

mately necessary to allow prompt, definitive therapy of metastatic thyroid cancer with radioiodine.

Both ^{131}I and ^{201}Tl scintigraphy are the most useful diagnostic modalities for the diagnosis of residual, recurrent or metastatic thyroid cancer, in conjunction with serum thyroglobulin measurements (22,26). The higher sensitivity of the thallium scan in identifying additional foci not seen on the ^{131}I scan may stem from the lower avidity of these lesions to iodine, particularly in view of the increased stable iodide pool.

CONCLUSION

We presented a complex case of thyroid carcinoma illustrating a tailored medical management: acute medical treatment of accelerated hyperthyroidism, palliative radiation therapy and definitive therapy with radioiodine. The beneficial effect of GCSF in stimulating bone marrow activity should be considered when neutropenia complicates the course of combined modality therapies for thyroid cancer.

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Technetium-99m-Sestamibi SPECT Localization of Mediastinal Parathyroid Adenoma

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We report a case in which $^{99\text{m}}\text{Tc}$ -sestamibi SPECT was used to localize a middle mediastinum parathyroid adenoma that was not detected with planar sestamibi imaging on two previous occasions. Despite prior surgical exploration of the neck and mediastinum, the patient had a 20-yr history of hyperparathyroidism.

Key Words: hyperparathyroidism; technetium-99m-sestamibi; SPECT; parathyroid adenoma

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The usefulness of preoperative localization of hyperfunctioning parathyroid tissue in patients with recurrent or persistent hyperparathyroidism after previous neck surgery is well estab-

lished (1). When preoperative imaging is performed, the success rate for reoperation in patients with persistent or recurrent hyperparathyroidism increases from approximately 60% to 90% (1-3). We report a case of $^{99\text{m}}\text{Tc}$ -sestamibi SPECT localization of a middle mediastinum parathyroid adenoma which was not detected either with planar sestamibi imaging on two occasions or with prior mediastinal exploration.

CASE REPORT

A 48-yr-old man had a history of hyperparathyroidism and hypercalcemia since 1975. A 3 1/2-gland parathyroidectomy and neck exploration were performed in 1975, but the patient had persistent hyperparathyroidism thereafter. Exploration of the neck was repeated in June 1976 but did not reveal any hyperfunctioning parathyroid tissue. In April 1977, the patient underwent cervical exploration with thymectomy, pericardial exploration and bilateral subtotal thyroid lobectomies. Again, he had no relief of his hyperparathyroidism, and he subsequently experienced pathologic

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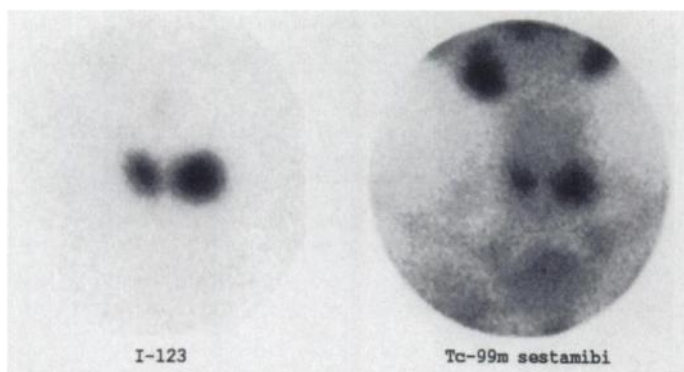


FIGURE 1. Iodine-123 and ^{99m}Tc -sestamibi images of the neck show no abnormal foci (patient has had subtotal thyroidectomy).

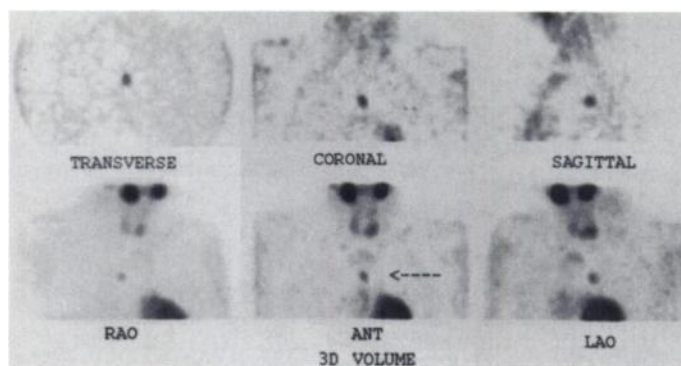


FIGURE 3. SPECT images clearly demonstrate an abnormal focus (arrow) in the middle mediastinum.

fractures from brown tumors, declining renal function secondary to repeated episodes of urolithiasis and several episodes of pancreatitis. Results of a sestamibi parathyroid scan performed in March 1994 with early and delayed planar imaging were negative. Mediastinoscopy in August 1994 did not yield any parathyroid tissue. The patient then presented to our institution for further evaluation.

Four hours after oral administration of $310 \mu\text{Ci } ^{123}\text{I NaI}$, a 10-min static image was acquired with a converging collimator centered over the thyroid bed. Without moving the patient, $21 \text{ mCi } ^{99m}\text{Tc}$ -sestamibi were injected and 5-min static images were acquired 10 and 15 min later. A 10-min, parallel-hole image of the chest was then obtained and repeated 2 hr later. The images of the neck, including subtraction studies (not shown), revealed no abnormal foci (Fig. 1). Parallel-hole images of the chest showed faint activity underlying the sternum (Fig. 2). This activity was not considered to be clearly indicative of an abnormal focus, since the intensity declined on 2-hr delayed imaging. To better evaluate the mediastinum, SPECT images were acquired approximately 2.5 hr after the sestamibi injection. Acquisition was performed with a triple-head camera using a noncircular orbit, 3° angular sampling, 30 sec per stop, a low-energy ultra-resolution collimator and an acquisition matrix of 128×128 . Transverse slices were reconstructed by using filtered backprojection with a Hamming filter and high-frequency cutoff of 1.0 cycles/cm. Coronal and sagittal projections, as well as three-dimensional volume images, were generated. These clearly depicted a focus of increased activity in the middle mediastinum near the aorticopulmonary window (Fig. 3).

In May 1995, the patient underwent left thoracotomy during which a 2-g tumor, later pathologically proven as a 2-g parathyroid adenoma, was removed from its location anterior and medial to the left mainstem bronchus between the aorta and pulmonary artery. The patient's calcium promptly decreased from a preoperative

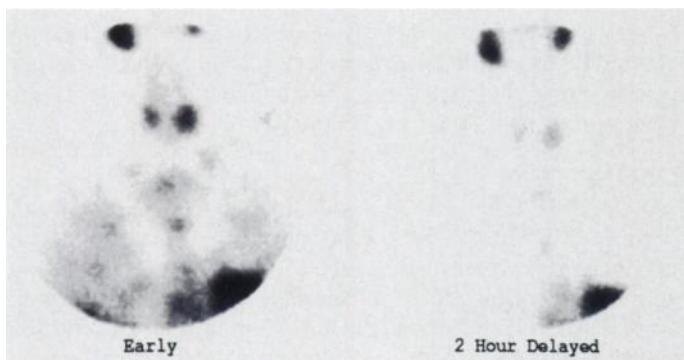


FIGURE 2. Early and 2-hr delayed ^{99m}Tc -sestamibi images of the mediastinum show no definite abnormality. The faint activity in the region of the sternum was thought to wash out on delayed images.

level of 11.2 mg/dl (normal 8.5–10.5 mg/dl) to 7.8 mg/dl postoperatively; at 1-mo follow-up, his calcium level was 7.5–8.0 mg/dl. If he continues to be hypocalcemic, his cryopreserved parathyroid tissue may be implanted in his forearm.

DISCUSSION

This case demonstrates the usefulness of ^{99m}Tc -sestamibi SPECT in the preoperative localization of a middle mediastinal parathyroid adenoma that was previously undetected with planar sestamibi imaging and mediastinal exploration. In patients with primary hyperparathyroidism, initial neck surgery results in cure rates of 90%–96% without preoperative localizing studies (2–4). Parathyroid imaging is useful for localization of both normal and ectopic parathyroid tissue. Imaging can be done with nuclear medicine, CT, US or MRI. However, as none of these modalities has been shown to be superior, imaging may not be cost-effective when routinely performed prior to initial surgery (5).

Localization studies are most appropriate for patients who have recurrent or persistent hyperparathyroidism and who require reoperation. Each subsequent surgery is less likely to be successful, since the remaining hyperfunctioning parathyroid glands are more difficult to identify because of scarring and loss of normal tissue planes (1,6). When imaging is performed prior to reoperation, the success rate increases from approximately 60% to 90% (1–3). Preoperative parathyroid localization also shortens operating time, improves surgical results and reduces operative complications (1).

Persistent hyperparathyroidism after initial surgery may be due to incomplete excision of the parathyroid glands, ectopic glands or supernumerary glands. Up to 20% of parathyroid glands can be ectopic, and these are usually located in the mediastinum (7).

In 1983, Ferlin et al. (8) introduced dual-isotope planar subtraction scintigraphy, which used ^{201}Tl and [^{99m}Tc]pertechnetate subtraction scintigraphy for imaging parathyroid tissue (8). Until recently, modifications of their original technique have been the standard for localizing parathyroid tissue (9,10). Published studies show 42%–96% sensitivity for ^{201}Tl and [^{99m}Tc]pertechnetate subtraction scintigraphy in imaging parathyroid adenomas (11). A comprehensive study should include images of the chest (mediastinum) as well as the neck because of the significant incidence of ectopic parathyroid tissue (12).

In 1989, Coakley et al. (13) reported the use of ^{99m}Tc -sestamibi as a new agent for parathyroid imaging (13). Initial studies showed that using ^{99m}Tc -sestamibi in conjunction with ^{123}I or [^{99m}Tc]pertechnetate subtraction imaging is an excellent imaging technique to locate parathyroid adenomas; sensitivity is reported to be 90%–100% (14–18).

Accumulation of ^{99m}Tc -sestamibi in tissue is analogous to that of thallium and uptake is proportional to blood flow. In addition, tissues that are mitochondria-rich show a longer retention of ^{99m}Tc -sestamibi (18). Sandrock et al. (11) showed that parathyroid adenomas are mitochondria-rich and that ^{99m}Tc -sestamibi is taken up more avidly and released more slowly by these adenomas than by the surrounding thyroid (11). Early and delayed images with ^{99m}Tc -sestamibi take advantage of its differential kinetics: ^{99m}Tc -sestamibi, like ^{201}Tl , washes out of the thyroid gland quickly; unlike ^{201}Tl , however, it is retained in hyperfunctioning parathyroid tissue thereby allowing better visualization (19). This differential in washout times results in a 90% sensitivity for detecting parathyroid adenomas when ^{99m}Tc -sestamibi is used as a single agent (double-phase study) (20).

Initial studies have suggested improved localization with the addition of SPECT (21–26). SPECT offers the advantages of greater tissue contrast, reasonable resolution at depth, and three-dimensional localization. Neumann et al. (27) recently reported demonstration of a mediastinal parathyroid adenoma with SPECT. The report did not indicate whether planar imaging was attempted. In comparison to ^{201}Tl , ^{99m}Tc has higher energy that allows better penetration of the thorax. In addition, the larger administered dose of ^{99m}Tc -sestamibi permits shorter imaging times and facilitates the use of SPECT (28,29).

CONCLUSION

In our patient, ^{99m}Tc -sestamibi SPECT demonstrated an abnormal focus of activity in the middle mediastinum, which correlated with a pathologically proven parathyroid adenoma that was not detected with planar imaging or prior undirected mediastinal exploration. We suggest routine use of ^{99m}Tc -sestamibi SPECT of the mediastinum when standard planar images are negative. This case illustrates the usefulness of ^{99m}Tc -sestamibi SPECT in localizing mediastinal parathyroid adenomas preoperatively.

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Somatostatin-Receptor Scintigraphy of Subcutaneous and Thyroid Metastases from Bronchial Carcinoid

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We present a case of bronchial carcinoid tumor with multiple metastases in the retina, subcutaneous tissues and thyroid gland. These metastatic lesions were detected by ^{111}In -pentetreotide scintigraphy 15 yr after removal of the primary tumor. The extensive

metastatic involvement documented on scintigraphy spared the patient unnecessary total thyroidectomy and directed the attention of the primary physician to previously unknown and potentially more important foci of metastatic disease.

Key Words: carcinoid; subcutaneous metastases; thyroid; retinal metastases; indium-111-pentetreotide

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