Cysts are the most common space-occupying lesions of the kidney. Whereas their presence is mentioned in the older literature and their pathogenesis discussed as far back as the 19th century, it is only with the arrival of noninvasive methods of abdominal imaging over the past 50 yr that their clinical importance has grown. Technical advances in imaging, accrued expertise in their use and interpretation, and the expanding but varied populations studied over the years make it difficult to compare adequately published reports over time.

A turning point in this evolution was a 1964 classification of renal cystic diseases on the basis of microdissection of kidneys that localized cysts to specific nephron segments and classified them broadly as hereditary, nonhereditary, or acquired.1 Subsequent nosologic refinements coupled with clinical, morphologic, and radiologic observations have clarified and expanded the field of renal cystic diseases.2–4 Major advances in understanding inherited forms of cystic disease, particularly autosomal dominant polycystic kidney disease, provide compelling evidence for the role of genetics and epithelial cilia in the formation of cysts.5,6 The nonhereditary forms of cystic lesions have received less attention at a time when widespread use of abdominal imaging has increased their detection and refined their diagnosis in general, particularly the simple cyst. Much of the attention on the latter has focused on their radiologic diagnosis and indications for surgical intervention. Recent evidence suggests additional linkages and problems such as their association with hypertension, kidney size, and renal function.7–11

Simple cysts are usually unilateral and solitary lesions with well-defined features.2–4 Their importance stems from their increased detection in aging populations with widespread use of abdominal ultrasonography and computed tomography (CT). The diagnostic challenges they present is their differentiation from the atypical features of the far less common complex cysts associated with malignancy and, when numerous the possible heralding of genetic or acquired multicystic diseases of the kidney.

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Cysts is variable. Depending on the population and method of study, reported prevalences range from 5 to 41% but are likely in the range of 7 to 10%. Older autopsy studies reported their presence in 3 to 5% of cases.

Simple cysts are discrete lesions within the kidney that are typically cortical, extending outside the parenchyma and distorting the renal contour. They are oval or circular in shape and have a distinct, sharply defined outline. The cyst wall is characteristically smooth, transparent, avascular, yellowish or bluish white in color, and formed by a thin layer of fibrous tissue lined by a single layer of flattened or cuboidal epithelia. They are filled with a homogeneous transudate-like, clear or straw-colored fluid of low viscosity, with a radiodensity similar to water of $-10$ to 20 Hounsfield units (HU). Approximately 70 to 80% are solitary, unilateral, and cortical. As is the case of their occurrence, their number in the same kidney and laterality increase with age, with more than one cyst reported in half and bilateral cysts in one third of older individuals. Simple cysts are variable in size on initial detection but increase in size over time in approximately one fourth of cases, particularly in younger individuals, in whom they are more likely to enlarge. In general, the increase in size is slow, estimated rate of 1.6 mm or approximately 4 to 5% per year, and may double the original size over 10 yr. In follow-up studies, the increase in size was more evident during the first 2 to 3 yr after detection and seemed to stabilize thereafter. Multiloculated and bilateral cysts were more likely to increase in size.

Risk factors incriminated in the occurrence of simple cysts are serum creatinine, smoking, and hypertension; however, these associations may well be coincidental given the retrospective nature of the reported studies, with variable reasons for diagnostic referral of differing cohorts, with age being an overarching confounder of all reported associations.

As a rule, simple cysts are an asymptomatic incidental finding on abdominal imaging. Occasionally, they become symptomatic and may present with flank pain, abdominal discomfort, a palpable mass, or hematuria; as a result of complications; or consequent to an enlarging cyst. A large cyst may cause obstructive symptoms, particularly when proximal to or encompassing the renal pelvis. Clinical symptoms are more common with neoplasms than simple cysts, and the onset of symptoms should always raise the possibility of an associated malignancy and the need for additional diagnostic studies.

Complications are rare with a reported range of 2 to 4%. The principal complications are hemorrhage, infection, or rupture. Apart from becoming symptomatic, cysts that develop complications acquire features that overlap with atypical complex cysts. Hemorrhage may occur in a preexisting simple cyst, or a cyst may form from the liquefaction of a traumatic hemorrhage within the kidney parenchyma. Approximately 6% of simple cysts are complicated by hemorrhage, usually as a result of trauma, enlargement, or bleeding diathesis. Acute hemorrhage increases the attenuation value of a cyst (70 to 90 HU), but as blood liquefies and organizes, attenuation values decrease. Hyperdense, well-defined, homogeneous cysts with an attenuation of 50 to 100 HU that does not enhance usually represent acute hemorrhage. As hemorrhagic cysts resolve, they develop residual calcification in a central pattern or within the cyst wall that becomes thickened and develops septae with the cyst becoming multilocular or multilobed or within the cyst wall that becomes thickened and develops septae with the cyst becoming multilocular or multilobed, essentially acquiring the features of a complex cyst. As such, hemorrhagic cysts will require careful evaluation to rule out a malignancy and determine the need for surgical intervention.

As with hemorrhage, simple cysts may become infected or a renal abscess may resolve into a cyst. The wall of infected cysts is often thickened markedly and calcified occasionally. Attenuation is increased and may be nonhomogeneous but is not enhanced after dye. Clinical features may well define an infected cyst.

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**Table 1. Criteria used in the Bosniak renal cyst classification system**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Cyst Wall</th>
<th>Septae</th>
<th>Calcification</th>
<th>Enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hairline thin</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>II</td>
<td>Minimal regular thickening</td>
<td>Few, hairline thin</td>
<td>Smooth, hairline thin</td>
<td>No</td>
</tr>
<tr>
<td>IIIF*</td>
<td>Minimal regular thickening</td>
<td>Multiple, minimal smooth thickening</td>
<td>Thick, nodular</td>
<td>No</td>
</tr>
<tr>
<td>III</td>
<td>Irregular thickening</td>
<td>Measurably thick, irregular</td>
<td>Thick, nodular, irregular</td>
<td>Yes</td>
</tr>
<tr>
<td>IV</td>
<td>Gross irregular thickening</td>
<td>Irregular gross thickening</td>
<td>Thick, nodular, irregular</td>
<td>Yes, tissue and cyst</td>
</tr>
</tbody>
</table>

*F in IIIF is for follow-up. Cyst size of $>3$ cm in diameter is another criterion for follow-up and by extension inclusion in class IIIF.
Alternatively, this is one situation in which cyst puncture and aspiration can be diagnostic and either circumvent the need for surgery or limit it to drainage of an infected cyst.4,16

A classification of renal cysts on the basis of their appearance and enhancement on CT was introduced by Bosniak in 1986 and refined in 2003 (Table 1)17 and is accepted by urologists and radiologists for the diagnosis, evaluation, and management of cystic lesions. Technical adequacy, high-quality imaging, operator skill, interpretive expertise, and the population studied affect the variable results in the literature. It is important to note that the classification criteria are based on CT and only retrospectively extended to ultrasonography for the diagnosis of a simple cyst.

Whether labeled simple or complex or however reported radiologically, the terms used all are descriptive. Whenever concern of their association with neoplasms exists, a final diagnosis can be made only with histologic examination. Approximately 40 to 60% of class III and 85 to 100% of class IV cysts prove to be malignant.2–4 Nevertheless, imaging findings can be diagnostic and circumvent unnecessary surgery. As a rule, sharply defined cysts with well-transmitted sound waves and absence of any echoes on ultrasonography define a simple cyst. Any complexity that deviates from this should be further evaluated by CT. The features of note on CT that are associated with increased risk for malignancy are the cumulative complexity of these features that determine the Bosniak classification (Table 1). Magnetic resistance imaging has better contrast resolution than CT and can be useful in indeterminate class II and III cases but is not necessary for routine evaluation.2,4

Taken together, lobularity, irregularity, calcification, and measurable dye enhancement (increased attenuation of >10 to 15 HU) of a cyst determine its current classification and approach (Table 1). Although there are no evidence-based guidelines, the available literature suggests that2–4 class IV cysts and definite class III features should be considered surgical. Class IIF and indeterminate class III should be followed by CT at 3, 6, and 12 mo and annually thereafter. Class I and II cysts are benign but may need periodic evaluation by ultrasonography for the first 2 to 3 yr, especially in younger patients with cyst diameters of >3 cm. Renal neoplasms originating from a simple cyst wall were observed in two of 61 patients followed for 10 yr.8 As such, periodic evaluation at progressively longer intervals of enlarging or symptomatic cysts would be prudent. The role of therapeutic shrinkage of enlarging cysts is questionable.2–4

DISCLOSURES
None.

REFERENCES