# Adrenal Imaging

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**KEYWORDS**

• Adrenal imaging • Pheochromocytomas • Adrenal venous sampling
• Adrenal incidentaloma

**KEY POINTS**

- Cross-sectional imaging can make a specific diagnosis in lesions, such as myelolipomas, cysts, and hemorrhage, and is often sufficient to distinguish benign from malignant adrenal processes.
- CT and MRI are also useful studies to identify pheochromocytomas and cortisol-secreting or androgen-secreting tumors.
- In patients with primary aldosteronism, adrenal venous sampling (AVS), remains the most accurate localizing study and should be performed in all patients older than 35 years of age, even if an adenoma is detected by CT or MRI.
- Radiolabeled isotope studies serve as second-line diagnostic tests for malignant adrenal tumors, either primary or metastatic, as well as for pheochromocytoma.
- Nuclear imaging studies should always follow a robust hormonal diagnosis and be correlated with findings on cross-sectional imaging.

## INTRODUCTION

Medical imaging plays an increasingly prominent role in patients with endocrine diseases.[1] In patients with either a cortisol-secreting adrenal tumor or pheochromocytoma, the degree of hormonal excess correlates directly with the size of the secreting tumor,[2–4] and CT is highly accurate in localizing the tumor. Conversely, cross-sectional imaging is not as accurate in localizing aldosterone-producing adenomas due to their small size. Furthermore, an adrenal nodule found on imaging may not be secreting aldosterone. AVS, which measures the hormone level coming

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from each gland, may identify adenomas too small to be confidently diagnosed on CT or MRI. The concordance between CT or MRI and AVS varies from 50% to 76% and decreases with age.[5–7] Thus, AVS is often used in the subclassification of patients with primary aldosteronism.[7,8]

Although CT and MRI are valuable in localizing hormone-producing tumors, incidental findings are often detected in organs other than the one for which the examination was designed. Adrenal nodules are common incidental findings, and the frequency with which these adrenal incidentalomas (AIs) are found has increased, probably due to advances in imaging technology. In a study of 61,054 patients undergoing CT scans between 1985 and 1989, only 259 (0.4%) patients were found to have incidental adrenal nodules larger than 1 cm.[9] In more recent years, AIs have been reported in more than 4% of patients.[10,11] The prevalence of AI increases with age, to as high as 10%, as suggested by both imaging and autopsy studies.[12] AIs are most commonly unilateral, but up to 15% of patients may have bilateral nodules.[13,14] When an AI is found, 2 aspects are relevant in their clinical assessment: (1) their etiology and malignant potential and (2) their hormonal status. Contemporary imaging studies can assist in addressing both questions.

Cross-sectional imaging dedicated to the adrenal gland is second only to surgical pathology in determining the malignant potential of adrenal masses. The physiologic nature of radionuclide studies, such as PET/CT and metaiodobenzylguanidine (MIBG), is also useful in clarifying the diagnosis of suspicious adrenal nodules. When correlated with the clinical context, imaging can often diagnose the specific cause of an adrenal mass.

If the cause of an adrenal lesion is uncertain, imaging may direct a percutaneous adrenal biopsy. This is most often performed with ultrasound guidance, but CT may be used, especially in deep lesions where the ultrasound images are degraded by intervening fat. Biopsy performs poorly, however, in differentiating benign adenomas from adrenocortical carcinomas (ACCs). A meta-analysis of 8 studies (240 biopsies) found that the sensitivity of biopsy for detecting adrenal cortical carcinoma was only 70%.[15] Thus, adrenal biopsy is only rarely indicated for indeterminate adrenal nodules and must be performed only after hormonal testing to exclude pheochromocytoma. Image-guided biopsy can be offered to patients with suspected metastases from an extra-adrenal malignancy if confirmation of the metastases will change therapy. Longitudinal imaging of AI remains a topic of debate. For lipid-rich adrenal nodules smaller than 4 cm, follow-up imaging may not be necessary.[12,16] Conversely, surveillance CT or MRI is recommended for patients with larger lesions and those with indeterminate findings on the initial assessment.[12,17]

## IMAGING FINDINGS

The adrenal glands are seen on all CT and MRI scans of the abdomen. On cross-sectional imaging, the normal adrenal glands appear as an inverted V shape or Y shape, lying anterior and superior to the kidneys, within Gerota fascia. The 2 limbs converge to form the apex of the gland. The mean thickness of the gland is between 5 mm and 10 mm.[18,19] Adrenal cysts, hematomas, and myelolipomas are often easily characterized. Other lesions, however, usually require dedicated imaging techniques. In the absence of a known malignancy, a lesion larger than 1 cm usually undergoes further investigation.

### *Benign Adrenal Lesions*

#### *Adrenal adenoma*

A majority of adrenal adenomas are nonhyperfunctioning; however, contralateral adrenal atrophy suggests a hyperfunctioning lesion.[20,21] Adenomas are usually