

UPDATE

Diffusion-weighted MR imaging of pancreatic carcinoma

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Abstract

Purpose: The aim of this study was to demonstrate the feasibility of body diffusion-weighted (DW) MR imaging in the evaluation of a pancreatic carcinoma.

Material and methods: In nine normal volunteers and in eight patients with pancreatic carcinoma, DW images were obtained on the axial plane scanning with a multisection spin-echo-type single-shot echo planar sequence with a body coil. Moreover, we measured the apparent diffusion coefficient (ADC) value in a circular region of interest (ROI) within the normal pancreas, pancreatic carcinoma, and tumor-associated chronic pancreatitis.

Results: On the DW images, all eight carcinomas were clearly shown as high signal intensity relative to the surrounding tissue. The ADC value ($\times 10^{-3}$ mm²/s) in the carcinoma was 1.44 ± 0.20 , which was significantly lower compared to that of normal pancreas (1.90 ± 0.06) and tumor-associated chronic pancreatitis (2.31 ± 0.18).

Conclusion: Diffusion-weighted (DW) images can be helpful in detecting the pancreatic carcinoma and accessing the extent of the tumor.

Key words: Pancreatic carcinoma—MRI—Diffusion-weighted MR imaging—ADC value—Pancreas

The utilization of diffusion-weighted (DW) MR imaging in the abdomen was attractive in the detection of the malignant tumors, such as malignant hepatic, renal, prostatic, colonic, and uterine cervical tumors [1]. However, its application to the abdomen has been hindered in

the presence of bulky physiologic motions such as respiration, peristalsis, and blood flow. Therefore, to reduce respiratory motion, breath holding under the examination is required. Such an approach limits the acquisition time, and both the signal-to-noise ratio and the spatial resolution must be compromised as a result. For resolving those defaults, Takahara et al. [2] reported a body DW MR imaging under free breathing, which affords a longer scan time. This technique gives more and thin slice images with multiple signals averaging. In this study, we discussed the feasibility of DW MR imaging under free breathing in the evaluation of a pancreatic carcinoma.

Material and methods

Nine normal volunteers and eight consecutive patients (six women and two men; age range 59–73 years; mean 66 years) with histopathologically proven pancreatic adenocarcinoma by surgery were examined. One patient underwent FDG PET/CT examination. The carcinomas were in the pancreatic uncus or head in three patients, in the body in four patients, and in the tail in one patient. The diameter of the tumors ranged from 13.2 to 33.6 mm (mean 20.8 mm). Normal volunteers and patients were scanned using a 1.5-T MRI scanner (SIGNA MR/I Echo Speed 1.5 T CV Option, General Electric Medical Systems, Milwaukee, WI, USA). DW MR images were obtained using a multisection spin-echo-type, single-shot echo planar on the axial plane under free breathing scanning with a body coil. It was designed with the following parameters; TR/TE = 7500/68 ms, band width = 143 kHz, 128×128 matrix, slice thickness of 5 mm, intersection gap of 0 mm, 480×480 mm FOV, seven excitations, water excitation with *b* value of 0 and 800 s/mm². The MPG pulses were placed in the *X*-, *Y*-

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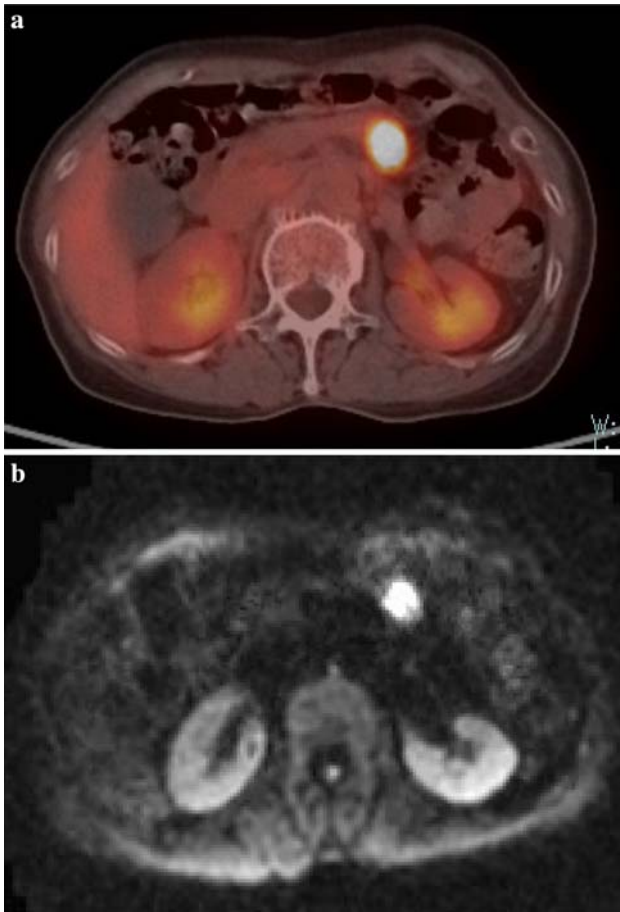


Fig. 1. 73-year-old woman with pancreatic adenocarcinoma. **a** Fused image of PET and CT images clearly shows a tumor with intense FDG uptake in the pancreatic body. **b** Diffusion-weighted (DW) MR image clearly shows a tumor with marked high signal intensity in the pancreatic body, and this finding is similar to FDG PET/CT findings.

and Z-axes. Respiratory trigger was not used. Thirty-four slices were obtained in 190 s. Imaging analyses were as follows. (a) The identification of the pancreatic carcinomas on DW images was determined in the comparison of the operative findings. (b) The apparent diffusion coefficient (ADC) values of the eight carcinomas and the four tumor-associated pancreatitis in eight patients and the nine normal pancreases in nine normal volunteer were calculated and compared. The ADC values ($\times 10^{-3} \text{ mm}^2/\text{s}$) were calculated as follows: $\text{ADC} = (1/(b1 - b0)) \ln(S0/S1)$. To compare ADC values among them, an unpaired *t*-test was used. $P < 0.05$ was considered as statistically significant.

Results

On the DW images, all eight carcinomas were clearly shown as high signal intensity relative to the surrounding tissue (Fig. 1). The mean and standard deviations of the ADC values ($\times 10^{-3} \text{ mm}^2/\text{s}$) were as follows: carcinomas

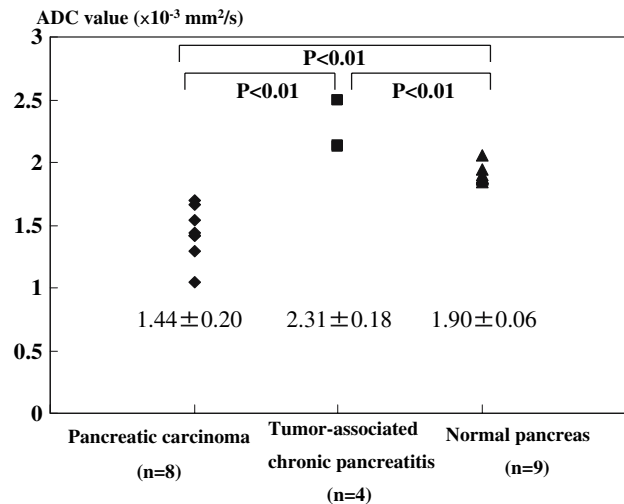


Fig. 2. Scatterplots of apparent diffusion coefficients (ADCs) of pancreatic carcinomas, tumor-associated chronic pancreatitis and normal pancreas. The ADC values ($\times 10^{-3} \text{ mm}^2/\text{s}$) of the pancreatic carcinomas (1.44 ± 0.20) are significantly lower compared to those of tumor-associated chronic pancreatitis (2.31 ± 0.18) and normal pancreas (1.90 ± 0.06).

($n = 8$), 1.43 ± 0.20 (1.04–1.70), tumor-associated chronic pancreatitis ($n = 4$) 2.09 ± 0.40 (2.12–2.49) and normal pancreas ($n = 9$), 1.90 ± 0.05 [1.84–2.06 (Fig. 2)]. ADC values of the carcinomas were significantly lower compared with those of tumor-associated chronic pancreatitis and normal pancreas. ADC values of normal pancreas closely agreed with previously reported ADC values [3].

Discussion

Diffusion is the thermally induced motion of water molecules in biologic tissues, called Brownian motion. With the addition of diffusion gradient pulses, measurement of ADC values from diffusion-weighted (DW) images is currently the best imaging method for in vivo quantification of the combined effects of capillary perfusion and water diffusion. Body DW MR images hold a great potential for abdominal imaging, in particular for focal lesion detection and characterization [1]. Previous reports demonstrated that ADC values of malignant hepatic, renal, prostatic, colonic and uterine cervical tumors were lower than those of benign lesions or normal tissue, and DW MR images showed these malignant tumors as high signal intensity [1]. The cause of a decrease of the ADC values is considered to be that malignancies commonly have a larger cell diameter and denser cellularity than normal tissue, which restrict water diffusion. However, the body DW MR imaging under breath holding does not permit thin slice imaging with adequate signal-to-noise ratio and multiple excitations and, therefore, the clinical use of body DW MR imaging was limited. Then, Takahara

et al. [2] reported a body DW MR imaging under free breathing, which afforded more slices with multiple signal averaging and higher SNR. In this study, DW images under free breathing clearly showed a pancreatic carcinoma with high signal intensity to the surrounding tissue. The ADC value of the carcinoma was lower compared to that of the normal pancreas and tumor-associated chronic pancreatitis. Based on these results, the DW images can be helpful in detecting the pancreatic carcinoma and accessing the extent of the tumor.

References

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