

Free-breathing and high b-value Diffusion-weighted MR images of solid pancreatic tumors and tumor-like lesions

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[Introduction] Most of pancreatic malignancies are ductal adenocarcinomas, which are hypovascular masses and may appear as distinctly hypoattenuating areas to the normal pancreatic parenchyma during the arterial phase, and as iso- or slightly hyperattenuating areas on the delayed phase of dynamic contrast-enhanced CT scans reflecting its desmoplastic nature. Some benign inflammatory pathologies such as mass-forming chronic pancreatitis, and autoimmune pancreatitis may mimic ductal adenocarcinomas on imaging and preoperative diagnosis is often difficult. The purpose of this study is to evaluate benign and malignant solid pancreatic tumors and tumor-like lesions by free-breathing and high b-value diffusion-weighted images (DWI) and corresponding isotropic ADC maps to differentiate benign lesions from malignancies.

[Materials and Methods] Ten pancreatic ductal adenocarcinomas (nine were untreated and one was after irradiation and chemotherapy at MR examination), two islet cell tumors, and six benign inflammatory pathologies mimicking malignancy (two autoimmune pancreatitis, three mass-forming chronic pancreatitis, and one chronic pancreatitis with pseudocyst and pancreatic duct occlusion) were evaluated. All neoplastic lesions, one mass-forming chronic pancreatitis and one chronic pancreatitis with pseudocyst were surgically or autopsy proven. Two autoimmune pancreatitis and two mass-forming chronic pancreatitis were diagnosed clinically. Free-breathing DWI with high b-value ($b=800 \text{ sec/mm}^2$) was performed in all subjects with a spin-echo, single-shot EPI sequence on a system with a 1.5-T superconducting unit (Signa Excite, General Electric, Milwaukee, WI) with 8ch body-array torso coils. The parallel image-encoding techniques (the array spatial sensitivity encoding techniques: ASSET, General Electric, Milwaukee, WI) were employed. Signal intensity on DWI (black and white inversion) was visually evaluated by three radiologists. The isotropic apparent diffusion coefficients (ADCs) of the pathologies and pancreatic parenchyma were measured from ADC maps.

[Results] All nine untreated pancreatic ductal adenocarcinomas showed very high signal intensity on DWI. One treated ductal adenocarcinoma, three mass-forming chronic pancreatitis, and two islet cell tumors showed slight high to iso signal intensity on DWI. One chronic pancreatitis with pseudocyst and pancreatic duct occlusion was suspected as small ductal adenocarcinoma by ERCP, but no focal lesion was detected on CT scans and DWI. Two autoimmune pancreatitis showed gradual contrast-enhancement on dynamic CT simulating diffuse invasive ductal adenocarcinomas but showed relatively homogeneous slight high signal intensity on DWI. The ADC in normal pancreatic parenchyma measured in six patients with tumors was $2.72 +/- 0.31 \times 10^{-3} \text{ mm}^2/\text{sec}$. The ADC in nine untreated ductal adenocarcinomas was $1.44 +/- 0.37 \times 10^{-3} \text{ mm}^2/\text{sec}$. The ADC in two islet tumors was $1.55 +/- 0.05 \times 10^{-3} \text{ mm}^2/\text{sec}$. The ADC in three mass-forming chronic pancreatitis was $0.97 +/- 0.21 \times 10^{-3} \text{ mm}^2/\text{sec}$. The ADC in two autoimmune pancreatitis was $1.05 +/- 0.07 \times 10^{-3} \text{ mm}^2/\text{sec}$. In ductal adenocarcinomas, lymph node metastasis, liver metastasis, and adrenal metastasis also showed very high signal intensity on DWI.

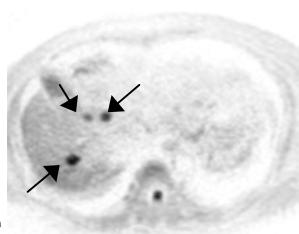
[Conclusions] Free-breathing and high b-value DWI may be useful in primary tumor and metastatic lesion detection of pancreatic ductal adenocarcinoma, and in differentiation from benign tumor-like pathologies such as mass-forming chronic pancreatitis, autoimmune pancreatitis and so on. Benign islet cell tumors may show similar signal intensity to benign tumor-like lesions on DWI.



Fig. 1A.



1B.



1C.

Fig. 1. Ductal adenocarcinoma with liver metastases

A. Arterial phase of dynamic contrast-enhanced CT demonstrated a hypoattenuating mass of the pancreas.

B, C. DWI (black and white inversion) shows primary tumor and liver metastases as very high intensity lesions.

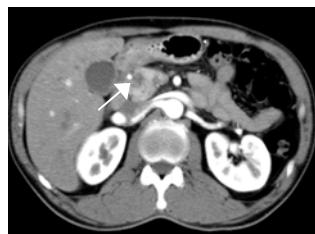
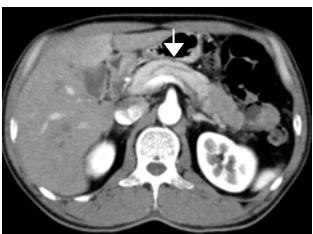
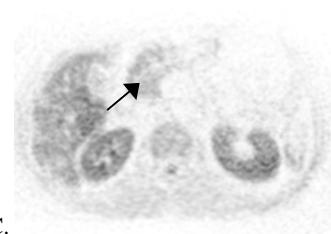


Fig. 2A.



2B.



2C.

Fig. 2. Mass-forming chronic pancreatitis

A. Arterial phase of dynamic contrast-enhanced CT demonstrated a hypoattenuating mass of the pancreas.

B. Mild dilatation of the main pancreatic duct was also observed and ductal adenocarcinoma was suspected.

C. No high intensity mass was detected on DWI. Histopathologic examination revealed fibrous tissue proliferation resulting in chronic inflammatory changes and diagnosed as mass-forming chronic pancreatitis.