Hybrid SPECT/CT imaging, do we really need it?

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What is SPECT/CT?
- Comparing the functional images of Nuclear Medicine with the more anatomical modalities like CT has been done in the past with side-by-side comparison techniques or by the use of software based fusion, overlaying the two sets of data information.

Why Hybrid?
- Following the success of hybrid PET/CT, hybrid SPECT/CT can combine the functional imaging capabilities of SPECT with the precise anatomical overlay of CT images, all performed in the one imaging session.

Hybrid SPECT/CT Provides:
- Precise IMAGE FUSION for anatomical referencing.
- Accurate patient specific ATTENUATION CORRECTION, giving better localisation and definition of organs and lesions, resulting in more accurate diagnoses and improved patient management.

Attenuation Correction
- Correcting for tissue attenuation requires an accurate measurement of the spatial distribution of attenuation coefficients within the patient.
- The Hounsfield units from CT data may be used for this, giving improved statistical information, and greater confidence in detection of abnormalities within deeper organs.
Myocardial Perfusion Scan

- Uncorrected
- Corrected for Tissue Attenuation and Scatter

Short Axis
Vertical Long Axis
Horizontal Long Axis

Image Fusion
- Also called image registration or functional anatomical mapping (FAM).
- Hybrid systems will provide precision alignment of the two sets of image data and eliminate inaccuracies caused by variations in patient position, couch surfaces and the internal changes within the patient from one imaging session to the next.

Hybrid SPECT/CT systems
Hybrid SPECT/CT systems

- Studies have shown SPECT/CT to benefit in the management of patients with a variety of clinical conditions
- In Oncology, to localise tumour sites, assess invasion into surrounding tissues and demonstrate their functional status
- Quality CT images allow Radiologists to compare structural detail with isotope activity, potentially giving a differential diagnosis with no further imaging.

The range of clinical applications includes

- Myocardial Perfusion – Tc99m Sestamibi, Tc99m Myoview or Thallium201
- Skeletal – Tc HDP or MDP
- Neuroendocrine – In111 Octreotide
- Adrenal – I123 MIBG
- Lymphomas and Infections – Gallium67
- Sentinel Node mapping – Tc Colloid
- Parathyroid Adenomas – Tc MIBI
- And many more…..

Case Examples

- In over 12 months of use we have encountered many interesting cases, some merely unusual, but a large number where the additional information provided by hybrid imaging has either changed or vastly improved upon the quality of the diagnosis.

Procedure – Bone Scan

- Patient with history of Breast Carcinoma, and low back pain.
- Dose of 865 MBq Tc99m HDP given.
- Delayed whole body and spot views of ribs and skull plus SPECT imaging and low dose non-diagnostic CT of Lumbar Spine for lesion localisation.
Outcome - Localisation of activity in the Lumbar spine

- SPECT/CT fusion images distinguished facet joint arthropathy from Pars fractures therefore targeting the treatment outcomes
- Also indicated that metastases from the breast primary were unlikely.

Procedure – Bone Scan

- 17 yr old female with increasing low back pain and raised ESR.
- Dose of 802 MBq Tc99m HDP given.
- Three phase bone scan of the spine and pelvis, plus SPECT imaging and low dose non-diagnostic CT of Lumbar Spine for lesion localisation.
Findings

- Marked increased uptake is seen just to the left of midline and centred on L3.
- SPECT images locate the foci to the spinous process on the left and posterior to the facet joint of L3/4.
- CT shows the joint and spinous process are unchanged, with the lesion lying within the left Para spinal muscle.

- MRI showed an enhanced lesion on T1 and T2 suspicious of an infective process.
- A Biopsy performed under fluoroscopy was inconclusive.
- Follow-up MRI was more in keeping with a Benign Heterotrophic ossification or Myositis Ossificans.
- CT found the ossification to have progressed, with an increase in size, but no aggressive features were demonstrated.
Patient with a history of Prostatic Cancer and a PSA of 15, ? Metastases.

- Dose of 843 MBq Tc99m HDP given.
- Delayed whole body and spot views of ribs and skull plus SPECT imaging and low dose non-diagnostic CT of Lumbar Spine for lesion localisation.
**Findings**

- Small area of intense uptake at the right inferior sacrum, localised to a sclerotic lesion on the fusion CT, consistent with skeletal metastases.
- Degenerative uptake in the right shoulder joint, mid and lower lumbar spine, both knees and the left wrist.

**Procedure – Bone Scan**

- 85 yr old patient with a history of Prostatic Cancer and a rising PSA ? Metastases.
- Dose of 843 MBq Tc99m HDP given.
- Delayed whole body and spot views of ribs, skull and pelvis, plus SPECT imaging and low dose non-diagnostic CT of Pelvis for lesion localisation.
Findings
- Degenerative changes in cervical and lumbar spine
- Paget's disease in right hemipelvis
- Bladder diverticulum within a right inguinal hernia
- No evidence of metastatic disease

White Blood Cell labelled scan of Polycystic Kidneys
- Patient received 809 MBq Tc 99m Labeled autologous white blood cells.
- One hour and three hour planar images were performed, with SPECT/CT imaging of the abdomen for lesion localization.
Findings

- There is no abnormal tracer uptake in the kidneys.
- Low grade tracer uptake in the stomach and thyroid gland likely artifact from free Pertechnetate.
- Note is made of the kidney and liver disease on the CT scan.

Procedure – Gallium 67 scan

- Patient presented with left otitis externa, suspected osteomyelitis left temporal bone and facial nerve palsy.
- A three phase bone scan was performed, followed by a Gallium67 infection study.

Planar static views

Blood Pool

48 hr Ga67

Bone scan - Transverse slices

Findings – Bone Scan

- Moderate increased tracer uptake at the left base of skull likely osteomyelitis.
- CT localised the activity to the left mastoid process, and ruled out Pagets.
- Other skeletal activity attributed to Pagets’ disease
- Low grade activity also seen on the Gallium scan.

Gallium 67 Coronal and Transverse slices
A repeat Gallium scan at 3 months after intensive antibiotic therapy showed only very mild uptake in the region of the left mastoid.

Procedure – Parathyroid Scan

- 39 yr old female with hypercalcaemia secondary to hyperparathyroidism
- 5 days post caesarean section.
- Scheduled for urgent surgery.

Technique

- Patient received 831 MBq Tc 99m Sestamibi and 196 MBq Tc99m Pertechnetate.
- Early and delayed planar images were performed.
- SPECT imaging and low dose non diagnostic CT was performed of the neck and chest for lesion localization.
Findings

- A large focus of increased uptake related to the upper pole of the right thyroid is present on all phases of imaging.
- CT correlates this with a corresponding low density lesion of approximately 2cm diameter in the right paraoesophageal groove.

Procedure – In111 Octreotide scan

- Follow up scanning for patient with known metastatic Gastrinoma.
- 151MBq Indium111 Octreotide given.
- Whole body and abdomen images obtained at 4 and 24 hours.
- SPECT/CT of the chest and abdomen.
Findings

- Multiple sites of Octreotide avid disease in the Liver, showing progression from the previous studies
- SPECT/CT localises these areas, but also demonstrates one lesion on the CT which is not avid for Octreotide, a PET scan was recommended.

Sentinel Lymph node study

- Patient with known melanoma in the right posterior auricular region
- 20MBq Tc99m Antimony Sulphur Colloid given in four intra-dermal injections
- Early and delayed static imaging performed, plus SPECT/CT of the head and neck.
Findings

- Moderate tracer uptake seen on the right, slightly inferiorly to the injection site
- SPECT/CT localised this to a 5x3 mm infra-parotid node, posterior to the mandible
- Marked on the skin with ink.

Incidental findings on SPECT/CT scans

- The diagnostic quality of the CT portion of the imaging process allows visualisation of other structural abnormalities, most often normal variants or pre existing pathologies.
- However, these must still be commented upon in the reporting.

CT for Myocardial Perfusion study – cysts in liver

Calcified Plaques typical of Asbestosis

Surgical clips in resected Liver Secondaries

Bone Scan – Patient with low back pain showed uptake in posterior ribs
Large mass in Rt lower lobe

Practical Implications

- Costs
- Space
- Radiation Protection
- Staff training
- Projected uses

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References