Scintigraphic Pitfalls in Giant Parathyroid Glands

Anton Staudenherz, Dikran Telfeyan, Erich Steiner, Bruno Niederle, Thomas Leitha and Kurt Kletter

Clinics of Nuclear Medicine, General Surgery and Radiology, University of Vienna, Vienna, Austria

We report a case of hyperparathyroidism with surgically confirmed bilaterally enlarged parathyroid glands mimicking a normal thyroid gland. Technetium-99m-pertechnetate-201 TI chloride subtraction scintigraphy was inconclusive because of suppressed thyroidal [99mTc]pertechnetate uptake after coronary angiography. Technetium-99m-sestamibi double-phase scintigraphy showed homogeneous 99mTc-sestamibi uptake that mimicked a normal thyroid gland and no differential washout, thus leading to an erroneous visual interpretation of a normal scan. Semiguantitative assessment of tracer washout, however, can differentiate between normal thyroid tissue and symmetrical parathyroid uptake mimicking normal thyroid tissue. We conclude that semiguantitative assessment of tracer washout increases the diagnostic sensitivity of 99mTc-sestamibi doublephase scintigraphy if: (a) the interpreter is unaware of the anatomical situation, (b) the scintigraphic delineation of the thyroid is hampered by a blocked tracer uptake or (c) the visual interpretation reveals no differential washout in the neck region.

Key Words: parathyroid glands; technetium-thallium subtraction scintigraphy; technetium-99m-pertechnetate; technetium-99msestamibi; hyperparathyroidism

J Nucl Med 1995: 36:467-469

echnetium-99m-²⁰¹Tl subtraction scintigraphy is the most commonly applied imaging technique for the localization of the parathyroid tumors (1-4). As an alternative approach, the combined use of 99mTc-sestamibi and $[^{123}I]$ sodium has been proposed by O'Doherty et al. (5). The most recent improvement in parathyroid imaging was described by Taillefer et al. (6) who used a single radionuclide double-phase protocol with 99m Tc-sestamibi. In contrast to ^{99m}Tc-²⁰¹Tl subtraction scintigraphy, their protocol takes advantage of the superior physical properties of ^{99m}Tc and is not hampered by motion artifacts. The current preoperative work-up of hyperparathyroidism in our institution includes ^{99m}Tc-²⁰¹Tl subtraction scintigraphy and ultrasonography of the neck. The single radionuclide double-phase ^{99m}Tc-sestamibi technique was performed alternatively in inconclusive cases.

CASE REPORT

A 66-yr-old male with a history of chronic renal insufficiency, coronary heart disease and biochemically verified hyperparathyroidism was admitted to our hospital for preoperative localization of the parathyroid glands. Laboratory evaluation confirmed renal insufficiency (7.5 mg/100 ml creatinine) and hyperparathyroidism (1190 pg/ml PTH). Physical examination showed a normal sized thyroid gland of normal consistency without palpable nodules. Ultrasound revealed a significant enlargement of both cranial parathyroid glands (Fig. 1B). Radionuclide studies were performed as part of a blinded study and the investigators were unaware of the result of the other imaging procedures and laboratory findings.

Technetium-99m-²⁰¹Tl subtraction scintigraphy was performed with a LFOV gamma camera equipped with a LEGP parallel-hole collimator. The patient was positioned comfortably and fixed to prevent motion. Immediately after i.v. injection of 74 MBq ²⁰¹Tl, planar images (matrix: 256×256 ; 500,000 cts) of the upper mediastinum and the thyroid were acquired in a 20% energy window set at 71 keV. Fifteen minutes after i.v. injection of 74 MBq 99mTc, the thyroid image (matrix: 256 × 256; 500,000 cts) was repeated in a 20% energy window set at 140 keV. After an interpolative background correction and count normalization of both thyroid images, the ^{99m}Tc image was digitally subtracted from the ²⁰¹Tl image. Any residual focal activity was considered as representing parathyroid tissue. Ultrasonography was performed using a 5-10 MHz transducer (UM9-HDI). Transverse and sagital scans were obtained from the level of the mandible to the clavicle with the patient's neck hyperextended.

Technetium-99m-sestamibi double-phase imaging uses a commercial kit preparation (Cardiolite; Du Pont Pharma, FRG). Planar images (matrix: 256×256 ; 500,000 cts) of the thyroid and the mediastinum are acquired in a 20% energy window set at 140 keV 15 min and 3 hr after i.v. injection of 550 MBq ^{99m}Tc-sestamibi with a LFOV gamma camera (PRISM 3000; Picker Corp., United States of America) equipped with an LEUHR parallel-hole collimator. All areas in the thyroid region and the upper mediastinum showing focal ^{99m}Tc-sestamibi retention are considered to represent parathyroid glands (4). In addition, semiquantitative analysis of the ^{99m}Tc-sestamibi double-phase images was done. For this purpose, regions of interest (ROIs) were manually drawn around the suspected parathyroid adenoma and the thyroid gland. Adjacent areas $(3 \times 3 \text{ pixels})$ were taken as background and normalized according to the size of the parathyroid or the thyroid ROIs, respectively. Target-to-background ratios were determined for the parathyroid and the thyroid ROIs in the images 15 min and 3 hr p.i. of ^{99m}Tc-sestamibi.

The ²⁰¹Tl uptake in both lobes was homogeneous and the right lobe appeared slightly larger than the left (Fig. 2). The scintigram was interpreted as showing normal thyroidal ²⁰¹Tl uptake. Digital subtraction, could not be performed because [99mTc]pertechne-

Received Feb. 17, 1994; revision accepted Oct. 17, 1994.

For correspondence or reprints contact: K. Kletter, MD, PhD, University of Vienna, Univ. Clinic of Nuclear Medicien, Währinger-Gürtel 18-20, A-1090 Wien, Austria.

FIGURE 1. (A) In situ preparation of the right parathyroid gland. The greatest diameter of the right gland was 5.5 cm. (B) Axial sonogram of the thyroid and parathyroid glands. Two markedly enlarged inferior parathyroid glands are demonstrated as well-delineated, hypoechoic masses behind the right and left thyroid lobe (+1, +2). S = acoustic shadowing of the trachea, T = thyroid gland, A = carotid artery, V = internal jugular vein.



tate uptake of the thyroid was blocked. Questioning of the patient revealed that coronary angiography 3 mo prior to scintigraphy was the cause of the suppressed ^{99m}Tc uptake.

The subtraction scintigraphs were thus regarded as inconclusive. Therefore the ^{99m}Tc-sestamibi double-phase study was performed two days later. Both lobes showed homogeneous ^{99m}Tcsestamibi uptake in the early image. Again, the right lobe appeared comparatively larger than the left lobe (Fig. 3). No qualitative differences were seen on the early and the delayed images. This was interpreted as homogeneous washout without focal tracer retention and the patient was thought to have a normal thyroid gland and no parathyroid adenomas. Surgery performed two days later revealed enormously enlarged parathyroid glands on both sides. The greatest diameter of the right gland was 5.5 cm (width: 3.0 cm) and that of the left gland 4 cm (width: 2.5 cm), respectively (Fig. 1A). A postoperative ^{99m}Tc-sestamibi scan (Fig. 3) showed an initial faint uptake in the thyroid and complete tracer washout in the delayed image.

DISCUSSION

The reported sensitivity values of ^{99m}Tc-²⁰¹Tl subtraction scintigraphy for the localization of parathyroid adenomas range from 38% to 92% (7–10). Preliminary studies found a slightly higher sensitivity for the recently introduced ^{99m}Tc-sestamibi ¹²³I subtraction scintigraphy, but as in all other scintigraphic subtraction methods, the noise in the re-



FIGURE 2. The ²⁰¹TI image shows homogeneous tracer uptake in both lobes. The right lobe appeared slightly larger than the left. The initial interpretation was normal thyroidal uptake.

sulting scintigram is high for both methods (11, 12). In addition, a sufficient thyroidal tracer uptake for [99mTc]pertechnetate or ¹²³I is essential for delineation of the thyroid and digital subtraction. Patients with suspected hyperparathyroidism are prone to other disorders, especially cardiac and renal diseases. Radiological investigations with i.v. application of contrast media are therefore common in these patients and may cause a low ^{99m}Tc or ¹²³I uptake as it has been the case in our subject (13). In this situation, a single tracer double-phase study using 99mTc-sestamibi as proposed by Tallefier et al. (6) seems to be an appropriate method for localization of the parathyroid adenomas. Our case demonstrates that a qualitative interpretation, based on the visualization of differential washout as the only diagnostic criterion, may be misleading if the interpreter is unaware of abnormal anatomical outlines of the thyroid and the parathyroid glands.

This difficulty may be overcome by using semiquantita-



FIGURE 3. Top row: Preoperative ^{99m}Tc-sestamibi scintigrams show homogeneous uptake and no change in tracer distribution for the early (left) and late (right) phases. Bottom row: Postoperative ^{99m}Tc-sestamibi scintigram shows only faint uptake for the early phase in the thyroid region and no tracer retention 3 hr p.i.

tive assessment of 99mTc-sestamibi washout. In five patients with surgically confirmed parathyroid adenomas, a target-to-background ratio was calculated for adenomas and normal thyroid tissue as described above. From 15 min to 3 hr, the ratio dropped by only 15%-35% for the adenomas, whereas for the areas corresponding to thyroid tissue, the decrease was in the range of 40%-62%. Retrospective analysis of our case revealed a 31% increase in the ratio for the areas which were misinterpreted as representing normal thyroid tissue. In other words, a parameter corresponding to ^{99m}Tc-sestamibi washout can be easily assessed and allows one to differentiate between normal thyroid tissue and symmetrical parathyroid uptake, thus avoiding visual misinterpretations of the scintigrams. Therefore, we conclude that semiquantitative assessment of ^{99m}Tc-sestamibi washout in a double-phase study is necessary in certain situations.

REFERENCES

- Fukunaga M, Morita R, Yonekura Y, et al. Accumulation of ²⁰¹Ti-chloride in a parathyroid adenoma. *Clin Nucl Med* 1979;4:229-230.
- Ferlin G, Bursato N, Camerani M, Conte N, Zotti D. New perspectives in localizing enlarged parathyroid glands by technetium-thallium subtraction scan. J Nucl Med 1983;24:438-441.
- 3. Young AE, Gaunt JI, Groft 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.

- Hauty M, Swatz K, McClung M, et al. Technetium-thallium scintiscanning for the localization of parathyroid adenomas and hyperplasia: a reappraisal. *Am J Surg* 1987;153:479-486.
- O'Doherty MJ, Kettle Ag, Wells PH, Collins REC, Coakley AJ. Parathyroid imaging with technetium-99m-sestamibi: preoperative localization and tissue uptake studies. J Nucl Med 1992;33:313-318.
- Taillefer R, Boucher Y, Potvin C, Lambert R. Detection and localization of parathyroid adenomas in patients with hyperparathyroidism using a single radionuclide imaging procedure with technetium-99m-sestamibi (doublephase study). J Nucl Med 1992;33:1801–1807.
- Okerlund MD, Sheldon K, Corpuz S, et al. A new method with high sensitivity and specifity for localization for abnormal parathyroid glands. *Ann Surg* 1984;200:381-388.
- Basarab Rm, Manni A, Harrison TS. Dual Isotope subtraction parathyroid scintigraphy in the preoperative evaluation of suspect hyperparathyroidism. *Clin Nucl Med* 1985;10:300-314.
- Sandrock D, Merino MJ, Norton JA, Neumann RD. Parathyroid imaging by Tc/Tl scintigraphy. Eur J Nucl Med 1990;16:607-613.
- Coakley AJ. Parathyroid imaging—how and when? Eur J Nucl Med 1991; 18:151-152.
- Wei JP, Burke GJ, Mansberger AR. Prospective evaluation of the efficacy of technetium-99m stestamibi and iodine-123 radionuclide imaging of abnormal parathyroid glands. *Surgery* 1992;112:1111–1117.
- Weber CJ, Vansant J, Alazraki N, et al. Value of technetium 99m sestamibi iodine-123 imaging in preoperative parathyroid surgery. *Surgery* 1993;114: 1011–1018.
- Chan TYK, Serpell JW, Chan O, Gaunt JI, Young AE, Nunan TO. Misinterpretation of the upper parathyroid adenoma on thallium-201 and technetium-99m subtraction scintigraphy. Br J Radiol 1991;64:1-4.