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Sonography of Benign Renal Cystic Disease

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When evaluating renal masses, differentiating cysts from solid lesions is the primary role of ultrasound (US). US is also helpful and frequently superior to CT, in demonstrating the complex internal architecture of cystic lesions in terms of internal fluid content, septations, tiny nodules, and wall abnormalities, including associated soft tissue masses. Renal cysts are common in the population older than 50 years, occurring in at least 50% of people [1]. Scanning technique is important to the success of demonstrating renal masses with US. The kidneys should be evaluated in multiple patient positions, including supine, lateral decubitus, and occasionally oblique or prone positions. The mass should be scanned with an appropriate focal zone. Simple renal cysts will frequently be better demonstrated with tissue harmonic imaging, which can eliminate low-level internal echoes by reducing background noise [2]. The Bosniak Classification System of renal cysts, shown in Box 1, has become an important tool used by radiologists and urologists to communicate the significance of renal cyst imaging characteristics [3,4]. The primary goal of the radiologist in evaluating cystic renal masses is the differentiation of nonsurgical from surgical lesions [5].

Simple cortical cysts

The sonographic criteria used to diagnose a simple cyst include the following characteristics: internally anechoic, posterior acoustic enhancement, and a sharply defined, imperceptible, smooth far wall. Simple cysts are usually round or ovoid in shape. If all these sonographic criteria are met, further evaluation or follow-up is not required. Maintaining rigid criteria is necessary to ensure the highest possible accuracy with US [6]. The simple renal cyst is a Bosniak category I cyst [Fig. 1] [3].

Complex renal cysts

Complex cysts do not meet the strict US criteria of a simple renal cyst. Five to ten percent of all renal

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Box 1: **Bosniak classification of renal cystic disease**

Category I

Simple benign cyst by imaging criteria

Category II

Cystic lesions characterized by:

- One or two thin ($\leq$1 mm thick) septations or thin, fine calcification in the wall or septa
- Hyperdence, homogeneous benign cysts
- Diameter of 3 cm or less
- One quarter of its wall extending outside the kidney so the wall can be assessed
- No contrast enhancement

Category IIF

Cystic lesions that are minimally complicated that need follow-up. Some suspicious features in these lesions need follow-up to detect any change in character.

Category III

True indeterminate cystic masses that need surgical evaluation, although many prove to be benign, characterized by:

- Uniform wall thickening or nodularity
- Thick or irregular peripheral calcification
- Multilocular nature with multiple enhancing septa
- Hyperdense lesions that do not meet category II criteria

Category IV

Lesions with findings that are clearly malignant, including:

- Nonuniform or enhancing thick wall
- Enhancing or large nodules in the wall
- Clearly solid components in the cystic lesions
- Irregular margins

cysts are not simple cysts, and 5% to 10% of renal cysts with complex features prove to be tumors [7]. These complex renal cysts may contain complex fluid, septations, calcification, perceptible defined wall, or mural nodularity. Bosniak category II cysts are minimally complicated cysts that may contain septations or thin calcification, and include infected cysts and high-density cysts seen on noncontrast CT examination. High-density cysts are defined as having a density greater than 20 Hounsfield units (HU) on noncontrast CT. US may confirm the cystic nature in 50% of these lesions, especially if larger in size (1.5–3.0 cm). Equivocal cases can be placed in category IIF, created for minimally complicated cysts that require follow-up. Size criterion of 3 cm differentiates between II and IIF lesions. These cysts need at least 6-month follow-up and are most likely benign but somewhat suspicious [8]. Many of these cysts, depending on the degree of abnormality, will require further imaging with MR or CT.

Internal echoes within a renal cyst may be caused by a complicating hemorrhage or infection. Infected cysts on US usually have a thickened wall and may exhibit a debris-fluid or gas-fluid level. Aspiration and drainage may be required for diagnosis and treatment. Hemorrhagic cysts can usually be followed with serial US examination if there is no evidence of malignancy at MR or CT evaluation. Septations within a cyst may occur following hemorrhage, infection, or percutaneous aspiration [Fig. 2]. Two adjacent cysts may share a common wall and mimic a large septated cyst. There may be a small amount of renal parenchyma between two adjacent cysts, suggesting a thick septation. If septa are "paper" thin ($\leq$1 mm), smooth, and attached to the cyst wall without focal thickening or nodularity, a benign cyst can be diagnosed [3,8]. Fewer than five septations should be present in a benign cyst. If the cystic lesion shows septal irregularity, septal thickness greater than 1 mm, thick calcifications, or solid elements at the wall attachment, the lesion must be presumed malignant and requires further evaluation with MR or CT.

Calcifications in renal cysts may be fine and linear, or amorphous and thick. The presence of a small amount of calcium or thin, fine areas of calcification in the wall or a septation, without an associated soft tissue nodule, likely represents a complicated cyst rather than malignancy. Thick, irregular, amorphous calcification had been thought to be more concerning for malignancy; however, a recent report demonstrates that calcification in a cystic renal mass is not as important in the diagnosis as the presence of enhancing soft-tissue elements [9]. Renal cysts with milk-of-calcium will show layering, echogenic, dependent material that may be mobile. These cysts are always benign. At real-time US, bright echogenic foci with ringdown may be seen on septa and in the cyst walls; however, calcification may not be of sufficient density to be identified on CT examination.

Bosniak category III lesions are moderately complicated cysts that have more numerous or thickened septae; a thickened wall; thicker, irregular calcification; or multiloculated features. Benign and malignant tumors may be classified as Bosniak category III lesions. Because most category III lesions will be malignant [10], all category III lesions require surgical resection or biopsy. Benign lesions in this category include the multilocular cystic nephroma; complex septated and multiloculated