

Clinical Usefulness of SPECT/CT in Thyroid Cancer

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Abstract

Thyroid Cancer is the most common malignancy of the endocrine system with the well-differentiated tumors (papillary or follicular) being predominant. In the Philippines, it is the 7th leading cancer, three times more common in females than in males. Precise localization of the foci of I-131 uptake for the management of patients with differentiated thyroid carcinoma is made difficult due to lack of anatomical landmarks in the whole body scan. Hybrid systems are opening up a new era in SPECT imaging. A tertiary hospital in the Philippines has recently acquired the country's first hybrid imaging device combining a dual-detector, variable angle gamma camera with a low dose X-ray tube attached to the same gantry. The objective of the study is to demonstrate the clinical usefulness of I-131 SPECT/CT fusion imaging in patients with well-differentiated thyroid carcinoma. The data from whole body I-131 planar images were first interpreted alone and then re-assessed with the addition of SPECT/CT co-registered images. A total number of 42 patients were studied. Pathologic sites in 26 out of 42 (62 %) patients were identified in both planar and co-registered images. SPECT/CT also provided precise anatomical localization in 10 (24 %) patients not clearly evident in planar images alone. It also enabled exclusion of the disease sites of physiologic tracer deposition in 12 (26 %) patients found suspicious in planar studies alone. Introduction of SPECT/CT imaging altered the therapeutic option, particularly with the administered therapeutic dose of I-131 in 7 (16 %) of patients. Based on our limited experience

in this field we concluded that SPECT/CT allows more precise interpretation of I-131 whole body scan thereby improving diagnostic accuracy and guiding therapeutic options.

Keywords: Thyroid Cancer, SPECT/CT, Hybrid imaging, Co-registration imaging

World J Nucl Med 2007;6:92-95

Introduction

Nuclear medicine studies are largely based on function. They become more meaningful, accurate and reliable when supported by precise anatomical localization (1). Recently, hybrid systems have started a new era in single-photon emission computed tomography (SPECT) imaging. It provides a fusion of functional and anatomic imaging, where functional imaging benefits from anatomical landmarks (2-4). Co-registered data have been shown to be useful in the evaluation of patients with cancer at diagnosis and staging, in monitoring the response to treatment, and during follow up, for early detection of recurrence (5). It is needless to say that anatomic imaging without functional information is incomplete and unsatisfactory.

A tertiary hospital in the Philippines has recently acquired the first and only hybrid imaging device in the country combining a dual detector, variable angle gamma camera with low dose X-ray tube attached to the same gantry. This system enables sequential interchangeable sequence in a single session, acquisition together with SPECT data, of cross-sectional X-ray transmission images with subsequent merging of data into a composite image display (1, 3, 5-6). Additionally, attenuation correction of the emission images is performed with the same anatomical maps to generate transmission maps (1).

Less than one percent of malignant tumors in humans are due to thyroid carcinomas (7). In the Philippines, thyroid cancer is the 7th leading cancer, three times more common in females than in males (8). It is the most common malignancy of the endocrine system with the well-differentiated tumors (papillary or follicular) being predominant (7-9). Precise localization of I-131 uptake on a planar whole body scan is made difficult due to lack of

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anatomic landmarks (10). The objective of this study was to demonstrate the clinical usefulness of I-131 SPECT/CT fusion images in patients with well differentiated thyroid carcinoma.

Methods

Clinical data of patients with well-differentiated thyroid cancers referred for whole body scans with I-131 were analyzed. Routine whole body scan with I-131 was performed with a dual head gamma camera (Infinia Hawkeye General Electric Milwaukee, USA) using a large field of view with high energy collimator a 20 % energy window centered at 364 keV and, 1024 x 512 matrix. Each patient was administered 2 - 5 mCi of I-131 with data acquisition performed 48 – 72 hours later. Anterior and posterior views from head to mid-thigh were obtained. Pinhole images of the thyroid remnants for a total of 200k counts using a 256 x 256 matrix were also acquired. Spot views of suspected sites of metastasis using 256 x 256 matrix for a total of 200k counts were likewise acquired. SPECT images were obtained with 45 sec/frame, 60 projections, 20 % window centered at 364 keV, matrix size of 128 x 128 and zoom factor of 1.0. This was followed by CT acquisition using single slice (1 cm thickness). Using volumetrix software in Xeleris, fused images in coronal, sagittal and transaxial views were then obtained. Whole body planar images were first interpreted alone. Then, they were reassessed with the addition of SPECT/CT co-registered images.

Results

Our study included forty-two (42) patients with well-differentiated thyroid cancer in the first year of operation of SPECT/CT co-registered imaging systems. The pathologic sites in 26 out of 42 (62 %) patients were identified in both planar and SPECT/CT co-registered images. Additionally, SPECT/CT provided precise anatomical localization in 10 (24 %) patients not clearly evident in planar images alone. It also enabled exclusion of disease in sites of physiologic tracer deposition in 12 (26 %) patients found suspicious in planar studies alone leading to a change in therapeutic option particularly with I-131 therapy doses in 7 (16 %) patients. Figures 1 and 2 represent examples of the complimentary role I-131 planar whole body scan and the SPECT/CT in one patient showing significant thyroid cancer in the neck functioning metastases in right lung and anterior chest wall.

Discussion

High quality SPECT images focus on functional abnormalities that appear earlier than the anatomical changes seen with computed tomography (CT) alone. SPECT and positron emission tomography (PET) are very

reliable and accurate methods for detecting malignancies and other related abnormalities. However, these methods do not provide the much needed anatomical landmarks to exactly localize the lesions with high precision (11). On the other hand, CT pinpoints disease location by providing the anatomical details where the lesion resides. Fusion imaging, acquired in a single examination, inherently registers two images for a complete pathology picture. It combines anatomical studies with functional detail and as such, it overcomes the drawbacks of both modalities and emphasizing their individual strengths (2-5). Thus, it increases the diagnostic accuracy of SPECT as co-registered data have shown to be useful in the evaluation of patients with cancer at diagnosis and staging, in monitoring the response to treatment, and during follow up, for early detection of recurrence; all of these leading to a much clearer path to patient management (3-4, 6, 10-17, 19-23). The primary disadvantage of the technique however is the low-dose CT scan. The images obtained are of low resolution. Nevertheless they are very useful for spatial localization and fusion with SPECT data. As such, it cannot be a substitute for CT with high resolution diagnostic quality images. It is also worthwhile to note that radiation burden due to CT is very low at 0.5 mSv as the X-ray tube operates at 2.5 mA (4, 18).

Keider et al. have reported that hybrid studies provide highly accurate localization of tumor sites, assessment of invasion into surrounding tissues and characterization of functional status (3). They have also shown that attempts to co-register functional and anatomical information following acquisitions of two imaging modalities on separate machines, in different sessions failed to disclose proper alignment with precise co-registration. In a study by Schillaci and Simonetti, it has been reported that dual modality integrated imaging systems (SPECT/CT and PET/CT) are particularly useful in tumor imaging as they provide precise localization and allow exclusion of disease in sites of physiologic tracer accumulation. Furthermore, they have also indicated that software-based fusion of independently performed scintigraphic and radiologic images was time consuming and therefore impractical for clinical use (11).

In thyroid cancer, precise anatomical localization of areas of increased I-131 uptake and differentiation of malignant lesions from normal physiologic uptake and benign lesions are not trivial problems in the follow-up of patients with differentiated thyroid carcinoma (4). Tharp, et al. have shown that SPECT/CT fusion images improve the interpretation of I-131 scintigraphy alone in patients with differentiated thyroid carcinoma leading to a change in the therapeutic option in 41 % of the patients. It therefore avoided unnecessary therapy in cases of physiologic uptake at non-malignant lesions and facilitated planning of the surgical approach and optimized therapeutic dose of I-131 (19).

Our findings are similar to those reported in the literature

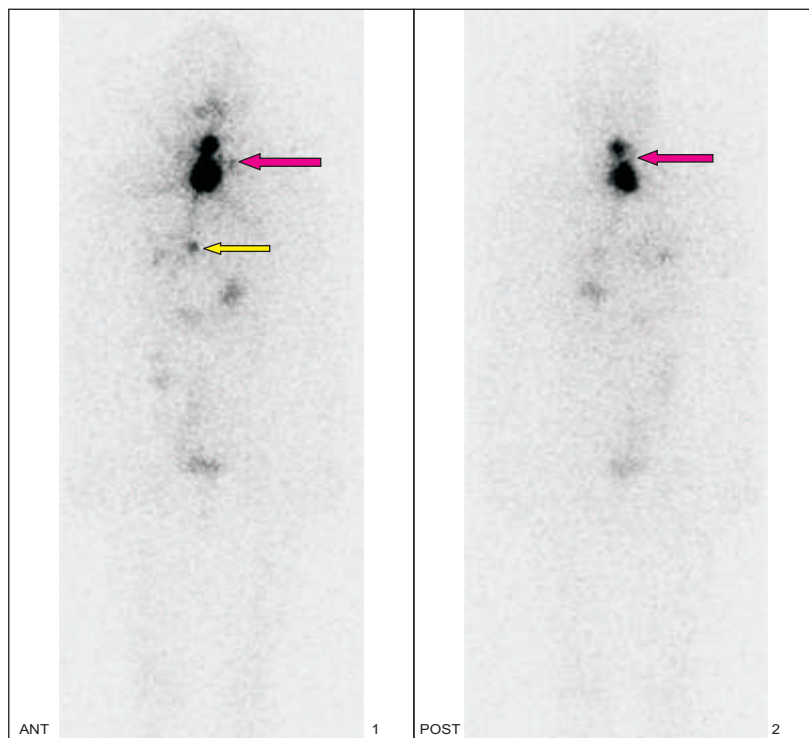


Figure 1. I-131 whole body scan in a patient of follicular carcinoma of thyroid. Status post near-total Thyroidectomy. The anterior (Left) and posterior (Right) view scans reveal significant residual thyroid tissue/residual tumor in the neck (Red arrow). The scan also shows another small focus of I-131 uptake in the anterior view in the anterior

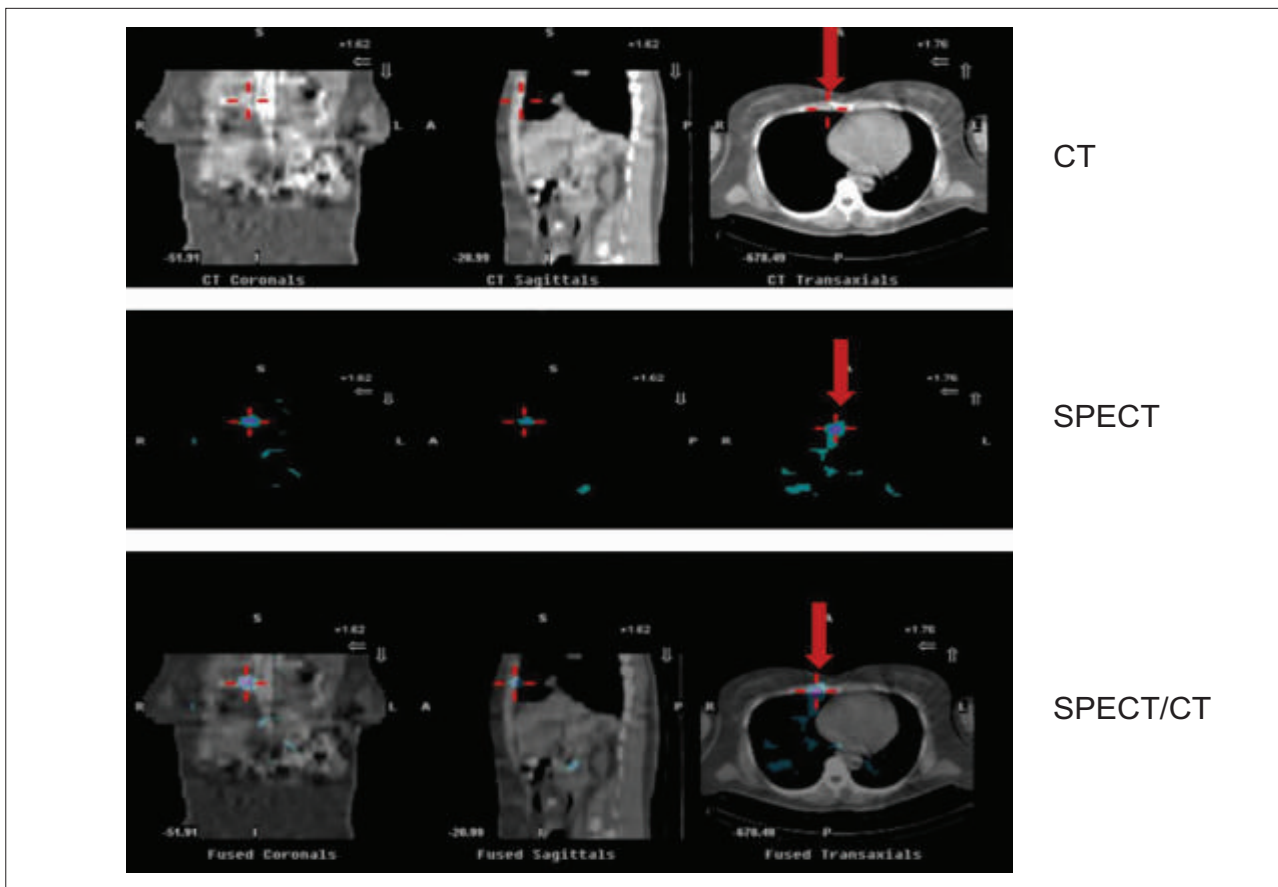


Figure 2. SPECT/CT scans of the chest in the same patient as in Figure-1 localizes the small thoracic lesion in the right lung close to the anterior chest wall (Red arrow).

(3-4, 6,10-12, 19-23). Undeniably, PET/CT represents the fastest growing imaging modality in nuclear medicine to day. However, SPECT/CT also has its own place in clinical practice, and should not be seen as an alternative but as a useful technology for several clinical indications. SPECT/CT is not to be viewed as a technique allowing simple summation of different data. Rather, it efficaciously displays anatomical and physiological relationships. It facilitates both understanding of diagnostic information and characterization of underlying physiology (4). It aids not only in diagnosis and follow-up but also in the selection and planning of appropriate therapeutic options. (4, 19)

Conclusions

SPECT/CT allows more precise interpretation of I-131 whole body scan thereby improving its diagnostic accuracy. It also has impact on patient management more particularly by influencing referral for I-131 treatment, facilitated planning of the surgical approach and optimizing therapeutic dose of I-131 indicating its usefulness in clinical practice.

References

- Bocher M, Balan A, Krausz Y, et al. Gamma camera-mounted anatomical X-ray tomography: technology, system characteristics and first images. *Eur J Nucl Med* 2000; 27:619-27.
- Von Schulthess GK, Pelc NJ. Integrated-modality imaging: the best of both worlds. *Acad Radiol* 2002; 9:1241-4.
- Keidar Z, Israel O, Krausz Y. SPECT/CT in tumor imaging: technical aspects and clinical applications. *Semin Nucl Med* 2003; 33:205-18.
- Schillaci O. Hybrid SPECT/CT: a new era of SPECT imaging ?. *Eur J Nucl Med Mol Imaging* 2005; 32:521-24.
- Israel O, Keidar Z, Iosilevsky G, Bettman L, Sachs J, Frenkel A. The fusion of anatomic and physiologic imaging in the management of patients with cancer. *Semin Nucl Med* 2001; 31(3): 191-205.
- Krausz Y, Israel O. Single-photon emission computed tomography /computed tomography in endocrinology. *Semin Nucl Med* 2006; 36(4): 267-74.
- AACE Clinical practice guideline for the management of thyroid carcinoma. *Endocr Pract* 1997; 3: 60-71.
- Magboo VP, Mania ML, Magboo-Gaviola MLC, San Luis TOL. Prognostic factors for thyroid cancer among Filipinos. *Hell J Nucl Med* 2002; 1 : 46-50.
- Singer PA, Cooper DS, Daniels GH, et al. Treatment guidelines for patients with thyroid nodules and well differentiated thyroid cancer. *Arch Inter Med* 1996; 156:2165-72.
- Yamamoto Y, Nishiyama Y, Monden T, et al. Clinical usefulness of fusion of 131I SPECT and CT images in patients with differentiated thyroid carcinoma. *J Nucl Med* 2003; 44(12): 1905-10.
- Schillaci O, Simonetti G. Fusion imaging in nuclear medicine applications of dual-modality systems in oncology. *Cancer Biother Radiopharm* 2004; 19(1): 1-10.
- Schillaci O, Danieli R, Manni C, Simonetti G. Is SPECT/CT with a hybrid camera useful to improve scintigraphic imaging interpretation ? *Nucl Med Commun* 2004; 25(7): 705-10.
- Schillaci O. Functional-anatomical image fusion in neuroendocrine tumors. *Cancer Biother Radiopharm* 2004; 19(1):129-34
- Krausz Y, Keidar Z, Kogan I, et al. SPECT/CT hybrid imaging with 111In-pentetreotide in assessment of neuroendocrine tumours. *Clin Endocrinol* 2003; 59(5):565-73.
- Jemal A, Tiwari RC, Murray T, et al. Cancer statistics, 2004. *CA Cancer J Clin* 2004; 5:8-29.
- Pfannenber AC, Eschmann SM, Horger M, et al. Benefit of anatomical-functional image fusion in the diagnostic work-up of neuroendocrine neoplasms. *Eur J Nucl Med Mol Imaging* 2003; 30:835-43.
- Hasegawa BH, Wong KH, Iwata K, et al. Dual-modality imaging of the cancer with SPECT/CT. *Technol Cancer Res Treat* 2002; 1(6):449-58.
- Kneifel S. Radiation dose and radiation protection. In: von Schulthess GK (Ed), *Clinical molecular anatomic imaging*. Philadelphia: Lippincott 2003. p. 68-71.
- Tharp K, Israel O, Hausmann J, et al. Impact of 131I-SPECT/CT images obtained with an integrated system in the follow-up of patients with thyroid carcinoma. *Eur J Nucl Med Mol Imaging* 2004; 31:1435-42.
- Even-Sapir E, Keidar Z, Sachs J, et al. The new technology of combined transmission and emission tomography in evaluation of endocrine neoplasms. *J Nucl Med* 2001; 42:998-1004.
- Kainberger F, Kurtaran A, Kienast O, Dobrozemsky G, Czerny C, Kletter K. Hybrid imaging for endocrine diseases: new perspectives. *Wien Klin Wochenschr* 2003; 115 Suppl 2:87-90.
- Ruf J, Lehmkuhl L, Bertram H, et al. Impact of SPECT and integrated low-Dose CT after radioiodine therapy on the management of patients with thyroid carcinoma. *Nucl Med Commun* 2004; 25(12):1177-82.
- Ingui CJ, Shah NP, Oates ME. Endocrine neoplasm scintigraphy: added value of fusing SPECT/CT images compared with traditional side-by-side analysis. *Clin Nucl Med* 2006; 3(11): 665-72.