Original Article

Iodine-131MIBG SPECT/CT in neuroendocrine tumours: An institutional experience

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ABSTRACT

Context: Radiolabelled metaiodobenzylguanidine (MIBG) is commonly used for imaging of neuroendocrine tumors (NETs). The hybrid imaging with single photon emission computerized tomography/computerized tomography (SPECT/CT) co-registration can give that additional edge to this functional imaging modality. **Aims:** To study the additional value of ^{131}I-MIBG SPECT/CT scintigraphy in evaluation of NETs. **Settings and Design:** We performed a retrospective study of the scintigraphic data of patients referred to our department for detection and follow-up of NETs from 2004 to 2008. **Materials and Methods:** Total number of studies were 370. Twenty-eight patients with equivocal findings on planar imaging had undergone additional SPECT/CT imaging. The contribution made by SPECT/CT imaging in these studies was analyzed. **Results:** In 27 of 28 cases, SPECT/CT provided vital additional information. **Conclusions:** We concluded that SPECT/CT co-registration helps in exclusion, identification, and localization of primary and metastatic NETs. It differentiates physiological from pathological tracer distribution. It helps increase the confidence in reporting, especially in equivocal findings on planar imaging.

Keywords: Radiolabelled metaiodobenzylguanidine, neuroendocrine tumors, single photon emission computerized tomography/computerized tomography

INTRODUCTION

Neuroendocrine tumors (NETs) are rare tumors. They represent a group of neoplasms derived from neuroendocrine cells or pluripotent stem cells that are characterized by expression of different peptides and biogenic amines. They grow slowly and are difficult to detect by conventional radiological modalities.[1-4] Radiolabeled metaiodobenzylguanidine (MIBG) is commonly used for imaging of NETs. It provides excellent functional information, though anatomical localization frequently remains poor. The hybrid imaging with single photon emission computerized tomography/computerized tomography (SPECT/CT) co-registration can give that additional edge to this functional imaging modality. This study aims to focus on the additional value of SPECT/CT imaging in MIBG scintigraphy for NET, detection, and follow-up with the experience of studies performed in our institute.

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MATERIALS AND METHODS

Patients

We conducted a retrospective study of the scintigraphic data of patients referred to our department for detection and follow-up of NETs from 2004 to 2008. Total number of studies were 370. The patients with equivocal findings on planar imaging had undergone SPECT/CT. A total of 28 patients were studies (10 females, 18 males; age range: 15-63 years, mean age: 37.39 years).

Patient preparation

^{131}I-MIBG whole-body scintigraphy was performed after stopping all interfering medications like opioids, tricyclic antidepressants, sympathomimetics, and antihypertensives for 7-21 days, as applicable.[5] Thyroid blockade was done using 400 mg potassium perchlorate powder, administered on the day of ^{131}I-MIBG injection, followed for 2 more days at the same dose.

Radiopharmaceutical and dose

^{131}I-MIBG (37 MBq) was administered as slow intravenous injection.

Imaging protocol

Whole-body planar images, in anterior and posterior views, were acquired at 24, 48, and 72 h with double-head gamma camera (Infinia Hawkeye, GE Healthcare, Milwaukee, USA).

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The window was centered at 364 kev ± 15. The matrix chosen was 256 × 1024 and images acquired for 450 s/step in 3 steps.

SPECT/low dose CT was performed at 48 h using the same double-head gamma camera Infinia Hawkeye. The window was centered at 364 keV ± 15%. The matrix chosen was 64 × 64. Acquisition was done with 30-60 s/projection for 60 projections in step and shoot mode, 360° rotation of the camera head in clockwise direction in elliptical orbit. CT was acquired in 256 × 256 matrix with 140 kVp voltage and 2.5 mA current. The slice thickness was 10 mm and up to 40 slices could be obtained in one study. We limited our number of slices to the area of interest.

SPECT/CT processing was done with iterative reconstruction including attenuation and scatter correction using the software Volumetrix Hawkeye.

Image interpretation

The images were interpreted and reported by the five nuclear medicine physicians in our department. They were not blinded. The planar and SPECT/CT reporting for one person was done by the same nuclear medicine physician. For each scan, a consensus was reached after the opinion of all nuclear medicine physicians.

RESULTS

In 27 of the 28 cases studied, SPECT/CT provided pertinent additional vital information for us to arrive at an impression for the given study. It also increased our confidence in reporting [Table 1].

Table 1: SPECT/CT contribution

Contribution made by SPECT/CT	Number of studies
Distinguished bilateral adrenal activity from renal activity	1
Differentiated liver metastases and physiological liver uptake	3
Localized primary neuroendocrine tumor	11
2 liver	
1 neck	
1 gastric	
4 pheochromocytoma	
1 paracardiac	
2 paraganglioma	
Localized metastases	5
2 skeletal metastases	
1 supraclavicular LN	
2 liver	
Provided vital information regarding indentation of and relation with the adjacent structures of the NET	1
Differentiated faint activity in bowel from adrenal tracer uptake	1
Ruled out functioning neuroendocrine tumor where SPECT/CT was performed due to high clinical suspicion	5
Total	27

NET: Neuroendocrine tumor, SPECT/CT: Single photon emission computerized tomography/computerized tomography, LN: Lymph node

In one study, SPECT/CT was reported falsely as liver metastases, where, subsequently, the Tc99m octreotide scan was negative.

Thus, SPECT/CT improved the diagnostic accuracy in 96.42% of equivocal cases.

DISCUSSION

MIBG is an analog of guanethidine. Radioiodinated MIBG was the first radiopharmaceutical to be applied for imaging and therapy of some NETs, in particular catecholamine-secreting tumors (pheochromocytomas, paragangliomas, and neuroblastomas), medullary thyroid carcinomas, and carcinoid tumors.[6,7] It is also used as a carrier for targeted radionuclide therapy. But anatomic localization of MIBG scintigraphy is not accurate. It is partially improved by SPECT. The combination of structural images with functional images can provide complementary anatomical and physiological information that is of great importance to diagnosis and treatment.[8] SPECT/CT technology co-registered tomoscintigraphic images can achieve this purpose.

Few similar studies have also emphasized the importance of SPECT/CT in MIBG scintigraphy.[9,10] They have revealed results similar to our analysis, but in specific clinical entities. Pfannenberg *et al.*,[9] observed that SPECT/CT altered the management and provided valuable information like excluding liver metastases, detection, and localization of liver metastases in patients with metastatic carcinoid. Ozer *et al.*,[10] studied the role of SPECT/CT imaging for MIBG scintigraphy in a 31 patients with suspected pheochromocytoma. In 81% of the cases, fused images correctly characterized the focal tracer uptake detected on planar 123I-MIBG scan segregating physiological from pathological uptake. It also differentiated bone metastases from a local recurrence of pheochromocytoma. Figure 1 and 2 show how SPECT/ CT helped us in localizing metastasis and primary tumour respectively in two of our patients.

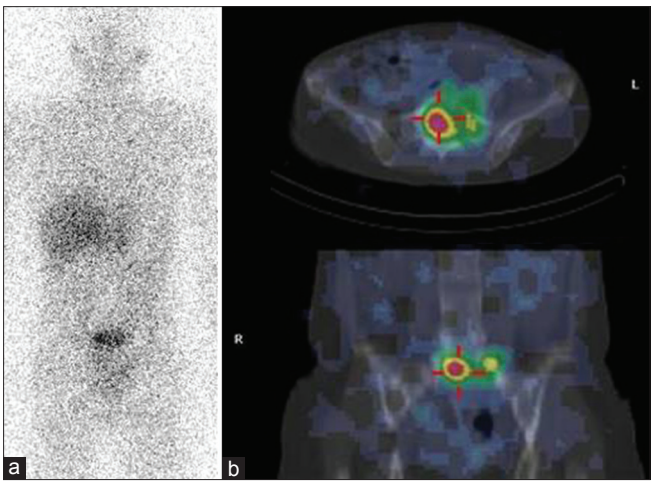

Figure 1: (a) The ^{131}I-MIBG planar images at 48 h reveal abnormal tracer activity in the pelvic region; (b) SPECT/CT images of same patient show the abnormal tracer activity localized to sacrum suggestive of metastasis

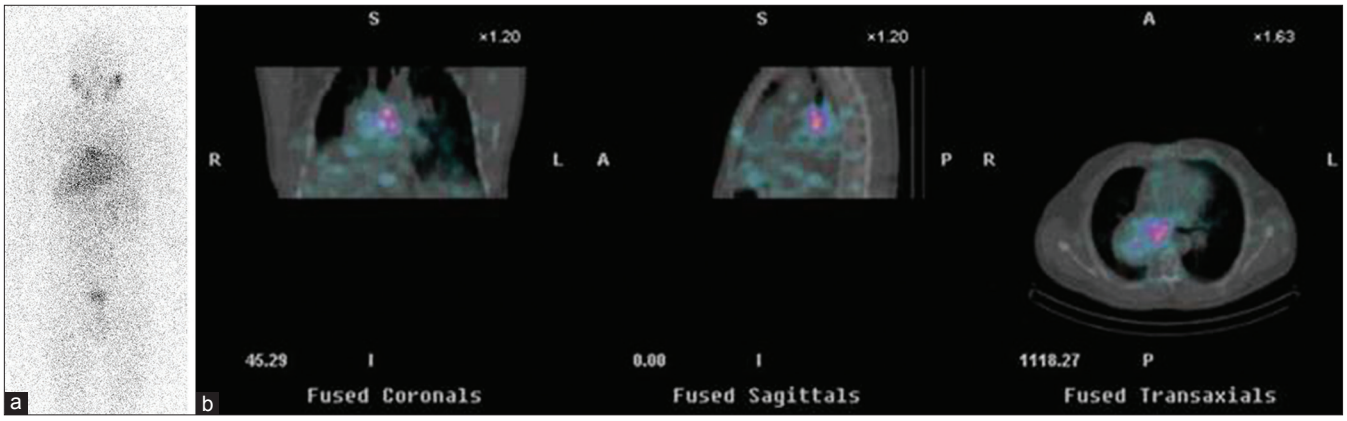

Figure 2: (a) The ^{131}I-MIBG planar images at 48 h reveal tracer uptake in the right side of chest; (b) SPECT/CT images of the same patient show a focal tracer activity in the right paracardiac region, suggesting the presence of right paracardiac NET

In our study, SPECT/CT helped distinguish physiological liver and bowel activities from tumor uptake. It also helped in localizing primary as well as metastatic neuroendocrine lesions. It distinguished bilateral adrenal activity from renal activity in one study. Usually, to distinguish between adrenal and renal activity, a Tc-99m diethylenetriaminepentaacetic acid (DTPA) scan subtracted from the ^{131}I-MIBG planar image, is used. But for one patient, SPECT/CT was utilized for this purpose to save time as early report was warranted by the clinicians for appropriate management. In two studies, it localized a second NET at a different site than the one already mentioned in the clinical details provided for the scintigraphy. We could identify primary, residual, recurrent, and metastatic lesions with the help of SPECT/CT in cases of faint tracer uptake on planar imaging or patients with high clinical suspicion with confidence. One case of false-positive liver metastases in our study may be due to misinterpretation of physiological tracer activity. However, our results show more than 95% improvement in diagnostic accuracy on addition of SPECT/CT in equivocal cases on planar images.

A limitation of this study is was the small number and the heterogeneous sampling of the subjects.

In conclusion, SPECT/CT hybrid imaging provides important additional information in MIBG scintigraphy in cases of equivocal planar studies. SPECT/CT co-registration helps in exclusion of NETs in case of high clinical suspicion and equivocal planar image findings. It differentiates physiological from pathological tracer distribution and resolves diffuse or faint tracer activity seen in the planar image. Anatomic localization of functionally active lesions was more accurate. Additional new NET may also be picked up and localized. Few shortcomings of anatomical inaccuracy may be overcome by using a contrast-enhanced diagnostic CT.

When SPECT/contrast-enhanced CT becomes routine practice, MIBG SPECT/CT may become a diagnostic one-stop shop for diagnosis and monitoring of neuroblastoma and pheochromocytoma.[11]

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