Abstract

In this study we compared whole body scintigraphy with Tc-99m-methoxyisobutyli-sonitrile (MIBI) and Iodine-131 Na (\(^{131}\)I) for detection of residual and/or metastatic disease in well differentiated thyroid carcinoma.

Methods

MIBI and I-131 scans were obtained in 60 patients. TSH measurements were done in all the patients prior to scintigraphy.

Results

Out of 60 patients, for whom both I-131 and MIBI scans were done, I-131 scans were positive in 59 (98.3%) patients, whereas MIBI scans were positive in only 17 (27%) patients. There was only one patient in which I-131 scan was negative and MIBI scan was positive.

Conclusion

I-131 scintigraphy still remains the best way to successfully detect residual/metastatic disease in differentiated thyroid carcinoma.

Key words

Iodine scan, MIBI scan, Whole body scintigraphy, Thyroid cancer.

Introduction

The assessment and follow up of thyroid cancer patients can be done by a variety of methods like clinical evaluation, laboratory tests including tumor markers, x-rays and I-131 scintigraphic imaging. However, in a small percentage of cases, inconsistent results are seen where high level of serum thyroglobulin points towards the presence of disease but x-rays and other investigations including I-131 scintigraphy may fail to demonstrate the presence of lesions. Moreover, before I-131 scintigraphy can be done, thyroid hormones have to be withdrawn for 4-6 weeks which can lead to various problems to the patient like fatigue, malaise, inability to continue with daily activities and reactivation of the disease due to TSH stimulation \(^{(1)}\).

As the results of I-131 scan are sometimes inconclusive, attempts have been made to find out alternative radiopharmaceuticals for scintigraphy which can increase the positivity of the scan. Of these, T1-201 and MIBI are recommended for the follow up of the patients with well differentiated thyroid carcinoma. The various advantages of using these radiopharmaceuticals over I-131 are (i) no need to stop the thyroid hormone suppressive therapy (ii) a shorter period of time interval between injection and imaging (iii) a lower radiation dose and (iv) the possibility of using SPECT due to the better imaging characteristics compared with I-131 \(^{(2)}\). Recently, it has been suggested that MIBI whole body imaging may be more sensitive than other imaging methods for the detection of recurrence and metastasis in patients with high plasma levels of biochemical tumor markers \(^{(3)}\). MIBI has been reported to localize in various tumors and also in thyroid tissues with various pathological conditions such as primary thyroid lymphoma, thyroid nodules, medullary thyroid cancer and distant metastasis of thyroid cancer as reported by various authors \(^{(4-7)}\).

Materials and Methods

Sixty randomly selected patients of differentiated thyroid cancer who attended the Department of Radiation Oncology at Kuwait Cancer Control Centre, Kuwait between May 1998 and November 1999 were evaluated by...
Comparison of Whole Body scan, Al-Saleh, et al

MIBI and I-131 scintigraphy. All patients were histopathologically proved. Forty-three were females and 17 were males. The mean age was 42 yrs. (Range 10-70 yrs). All patients had undergone total or near total thyroidectomy. The histopathologies studied were papillary 52 pts. and follicular 8 pts. Out of the 60 patients which were evaluated by MIBI and I-131 scintigraphy, 39 patients were in post operative group, 16 were post operative and post ablative group and 5 were in post operated and post therapy group. Seven out of 60 patients had metastatic disease either in lung or in bone or both. TSH measurements were done in all patients, prior to scintigraphy and patients were included in the study only when the TSH levels were >30 i.u./ml. The suppressive dose of eltroxin was not started in the new patients and stopped for 5-6 weeks in those who were already on eltroxin.

Serum thyroglobulin estimation was not done in most of these patients due to lack of facility at that time in our hospital. So we had omitted this important investigation in our study. Otherwise it is a routine now-a-days to do thyroglobulin estimation in such patients in our institute.

The ablative dose of Iodine 131 therapy varied from 80 to 100 mCi and therapeutic dose ranged from 150-200 mCi. Iodine therapy was not given in patients who have no significant uptake after postoperative thyroid scan. In patients who had metastatic disease either in lung or bone (proved by plain X-ray) therapeutic Iodine was administered without prior uptake and post therapy dose scanning was done to check the uptake at the site of the disease.

Scintigraphy

The images were obtained using a 256 x 1024 matrix, multispect Siemens Gamma Camera using low energy general purpose collimator autocontour.

I-131 Scintigraphy

The patients received 3-5 mCi of I-131 Na orally and scintigraphy was performed 72 hours later. A 20% symmetric window centered at 364 KeV was used for photon detection. Both anterior and posterior whole body images were obtained (Fig.1 and 2).

Fig. 1: I-131 Whole body scan for a patient with skull bony metastasis of differentiated thyroid carcinoma. (A) ant. Skull view (B) left lateral view

Fig. 2: Same patient in Fig. (1) with (A) anterior chest view (B) anterior abdomen view.

MIBI Scintigraphy

The patients were given 20 mCi of Tc-99 MIBI intravenously. A 20% symmetric window centered at 140 KeV was used for photon detection. The patients were given 6 oz milk orally 30 minutes after the injection. The imaging was done after 1 hour of MIBI injection. Both anterior and posterior view images were obtained. Spot images of pathological areas were taken if necessary (Fig. 3 & 4).

All the scan images were evaluated by two nuclear medicine specialists independently and consensus was then reached concerning the visualization or non-visualization of lesions.

Results

Out of 60 patients who were evaluated for I-131 and MIBI scan, 39 patients were in post operative study group, 16 were in post ablative group and 5 were in the post therapy group. In the post operative study group, out of 39
patients, 34 (87%) were positive on Iodine scan whereas only 14 (36%) were positive on MIBI scan. These 14 patients were also positive for Iodine scan. The remaining 5/39 patients were negative for both I-131 and MIBI scans [Table 1].

<table>
<thead>
<tr>
<th>Post op. study</th>
<th>+ve I-131</th>
<th>-ve I-131</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ve MIBI</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>-ve MIBI</td>
<td>20</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>5</td>
<td>39</td>
</tr>
</tbody>
</table>

**Table 1.**

In the post ablative group, out of 16 patients, only 3 (19%) were positive on Iodine scan and I was positive on MIBI scan. This one patient was also positive on Iodine scan. Rest of the 13/16 patients were negative on both I-131 and MIBI scan [Table 2].

<table>
<thead>
<tr>
<th>Post ablative group</th>
<th>+ve I-131</th>
<th>-ve I-131</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ve MIBI</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-ve MIBI</td>
<td>2</td>
<td>13</td>
<td>15</td>
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<tr>
<td>Total</td>
<td>3</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>

**Table 2.**

In the post therapy group, there were 5 patients, out of which 4 (89%) were positive on Iodine scan and 1 patient was negative on Iodine scan. The same 5 Patients also had MIBI scan, out of which 2 (40%) were positive and 3 were negative for MIBI scan. [Table 3]. One patient who was negative for Iodine scan was positive for MIBI scan. This patient had bilateral lung metastasis.

**Discussion**

In an attempt to improve the diagnostic sensitivity of differentiated thyroid cancers various radioactive isotopes have been used
Comparison of Whole Body scan, Al-Saleh, et al

Table 3.

<table>
<thead>
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<th>Post therapy group</th>
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<th>-ve I-131</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ve MIBI</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>-ve MIBI</td>
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<td>3</td>
</tr>
<tr>
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<td>4</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 4.

<table>
<thead>
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<th>Post study</th>
<th>+ve I-131</th>
<th>-ve I-131</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ve MIBI</td>
<td>16</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>-ve MIBI</td>
<td>25</td>
<td>18</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>19</td>
<td>60</td>
</tr>
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</table>

In the past, Iodine 131 has been the primary radiopharmaceutical for detection of thyroid carcinoma. However, the diagnostic yield in the presence of functioning thyroid tissue or when the patient is euthyroid is very poor \(^{(1)}\). Its use in follow up of these patients has certain disadvantages like withdrawal of suppressing doses of thyroid hormones for about 4-6 weeks and need to restrict the iodine intake of these patients. Additionally, the elevated levels of TSH could stimulate tumor growth. As an alternative to I-131 scintigraphy T1-201 and MIBI scans, as well as measurement of Tg levels have been suggested as screening tools in the follow up of well differentiated thyroid cancers. MIBI, which is a myocardial perfusion agent, has been used for tumor imaging for the last few years \(^{(7,8)}\). MIBI accumulates within cell mitochondria and cytoplasm through electrical potentials generated across membrane bilayers \(^{(9,10)}\). The cationic change and lipophilicity of MIBI, the mitochondrial and plasma membrane potentials of the tumor cells and cellular mitochondrial content are considered to play a significant role in the mechanism of this agent’s tumor uptake \(^{(11)}\). However, MIBI accumulation is not specific for thyroid malignancy. According to Foldes et al \(^{(12)}\), its uptake depends mainly on thyroid tissue viability. The role of MIBI in localizing thyroid cancer metastasis has been evaluated successfully \(^{(4,7,13)}\).

In the present study, both I-131 and MIBI scans were done in all the 60 patients. I-131 scans were positive in 59 (98.3%) patients whereas MIBI scans were positive in only 17 (27%) patients. There was only one patient out of 60 where Iodine scan was negative and MIBI scan was positive, whereas all the 17 patients who were positive on MIBI scan were also positive on Iodine scan [Table 4].

In this study we found I-131 to have a better specificity and sensitivity than MIBI for the detection of tumor lesions. The main advantage of using I-131 is that the treatment of lesions showing positive uptake can be planned ahead, something, which is not possible with MIBI \(^{(14)}\). Even if a lesion was to be detected by MIBI that was missed by I-131, no additional therapeutic benefit would accrue because surgical resection is rarely indicated in these patients. However, if before the I-131 scan a lesion is detected using MIBI scintigraphy, the diagnostic dose of I-131 could be adjusted to alter the uptake of the therapeutic dose. MIBI is taken up by normal residual thyroid tissue in pre-ablation patients, making MIBI less specific in the detection of thyroid tumor in the presence of normal thyroid tissue \(^{(6)}\). However, this is not a problem in the post I-131 ablation patients with recurrence of tumor or metastatic disease.

**Conclusion**

The results of I-131 scintigraphy were significantly better than those of MIBI imaging in detection of residual and/or metastatic disease in well differentiated thyroid carcinoma and therefore iodine scintigraphy still remains the best gold standard sensitive method. MIBI scintigraphy may be used as an adjuvant.


