Spectrum of single photon emission computed tomography/computed tomography findings in patients with parathyroid adenomas

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ABSTRACT

Primary hyperparathyroidism results from excessive parathyroid hormone secretion. Approximately 85% of all cases of primary hyperparathyroidism are caused by a single parathyroid adenoma; 10–15% of the cases are caused by parathyroid hyperplasia. Parathyroid carcinoma accounts for approximately 3–4% of cases of primary disease. Technetium-99m-sestamibi (MIBI), the current scintigraphic procedure of choice for preoperative parathyroid localization, can be performed in various ways. The "single-isotope, double-phase technique" is based on the fact that MIBI washes out more rapidly from the thyroid than from abnormal parathyroid tissue. However, not all parathyroid lesions retain MIBI and not all thyroid tissue washes out quickly, and subtraction imaging is helpful. Single photon emission computed tomography (SPECT) provides information for localizing parathyroid lesions, differentiating thyroid from parathyroid lesions, and detecting and localizing ectopic parathyroid lesions. Addition of CT with SPECT improves the sensitivity. This pictorial assay demonstrates various SPECT/CT patterns observed in parathyroid scintigraphy.

Keywords: Adenoma, ectopic, parathyroid, single photon emission computed tomography/computed tomography, sestamibi

INTRODUCTION

The parathyroid glands develop during the sixth week of gestation. The superior glands develop from the fourth brachial pouch and the inferior parathyroid glands develop from the third. Even though there are typically four parathyroid glands, approximately 10% of individuals have between five and seven glands, known as supernumerary parathyroid glands, and 2–3% of individuals have fewer than four glands. The location of the superior parathyroid glands is fairly constant. They are found at the junction of upper and middle third of thyroid gland, posterolateral to the cricothyroid junction in majority of the population. Occasionally, the superior gland may

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DOI: 10.4103/0972-3919.84618

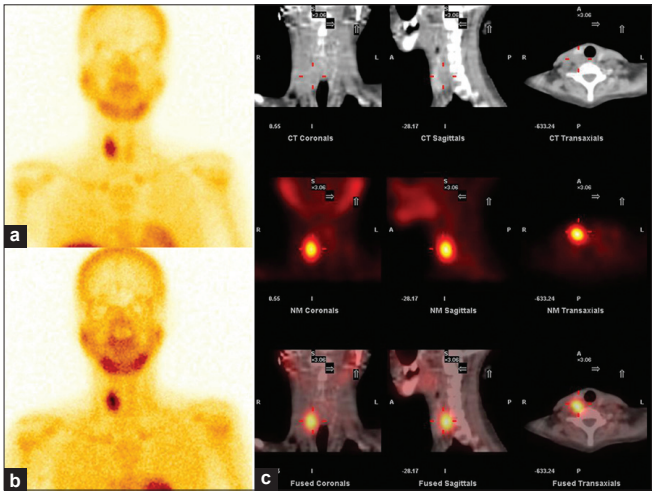

Figure 1: A 37-year-old female presented with elevated calcium and decreased phosphorus and increased parathyroid hormone (PTH). USG neck showed right superior parathyroid adenoma. Tc99m sestamibi scan (a) early images show increased tracer uptake in the area corresponding to the right lobe of the thyroid and faint tracer uptake in the left lobe of the thyroid gland; (b) delayed images show retention of tracer in the right side. Wash out of tracer is noted from the left lobe of thyroid. (c) SPECT/CT images localize increased tracer uptake to the posterior aspect of right lobe of the thyroid and CT shows the adenoma

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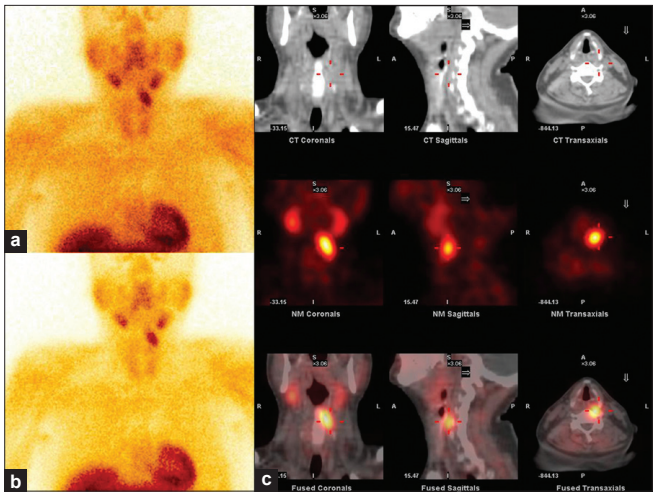

Figure 2: A 49-year-old male presented with hypercalcemia and mildly elevated PTH. USG of the neck did not reveal any parathyroid adenoma. (a) Early images of Tc99m sestamibi scan show homogenous tracer uptake in the both lobes of the thyroid gland. A focus of intense area of tracer uptake is noted in the cervical region superior to the left lobe of the thyroid gland. (b) Delayed images show retention of the tracer in the focus with wash out from thyroid gland. (c) SPECT/CT images show focal tracer uptake in the prevertebral region opposite to the body of C-6 vertebra

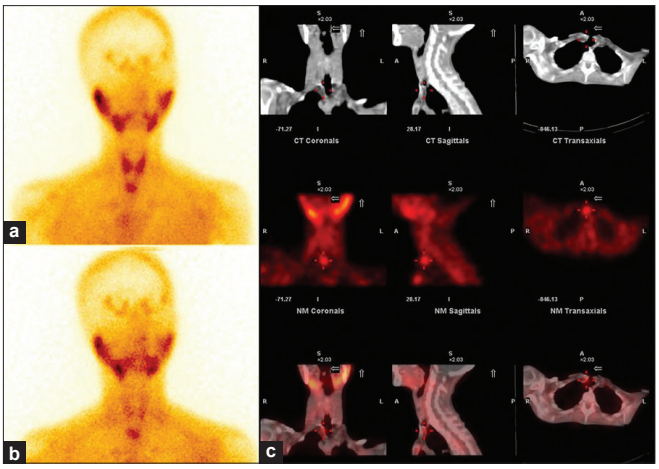

Figure 3: A 30-year-old female, case of pancreatitis, on workup was found to have raised serum calcium and PTH levels. USG neck was normal. (a) Early images of Tc99m sestamibi scan showed intense tracer uptake in the paratracheal region inferior to the thyroid gland along with uptake in both lobes of the thyroid gland. (b) Delayed images at 1 hour show focal retention of tracer in the paratracheal region with wash out from thyroid gland. (c) SPECT/CT imaging localizes the tracer uptake to the right paratracheal region inferior to thyroid gland superior to sterno-clavicular joint

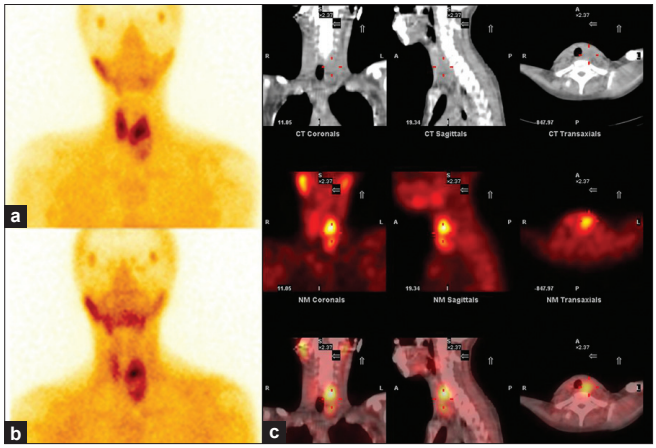

Figure 4: A 50-year-old female presented with hypercalcemia and raised PTH. (a) Tc99m sestamibi scan shows a photopenic area inferior to the left lobe of the thyroid with tracer uptake in the periphery in the form of a rim and uniform tracer uptake in both lobes of the thyroid. (b) Delayed images show washout of the tracer from both lobes. However, retention of the tracer is noted in the periphery of the photopenic area inferior to the left lobe of the thyroid gland. (c) SPECT/CT images show a cystic lesion, posterior to the left lobe of thyroid, whose periphery shows tracer uptake. A parathyroid cyst was found at surgery

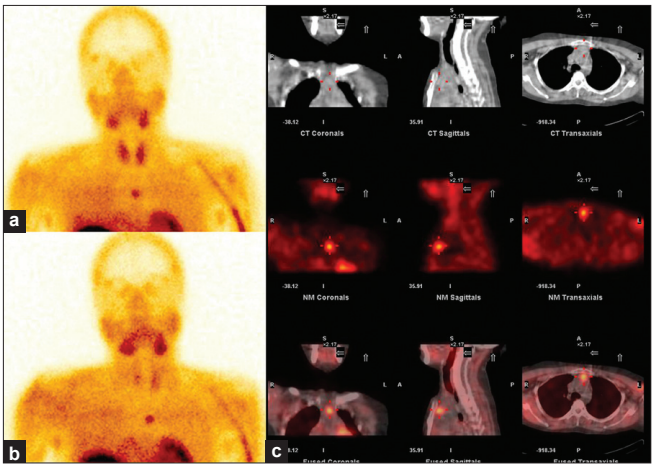

Figure 5: A 37-year-old female presented with hypercalcemia with raised PTH. USG of the neck was normal. (a and b) Dual-phase Tc99m sestamibi scan showed ectopic functioning parathyroid tissue in the anterior mediastinum. (c) Hybrid SPECT/CT localizes the area of hypermetabolic focus in the anterior mediastinum

remain undescended near the hyoid bone, along the pharyngeal musculature described as a parapharyngeus, or anywhere along its route of descent adjacent to the carotid sheath. Rarely, they are intrathyroidal or retroesophageal. The inferior parathyroid glands have a more varied anatomy and are more commonly found in ectopic sites. They can be found anywhere between the aortic bifurcation to the mediastinum. The most common ectopic location of the inferior parathyroid gland is within the thymic capsule or the superior mediastinum.[1]

Primary hyperparathyroidism is characterized by the autonomous production of parathyroid hormone, resulting in hypercalcemia. It affects 1 in 500 women and 1 in 2000 men annually.[2] It occurs 2–3 times more frequently in women than in men. Hyperparathyroidism peaks in incidence in the fourth and fifth decades of life but can occur in young children and the elderly as well.[3] It is a severe, symptomatic disorder with skeletal, muscular and renal manifestations at a young age.[4,5] Normocalcemia is observed more often with frequency ranging from 50% in an earlier report[6] to 14% observed in a recent study.[5] Single adenoma is the most frequent etiology of primary hyperparathyroidism. Surgical treatment of hyperparathyroidism is successful in 95% of patients undergoing initial neck exploration.[7] Failure to find the parathyroidal lesion may be related to ectopia and anatomic variations in the location of the tumor. So far, the majority of parathyroid surgeons have held the consensus that preoperative localization studies are not indicated at initial exploration. However, this remains controversial. More recently, the better

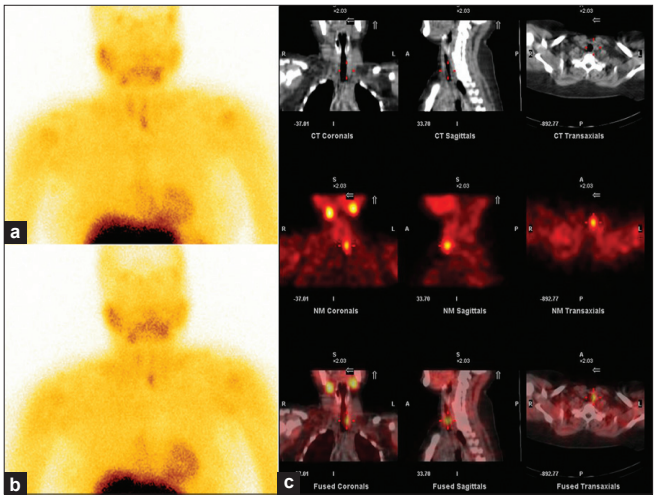

Figure 6: A 50-year-old female presented with renal stone disease with hypercalcemia. Dual-phase Tc99m sestamibi scan (a) early images show focal area of tracer concentration below left lobe of the thyroid; (b) delayed images show retention of tracer uptake in the anterior neck left of the midline. (c) SPECT/CT localizes increased tracer uptake to the left paratracheal region

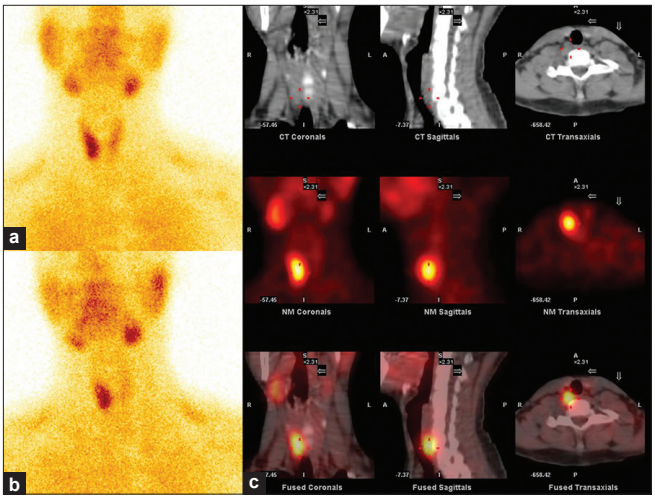

Figure 7: A 17-year-old male had history of pancreatitis and raised parathyroid hormone. (a) Early images of Tc99m sestamibi show increased tracer uptake in the lower part of right lobe of the thyroid. (b) Retention of the tracer is seen in the right lobe in delayed images. (c) SPECT/CT localizes abnormal tracer uptake to a soft tissue mass in the prevertebral region (right of the midline) opposite the 7th cervical vertebra

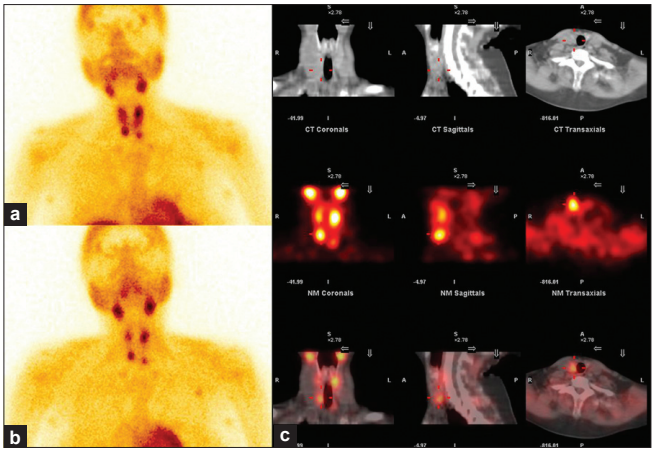

Figure 8: A 44-year-old female presented with severely raised parathormone with USG features showing bilateral parathyroid adenoma with multiple hypoechoic lesions in thyroid gland. Tc99m sestamibi scan (a) early images show increased tracer uptake in the upper and lower poles of the both lobes of the thyroid gland with normal uptake in the other areas; (b) delayed images show retention of the tracer in upper and lower poles of the both lobes of the thyroid gland with washout from other parts. (c) SPECT/CT localizes area of increased tracer uptake to the posterior part of the upper and lower poles of both lobes of the thyroid

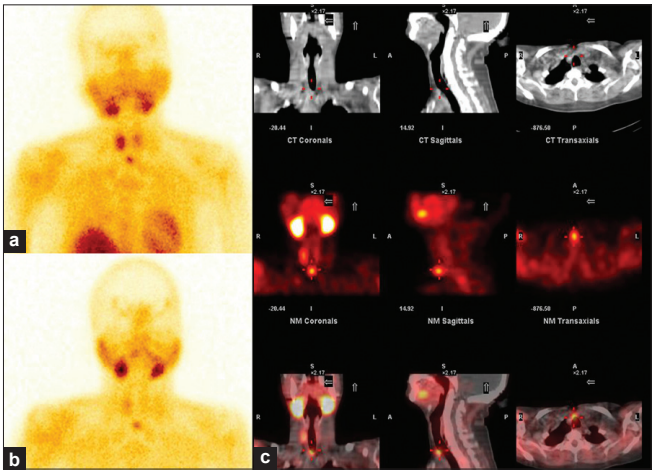

Figure 9: A 53-year-old female presented with raised serum parathormone; however, serum calcium and phosphorus were within normal limits. Ultrasonography neck showed features suggestive of enlarged right lobe of thyroid with three nodules with calcific foci within it. Tc99m sestamibi scan (a) early images show homogenous tracer uptake in both lobes of the thyroid (Righ > Left) along with small focus of tracer uptake below the thyroid; (b) delayed images show uniform washout of the tracer from both lobes with retention of tracer in the small focus below the thyroid. (c) SPECT/CT of neck and mediastinum localizes the increased tracer uptake in the pretracheal region

availability of preoperative parathyroid imaging techniques have made possible minimally invasive surgery, including unilateral neck exploration under local anesthesia[8,9] and endoscopic parathyroidectomy through a very small incision.[10] Accurate preoperative localization and intraoperative guidance are required to enable selective minimal surgery and to reduce the operative failure rate.[11] Moreover, repeated exploration is associated with a higher rate of complications, including recurrent laryngeal nerve paralysis and hypoparathyroidism.[12]

Anatomic imaging modalities including ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) have a relatively low sensitivity for detection of parathyroid adenomas.[13] Single-tracer dual-phase or the double-tracer subtraction parathyroid scintigraphy techniques provide high-quality imaging and reproducible scintigraphic findings. The previously used imaging approach combining Tl-201 and Tc99m subtraction scintigraphy showed only 45–75% sensitivity. Technetium-99m-MIBI scintigraphy has a higher target-to-background ratio and addition of single photon emission computed tomography (SPECT) improves the sensitivity to 90%.[14] Use of SPECT/CT helps to localize the ectopic parathyroid tissue. A combination of neck ultrasound and SPECT/CT has been shown to have incremental value over either technique alone and allows for selection of patients for minimally invasive parathyroid surgery.[15]

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How to cite this article: Chakraborty D, Mittal BR, Harisankar CB, Bhattacharya A, Bhadada S. Spectrum of single photon emission computed tomography/computed tomography findings in patients with parathyroid adenomas. Indian J Nucl Med 2011;26:52-5.

Source of Support: Nil. **Conflict of Interest:** None declared.