Cysts of the kidney, one of the most common conditions of the body, are usually one of the easiest conditions to diagnose accurately with imaging studies but occasionally are so complex that they defy diagnosis even by pathologic examination. The purpose of this paper is not to review and describe the myriad of renal cystic diseases or to give a new classification or a new nomenclature but, rather, to give an approach to the diagnosis of cysts of the kidney that are encountered in daily radiologic practice.

While simple, uncomplicated cysts are easy to diagnose and pose no problem, complicated cystic lesions can create considerable difficulty in diagnosis and can lead to a difference of opinion concerning the proper diagnostic and therapeutic approach. Many factors are involved in the decision about management of each individual case, including the clinical status of the patient, the availability and quality of equipment, and the experience (and philosophy) of the radiologist and the urologist. While space restrictions will not allow a discussion of all of these factors, it is hoped that a general approach to the diagnosis of renal cysts can be formulated based primarily on radiologic findings so that these commonly encountered lesions can be handled with accuracy in the most economical and least invasive manner possible.

The overwhelming majority of renal cysts are found by chance when an imaging study is performed to evaluate a patient for a urinary tract or other abdominal or pelvic process. Only on rare occasions does the cyst call attention to itself by producing symptoms (pain) or signs (mass). Many cysts are discovered using urography, but currently they are discovered more often by means of ultrasound (US) or computed tomography (CT). The workup of the lesion will vary, depending on how it was detected.

SONOGRAPHY

If a mass is found by means of urography, unless the mass has characteristics (such as fat or calcification within the mass, increased tissue density, irregularity of margin, or invasion of the collecting system) that suggest it is something other than a simple benign cyst, generally it is agreed that sonography should be the next study because it is noninvasive, accurate, and relatively inexpensive. If the sonogram displays all of the criteria for a simple cyst, this diagnosis can be made with confidence and no further studies need be done. However, if there are compelling clinical aspects that create the need for further assurance of the benignity of the mass—such as unexplained hematuria or widespread metastatic disease without a known primary—then further confirmation is required. Sonographic criteria for cyst must be rigidly adhered to; any deviation from these criteria should lead to an additional radiologic study—a CT examination. The criteria needed to make a confident sonographic diagnosis of simple cyst have been described many times but they are repeated here because of their extreme importance: (a) good through transmission (acoustic enhancement behind the lesion consistent with the size of the lesion), (b) no echoes within the mass (anechoic), and (c) sharply marginated, smooth walls.

Diagnostic errors can be kept to a minimum if the following potential pitfalls are remembered:

1. If sonography is being performed to evaluate a mass seen on an excretory urogram (or CT scan), then the prior examination should be available for review to be certain that the mass in question is being evaluated. This will help eliminate the possibility of focusing on an adjacent cyst and not appreciating the lesion under suspicion. This will also help avoid the error of mistaking localized hydronephrosis or calyceal diverticulum for parenchymal cyst or a dilated renal pelvis for a peripelvic cyst.

2. A clustering of cysts closely adjacent to one another may harbor a small carcinoma which could be missed on the US examination. Such cases should also be studied by CT.

3. Vascular malformations or aneurysms, while rare, could be mistaken for cystic disease of the kidney if real-time studies do not demonstrate pulsations or large feeding vessels are not delineated.

4. Because of their location adjacent to (and often interspersed between) the structures of the collecting system, peripelvic cysts often contain artifactually created echoes and need CT for confirmation.

5. Lesions that contain calcium, septations, irregular margins, or any suspicious area should be studied further by CT.

Cysts are also frequently discovered incidentally on sonograms. The same criteria for diagnosis described above are used, but since a urogram is not available for comparison, the potential pitfalls of sonography should be even more carefully considered.

Since sonography is operator dependent, its accuracy, reliability, and definitiveness will be affected by the effort and experience of the individuals involved with the performance and interpretation of the examina
tion. This, of course, will affect how often there is need for further study with CT. Further details of sonography, including technical aspects and errors in diagnosis, are discussed more fully in important published articles on the subject (1–3).

**COMPUTED TOMOGRAPHY**

Computed tomography has enabled us to appreciate the frequency of renal cysts in the general population, which are estimated to occur in at least 50% of all people over the age of 50 (4). Cysts are diagnosed definitively every day in the performance of abdominal CT. The great majority of cases are cysts discovered incidentally in the kidney when the patient has undergone CT for some other reason. These cysts range in size from less than 1 cm to 10–15 cm. The criteria for the diagnosis of cyst using CT are (5): (a) sharp margination and demarcation from surrounding renal parenchyma; (b) smooth, thin wall; (c) water density content which is homogeneous throughout (0–20 HU); and (d) no enhancement following intravenous administration of contrast material.

In routine CT, usually only intravenous contrast-enhanced scanning is performed. Therefore, the opportunity to evaluate enhancement of the lesion (criterion d) is often not available. However, a benign cyst can still be diagnosed even without this information if the other criteria are clear. However, if a patient is referred for a CT examination specifically for evaluation of a renal mass discovered by urography or sonography that for some reason is not considered a typical cyst, then it is important to obtain non-contrast-enhanced scans through the lesion so that information concerning possible contrast enhancement of the lesion or a portion of it is available. This makes the examination much more valuable. Contrast enhancement of a renal lesion is one of the most definitive radiologic findings indicating a vascular renal mass. The availability of initial non-contrast-enhanced scans also ensures that such findings as calcification or small amounts of fat or recent hemorrhage within the mass will not be obscured by the contrast media and that high-density nonenhancing renal cysts are not mistaken for solid masses. In addition, incidental small calculi in either kidney which might have therape-

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**Figure 1.** Benign cyst. A 63-year-old woman underwent CT scanning for investigation of upper abdominal pain. (a) Contrast-enhanced CT scan reveals a 2-cm defect in the right kidney. Margins are minimally hazy, and the lesion measured 38 HU. (b) Sonogram reveals a sonolucent defect in the right kidney with some through transmission representing a small cyst corresponding to the lesion seen on the CT scan. Nothing further was done concerning the kidney of this patient. The high attenuation number of the cyst was believed due to "partial voluming" of the lesion or possible high protein content of fluid.

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**Figure 2.** Renal cell carcinoma. A 51-year-old man was studied for pancreatic disease. (a) Contrast-enhanced CT scan reveals a 2-cm defect in the right kidney. Margins are sharp, but the lesion measures 44 HU. (b) Sonogram is unable to depict a cyst in right kidney indicating a solid lesion might be present. Patient underwent repeat CT scanning with and without contrast media, and the lesion enhanced by 20 HU, indicating a solid, vascular lesion. (c) Pathologic specimen demonstrates a renal cell carcinoma 2 cm in diameter.
The diagnosis of renal cysts by CT is greatly dependent on knowing that the fluid in the cyst is near water in density (0-20 HU). While it is well known that there may be considerable variation in CT numbers from machine to machine and even in the same machine from day to day (6), the ability to establish the density of the fluid in a lesion is essential, particularly when only a contrast-enhanced CT scan (or only a nonenhanced scan) is available because, besides the contour characteristics of the lesion, the lesion must contain fluid of near-water density to be diagnosed as a cyst. The radiologist must therefore be confident of the validity of the CT numbers of the equipment being used. Fortunately, there has been an improvement in the reliability of the numbers in third- and fourth-generation scanners. Scanners should be regularly calibrated. CT numbers can be roughly checked on each abdominal scan by noting the attenuation coefficient of the fluid in the gallbladder and using this measurement as a rough comparison with the measurements obtained for the fluid-filled lesions of the kidney. The opportunity to test the validity of the CT numbers is also available when a non-contrast-enhanced scan is obtained. The urine in an extrarenal pelvis or the urinary bladder can be measured and used as a control to test the validity of the CT numbers. Space limitations do not allow a full discussion concerning the measurement and validation of CT numbers, but it should be stressed that, particularly in questionable cases, multiple measurements in all areas of the lesion are needed and the effect of scan artifacts and high standard deviations should be integrated into the final evaluation of the significance of the attenuation coefficients.

By studying a number of cysts over a period of time, one can establish the accepted range of CT densities for fluid in cysts for the equipment used. The CT attenuation values of the fluid in renal cysts vary considerably from cyst to cyst, depending mainly on the protein content, the presence of blood-breakdown products, and possibly calcium content (7, 8). One only has to note the wide range of attenuation values of fluid in various cysts in a patient with multiple cysts (or polycystic kidney disease) to appreciate this. At what fluid attenuation level does one accept a diagnosis of benign cyst? My own experience and the experience of others suggest 20 HU as the upper level (9). I personally have not yet seen a tumor with the characteristics of cyst that measured less than 20 HU on a contrast-enhanced CT scan. Lesions which measure above 20 HU may be cysts, but these lesions need correlation with sonography (or by repeat CT scanning with and without contrast). If the lesion (that measures above 20 HU) is a clear cyst according to sonography, that diagnosis is accepted and no further evaluation is needed (Fig. 1). On the other hand, if sonographic study cannot establish a clear diagnosis of cyst, then repeat CT scanning with and without contrast is indicated to establish possible enhancement of the lesion. If the lesion enhances, a diagnosis of tumor (benign or malignant) or abscess is established (Fig. 2). If the lesion does not enhance, then correlation with sonographic findings is necessary (Fig. 3) and a decision is made concerning what further approach should be taken (discussed later in article).

**Technique**

If CT is being performed to evaluate further a lesion that did not fulfill all of the criteria for a simple cyst on a previous urogram, sonogram, or initial screening CT scan, the study should include scans of the kidney.

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**Figure 3.** Cystic renal cell carcinoma. A 55-year-old man had lower-urinary-tract symptoms, and a mass was detected at the upper pole of the right kidney using IV urography. (a) Sonogram reveals a large mass at the upper pole of the right kidney. The mass contains multiple echoes with no through transmission, suggesting a solid tumor. (b) Nonenhanced CT scan. A section through the lesion reveals a round, smooth lesion with some wispy irregularity on its medial surface. The mass measured 27 HU. (c) Contrast-enhanced CT scan. No enhancement of the lesion occurred, except minimally in some areas at the periphery (arrows). A right nephrectomy was performed and a totally cystic carcinoma filled with bloody debris was found. Viable tumor was found in the wall of the lesion. The nature of the debris apparently created the "solid" appearance on the sonogram. Although the CT scan showed only minimal evidence of a complicated cystic lesion, the sonogram clearly indicated a lesion requiring surgery.

Volume 158  Number 1  Radiology • 3
prior to the intravenous introduction of contrast medium. In general, 10-
mm-thick sections are obtained unless the lesion is small (or a particular
area of a large lesion needs further study), in which case 5-mm-thick sec-
tions should be obtained. It is important that scans be obtained through
the lesion being evaluated while there is a high level of contrast media
in the blood, a level that can be obtained by the bolus-infusion tech-
nique. Finally, both kidneys should be included in entirety in the scan to
ensure visualization of any other renal lesions that might be present.

RANGE OF CYSTIC LESIONS

Fortunately, the overwhelming majority of cystic lesions of the kid-
ney are easy to diagnose using CT, US, or a combination of the two. As
previously discussed, simple cysts are easily diagnosed and cystic mali-
gnant neoplasms can also be readily appreciated, allowing a firm diagno-
sis and therapeutic approach. Even tumors in the wall of cysts or adja-
cent to cysts—which used to be considered a particularly difficult diag-
nostic problem—can be clearly outlined (Fig. 4). However, a number
of complicated cystic lesions have many radiologic criteria indicative of
benignity but demonstrate some findings seen in malignant lesions as
well. Such cases are most difficult to diagnose accurately, and there is a
wide difference of opinion among radiologists and urologists as to how
they should be managed. There are those who believe that all such cases
should be explored surgically and that the decision about the type of
surgery should be made at the operating room table by the surgeon (and
pathologist on the basis of the frozen section). While this approach is
deemed necessary for many lesions, it is important to distinguish com-
licated benign lesions that do not require surgery from those which do.

In order to get a better understanding of the spectrum of these cystic
lesions, and to attempt to set up some criteria to help determine the most
advantageous diagnostic and therapeautic approach, it might be helpful
to divide cysts and cystic lesions into four categories: category I, simple be-
nign cysts; category II, benign cystic lesions that are minimally complica-
ed and for which experience is being accumulated that will allow surgery
to be avoided if possible; category III, more complicated, cystic lesions that
exhibit some radiologic features seen in malignancy and therefore need
surgical exploration; category IV, lesions that are clearly malignant—cys-
tic carcinomas.

Category I lesions, discussed pre-
viously, are by far the most common. These lesions are uncomplicated,
simple benign cysts of the kidney

\[\text{Figure 4. Tumor and cyst. Urography revealed a mass in the right kidney of a 75-year-old man. (a) Transverse sonogram of the right kidney reveals a cyst at the lateral surface near the lower pole of the kidney. However, a solid mass is seen projecting into the cyst at its anterior aspect (arrow). (b) Contrast-enhanced CT scan reveals a cyst of the right kidney (fluid measured 12 HU) and a vascular mass projecting into the cyst (arrow). Right nephrectomy revealed a cyst 5 cm in diameter filled with clear fluid and a renal cell carcinoma 1.8 cm in diameter pushing on the wall of the cyst but not infiltrating it.}\]

\[\text{Figure 5. Septated cyst; category II cystic lesion. (a) Prone transverse sonogram of the lower pole of the left kidney reveals fluid-filled lesion with echogenic foci within it. (b) Corresponding contrast-enhanced CT scan reveals septated cyst. Septa contained minute areas of calcification. Fluid measured 10 HU and did not enhance. A small, centrally placed pericystic cyst is also seen.}\]
avoid surgery on these cases and to separate them from lesions (i.e., category III) that require surgical exploration.

Category III lesions are more complicated cystic lesions. These lesions exhibit some findings seen in malignant lesions, and radiologically they cannot confidently be distinguished from malignancy. All of these cases should be explored surgically unless clinically contraindicated (because of, e.g., old age or poor operative risk). Some of these lesions will be found to be benign, for example, multiloculated cystic nephromas (Fig. 9), multiloculated cysts, hemorrhagic cysts, complex septated cysts (Fig. 10), chronically infected or calcified cysts; and some will be malignant, for example, cystic renal cell carcinomas (Fig. 11). While the radiologic findings do not allow clear distinction of benignity from malignancy in these cases, the surgical options can be affected by the radiologist's evaluation of whether the

Figure 6. Multiloculated cyst; category II cystic lesion. (a) Sonogram displays a cystic mass with multiple locules separated by thin septa. (b) Corresponding contrast-enhanced CT scan reveals multiloculated cystic lesion. Fluid measured 8 HU and did not enhance.

Figure 7. Minimally calcified benign cyst; category II lesion. (a, b) Two contrast-enhanced CT scans for two patients are shown. Both show small amounts of calcification in the wall of the cysts or in the cyst septa. There is no soft-tissue density or thickness associated with the focal calcification. Fluid in the cysts measured below 15 HU; there was no enhancement of the fluid or the walls of the lesions.

Figure 8. Hyperdense benign cyst; category II lesion. Contrast-enhanced CT scan shows a dense (68 HU) mass protruding from the outer margin of kidney. The lesion is homogeneous and smoothly margined and did not enhance following intravenous administration of contrast material. A follow-up scan obtained 4 years later showed no change.
lesion is more likely to be benign or more likely to be malignant. If the lesion is considered more likely benign, the approach could be to explore it surgically, perform a biopsy, and unroof it if it is found to be benign or, if found to be malignant, remove it by tumorectomy, partial nephrectomy, or nephrectomy. On the other hand, if the lesion exhibits the radiologic criteria suggesting malignancy, a tumorectomy, partial nephrectomy, or radical nephrectomy might be performed without exposing the lesion, since the urologist often cannot determine the benignity or malignancy of the lesion at the operating table and might not want to open Gerota's fascia. The various surgical approaches to these complicated cystic lesions and the wide range of urologist's philosophies concerning this problem cannot be considered within this paper, but since the initial diagnosis of these lesions is made on radiologic grounds, it is important for the radiologist to predict the likely histology of the lesion for the surgeon so that the best possible result is obtained. This often means preserving as much renal tissue as possible—particularly in benign conditions—while avoiding the possibility of leaving behind malignant disease.

Category IV lesions are clearly malignant lesions with large cystic components. These lesions show irregularity of margins and have solid vascular elements; while they are superficially cystlike, they are clearly malignant and should be treated by removal. (Some urologists currently remove some category III and IV lesions by partial nephrectomy if they are small and polar in position.)

(Figs. 12, 13.)

RADIOLOGIC FINDINGS

While it would be impossible to include all of the radiologic findings that occur in these lesions and discuss all of the criteria that determine whether a nonsurgical (category II) or a surgical (categories III or IV) approach is necessary, the following findings are the more common and important ones used in this decision.

1. Calcification

While calcification in a renal lesion is always a troubling sign of possible malignancy, small plaques of fine linear calcium can occur in the wall of benign cysts, so the pattern and amount of the calcium are important. If all other US and CT criteria for cyst are present, the presence of a small amount of calcium or a thin, fine area of calcium in the wall or septa of a lesion without evidence of associated soft-tissue density or contrast enhancement can be consistent with a complicated cyst and not a sign of malignancy (category II; Fig. 7). On the other hand, more extensive calcification in the wall of a lesion, particularly if it is thick and irregular, puts the lesion into category III, which may be benign or malignant, and requires its surgical exploration (10, 11). Obviously, calcification associated with enhancing soft-tissue mass indicates malignancy (category IV) and requires radical nephrectomy (Fig. 12).

2. Septa

Many cysts have fine septa running through them. In most in-

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**Figure 9.** A 55-year-old woman with a large cystic lesion (category III) in right kidney. (a) Contrast-enhanced CT scan reveals mostly fluid-filled mass but multiple, minimally enhancing septa throughout. Some areas of confluence of septa, indicating solid elements, are seen. (b) Corresponding selective right renal angiogram demonstrates minimal vascularity in the lesion. While no obvious irregular "tumor vessels" are seen, vessels originating in the kidney are seen to traverse the mass. At surgery a benign multiloculated cystic nephroma was found and removed.

**Figure 10.** A 31-year-old woman with a category III cystic lesion. (a) Sonogram reveals a predominantly cystic mass in the kidney with multiple septa. (b) CT scan shows one solid area in the anterior medial portion of the lesion which did not enhance. At surgical exploration, a benign, complicated multiloculated lesion was found. Multiple biopsy specimens were taken which revealed fibrotic elements. The cyst was unroofed.
stances these are well seen on US and CT and can be appreciated for what they are (12). If thin strands (even if they contain fine wisps of calcium) are present and are not too numerous, the lesion can be considered benign and treated as such (category II; Figs. 5–7). The difficult question is, when are these septa too numerous or too thick and irregular to be considered benign? This is an impossible question to answer directly and requires some experience in dealing with these lesions. What might be considered a benign septated cyst (category II) by one physician might be considered highly suspicious for malignancy (category III) by another. In general, if the septa are thin (one mm or less), smooth, and attach to the walls of the cysts without associated thickened elements, a benign cyst can be diagnosed. On the other hand, irregularity of the septum wall, thickness over 1 mm, or associated solid elements at its attachments indicate a lesion that must be explored (category III; Figs. 9–11). If very irregular and numerous septa are present and are associated with solid areas, a cystic carcinoma (category IV; Fig. 13) should be diagnosed. These lesions will not be helped by aspiration since there are multiple loculated compartments and multiple punctures of such lesions would be time consuming, incomplete, and likely unrevealing.

3. High-Density Fluid in Cysts

Much has appeared in the literature recently about hyperdense renal cysts—renal cysts (usually containing old blood) that have a higher attenuation than surrounding renal parenchyma on the non-contrast-enhanced CT scan (8, 13–15) (Fig. 8). The overwhelming majority of the reported lesions are small (less than 3 cm in diameter), incidental findings and usually extend peripherally from the kidney. They are frequently encountered in patients with polycystic kidney disease (16). Hyperdense cysts tend to measure about 60–70 HU with a range of approximately 40–100 HU. Following intravenous administration of contrast material, they appear either isodense or hypodense compared with the renal parenchyma. Based on published research and my own personal experience with these lesions, they can be assumed to be benign and need not be surgically explored but followed by serial CT scanning if these criteria are satisfied: (a) the lesion must be perfectly smooth, round, sharply margined, and homogeneous; (b) the lesion must not enhance upon intravenous administration of contrast material and its configuration must remain unchanged; (c) the lesion must be 3 cm or less in size. (3 cm was chosen as a cutoff point because of the availability of proved case material at this size level.) If over 3 cm, the lesion is still probably a benign cyst, but sonography must characterize it as a fluid-filled cyst. If one is unable to establish this by sonography, clinical factors such as the patient’s age and health become important. Aspiration...
and opacification of the lesion could be tried to establish the diagnosis of benignity, or follow-up CT studies at progressively lengthening intervals to watch for interval change can also be included in the management of these cases.

Any deviation from the foregoing—irregularity of contour, hazy margination, inhomogeneity or enhancement with contrast material—would indicate a lesion that would have to be dealt with surgically (17).

The same criteria can be used in any cyst of the kidney which contains fluid with higher numbers. As long as the sonogram indicates a cyst and the lesion is thin walled, smooth, and does not enhance with contrast material, a diagnosis of cyst can be made. The measurement of the attenuation of the fluid in the cyst would be the least important criterion in these cases and should not in itself call for surgical exploration. In these cases, the cyst could be punctured and its fluid examined for malignant cells, and contrast material could be used to outline the cyst walls, but high-quality, thin-section CT scanning can show the walls of the lesion with great accuracy, and the chance of finding malignant cells in such a case is rare. However, in perplexing or indeterminate cases, puncture with opacification might prove helpful.

4. Multiple Cysts Adjacent to One Another

Occasionally one sees a complicated cystic lesion made up of a large number of cysts adjacent to one another, with thin wisps or tongues of normal renal tissue between them. Since the normal tissue between these lesions appears enhanced upon intravenous administration of contrast material, a false impression that the lesion is a cystic lesion with vascular solid elements within it may be suggested. In these cases multiple CT sections are required to sort out the components of this complex cystic mass and to establish that each cyst is an independent structure and that the septa or solid elements, though thick, are smooth and enhance as normal renal tissue and, indeed, represent interspersed renal parenchyma. Whether one can appreciate the true benign nature of the lesion will depend on how complicated this conglomerate mass is and how detailed the CT examination is. In these lesions (as well as the multiseptated lesions discussed earlier), renal angio-

Figure 13. A 56-year-old woman with a cystic renal neoplasm; category IV lesion. (a) Sonogram reveals a cystic mass in the central portion of the right kidney. At the lateral and inferior portion of the mass, some solid tissue is seen (arrow). (b) Contrast-enhanced CT scan through the center of the lesion reveals a cystic mass but with irregular and enhanced solid elements laterally. Another section 2 cm inferior to this revealed a mostly solid neoplasm. A right nephrectomy was performed, and a cystic renal cell carcinoma was removed.

5. Irregularity of Wall or Solid Elements

Any thickening or irregularity of the wall of a lesion or any evidence of solid tissue within the wall or evidence of a mass abutting the wall of a cyst is a bothersome finding and basically excludes a radiologic diagnosis of benignity. Such lesions belong in either category III or category IV, depending on the severity of the findings, and require surgical exploration and removal (Figs. 4, 9–13).

Correlation of US with CT

US is very sensitive in differentiating solid from fluid and has the advantage of longitudinal display. CT is able to determine vascularity, and with its excellent spatial resolution visualizes margins of lesions with great precision. The combination of the two is therefore very important in the final diagnosis of some difficult cases. Occasionally, however, there will be a difference of view between these two modalities as to whether a mass is a cyst or noncyst. In general, in a case wherein both studies are technically excellent, it is best to base one’s judgment on the modality that suggests the more ominous diagnosis. On the other hand, a judgment concerning the relative value of each modality is necessary. For example, if the sonogram suggests multiple echoes in a lesion indicating that it is complex or that the fluid contains debris, such sonographic evidence should be trusted regardless of the findings on CT. This is nicely depicted in Figure 3.

Cyst Puncture and Opacification

The technique of cyst puncture and opacification has been in use since 1939 and was widely used to diagnose renal cysts in the 1960s and 1970s. However, over the past 5–10 years there has been a marked decrease in the need for and use of renal cyst puncture (even though there has been a great increase in the use of thin-needle aspiration biopsy for diagnosis of malignancy throughout the body), because most radiologists believe that the information obtained by cyst puncture and opacification is available through sonography (1) and CT (5). In a recent survey of 20 leading urologists at large medical centers in North America, 16 indicated that the procedure was performed in their institutions less than ten times per year.

8 • Radiology  January 1986
(nine indicated less than five per year). Almost all indicated that the need for and use of the procedure had greatly decreased and that it was primarily the availability of modern CT equipment that was responsible for this change.

The number of times cyst puncture is needed for diagnosis depends on the quality of CT available as well as the experience and prejudices (philosophy) of the physicians involved in the case. Most radiologists believe that the procedure is rarely necessary, and many urologists feel that if there is a strong chance that the lesion under study is malignant, then surgical exploration should be performed. While it is reported only rarely, there is a potential for seeding malignancy with this technique (18), and major complications, while not common, can occur (19). On the other hand, there still are some proponents for the technique who consider it an important part of the diagnosis of cysts and their differentiation from malignancy.

While there remains some difference of opinion as to the role of cyst puncture, in a number of instances this technique can clearly be of benefit:

1. Diagnosis of lesions suspected of being infected cysts or abscesses may be aided by puncture. Occasionally these lesions can be difficult to diagnose using CT and sonography. Obtaining infected fluid or pus by needle aspiration is not only diagnostic but, by conversion to percutaneous catheter drainage, becomes therapeutic as well. Therefore, patients with a cystic renal mass and any signs, symptoms, or laboratory findings suggestive of infection should undergo aspiration for diagnosis and treatment.

2. Diagnosis of lesions that are indeterminate on a combination of CT and US studies may benefit from cyst puncture. For example, if a lesion has low-level echoes on sonography that might be artifactual and the CT scans indicate cyst, puncture could help resolve the problem.

3. Diagnosis of lesions that might be malignant (category III lesion) in the patient who presents a poor surgical risk might benefit from cyst puncture in an attempt to avoid surgery. However, it must be remembered that a cyst aspiration with negative cytologic findings has not ruled out malignancy, and the finding of hemorrhagic fluid does not prove a lesion malignant, even though it may now fall into the category of “malignant until proved otherwise.”

4. Puncture may be used in diagnosis of lesions that are likely benign (some category II lesions) but further proof is required for the referring physician in order to avoid exploration. Multiplecated lesions are a problem since each locule would have to be punctured. Lesions with more than two to three locules probably should not be punctured.

5. Cyst puncture may be used in therapy. In the rare case when a cyst causes pain or discomfort, obstructs the kidney or a portion of it, or is suspected of causing hypertension, aspiration to decompress the cyst could be performed, first as a clinical trial and then with a sclerosing agent if the cyst recurs.

Space restrictions preclude further discussion of the use of cyst puncture. However, it should be noted that there remains a considerable difference of opinion concerning the performance and interpretation of this examination, including the significance of the color and turbidity of the fluid obtained, the extent to which the fluid should be studied (through cytology, chemistry, etc.), and whether the cyst should be opacified, and if so, whether this should be a single- or double-contrast study.

OTHER RADIOLOGIC STUDIES

Nephrotomography as an independent examination to help differentiate renal cyst from tumor is no longer used. However, tomography remains an essential part of the urogram.

Renal angiography has only a minor role in differentiating cyst from tumor. Because of the superior contrast resolution available from CT, the ability to determine blood flow to a lesion using CT far exceeds the sensitivity of selective angiography; therefore, the diagnosis of hypovascular (or “angiographically avascular”) tumors, previously a source of error, is no longer a diagnostic problem. Using CT, one can appreciate the flow of contrast material in capillaries and small vessels too small to be seen using angiography. Angiographic diagnosis is also limited because complicated cystic lesions, even if they are benign (e.g., multiloculated cystic nephroma), may show “vascularity” in thin septa that will suggest a malignant lesion on the angiogram—a false-positive result (Fig. 9). On the other hand, although it is rare to visualize clearly “malignant-appearing vessels” in these complicated cystic lesions, if they are seen, the diagnosis of cystic carcinoma (category IV lesion) can be made. While its role in diagnosis is therefore very limited, renal angiography does have a role in patient management because partial nephrectomies and tumorectomies are being performed more and more for these difficult lesions. A selective renal angiogram prior to such a procedure is an important part of preoperative surgical planning.

Magnetic resonance imaging may have some value in differentiating some of these problematic lesions. However, insufficient experience thus far has been available to allow clear judgments on this matter.

SUMMARY AND CONCLUSIONS

The radiologic diagnosis of renal cysts (and their differentiation from renal neoplasms) has come a long way since the 1950s when the approach was surgical exploration, unless clinically contraindicated, for every renal mass detected using urography. Nephrotomography, renal angiography, and cyst puncture have contributed over the ensuing years to the differentiation of cyst from tumor. However, for the most part, sonography and CT (or a combination of these when necessary) have become the main diagnostic techniques for evaluating renal masses, and with their use we have never been more accurate, noninvasive, and relatively economically efficient. The more widespread use of CT has enabled serendipitous discovery of many small renal carcinomas, the removal of which should result in an improvement in the overall cure rate of patients with renal parenchymal neoplasms. On the other hand, we are also discovering many more cysts than we have previously. We must be on guard, therefore, against discovering lesions for which we are unable to establish a radiologic diagnosis of benignity, because this will only increase the need for exploratory surgery once again. It is thus imperative that imaging studies be performed with great care, that diagnoses be based on rigid criteria, and that more experience with difficult lesions be gained so that the proper approach to treatment will be determined. If we are able to accomplish this, then the present radiologic age can be remembered as a time when great advances in the evaluation of renal masses were made, with resultant improved
patient management and cure of disease.

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