxic plaque is a dangerous plaque
- As resolution improves and sensitivity increases so better gating coronary arteries can be seen and assessed