

## DIAGNOSIS OF PARATHYROID ADENOMA USING TECHNETIUM-99m-SESTAMIBI IMAGING

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### ABSTRACT

A 24-year-old female was referred for Technetium-99m-Sestamibi ( $^{99m}\text{Tc}$ -MIBI) parathyroid imaging, due to highly suspected of primary hyperparathyroidism from the clinical and biochemical findings. The early  $^{99m}\text{Tc}$ -MIBI parathyroid imaging clearly demonstrated a focal increased uptake located just inferior to the left lobe of thyroid gland and the lesion showed significantly increased uptake on late imaging at 2 hours after  $^{99m}\text{Tc}$ -MIBI injection, in contrast to the gradually decreased uptake of the normal thyroid tissue. The scintigraphic findings were typical for left parathyroid adenoma. Surgical finding and histopathologic examination also confirmed the diagnosis of the left parathyroid adenoma.

### INTRODUCTION

Hyperparathyroidism is a disease characterized by an excess secretion of parathyroid hormone by adenomatous or hyperplastic glands. The incidence of primary hyperparathyroidism in females and males is about two to one and the disease is most prevalent in the third to fifth decades of life.<sup>1</sup>

The most common cause of primary hyperparathyroidism is due to a single parathyroid adenoma, which is found approximately 80-95%. The remainders are due to parathyroid hyperplasia, multiple parathyroid adenomas and rarely parathyroid carcinoma.<sup>1,2</sup> Adenomas are most often located in the inferior parathyroid gland, but may be found in ectopic locations in about 6-10% of patients.<sup>1</sup>

Different imaging techniques have been used for diagnosis and detection of abnormal parathyroid glands such as radionuclide parathyroid imaging, high resolution ultrasonography, high resolution computed tomography, selective arteriography and magnetic

resonance imaging.<sup>2-6</sup> Among These techniques, dual radionuclide parathyroid imaging using Thallium-201 ( $^{201}\text{Tl}$ )/Technetium-99m-pertechnetate or  $^{201}\text{Tl}$ /Iodine-123 ( $^{123}\text{I}$ ) parathyroid subtraction imagings are well recognized as a useful procedure in the preoperative localization of parathyroid adenoma and hyperplasia.<sup>2,3,7-10</sup>

Recently, the use of Technetium-99m-Sestamibi ( $^{99m}\text{Tc}$ -MIBI) as a new agent for parathyroid imaging was initially reported by Coakley et al in 1989.<sup>11</sup>  $^{99m}\text{Tc}$ -MIBI is a cationic isonitrile analog that has been introduced for myocardial perfusion imaging as an alternative to  $^{201}\text{Tl}$ <sup>12</sup> and later it was applied to parathyroid imaging.<sup>11</sup> Subsequently, the usefulness and effectiveness of  $^{99m}\text{Tc}$ -MIBI in parathyroid imagings have been reported in many series.<sup>13-18</sup>

Parathyroid imagings either with single radionuclide using  $^{99m}\text{Tc}$ -MIBI or dual radionuclide using  $^{99m}\text{Tc}$ -MIBI/ $^{123}\text{I}$  subtraction imaging is a promising procedure in the preoperative detection and localization of parathyroid adenoma(s) in patients with suspected of primary hyperparathyroidism.<sup>11,13-16</sup> Because they can

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locate the lesion in both normal anatomic and ectopic locations. In addition, they are also useful for postoperative detection and localization of abnormal parathyroid glands as well, especially in patients with persistent or recurrent hyperparathyroidism.<sup>15,17,18</sup>

We present a case of primary hyperparathyroidism from left parathyroid adenoma, which produced the typical scintigraphic patterns from the <sup>99m</sup>Tc-MIBI parathyroid imaging.

## CASE REPORT

A 24-year-old female presented with a history of back pain with kyphosis for 5 months prior to admission. Upon physical examination, no neck mass was found and thyroid gland was also normal on palpation. Complete blood count was normal. Serum creatinine and BUN were 1.5 mg% (normal 0.6-1.7) and 20 mg% (normal 7-27) respectively. Serum calcium was 9.3 mg% (normal 9-11) and parathyroid hormone level was 316 pg/ml (normal 10-65). Serum alkaline phosphatase was 289 IU/L (normal 9-35). Bone survey demonstrated collapse of the T12-L3 spines, which caused back pain and kyphosis in this patient, with generalized extensive bone change characteristic of hyperparathyroidism. First ultrasonography of the neck revealed no definite neck mass seen. She was then referred for <sup>99m</sup>Tc-MIBI parathyroid imaging, due to highly suspected of primary hyperparathyroidism. The <sup>99m</sup>Tc-MIBI parathyroid imaging was performed with intravenous injection of 15 mCi of <sup>99m</sup>Tc-MIBI and anterior cervicothoracic planar imagings were done at 10 minutes and at 2 hours after injection with the patient supine and the head and neck extended and immobilized, using the Apex-SP4 Elscint gamma camera. The parathyroid imagings were acquired with a preset-time mode of 5 minutes for each image and with the zoom factor of 1.5 in 256×256 matrix, using a large-field-of-view, low energy, general purpose parallel hole collimator. Early image at 10 minutes clearly demonstrated a focal area of increased <sup>99m</sup>Tc-MIBI uptake caudal to the left lobe of thyroid gland extending inferiorly (Fig.1). Delayed images at 2 hours revealed more intense of the tracer accumulation in the lesion (Fig.2), which was compatible with a left parathyroid adenoma. Thyroid scan of the patient was also performed in the following day with 5 mCi of <sup>99m</sup>Tc-pertechnetate, in order to outline the thyroid parenchyma and it showed no definite radiopertechnetate uptake seen in the region inferior to the lower pole of the left thyroid lobe (Fig.3). Therefore, repeated ultrasonography of the thyroid

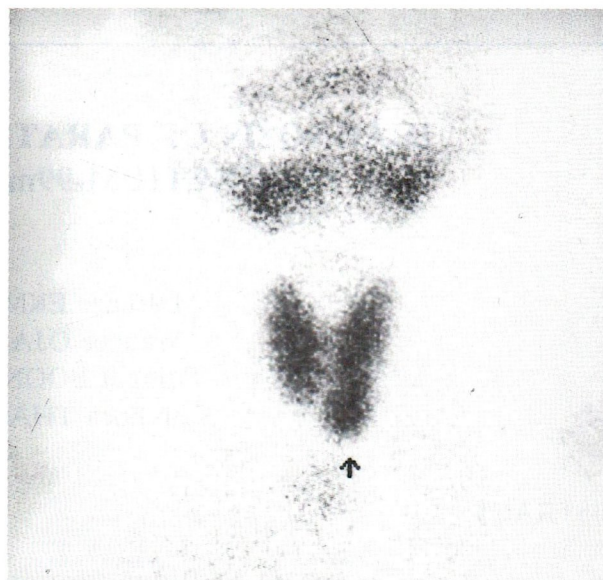


Fig.1: Parathyroid imaging with <sup>99m</sup>Tc-MIBI at 10 min reveals a focal increased uptake located adjacent to the lower pole of the left thyroid lobe extending inferiorly (arrow).

gland was performed and revealed a 2 cm hypoechoic lesion located posterior and inferior to the lower pole of left thyroid lobe, corresponding with the scintigraphic finding from <sup>99m</sup>Tc-MIBI imaging (Fig.4). The ultrasonographic lesion was located rather behind the left sternoclavicular joint. That is why it was missed from the first ultrasonography of the neck. Surgery was performed and a 2.5×2×1.5 cm parathyroid adenoma located inferoposterior to the lower pole of the left thyroid lobe removed. The histopathologic findings revealed a well encapsulated mass composing of uniformed parathyroid chief cells with a delicate capillary networks seen around the nests of the tumor cells, which was compatible with the diagnosis of left parathyroid adenoma. After surgical treatment, her serum parathyroid hormone level returned to normal value.

## DISCUSSION

Hypercalcemia is the most common manifestation in primary hyperparathyroidism, either sustained or intermittent hypercalcemia. However, some cases of normocalcemic hyperparathyroidism may present and this condition may cause by coexistent vitamin D deficiency, hypoalbuminemia, severe malabsorption or acidosis.<sup>1,19</sup> Like this patient, her serum calcium was in normal range, but other findings included significant elevated serum parathyroid hormone level were highly suggestive of primary hyperparathyroidism.

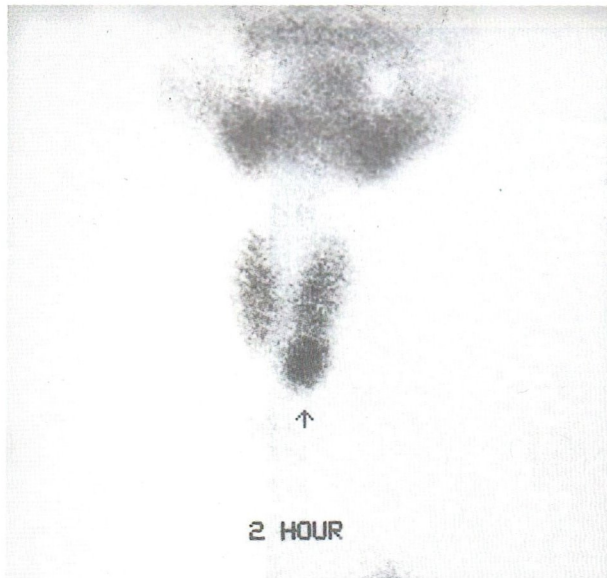


Fig.2: Delayed  $^{99m}\text{Tc}$ -MIBI parathyroid imaging at 2 hours shows significantly increased uptake at the lesion (arrow), in contrast to the gradually decreased uptake of the normal thyroid tissue.



Fig.3: Thyroid scan with  $^{99m}\text{Tc}$ -pertechnetate reveals no definite activity seen in the region inferior to the lower pole of the left thyroid lobe (arrow), whereas the  $^{99m}\text{Tc}$ -MIBI imaging shows a definite focal increased uptake in that region.

It is said that surgery of primary hyperparathyroidism is successful in approximately 90-95% of patients by experienced surgeons.<sup>1,2,15-17</sup> However, 5-10% of cases are failed from the first operation, which may be due to ectopic locations or supernumerary glands not identified at operation.<sup>15-18</sup> Therefore, localization of abnormal parathyroid glands preoperatively has become a more widely used procedure in the past several years.

Preoperative localization of abnormal parathyroid glands may produce many advantages such as increase surgical successful rate, limit neck surgery with smaller incision, decrease operative and anesthesia time and also decrease the risk of surgical complications by guiding the surgeon to the site of abnormality directly.<sup>15-17</sup>

Parathyroid imaging using single radionuclide with  $^{99m}\text{Tc}$ -MIBI is a promising procedure in the preoperative detection and localization of parathyroid adenomas in patients with primary hyperparathyroidism.<sup>11,13,14</sup> The early image at 10 minutes after injection is used as the thyroid phase of the study, because the radiotracer is rapidly concentrated in the thyroid parenchyma. The delayed image at 2-3 hours is represent the parathyroid phase, since the radioactivity will be progressively washout from the normal thyroid tissue in contrast to uptake in the parathyroid lesion, which will show progressively increased  $^{99m}\text{Tc}$ -MIBI

uptake over time.<sup>13</sup> The double phase  $^{99m}\text{Tc}$ -MIBI parathyroid imaging is more simple and convenient as compared with the subtraction method using either  $^{201}\text{Tl}/^{99m}\text{Tc}$ -pertechnetate,  $^{201}\text{Tl}/^{123}\text{I}$  or  $^{99m}\text{Tc}$ -MIBI/ $^{123}\text{I}$ . It is reported to have a diagnostic accuracy of more than 90% for diagnosis of parathyroid adenoma.<sup>13,14</sup> In addition, the superiority of this technique is using only single radiotracer, less radiation exposure, cheaper and it does not require the immobilization of the patient.<sup>13</sup>

Presumably, the initial  $^{99m}\text{Tc}$ -MIBI uptake in parathyroid adenoma relates to increase perfusion or cellularity in the tumor. Furthermore, it may associate with the size of the adenoma or hyperplastic gland. The prolonged retention of  $^{99m}\text{Tc}$ -MIBI in the parathyroid gland is hypothesized to be related to the presence and number of mitochondria-rich oxyphil cells, which is usually found in abnormal parathyroid glands.<sup>14,20</sup>

The typical  $^{99m}\text{Tc}$ -MIBI parathyroid imaging for parathyroid adenoma is defined as an area of focal increased uptake which persists or reveals relatively increased uptake on delayed imaging, in contrast to the uptake in the normal thyroid tissue which progressively decreases over time.<sup>13,14</sup> Like this case, the scintigraphic finding was typical for left parathyroid adenoma, which was confirmed later from the surgery and histopathologic examination.



Fig.4: Longitudinal sonographic scan of the left lobe of thyroid gland demonstrates a triangular shaped hypoechoic mass (arrow) with echogenic line separating it from the inferoposterior aspect of the lower pole of thyroid gland, corresponding with the focal increased uptake from the  $^{99m}\text{Tc}$ -MIBI imaging.

In conclusion, the double phase  $^{99m}\text{Tc}$ -MIBI parathyroid imaging is highly recommended for both preoperative and postoperative localization of abnormal parathyroid glands in patients with suspected of primary hyperparathyroidism and in patients with persistent or recurrent hyperparathyroidism as well.

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