Technetium-99m-Sestamibi/Thallium-201 Mismatch of Thyroid and Parathyroid Adenoma in Chronic Renal Failure

Rik Pijpers, Bert-Jan Potter van Loon, Jan C. Roos and Otto S. Hoekstra

Department of Nuclear Medicine, Free University Hospital, Amsterdam, The Netherlands and Department of Internal Medicine, St. Lucas Hospital, Amsterdam, The Netherlands

We report on a patient who had chronic renal failure and relapse of secondary hyperparathyroidism after earlier extirpation of three glands. Whereas ^{201}Tl-chloride uptake was absent in the thyroid and an ectopic parathyroid adenoma during routine subtraction ^{201}Tl-^{99m}Tc scintigraphy, both glands could be visualized with ^{99m}Tc-sestamibi and [^{123}I]sodium.

Key Words: hyperparathyroidism; parathyroid adenoma; technetium-99m-sestamibi; thallium-201; chronic renal failure

J Nucl Med 1995; 36:826–828

When the glomerular filtration rate drops below 50% of normal in chronic renal failure, secondary hyperparathyroidism may develop (*1*). If conservative treatment with suppressive doses of active vitamin D analogs fails (*2*), total or subtotal parathyroidectomy in combination with autotransplantation of one gland is the procedure of choice. A majority of patients can be treated without preoperative localization of the glands (*3,4*). If not all glands can be removed during the first surgery and symptoms of hyperparathyroidism persist or return, several imaging modalities may be helpful to localize the remaining gland(s): ultrasound (*4,5*), CT (*4,5*), scintigraphy (*3–9*) and, more recently, MRI (*4,5,7*). Venous sampling is a more invasive and indirect method to localize hyperfunctioning parathyroid glands (*4*). We report the scintigraphic findings in a patient with secondary hyperparathyroidism in whom only three parathyroid glands could be removed during earlier surgery.

CASE REPORT

The patient was a 39-yr-old man with IgA nephropathy since age 21. Hemodialysis was initiated at age 26 and at age 32 the patient received a cadaveric renal allograft, which functioned adequately until age 36, when the patient was reinstituted on hemodialysis. At age 37, parathyroidectomy was performed. Three enlarged glands were removed from both upper poles and from the right lower pole of the thyroid. Serum calcium dropped from 2.66 mmole/liter to a postoperative nadir of 1.53 mmole/liter and parathyroid hormone (PTH) from 189 to 76 pmole/liter (normal range 2–12 pmole/liter). The patient was treated with calciumacetate as phosphorus binder and, since 6 mo before scintigraphy, with intravenous 1-alfa-hydroxy-vitamin D3, but hyperparathyroidism persisted (PTH 339 pmole/liter) and hypercalcemia returned up to 2.77 mmole/liter. Examination by ultrasound and CT disclosed no parathyroid mass and a venous sampling procedure was unable to localize the site of the excess PTH production.

Subtraction scintigraphy was performed with [^{99m}Tc]pertechnetate and ^{201}Tl. The patient was in the supine position under a gamma camera equipped with a pinhole collimator. Twenty minutes after injection of 70 MBq [^{99m}Tc]pertechnetate, a normal thyroid gland was visualized (Fig. 1A). During 20 min of dynamic imaging, after injection of 70 MBq ^{201}Tl, neither the thyroid nor a parathyroid gland was seen (Fig. 1B). A mediastinal view did show physiological accumulation of ^{201}Tl in the myocardium, but no signs of an ectopic parathyroid gland. Four weeks later, scintigraphy with ^{123}I and ^{99m}Tc-sestamibi was performed. The gamma camera was equipped with a parallel-hole, high-resolution collimator. Four hours after intravenous administration of 20 MBq ^{123}I, an image of the thyroid gland was acquired (Fig. 2A) followed by a 300-sec scatter image in the ^{99m}Tc channel.

During bolus injection of 185 MBq ^{99m}Tc-sestamibi, dynamic acquisition of 10 images (120 sec per frame) was started with the camera in the same position. After 2 min, extrathyroidal accumulation of ^{99m}Tc-sestamibi was seen at the level of the left sternoclavicular joint (Fig. 2B). Static images of the mediastinum as well as subtraction images revealed no additional information. Both studies were performed 36 hr after dialysis. There had been no change in medication between the two studies and laboratory data showed a stable pattern during the examination period, with predialysis values of 137–138 mmole/liter (sodium), 4.4–4.7 mmole/liter (potassium), 101–104 mmole/liter (chloride), 1468–1531 μmole/liter (creatinine) and 21.7–23.8 mmole/liter (urea). During surgery, a 6-g parathyroid adenoma was removed. Four months postoperatively, PTH and serum calcium were normal (4 pmole/liter and 2.47 mmole/liter, respectively).

DISCUSSION

The benefit of preoperative imaging in secondary hyperparathyroidism has yet to be established. In the majority of

Received May 5, 1994; revision accepted Oct. 17, 1994.

For correspondence or reprints contact: R. Pijpers MD, Department of Nuclear Medicine, Free University Hospital, De Boelelaan 1117, 1081 HV Amsterdam, The Netherlands.

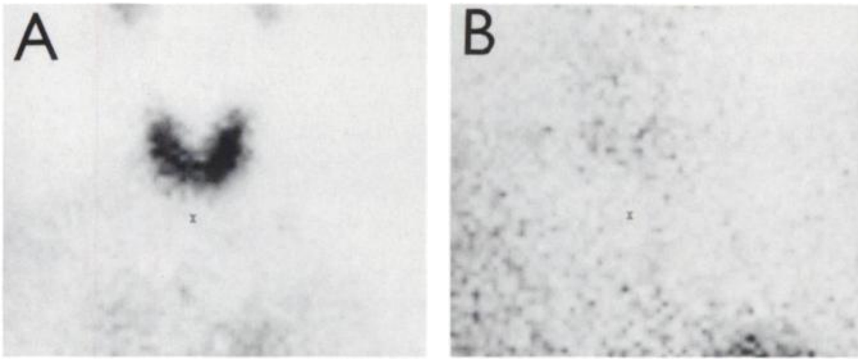

FIGURE 1. Normal [^{99m}Tc]pertechnetate uptake in the thyroid (A) without accumulation of ^{201}Tl (B). There is uptake in the myocardium. x = jugular notch.

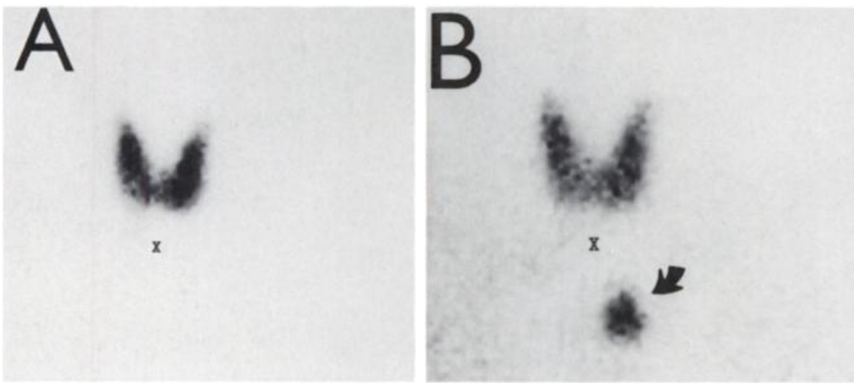

FIGURE 2. (A) Visualization of the thyroid with ^{123}I. (B) Technetium-99m-sestamibi uptake in the thyroid and an ectopic parathyroid gland (arrow). x = jugular notch.

patients, an experienced surgeon will be able to remove all parathyroid glands (*3,4,8*). This statement appears true when there are no supernumerary or ectopic glands. When all glands cannot be located and removed, however, and symptoms persist or relapse (*10*), imaging procedures may be useful before performing a second operation (*11*). Preoperative imaging can also be helpful to shorten surgery time in patients with more than average risk (*8*). A number of studies have been performed to evaluate ultrasound (*4,5*), CT (*4,5*) and MRI (*3–5,7*). None of these methods have indisputably proved to be more accurate than isotopic techniques. Quite often, a combination of several techniques is needed to improve sensitivity (*7*). Reports on ^{201}Tl/^{99m}Tc subtraction scintigraphy give sensitivity figures from a disappointing 26% to over 90% (*7,8*). This diversity may relate to several factors: histology, localization (*10*) and size (*3,7,12*) of the gland. In relapsing secondary hyperparathyroidism, potential additional problems are previous surgery (*4*), the smaller size of hyperplastic glands (*3,7*) and, possibly, impaired trapping of the tracers (*8*). None of these factors, however, influenced the scintigraphic outcome unequivocally (*6,7*).

Our patient had normal visualization of the thyroid gland with [^{99m}Tc]pertechnetate and ^{123}I and a total absence of uptake with ^{201}Tl in the thyroid as well as in the parathyroid adenoma. Because the myocardium was normally visualized with ^{201}Tl, a technical artifact was unlikely. Scatter of ^{99m}Tc in the ^{201}Tl window cannot explain the missed adenoma because the thyroid was not visualized either. Because our patient had chronic renal failure, hyperkalemia could theoretically have reduced tracer uptake in the cells (*13–15*). Potassium serum levels, however, were not elevated during the examination (4.4 mmole/liter).

Several authors described a low sensitivity in renal failure and secondary hyperparathyroidism (*11,16*). Except for hyperplasia, which may be related to smaller parathyroid glands (*3,7*), no explanation has been offered for the lower sensitivity in these studies. Our patient, however, had one large parathyroid adenoma which normally should have been depicted.

Because of the total absence of ^{201}Tl uptake, the study was repeated with ^{123}I and ^{99m}Tc-sestamibi, a tracer developed as an alternative to ^{201}Tl in myocardial perfusion studies. As a ^{99m}Tc-labeled agent, sestamibi has several advantages (*9*) and has proven useful in tumor and parathyroid imaging (*9,17,18*). In our patient, the parathyroid adenoma was clearly visualized with ^{99m}Tc-sestamibi. Because the data show that ^{201}Tl has only a moderate sensitivity in patients with renal failure (*11,14,15*), imaging with ^{99m}Tc-sestamibi may be preferable.

REFERENCES

1. Arnaud C. Hyperparathyroidism and renal failure. *Kidney Int* 1973;4:89–92.
2. Slatopolsky E, Weerts C, Thielen J, Horst R, Harter H, Martin KJ. Marked suppression of secondary hyperparathyroidism by intravenous administration of 1,25 dihydroxycholecalciferol in uremic patients. *J Clin Invest* 1984; 74:2136–2143.
3. Fine EJ. Parathyroid imaging: its current status and future role. *Semin Nucl Med* 1987;17:350–359.

4. Winzelberg GG. Parathyroid imaging. *Ann Intern Med* 1987;107:64–70.
5. Kneeland JB, Krubsack AJ, Lawson TL, et al. Enlarged parathyroid glands: high-resolution local coil MR imaging. *Radiology* 1987;164:143–146.
6. Sandrock D, Merino ML, Norton JA, Neumann RD. Parathyroid imaging by Tl/Tc scintigraphy. *Eur J Nucl Med* 1990;16:607–613.
7. Goris ML, Basso LV, Keeling C. Parathyroid imaging. *J Nucl Med* 1991; 32:887–889.
8. Coakley AJ. Parathyroid localization—how and when? *Eur J Nucl Med* 1991;18:151–152.
9. Coakley AJ, Kettle AG, Wells CP, O'Doherty MJ, Collins REC. Technetium-99m-sestamibi—a new agent for parathyroid imaging. *Nucl Med Commun* 1989;10:791–794.
10. Kessler M, Avila JM, Renoult E, Mathieu P. Reoperation for secondary hyperparathyroidism in chronic renal failure. *Nephrol Dial Transplant* 1991; 6:176–179.
11. Moolenaar W, Heslinga JM, Arndt JW, v.d.Velde CJH, Pauwels EKJ, Valentijn RM. Thallium-201/^{99m}Tc subtraction scintigraphy in secondary hyperparathyroidism in chronic renal failure. *Nephrol Dial Transplant* 1988; 2:166–168.
12. Gimlette TMD, Brownless SM, Taylor WH, Shields R, Simkin EP. Limits to parathyroid imaging with thallium-201 confirmed by tissue uptake and phantom studies. *J Nucl Med* 1986;27:1262–1265.
13. Sandrock D, Merino MJ, Norton JA, Neumann RD. Ultrastructural histology correlates with results of thallium-201/technetium-99m parathyroid subtraction scintigraphy. *J Nucl Med* 1993;34:24–29.
14. Maayan ML, Rubin JE, Berlyne G, et al. Parathyroid scans and thyroid uptake of thallium-201 of subjects in chronic hemodialysis [Abstract]. *J Nucl Med* 1984;25:P19.
15. Adelet I, Hawkins T, Clark F, Wilkinson R. Thallium-technetium scintigraphy in secondary hyperparathyroidism. *Eur J Nucl Med* 1994;21:509–513.
16. Fabretti F, Calabrese V, Fornasari V, Poletti I. Subtotal parathyroidectomy for secondary hyperparathyroidism in chronic renal failure. *J Laryngol Otol* 1991;105:562–567.
17. O'Doherty MJ, Kettle AG, Wells P, Collins REC, Coakley AJ. Parathyroid imaging with Tc-99m-sestamibi: preoperative localization and tissue uptake studies. *J Nucl Med* 1992;33:313–318.
18. Piwnica-Worms D, Holman BL. Noncardiac applications of hexakis-(alkylisonitrile) Tc-99m complexes [Editorial]. *J Nucl Med* 1990;31:16–17.