The Usefulness of Diffusion MR Imaging in the Detection of PancreaticCancer: Pathological Correlation with ADC Values

N. Muraoka[1], H. Uematsu[1], H. Kimura[1], T. Sakai[1], Y. Fujiwara[1], and H. Itoh[1]
[1]Radiology, University of Fukui, Fukui, Fukui, Japan

Purpose: The detection of pancreatic cancer remains difficult using conventional MR imaging. Recently, diffusion-weighted MR imaging (DWI) has been used extensively in the central nervous system for imaging tumors as well as acute stroke. Furthermore, recent developments in clinical MR scanners have facilitated application of the DWI sequence for body areas. We hypothesized that DWI could be useful to detect pancreatic cancer and reflect its histopathological features.

Material and Methods: Twenty-seven subjects (20 men and 7 women, mean age: 67.9 years) with pancreatic cancer were recruited. Thirteen cases were surgically confirmed (surgical resection: n=8, biopsy: n=5) to be pancreatic cancer after MR studies. The other 14 cases were clinically confirmed based on imaging findings and serological tumor markers. A single-shot EPI-DWI technique (b=0 and 500 s/mm^2) was employed. Apparent diffusion coefficient (ADC) values were compared between the tumor and normal-appearing parenchyma using the Wilcoxon matched-pairs test. Furthermore, differences between the ADC value of the tumor and the normal-appearing parenchyma were evaluated by ROC analysis. We also compared ADC value of the cancer with pathological findings in the 8 subjects who underwent tumor resection.

Results: In all 27 cases, signal intensity on DWI was higher for the tumor than for normal-appearing pancreatic tissue (Figs.1, 2). Mean ADC value of the tumor ($1.33\pm0.33\times10^{-3}$ mm^2/s) was significantly lower than that of normal-appearing pancreatic tissue ($1.65\pm0.32\times10^{-3}$ mm^2/s, P<0.0001), although some overlap existed. ROC analysis demonstrated a diagnostic accuracy of 0.81 for ADC values alone. Setting a cutoff of 1.46×10^{-3} mm^2/s or lower for tumor ADC resulted in sensitivity and specificity of 74% and 78%, respectively. Regarding correlation between ADC and histopathological features in the 8 surgically resected cases, 6 cases exhibited lower ADC values in the cancerous area than in normal-appearing parenchyma. In these 6 cases, histopathological examination demonstrated hyperplasia of the cellular component, coagulation necrosis, and the dense collagenous fibers (Fig 1). In remaining 2 subjects, ADC value of the cancerous area was higher than that of normal-appearing parenchyma. Histopathological examination showed edematous fibrosis and loose collagen fibers (Fig 2); pathological features were completely different from those shown in Fig 1.

Discussion and Conclusion: Signal intensity of pancreatic cancer was higher than that of normal-appearing pancreatic tissue on DWI. The pathological features of the tumor appear to affect the ADC value. These results support the hypothesis that DWI could be useful to detect pancreatic cancer and indicate its pathological features.
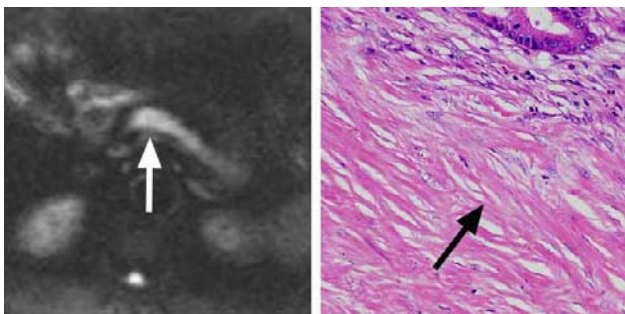

Figure 1. Representative case of cancer of pancreatic body (73-year-old man)   The tumor (white arrow) was visualized as a high signal lesion on DWI (left). ADC value of this tumor and normal-appearing parenchyma were 1.3×10^{-3} mm^2/s and 2.1×10^{-3} mm^2/s, respectively. The dense collagenous fiber (black arrow) was found in this pancreas cancer (right, H-E; original magnification×500).
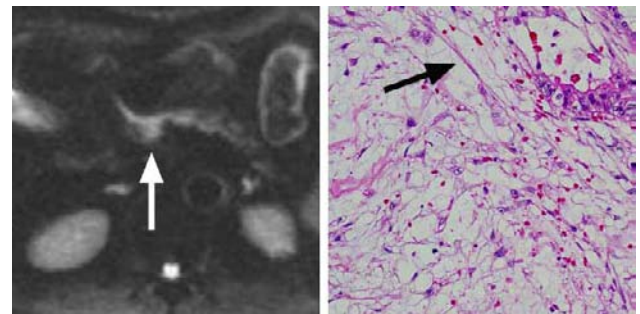

Figure 2. Representative case of pancreas head cancer (71-year-old man)   The tumor (white arrow) was demonstrated as high signal intensity on DWI (left). ADC value of this cancer and normal-appearing parenchyma were 2.3×10^{-3} mm^2/s and 1.7×10^{-3} mm^2/s, respectively. Histopathological examination revealed edematous fibrosis (black arrow) within the tumor (right, H-E; original magnification×500).

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