Added Value of Abdominal I-131 SPECT/CT in Differentiated Thyroid Cancer

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Abstract

**Purpose:** To evaluate value of the abdominal SPECT/CT in post I-131 treatment imaging for differentiated thyroid cancer.

**Material and methods:** Retrospective descriptive study of 43 patients with differentiated thyroid cancer underwent total or complete thyroidectomy, followed by first I-131 ablation and/or treatment (150mCi). Each post I-131 treatment imaging includes planar total body scan and abdominal SPECT/CT.

**Results:** Among 43 patients (M8, F35, age 19-70 years, mean age 47 years, median age 48 years), 36 foci iodine-avid lesions were found in 29 patients. Thirteen significant lesions from 7 patients were observed.

**Conclusion:** Thirteen of 36 foci iodine-avid lesions were significant lesions which represented 10 metastases, 1 renal cyst, 1 ovarian cyst and 1 fetal thyroid. Abdominal SPECT/CT in post I-131 treatment imaging of patients with differentiated thyroid cancer would be of additional value in identifying accurate location which lead to prompt and proper investigation or management for significant lesion and also excluded the non-significant one. The significant focal iodine-avid lesions could be in almost all abdominal zones. The non-significant lesions tend to be in LUQ and MLQ. Most of the significant lesions showed intense avid uptake while all faint uptake were non-significant physiologic tracer accumulation.

**Background**

Thyroid cancer is the most common endocrine cancer. Its incidence has continuously increased in the last three decades all over the world. Now the incidence is approximately 1.0-1.5% of all new cancers diagnosed in each year (1, 2). Differentiated thyroid cancer (DTC), which includes papillary and follicular cancer, is about 90% of all thyroid cancer (3, 4).
Complete thyroidectomy is known as the initial treatment (3, 5). Postoperative radioiodine ablation also has role for diagnostic and treatment purposes which are for postoperative staging and destroying postsurgical thyroid remnant, locoregional residual tumor or distant metastasis (2, 3).

The mechanism of iodine uptake is mediated by an intrinsic thyrocyst-based plasma membrane glycoprotein, Sodium-Iodine symporter (NIS), which found in thyroid gland(6). However, there are many sources of benign radioiodine uptake in other organs such as extrathyroidal tissue that express NIS in gastric mucosa, salivary and lacrimal glands, radioiodine excretory pathway in gallbladder, kidney, large and small bowel as well as passive diffusion in cysts(6). So the uptake in radioiodine scintigraphy can be from thyroid tissue or physiologic biodistribution and benign findings.

Radioiodine imaging using conventional I-131 planar total body scan combined with serum globulin measurement has been used for the routine evaluation for restaging and long-term follow-up (2, 6). Still, it is limited due to lack of anatomical landmarks and nonspecific uptake(2).

Hybrid SPECT (Single-photon emission computer tomography)/CT, a rotational gamma camera with low dose CT scan significantly increases the accuracy of the imaging study because it can precisely localize foci of radioactivity to anatomic structure (2, 6).

In Thailand, the SPECT/CT does not use widespread. Only some institutions have the SPECT/CT and additional SPECT/CT is not included in the routine evaluation. So there is limited amount of information on the SPECT/CT study, especially on abdominal SPECT/CT which is not the primary site of the cancer.

Therefore, this study will present the findings, especially the clinical significant one, in abdominal I-131 SPECT/CT in our institution from 2012 – 2013.
Materials and methods

Study design

We conducted a descriptive study using retrospective data of patients who underwent I-131 planar total body scan and SPECT/CT of abdomen at our institution (Ramathibodi hospital, Mahidol University, Thailand) between January 2012 to December 2013.

The study was approved by the Ethics committee on human rights related to research involving human subjects, Faculty of Medicine Ramathibodi Hospital, Mahidol University. Inform consent was waived.

Patient selection

The study group consists of patients who underwent total or complete thyroidectomy, followed by first I-131 ablation and/or treatment (150mCi). Each post I-131 ablation and/or treatment imaging includes planar total body scan and abdominal SPECT/CT at our institution, Ramathibodi hospital, Mahidol University, Thailand between January 2012 to December 2013. The reports of all included study were reviewed retrospectively by a nuclear radiologist (WC) and 3rd year radiology resident (PT).

The inclusion and exclusion criteria are as the followings

Inclusion criteria

1. Patients who were diagnosed differentiated thyroid cancer by pathological report
2. Patients who performed first radioiodine ablation/ treatment using I-131 150 mCi
3. Patients who performed abdominal SPECT/CT
**Exclusion criteria**

1. Patients who performed the diagnostic I-131 abdominal SPECT/CT using 2 mCi.
2. Patients who performed the radioiodine ablation/treatment using other dose of I-131 rather than 150 mCi.
3. Not first radioiodine ablation/treatment studies
4. Patients who have missing clinical information data

**Data collection**

**Patient characteristic**

Data were collected from electronic medical records and included patient characteristic, included age and gender and type of differentiated thyroid malignancy.

**Imaging technique**

Post I-131 treatment imaging was done using GE Infinia VC Hawkeye 4 after administered I-131 150 mCi for 7-12 days. The imaging included planar total body scan and SPECT/CT from neck to pelvis in most patients.

**Imaging analysis**

Images of all cases were loaded into the Picture Archiving and Communications System (PACS) at our hospital, using a DICOM Conformance (Synapse version 3.2.0, FUJIFILM Medical Systems USA’s Synapse® PACS System, USA).

All images were reviewed retrospectively by a nuclear radiologist (WC) who will be blinded to the clinical information.

The iodine-avid focal lesions, well-defined rounded or oval-shaped lesions which locate in one quadrant of abdomen, on I-131 planar total body scan and
SPECT/CT findings were recorded and classified by position and intensity as followed:

1. Position in abdominal regions which were separated into 9 regions in abdomen which are right upper, middle upper, left upper, right middle, central, left middle, right lower, middle lower and left lower quadrants.

2. Faint, moderate or intense degrees of intensity

Chart review

The medical records were reviewed for all patients who were included in our study by a nuclear radiologist (WC) and 3rd year radiology resident (PT) after the imaging data were interpreted to correlated with Tg, antiTg and TSH in the nearby date of imaging studies and to determine which additional imaging examinations, treatments or follow-up data were performed for important findings. At least 1 year of follow-up was possible for each patient.

Result

There were 45 patients who had first I-131 ablation and/or treatment using 150mCi and then underwent planar total body scan and SPECT/CT of abdomen. Two of them were excluded due to poorly differentiated thyroid carcinoma and undifferentiated thyroid carcinoma diagnoses. The 43 patients included 8 men and 35 women, age from 19-70 years (mean age 47 years, median age 48 years). 35 patients had papillary thyroid cancer, 3 patients had follicular thyroid cancer and 5 patients had papillary thyroid cancer with follicular variants. (Table1)
Table 1 Characteristic of the population

<table>
<thead>
<tr>
<th>Details</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Female</td>
<td>35</td>
<td>81</td>
</tr>
<tr>
<td><strong>Type of thyroid cancer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papillary</td>
<td>35</td>
<td>81</td>
</tr>
<tr>
<td>Follicular</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Papillary with follicular variant</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 2 Details of 36 iodine-avid focal lesions in 29 patients

<table>
<thead>
<tr>
<th>Position</th>
<th>Number of foci</th>
<th>Percentage</th>
<th>Faint</th>
<th>Moderate</th>
<th>Intense</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUQ</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2(100%)</td>
</tr>
<tr>
<td>MUQ</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2(100%)</td>
</tr>
<tr>
<td>LUQ</td>
<td>7</td>
<td>19</td>
<td>4(57%)</td>
<td>1(14%)</td>
<td>2(29%)</td>
</tr>
<tr>
<td>RMQ</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>3(100%)</td>
</tr>
<tr>
<td>Central</td>
<td>3</td>
<td>8</td>
<td>1(33%)</td>
<td>1(33%)</td>
<td>1(33%)</td>
</tr>
<tr>
<td>LMQ</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RLQ</td>
<td>6</td>
<td>17</td>
<td>2(33%)</td>
<td>1(17%)</td>
<td>3(50%)</td>
</tr>
<tr>
<td>MLQ</td>
<td>10</td>
<td>28</td>
<td>2(20%)</td>
<td>3(30%)</td>
<td>5(50%)</td>
</tr>
<tr>
<td>LLQ</td>
<td>3</td>
<td>8</td>
<td>1(33%)</td>
<td>2(67%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Of the 43 studies there were 36 foci iodine-avid lesions were found in 29 patients. There were 2 foci(6%) at right upper quadrant, 2(6%) foci at middle upper quadrant, 7 foci(19%) at left upper quadrant, 3 foci(8%) at right middle quadrant, 3 foci(8%) at central quadrant, 0 focus at left middle quadrant, 6 foci(17%) at right lower quadrant, 10 foci(28%) at middle lower quadrant and 3 foci(8%) at left lower
quadrant. (Table 2) Also 10 foci (28%) of faint degree, 8 foci (22%) of moderate degree and 18 foci (50%) of intense degree of intensity were observed.

Of the 36 foci iodine–avid lesions there were 6 uteri, 6 stomachs, 11 intestines, 10 metastases, 1 renal cyst, 1 ovarian cyst and 1 fetal thyroid. Thirteen lesions from 7 patients are significant lesions which need further investigation or management. The location and intensity of the lesions are showed in table 3, table 4 and picture 1.

**Table 3** Position of significant and non-significant uptake lesions

<table>
<thead>
<tr>
<th>Position</th>
<th>Lesions</th>
<th>Significant lesions(%)</th>
<th>Physiologic uptake(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>GI</td>
</tr>
<tr>
<td>RUQ</td>
<td>2</td>
<td>2(100%)</td>
<td>0</td>
</tr>
<tr>
<td>MUQ</td>
<td>2</td>
<td>2(100%)</td>
<td>0</td>
</tr>
<tr>
<td>LUQ</td>
<td>7</td>
<td>1(14%)</td>
<td>6(86%)</td>
</tr>
<tr>
<td>RMQ</td>
<td>3</td>
<td>2(67%)</td>
<td>1(33%)</td>
</tr>
<tr>
<td>Central</td>
<td>3</td>
<td>1(33%)</td>
<td>2(67%)</td>
</tr>
<tr>
<td>LMQ</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RLQ</td>
<td>6</td>
<td>3(50%)</td>
<td>3(50%)</td>
</tr>
<tr>
<td>LMQ</td>
<td>10</td>
<td>1(10%)</td>
<td>3(30%)</td>
</tr>
<tr>
<td>LLQ</td>
<td>3</td>
<td>1(33%)</td>
<td>2(67%)</td>
</tr>
</tbody>
</table>

**Table 4** Intensity of significant and non-significant uptake lesions

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Lesions</th>
<th>Significant lesions(%)</th>
<th>Physiologic uptake(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>GI</td>
</tr>
<tr>
<td>Faint</td>
<td>10</td>
<td>0</td>
<td>9(90%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>8</td>
<td>2(25%)</td>
<td>4(50%)</td>
</tr>
<tr>
<td>Intense</td>
<td>18</td>
<td>11(14%)</td>
<td>6(86%)</td>
</tr>
</tbody>
</table>
The significant lesions from each patient are detailed as followed;

**Patient A** is a 63-year-old man with PTC. His SPECT/CT study showed intense avid lesion at RUQ. He was diagnosed right kidney metastasis and went right nephrectomy.
**Patient B** is a 50-year-old woman known case of PTC with FTC variant. Her study showed intense avid lesions at RUQ, MUQ, LUQ, RMQ, central, RLQ and MLQ. He was diagnosed liver, spine and kidney metastasis. He was treated with I-131 550 mCi and a year later his diagnostic I-131 imaging (2mCi) showed partial improvement of metastasis and lower stimulated thyroglobulin (Tg) level.

**Patient C** is a 67-year-old woman with PTC. Her study showed intense avid lesions at MUQ. She was diagnosed T12 vertebra metastasis. Her follow-up a year later showed low stimulated thyroglobulin (Tg) level and negative diagnostic I-131 imaging (2mCi).
Patient D is a 43-year-old woman with FTC. Her study showed moderate avid lesion at RLQ. She was diagnosed right iliac metastasis and re I-131 treatment was done.

Patient E is a 31-year-old woman with FTC. Her study showed avid lesion at LLQ. She was diagnosed left ovarian cyst. She went left cystectomy of the left ovarian cyst. The pathology is mature cystic teratoma.
**Patient F** is a 26 year-old woman with FTC. Her study showed intense avid lesion at LLQ. She was pregnant and the lesion was fetal thyroid. She had an abortion.

**Patient G** is a 43 year-old woman with FTC. Her study showed intense avid lesion at RMQ. It was right renal cyst. Her ultrasound shows simple renal cyst at right lower pole.
Discussion

In several previous studies showed that SPECT/CT improved the diagnosis, staging and follow-up in patient with DTC (2). In Wakabayashi H, et al. study reported that SPECT/CT also improved confidence of the nuclear radiologists to make precise localization and differentiated physiological from pathological foci (8).

In the study of Menges, et al. published that the sensitivities of SPECT/CT and planar imaging did not significantly difference, were both 62%, but the specificity was significantly higher in SPECT/CT (98%) compared to planar imaging(78%)(9).

There is another study by Ciapuccini et al. which said that neck and thorax SPECT/CT has high sensitivity(78%) and specificity(100%) in the diagnosis of 32 patients(10).

In our study, we focused on abdominal SPECT/CT in post I-131 treatment imaging of patients with differentiated thyroid cancer in Ramathibodi hospital. The study shows that abdominal SPECT/CT would be of value in identifying accurate location and organ. In addition, our data also provide further information of the significant location and intensity of the avid uptake foci which help to prompt and proper investigation or management.

The significant focal iodine-avid lesions could be in almost all abdominal zones. The non-significant lesions tend to be in LUQ and MLQ which are physiologic uptake such as stomach, intestine and uterus.

Most of the significant lesions showed intense avid uptake, about 85%. Only 25% of moderate uptake lesions were significance. All faint uptake were non-significant physiologic tracer accumulation.

Limitations

There are some limitations in this study. First, not every patient underwent abdominal SPECT/CT after planar total body scan in our institution. This could lead to small amount of population in our study and some selection bias. Second, the
retrospective nature resulted in some missing data in the clinical information. Third, most of the lesions had no pathological confirmation. Finally, there were certain numbers of lesion diagnosed by correlation with clinical and laboratory findings or follow-up images rather than histopathology.

Conclusion

36 foci iodine-avid lesions were found in 29 patients. Thirteen of them were significant lesions which represented 10 metastases, 1 renal cyst, 1 ovarian cyst and 1 fetal thyroid.

Abdominal SPECT/CT in post I-131 treatment imaging of patients with differentiated thyroid cancer would be of additional value in identifying accurate location which lead to prompt and proper investigation or management for significant lesion and also excluded the non-significant one.

The significant focal iodine-avid lesions could be in almost all abdominal zones. The non-significant lesions tend to be in LUQ and MLQ. Most of the significant lesions showed intense avid uptake while all faint uptake were non-significant physiologic tracer accumulation.

References


