NET imaging with SPECT/CT
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While imaging of neuroendocrine tumors with somatostatin receptor agonists or antagonists for PET receives most of the attention these days, gamma camera imaging of somatostatin receptor agonists or norepinephrine analogs have been used for decades and remains the workhorse of functional imaging for these tumor types across the world. This article will summarize the role of SPECT/CT imaging for neuroendocrine tumors.

I-123 / I-131 mIBG
Metaiodobenzylguanidine (mIBG) can be coupled to either I-123 or I-131 to provide functional imaging of neuroblastomas, pheochromocytomas, or less commonly, medullary thyroid cancer. I-123, while more expensive, is favored for a number of reasons including better dosimetry, better image quality, and less potential for damage to the thyroid gland in the event of dissociation of the radioisotope from the pharmaceutical. The latter is further protected using either potassium ioidide pills or super-saturated potassium iodide drops (SSKI). mIBG itself acts as a norepinephrine analog and is taken up the presynaptic vesicles of the adrenergic nervous system.

Using I-123 mIBG, which has a physical half-life of 13 hours, the optimal time-point for imaging is at 24 hours post injection, especially when doing SPECT/CT. Early imaging can be done at approximately 4 hours post-injection and delayed imaging at 48 hours post-injection. However, there is limited circulation time at 4 hours, and the image quality is reduced at 48 hours. SPECT/CT can be very important for mIBG scans because smaller lesions are often missed on the planar images (improved contrast resolution), and also for improved anatomical localization. Figure 1 shows a good example of this for a patient with suspected pheochromocytoma. Conversely, patients with more widespread metastatic disease (Figure 2) would have less benefit from SPECT/CT as the findings are obvious.

Figure 1: Utility of SPECT in evaluation of small lesions on an I-123 mIBG scan. Planar image on the left, SPECT/CT image on the right.

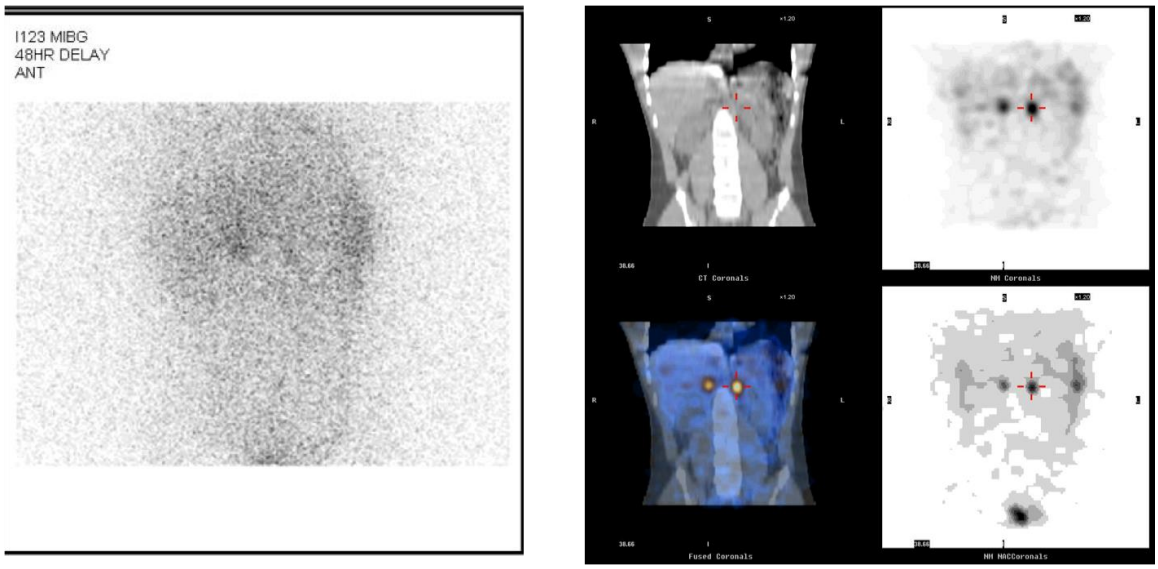
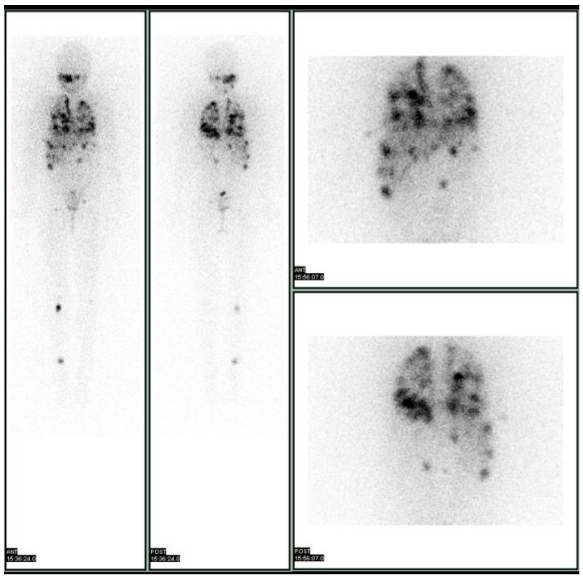


Figure 2. I-123 mIBG whole body scan with widespread metastases. SPECT would be of limited utility in this case.



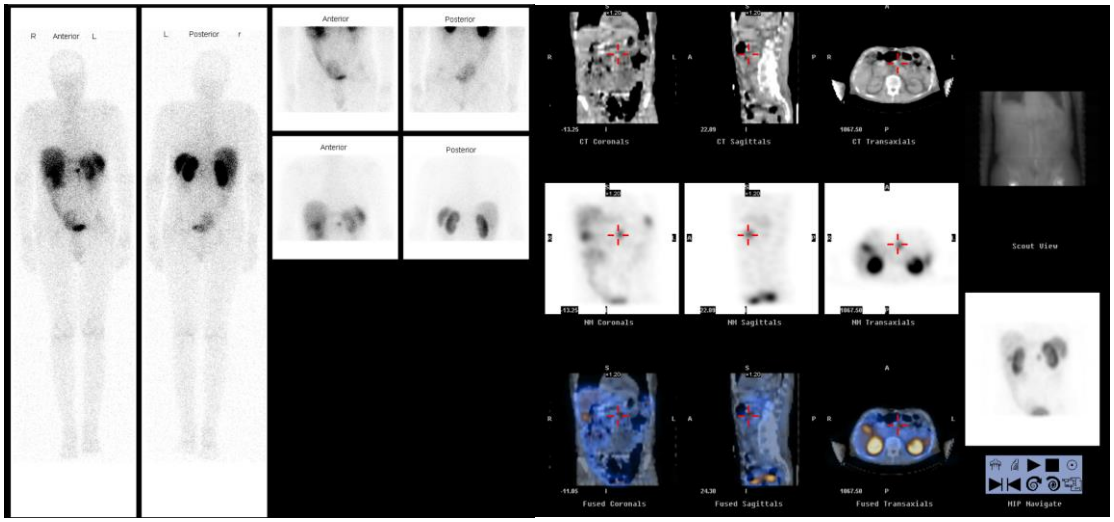
In-111 Pentreotide (OctreoScan)

The medication / chemotherapy Octreotide (Sandostatin) uses an abbreviated 8-amino acid sequence peptide derived from the 14-amino acid sequence human somatostatin molecule to form a somastatin receptor (SSTR) analog used for symptom control in patients with hormone-producing neuroendocrine tumors. It is also often used off-label for prevention of disease progression. Pentreotide uses essentially the same molecule, attached to Indium-111, to form a gamma-emitting

radiopharmaceutical for the functional imaging of a variety of neuroendocrine tumors (NETs). Of the five SSTRs, pentreotide primarily binds to subtype 2, and to a lesser extent subtype 5. As such, not all NETs are imaged with equal efficacy using In-111 Pentreotide depending on the expression of SSTR-2 and -5. Insulinomas, in particular, have poor sensitivity with this imaging agent.

Given the approximately 3-day physical half-life of In-111, there is a wider imaging window for an OctreoScan, with both 24 and 48 hour images providing good image quality for both planar and SPECT/CT imaging. Even further delayed imaging can be done as needed up to one-week post-injection. Typically, a whole-body scan will be done using a planar approach, and then dedicated SPECT/CT imaging of the area of interest or primary disease. While SPECT/CT imaging can be done at multiple time-points, as the goal of the dual-time point imaging is to differentiate physiologic from malignant uptake, often performing only one SPECT/CT at 48 hours, with planar imaging at both time-points is sufficient (for instance to differentiate bowel activity from a lesion within the bowel). However, if there are small lesions, then as in a I-123 mIBG scan, discretion must be applied and potentially multiple SPECT/CTs can be useful. Figure 3 shows an example where a small lesion is seen on the planar image, but better characterized with the help of SPECT/CT by increasing the diagnostic comfort of the primary lesion (i.e., true positive, and anatomical localization), and excluding other sites of disease as being physiologic.

Figure 3. Planar (left) and SPECT/CT (right) images from an In-111 pentreotide scan on a patient with suspected pancreatic NET.



Radiation Considerations

It is interesting and important to know how much additional radiation dose is received by the patient when performing a SPECT/CT scan in addition to planar scintigraphy with these radiopharmaceuticals. These radiation doses, as well as some comparisons, are provided in the table below.

Type of exam	**Typical radiation dose to patient**
SPECT alone	None
I-123 mIBG injection	4.8 mSv
I-131 mIBG injection	7.4 mSv
In-111 pentreotide injection	12 mSv
CT of SPECT (80 kVp, 10 mA)	0.3 mSv
CT of PET (120 kVP, 60 mA)	1-2 mSv
Diagnostic CT (140 kVP, 190 mA)	5-20 mSv
Source: http://www.doseinfo-radar.com/RADARDoseRiskCalc.html	