PATIENTS with hypertension may exhibit clinical signs and biochemical abnormalities which point to an adrenal lesion as the underlying cause. The presence of episodic hypertension, Cushing's syndrome, elevated urine vanillylmandelic acid and metanephrine, or persistent hypokalemia is an important finding that suggests an adrenal lesion. Ultimately, the actual demonstration of the lesion, localization of the proper side, or, in the case of the pheochromocytoma, proof of the adrenal or extraadrenal location of a mass is an important consideration prior to surgical intervention. This can be relatively easily and accurately accomplished by adrenal venography.\(^1\)\(^2\)

Prior to the development of selective angiographic technics, roentgenologic evaluation of the adrenal gland was a relatively gross procedure and usually only large lesions could be identified. Unless the lesion was of such a size that it displaced the kidney, urography was of little value. Presacral gas studies were somewhat more sensitive if adequate amounts of gas dissected around the gland. Even when adequate gas distribution was obtained, one only visualized the contour of the gland so that small or completely intraparenchymal lesions were missed by this technic.

Angiographic evaluation of the adrenal gland can be performed from the arterial or venous approach. Aortography is usually inadequate for the demonstration of small lesions because the overlying mesenteric,
celiac, and lumbar vessels obscure the fine adrenal vasculature. This problem can be overcome by selective adrenal arteriography. However, since each adrenal is usually supplied by three small arteries, a complete selective arteriographic study is tedious and time consuming. Adrenal venography offers two advantages. First, each gland is usually drained by a single vein so that the entire gland can be adequately delineated by retrograde injection of contrast material into only one vessel. Second, blood samples may be obtained directly from the vein at the same time, allowing assay of various hormones.

Catheterization of the adrenal veins is accomplished in a percutaneous fashion through the femoral vein utilizing the Seldinger technic. The right adrenal vein drains directly into the inferior vena cava while the left adrenal vein courses almost vertically downward to enter the superior aspect of the left renal vein. A distinctly different-shaped catheter is used for each side because of this difference in anatomy. The catheter is manipulated under fluoroscopic control and its position within the adrenal vein is confirmed by a test injection of a small amount of contrast material. Blood is withdrawn for hormonal assay and then a larger amount of contrast material is injected while the sequential films are made.

The normal adrenal venogram is characterized by a branching network of fine vessels that extends from a central vein more or less evenly throughout the gland (figs. 1, 2). If additional contrast material is injected, one may also obtain a parenchymal blush, but

**Figure 2**

Normal left adrenal venogram. The left adrenal is larger than the right and tends to have somewhat more rounded contours (arrows). The central vein is larger and empties into the renal vein (RV).

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**Figure 3**

Adenoma causing Cushing’s syndrome. These tumors tend to be round. Note the irregular venous network within the lesion.
care must be exercised because too forceful an injection will result in rupture of a vein and extravasation of contrast material.5

The right adrenal gland is roughly triangular in shape and is usually related to the anterior and superior aspect of the kidney. The left gland is somewhat larger than the right and may have rounded contours (fig. 2). It extends from the upper pole of the kidney anteriorly and medially and in most cases reaches the renal hilum.

Hypertension is a feature of Cushing’s syndrome and can be caused by tumor or hyperfunction of the adrenal gland. The tumors associated with this condition are usually sizable enough to be easily demonstrated by adrenal venography. These neoplasms are often round and displace the normal intraadrenal veins. Irregular venous channels in the tumor are also often opacified (fig. 3). The diagnosis of hyperplasia is somewhat more difficult to establish. In some cases the contours of a hyperplastic gland are more convex than in the normal and the gland may be enlarged (fig. 4). There is, however, a spectrum of size and shape to the normal gland so that in some patients with clinical and biochemical evidence of hyperfunction the radiographic diagnosis cannot be made with any degree of certainty. On the other hand, one can confidently exclude the presence of a tumor in these patients following an adequate study.

Venography is an accurate method of detecting intraadrenal pheochromocytoma. The tumor is usually large enough to form a rounded vascular mass on the venogram (fig. 5). To avoid the risk of a hypertensive crisis, adequate administration of phentolamine (Regitine) and monitoring of the blood pressure during the procedure are mandatory. If a pheochromocytoma is suspected and it is

Figure 4

Hyperplasia causing Cushing's syndrome. The gland is enlarged and has convex contours. Multiple collateral vessels are also filled.

Figure 5

Pheochromocytoma demonstrated in a patient with episodic hypertension. This right adrenal adenoma demonstrates a fine diffuse neovascularity.
Aldosteronoma. This left-sided adenoma measures only 4 mm but was responsible for persistent hypertension and hypokalemia. Vessels are draped around the periphery of the tumor (arrows).

not demonstrated in the adrenal gland, it is important to perform aortography and selective arteriography as these tumors may arise in extraadrenal locations.

The aldosteronoma provides the greatest challenge to the angiographer because these lesions are often less than 1 cm in diameter and yet have profound physiologic effect in the form of hypertension and hypokalemia. Although such small lesions may be missed at the time of surgery, they can be detected by adrenal venography (fig. 6). The tumors may be identified simply by displacement of surrounding normal adrenal veins, although in some cases vascularity may be seen within the lesion. In some patients, despite adequate venographic study, the tumor may not be demonstrated. Fortunately, the analysis of the adrenal blood samples for aldosterone has proved to be a reliable alternate means for localization of the lesion.6,7

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Correction
Nacim F, et al: Circulation 45: 1231, 1972. On page 1235, line 25, right column, the statement "Approximately 9% of the patients in the cardiac rupture group were diabetic as compared with 18% in group A and B," should read ". . . as compared with 18% in group A and 8% in group B."
Adrenal Venography in the Study of Hypertension

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