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

Hiroto Kizu¹, Teruhiko Takayama¹, Hiroyuki Tsushima¹, Atsushi Noguchi¹, Kenichi Nakajima², Masahisa Onoguchi¹, and Seigo Kinuya²

¹Department of Health Sciences, Graduate School of Medical Science, Kanazawa University, Kanazawa, Japan; and ²Department of Biotracer Medicine, Graduate School of Medical Science, Kanazawa University, Kanazawa, Japan

$^{131}$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

DOI: 10.2967/jnmt.108.051656

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 mcytoma (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 $^{99m}$Tc-pertechnetate. Imaging datasets from the 2 modalities were coregistered and manually superimposed using free software (MRICro; www.mricro.com) (10).

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.

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.

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.
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**

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Number of hot spots on $^{123}$I-MIBG scintigraphy</th>
<th>Locations of metastases found with the 3 imaging techniques*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bone</td>
<td>Chest</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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.
CONCLUSION

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

REFERENCES

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

Hirot0 Kizu, Teruhiko Takayama, Hiroyuki Tsushima, Atsushi Noguchi, Kenichi Nakajima, Masahisa Onoguchi and Seigo Kinuya

JNMT
Published online: November 13, 2008.
Doi: 10.2967/jnmt.108.051656

This article and updated information are available at:
http://tech.snmjournals.org/content/early/2008/11/13/jnmt.108.051656.citation

Information about reproducing figures, tables, or other portions of this article can be found online at:
http://tech.snmjournals.org/site/misc/permission.xhtml

Information about subscriptions to can be found at:
http://tech.snmjournals.org/site/subscriptions/online.xhtml

JNMT ahead of print articles have been peer reviewed and accepted for publication in JNMT. They have not been copyedited, nor have they appeared in a print or online issue of the journal. Once the accepted manuscripts appear in the JNMT ahead of print area, they will be prepared for print and online publication, which includes copyediting, typesetting, proofreading, and author review. This process may lead to differences between the accepted version of the manuscript and the final, published version.