

Localization of Metastases from Malignant Pheochromocytoma in Patients Undergoing ^{131}I -MIBG Therapy with Manually Fused ^{123}I -MIBG SPECT and CT Images

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^{131}I -metaiodobenzylguanidine (MIBG) has been used as a therapeutic agent for pheochromocytoma. Tumor localization and precise staging are essential for therapy with high-dose ^{131}I -MIBG. The sites and extent of ^{123}I -MIBG uptake are usually estimated to predict the effectiveness of therapy before administration. However, conventional scintigraphic images provide insufficient anatomic information. Therefore, we tried to manually superimpose ^{123}I -MIBG SPECT and CT images using free software.

Key Words: pheochromocytoma; SPECT; registration; ^{123}I -MIBG; x-ray CT

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The recent introduction of a hybrid SPECT/CT system has facilitated the process of image fusion (1), but the availability of such specialized equipment is still limited. Therefore, we tried to construct SPECT/CT fusion images without using such equipment (2–6). This study investigated the feasibility and validity of producing SPECT/CT fusion images for accurate localization of metastases from malignant pheochromocytoma.

MATERIALS AND METHODS

This study enrolled 7 patients referred to the Kanazawa University Hospital for therapy with high-dose ^{131}I -metaiodobenzylguanidine (MIBG) for recurrence or metastases from malignant pheochromocytoma (7–9).

All patients underwent CT and ^{123}I -MIBG imaging to evaluate the sites and extent of ^{131}I -MIBG uptake. On imaging of CT and scintigraphy, external markers were placed on the same skin surfaces: the center of the sternal notch, the xiphoid process, and bilaterally on the iliac crests (Fig. 1). The markers consisted of 4 small plastic bullets with a diameter of 8 mm, and for SPECT the markers contained 0.3 MBq of $^{99\text{m}}\text{Tc}$ -pertechnetate. Imaging datasets from the 2 modalities were coregistered and manually superimposed using free software (MRicro; www.mricro.com) (10).

RESULTS

Table 1 shows the rate of metastasis detection by the different imaging modalities. Overall, ^{123}I -MIBG scintigraphy detected 56 metastatic lesions, comprising 35 in

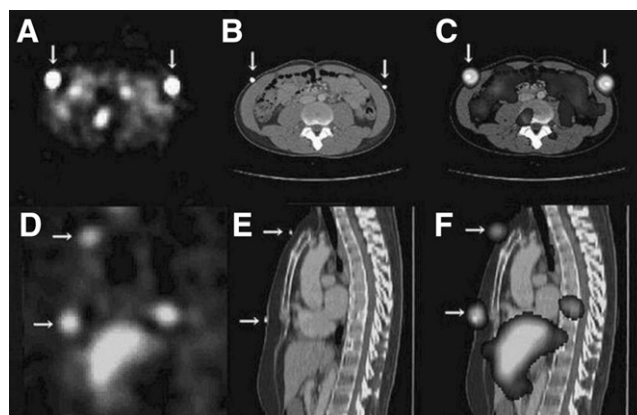


FIGURE 1. SPECT images (A, axial; D, sagittal) and CT images (B, axial; E, sagittal) show external markers bilaterally on iliac crests (arrows), sternal notch, and xiphoid process (arrows). In fused images (C, axial; F, sagittal), all CT markers are completely included in SPECT markers, representing good registration.

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bone, 10 in the chest, and 11 in the abdomen. In patient 1, bone metastasis was overlooked on CT images, despite abnormal uptake at the upper lung level on scintigraphy (Fig. 2). Fused images demonstrated that the site of abnormal uptake corresponded to a metastasis on the T2 vertebra, which was confirmed with MRI. In contrast, CT was superior to scintigraphy in detecting small lesions in the lung field and liver. In our experience, poor registrations occurred more frequently in the lower chest and upper abdomen. Registration of bone lesions was performed correctly because of the limited effect of respiratory movement on those regions.

DISCUSSION

Compared with hybrid SPECT/CT systems, the procedure in the present study has some advantages. Fusion of images can easily be obtained without such specialized equipment, and the patient's exposure to radiation is reduced. We used the data from CT to construct fusion images, which were used to search for metastases. But, the procedure in the present study has some disadvantages. Manual fusion requires a few minutes for data transfer and processing, and external markers need to be correctly placed on the body surface to avoid misregistration between CT and scintigraphic images.

TABLE 1
Detection of Metastases by Different Imaging Modalities in the 7 Patients

Patient no.	Number of hot spots on ¹²³ I-MIBG scintigraphy				Locations of metastases found with the 3 imaging techniques*		
	Bone	Chest	Abdomen	Total	Planar	SPECT	CT
1	1	2	1	4	T2 (1) Lung (2) Liver (1)	T2 (1) Lung (2) Liver (1)	T2 [†] Lung Liver
2	3	2	3	8	T9 (1) Rib (1) Scapula (1) ‡ Liver (1) Lymph node (4)	T9 (1) Rib (1) Scapula (1) ‡ Liver (1) Lymph node (4)	T9 ‡ ‡ Lung Liver Lymph node
3	4	0	0	4	T6–T8 (1) Rib (3) ‡ ‡	T6–T8 (1) Rib (3) ‡ ‡	T6–T8 ‡ Lung Liver
4	0	0	2	2	Adrenal gland (2)	Adrenal gland (2)	Adrenal gland
5	8	0	1	9	T5, T7, T11 (3) Scapula (3) Sternum (1) Femur (1) Lymph node (1)	T5, T7, T11 (3) Scapula (3) Sternum (1) § §	T5, T7, T11 Scapula Sternum [†] § Lymph node
6	18	1	4	23	Skull (1) T9, T11, T12 (3) L2, L4, L5 (3) Upper arm (2) Sternum (1) Pelvic bone (6) Femur (2) Adrenal gland (1) Lymph node (4) ‡	§ T9, T11, T12 (3) L2, L4, L5 (3) § § Pelvic bone (6) § Adrenal gland (1) Lymph node (3) ‡	§ T9, T11, T12 [†] L2, L4, L5 [†] § Sternum [†] Pelvic bone [†] § Adrenal gland Lymph node Liver
7	1	5	0	6	T3 (1) Lung (4) Lymph node (1)* ‡	T3 (1) Lung (4) Lymph node (1) ‡	T3 [†] Lung ‡ Liver
Total	35	10	11	56	56	47	—

*Numbers of hot spots are in parentheses.

[†]Negative on initial report, but positive with retrospective interpretation after fusion.

[‡]No significant findings.

[§]Lesion outside field of view.

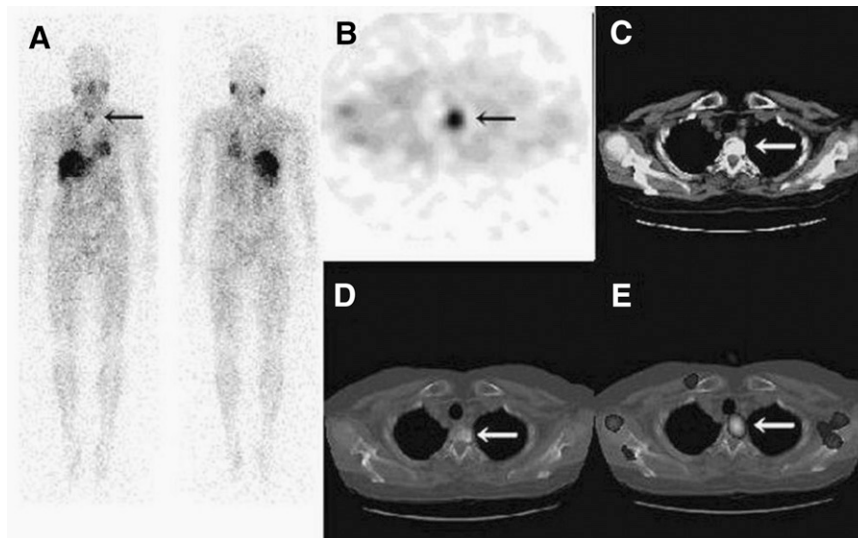


FIGURE 2. (A) ^{123}I -MIBG whole-body scintigraphy of 72-y-old woman (left, anterior; right, posterior) shows area (arrow) of abnormally increased tracer uptake at level of upper chest. (B) Axial SPECT image clearly shows increased tracer uptake, but sites were indeterminate because of lack of anatomic structures. (C and D) Axial CT images do not depict any abnormality under routine imaging conditions, with heterogeneous density under optimal window level (arrows). (E) Fused image shows abnormal uptake (arrow) in metastatic T2 vertebra, with good registration.

CONCLUSION

Image fusion was successful, showed the relationship between the structural CT data and the functional SPECT data, and precisely localized metastatic pheochromocytoma.

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