

SPECT/CT in Neuroendocrine Tumours – a Real Imaging Tool; Applications and Benefits

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In a way comparable with the combined use of PET with CT or MR, hybrid imaging of SPECT using single photon tracers in combination with low dose CT is a recent adjunct, which allows better detection and localisation of diseases. Where PET/CT is not available, SPECT/CT is a relatively inexpensive alternative, which is associated with improved diagnostic sensitivity and accuracy over planar scintigraphic procedures. Moreover, currently the choice of commercially available single photon tracers is greater than that of positron emitting radiopharmaceuticals.

A SPECT/CT scan is generally added to planar scintigraphy in selected cases using a variety of single photon radiopharmaceuticals for a great variety of indications, e.g. scintigraphy of the brain, thyroid and parathyroid, heart and lungs, liver and spleen, kidneys, bone, as well as imaging of infection, bleeding, lymphatic drainage (sentinel lymph node biopsy) and tumours using tumourseeking radiopharmaceuticals, either for diagnostic imaging or for radionuclide therapy.

Following the administration of radiopharmaceutical and a waiting time, which is dependent on the radiopharmaceutical used, first planar scintigraphy is performed, either as a total body procedure or with spot views. On the basis of the scintigram it is determined if additional SPECT/CT is required/meaningful and, if so, the area of interest for SPECT/CT acquisition is selected. First SPECT of the selected area is performed. Subsequently a X-topogram of the area of interest is made, followed by a spiral CT-scan, either with low dose (suffices in most cases) or with diagnostic dose and i.v. contrast.

Then SPECT image reconstruction is performed, both uncorrected and attenuation corrected, and the corrected images are fused with the CT slices, resulting in additional series of transaxial, coronal and sagittal SPECT/CT fusion images.

3D Volume display and stacking of transaxial SPECT/CT slices to form 3D Volume rendered rotational images may also be helpful and illustrative for the referring physician.

For tumour imaging a great variety tumourseeking radiopharmaceuticals may be used, varying from aspecific, like ^{201}Tl -chloride, ^{67}Ga -citrate, $^{99\text{m}}\text{Tc}$ -sestamibi, $^{99\text{m}}\text{Tc}$ -tetrofosmin, $^{99\text{m}}\text{Tc}$ -pentevalent DMSA, to more specific, like $^{99\text{m}}\text{Tc}$ -hypoxymarker, $^{99\text{m}}\text{Tc}$ -annexin V, ^{123}I -MIBG, ^{111}In -pentetreotide, ^{123}I and ^{131}I as iodide, ^{131}I -MIBG, radiolabelled antibodies and others. Specific targeting to neuroendocrine tumours may be achieved by 3 routes: via the metabolism (tumours deriving from the neural crest have an unique active uptake-1 mechanism and granular storage of ^{123}I -MIBG or ^{131}I -MIBG), via peptide binding by receptors at the cell membrane (using ^{111}In - or $^{99\text{m}}\text{Tc}$ -labelled octreotide) or by radiolabelled antibodies directed against neuroblastoma and medullary thyroid carcinoma.

Adding SPECT/CT may not only have advantages over planar scintigraphy in terms of greater sensitivity and better localisation of lesions, but may also be the prelude to therapeutic use of some of these radiopharmaceuticals (selection of patients, dosimetric assessment).

Clinical examples will be demonstrated, in which SPECT/CT, using these specific tumourseeking radiopharmaceuticals may actually be superior to PET/CT, when the relatively aspecific tracer ^{18}F -deoxyglucose (FDG) is used. And in recent years the imaging quality of SPECT/CT has significantly improved, so that SPECT/CT fusion images can well be compared with PET/CT.

Although many radiopharmaceuticals used for radionuclide therapy have less favourable characteristics for scintigraphic imaging, this is much less of a problem for the use of SPECT/CT. Not only does the higher administered dose provide better statistics for the SPECT reconstruction (compared to a diagnostic dose), also the poorer resolution is much less obvious, thanks to the fact that SPECT images will be fused with CT. As a result both the detection and the localisation of tumour sites targeted by the therapy, as well as the assessment of its distribution within/around the tumour, are significantly improved.

In ¹³¹I-ablation therapy of differentiated thyroid carcinoma ¹³¹I-SPECT/CT makes it easier to distinguish normal residual thyroid tissue from lymph node metastases and may detect small metastases missed on planar post-ablation scintigraphy. In non-¹³¹I-avid thyroid tumours, treated with ¹³¹I-iodide based on the thyroglobulin level only, SPECT/CT may demonstrate ¹³¹I-uptake in occult lesions, providing an explanation for the observed response.

The same is true in patients with metastatic neuroendocrine tumours: pre-therapy ¹²³I-/¹³¹I-MIBG and ¹¹¹In-octreotide scintigraphy with SPECT/CT may indicate which of these targeting mechanisms is the prominent one; this will provide the key to therapy. Moreover, the CT-component of this technique may reveal additional tumour localisations, which are not targeted by these radiopharmaceuticals and would require a different treatment modality.

After treatment, post-therapy whole body scintigraphy may be complemented by SPECT/CT to elucidate the successful tumour concentration and retention of either ¹³¹I-MIBG or ⁹⁰Y-Dotatoc/¹⁷⁷Lu-Dotatate.

Conclusions

1. SPECT/CT is a valuable adjunct to many planar nuclear medicine procedures, providing improved detection and localisation of disease.
2. As is the case of PET/CT, hybrid imaging with SPECT/CT is superior to SPECT only.
3. When/where PET/CT is not available or practicable, upgrade or renewal of a gammacamera with a SPECT/CT camera is a more affordable and useful alternative, in view of the many single photon tumourseeking tracers commercially available.
4. In radionuclide tumour therapy SPECT/CT may provide more insight into the effectiveness of the targeting, be an aid in dosimetric assessment and explain the observed response.

References

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Oct.28