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 (TI-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, $^{99m}$Tc pertechnetate)
- **Wait 15 minutes,** then rescan
- **Subtract images**
Washout technique

- Inject agent which **washes out of thyroid but not parathyroid** (**$^{99m}$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
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
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 that 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, ↑BP, palpitations)

‘10%’
- 10% malignant
- 10% bilateral
- 10% ectopic
- 10% found in children
- 10% associated with syndrome
- 10% neg MIBG scan
Malignant Metastatic Phaeochromocytoma

Treatment

High dose (5GBq) x3 $^{131}$I-MIBG if $^{123}$IMIBG scan is positive
Conn’s syndrome

- Named after Jermone 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 > 100mSv
- 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 ± sem values are shown in six subjects.
Normal uptake
Conn’s tumour
Small tumour

6mm 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