Contrast-enhanced diffusion-weighted MRI vs contrast-enhanced CT for detecting liver metastases for potentially resectable pancreatic ductal adenocarcinoma

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Purpose

To explore the value of contrast-enhanced diffusion-weighted MRI (CE-DW-MRI) versus contrast-enhanced CT (CECT) for detection of liver metastases for potentially resectable pancreatic ductal adenocarcinoma (PDAC).
Methods and materials

Retrospective analysis of 46 patients (29 men, 17 women; mean age 64y, range 36-82y) with a potentially resectable PDAC on CECT who also underwent a CE-DW-MRI (3 Tesla) between January 2012 and December 2014.

CECT images were obtained from different hospitals in the region. Only high quality datasets with image acquisition in the portal venous phase and/or parenchymal phase and with a slice thickness of 3-5 mm were accepted.

MR imaging of the abdomen was performed on a 3.0 Tesla system (Magnetom Skyra, Siemens Healthcare, Erlangen, Germany). Respiratory-triggered single-shot spin-echo echoplanar DWI was performed with b-values of 0/50, 500 and 800 s/mm². ADC maps were automatically generated based on the available b-values. The clinical MR study included coronal breath-hold half fourier acquisition single-shot turbo spin-echo (HASTE) imaging (TR/TE = 1400/87 ms; field of view 350 mm; matrix 320 x 256; section thickness 5 mm; gap 0.5 mm; number of acquisitions 1), axial breath-hold HASTE with fat suppression (TR/TE = 1600/95 ms), and an axial in- and opposed phase T1-weighted gradient-echo using volumetric interpolated breath-hold examination (VIBE) (TR/TEopp/TEin = 4.35/1.33/2.45 ms; flip angle 9°; section thickness 3 mm; field of view 30 cm; matrix 320 x 195). Axial pre- and postcontrast fat-saturated T1-weighted 3D gradient-echo VIBE images were obtained (TR/TE = 4.34/1.89 ms; flip angle 9°; section thickness 3 mm; field of view 30 cm; matrix 320 x 195) and coronal postcontrast fat-saturated T1-weighted 3D gradient-echo VIBE images (TR/TE = 2.92/1.05 ms; flip angle 11°; section thickness 1.5 mm; field of view 30 cm; matrix 256 x 243). Contrast agent: intravenous gadoterate meglumine (Gd-DOTA).

A single observer with 14 years of experience re-evaluated MRI and CT on a per lesion and a per patient basis and was blinded to imaging, pathology and surgery reports on the presence of metastases. Whenever more than 10 liver metastases were present, an estimation was made of the number of metastases. All liver lesions were scored using a 3-point scale: 1-benign, 2-indeterminate, 3-malignant in both modalities. Benign lesions were diagnosed using established imaging criteria. Presence of a metastasis on CECT was documented when a hypodense lesion not showing typical features of a simple cyst, a hemangioma, or focal fatty infiltration was seen1. On MRI metastases of pancreatic cancer are typically of moderately high signal intensity to isointense on T2W-images and mildly hypointense to isointense on T1W-images. Metastases can either be hypo- or hypervascular, show homogeneous or peripheral rim enhancement in the arterial phase, homogeneous enhancement or ring enhancement with complete or incomplete centripetal progression in the portal venous and interstitial phase.2 A lesion was considered benign on DWI, when it was hyperintense at b = 0/50 s/mm², showed
a substantial decrease in signal intensity at higher b values. A lesion was classified as malignant, when it was (moderately) hyperintense at $b = 0/50 \text{ s/mm}^2$, remained hyperintense at $b=800 \text{ s/mm}^2$. If none of the criteria were met, a lesion was classified as indeterminate.
Results

In 14 patients (30%) liver metastases were present. Confirmation of liver metastases was obtained by histopathology (n=6), 18FDG-PET (n=6) or MR imaging characteristics only (n=2). In retrospect metastases were visible on CECT in 3/14 patients. CE-DW-MRI showed metastases in 13/14 patients. In one patient neither CECT nor CE-DW-MRI detected liver metastases. Sensitivity of CE-DW-MRI was 93% (CI 66-99%).

CE-DW-MRI showed a significantly greater number of small metastases (<5 mm) than CECT (p<0.05). More than 95% of all liver metastases were subcentimeter lesions: 89% <5 mm, 8% 5-10 mm and 3% >10 mm. The DW-MRI provided a better estimate of metastatic load compared to CE-MRI, and showed more metastases than CE-MRI in nine patients (69%). The difference was most obvious in subcentimeter metastases.

Survival

The mean survival in PDAC with and without synchronous liver metastases was 4 months (range 0-9 months), respectively 13 months (range 1-30 and alive) and was statistically significant (p<0.001).
Fig. 4: Kaplan-Meier curve in patients with and without synchronous liver metastases of potentially resectable PDAC

References: Department of Radiology, Radboudumc - Nijmegen/NL
**Fig. 1:** Patient with multiple liver metastases. a. CECT b. T2W-MRI c. CE-MRI d. DW-MRI. No metastases are visible on CECT, T2W-MRI and CE-MRI. DW-MRI shows multiple small lesions (>100) with high signal intensity on b=800 s/mm².

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Fig. 2: Patient with a subcapsular metastasis in liver segment 4a/8. a. CECT b. T2W-MRI c. CE-MRI d. DW-MRI. CECT shows slight retraction of liver capsule, no visible liver metastases. MRI shows a metastatic lesion where liver capsule is retracted with moderately high signal intensity on T2W-image, perilesional rim enhancement with incomplete progression and high signal intensity on DW-MRI b=800 s/mm2.

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Fig. 3: Patient with liver metastases. a. CECT b. T2W-MRI c. CE-MRI d. DW-MRI. On CECT hypodense indeterminate lesion in liver segment 8. MRI shows a metastatic lesion isointense on T2W-image, with perilesional rim enhancement in the arterial phase on CE-MRI and high signal intensity on DW-MRI b=800 s/mm².

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**Fig. 4:** Kaplan-Meier curve in patients with and without synchronous liver metastases of potentially resectable PDAC

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Conclusion

CE-DW-MRI is superior to the current routinely performed CECT in the detection of liver metastases in potentially resectable PDAC. It is especially promising in the detection of small metastases.
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