Abstract Over the past several decades, the 5-year survival rates after resection of colorectal liver metastases have almost doubled, from about 30% to about 60%. Among other factors, this improved survival has been attributed to better preoperative imaging techniques, which have improved patient selection. In patients being considered for surgical therapy of hepatic colorectal metastases, a high-quality cross-sectional imaging study, either contrast-enhanced CT or MRI, should be performed to evaluate these metastases before surgery. MRI, however, is inferior to CT in the evaluation of extrahepatic disease but superior in patients after preoperative chemotherapy. PET/CT appears to improve patient selection and should be considered as part of the preoperative evaluation of resectability in high-risk patients.

2.1 Introduction

The liver is the first and most common site of metastatic spread from colorectal carcinoma. In studies reporting on autopsy results, metastases involve up to 70% of patients. Metastases are confined to the liver in 30–40% of patients at the time of detection [1, 2]. In patients with metastatic colorectal cancer, imaging plays a principal role in screening for disease presence, tumor staging, evaluation of the response to treatment, and surveillance for tumor recurrence following surgery.

The choice of the optimal treatment strategy in patients with liver metastases depends on general clinical data but is mainly based upon an accurate assessment of the imaging characteristics of both the liver and the hepatic lesions, including their number, size and location, type of tissue, and the number of involved liver segments [3]. A detailed mapping of metastatic liver involvement is therefore essential to define the most adequate and effective treatment.

Pre-operative staging is important in patient selection to avoid inappropriate surgery [4, 5]. Evaluation of tumor resectability includes assessment of vascular structures for tumor invasion and vascular anomalies. The evolution of imaging over the
past several decades has allowed earlier, more accurate detection and characterization of colorectal liver metastases. The current challenge for diagnostic imaging is the provision of a reproducible, non-invasive study that is highly sensitive and specific and well tolerated by the patient. The optimal imaging strategy for staging patients with colorectal liver metastases for resection remains to be defined and depends to some degree on local resources and expertise and, crucially, on the availability of the imaging modalities [1].

2.2 Ultrasonography

2.2.1 Technique

Conventional transabdominal ultrasonography (US) is still used to detect the presence of liver metastases. Real-time trans-abdominal US offers a rapid and non-invasive technique for screening patients with suspected colorectal liver metastases. Conventional US is carried out using a curved 3.5-MHz transducer and conventional B-mode. The acoustic power usually is preset at a mechanical index (MI) of 0.08–0.18 (mean 0.10). The examination is performed in longitudinal and transversal planes of the liver, with the patient placed in the supine and oblique left position, respectively. Good scanning is obtained when the posterior and lateral surfaces of the liver are clearly visualized by a subcostal medioclavicular approach.

Contrast-enhanced US (CEUS), in which the patient is administered intravenous contrast media, seems to improve the sensitivity of detecting liver metastases. At present, CEUS is carried out following intravenous infusion of new-generation microbubble contrast agents (perfluorocarbon or sodium chloride gas stabilized by a protein, lipid, or polymer shell), which are detected using optimized imaging methods, i.e., a conventional US imager sends pulses into tissue at one frequency but selectively detects echoes at double that frequency (harmonic imaging). Microbubble contrast agents, which are purely intravascular, are well tolerated and allow for the sensitive real-time evaluation of blood flow in hepatic lesions. Patients receive a bolus infusion of a contrast agent in a peripheral vein immediately followed by a 5-ml saline flush to clear the infusion line and to prevent a decrease in the flow of contrast agent in the veins of the arm. CEUS is performed using contrast-specific imaging software at low acoustic power output (MI < 0.1). The liver is assessed in the arterial (15–35 s), portal-venous (40–120 s), and late (> 120 s) phases following the injection of contrast medium. Exploration of the liver is possible until a marked overall decrease in contrast signal intensity occurs or when the complete disappearance of contrast has been reached; the latter occurs, on average, 3–6 min after contrast injection [6].