Incidentally Discovered Adrenal Mass
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Gajraj H, Young AE. Adrenal incidentaloma. *Br J Surg* 1993; 80(4):422-426.	12	N/A	To determine a policy for adrenal incidentaloma in patients without known malignancy.	The risk of malignancy is so low in this population that any lesion <6 cm can be safely followed. Enlarging lesions at 1 year should be biopsied or removed.	4
2. Herrera MF, Grant CS, van Heerden JA, Sheedy PF, Ilstrup DM. Incidentally discovered adrenal tumors: an institutional perspective. *Surgery* 1991; 110(6):1014-1021.	13	342	To investigate the effect of size of incidental adrenal masses in patients without known malignancy.	2% were chemically active. 1.5% had a tumor and all of these were >5 cm. Authors suggest biochemical screening and surgical excision for all lesions >4 cm. Follow-up CT should be performed at 3 months in lesions <4 cm.	2
3. Song JH, Chaudhry FS, Mayo-Smith WW. The incidental adrenal mass on CT: prevalence of adrenal disease in 1,049 consecutive adrenal masses in patients with no known malignancy. *AJR* 2008; 190(5):1163-1168.	13	973 patients 1,049 adrenal masses	Retrospective study to determine the nature and prevalence of adrenal lesions identified on CT in patients with no known malignancy.	In 973 patients with an incidental adrenal mass and no history of cancer, no malignant lesions were identified. The common lesions were adenomas (75%) and myelolipomas (6%).	2
4. Bernardino ME, Walther MM, Phillips VM, et al. CT-guided adrenal biopsy: accuracy, safety, and indications. *AJR* 1985; 144(1):67-69.	10	53 patients 58 needle biopsies	To review the accuracy of CT-guided adrenal biopsy performed in a mixed population.	44 (83%) of 53 had correct tissue diagnosis at initial biopsy. 17% of samples were insufficient for diagnosis. Accurate diagnosis was obtained in 48 (90.6%) when both first and second biopsy attempts were combined. 46% of lesions were malignant. 11.3% had complications, mainly bleeding. Authors conclude that procedure is accurate and safe alternative to surgical biopsy.	2
5. Francis IR, Smid A, Gross MD, Shapiro B, Naylor B, Glazer GM. Adrenal masses in oncologic patients: functional and morphologic evaluation. *Radiology* 1988; 166(2):353-356.	10	28	Prospective study to investigate the role of NP-59 scintigraphy in the evaluation of unilateral adrenal masses detected by CT in the oncologic patient with normal adrenal function.	14/28 had an increased uptake of the NP-59 on the side of the adrenal mass detected at CT (concordant uptake).13/14 masses with concordant uptake were >2 cm, and one was 1.5 cm; all were found to be adenomas. 11/28 had decreased uptake on the side of the mass detected at CT (discordant uptake). Most were metastases. Uptake was indeterminate (symmetric) in 3 patients–2 had adrenal adenomas and adrenal metastasis.	2

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6. McGahan JP. Adrenal gland: MR imaging. *Radiology* 1988; 166(1 Pt 1):284-285.	15 (letter)	N/A	Comment on an article by Chang et al on MRI of the adrenal gland.	In this article, Chang et al found that intensity ratios of adrenal masses to liver were not statistically significant in distinguishing benign and malignant adrenal lesions. However, the mass/fat intensity ratio was statistically significant in separating benign and malignant adrenal lesions. In this study, all lesions with a mass/fat intensity ratio >0.8 were malignant and all adrenal masses with a ratio <0.6 were benign (adenomas). 8 of the masses were indeterminate.	4
7. Oliver TW, Jr., Bernardino ME, Miller JI, Mansour K, Greene D, Davis WA. Isolated adrenal masses in nonsmall-cell bronchogenic carcinoma. *Radiology* 1984; 153(1):217-218.	13	330	Combined retrospective-prospective study to determine the incidence of benign vs malignant isolated adrenal lesions in patients undergoing CT staging for nonsmall-cell bronchogenic carcinoma.	32 had adrenal masses. 8/32 masses were metastases, 17 were adenomas, and 7 did not undergo biopsy. In patients with nonsmall-cell bronchogenic carcinoma, an isolated adrenal mass is more likely benign than metastatic, and biopsy is advocated prior to withholding potentially curative surgery. CT has become useful in staging of patients with bronchogenic carcinoma.	2
8. Candel AG, Gattuso P, Reyes CV, Prinz RA, Castelli MJ. Fine-needle aspiration biopsy of adrenal masses in patients with extraadrenal malignancy. *Surgery* 1993; 114(6):1132-1136; discussion 1136-1137.	13	36	To investigate the effect of size of incidental adrenal masses on fine-needle outcome in patients with known malignancies.	Using 3 cm as a dividing value, 87% of masses <3 cm were benign and more than 95% of lesions >3 cm were malignant in patients with known malignancies. Authors conclude that there is a significant correlation between the size of an adrenal nodule and the presence of metastases.	3
9. Caplan RH, Strutt PJ, Wickus GG. Subclinical hormone secretion by incidentally discovered adrenal masses. *Arch Surg* 1994; 129(3):291-296.	13	26	Review radiologic reports to determine the frequency of subclinical hormone secretion in incidentally discovered adrenal masses in patients without a history of tumor.	One patient had unrecognized primary aldosteronism, 2 had elevated free catecholamine excretion, and 3 (12%) had subclinical Cushing's syndrome. Authors conclude that subclinical hormone secretion, especially cortisol secretion, is common in patients with incidentally discovered adrenal masses and therefore surgeons/anesthesiologists must be aware that adrenal may develop in patients with incidentally discovered adrenal masses.	3

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10. Lee MJ, Hahn PF, Papanicolaou N, et al. Benign and malignant adrenal masses: CT distinction with attenuation coefficients, size, and observer analysis. *Radiology* 1991; 179(2):415-418.	10	55 patients 66 adrenal masses 3 observers	Retrospective blinded study to investigate the role of CT attenuation coefficients in differentiating benign and malignant lesions in a mixed population.	The mean CT attenuation coefficient for benign adrenal masses was -2.2 HU +/- 16.0 and was significantly different from the mean for malignant lesions (28.9 HU +/- 10.6). The area under the ROC curve for CT attenuation coefficients (0.91 +/- 0.04) was significantly larger than that for lesion size (0.84 +/- 0.05) or best observer interpretation (0.84 +/- 0.05). A threshold CT attenuation value of 0 HU had a sensitivity-to-specificity ratio of 47%:100% for characterizing benign adrenal masses, whereas a threshold attenuation of 10 HU had a ratio of 79%:96%.	2
11. van Erkel AR, van Gils AP, Lequin M, Kruitwagen C, Bloem JL, Falke TH. CT and MR distinction of adenomas and nonadenomas of the adrenal gland. *J Comput Assist Tomogr* 1994; 18(3):432-438.	9	37 patients 44 adrenal masses	To determine which of these: size, CT attenuation values, MRI signal intensity (SI) ratios on T1- and T2-weighted sequences, calculated T2 relaxation times, or T2 relaxation time ratios provide better distinction of adenomas and non-adenomas of the adrenal gland.	Using a threshold of 15 HU they found no malignancies although there were some cysts. The optimal size threshold was 3.1 cm but it did not discriminate all lesions (93%). Attenuation values on non-contrast-enhanced CT are recommended in discriminating adrenal adenomas from non-adenomas.	2
12. Reincke M, Nieke J, Krestin GP, Saeger W, Allolio B, Winkelmann W. Preclinical Cushing's syndrome in adrenal "incidentalomas": comparison with adrenal Cushing's syndrome. *J Clin Endocrinol Metab* 1992; 75(3):826-832.	13	68	Prospective study to determine the frequency of subclinical hormone secretion in incidentally discovered adrenal masses in patients without a history of tumor.	12% of incidentalomas showed cortisol secretion with dexamethasone suppression test consistent with adrenal cortical hyperfunction.	2
13. Bulow B, Ahren B. Adrenal incidentaloma--experience of a standardized diagnostic programme in the Swedish prospective study. *J Intern Med* 2002; 252(3):239-246.	13	381	Prospective multicenter study to report a 5-year experience of a diagnostic program for adrenal incidentaloma. Emphasis on hormonally active and malignant lesions.	5% of 381 cases had benign hyper secreting tumors and about 4% had malignant tumors. The results of the biochemical diagnostic tests used had a high compatibility with the histological diagnosis found at operation in the patients with hyper secreting tumors. Tumor size, male gender and high age were predictive for the risk of a malignant tumor.	2

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14. Baguet JP, Hammer L, Mazzuco TL, et al. Circumstances of discovery of phaeochromocytoma: a retrospective study of 41 consecutive patients. *Eur J Endocrinol* 2004; 150(5):681-686.	13	41	Retrospective study to determine circumstances of discovery of pheochromocytomas.	The association of headaches and palpitations with sweating was found in 24% of cases (10/41). Blood pressure anomalies led to the discovery of phaeochromocytoma in 51% of cases (21/41) and 59% (24/41) of all the patients suffered from hypertension. Tumor was in almost half the cases (20/41); the tumor was discovered by an imaging method (US, CT scan or MRI) which had been performed for reasons unrelated to a blood pressure abnormality.	3
15. Motta-Ramirez GA, Remer EM, Herts BR, Gill IS, Hamrahian AH. Comparison of CT findings in symptomatic and incidentally discovered pheochromocytomas. *AJR* 2005; 185(3):684-688.	13	33	Retrospective study to determine incidence of incidental pheochromocytomas, see if there are differences between incidental and symptomatic pheochromocytomas.	57.6% of the pheochromocytomas were incidental. None of the pheochromocytomas had attenuation values of less than 10 H on unenhanced CT scans. No imaging appearance differences between incidental and symptomatic pheochromocytomas.	2
16. Singer AA, Obuchowski NA, Einstein DM, Paushter DM. Metastasis or adenoma? Computed tomographic evaluation of the adrenal mass. *Cleve Clin J Med* 1994; 61(3):200-205.	10	24	To investigate the role of CT attenuation coefficients in differentiating benign and malignant lesions in patients with known malignancy.	Using a threshold of 0 HU 33:100 sensitivity/specificity ratio was seen. With 10 HU same ratio was 58:92. Size threshold of 2.5 cm produced ratio of 58:100. Authors conclude that benign adenomas can be identified by measuring the size and attenuation of adrenal masses.	3
17. Stadler A, Schima W, Prager G, et al. CT density measurements for characterization of adrenal tumors ex vivo: variability among three CT scanners. *AJR* 2004; 182(3):671-675.	14	7	Assess the variability of CT attenuation values for adrenal tumors with different scanning protocols and CT scanners to determine whether the establishment of a scanner-independent threshold for differentiation between adenomas and non-adenomas was possible.	CT density measurements varied by 2-4 HU depending on the manufacturer. This should be considered when setting absolute threshold values for CT density.	4
18. Boland GW, Lee MJ, Gazelle GS, Halpern EF, McNicholas MM, Mueller PR. Characterization of adrenal masses using unenhanced CT: an analysis of the CT literature. *AJR* 1998; 171(1):201-204.	11	10 CT reports 495 adrenal lesions (272 benign, 223 malignant).	Analysis of CT reports to determine optimal threshold value for separating benign from malignant lesions in adrenal masses.	Sensitivity for characterizing a lesion as benign ranged from 47% at a threshold of 2 H to 88% at a threshold of 20 H. Specificity varied from 100% at a threshold of 2 H to 84% at a threshold of 20 H. Attempt to be certain that a lesion is benign may lead to an unacceptably low sensitivity for characterization. Choice of threshold is dependent on patient population and the cost-benefit approach to patient care.	3

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19. Bae KT, Fuangtharnthip P, Prasad SR, Joe BN, Heiken JP. Adrenal masses: CT characterization with histogram analysis method. *Radiology* 2003; 228(3):735-742.	9	193 patients 223 adenomas	Retrospective study to determine whether a histogram analysis method is more accurate than region of interest measurements for determining adenomas on non enhanced CT.	Histogram method has greater sensitivity than the 10-HU threshold method for diagnosis of adrenal adenomas at enhanced CT, with specificity maintained at 100%.	2
20. Remer EM, Motta-Ramirez GA, Shepardson LB, Hamrahian AH, Herts BR. CT histogram analysis in pathologically proven adrenal masses. *AJR* 2006; 187(1):191-196.	10	187 patients 208 adenomas 2 observers	Retrospective review to evaluate if a CT histogram analysis method can distinguish adrenal adenomas from metastases, pheochromocytomas and adrenal cortical carcinomas. Compared adenomas on unenhanced CT with enhanced CT.	Specificity for a 10% negative pixel threshold was approximately 88% for unenhanced CT scans and 99% for enhanced CT scans, with sensitivities of 71% and 12%, respectively. Although the specificity for adenoma diagnosis on enhanced CT is high using a histogram analysis method with a 10% negative threshold, low sensitivity limits clinical usefulness.	2
21. Ho LM, Paulson EK, Brady MJ, Wong TZ, Schindera ST. Lipid-poor adenomas on unenhanced CT: does histogram analysis increase sensitivity compared with a mean attenuation threshold? *AJR* 2008; 191(1):234-238.	9	104 patients 132 adrenal nodules	Retrospective study. Compare histogram analysis with mean attenuation threshold to determine the value of CT histogram analysis for further characterization of lipid-poor adenomas on unenhanced CT.	• Unenhanced CT mean attenuation threshold <10 H yielded a sensitivity of 68% and specificity of 100% for the diagnosis of an adenoma. • Unenhanced CT threshold >10% negative pixels yielded a sensitivity of 84% and specificity of 100% for the diagnosis of an adenoma. • Authors conclude that CT histogram analysis is superior to mean CT attenuation analysis for the evaluation of adrenal nodules and may help decrease referrals for additional imaging or biopsy.	2
22. Korobkin M, Brodeur FJ, Francis IR, Quint LE, Dunnick NR, Londy F. CT time-attenuation washout curves of adrenal adenomas and nonadenomas. *AJR* 1998; 170(3):747-752.	10	66 patients 52 adrenal adenomas 24 non-adenomas	To determine if delayed washout CT improved differentiation of benign and malignant adrenal lesions.	The sensitivity and specificity for the diagnosis of adenoma were both 96% at a threshold attenuation value of 37 HU on the 15-minute delayed enhanced scan. Delayed washout CT appears very promising as a method of differentiating adenomas and metastases.	2
23. Korobkin M, Francis IR. Imaging of adrenal masses. *Urol Clin North Am* 1997; 24(3):603-622.	12	N/A	Review clinical features and imaging findings of patients with known or suspected adrenal masses.	In patients with hyperfunctioning adrenal syndrome, CT is useful. In patients with a non-hyperfunctioning adrenal mass, chemical shift MRI and CT densitometry are now replacing percutaneous adrenal biopsy or serial follow-up CT as methods to establish a specific diagnosis.	4

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24. Caoili EM, Korobkin M, Francis IR, Cohan RH, Dunnick NR. Delayed enhanced CT of lipid-poor adrenal adenomas. *AJR* 2000; 175(5):1411-1415.	9	18 lipid-poor adenomas 56 lipid-rich adenomas 40 adrenal non-adenomas	Compared the delayed contrast-enhanced CT features of lipid-poor adenomas with those of lipid-rich adenomas and adrenal non-adenomas to determine whether there were differences in the washout features between these groups of lesions.	A single mean attenuation value cannot differentiate lipid-poor adenomas from adrenal non-adenomas. Lipid-poor adenomas show enhancement and enhancement washout features similar to lipid-rich adenomas and can be distinguished from non-adenomas on the basis of a percentage washout threshold value of 60% and a relative percentage washout of 40%.	2
25. Kebapci M, Kaya T, Gurbuz E, Adapinar B, Kebapci N, Demirustu C. Differentiation of adrenal adenomas (lipid rich and lipid poor) from nonadenomas by use of washout characteristics on delayed enhanced CT. *Abdom Imaging* 2003; 28(5):709-715.	9	65 patients 77 adrenal masses	Describe non-enhanced, early contrast-enhanced and delayed contrast-enhanced CT features and contrast washout characteristics of adrenal adenomas (lipid rich and lipid poor) and non-adenomas to determine the role of these methods in distinguishing one type from the other.	The absolute or relative percentage washout of contrast material on delayed contrast-enhanced CT is highly specific for differentiation of lipid-poor and lipid-rich adrenal adenomas from adrenal non-adenomas.	2
26. Szolar DH, Kammerhuber FH. Adrenal adenomas and nonadenomas: assessment of washout at delayed contrast-enhanced CT. *Radiology* 1998; 207(2):369-375	9	122 patients 135 adrenal masses	To determine if delayed washout CT can better differentiate adenomas from non-adenomas.	Delayed enhanced CT at 10 minutes (sensitivity 92%; specificity 95%) and 30 minutes (sensitivity 97%; specificity 100%) was more accurate for differentiation of adenomas and non-adenomas than unenhanced CT (sensitivity 82%; specificity 95%). Authors conclude that adrenal adenomas show greater washout of contrast material than adrenal non-adenomas. Recommends combining percentage change in washout of contrast material to absolute CT attenuation values in differentiation of adrenal adenomas and non-adenomas.	2
27. Caoili EM, Korobkin M, Francis IR, et al. Adrenal masses: characterization with combined unenhanced and delayed enhanced CT. *Radiology* 2002; 222(3):629-633.	10	116 patients 166 adrenal masses	To assess accuracy of dedicated CT adrenal protocol with unenhanced and delayed washout attenuation values.	Sensitivity and specificity of protocol was 98% and 92% with 96% accuracy. With combination of unenhanced and delayed washout CT nearly all masses can be categorized accurately as adenomas or non adenomas.	2
28. Choyke PL. From needles to numbers: can noninvasive imaging distinguish benign and malignant adrenal lesions? *World J Urol* 1998; 16(1):29-34.	12	N/A	Review to determine role of non-invasive imaging in differentiating benign and malignant adrenal lesions.	CT densitometry with or without contrast media and chemical shift MRI have adequate sensitivity (50%-90%) and excellent specificity (>95%) for adrenal adenomas.	4

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29. Szolar DH, Korobkin M, Reittner P, et al. Adrenocortical carcinomas and adrenal pheochromocytomas: mass and enhancement loss evaluation at delayed contrast-enhanced CT. *Radiology* 2005; 234(2):479-485.	9	67 patients (11 with adrenocortical carcinoma 17 with pheochromocytoma 23 with adrenal adenoma 16 with metastasis to adrenal gland)	To retrospectively measure the adrenal gland attenuation and the percentage loss of adrenal gland enhancement at delayed contrast medium-enhanced CT in patients with adrenocortical carcinomas and pheochromocytomas and to compare these data with those in patients with adenomas and metastases.	At optimal threshold values of 50% for absolute percentage of enhancement loss and 40% for relative percentage of enhancement loss at 10 minutes, both the sensitivity and the specificity for the diagnosis of adenoma were 100% when adenomas were compared with carcinomas, pheochromocytomas, and metastases. The enhancement loss in adrenocortical carcinomas and pheochromocytomas is similar to that in adrenal metastases but significantly less than that in adrenal adenomas. The percentage change in contrast material washout is a useful addition to absolute CT attenuation values in differentiating adrenal adenomas from adrenocortical carcinomas and pheochromocytomas.	2
30. Leroy-Willig A, Bittoun J, Luton JP, et al. In vivo MR spectroscopic imaging of the adrenal glands: distinction between adenomas and carcinomas larger than 15 mm based on lipid content. *AJR* 1989; 153(4):771-773.	10	20 patients 22 adrenal tumors	To investigate the role of chemical shift MRI in differentiating benign and malignant adrenal masses in a mixed population.	Lipid percentage was higher for adenomas (n=15) than for metastatic (n=7). One adenoma had a lipid percentage overlapping with malignant (96% correct). In vivo MR spectroscopic imaging of adrenal tumors is useful.	3
31. Mitchell DG, Crovello M, Matteucci T, Petersen RO, Miettinen MM. Benign adrenocortical masses: diagnosis with chemical shift MR imaging. *Radiology* 1992; 185(2):345-351.	10	31 patients 45 adrenal masses	To investigate the role of chemical shift MRI in differentiating benign and malignant adrenal masses in a mixed population.	Both myelolipomas and 26/27 benign cortical masses showed a loss of SI on at least one chemical shift image. Opposed-phase images were slightly more sensitive than fat-suppressed images in depicting lipid within benign cortical masses. All masses had higher SI than that of the liver on standard T2-weighted MR images. Chemical shift MRI can demonstrate lipid within benign adrenocortical masses and thus increase specificity, potentially obviating biopsy and aggressive follow-up.	2

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32. Tsushima Y, Ishizaka H, Matsumoto M. Adrenal masses: differentiation with chemical shift, fast low-angle shot MR imaging. *Radiology* 1993; 186(3):705-709.	10	46 patients 53 adenomas	Prospective study to investigate the role of chemical shift MRI in differentiating benign and malignant adrenal masses in a mixed population.	The signal-intensity indexes of adrenal masses ([SI on IP - SI on OP]/[SI on IP x 100]), where IP = in-phase image and OP = out-of-phase image, were calculated. All adenomas had SI indexes >5%, while SI indexes of metastatic tumors and pheochromocytomas were <5%, with accuracy of 100%. Chemical shift MRI was superior to the calculated T2.	2
33. Mayo-Smith WW, Lee MJ, McNicholas MM, Hahn PF, Boland GW, Saini S. Characterization of adrenal masses (< 5 cm) by use of chemical shift MR imaging: observer performance versus quantitative measures. *AJR* 1995; 165(1):91-95.	10	43 patients 46 adrenal lesions 3 observers	To evaluate the ability of chemical shift MRI to differentiate <5 cm adrenal adenomas from metastases and to compare subjective interpretation with several different quantitative measures.	Mean SI was significantly different between adenomas and metastases on out-of-phase images (64 vs 98) (P<.0005) but not in-phase images (130 vs 122) (P=.47). The adrenal-spleen ratio discriminated between adenomas and metastases better than did the adrenal-liver ratio, the adrenal-muscle ratio, or the SI index. No significant difference in interpretation among the three observers was evident (areas under the ROC curves, 0.93, 0.95, and 0.96). The performance of the observers was comparable to the results obtained with the adrenal-spleen ratio measurement (area under the ROC curve, 0.97).	2
34. McNicholas MM, Lee MJ, Mayo-Smith WW, Hahn PF, Boland GW, Mueller PR. An imaging algorithm for the differential diagnosis of adrenal adenomas and metastases. *AJR* 1995; 165(6):1453-1459.	10	33 patients 37 adrenal masses	Prospective study to develop an algorithm using CT and chemical-shift MRI for the characterization of adrenal masses in patients with a primary cancer and no other evidence of metastatic disease.	Lesions ≤0 H may be benign and further work-up is not required. Lesions with density >20 H may be malignant and should be biopsied when the result will influence management. Study recommends chemical-shift MRI for CT-indeterminate lesions. An adrenal-spleen ratio (ASR) threshold of 70 indicates a benign lesion, and no further workup is required in these patients. Lesions with ASR >70 should have a biopsy performed, depending on the clinical situation.	2

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35. Outwater EK, Siegelman ES, Radecki PD, Piccoli CW, Mitchell DG. Distinction between benign and malignant adrenal masses: value of T1-weighted chemical-shift MR imaging. *AJR* 1995; 165(3):579-583.	10	50 patients 58 adrenal masses 3 observers	Blinded study to determine value of T1-weighted chemical-shift MRI for distinction between benign and malignant adrenal masses.	The 3 readers had mean sensitivity of 87%, specificity of 92%, and PPV of 95% for diagnosis of benign lesion. At the highest (definite) confidence of a benign lesion, the mean PPV was 99%, with lower sensitivity (54%). Areas under ROC curves for the 3 radiologists were .98 (95% CI: .94-1.00), .96 (CI: .91-1.00), and .95 (CI: .89-1.00). Inter-observer variation for the diagnosis of a benign mass was low (kappa = .79). Authors conclude that chemical-shift imaging using breath-hold opposed-phase T1-weighted MRI is a reliable and reproducible technique for the diagnosis of most benign adrenal masses at the highest threshold of confidence.	2
36. Fujiyoshi F, Nakajo M, Fukukura Y, Tsuchimochi S. Characterization of adrenal tumors by chemical shift fast low-angle shot MR imaging: comparison of four methods of quantitative evaluation. *AJR* 2003; 180(6):1649-1657.	9	88 patients 102 adrenal masses	Retrospective study to compare and assess 4 quantitative methods of distinguishing adenomas from malignant adrenal lesions using chemical shift fast low-angle shot MRI.	The SI index was the best method of distinguishing benign and malignant lesions. In this study 100% were identified correctly using a SI index of 11.2 to 16.5%.	2
37. Haider MA, Ghai S, Jhaveri K, Lockwood G. Chemical shift MR imaging of hyperattenuating (>10 HU) adrenal masses: does it still have a role? *Radiology* 2004; 231(3):711-716.	10	36 patients 38 masses	Retrospective study to determine whether chemical shift MRI can characterize hyperattenuating adrenal masses.	89% (17/19 masses) of adrenal adenomas >10HU were detected by chemical shift MRI. Authors conclude that for some circumstances, chemical shift MRI is a reasonable second imaging test for further characterization of a hyperattenuating adrenal mass.	2
38. Israel GM, Korobkin M, Wang C, Hecht EN, Krinsky GA. Comparison of unenhanced CT and chemical shift MRI in evaluating lipid-rich adrenal adenomas. *AJR* 2004; 183(1):215-219.	9	40 patients 42 adrenal masses 2 observers	Retrospective analysis to compare unenhanced CT with chemical shift MRI to determine if MRI can characterize adrenal lesions which are indeterminate by CT.	The sensitivities and specificities for diagnosing a lipid-rich adenoma using the qualitative, adrenal-to-spleen chemical shift ratio, signal-intensity index, and unenhanced CT attenuation analyses were 92% (33/36) and 17% (1/6), 100% (36/36) and 100% (6/6), 100% (36/36) and 67% (4/6), and 78% (28/36) and 83% (5/6), respectively. 8 of 13 adrenal adenomas >10 HU on unenhanced CT were characterized with chemical shift MRI.	2

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39. Gabriel H, Pizzitola V, McComb EN, Wiley E, Miller FH. Adrenal lesions with heterogeneous suppression on chemical shift imaging: clinical implications. *J Magn Reson Imaging* 2004; 19(3):308-316.	13	242	Retrospective study to determine the frequency and value of adrenal lesions that demonstrate heterogeneous suppression on chemical shift MRI.	Heterogeneous suppression was seen in 14% of patients. Imaging or pathologic follow-up was available for 18 of the heterogeneously suppressing lesions. 18/18 cases were benign. Therefore, heterogeneous suppression has the same significance as homogeneous suppression.	2
40. Park BK, Kim CK, Kim B, Lee JH. Comparison of delayed enhanced CT and chemical shift MR for evaluating hyperattenuating incidental adrenal masses. *Radiology* 2007; 243(3):760-765.	9	34 patients 43 adrenal masses	Retrospective study to compare the accuracy of delayed enhanced CT and chemical shift MRI for characterizing hyperattenuating adrenal masses at CT, with either follow-up imaging or pathologic review as the reference standard.	Sensitivity, specificity, and accuracy for adenoma at CT were 97% (36/37), 100% (6/6), and 98% (42/43), respectively, and at MR were 86% (32/37), 50% (3/6), and 49% (21/43), respectively. CT helped confirm 5 more adenomas and 3 more metastatic tumors than did MRI. However, there was no significant difference for diagnostic accuracy between the two imaging modalities (P>.05).	2
41. Gillams A, Roberts CM, Shaw P, Spiro SG, Goldstraw P. The value of CT scanning and percutaneous fine needle aspiration of adrenal masses in biopsy-proven lung cancer. *Clin Radiol* 1992; 46(1):18-22.	10	16 patients had FNA	To review the accuracy of CT and percutaneous fine needle aspiration (FNA) of adrenal masses in biopsy-proven lung cancer.	19% of samples were insufficient. 5 patients with positive FNA died within 24 months but 2/5 with negative biopsies died with metastatic disease within 11 months. Lesions <2 cm were benign. Biopsy was necessary for diagnosis since the CT appearances of many adrenal lesions were insufficiently distinctive to exclude malignancy.	3
42. Silverman SG, Mueller PR, Pinkney LP, Koenker RM, Seltzer SE. Predictive value of image-guided adrenal biopsy: analysis of results of 101 biopsies. *Radiology* 1993; 187(3):715-718.	10	97 patients 101 biopsies	To review the accuracy of biopsy performed in a mixed population.	Diagnostic samples were obtained in 86%. Biopsy had sensitivity of 93%, NPV of 91% and accuracy of 96%. Three small masses <3 cm proved to be malignant. Biopsy is an accurate procedure, however if benign tissue is not obtained then repeat biopsy or surgery is indicated. 8% complications.	2
43. Tikkakoski T, Taavitsainen M, Paivansalo M, Lahde S, Apaja-Sarkkinen M. Accuracy of adrenal biopsy guided by ultrasound and CT. *Acta Radiol* 1991; 32(5):371-374.	10	56	To review the results of FNA of the adrenal glands guided by US or CT and determine its accuracy.	Sufficient material was obtained in 96%. Overall accuracy to differentiate benign and malignant disease was 85.7% with 2 false negatives and one false positive. No complications.	3
44. Lumachi F, Borsato S, Tregnaghi A, et al. CT-scan, MRI and image-guided FNA cytology of incidental adrenal masses. *Eur J Surg Oncol* 2003; 29(8):689-692.	9	34	Prospective study to compare value of CT, MRI and FNA in patients with incidentalomas.	Sensitivity, specificity, and PPV were 66.7, 85.7, and 50.0%, for CT scan, 83.3, 92.9, and 71.4% for MRI, and 83.3, 100, and 100% (P<0.05) for FNA cytology, respectively. Image-guided FNA cytology was safe and definitive in many patients.	2

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45. Paulsen SD, Nghiem HV, Korobkin M, Caoili EM, Higgins EJ. Changing role of imaging-guided percutaneous biopsy of adrenal masses: evaluation of 50 adrenal biopsies. *AJR* 2004; 182(4):1033-1037.	10	50 biopsies	Retrospective study to assess the effect of dedicated adrenal imaging with CT and MRI on the rate of percutaneous imaging-guided biopsies of adrenal masses.	Only 6/50 (12%) of adrenal biopsied were adenomas. The number of adrenal adenomas biopsied has declined markedly with the introduction of dedicated adrenal CT and MRI for adrenal adenomas. Percutaneous imaging-guided biopsy is useful in confirming the presence and nature of suspected adrenal metastases.	2
46. Hoh CK, Schiepers C, Seltzer MA, et al. PET in oncology: will it replace the other modalities? *Semin Nucl Med* 1997; 27(2):94-106.	12	N/A	Review literature over last 3 years to examine role of PET in relation to other tumor imaging modalities.	Currently, PET is used in characterizing tumor lesions, differentiating recurrent disease from treatment effects, staging tumors, evaluating the extent of disease, and monitoring therapy. In the future, PET may be used in molecular medicine and genetics.	3
47. Kumar R, Xiu Y, Yu JQ, et al. 18F-FDG PET in evaluation of adrenal lesions in patients with lung cancer. *J Nucl Med* 2004; 45(12):2058-2062.	10	94 patients 113 adrenal masses 3 observers	Retrospective study to assess the role of FDG-PET in differentiating benign from metastatic adrenal masses detected on CT or MRI scans of patients with lung cancer.	The sensitivity, specificity, and accuracy for detecting metastatic disease were 93%, 90%, and 92%, respectively. FDG-PET is an accurate, noninvasive technique for differentiating benign from metastatic adrenal lesions detected on CT or MRI in patients with lung cancer. It can be falsely negative in necrotic and hemorrhagic metastases and in small lesions (<11 mm in this series).	2
48. Kutlu CA, Pastorino U, Maisey M, Goldstraw P. Selective use of PET scan in the preoperative staging of NSCLC. *Lung Cancer* 1998; 21(3):177-184.	10	21	To determine the sensitivity of FDG-PET for metastases in non small cell lung cancer.	Accuracy of PET in assessment of non pulmonary lesions found on CT in operable NSCLC was 96% with sensitivity of 93% and specificity of 100%. Results show PET is useful in small cell lung cancer.	2
49. Metser U, Miller E, Lerman H, Lievshitz G, Avital S, Even-Sapir E. 18F-FDG PET/CT in the evaluation of adrenal masses. *J Nucl Med* 2006; 47(1):32-37.	10	150 patients 175 adrenal masses	To evaluate the performance of FDG-PET/CT in characterizing adrenal masses in oncology patients.	For combined PET/CT data, the sensitivity, specificity, PPV, and NPV were 100%, 98%, 97%, 100%, respectively. When a cutoff SUV of 3.1 was used for this group, FDG-PET/CT correctly classified all lesions.	2
50. Yun M, Kim W, Alnafisi N, Lacorte L, Jang S, Alavi A. 18F-FDG PET in characterizing adrenal lesions detected on CT or MRI. *J Nucl Med* 2001; 42(12):1795-1799.	10	41 patients 50 adrenal masses	Retrospective analysis to evaluate the ability of FDG-PET to characterize adrenal lesions in patients with proven or suspected cancers.	FDG-PET for characterization of adrenal lesions showed a sensitivity of 100%, a specificity of 94%, and an accuracy of 96%. FDG-PET has the additional advantage of evaluating the primary lesions as well as metastases, it could be cost-effective and the modality of choice for the characterization of adrenal lesions, especially in patients with malignancy.	2

Incidentally Discovered Adrenal Mass
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
51. Minn H, Salonen A, Friberg J, et al. Imaging of adrenal incidentalomas with PET using (11)C-metomidate and (18)F-FDG. *J Nucl Med* 2004; 45(6):972-979.	10	21	To examine imaging of adrenal incidentalomas with PET using (11) C-metomidate and FDG.	FDG detected 2/3 noncortical malignancies but failed to detect adrenal metastases from renal cell carcinoma. Authors conclude that (11)C-Metomidate is a promising PET tracer to identify incidentalomas of adrenocortical origin. FDG is recommended for patients with a moderate to high likelihood of neoplastic disease.	2
52. Zettinig G, Mitterhauser M, Wadsak W, et al. Positron emission tomography imaging of adrenal masses: (18)F-fluorodeoxyglucose and the 11beta-hydroxylase tracer (11)C-metomidate. *Eur J Nucl Med Mol Imaging* 2004; 31(9):1224-1230	9	16	Study aimed to: • Evaluate (11)C-metomidate (MTO). • Point out possible advantages in comparison with FDG. • Examine in vivo the expression of 11beta-hydroxylase in patients with primary aldosteronism.	• MTO is an excellent imaging tool to distinguish adrenocortical and non-cortical lesions. • The in vivo expression of 11beta-hydroxylase is lower in Cushing's syndrome than in Conn's syndrome, and there is no suppression of the contralateral gland in primary aldosteronism. • FDG is the tracer of choice for discriminating between benign and malignant lesions.	2
53. NIH state-of-the-science statement on management of the clinically inapparent adrenal mass ("incidentaloma"). *NIH Consens State Sci Statements* 2002; 19(2):1-25.	15 (consensus development conference)	N/A	To evaluate data regarding the management of clinically unapparent adrenal masses (incidentalomas).	There is insufficient data to recommend a surgical or nonsurgical for the management of patients with subclinical hyper-functioning adrenal cortical adenomas.	3
54. American College of Radiology. *Manual on Contrast Media*. Available at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx	15	N/A	Guidance document on contrast media to assist radiologists in recognizing and managing risks associated with the use of contrast media.	N/A	3

Evidence Table Key

Study Type Key

Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
    a. Cohort
    b. Cross-sectional
    c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews

8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.