Simultaneous Scintigraphic Depiction of Aldosteronoma and Adrenal Infarction

Roma Y. Gianchandani, Gregory A. Quin, Roger J. Grekin, Milton D. Gross, James C. Sisson, Norman W. Thompson and Brahm Shapiro

Divisions of Endocrinology and Metabolism and Nuclear Medicine, Department of Internal Medicine and Surgery, University of Michigan Medical Center; and Department of Nuclear Medicine, Department of Veterans Affairs Medical Center, Ann Arbor, Michigan

Primary aldosteronism is a potentially curable cause of hypertension, especially when caused by an adrenal adenoma. Aldosteronomas because of their small size often elude techniques to locate them. This case illustrates the advantages, disadvantages and complications of noninvasive and invasive techniques used for their diagnosis.

A patient with hypertension and hypokalemia underwent an adrenal venous effluent sampling for measurement of aldosterone concentrations. This procedure was complicated by an injury to the right adrenal gland. Subsequently, it was difficult to control the patient's hypertension and hypokalemia with medical therapy alone. A re-assessment years after his initial diagnosis included a CT scan, which now visualized a left adrenal tumor. The functional status of this tumor and lack of function of the previously injured right adrenal gland were demonstrated by NP-59 scintigraphy. This information modified the surgical intervention (adenectomy rather than total adrenalectomy) and the residual left sided adrenal tissue prevented adrenocortical insufficiency. A year later the patient remains euadrenal.

Key Words: aldosteronoma; adrenal infarction; NP-59 scintigraphy

J Nucl Med 1996; 37:852–854

Primary aldosteronism (*1*) is a rare but potentially curable cause for hypertension. It may be caused by either an unilateral adrenal tumor or bilateral adrenal hyperplasia. Adrenal tumors causing aldosteronism are often small, hypovascular and unsatisfactorily visualized by noninvasive radiological procedures. Several localizing techniques have been devized to assist in their diagnosis. These include adrenal venography with adrenal venous sampling of aldosterone concentrations (*2,3*), arteriography (*4,5*) and adrenal scintigraphy (*6,7*).

Venography, usually a safe procedure for most adrenal tumors may be complicated by contrast extravasation and adrenal hemorrhage when performed for aldosteronoma. These complications are attributed to "fragile" adrenal venous anatomy (*8*), although no specific histological abnormalities of blood vessels has been demonstrated and may follow injection of as little as 0.5 cc of contrast medium (*8*).

The gold standard for lateralizing an aldosteronoma remains the obtaining measurement of aldosterone concentration in adrenal venous effluent samples. This method has all the problems of an invasive venographic procedure, which are compounded in the presence of a tortuous or short right adrenal vein. Anatomical variations of the adrenal venous system, especially of the right side, make cannulation difficult, and often lead to either an unsuccessful or a complicated procedure.

Received Mar. 31, 1995; revision accepted Aug. 4, 1995.

For correspondence or reprints contact Brahm Shapiro, Division of Nuclear Medicine, University of Michigan Medical Center, 1500 East Medical Center Dr., Ann Arbor, MI 48109-0028.

Adrenal scintigraphy is currently performed with NP-59 (6β ^{131}I-iodomethyl norcholesterol) (*9,10*) or 6β ^{75}Se-selenomethyl norcholesterol (*11*) often with oral dexamethasone suppression. This suppresses the glucocorticoid responsive inner adrenal cortical tissue but allows aldosterone secreting cells to accumulate NP-59 (*12*). By this method, the characteristic imaging pattern of an aldosteronoma is the unilateral NP-59 imaging of the tumor by days four or five postinjection.

We report a case of an aldosteronoma initially evaluated by a venous effluent sampling procedure which was complicated by adrenal hemorrhage. Years later, NP-59 scintigraphy lateralized the functional adenoma and additionally determined the extent of damage caused to the contralateral adrenal by the previous venographic procedure. Scintigraphy permitted the rational planning of the extent of his surgical intervention.

CASE REPORT

A 61-yr-old patient presented more than a decade after onset of initial symptoms for reevaluation of a left adrenal aldosteronoma. The patient had been hypertensive since the early 1970s and subsequently developed episodic anginal chest pain, atrial fibrillation, congestive heart failure and presyncope. Multiple hospital admissions later, the patient showed unprovoked hypokalemia. His interim medications included quinidine, diazepam, verapamil, enalapril, digoxin, nitroglycerine and lorazepam. In 1987, frustrated by repeated failures to respond to medical therapy, he sought further consultation. This evaluation included a normal coronary angiogram, while the concurrent hypertension and unprovoked hypokalemia initiated a search for aldosteronism.

Data obtained prior to his evaluation in our clinic included a low plasma renin of 0.05 ng/l/sec (0.18 ng/ml/hr) and high aldosterone of 3.2 nmole/liter (116 ng/dliter). An initial abdominal CT scan was equivocal (Table 1) and was followed by an adrenal venous effluent sampling procedure for aldosterone (Table 2) which was complicated by contrast medium extravasation into the right adrenal gland. The injury caused no symptoms, and since the patient had demonstrated an allergic reaction to spironolactone, amiloride and potassium supplements were added to the medical regimen. These drugs reduced the episodes of uncontrolled hypertension and atrial fibrillation.

At the initial visit to our clinic in 1993, the patient was asymptomatic. The blood pressure on optimum therapy was 160/100 mmHg, pulse 62 beats/min, regular with no apex pulse deficit. The pedal pulses were intact and there was no edema. The optic fundi manifested tortuous and narrow arterioles with atrioventricular nicking. The lungs were clear and the cardiac examination was normal. No abdominal organomegaly or bruits were present and the patient was neurologically intact.

A CT scan depicted a 1.8 cm mass in the left adrenal, while the right gland was morphologically normal (Fig. 1A). One millicurie

TABLE 1
Results of Serial CT Scans of the Adrenals

Date	Left adrenal	Right adrenal
5/87 (prior to venous sampling)	Mild thickening of proximal portion of lateral limb, with lobulation approximately 6 mm diameter	Normal
6/87 (soon after venous sampling)	Unchanged	2 cm soft tissue density consistent with hemorrhage into the gland resulting from adrenal venography
9/87	Unchanged	Reduction in size of soft tissue mass
6/88	Fullness in lateral limb of left adrenal unchanged since 5/87	Complete resolution of right soft tissue mass
9/89	1.2 cm mass in left adrenal not definitely visualized on earlier studies	Normal
9/91	Unchanged since 1989	
9/93 (at our institution)	1.8 cm left adrenal mass	Normal

TABLE 2
Selective Venous Catheterization of Adrenal Glands (5/87)

Region	Aldosterone (nmole/liter)	Norepinephrine/ epinephrine (pmole/liter)
Peripheral plasma	0.56	
IVC	–	191/113
Left adrenal vein	271	1426/5455
Right adrenal vein	35	14270/57750

Peripheral plasma renin 0.044 ng/liter/sec

of NP-59 was injected without dexamethasone suppression and clearly visualized the left adrenal gland but not the right 5 and 8 days postinjection (Fig. 1B). This allowed us to conclude that the aldosteronism arose from the left adrenal gland, probably from an adenoma, and that the right adrenal had no function. The patient was advised to undergo selective surgical resection for the aldosteronoma. A left partial adrenalectomy was performed. Normal adrenal tissue conserved on the left side allowed for preservation of adrenocortical function. After surgery, the serum potassium normalized and the blood pressure was well-controlled with verapamil alone (mean BP–140/70). Assessment of the adrenal secretory reserve 6 wk after surgery, demonstrated a normal baseline cortisol at 0.34 μmole/liter (12 μg/dl) which rose to 0.53 μmole/liter (19 μg/dl) following cortrosyn stimulation. A year later the patient remains normokalemic and a stimulated cortisol value was 0.66 μmole/liter (23 μg/dl).

DISCUSSION

The patient's initial biochemical parameters were diagnostic of primary aldosteronism and treatment with multiple medical regimens was unsuccessful.

Initial CT scans revealed left adrenal fullness, and follow-up scans demonstrated the development of an adrenal mass. Small aldosteronomas are not always readily visualized by CT. When larger than 0.8 cm, localizing accuracies range between 60% and 80%, depending upon the type of scanner and the technique used (*13,14*).

Adrenal effluent sampling performed early in the patient's course, revealed high aldosterone levels bilaterally (Table 1). The left-to-right aldosterone ratio although not diagnostic was very suggestive of a left sided aldosteronoma. Additionally, the extremely high epinephrine and norepinephrine levels on the right suggest hormone release due to adrenal injury of that side. We were unaware as to the reasons for the patient's protracted medical course, since the biochemical and localizing studies would have resulted in unilateral adrenalectomy at most centers. We presume it was due to the concern for adrenal insufficiency in the setting of contralateral adrenal injury.

This case illustrates one of the potential complications encountered with venography and venous sampling. The most serious complication, namely hemorrhage and infarction which, if bilateral, may lead to complete loss of adrenal function. There are several reports of bilateral adrenal infarction, adrenal hemorrhage (*8,15*) with hypoadrenalism (*16,17*) and even death (*18*) related to this procedure.

NP-59 scintigraphy for aldosteronism is usually performed under dexamethasone suppression, but in this case, an unsuppressed NP-59 scan better served to demonstrate the function (or lack of function) of the morphologically normal right adrenal gland (*19*). The scintigraphic results permitted the surgeon to choose tumor resection (adenectomy) rather than total adrenalectomy, which is the usual and easier surgical approach. Had it been present, normal NP-59 uptake on the right side, would predict a low risk of hypoadrenalizm following a complete left adrenalectomy. Absence of NP-59 uptake, and by inference adrenal function, depicted by scintigraphy with normal morphology on CT scan could be due to organi-

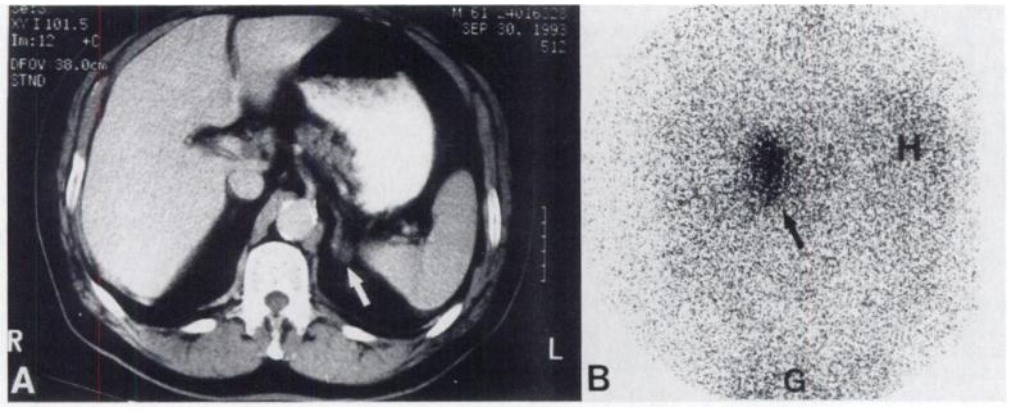

FIGURE 1. (A) Abdominal CT (9/93) demonstrates a left-sided adrenal tumor and a normal right adrenal gland. (B) Posterior abdominal NP-59 scintigraphy (8 days postinjection) demonstrates intense unilateral left adrenal tracer uptake (arrow), strongly suggesting an aldosteronoma. There is no significant functional adrenal cortical tissue in the right adrenal gland. H = normal liver uptake; G = normal gut excretion of tracer.

zation of a hemorrhage secondary to contrast extravasation at the time of venous sampling. If performed appropriately, as in this case, adrenal scintigraphy has the advantage of being noninvasive, cost-effective and accurate in defining functionality of an adrenal tumor. When performed under dexamethasone suppression, its efficacy exceeds that of CT and MRI especially in the diagnosis of bilateral adrenal hyperplasia. Series of NP-59 scintigraphy yield varied results of efficacy due either to differences in techniques, dexamethasone suppression protocols, and variation in interpreter experience. In our experience an accuracy as high as 94% and sensitivity of 96% has been noted (*14*).

When aldosteronism is biochemically confirmed (with high plasma or urinary aldosterone levels and suppressed plasma renin activity), an evaluation for the site(s) of aldosterone hypersecretion must be initiated. CT scanning or adrenal scintigraphy usually correctly lateralize an aldosteronoma. CT scanning is used first as it is widely available and may be sufficient when it yields an unequivocal result. NP-59 is most useful when CT results are equivocal, for the positive identification of bilateral hyperplasia and in problem cases such as this one. Adrenal venous sampling is reserved for cases where both the above tests fail to identify the adrenal abnormality.

Sampling in addition to being invasive, requires the administration of iodinated contrast and the skills of a highly experienced invasive radiologist. NP-59 scintigraphy plays an important role in aldosteronism for tumor localization and the differentiation from bilateral adrenal hyperplasia. Additionally as this case illustrates, scintigraphy can locate sites of residual adrenocortical function when there has been injury to one or both adrenal glands. Adrenocortical radiopharmaceuticals are widely available around the world, but in the United States NP-59 remains an Investigational New Drug and thus must be utilized as part of an experimental protocol which is a significant logistic hurdle in its widespread use.

REFERENCES

1. Conn JW. Primary aldosteronism, a new clinical syndrome. *J Lab Clin Med* 1955;45:3–17.
2. Melby JC, Spark RF, Dale SL, Egdahl RH, Kahn PC. Diagnosis and localization of aldosterone-producing adenomas by adrenal vein catheterization. *N Engl J Med* 1967;277:1050–1057.
3. Bucht H, Bergstrom J, Lindholmer B, Wijnbladh Hj, Hokfelt catheterization of the left adrenal vein for contrast injection and steroid analysis in a case of Conn's syndrome. *Acta Med Scand* 1964;176:233–241.
4. Kahn PC, Nickrosz LV. Selective angiography of the adrenal glands. *Am J Roentgen* 1967;101:739–749.
5. Kahn PC, Kelleher MD, Egdahl RH, Melby JC. Adrenal arteriography and venography in primary aldosteronism. *Radiology* 1971;101:71–78.
6. Blair RJ, Beierwalters WH, Lieberman LM, et al. Radiolabelled cholesterol as an adrenal agent. *J Nucl Med* 1971;12:176–182.
7. Beierwalters WH, Lieberman LM, Ansari AN, Nishiyama H. Localization of human adrenal glands in vivo by scintillation scanning. *JAMA* 1971;216:275–277.
8. Bookstein JJ, Conn JW, Reuter SR. Adrenal hemorrhage as a complication of adrenal venography in primary aldosteronism. *Radiology* 1968;90:778–779.
9. Basmadjian GP, Hertzel KR, Ice RD, Beierwaltes WH. Synthesis of a new adrenal cortex imaging agent 6β-^{131}I-iodomethyl-19-norcholest-5(10)en-3β-ol (NP-59). J Labd Compd 1975;11:427–431.
10. Sarkar SD, Beierwalters WH, Ice RD, et al. A new and superior adrenal scanning agent, NP-59. *J Nucl Med* 1974;16:1038–1042.
11. Shapiro B, Britton KE, Hawkins LA, Edwards CE. Clinical experience with ^{75}Se-selenomethylcholesterol adrenal imaging. *Clin Endocrinol (Oxf)* 1981;15:19–27.
12. Conn JW, Cohen EL, Herwig KR. The dexamethasone modified adrenal scintiscan in hyporeninemic aldosteronism (tumor versus hyperplasia). *J Lab Clin Med* 1976;88: 841–855.
13. Guerin CK, Wahner HW, Gorman CA, Carpenter PC, Sheddy PF. Computed tomographic scanning versus radioisotope imaging in adrenocortical diagnosis. *Am J Med* 1983;75:653–657.
14. Gross MD, Shapiro B, Grekin RJ, et al. Scintigraphic localization of adrenal lesions in primary aldosteronism. *Am J Med* 1984;77:839–844.
15. Fischer CE, Turner FA, Horton R. Remission of primary hyperaldosteronism after adrenal venography. *N Engl J Med* 1971;285:334–335.
16. Taylor HC, Sacks CR. Primary aldosteronism: remission and development of adrenal insufficiency after adrenal venography. *Ann Intern Med* 1976;85:207–209.
17. Eagen RT, Page MI. Adrenal insufficiency following bilateral adrenal venography. *JAMA* 1971;215:115–116.
18. Bayliss RI, Edwards MB, Starter F. Complications of adrenal venography. *Br J Radiol* 1970;43:531–533.
19. Gross MD, Freitas JE, Swanson DP, Brady T, Beierwalters WH. The normal dexamethasone-suppression adrenal scan. *J Nucl Med* 1979;20:1131–1135.

Gastric Antral Vascular Ectasia: A Case Report and Review of the Literature

Barry E. Herman, John J. Vargo, Stephen Baum, Eugene D. Silverman and John Eisold

Twin Rivers Gastroenterology Center, Easton, Pennsylvania; Cleveland Clinic Foundation, Cleveland, Ohio; St. Vincent Hospital and Health Center, Billings, Montana; Department of Radiology and Nuclear Medicine, National Naval Medical Center, Bethesda, Maryland; and Office of the Attending Physician, U.S. Capitol, Washington, D.C.

We present an 83-yr-old woman with a history of renal insufficiency, diabetes and idiopathic thrombocytopenic purpura (ITP) who experienced recurrent hemorrhage from gastric antral vascular ectasias (GAVE). **Methods:** Extensive evaluation consisting of barium small bowel series, colonoscopy, abdominal CT scan and visceral angiography excluded other causes of bleeding. **Results:** After ^{99m}Tc-labeled red cell imaging to localize the bleeding to the antrum, an antrectomy was performed. Seven months postsurgery, the patient experienced no further hemorrhage. **Conclusion:** ^{99m}Tc-labeled red cell scans can be used for the diagnosis of GAVE.

Received Mar. 6, 1995; revision accepted Oct. 8, 1995.

For correspondence or reprints contact: Eugene D. Silverman, MD, Department of Radiology, National Naval Medical Center, Bethesda, MD 20889-5600.

The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official policy or as reflecting of the Department of Defense.

Key Words: gastric antral vascular ectasias; technetium-99m-RBCs

J Nucl Med 1996; 37:854–856

Gastric antral vascular ectasia (GAVE) is a rare condition associated with chronic iron deficiency anemia (*1–5*). GAVE usually occurs in elderly women and has been reported in association with achlorhydria (*4*) and cirrhosis (*2*). In 1984, Jabbari et al. (*5*) coined the condition with the term "watermelon" stomach (*5*) due to the characteristic linear antral streaking seen endoscopically.

Hemorrhage from GAVE (*6*) is rare. We describe a case of GAVE with recurrent hemorrhage documented by a ^{99m}Tc-labeled red cell scan and reviewed the reported cases of this entity.