Renal Masses
Imaging Evaluation

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KEYWORDS

• Cystic renal masses • Solid renal masses • Computed tomography • MR imaging

KEY POINTS

- Cystic renal masses of increasing complexity are more likely to be malignant. Imaging, rather than biopsy, plays a major role in follow-up of cystic renal masses.
- No single imaging feature can be used to distinguish malignant from benign solid renal masses on computed tomography or MR imaging; however, on some occasions, combinations of features can be helpful. Biopsy, rather than imaging, plays a major role in the evaluation of most solid renal masses.
- Renal cancers can be staged with more than 90% accuracy; however, identification of stage T3a disease can be problematic.
- RENAL nephrometry should be performed when evaluating renal masses, because this approach suggests the ease with which partial nephrectomy and, possibly, thermal ablation can be performed (as well as the likelihood of complications).
- Radiologists should be familiar with the posttherapy imaging appearance of renal cancers. This includes the appearance of hemostatic material, which is frequently used during partial nephrectomy, which can last for months after surgery, and which can mimic fluid collections or residual or recurrent tumor masses.
- Metastatic renal cancer often decreases in size following chemotherapy but may become necrotic without substantial size change. Size change can be described using the Response Evaluation Criteria In Solid Tumors (RECIST); however, RECIST alone is not always accurate in patients who respond by developing necrosis within metastases.

INTRODUCTION

After renal mass detection, imaging can sometimes help differentiate benign from malignant renal masses, stage the tumor, and assist surgical planning. In this article, currently used computed tomography (CT) and magnetic resonance (MR) imaging techniques for evaluating renal masses are summarized, with an emphasis on features used to predict whether a cystic or solid renal mass is benign or malignant. When successful in identifying a benign lesion, imaging can prevent the need for biopsy or avoid unnecessary treatment. Also reviewed is the staging of renal cancer as well as the increasingly common use of nephrometry for predicting the likelihood of complications and of success following partial nephrectomy. The post-treatment appearance in patients with renal cancer is also summarized.

RENAL MASS IMAGING TECHNIQUE

Renal masses are frequently detected on ultrasonography, with most identified masses being simple cysts. Ultrasound is effective in determining whether a detected cyst is simple and therefore

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benign. When complex cysts or solid masses are identified with ultrasound, or an indeterminate lesion (ie, pseudolesion vs true mass) is present, CT or MR imaging is usually required for further evaluation (Table 1).

When requested to evaluate a patient with a known or suspected renal mass, both CT and MR imaging examinations should include a series of unenhanced and intravenous contrast-enhanced thin-section images, with images reconstructed using no greater than 2.5- to 3.0-mm thickness and 2.5- to 3.0-mm reconstruction intervals. On MR imaging, precontrast images should include T1-weighted and T2-weighted series as well as dual echo gradient echo and diffusion-weighted imaging. Fat suppression is performed to identify macroscopic fat.

Renal enhancement on CT or MR imaging occurs in several phases.[1] During the arterial phase, which normally occurs about 20 seconds after contrast material injection begins, the aorta and renal arteries opacify briskly. There is also bright renal cortical, but little medullary, enhancement. During the portal venous or corticomedullary phase (CMP), which usually peaks at 60 to 70 seconds, the arteries do not enhance as briskly. There is still a pronounced difference in renal cortical and medullary enhancement, with the former remaining of much higher attenuation than the latter. During the nephrographic phase (NP), which usually occurs at 85 to 120 seconds, the renal medulla enhances more intensely and renal cortical enhancement fades, leading to homogeneous renal enhancement. This phase is thought to be most sensitive for renal mass detection.[2] Finally, during the excretory phase (EP), which usually begins at about 180 seconds, the still uniform renal parenchymal enhancement diminishes, while excreted contrast material appears in the renal collecting systems.

Contrast-enhanced images for renal mass CT or MR imaging must include at least one series obtained during the NP or EP, because renal masses are better detected and characterized when delayed enhanced images are acquired (Fig. 1). Additional contrast-enhanced series are occasionally required (see Table 1). For example, before partial nephrectomy or ablation, arterial phase imaging may be used for detailed assessment of the renal vasculature and its relationship to a renal mass, whereas EP imaging can be used to localize the relationship of a renal mass to the renal collecting system.

DIAGNOSTIC CRITERIA

On noncontrast CT, most of the solid renal neoplasms measure between 20 Hounsfield Units (HU) and 70 HU.[3] Masses that measure less than or greater than this range are most commonly simple or hyperdense cysts, respectively.[4] On noncontrast MR imaging, solid renal neoplasms can have a range of appearances on T1-, T2-, and diffusion-weighted images, with hypointensity on T2-weighted images being investigated as a potentially good prognostic indicator. Marked homogeneous hyperintensity on T2-weighted images is typical of a cyst, whereas marked homogeneous hyperintensity on T1-weighted images is typical of a hemorrhagic or proteinaceous cyst; in both cases, postcontrast imaging is helpful to confirm absent enhancement.

Table 1
Imaging protocols

Goal	CT	MR	Rationale
Renal mass characterization	Nonenhanced Postcontrast NP or EP	T1-weighted T2-weighted Diffusion-weighted Postcontrast NP or EP	Evaluate for macroscopic fat Assess enhancement Characterize tissue parameters (MR) Assess for complexity (cystic masses)
Treatment planning; nephrometry scoring[a]	Postcontrast arterial phase (optional for staging, ablation, nephrometry) Excretory phase	Postcontrast arterial phase (optional for staging, ablation, nephrometry) Excretory phase	Assess arterial vasculature and tumor supply Assess nearness to renal collecting system

All images reconstructed at 3.0 mm thickness or thinner, with contiguous or overlapping slices.

[a] Although EP imaging can be helpful in assessing how close the mass is to the collecting system, nephrometry can be performed without this phase of imaging because nearness to the sinus fat can be used instead.