

# Diffusion-weighted MR imaging improves sensitivity of lesion detection compared with gadolinium enhanced T1-weighted imaging in patients with suspected liver metastases from neuroendocrine tumours.

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**Introduction:** Diffusion-weighted MR imaging (DW-MRI) has been shown to improve the detection of colorectal liver metastases compared with unenhanced T2-weighted imaging [1], SPIO-enhanced T2\*-weighted imaging [2] and MnDPDP contrast enhanced T1-weighted imaging [3]. In theory, liver metastases of neuroendocrine origin should also lend themselves to being detected using DW-MRI because these tumours are often cellular and comprised of small round cells, which would be expected to show high signal intensity impeded water diffusion at DW-MRI [4]. However, as far as we are aware, the value of applying DW-MRI for the detection of neuroendocrine (NE) liver metastases compared with conventional gadolinium-DTPA (Gd) enhanced T1-weighted has not been previously established.

**Purpose:** The purpose of this study was to compare the sensitivity of liver lesion detection using DW-MRI compared with triphasic Gd-enhanced T1-weighted MR imaging in patients with malignant neuroendocrine tumours.

**Materials and methods:** 13 patients with pathologically confirmed primary tumours of neuroendocrine origin in whom liver metastases were suspected underwent prospective routine clinical MR imaging using Gd-enhanced MR imaging and DW-MRI on a 1.5T MR system. (Siemens' Avanto, Erlangen, Germany). Unenhanced T1-weighted gradient-echo and T2-weighted fast spin-echo sequences were first acquired. DW-MRI was performed using a free-breathing spin-echo echo-planar imaging (EPI) technique (TR/TE = 4500/60, 380 mm field view, 128 x 128 matrix GRAPPA = 2, section thickness = 6 mm, spectral attenuated inversion recovery fat suppression (SPAIR), bandwidth = 1850 hzt, number of excitations = 4, three-scan trace technique) employing 6 b-values (0, 50, 100, 250, 500, 750 s/mm<sup>2</sup>). Dynamic Gd-enhanced T1-weighted MR imaging was performed with 3D volume interpolated breath-hold (VIBE) technique (TR/TE = 5.7/2.6 ms, 380 mm field of view,  $\alpha$  = 10 degrees, 256 x 256 matrix, GRAPPA acceleration factor = 2, section thickness 3 mm, SPAIR fat suppression) employing bolus tracking to acquire images in the arterial, portovenous and interstitial phases of liver enhancement. Images were reviewed by two radiologists in consensus (15 years and 5 years experience) as two separate image sets: DW-MRI image set (unenhanced and DW-MR images) and Gd image set (unenhanced and dynamic Gd-enhanced images). Image sets were viewed in random order and separated by 2 weeks to minimize recall bias. For each image set, the size, location and likelihood of malignancy (on a 5 point scale) of each focal liver lesion identified was recorded. The presence or absence of a focal liver lesion was determined by reviewing all available clinical imaging after completion of radiological assessment. The sensitivity of lesion detection using DW-MRI and Gd-enhanced imaging was compared using McNemar test. A p-value of < 0.05 was taken to be statistically significant.

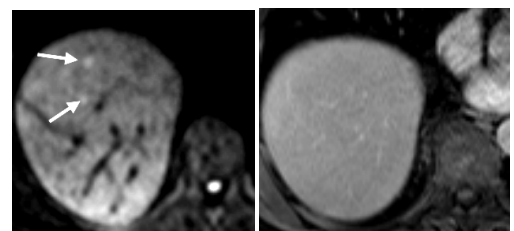
**Results:** A total of 368 focal lesions were identified on review of all available imaging. Of these, 357 were consistent with malignancy and 11 were benign. The mean lesion size was significantly larger measured on DW-MRI (14.4; 95% CI: 12.8 – 15.9 mm) compared with Gd-enhanced T1-weighted imaging (13.7, 95% CI: 12.2 – 14.4) (p = 0.03, paired t-test). 84 lesions (83 malignant, 1 benign) were not detected on Gd-enhanced MR imaging. These had a mean size of 7.4 mm (range 1- 22 mm). By comparison, 43 lesions (38 malignant, 5 benign) with a mean lesion size of 8.2 mm (range: 3 – 38mm) were not detected on DW-MRI. Using DW-MRI resulted in a significantly higher sensitivity (88%) for lesion detection compared with Gd-enhanced MR imaging (77%) (p = 0.001, McNemar Test). On Gd-enhanced MR imaging, lesions were missed because they mimicked hepatic vasculature, poor lesion enhancement (**Figure 1**) or respiratory motion artefacts. On DW-MRI, missed lesions resulted from imaging artefacts (**Figure 2**) or lesion isointensity on b-value DW-MRI images.

**Discussion:** The role of DW-MRI for the detection of liver metastases, particularly arising from colorectal cancer, is now established based on a number of imaging studies. There is reportedly an advantage when DW-MRI is combined with contrast enhanced MR imaging for the detection of liver metastases, as the two techniques could work synergistically to improve the diagnostic accuracy. In patients with neuroendocrine liver metastases, imaging determination of the size and distribution of metastatic disease is of value as it could influence choice of therapy. Limited disease in the liver may be resected or ablated by minimally invasive therapies, and the mean size of disseminated disease may have an implication on choice of radiolabelled targeted treatment. In our study, we established that DW-MRI had a significantly higher diagnostic sensitivity (88%) compared with Gd-enhanced T1-weighted imaging (77%). Nevertheless, the two techniques appeared complementary and the highest diagnostic sensitivity is likely to result when both techniques are employed. The main limitation of this study is lack of pathological confirmation of metastatic disease since these patients often have disseminated disease which is not amenable to surgery. However in all patients in this study there was clear biochemical evidence of metastatic disease.

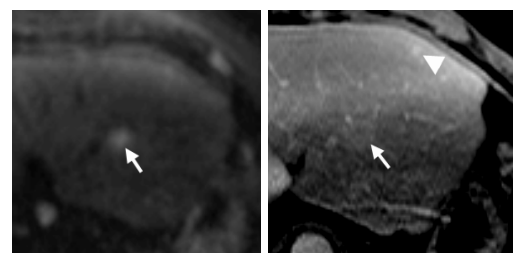
**Conclusions:** Compared with Gd-enhanced MR imaging, DW-MRI has a higher diagnostic sensitivity for the detection of focal liver lesions in patients with suspected liver metastases arising from neuroendocrine tumours. DW-MRI should be used in combination with Gd-enhanced MR imaging to improve lesion detection in this clinical population.

**References:** [1] Zech CJ et al. Invest Radiol 2008; 43: 261-6 [2] Nasu K et al. Radiology 2006; 239: 122-30 [3] Koh DM et al. Eur Radiol 2008; 18: 903-10 [4] Chang S et al. Radiographics 2007; 27: 1667-1679

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**Figure 1.** (Left) DW-MR image at b-value of 500 s/mm<sup>2</sup> shows two high signal intensity metastases (arrows) in the right lobe liver. (Right) These metastases are not seen on the corresponding fat suppressed T1-weighted Gd-enhanced arterial phase MR image as they appear isointense to the liver.



**Figure 2.** (Left) DW-MR image at b-value of 500 s/mm<sup>2</sup> shows a 2 cm metastasis in left lobe of liver (arrow). (Right). Gd-enhanced T1-weighted fat suppressed image shows corresponding metastasis (arrow) and a further enhancing lesion in the peripheral of the left lobe (arrowhead). This lesion was not clearly detected on DW-MRI due to movement artefacts at the edge of liver.