Recent Advances in Imaging Cancer of the Kidney and Urinary Tract

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KEYWORDS

• Kidney cancer • Bladder cancer • Urothelial cancer • Urinary tract cancer
• Radiologic imaging • Computed tomography • Magnetic resonance imaging
• Ultrasonography

KEY POINTS

- Cancer of the kidney and urinary tract continue to affect significant numbers of patients, and the incidence of renal cancer is increasing.
- New and evolving techniques in radiologic imaging have improved the detection, characterization, staging, and treatment planning of cancer of the kidney and urinary tract.
- For reassessment of advanced stage or recurrent kidney and urinary tract cancer after treatment, new, more functional radiologic imaging techniques such as diffusion-weighted magnetic resonance imaging have been shown to be useful.

CANCER OF THE KIDNEY

Epidemiology of Renal Cancer

More than 80% of renal cancers are adenocarcinomas arising from the renal parenchyma, that is, renal cell carcinoma (RCC).[1] It is difficult to obtain population-based data on the incidence and mortality of RCC, because published population data from different geographic regions combine RCC and cancer of the renal pelvis as 1 group. Thus, in this article, epidemiologic data regarding renal cancer refers to cancers of the renal parenchyma and renal pelvis. It was estimated that 65,150 new cases of cancer of the kidney and renal pelvis would be diagnosed in the United States in 2013.[2] Incidence rates for renal cancer in the United States have been increasing steadily for more than 3 decades, more rapidly for African Americans than whites. In the United States, the annual incidence of renal cancer increased by 2.6% per year between 1997 and 2007.[3] The increased incidence of renal cancer occurred across

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all age groups, with the greatest increase in patients with localized tumors.[1] The increase in incidence of localized tumors can be attributed to the introduction and widespread use of cross-sectional abdominal imaging, including diagnostic ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI), which allow detection of asymptomatic localized renal tumors. Up to 50% to 60% of renal cancers may be found incidentally in asymptomatic patients on abdominal imaging studies performed for unrelated indications.[4] However, the incidence of more advanced renal cancers in the United States, including those with regional extension or distant metastasis, also increased in all race and sex categories.[1] The global incidence of renal cancer increased from the 1970s until the mid-1990s, then leveled off or decreased in many countries.

New and Expanded Roles for Radiologic Imaging of Renal Cancer

The large number of renal tumors detected on routine survey-type abdominal imaging studies has stimulated further expansion of the role of imaging, because more focused imaging studies are often required to characterize these lesions as benign or malignant. Although as many as 85% of renal lesions believed to warrant surgery for presumed renal cancer are malignant,[5,6] the number of benign lesions with features on imaging that are indistinguishable from malignancy is not insignificant. In a series of 292 partial nephrectomies for presumed renal neoplasms, 22% of the lesions were benign.[7] Benign histology is more common in small lesions. In a series of 2675 patients treated surgically for renal lesions, the percentage of benign histology for lesions for those with diameter less than 1 cm was 38%.[8]

The task of modern imaging of renal lesions is not only to detect and stage lesions suspicious for cancer but also to provide definitive characterization of these lesions in as many cases as possible, to minimize unnecessary invasive procedures. For lesions believed likely to represent cancer, imaging is used for planning and execution of percutaneous and intraoperative biopsies and ablative procedures as well as for surgical planning. For patients undergoing nonsurgical treatment of unresectable, metastatic, residual, or recurrent renal cancer, radiologic imaging is used for staging to determine extent of disease and subsequently to assess treatment response. In recent years, novel methods have been introduced to determine treatment response beyond simple tumor bidirectional size measurements, using functional parameters.

Radiologic Imaging for Detection, Characterization, and Staging of RCC

Most renal masses are incidentally discovered on medical imaging studies obtained to investigate a large variety of abdominal conditions. Once it has been shown that the morphology of a renal mass is not in keeping with an uncomplicated simple cyst, the presence of vascularity in a renal mass is the most reliable finding to characterize the lesion as a neoplasm.[9]

When a renal mass has been defined as a probable cancer, radiologic imaging is used to stage the tumor. In the 1960s, the Robson classification was developed to stage renal cell cancers. In this system, stage I tumors were confined to the renal capsule; stage II tumors extended to the perirenal fat or ipsilateral adrenal gland; stage III tumors had vascular (A) or nodal (B) extension, or both (C); and stage IV indicated distant disease.[10] This system has been widely replaced with the TNM (tumor, node, metastasis) classification of the International Union Against Cancer (Union International Contre le Cancer [UICC]), which is being used worldwide (**Table 1**).[11] US, CT, and MRI are the standard imaging modalities used to evaluate renal masses.