

Cambridge University Hospitals **NHS**
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SPECT-CT and PET-CT in Endocrine tumours

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Introduction

- Parathyroid adenoma
- Hyperinsulinoma
- Adrenal imaging
- Pituitary imaging

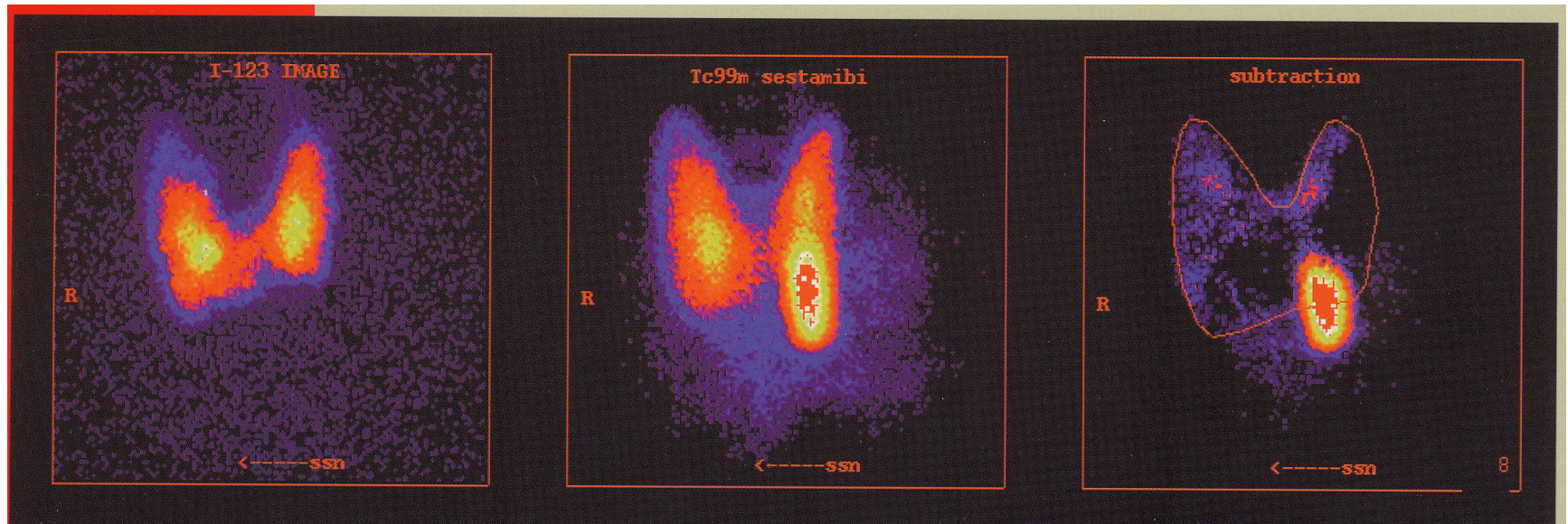
Parathyroid Tumours

Can be seen in MEN1

- Nuclear Medicine
- Localisation
 - Assist surgeon in reducing surgical operating times
 - May help reduce morbidity
 - Aids use of minimally invasive techniques
- ‘Second look’ !
 - Missed adenoma
 - Ectopic adenoma

Subtraction technique

- **Inject agent:** taken up by **thyroid and parathyroid** (Tl-201 or Tc-99m MIBI/TF)
- **Wait 30 minutes**, then scan neck
- **Keep** patient under camera, **inject** agent taken up by only thyroid (^{123}I , $^{99\text{m}}\text{Tc}$ pertechnetate)
- **Wait 15 minutes**, then rescan
- **Subtract** images

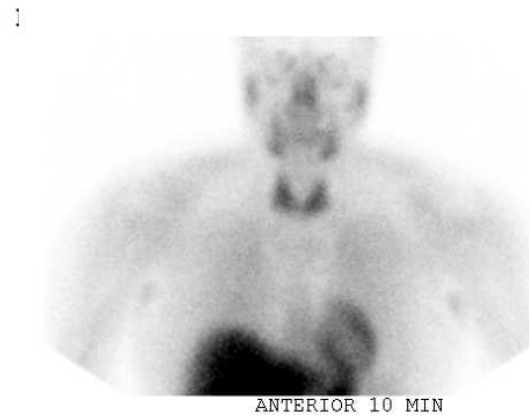


Washout technique

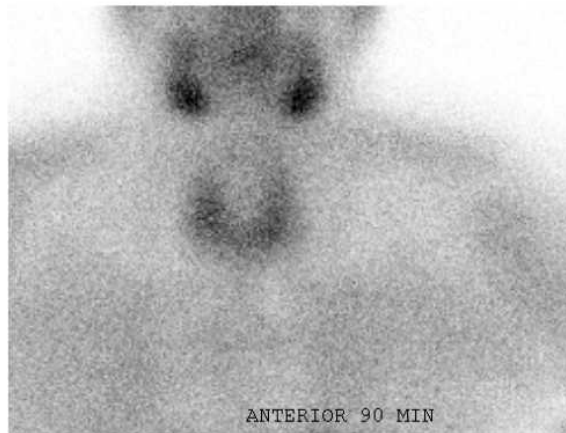
- Inject agent which washes out of thyroid but not parathyroid ($^{99\text{m}}$ Tc MIBI)
- Wait 15 minutes
- Perform planar and/or SPECT images
- Wait a further 2 hours
- Repeat planar and/or SPECT images
- Review images.

Normal (Negative) Washout Scan

Early

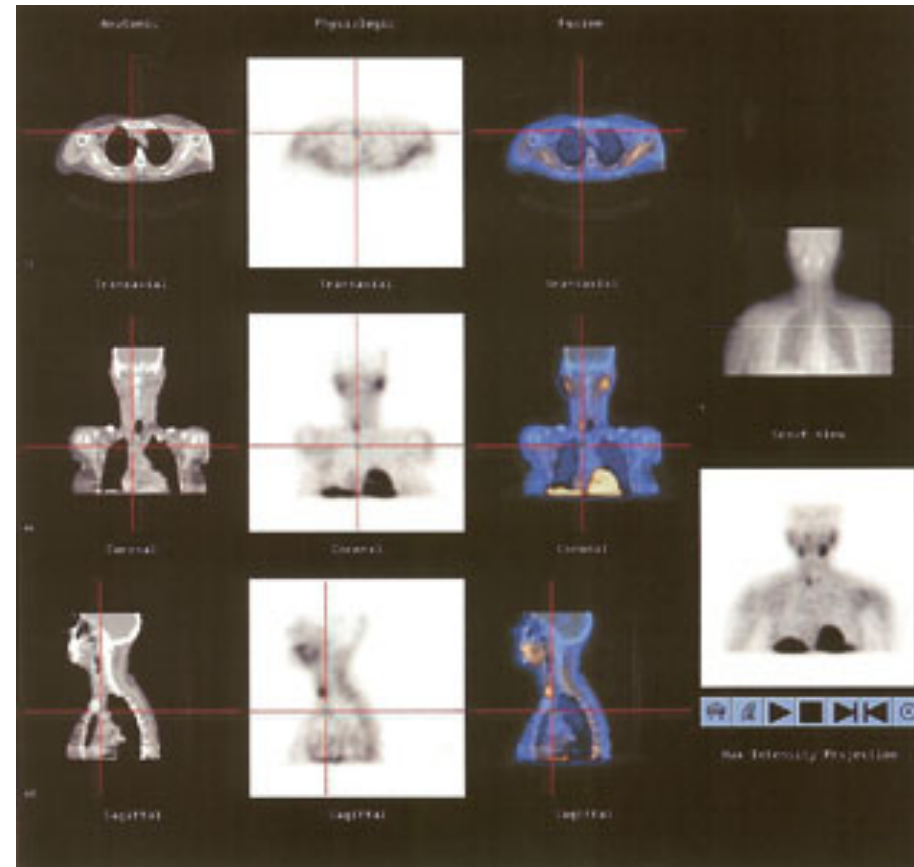


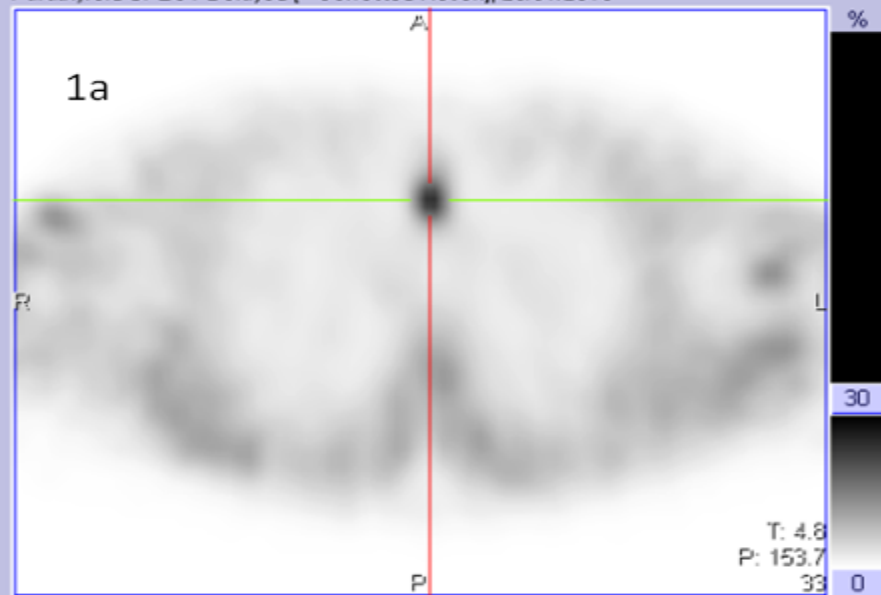
Late



Parathyroid imaging use of SPECT-CT

- Theoretically this is ideal use of SPECT-CT
- Does it work in practice
- Krausz et al at Jerusalem WJS 2006
- 39% had improved localisation using SPECT-CT esp ectopic adenomas





(B:0%,T:30%)
ThorRoutine 5.0 B60s Bone, 25/01/2010

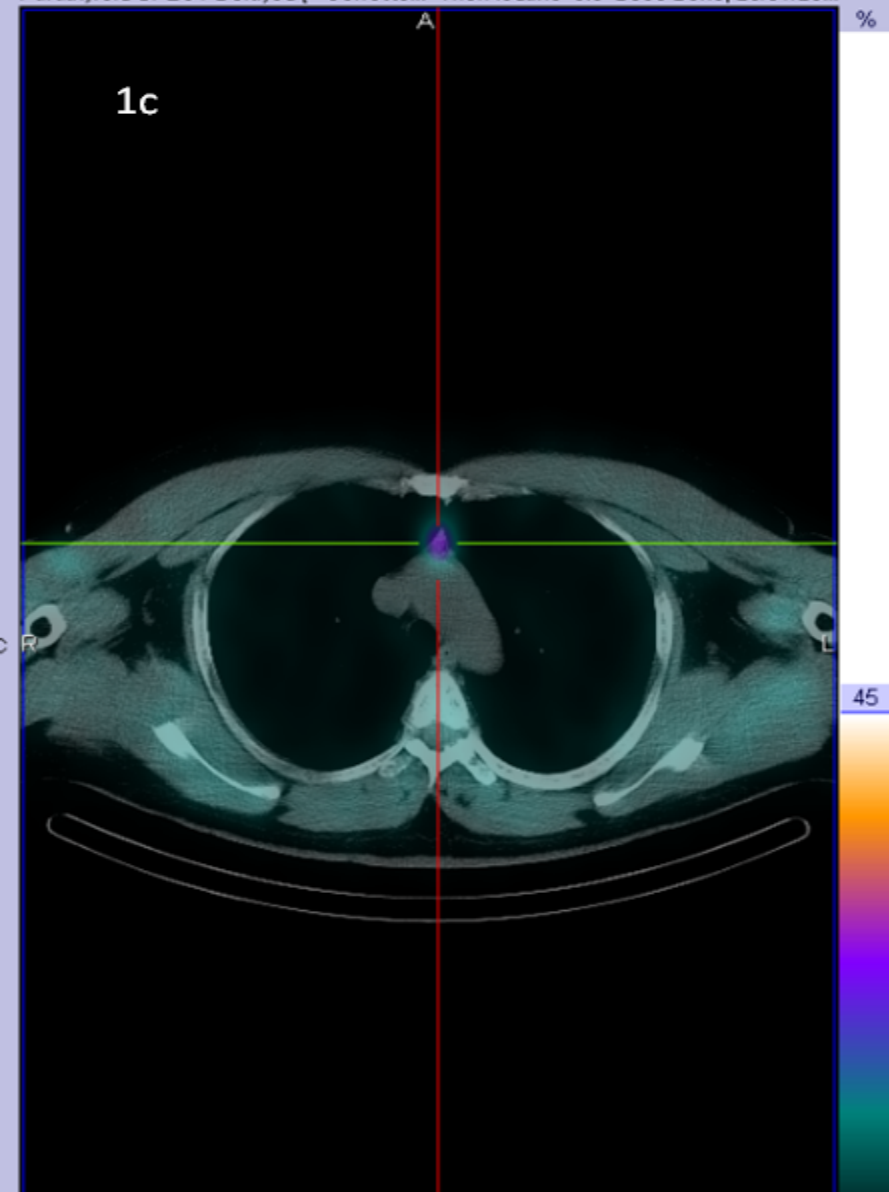
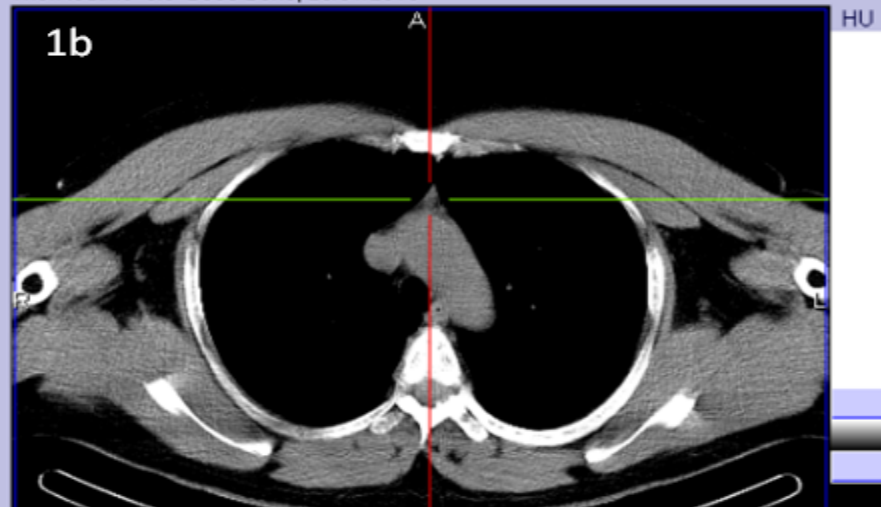
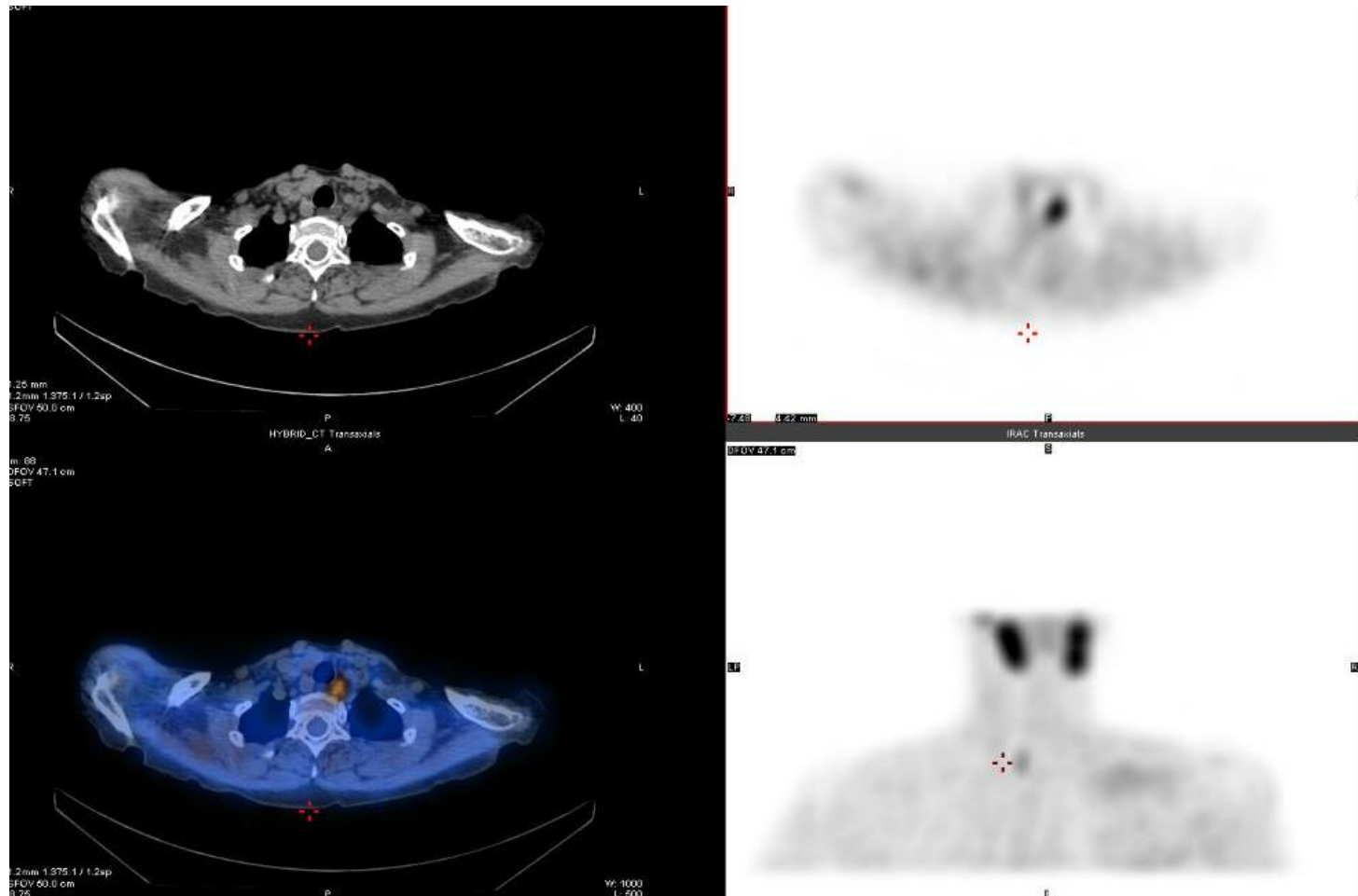
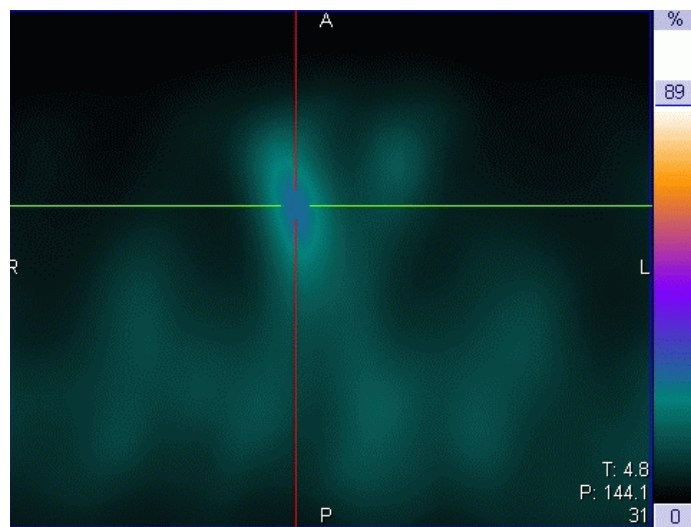


Figure 1. Ectopic parathyroid adenoma. Delayed phase axial (a) SPECT (b) CT and (c) fused SPECT/CT images depicting persistent ^{99m}Tc -MIBI uptake in an anterior mediastinal soft tissue lesion, indicative of a parathyroid adenoma. Without SPECT/CT, the lesion may have been mistaken for a small lymph node.

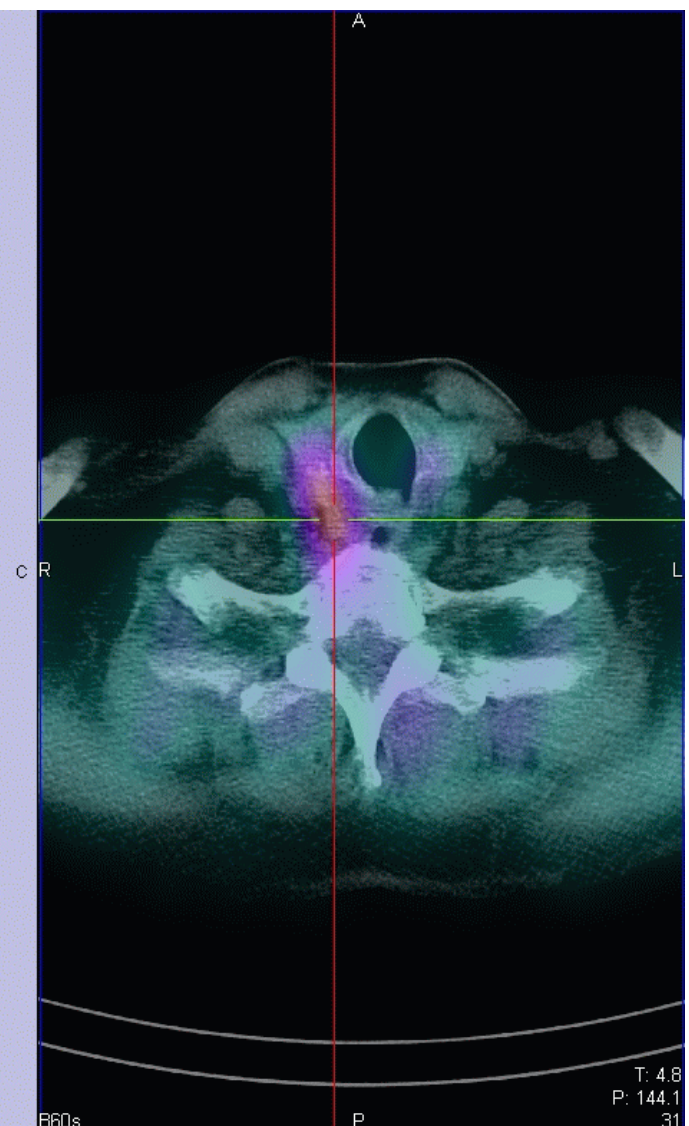
Retropharyngeal parathyroid





(B:0%,T:89%)

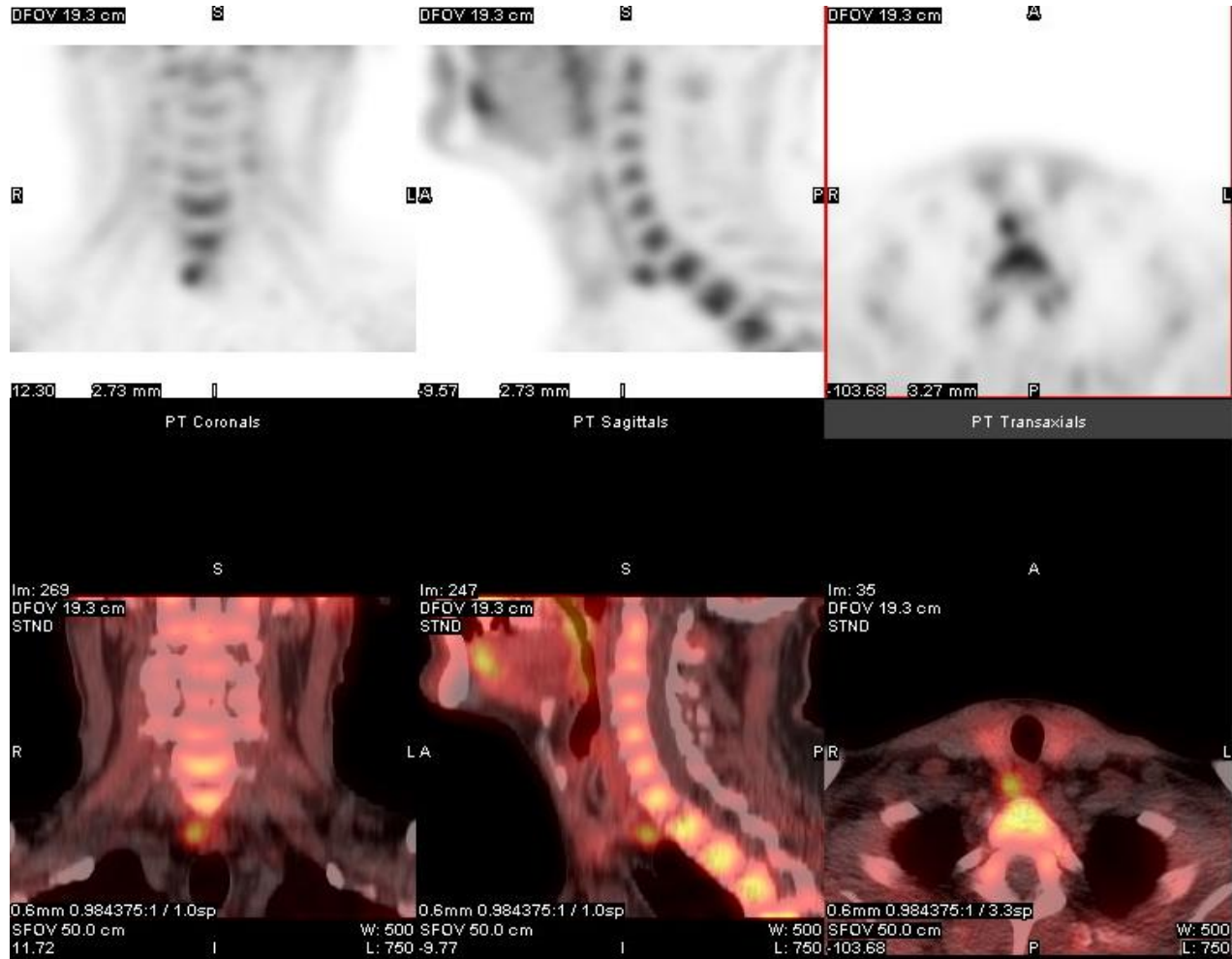
ThorRoutine 5.0 B60s Bone, 26/10/2009



What do you do if MIBI negative

- In about 10% of patients Tc-99m MIBI even with SPECT-CT will not find adenoma
- Normally because size is less than 10mm
- It has been found that in about half these cases a small adenoma may be found with C-11 methionine

C-11 methionine in PTHoma



Adrenal Imaging

- Adrenal gland lies in **retroperitoneal** space
 - Right – above right kidney
 - Left – superomedial to left kidney
- Gland is divided into **two anatomical and functional regions:**

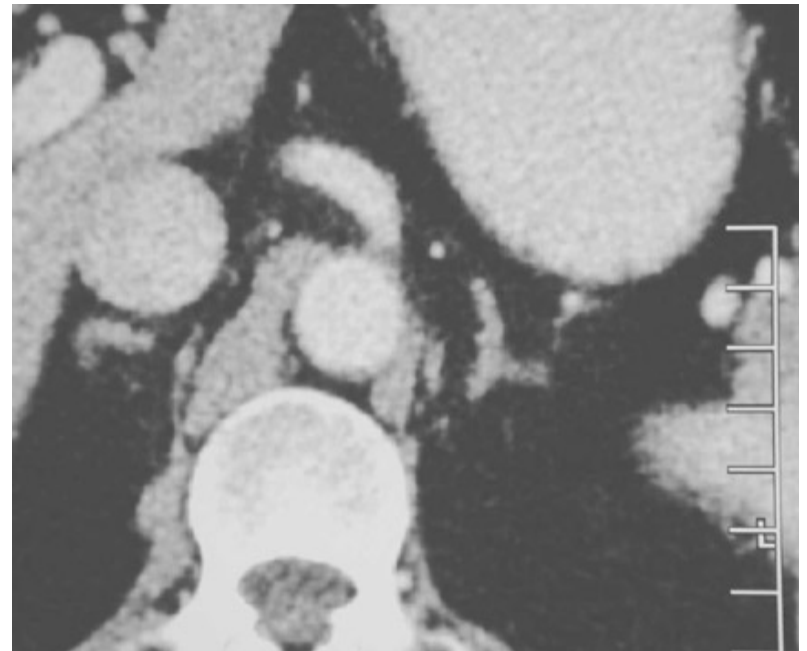
Cortex – produces hormones derived from cholesterol (aldosterone, steroids and androgens)

Medulla – produces catecholamines (adrenaline and noradrenaline). Sympathetic control

Adrenal Glands on CT



RIGHT



LEFT

Imaging of the Adrenal Gland

Adrenal Medulla

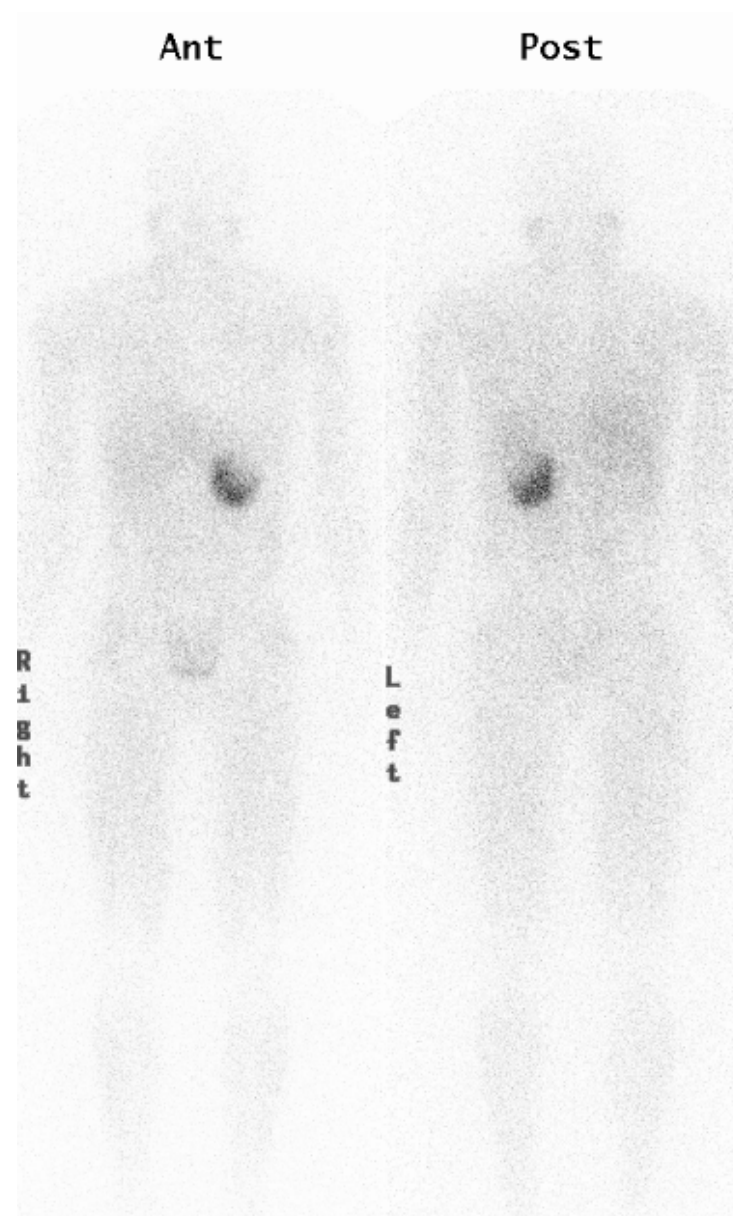
- **Indication:** localisation of phaeochromocytoma (should have +ve catecholamine in urine)
- **Tracer:** ^{123}I MIBG
- **Method of uptake:** amine uptake transporter mechanism present in neuroectodermal tissue
- May need to **stop** drugs which reduce uptake of ^{123}I MIBG - reserpine, cocaine(!) and labetolol and some anti-depressants
- Give **thyroid blockade:** e.g. potassium iodide 60mg bd for 3 days. Start at least 1hr prior to injection

Phaeochromocytoma

- Neoplasm arising from **adrenal medulla**
- **Triad** (paroxysmal headache, \uparrow BP, palpitations)

'10%'

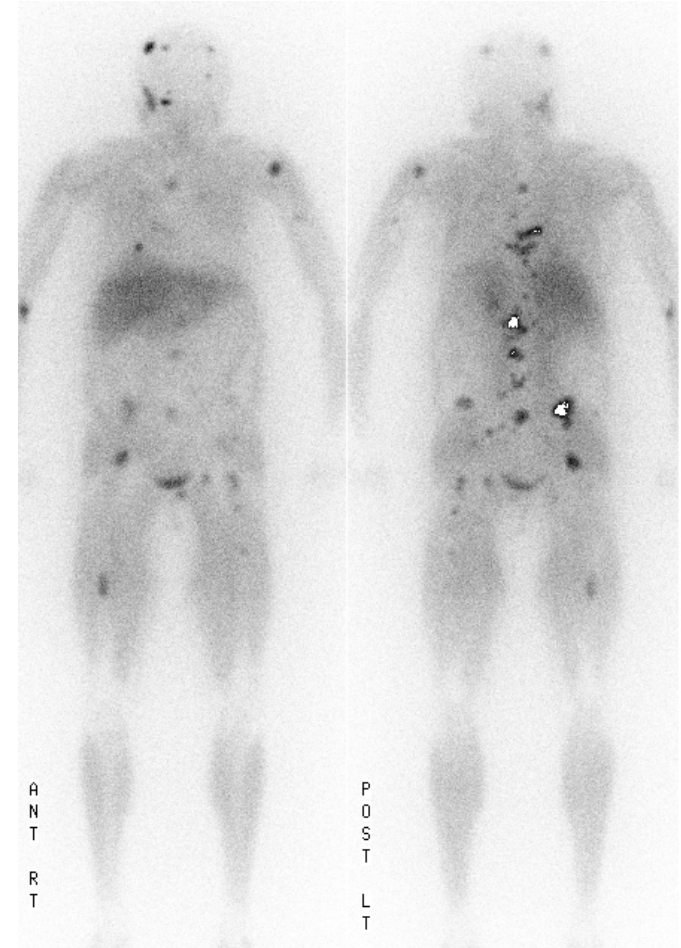
- 10% malignant
- 10% bilateral
- 10% ectopic
- 10% found in children
- 10% associated with syndrome
- 10% neg MIBG scan



Malignant Metastatic Pheochromocytoma

Treatment

High dose (5GBq) x3 ^{131}I -
MIBG if ^{123}I MIBG scan is
positive

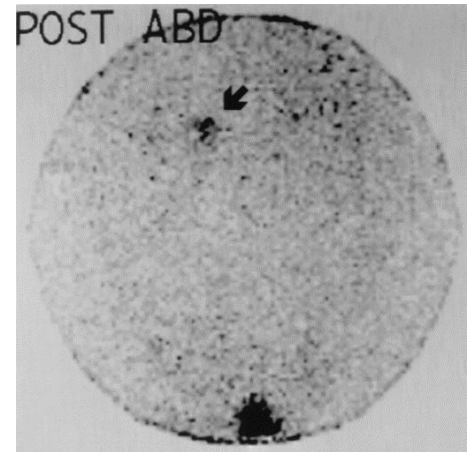


Conn's syndrome

- Named after Jerhorne Conn
- Characterised by raised Aldosterone – high Na, low K, hypertension and CCF
- 5% due to an adenoma
- Removal is curative
- Finding it is difficult
- Relies on CT, MRI and venous sampling
- Not always able to identify side

Traditional functional imaging

- Uptake of Se-75 methyl cholesterol imaging took two weeks
- Due to attenuation standards (known amounts injected in ping pong balls) also used
- More recently I-131 norcholesterol
- However very expensive
- Radiation dose $> 100\text{mSv}$
- Can only find large tumours



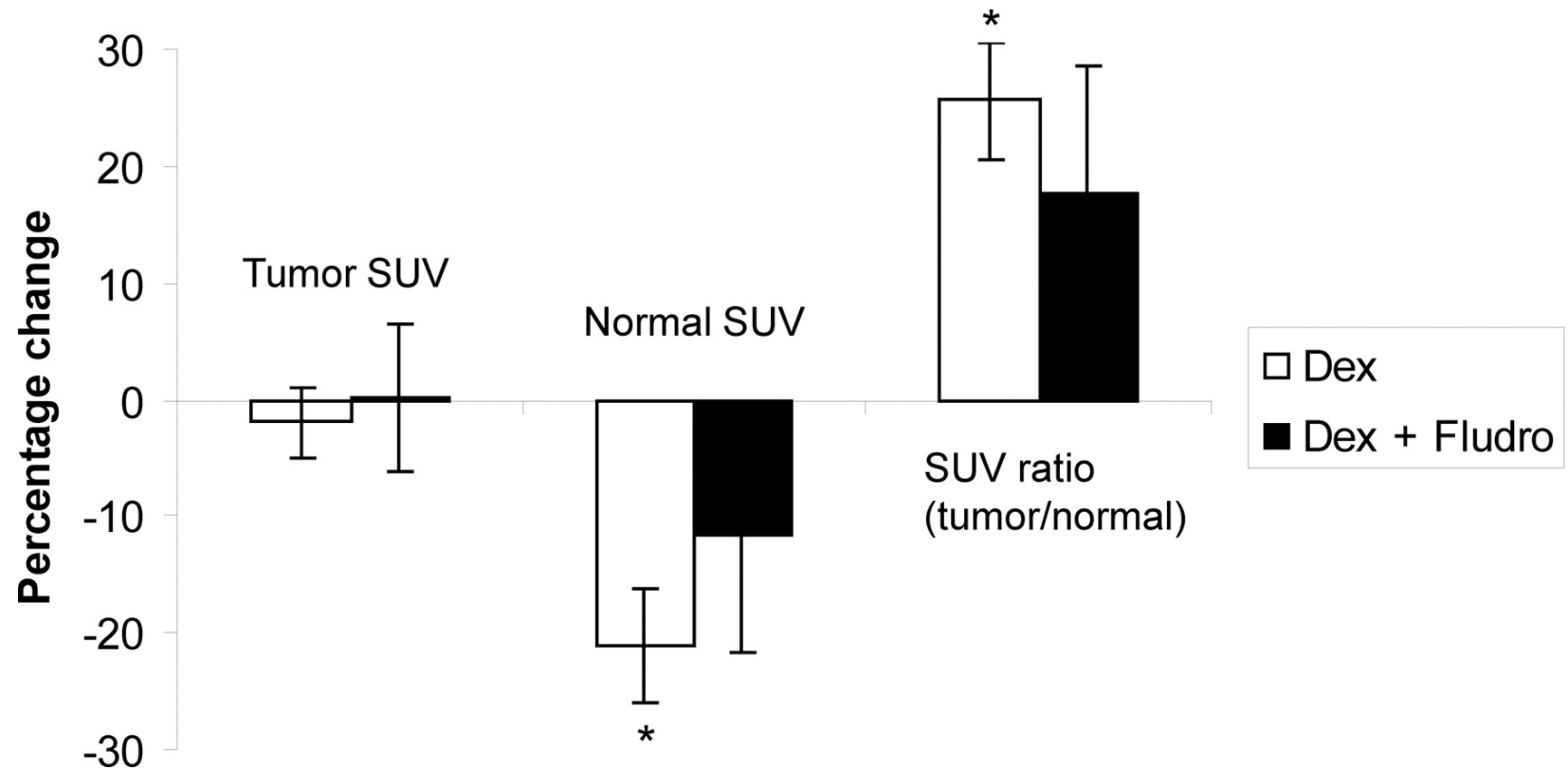
Metomidate

- Imidazole based methyl ester
- Inhibitor of 11beta hydroxylase
- Inhibits aldosterone production in adrenal cortex
- Bergstrom et al Uppsala JNM 2000
- Uptake in liver, stomach and adrenals
- Increased uptake in adreno-cortical lesions

C-11 Metomidate

- Burton et al JCEM 2012
- 39 patients studied some with Conn's some with incidentalomas
- Dexamethasone +/- fludrocortisone 3 days before C-11 metomidate increased TBR
- SUVmax of tumour 22, normal adrenal 14
- Incidentalomas same as normal adrenal or less

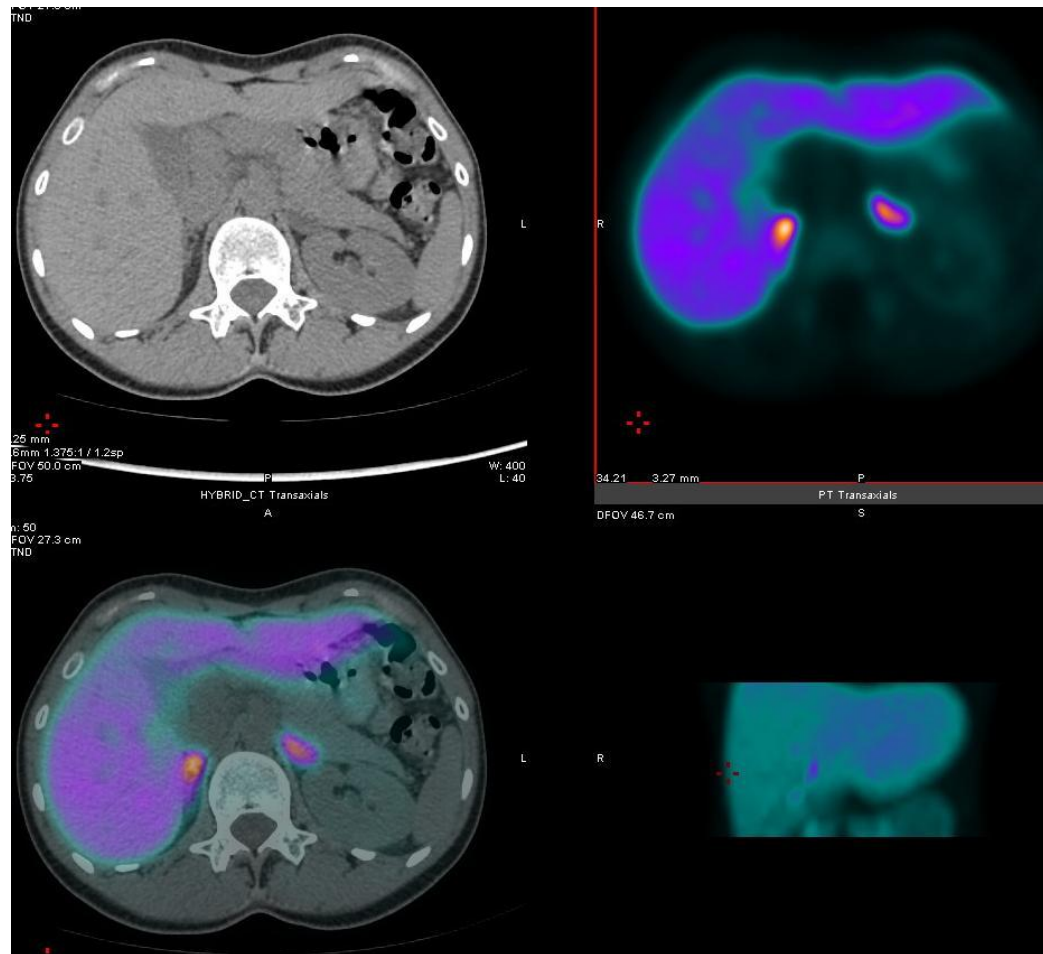
Effect of pretreatment on SUV. Mean \pm sem values are shown in six subjects.



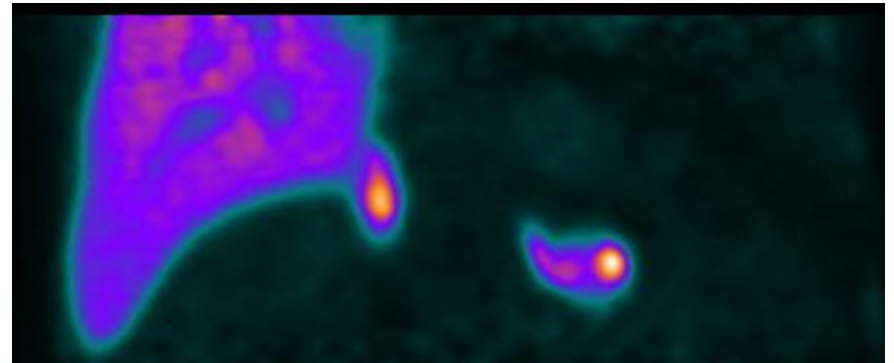
Burton T J et al. JCEM 2012;97:100-109

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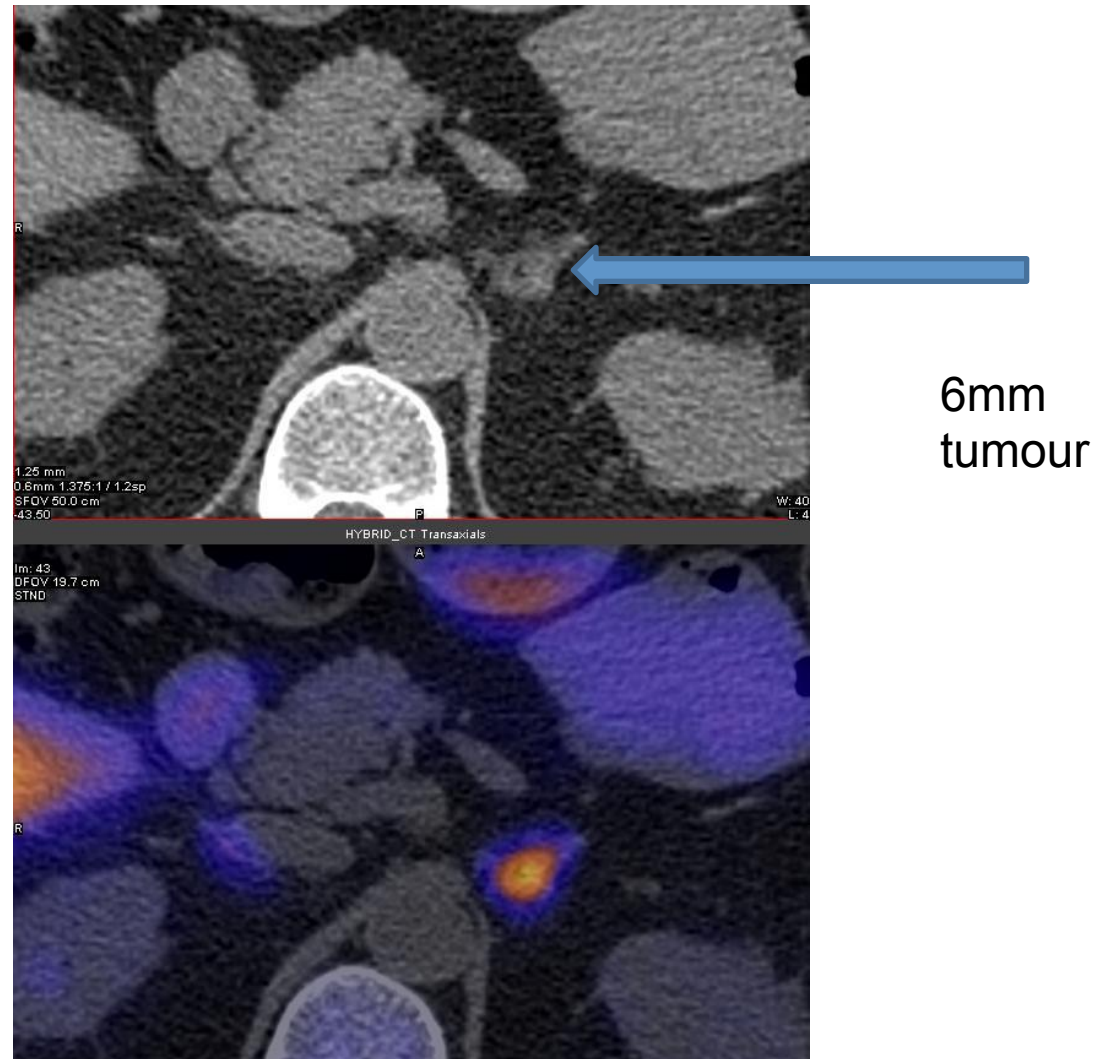
Normal uptake



Conn's tumour



Small tumour



Pituitary tumours

- Either productive
 - TSH
 - ACTH
 - GH
- Non productive tends to lead to syndromes of reduced uptake as replaces working cells
- Normal treatment surgery trans-sphenoidal
- However if symptoms persist ?residual disease

Finding recurrent tumour

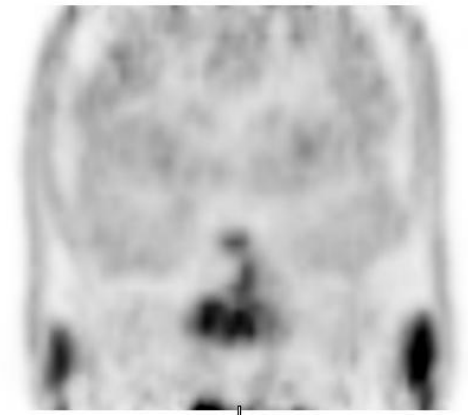
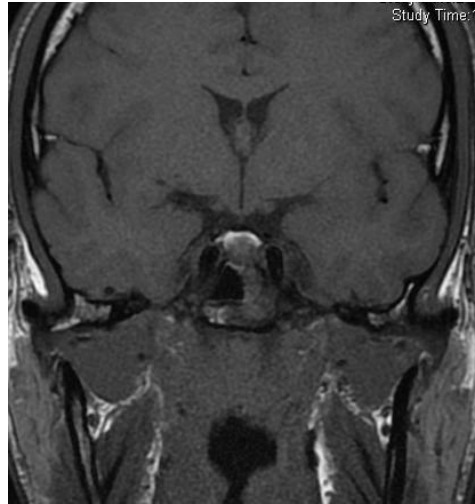
- Normally use MRI
- Look for hypointense on T1 and hyperintense on T2
- Enhances on Gd
- However changes can be non-specific



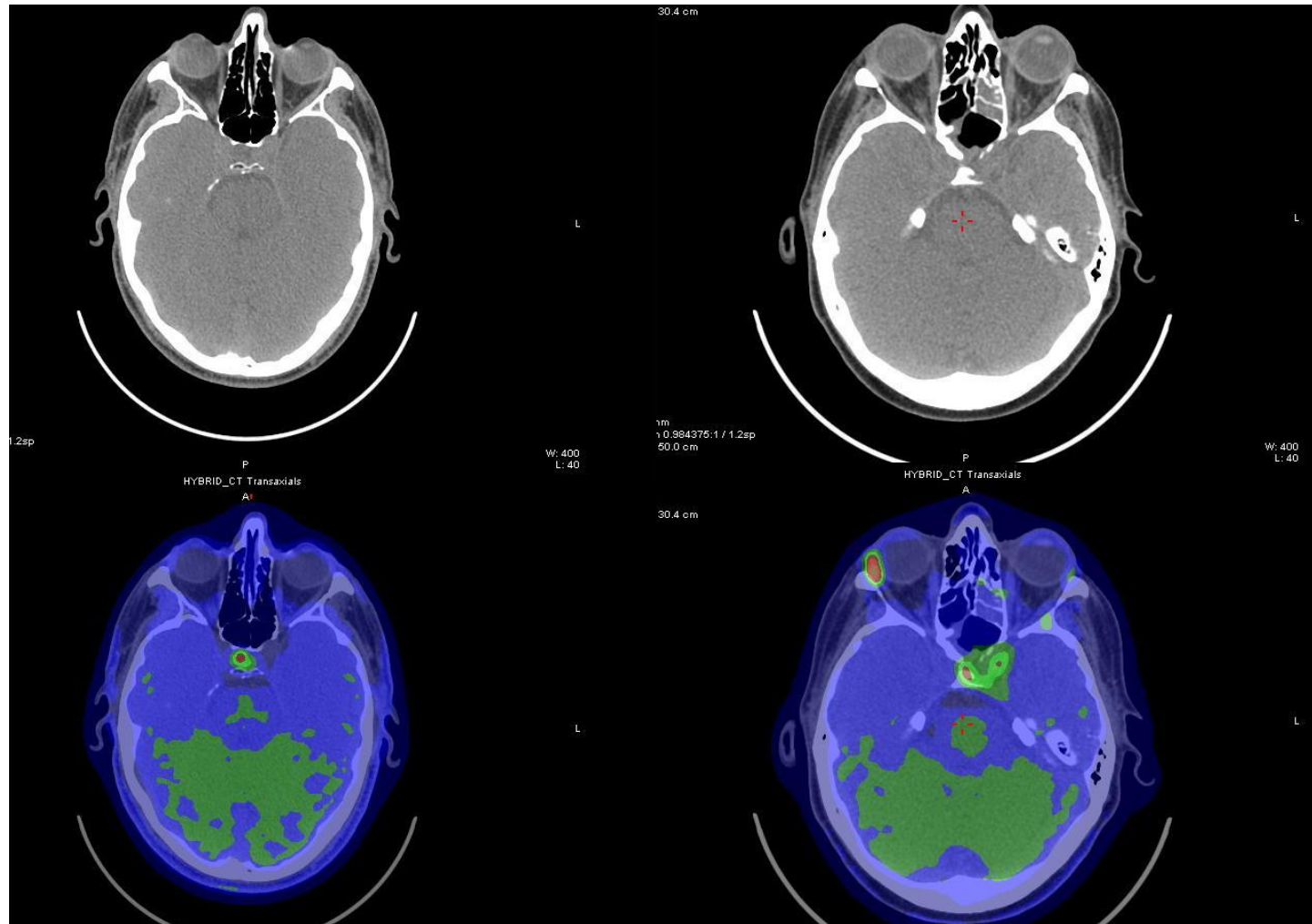
C-11 methionine

- Used to identify tumours
- Uptake related to cell growth
- In brain only malignant cells grow and divide
- So high TBR with normal brain c/w F-18 FDG
- Used to image brain tumours
- Developed use in post surgery recurrence
- Similar role in pituitary tumour

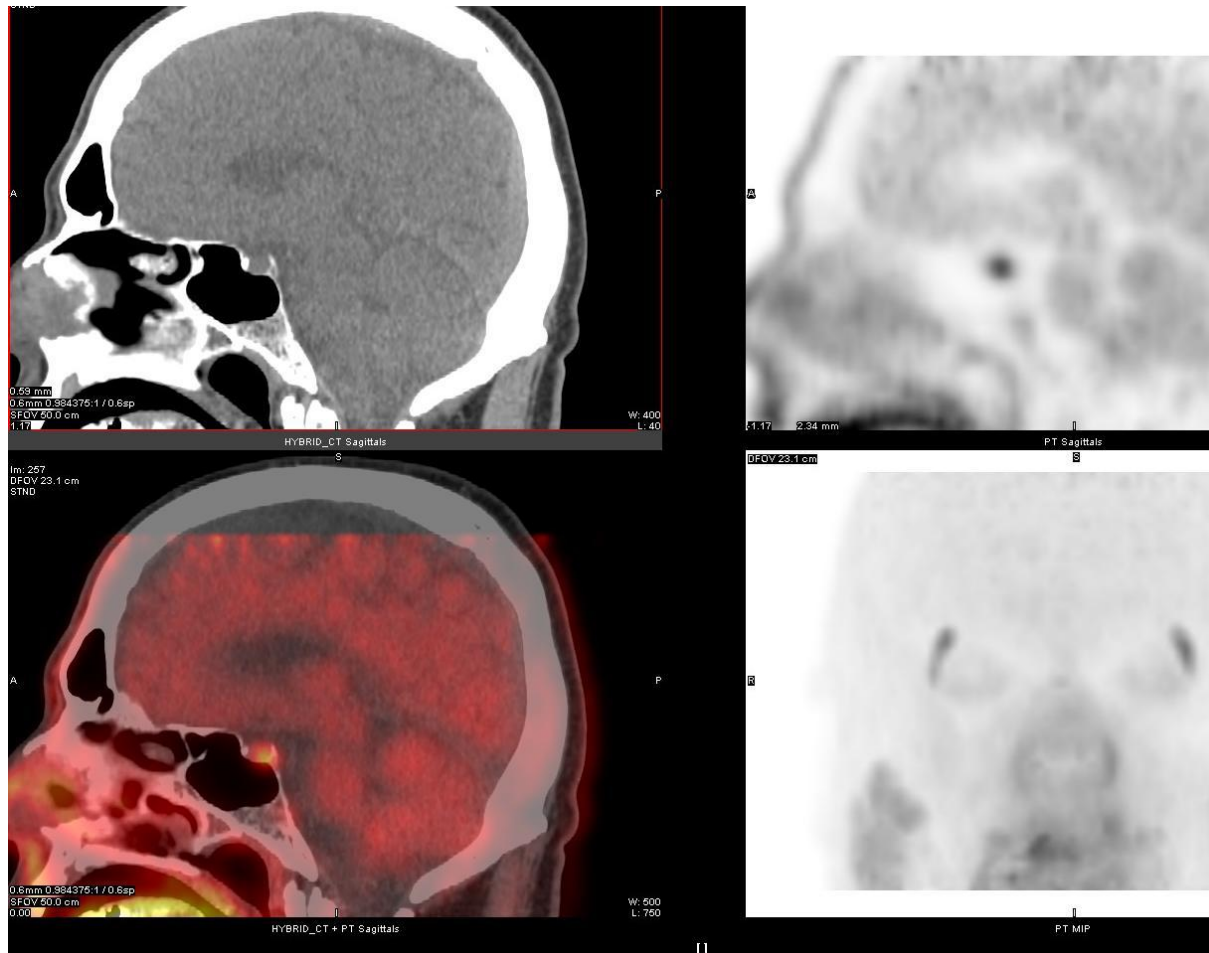
How may C-11 methionine help?



Different size recurrent tumours



Localize in pit fossa



C-11 methionine

- Tang et al EJNMMI Brussels 2005
- 33 patients post surgery with /recurrent tumour
- 24 functional
- 30/33 found with MET PET
- 19/33 found with MRI

Summary

- Single photon is not dead
- SPECT-CT have helped increase the accuracy and localisation of endocrine
- PET-CT techniques also increasing but needs specific C-11 based products so limited availability