

Brown Tumor of Bone: A Potential Source of False-Positive Thallium-201 Localization

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Brown tumor of bone (osteitis fibrosa cystica) should be included in the differential diagnosis of lesions that cause false-positive thallium-201 localization in patients with primary hyperparathyroidism. We report a case of a brown tumor of the upper sternum mimicking a superior mediastinal parathyroid neoplasm in a patient with persistent hyperparathyroidism 9 years after a negative neck exploration (with subtotal thyroidectomy and thymectomy). A $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ pertechnetate subtraction scintigram demonstrated complete subtraction of this ^{201}Tl focus.

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Thallium-201 (^{201}Tl)/technetium-99m ($^{99\text{m}}\text{Tc}$) pertechnetate subtraction scintigraphy is a useful technique for the detection of parathyroid neoplasms of the neck and mediastinum (1–11). Although the differential uptake of $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ is a nonspecific finding, it is particularly useful for localization of parathyroid neoplasms in patients with negative neck explorations and recurrent or persistent hypercalcemia (9–12). Up to 5% of hyperfunctional parathyroid lesions are missed at the initial operation (13–15). Most of these parathyroid neoplasms are located in the neck or thymic region. Thallium-201/ $^{99\text{m}}\text{Tc}$ subtraction imaging is a useful adjunct to other imaging modalities for detection of these neoplasms (9–11). However, knowledge of potential sources of ^{201}Tl localization may help avoid misinterpretation of focal ^{201}Tl localization due to a vascular neoplasm. We report a case of a brown tumor involving the upper sternum mimicking a superior mediastinal parathyroid neoplasm on ^{201}Tl images in a patient with persistent hypercalcemia 9 yr after the initial operation.

CASE REPORT

A 57-yr-old woman underwent a left thyroid lobectomy, inferior right thyroid lobe nodulectomy, thymectomy, and biopsy of two atrophic superior parathyroid glands during a negative neck exploration for primary hyperparathyroidism

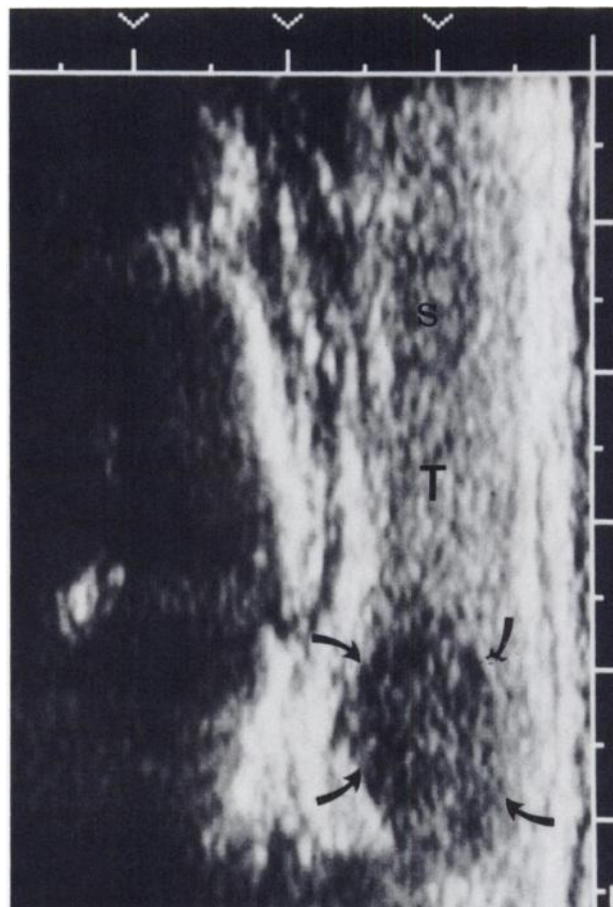


FIGURE 1 Sagittal sonogram revealing complex hypoechoic focus in the superior pole (S) and hypoechoic focus (arrows) in the inferior right lobe of the thyroid (T).

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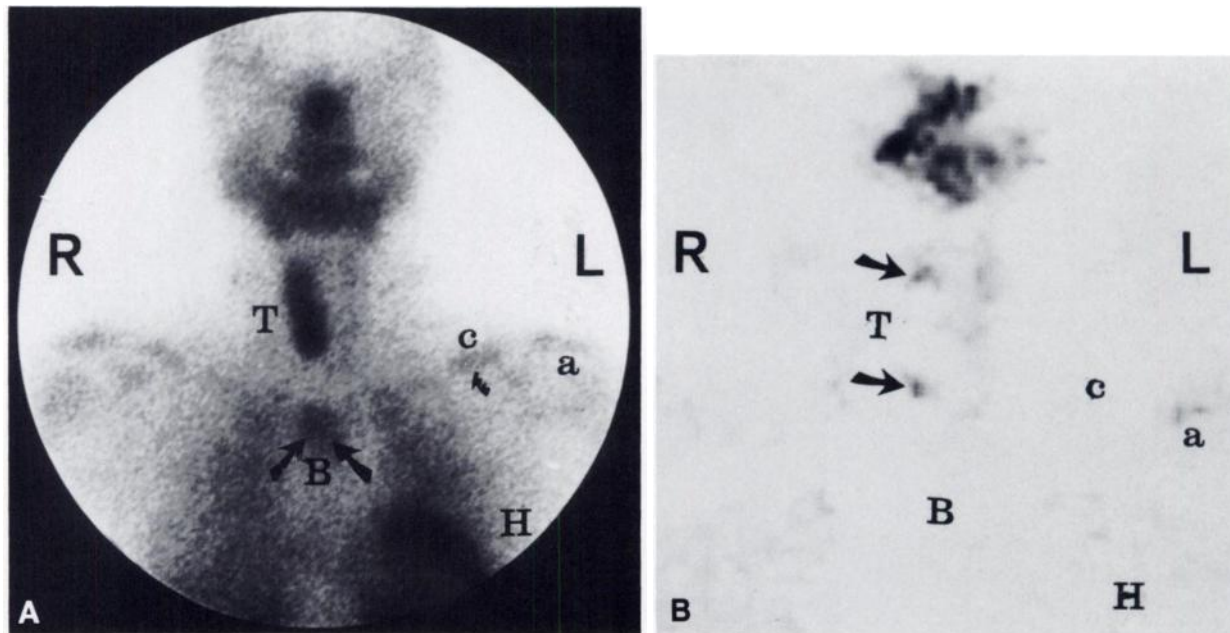


FIGURE 2

A: Thallium-201 (5-min image) of the neck and upper chest demonstrating localization in the right lobe of the thyroid (T), a focus in the superior mediastinum (B, arrows), left clavicle (c), left acromial process (a) and heart (H). B: $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image of the neck and upper chest demonstrating two focal sites of abnormal ^{201}Tl in the superior and inferior right thyroid bed (arrows). The focus in the superior mediastinum (B) and clavicle (c) are no longer visible.

in 1979. Postoperatively, she experienced persistent hypercalcemia, hypophosphatemia, and elevation of serum parathyroid hormone levels. Selective venous sampling 6 mo later failed to show a step-up in parathyroid hormone levels. The patient refused further diagnostic workup.

She returned in 1987 because of a left clavicular fracture. Sonograms of the neck revealed a hypoechoic focus in the inferior pole and a complex hypoechoic focus in the superior right lobe of the thyroid (Fig. 1). These findings were consistent with either a primary thyroid neoplasm or an intrathyroidal parathyroid neoplasm. Thallium-201 analog images (Fig. 2A) of the neck and upper chest demonstrated focal abnormalities in the superior and inferior poles of the right thyroid bed, the superior mediastinum, and the left clavicular region. A $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image (Fig. 2B) showed residual focal activity in the region of the superior and inferior thyroid bed with "complete subtraction" of activity from the superior mediastinal and left clavicular foci. A 35° left oblique view of the neck and upper chest showed the mediastinal focus to be very anterior in location. Images of the hands demonstrated focal ^{201}Tl localization in several digits (Fig. 3A), which corresponded to radiographic sites of brown tumors (Fig. 3B). A chest x-ray was negative for sternal or mediastinal abnormalities, but a pathologic fracture of the left clavicle was observed. Computed tomography of the chest demonstrated a cystic lesion of the sternum (Fig. 4), which corresponded to the mediastinal focus of abnormal ^{201}Tl tracer localization.

At neck exploration, an intrathyroidal parathyroid adenoma in the inferior right lobe and a follicular adenoma in the superior right lobe of the thyroid were removed by right thyroid lobectomy. The patient developed extremely low serum calcium, phosphate, and magnesium levels ("hungry bone syndrome") (16), which ultimately responded to cal-

cium, magnesium, and 1,25-dihydroxy vitamin D3 replacement. She is currently eucalcemic without medication.

DISCUSSION

Recurrent or persistent hyperparathyroidism is a difficult clinical problem. The success of a second operation is highly dependent upon accurate localization of the hyperfunctioning tissue. Knowledge of potential sources for ^{201}Tl localization is important for accurate interpretation. Common causes for false-positive $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction images include thyroid neoplasms, colloid goiter, and focal Hashimoto's thyroiditis. Less common causes include metastatic carcinomas, lymphoma, and sarcoidosis (17).

Brown tumors of bone are highly vascular, lytic bone cysts that occur in patients with hyperparathyroidism (18,19). These tumors occur less frequently than in the past, because of earlier detection of hypercalcemia by automated blood chemistry analysis. The incidence of osteitis fibrosa cystica is <10% in most current series (20). It is likely these tumors show ^{201}Tl localization because of their marked vascularity. This is supported by the absence of a residual ^{201}Tl focus on the $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image (Fig. 2B). When this tumor arises in the sternum, it could be mistaken for aberrant parathyroid tissue in the thymus or superior mediastinum particularly on nonsubtracted or only partially subtracted ^{201}Tl images (Fig. 2A).

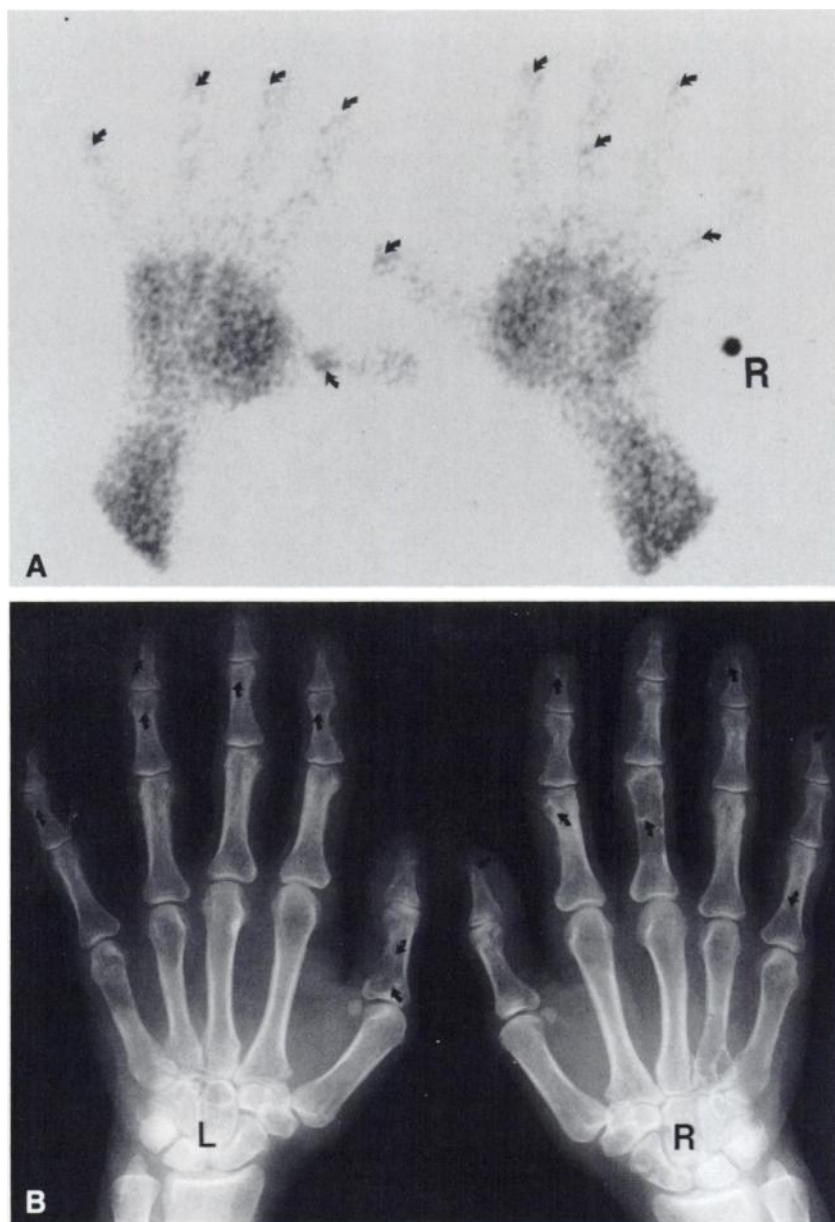


FIGURE 3

A: Thallium-201 image of the hands shows sites of varying amounts of focal tracer localization (arrows) in the proximal phalanx of the left thumb and several digits at sites of brown tumors. B: Plain film of the hands demonstrating osteitis fibrosa cystica (arrows). Not all lesions are well visualized on this view.

In our patient, the chest radiograph failed to reveal a lesion in the sternum, and the superior mediastinal focus was initially considered to be a possible ectopic parathyroid neoplasm. Computed tomography demonstrated a cystic lesion in the upper sternum. The acute left clavicular fracture also demonstrated ^{201}Tl localization, presumably on the basis of hyperemia secondary to increased bone remodeling. Residual ^{201}Tl localization was not identified at this site on the subtracted image (Fig. 2B).

The intrathyroidal parathyroid adenoma located in the inferior pole of the right lobe did not cause a focal "cold" defect on the $^{99\text{m}}\text{Tc}$ thyroid images, but did cause a positive $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image (Fig. 2B). This neoplasm had probably been missed during the initial neck exploration 9 yr previously. A follicular adenoma

in the upper right lobe of the thyroid also concentrated sufficient ^{201}Tl to cause a positive $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image (2,21). However, primary thyroid neoplasms usually cause a focal "cold" defect on $^{99\text{m}}\text{Tc}$ images (2, 20-23). Although high-resolution ultrasonography demonstrated hypoechoic intrathyroid neoplasms, this finding did not differentiate between parathyroid and thyroid origin.

Thallium-201/ $^{99\text{m}}\text{Tc}$ subtraction imaging was helpful in localizing the parathyroid adenoma in the inferior right lobe of the thyroid. Although the ^{201}Tl focus in the upper chest "subtracted out" on the $^{201}\text{Tl}/^{99\text{m}}\text{Tc}$ subtraction image, it was initially thought to be the result of a mediastinal parathyroid neoplasm until CT demonstrated a cystic lesion within the sternum. Focal ^{201}Tl localization corresponding to sites of osteitis fi-

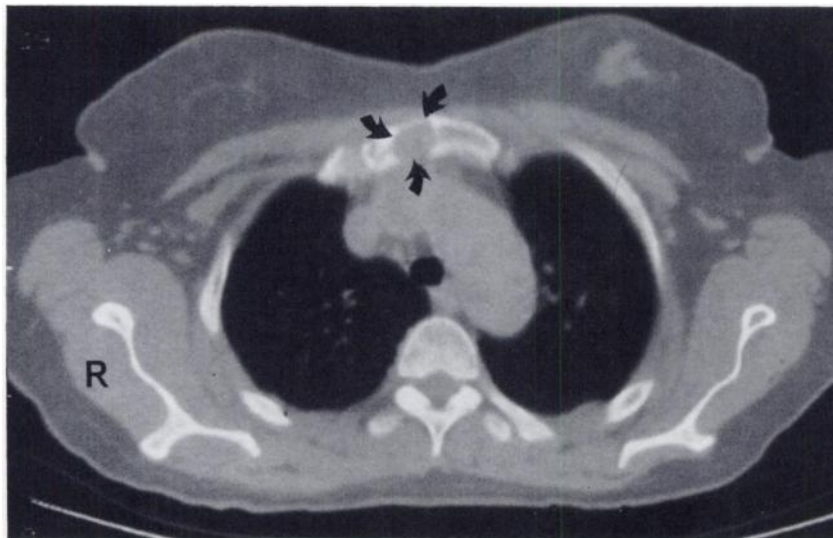


FIGURE 4
Computed tomogram of the chest (bone window setting) showing a cystic lesion (arrows) in the superior sternum.

brosa cystica on plain radiographs of the hands also offers support that brown tumors can cause false-positive ^{201}Tl localization on nonsubtracted images.

REFERENCES

1. Young AE, Gaunt JI, Croft DN, Collins REC, Wells CP, Coakley AJ. Location of parathyroid adenomas by thallium-201 and technetium-99m subtraction scanning. *Br Med J* 1983; 286:1384-1386.
2. Ferlin G, Borsato N, Camerani M, Conte N, Zotti D. New perspectives in localizing enlarged parathyroids by technetium-thallium subtraction scan. *J Nucl Med* 1983; 24:438-441.
3. Fogelman I, McKillop JH, Bessent RG, et al. Successful localisation of parathyroid adenomata by thallium-201 and technetium-99m subtraction scintigraphy: description of an improved technique. *Eur J Nucl Med* 1984; 9:545-547.
4. Okerlund MD, Sheldon K, Corpuz S, et al. A new method with high sensitivity and specificity for localization of abnormal parathyroid glands. *Ann Surg* 1984; 200:381-388.
5. Wheeler MH, Harrison BJ, French AP, Leach KG. Preliminary results of thallium 201 and technetium 99m subtraction scanning of parathyroid glands. *Surgery* 1984; 96:1078-1082.
6. Basarab RM, Manni A, Harrison TS. Dual isotope subtraction parathyroid scintigraphy in the preoperative evaluation of suspected hyperparathyroidism. *Clin Nucl Med* 1985; 10:300-314.
7. Stark DD, Gooding GAW, Moss AA, Clark OH, Ovenfors CO. Parathyroid imaging: comparison of high-resolution CT and high-resolution sonography. *Am J Roentgenol* 1983; 141:633-638.
8. Winzelberg GG, Hydovitz JD, O'Hara KR, et al. Parathyroid adenomas evaluated by Tl-201/Tc-99m pertechnetate subtraction scintigraphy and high-resolution ultrasonography. *Radiology* 1985; 155:231-235.
9. Gooding GAW, Okerlund MD, Stark DD, Clark OH. Parathyroid imaging: comparison of double-tracer (Tl-201, Tc-99m) scintigraphy and high-resolution US. *Radiology* 1986; 161:57-64.
10. Krubsack AJ, Wilson SD, Lawson TL, Collier BD, Hellman RS, Isitman AT. Prospective comparison of radionuclide, computed tomographic, and sonographic localization of parathyroid tumors. *World J Surg* 1986; 10:579-585.
11. Park CH, Intenzo C, Cohn HE. Dual tracer imaging for localization of parathyroid lesions. *Clin Nucl Med* 1986; 11:237-241.
12. Miller DL, Doppman JL, Shawker TH, et al. Localization of parathyroid adenomas in patients who have undergone surgery. Part I. Noninvasive methods. *Radiology* 1987; 162:133-137.
13. Behars O. Surgical management of hyperparathyroidism. *Ann R Coll Surg Engl* 1980; 62:31-34.
14. Brennan MF, Marx SJ, Doppman JL, et al. Results of reoperation for persistent and recurrent hyperparathyroidism. *Surgery* 1982; 91:6-11.
15. Wang CA. Parathyroid re-exploration. *Ann Surg* 1977; 186:140-145.
16. Brasier AR, Nussbaum SR. Hungry bone syndrome: clinical and biochemical predictions of its occurrence after parathyroid surgery. *Am J Med* 1988; 84:654-660.
17. Winzelberg GG. Thallium 201/ ^{99m}Tc parathyroid subtraction scintigraphy of the neck: single area of increased thallium uptake. *Semin Nucl Med* 1987; 17:273-275.
18. Teng CT, Nathan MH. Primary hyperparathyroidism. *Am J Roentgenol* 1960; 83:716-731.
19. Steinbach HL, Gordan GS, Eisenberg E, Crane JT, Silverman S, Goldman L. Primary hyperparathyroidism: a correlation of roentgen, clinical, and pathologic features. *Am J Roentgenol* 1961; 86:329-343.
20. Mundy GR, Cove DH, Finken R. Primary hyperparathyroidism: changes in pattern of clinical presentation. *Lancet* 1980; 1:1317-1320.
21. Krubsack AJ. Fetal adenoma of the thyroid. A common source for false-positive thallium-201/technetium-99m pertechnetate subtraction parathyroid scintigraphy. *Clin Nucl Med* 1987; 12:539-542.
22. Intenzo C, Park CH. Co-existent parathyroid adenoma and thyroid carcinoma. Nonspecificity of dual tracer parathyroid imaging for parathyroid lesions. *Clin Nucl Med* 1984; 8:560-561.
23. Krasnow AZ, Collier BD, Isitman AI, Hellman RS, Peck DC. The clinical significance of unusual sites of thallium-201 uptake. *Semin Nucl Med* 1988; 18:350-358.