European Journal of Radiology 97 (2017) 76–82

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Review article

Liver metastases: Detection and staging

Therese Lincke*, Christoph J. Zech

Clinic of Radiology und Nuclear Medicine, University Hospital Basel, Petersgraben 4, CH-4031 Basel, Switzerland

ARTICLE INFO

Keywords:
US
MDCT
MRI
PET/CT
PET/MRI
Liver metastases

ABSTRACT

The liver is more often involved with metastatic disease than primary liver tumors. The accurate detection and characterization of liver metastases are crucial since patient management depends on it. The imaging options, mainly consisting of contrast-enhanced ultrasound (CEUS), multidetector computed tomography (CT), magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI), extra-cellular contrast media and liver-specific contrast media as well as positron emission tomography/computed tomography (PET/CT), are constantly evolving. PET/MRI is a more recent hybrid method and a topic of major interest concerning liver metastases detection and characterization. This review gives a brief overview about the spectrum of imaging findings and focus on an update about the performance, advantages and potential limitations of each modality as well as current developments and innovations.

1. Introduction

The liver is one of the most affected organ to be involved with metastatic disease. Metastases are about 18–40 times more common than primary liver tumors [1]. The treatment strategies have expanded significantly in the recent years especially in patients with extensive liver metastases, moving from fixed regimen based on the number of metastases or segments to a focus on a sufficient liver remnant as the solely relevant threshold for extended resections. In such a setting, an exact detection of liver metastases is crucial, since clinical outcome and patient management depend on it.

Although imaging of liver metastases is still challenging, the improvement and further development of technology leads to better sensitivity and specificity in metastases detection as compared to a few years ago.

This review gives a brief overview about the spectrum of imaging findings of liver metastases and focuses on an update about the performance of current imaging modalities to detect liver metastases.

2. Radiologic-pathologic correlation

Liver metastases commonly present as multifocal lesions, sometimes as a solitary mass or confluent masses [2]. They do not contain functional hepatocytes or biliary ducts [3] and may be hypovascular, hypervascular or cystic – largely depending on the tissue components of the primary tumor.

Colon, lung and gastric carcinomas most commonly present with hypovascular metastases, whereas renal cell carcinoma, melanoma, thyroid carcinoma and carcinoid tumors more commonly present with hypervascular metastases. Breast metastases may be hypo- or hypervascularized. Cystic liver metastases mostly arise from cystic malignant tumors, such as ovarian carcinoma or mucinous cystadenocarcinoma of the pancreas. However, cystic liver metastases may also be seen from e.g. gastroinintestinal stroma tumor (GIST), leiomyosarcoma, malignant melanoma, carcinoid and pheochromocytoma, even though the primarius appears solid.

All liver metastases are predominately supplied by arterial blood flow. After injection of contrast media, liver metastases present with characteristic features in the varying phases.

Circumferential (ring-like) perilesional enhancement is recognized as a characteristic finding of liver metastases during arterial phase. It is seen in hyper- and hypovascular metastases and correlates inversely with the degree of peripheral tumor vascularity. Yu et al. considered increased functional arterioportal shunts due to increased sinusoidal pressure as an underlying cause [4,5].

The *"Peripheral low-density area sign" or "peripheral washout sign"* is seen during portal venous or equilibrium phase in hyper- and hypovascularized metastases. It is defined as an enhancing liver lesion with a peripheral rim that is hypodense to the center of the lesion. It is reported to be associated with malignant lesions with a sensitivity of 24.5% and a specificity of 100% (not only metastases, but also hepatocellular carcinoma and cholangiocarcinoma) [6]. However the case-report of *Alessandrino* et al. should be considered who recently found this specific sign on a histologically proven angiomyolipoma [7].

* Corresponding author.
E-mail address: therese.lincke@usb.ch (T. Lincke).

http://dx.doi.org/10.1016/j.ejrad.2017.10.016
Received 24 March 2017; Received in revised form 27 September 2017; Accepted 20 October 2017
0720-048X/ © 2017 Published by Elsevier Ireland Ltd.

3. Ultrasound

The sensitivity of conventional ultrasound (US) for metastases detection is reported in the literature as poor, reaches approximately 69% [8]. However, the introduction of contrast-enhanced ultrasound (CEUS) has significantly improved sensitivity as well as specificity for detection of hepatic metastases. Studies of the recent years suggest, that CEUS may be equivalent (sensitivity CEUS 0.91,vs. CT 0.89, 0,89) [9,10], or even better compared to CT [11] in the detection of liver metastases, when scanning conditions allow a complete investigation of the liver. However reports in the literature are variable. *Vialle* et al. recently published CEUS to be significantly inferior to CT in the preoperative detection of liver metastases (sensitivity CEUS 64.5% vs. CT 80.4%), referenced to intraoperative ultrasound examinations (IOUS) [12]. One reason for such inhomogeneous results is the fact that ultrasound largely depends on the skills of the examiner, and expert centers may achieve excellent but not representative results. Moreover, the documentation of findings related to anatomical landmarks (which are completely standardized for CT and MRI by the transversal orientation of the image slices) is variable in US and therefore not as reproducible as with CT and MRI. Therefore, it has currently not the same impact for surgical therapy planning as CT and MRI.

CEUS is recommended by recent international guidelines for the following indications [13]: 1. Characterization of indeterminate lesions found on CE-CT or CE-MRI. 2. To rule out liver metastases, except there are typical findings in conventional ultrasound. 3. For treatment planning, either alone or complementary to CE-CT/CE-MRI. 4. Surveillance of oncological patient, where CEUS has been useful before.

Currently available ultrasound contrast agents (UCA) consist of chemically stabilized gas filled microbubbles. The following UCA are deliverable: 1. SonoVue ® (sulfur hexafluoride with a phospholipid shell) Bracco SpA, Milan, Italy, introduced in 2001. 2. Definity®/ Luminity® (octafluoropropane [perflutren] with a lipid shell) Lantheus Medical, Billerica, MA, USA, introduced in 2001. 3. Sonazoid® (perfluorobutane with a phospholipid shell: hydrogenated egg phosphatidyl serine), Daiichi-Sankyo, GE Tokyo, Japan, introduced in 2007.

The size of microbubbles is comparable to red blood cells. UCA acts therefore as a blood pool agent with the potential to visualize micro- and macrovasculature. UCA is administered as a bolus injection (e.g. SonoVue ® 2.4 mL) followed by flush of saline (e.g. 10 mL). Visualization is done with a dual screen format showing low mechanical index (MI) B-mode images (0.3–0.05) next to contrast-only display. Lesions are visualized in real time during all phases and in continuous manner.

The enhancement pattern of liver metastases varies during arterial phase between non-enhancement, rim enhancement and complete enhancement. They typically appear in portal and late phase as a dark defect (syn. washout) explained by a lower fractional vascular volume and the absence of portal supply, compared to the surrounding non-tumorous liver parenchyma [14]. *Kong* et al. recently found diffuse homogenous hyper-enhancement followed by a rapid washout as the most common enhancement pattern of liver metastases [15]. Appearance of metastases in conventional ultrasound varies between hyper-, hypo- and isoechogenic.

Drawbacks of CEUS are partly consistent with conventional ultrasound including: operator dependency, limitation in obese or uncooperative patients, meteorism or intestinal interposition. Further limitations arise from the limited spatial resolution resulting in the smallest detectable metastases between 3 and 5 mm [16] and the limited penetration due to steatosis, with the potential of missing small and deep seated metastases. Moreover subdiaphragmal lesions might be inaccessible. Left lateral decubitus positioning and intercostal scanning can help to reduce the latter limitation. Hypersensitivity events are comparable to those of MRI agents [13].

4. Computed tomography (CT)

Multiphase CT is known as a reliable method in the detection of liver metastases, reaches sensitivity of approximately 92% [17]. It provides not only high quality coverage of the liver but also of the complete abdomen. However the optimal number and choice of acquisition phases is, due to the potential of high radiation dose exposure and the associated risks, still under debate.

The majorities of liver metastases are hypovascular and best imaged during portal venous phase (PVP) (beginning approximately 60 s after injection initiation), presented as a hypoattenuating lesion. However, the enhancement characteristics of liver metastases are variable and the benefit of adding arterial phase (hepatic arterial dominant phase (HADP)- 10–20 s after injection initiation or late arterial phase (LAT)- 25–30 sec after injection initiation) is still controversial. Several studies of the past years conclude that adding arterial phase to PVP yields no incremental value [18,19], especially in the evaluation of hypovascular metastases. Nevertheless hyper- as well as hypovascular metastases may show enhancement during arterial phase in varying forms. Honda et al. recently found adding LAT to a 2-phase imaging consisting of unenhanced and PVP improved the detectability, especially for lesions < 10 mm in size [20] and Silverman et al. reported an increased lesion detection rate of 8–13% by adding HADP to PVP [21].

Liver metastases become less conspicuous or even completely obscured in equilibrium phase (beginning approximately 100 s after injection initiation) [22]. Equilibrium phase adds therefore no incremental value and is primarily not recommended [18,23]. Non-contrast enhanced CT (NECT), either alone or in combination, is also reported to add only small incremental value to CECT [24] or is even reported to be inadequate [25]. However about 11% of liver metastases are calcified at initial presentation [26] and follow-up imaging after i.e. chemoembolization can be challenging without additional NECT.

Various studies of the past few years investigated further possibilities for optimizing image acquisitioning, e.g. by modifying iodine concentration. Higher iodine concentrations (400 mg I/mL) are thus described to provide improved hepatic enhancement and overall image quality [27,28]. Otherwise it is known, that contrast-induced nephropathy (CIN) is related to the total quantity of iodine injection in patients with renal insufficiency. One possibility to reduce iodine concentration and still achieve high lesion conspicuity is to lower tube kilovoltage (KV), with the additional benefit of decreased radiation dose. Disadvantage, on the other hand, is increased image noise and lower image quality [29]. The so-called iterative reconstruction of raw data is a relatively recent developed algorithm that models and decreases image noise and generate images with lower noise than images reconstructed with filtered back projection (FBP) [30]. By this way, image quality can be preserved despite reduced dose [31,32]. Several investigations however came to the conclusion that aggressive dose reduction may finally impair detectability of low-contrast lesions and result in poorer image quality [33–35].

Dual-energy CT (DECT) is a further exciting and promising development of the recent years. Two energy levels (typically 80 and 140 kVp) are acquired to generate additional datasets. Although each dataset pair is obtained at the same point, radiation dose is not twice the dose of a single energy CT (SECT) [36]. Several studies even revealed no increased radiation exposure when DECT is compared with SECT [37]. DECT enables even more radiation dose savings of up to 30.47 ± 7.07%, when real non-contrast CT is replaced by virtual non-contrast scan in a portal venous DECT phase [38] (Fig. 1). A further advantage of DECT is the possibility to generate iodine-specific images, which generate a map encoding the amount of iodine in every voxel (Fig. 1). Particular small lesions can be examined with regard to an iodine uptake and thus lesion detection and characterization can be improved.

With regard to dose reduction as a central element of current research, *Roessler* et al. recently investigated the potential of high atomic

Download English Version:

https://daneshyari.com/en/article/8822845

Download Persian Version:

https://daneshyari.com/article/8822845

Daneshyari.com