Sonographically Identified Echogenic Renal Masses Up to 1 cm in Size Are So Rarely Malignant They Can Be Safely Ignored

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Objectives—The purpose of this study was to determine whether small echogenic renal masses up to 1 cm in size incidentally detected by sonography are rarely malignant and thus do not need further workup.

Methods—We reviewed approximately 13,600 reports of all abdominal sonographic examinations performed between November 2001 and October 2007 that identified a small echogenic mass in a kidney. Patients with known malignancy of any kind, tuberous sclerosis, lesions larger than 1.0 cm, lesions with heterogeneous echogenicity, and lesions with posterior ring-down artifacts or posterior acoustic shadowing were excluded. All patients without magnetic resonance imaging or computed tomographic scans that completely characterized the lesions were excluded unless a follow-up study (sonography, magnetic resonance imaging, or contrast-enhanced computed tomography) at least 5 years later was available for comparison to prove that the lesion was benign.

Results—A total of 120 lesions in 111 patients satisfied the inclusion criteria. Lesion sizes were 0 to 5 mm (n = 16) and 6 to 10 mm (n = 104). Of these, 54 lesions were characterized as definitely benign (47 angiomyolipomas and 7 other benign entities: calcifications in stones or within a cyst or calyx and cysts that were either simple on follow-up studies or complicated with hemorrhagic or proteinaceous content). For the remaining 66 lesions, follow-up results after at least 5 years were normal in 24 cases (which meant that the lesion was no longer visible), and the remaining 42 lesions were stable in size. The mean duration of follow-up for these 66 lesions was 7.4 years.

Conclusions—Small echogenic renal masses up to 1 cm in size that fulfill our study criteria are so likely to be benign that they can be safely ignored.

Key Words—angiomyolipoma; echogenic renal mass; follow-up; genitourinary ultrasound; neoplastic potential; renal neoplasm

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Abbreviations
CT, computed tomography; MRI, magnetic resonance imaging

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Echogenic renal masses in general are more often angiomyolipomas than carcinomas. Without regard to size, the chance of carcinoma in general is high enough that echogenic masses should not be ignored, and further workup is advocated. To this end, a recent review by Farrelly et al[1] concluded that "all noncalcified echogenic renal lesions detected with ultrasound need a CT to rule out a renal cell carcinoma." Another study further recommended computed tomography (CT) to evaluate incidentally detected 1-cm echogenic masses.[2]

It is indeed prudent to do what is reasonable to detect cancer; however, the above studies have made their recommendations without knowledge of the true prevalence of cancer in echogenic renal masses of 1 cm and smaller. If the prevalence of cancer in this subgroup of tiny lesions is very low, then the recommendation for further workup needs to be reconsidered. This issue becomes especially important, as small echogenic renal lesions up to 1 cm in size, one of many types of so-called incidentalomas, are being identified more and more often as sonographic technology improves.

Although tiny echogenic renal carcinomas undoubtedly occur, and it is not the intent of this study to prove or suggest otherwise, it was speculated that the prevalence of carcinoma in this subcategory of tiny lesions is so small in relation to that of benign causes that small echogenic renal masses up to 1 cm in size may be safely ignored. This study was undertaken to evaluate that possibility.

Materials and Methods

Identification of Study Participants

This study was a retrospective analysis that was compliant with the Health Insurance Portability and Accountability Act. Institutional Review Board approval was obtained with waiver of written informed consent. Since it was necessary to review video clips of the kidneys to ensure that optimum size measurements of the lesions were obtained, as we did not wish to rely on the initial measurements, our study period started on November 1, 2001, which was when we started using a picture archiving and communication system. The study period covered November 1, 2001, through October 31, 2007. Studies that were more recent than October 31, 2007, were not included, as our follow-up period was a minimum of 5 years (the rationale for this interval is discussed later).

Our search commenced by performing 2 key word searches of the radiology ultrasound report database. The first key word search was for "echogenic" or "hyperechoic" and "renal" or "kidney" and "mass" or "lesion." The second key word search was for "AML" or "angiomyolipoma." This second search was added because it was noticed earlier that some hyperechoic masses were accidentally described or transcribed as "hypoechoic," and the first search would have missed those cases; however, in our experience, angiomyolipomas are virtually always mentioned in the differential diagnosis of echogenic masses, even if the mass was incorrectly described as "hypoechoic," and we do not believe that adding this second search biased the study toward selectively including angiomyolipomas for this reason.

The reports returned from this initial search were reviewed by either of 2 experienced ultrasound radiologists (R.O.B., 33 years in practice, and A.P., 27 years in practice) to identify echogenic renal cortical masses for this study. All reports in which the initial history described the presence of known angiomyolipomas were excluded so as not to bias the study sample to the selective inclusion of angiomyolipomas. This broad search returned approximately 13,600 examination reports. Statistics were not kept for the type of sonographic examinations in the sample, but it was our subjective impression that many were abdominal examinations and not focused renal studies.

The following exclusion criteria were then applied during review of this large number of reports. These patients were excluded: (1) younger than 18 years; (2) with known tuberous sclerosis; (3) with a history of malignancy or presence of a mass elsewhere that might be malignant; and (4) with multiple echogenic masses ("multiple" was defined as >3 in 1 kidney or >4 total in both kidneys) even if the diagnosis of tuberous sclerosis was not mentioned because of the possibility of underlying tuberous sclerosis. Lesions were excluded that fulfilled any of the following criteria: (1) were considered calculi by the author of the report; (2) were described as punctate; (3) produced a twinkle artifact; (4) had equivocal shadowing described as possible calculi; and (5) were described as being larger than 1 cm. Each patient was included only once when the reports from different examinations described the same lesion.

Either of the previously mentioned experienced ultrasound radiologists next searched the radiology report database to identify all study individuals who fulfill either of the following criteria: (1) had follow-up abdominal sonographic, CT, or magnetic resonance imaging (MRI) studies at least 5 years after the index sonographic examination (how we used these studies will be described later); or (2) had MRI or CT, either before or after the sonographic examination, which could characterize the lesion. Lesions not fulfilling either of these criteria were excluded. Using these criteria reduced the study sample to 161 patients with 171 lesions. The sonograms of these lesions were then reviewed independently by 3 radiologists (R.O.B., A.P., and M.I., a radiology fellow), who each recorded 3 orthogonal diameters (length and 2 perpendicular transverse diameters) for only those lesions that had both sagittal and axial video clips.

The 3 initially independent observers then met in consensus to apply the following exclusion criteria: (1) all lesions in which 3 orthogonal diameters could not be measured; (2) lesions that were more linear than spherical or ellipsoid in shape, defined as lesions with a short-to-long axis

ratio of less than 0.5; (3) lesions that appeared to be more than 50% exophytic from the cortex (if the mass was mostly extracortical, the adjacent echogenicity of retroperitoneal fat may have obscured the margins of the mass and limited the accuracy of the lesion measurements); (4) lesions that shadowed or that produced twinkle or ring-down artifacts, implying that they were, or may have been, calculi even when this finding was not mentioned in the report; (5) lesions that visually appeared to be, by volume, less than 50% echogenic (ie, hypoechoic mass with a partial echogenic component); (6) lesions that were not truly cortical masses but instead were extensions of sinus fat into the cortex; and (7) lesions with a measured largest diameter of greater than 1 cm. The 3 reviewers, also in consensus, compared lesion measurements. For tumors up to 1 cm in size, lesion measurement variation up to 2 mm among observers for each of the 3 orthogonal measurements was considered acceptable.[3,4] If the variation of any of the 3 diameters was greater than 2 mm, the discrepancy was resolved by consensus. The final size that was tabulated for each lesion was the single largest diameter.

Proof That a Lesion Was Benign or Malignant

For proof of the lesion character, the 3 radiologists met in consensus to compare the index sonograms with the CT, MRI, or sonographic studies. For a lesion to be considered benign, it either had to have CT or MRI proof that it was an angiomyolipoma or some other lesion for which assessment with CT or MRI is considered sufficient to prove it benign (see "Results" for a full listing of these entities), or it had to show an absence of growth for at least 5 years (a "stability study"). If the lesion did not meet either of these criteria, it could not be considered benign. For definitive characterization of the lesions, the 3 radiologists in consensus used either of the following: (1) MRI, with or without contrast, or contrast-enhanced CT to determine whether the lesions were angiomyolipomas or were other benign entities such as cysts, calyceal diverticula with milk of calcium, or fat-containing cortical defects; (2) sonography or CT any time after the study that showed the lesion to be a stone not characterizable as such on the index sonographic examination. A 5-year period of lesion stability was considered adequate proof of benignity because although renal tumors can be very slow growing, it is now accepted that a lack of growth for 5 years for small renal masses is adequate proof that such masses are benign.[5,6]

The criteria used to define an angiomyolipoma on CT were based on attenuation measurements. As this issue still is a topic of debate,[7–9] we elected to use conservative criteria to have higher specificity for angiomyolipoma detection. Since the lesions were small, and renal cancers that contain region-of-interest measurements of –10 Hounsfield units of macroscopic fat are larger than 1.9 cm,[8] we used a region of interest of at least 5 mm^2 and an attenuation measurement cutoff of –10 Hounsfield units for lesions smaller than 1 cm.[8] For angiomyolipoma diagnosis on MRI, we relied on the presence of a chemical shift artifact at the boundary of the lesion with the renal cortex. A few MRI studies had fat suppression sequences without opposed phase images, so we relied on diffuse signal loss within the lesion on fat-suppressed images to diagnose angiomyolipoma.

For stability studies, the MRI, contrast-enhanced CT, or sonographic examinations performed at least 5 years after the index sonographic examination were reviewed in consensus for all patients who had these studies. We recorded whether the lesions were stable (defined as being no larger than 2 mm in the largest dimension, as described earlier), were no longer apparent, or had increased greater than 2 mm in largest diameter and thus were not definitively benign.

Statistical consultation was sought from our departmental statistician. Since there were no cancers in our sample, it was determined that formal statistical calculations could not be performed, and the validity of our data rests on the fact that there were no cancers in a large sample of 120 masses.

Results

From the original sample of approximately 13,600 reports, the final study sample consisted of 120 echogenic renal masses of 1 cm or smaller in 111 patients. The mean patient age was 56 years (range, 22–94 years, with 100 patients >40 years) and included 79 female patients (71%) and 32 male patients (29%). Lesion distribution among kidneys was 69 lesions in right native kidneys, 48 lesions in left native kidneys (1.4:1 right-to-left ratio), and 3 lesions in renal transplants. Of the 111 patients, 104 had only 1 lesion, 5 had 2 lesions, and 2 had 3 lesions. Lesion sizes were 0 to 5 mm (n = 16) and 6 to 10 mm (n = 104). None of these 120 masses had imaging characteristics suggesting that they were malignant or not provably benign.

The follow-up studies were labeled "proof studies" if the lesions were characterizable and "stability studies" if the lesions were not characterizable but were stable or resolved on at least 5-year follow-up imaging and thus benign. Of the 120 lesions, 54 had proof studies. Of these, there were 47 angiomyolipomas: 26 characterized by MRI and 21 by CT. The rest of the lesions comprised 5 calyceal

diverticula or cysts (with or without milk of calcium, hemorrhage, or proteinaceous content), verified by MRI in 2 cases and CT in 3, and 2 calculi or focal calcifications unassociated with a mass, verified by CT.

Of the 54 lesions that had a proof study, 28 lesions also had follow-up imaging at least 5 years later. All lesions did not increase in size after 5 years. Of the 66 lesions that had a stability study only, the mean duration between the initial sonography and follow-up study was 7.4 years (SD, 1.7 years; range 5.0–11 years; Table 1). Among these 66 lesions, the follow-up studies showed stable lesions, as defined earlier in 42 cases: 34 with sonography, 7 with CT, and 1 with MRI. The remaining 24 lesions had a follow-up studies at least 5 years later, which no longer visualized the lesions at the locations of concern; these were documented with sonography in 12 cases, CT in 8, and MRI in 4.

Examples of 2 small echogenic lesions are illustrated in Figures 1 and 2. Figure 1 shows a 1-cm angiomyolipoma. Figure 2 shows a 9-mm cyst with layering milk of calcium.

Discussion

Table 1. Duration of Follow-up for the 66 Lesions With Stability Studies Only

Follow-up, y	Lesions, n
5–6	16
6–7	19
7–8	9
8–9	9
9–10	6
>10	7

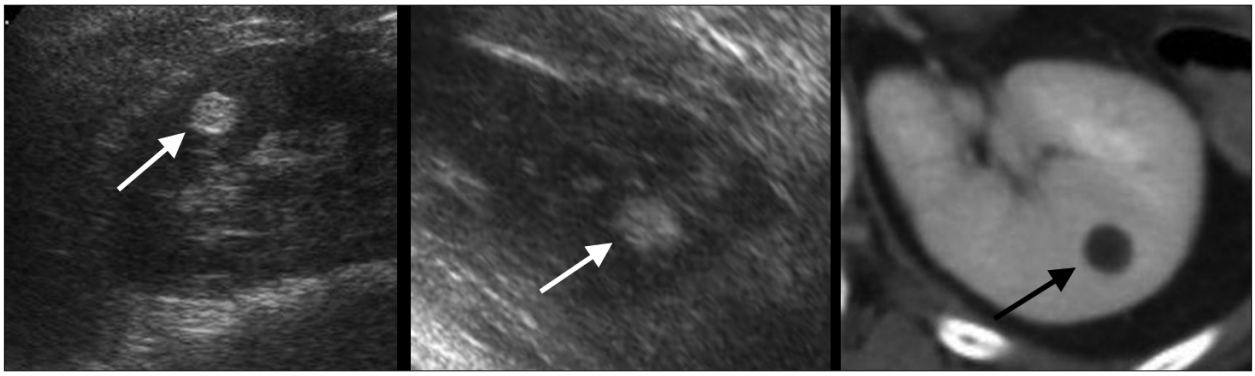
Small echogenic renal masses up to 1 cm in size are not rare and pose a potential problem in their management. Are these benign "incidentalomas," or should they all be further evaluated? Current recommendations are that they be further evaluated for the potential of malignancy[1,2]; however, these recommendations are not made on the basis of the actual prevalence of malignancy in these small echogenic renal lesions but rather on the observation that renal cell cancers may initially present as small echogenic renal masses. These two points are not the same.

It is acknowledged that if an echogenic renal mass that is 2 or 4 cm or larger has a high enough prevalence of malignancy, it should be further investigated, then it certainly must be the case that an echogenic renal mass of 1 cm or smaller might be malignant. None of the results or conclusions of this study should be construed as implying anything else. However, it has been our experience that a newly discovered renal carcinoma almost never in retrospect was initially identified as an echogenic renal mass of 1 cm or smaller. Echogenic masses this small might be so rarely malignant that they can and should be ignored.

Our results provide strong evidence that these masses are so rarely malignant that they can be ignored, since all 120 lesions in our study were benign. Since 47 of the 54 lesions (87%) whose character could be determined were angiomyolipomas, it is recommended that an echogenic renal mass up to 1 cm in size that fulfills the study criteria be described as "benign and likely an angiomyolipoma, which does not need further follow-up."

All 120 of the lesions in this study were benign, and none proved to be malignant. This finding was both a

Figure 1. The left and middle images are longitudinal and transverse views, respectively, of a small angiomyolipoma (arrows) in the left kidney. The CT image on the right shows the same angiomyolipoma (arrow) in the left kidney with attenuation of –35 Hounsfield units. The transverse sonogram is rotated to approximately the same orientation as the CT scan for ease of comparison.

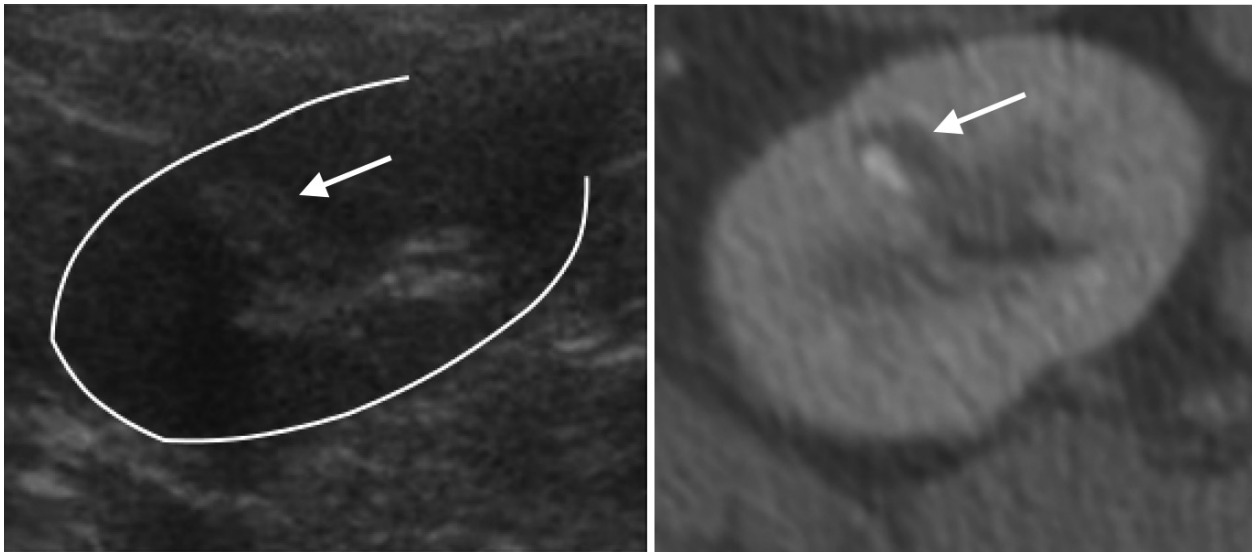


shortcoming and an advantage. It is a shortcoming in that without any malignancies, a rigorous statistical analysis could not be performed, and a true prevalence rate for malignancy in these lesions could not be estimated or determined. However, the advantage is that 120 is a large number, and if there were no malignancies in a sample this large, in our opinion, the chance that an echogenic mass of 1 cm or smaller is malignant is so low that it can, and perhaps should, be ignored. Failure to ignore these lesions would likely result in a huge number of needless follow-up examinations, often for 5 years.

An unquantifiable aspect of added reassurance in our results is the small size (≤1 cm) for which ignoring an echogenic mass is advocated. Renal carcinomas are typically slow growing, and a number of years might be required before a mass that is originally 1 cm or smaller at detection grows to a size (3–4 cm) at which metastases become a concern. Four studies reported mean tumor growth rates ranging from 0.13 to 0.36 cm/y for initial tumor sizes ranging from 2.1 to 3.5 cm,[10–13] and for the durations of these studies (≈3 years), the growth rate was linear. Furthermore, in a summary of 3 studies, metastases were only present in 1% to 8% of renal cell carcinomas of 3 to 4 cm in diameter, whereas in another study, there was a 5.2% prevalence of metastases in tumors smaller than 4 cm.[14] If the following assumptions are made: (1) a 1-cm echogenic mass eventually proves to be a carcinoma, which was missed by following the recommendations of this study; (2) a tumor of 1 cm in diameter grows at the same rate as the larger tumors in the previously mentioned studies (which may not be true—a small tumor might start out with a slower growth rate); and (3) growth to 4 cm is necessary before a substantial chance of metastatic disease is present; then a misdiagnosed 1-cm echogenic cancer might reach a size of 4 cm, at which metastatic disease is a substantial concern, between 8 years (at 0.36 cm/y growth) and 23 years (at 0.13 cm/y growth) after discovery. Although it is difficult to believe that a tumor could take 23 years before metastasizing, as it may not follow a linear growth pattern for that long, these relatively large time intervals imply that it is quite likely that a reasonable number of individuals would either have had a CT or MRI scan for other medical purposes in that 8- to 23-year interval, which would have detected the misdiagnosed cancer before it was 4 cm, or the patients would have died of their comorbidities or age-related maladies before the missed cancer became relevant. The magnitude of this scenario cannot be calculated but is likely not inconsiderable, and it serves to blunt the worry of a missed cancer originally presenting as an echogenic mass of 1 cm or smaller.

Strengths of this study included the following: (1) the rigorous methods used to identify echogenic masses; (2) the large sample size; and (3) the long follow-up period. A lack of change for 5 years is considered adequate proof that a renal mass is benign. Five years was our minimum follow-up interval, with a mean of 7.4 years and a maximum of 11 years. A shortcoming of our study was its retrospec-

Figure 2. Renal sonograms from an 85-year-old woman with acute renal failure show a 9-mm echogenic lesion (arrows) in the lower pole of the right kidney. The white line outlines the renal contour. Computed tomography done 10 days later proved the lesion to be a nonenhancing cyst with layering milk of calcium.



tive nature and our not knowing the histologic types of the echogenic lesions initially excluded because of inadequate follow-up, which is a shortcoming of virtually all retrospective studies. However, we believe that our large sample size still allows us to draw the conclusions we have reached. Another potential shortcoming was the female-to-male ratio of nearly 5:2 (79 female and 32 male) if the chances of malignancy in small echogenic masses are different for the sexes, which is something our study could not evaluate. The cause of this discrepancy is not known but one possible reason for the disproportion is that a large number of the examinations were right upper quadrant examinations for gallbladder-related issues. Since gallbladder conditions are more common in female than male patients, this factor likely accounted for at least part of the bias.

For some, it might be unsettling not to know the precise histologic type of a small echogenic mass. However, in the most important and pragmatic sense, our results strongly imply what it is in the most meaningful way: "not cancer." In our changing medical environment, where costs and resources are growing concerns, pragmatism may need to override curiosity.

In summary, the results of this study strongly suggest that a small echogenic renal mass up to 1 cm in size that is incidentally discovered sonographically has such a low prevalence of malignancy, current or future, that it can be ignored if it fulfills the following study criteria: (1) there is no history of malignancy or presence of a known mass elsewhere that might be malignant; (2) more than 50% of the mass is echogenic by visual estimation; (3) the mass is intracortical, visually extending less than 50% from the cortex either peripherally or into the renal sinus; (4) the maximum diameter can be measured in 3 orthogonal planes on axial and longitudinal sections; and (5) the patient is an adult.

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