Appearance of Colorectal Hepatic Metastases at Diffusion-weighted MR imaging Compared with Histopathology

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Introduction

Diffusion-weighted imaging (DWI) is useful for the detection of colorectal hepatic metastases [1]. Metastases demonstrate high signal intensity restricted diffusion at DWI, which facilitates their identification. The mean apparent diffusion coefficients (ADCs) of colorectal metastases are usually higher than that of liver parenchyma; suggesting necrosis may be present [2]. However, the range of appearances of colorectal metastases at DWI, and the pathology underlying the imaging findings has not been previously described. Appreciation of the DWI features of colorectal metastases can add confidence to their recognition and detection in the liver.

Purpose

The purpose of this study was to determine the DWI appearances of colorectal hepatic metastases compared with histopathology.

Materials and Methods

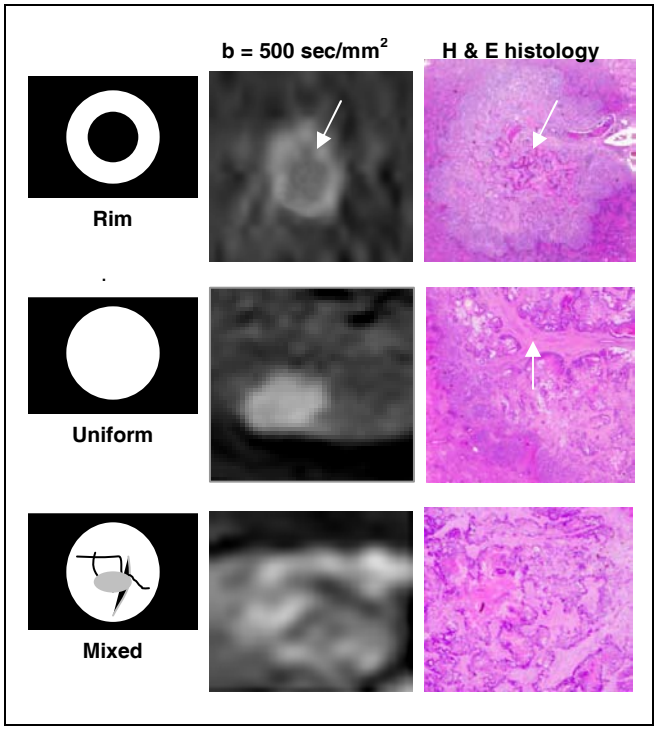
43 patients with known metastatic colorectal hepatic metastases were prospectively evaluated. Axial DWI of the liver was performed on a 1.5T MR system (Philips Intera, Software version 11) using breath-hold single-shot echo-planar imaging with three *b* values (0, 150 and 500 sec/mm^2) applied along three directions. Twelve sections were acquired during each 20 seconds breath-hold (*TR = 1850 ms, TE =56-72 ms, α = 90 degrees, 7 mm thickness, 1mm gap, FOV = 340 cm, Matrix = 112 x 256, SENSE factor = 2*) and the entire liver was evaluated in two breath-holds. All images were reviewed in consensus by two expert readers to determine the imaging appearances of metastases on the b = 150 sec/mm^2 and b = 500 sec/mm^2 images. In 18 patients, hepatic resection was performed enabling comparison of DWI findings with histopathology. In the remaining patients, interval growth or regression of lesions (at least 20% change in diameter) on following up imaging at 3 months was taken as evidence of metastatic disease. At histology, the centre of each metastasis was classified as predominantly cellular, predominantly necrotic/ mucinous, predominantly desmoplastic or mixture of these features.

Results

84 metastases were visualised at DWI in the 43 patients. The mean number of metastasis per patient was 1.9 (range: 1- 6). The mean size of metastasis was 3.1 cm (0.5 -16.5 cm). 15/84 (17.5%) were located in the left lobe but the majority 69/84 (82.5%) were in the right lobe. At DWI, the appearance of colorectal metastases could be classified into three categories on diffusion-weighted b = 150 or 500 sec/mm^2 images: (1) Rim high signal intensity (56/84; 66.7%), (2) Uniform high signal intensity (24/84; 28.6%), and (3) Mixed high signal intensity (4/84; 4.8%) (Figure 1). 25 metastases were surgically resected. Of these, 3 were < 1 cm in diameter and all showed uniform high signal intensity at DWI. Of the 22 metastases ≥ 1 cm in diameter, the distribution of DWI categorisation compared to histopathology features are summarised in Table 1. The rim high signal intensity pattern was a frequent feature of metastases with central necrosis or mucinous deposits (p = 0.02, Chi-square test). Uniform signal intensity was observed in 2 metastases exhibiting predominantly central desmoplastic reaction. Metastases showing a mixture of desmoplasia and necrosis had a range of imaging appearances. Lesions demonstrating mixed high signal intensity at DWI were significant larger in size (5.1cm versus 2.6 cm; p < 0.01, t-test).

Table 1. DWI appearances of colorectal hepatic metastases versus histopathology

DWI appearances (b = 150 or 500 sec/mm^2 images)	**Histopathology (n = 22)**			
	Cellular	***Necrotic/ mucinous***	***Desmoplastic***	***Mixed***
Rim	1	12	0	3
Uniform	0	0	2	1
Mixed	0	2	0	1



Discussion

Central necrosis is frequently encountered in colorectal hepatic metastases and has been reported in up to 40% [2]. Not surprisingly, the necrotic areas showed greater signal attenuation by comparison with the cellular periphery, thus resulting in a rim high signal intensity appearance on b = 150 or 500 sec/mm^2 images. The presence of mucinous deposits within the metastases also resulted in a similar rim appearance. Uniform high signal intensity was less frequently encountered. In the three pathological proven examples, dominant desmoplastic reaction was observed. Fibrosis restricts water diffusion, and may explain the imaging appearances. However, this observation needs to be further validated in our continuing investigation. Lesions demonstrating mixed high signal intensity were larger in size, which would account for the observed heterogeneity. Smaller metastases < 1 cm in diameter appeared to have uniform signal intensity at DWI as it was difficult to visualise their internal characteristics due to limits of spatial resolution.

Conclusions

Colorectal hepatic metastases exhibited characteristic findings at DWI. Rim high signal intensity was the most common appearance, and was related to central necrosis or mucinous deposits. Uniform high signal intensity of metastases may be related to desmoplastic reaction.

References: [1] Nasu et al. Radiology 2006. [2] Outwater E et al. Radiology 1991

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Figure 1. Patterns of colorectal metastases at DWI compared with histopathology. *Top row*: Rim pattern in a metastasis showing central necrosis (arrow). *Middle row:* Uniform high signal in a metastasis demonstrating bands of desmoplasia (arrow). *Bottom row:* Large heterogeneous metastasis showing a mixed appearance.