



Radiology Rounds

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Adrenal Masses

- **Most non-functional adrenal masses can be definitively characterized with CT; functional masses are best diagnosed by clinical examination and laboratory testing**
- **Adrenal protocol CT has a high sensitivity and specificity for differentiating between benign and malignant masses**
- **Non-functional masses indeterminate on CT may be further characterized by MRI, PET, or CT-guided biopsy**

Adrenal masses are found incidentally in about 3% of patients undergoing CT or MRI examinations for other purposes. Unless the patient is known to have cancer, the vast majority of lesions <4 cm in diameter are benign adenomas; but other possibilities must be considered, including metastasis, primary cancer, or a functional mass. As many as 15% of incidentally detected adrenal masses are functional, some of which are sub-clinical. Endocrine work-up should be obtained to evaluate these masses.

Adrenal imaging is an important diagnostic tool for differentiating benign from metastatic non-functional adrenal masses. On the other hand, clinical examination and laboratory tests are much more sensitive than radiology for the diagnosis of functional masses, such as pheochromocytoma, or aldosteroma, and adenomas associated with Cushing's syndrome.

Non-Functional Adrenal Masses

If clinical and laboratory findings indicate that an adrenal mass is non-functional, fine collimation non-contrast multi-detector CT is the best initial imaging examination. If a recent non-contrast CT scan is available, it may be unnecessary to perform an additional scan. If the attenuation of the mass measures <10 Hounsfield units (HU), it is highly unlikely to be malignant and non-functional lesions <0 HU are considered benign. All lesions that are not hemorrhagic or calcified but have an attenuation of >43 HU should be regarded as non-adenomas and suspicious for malignancy.

If the density of the adrenal mass is >10 HU, an adrenal protocol CT examination should be performed. In this protocol, images are obtained before and at 75 seconds and 10 minutes after administration of contrast. The relative percentage washout (RPW) and

Reported Accuracy of Imaging for Distinguishing Malignant from Benign Adrenal Masses

Imaging Method	Sensitivity	Specificity
Non-contrast CT ¹	71%	98-100%
Contrast CT with delayed washout images ²	100%	98%
Chemical-shift MRI ¹	81-100%	94-100%
PET (maximum SUV*) ³	100%	78%
PET/CT with delayed washout CT images (preliminary data) ³	100%	100%

*SUV, standard uptake values
Data from ²Blake et al, 2006a; ¹Mayo-Smith, et al, 2001;
³Blake et al, 2006b.

absolute percentage washout (APW) of contrast agent is then calculated. At a threshold of 38% for RPW, the sensitivity and specificity of detecting malignant lesions has been shown to be 100% and 95%, respectively and that for APW, at a threshold of 52%, is 100% and 98%, respectively. In this analysis, lesions that have pre-contrast attenuations <0 are considered benign and those over 43 HU as malignant.

Non-Functional Adrenal Lesions Indeterminate on Adrenal Protocol CT

If the adrenal protocol CT examination is indeterminate and the patient has a known extra-adrenal neoplasm, then the adrenal mass may be a metastasis and a CT-guided biopsy should be considered if needed for treatment planning. If there is no history of known extra-adrenal neoplasm, further imaging may help determine the identity of the mass.

Chemical shift imaging is the most accurate MRI method for distinguishing between adenomas and malignancies. In this method, T1 weighted images are acquired at echo times that are in phase and out of phase. In adenomas, out-of-phase signal intensity is lower than that on in-phase images. The sensitivity of chemical shift MRI varies with CT attenuation and is 89% for masses in the range of >10 to <30 HU and 67% for all the adenomas in the study, all of which had an attenuation >10. The specificity for detecting adenomas is 100% across the full range of attenuations. MRI is generally not used to characterize small (<1 cm) masses because of its lower resolution compared to CT.

FDG PET has excellent sensitivity for detecting adrenal malignancy and may be used to evaluate indeterminate adrenal lesions. Fusion PET-CT has the advantage of better image co-registration than separate PET and CT images acquired separately and preliminary findings indicate that both the sensitivity and specificity of using PET-CT and determining both FDG uptake and CT contrast agent APW is near 100%.

If no conclusive categorization of adrenal mass has been obtained, follow-up unenhanced CT imaging is recommended at 2, 6, and 18 months after the initial discovery of the adrenal lesion. These times are based on the expected growth rate of an adrenal carcinoma.



Figure 1. CT images of a 1.3 cm left adrenal nodule (arrows) in a 42 year old woman representing a typical adrenal adenoma with (A) unenhanced attenuation of 4HU, (B) IV contrast enhanced (performed for other indications) attenuation of 64 HU and (C) 10 minute delayed attenuation of 30 HU. The adenoma has a relative percentage washout of 53% and an absolute percentage washout of 57%.

General CT Features of Benign and Malignant Adrenal Lesions

Benign	Malignant
Often contain lipid (Unenhanced HU often <10)	Not lipid-containing (Unenhanced HU usually >10)
Smooth border, round	Irregular border and shape
Rapid washout of contrast	Slow washout of contrast
Homogeneous density	Inhomogeneous density
	Large size (>4 cm)

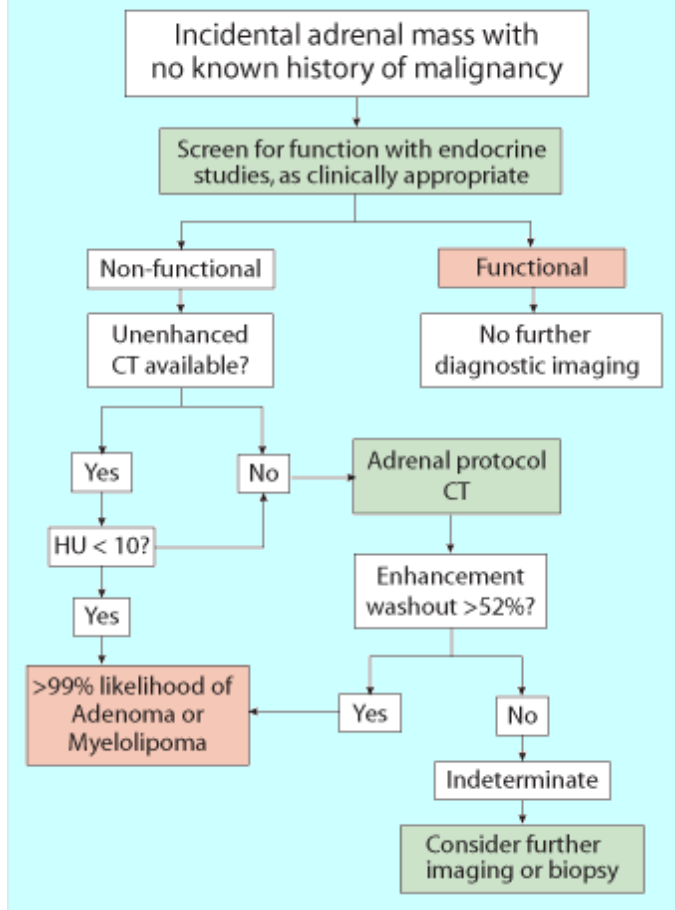
Pheochromocytoma

With the exception of pheochromocytoma, no additional imaging is generally necessary for diagnosis of functional masses. Pheochromocytomas are rare catecholamine-secreting tumors that can cause cardiovascular crises and are usually diagnosed with clinical evaluation and laboratory testing. However,

approximately 10-40% of pheochromocytomas are clinically silent and can mimic other adrenal lesions on both CT and MR imaging. Pheochromocytomas have been reported to represent 1.5-9% of adrenal masses incidentally detected on cross-sectional imaging in patients with no history of cancer.

There is some theoretical concern when administering iodinated contrast material to a patient with a clinically suspected pheochromocytoma but intravenous use of current non-ionic intravenous agents has been reported as acceptable practice in such cases. The most common appearance of a pheochromocytoma in MR images is a mass with high T2 and low T1 signal intensity, which avidly enhances with contrast material. However, many do not fit this description and the diagnostic accuracy of MRI for pheochromocytoma is about 65%. If needed, nuclear scintigraphy using ¹²³I-metaiodo-benzylguanidine (MIBG) can be used to confirm pheochromocytoma. This imaging technique has a specificity of 100% but a low sensitivity. MIBG scans can also be used to search for a clinically suspected extra-adrenal pheochromocytoma.

Algorithm for Diagnostic Evaluation of Adrenal Masses



Scheduling

Radiology examinations may be ordered through ROE (<http://mghroe/>) or by telephone 617-724-XRAY (9729) for all locations. CT is performed at the main campus as well as Mass General West Imaging, Waltham and Mass General Imaging, Chelsea. Nuclear imaging is performed at the MGH Main Campus and Mass General West Imaging, Waltham.

Further Information

For further questions, please contact [Michael A. Blake, M.R.C.P.I., F.R.C.R., F.F.R., R.C.S.I.](#), Abdominal and Interventional Radiology, 617-726-8396.

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