Hepatocellular Carcinoma and Other Hepatic Malignancies: MR Imaging

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KEYWORDS

• Hepatocellular carcinoma • Liver metastases • Cholangiocarcinoma • Fibrolamellar carcinoma
• Hepatoblastoma • Epithelioid hemangioendothelioma • Embryonal sarcoma • Hepatic lymphoma

KEY POINTS

- Magnetic resonance imaging is the most accurate noninvasive diagnostic method to evaluate liver lesions.
- Categorizing malignant liver lesions based on solid versus cystic nature and solid lesion vascularity provides a useful diagnostic algorithm.
- Hepatocellular carcinoma is the most common primary hepatic malignancy, usually occurring in the setting of chronic liver disease, representing the end point of the carcinogenic pathway and featuring an array of distinctive imaging features.
- Metastases are the most common secondary malignant liver lesions and malignant liver lesions overall and generally conform to the vascularity algorithmic approach.

INTRODUCTION

Characterizing liver lesions is a common endeavor in clinical practice. Although the ultimate goal is to assign a definitive diagnosis, the first step is generally to differentiate benign from malignant lesions. Malignant lesion management depends on the diagnosis, whereas benign lesions are managed expectantly. Malignant lesion management ranges from surveillance or local ablative treatment in the case of small hepatocellular carcinoma (HCC) lesions to surgical resection in a variety of clinical scenarios to nonsurgical treatments, such as intra-arterial chemotherapy for multiple malignant lesions. Therefore, accurate diagnosis is important. However, malignant liver lesions often feature distinctive characteristics facilitating accurate diagnosis.

There are several malignant liver lesions, but liver metastases and HCC outnumber the rest (**Table 1**). The 2 most common malignant liver lesions generally harbor clues to the diagnosis. Metastases (the most common hepatic malignancy[1]) usually present in a multifocal distribution with known primary malignancy outside the liver, whereas HCC (the most common primary hepatic malignancy) usually arises in the setting of cirrhosis. Beyond these clues, lesion-specific magnetic resonance (MR) imaging features generally present the most accurate diagnostic information short of histopathologic analysis. In a study analyzing the ability of MR imaging to characterize 96 lesions that are indeterminate on computed tomography (CT), MR imaging definitively characterized 58% of these with 99% accuracy.[2] Because of its diagnostic accuracy and technical

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Table 1
Malignant liver tumors

Epithelial tumors	HCC Intrahepatic cholangiocarcinoma Bile duct cystadenocarcinoma Combined HCC and cholangiocarcinoma Hepatoblastoma Undifferentiated carcinoma
Nonepithelial tumors	Epithelioid hemangioendothelioma Angiosarcoma Embryonal sarcoma Rhabdomyosarcoma Others
Miscellaneous tumors	Solitary fibrous tumor Teratoma Yolk sac tumor Carcinosarcoma Kaposi sarcoma Rhabdoid tumor Others
Hematopoietic and lymphoid tumors	Non-Hodgkin lymphoma
Secondary tumors	Carcinoma > lymphoma > sarcoma

Data from Hirohashi S, Ishak KG, Kojiro M, et al. Pathology and genetics of tumors of the digestive system. In: Hamilton SR, Aaltonen LA, editors. World Health Organization classification of tumors. Lyon (France): IARC Press; 2000. p. 203–17.

advancements ensuring superior and more reproducible image quality, MR imaging has gained an increasingly central role in evaluating liver lesions. Familiarity with MR imaging features is therefore increasingly important and certain general principles provide a useful framework.

Although many MR imaging features deserve attention, enhancement is usually the most important. Most malignant (and solid benign) liver lesions are either hypovascular or hypervascular; the remaining lesions are isovascular (**Table 2**). In addition, this lesional enhancement scheme is universally referenced and important to understand. Hypervascular liver lesions enhance avidly (more than normal liver), whereas hypovascular liver lesions enhance less than normal liver on arterial-phase images. Malignant lesions typically show relative hypointensity to liver on portal-phase and delayed postcontrast images. A constellation of additional imaging features help to further characterize liver lesions (**Table 3**). In addition, a small minority of malignant lesions are cystic, necessitating the ability to discriminate

Table 2
Malignant liver lesions by vascularity

Hypovascular Lesions	Hypervascular Lesions
Intrahepatic cholangiocarcinoma	Hepatocellular carcinoma
Lymphoma	Sarcomas
Hypovascular Metastases	**Hypervascular Metastases**
Colorectal carcinoma	Renal cell carcinoma
Pancreatic adenocarcinoma	Neuroendocrine tumors
Gastric carcinoma	Breast carcinoma
Lung carcinoma	Melanoma
Genitourinary (prostate, bladder)	Carcinoid tumor

solid from cystic lesions. Appreciating these features requires an understanding of MR imaging technique and the usefulness of the various MR sequences.

NORMAL ANATOMY AND IMAGING TECHNIQUE

The normal liver appearance serves as the background against which to describe the appearance of liver lesions. For example, most malignant liver lesions are hyperintense to the low signal of normal liver on T2-weighted imaging (T2WI), with the opposite appearance on T1-weighted imaging (T1WI), because of the higher content of bound water of hepatic parenchyma. Although a complete description of the liver imaging protocol is beyond the scope of this article, a brief review and systematic approach facilitates the discussion of lesion differential diagnosis. Sequences generally stratify into 2 major categories: T1 weighted and T2 weighted (**Table 4**). Because the liver receives approximately three-quarters of its blood supply from the portal system and the remainder from the hepatic artery, peak hepatic enhancement occurs during the portal phase and only mild enhancement is perceptible during the arterial phase. On delayed images, malignant lesions usually appear hypointense. This effect is magnified with hepatobiliary (HB) agents such as gadoxetate disodium, with which the normal liver retains contrast, accentuating the relative hypointensity of most liver lesions (typically imaged 20 minutes after injection: the hepatocyte or hepatobiliary phase [HP]).

T1WI sequences provide additional diagnostic information in characterizing liver lesions. Although out-of-phase (OOP) and in-phase images are usually acquired simultaneously, these