32 The Case for MRI

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32.1 Introduction

Since the introduction of magnetic resonance imaging (MRI) into clinical use, much attention has been given to renal imaging. A number of papers have demonstrated the ability of MRI to show normal renal parenchyma and to detect and stage renal tumors. During the past decade, advances in MRI technology have further improved the efficiency of renal MRI.

32.2 Advances in MRI Technology

Fast, single-breath-hold MRI techniques, such as half-Fourier acquisition single-shot turbo spin-echo (HASTE) and fast multiplanar spoiled gradient-recalled acquisition in the steady state (FMPSPGR), have improved image quality, interpretability, and reproducibility. In addition, these rapid MRI sequences allow increased patient throughput and thus have the potential to reduce the cost of renal MRI.

Another development in MRI technology is in-phase and opposed-phase gradient echo imaging. This technique is more sensitive for fat detection than computed tomography (CT) or fat-suppressed MRI, and it may play a future role in renal tumor characterization. Another gradient echo technique, gradient-recalled acquisition in the steady state (GRASS), can detect blood flow without intravenous contrast medium. This GRASS sequence is the most reliable, noninvasive method to detect vascular invasion by renal cell carcinomas (Goldfarb et al. 1990).

32.3 Tumor Detection

The ability of MRI and CT to detect renal masses is nearly equivalent, and both are superior to US for this purpose (Jami-Dow et al. 1996; Semelka et al. 1993). Both CT and MRI can detect approximately 90% of renal tumors over 1 cm in diameter. The use of gadolinium chelates with fast MRI sequences has further improved the ability of MRI to detect and characterize small (<3 cm) renal lesions (Yamashita et al. 1995). In some cases, it is difficult to determine the origin of a renal fossa mass on CT even after reformations into multiple planes. In these cases, the superior tissue contrast of MRI and its direct multiplanar imaging capabilities may be helpful in determining the organ of origin and thus aid in tumor characterization (Fig. 32.1).

32.4 Tumor Characterization

For renal tumor characterization, MRI is most useful in situations where iodinated contrast agents are contraindicated or when CT is inconclusive. Since CT requires bolus injection of intravenous contrast medium medi for accurate renal tumor character-
Fig. 32.1a, b. Value of multiplanar MRI in determination of lesion origin. a CT scan shows a right upper quadrant mass (T) contiguous with the upper pole of the right kidney and posterior segment of the right lobe of the liver. Renal cell carcinoma was a clinical concern. b Coronal SSFSE T2-weighted MR image shows that the mass (T) is separate from the right kidney and arises from the liver. Hepatocellular carcinoma was proven on pathology.

32.5 Renal Cell Carcinoma Staging

For renal tumor staging, MRI is the best study, but whether the incremental benefit of MRI over CT is worth the added cost is uncertain. To our knowledge, no cost analysis comparing CT and MRI for renal tumor staging has been performed. MRI and CT have comparable accuracies for determining perinephric extension, with sensitivities about 50% and specificities about 95% (Johnston et al. 1987; Hricak et al. 1988). Since both MRI and CT rely on lymph node size to detect lymphatic metastases, these tests have similar accuracy (about 90%) for determining lymph node metastases. The two studies are comparable in their ability to detect intrabdominal metastases, but clearly CT is better for detecting thorax metastases.

The major advantage of MRI over CT in renal cell carcinoma staging is the ability of MRI to detect vascular invasion without the need for contrast medium. Incomplete mixing of blood with contrast in the inferior vena cava (IVC) or renal vein may mimic the appearance of thrombus, leading to overstaging by contrast-enhanced CT or gadolinium-enhanced MRI (Fig. 32.1). In addition, studies requiring contrast medium to enhance vessels cannot reliably distinguish bland thrombus from tumor thrombus, because incomplete mixing of contrast with blood may simulate thrombus enhancement and erroneously suggest tumor thrombus. Furthermore, a dilated IVC is a nonspecific finding that can be caused by many conditions, such as right ventricular failure, increased blood flow secondary to renal cell carcinoma hypervascularity, venous thrombus, and tumor thrombus.

Since MRI using GRASS sequences show bright vessels without intravenous contrast medium, many of the problems of vascular imaging by CT are eliminated. Studies have shown that MRI using this sequence is superior to contrast-enhanced MRI or CT for the detection of vascular invasion (Goldfarb et al. 1990; Roubioux et al. 1992; Kallmann et al. 1992; Myneni et al. 1991). More importantly, MRI is more accurate than CT for determining the cephalad extent of tumor thrombus. Involvement of the distal renal veins or IVC by tumor and the cephalad extension of tumor within the IVC are important determinants of the surgical approach to renal cell carcinoma. MRI is 94–100% accurate at predicting the extent of IVC thrombus, whereas CT is only 33–73% accurate (Goldfarb et al. 1990; Myneni et al. 1991). In addition, GRASS sequences can distinguish bland