Diffusion-Weighted Magnetic Resonance Imaging of Healthy Pancreas: The Effect of Age on Apparent Diffusion Coefficient Values

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TARGET AUDIENCE: Researchers in the field of pancreatic MRI.

INTRODUCTION:

Several recent studies have indicated that DWI is promising in imaging pancreatic diseases.[1] ADCs in the literatures for healthy pancreas or normal pancreatic tissue with values ranging from 1.02 to 2.06×10^{-3} mm^2/s have been reported.[2-4] The wide spread in the values may be caused by different technical settings. However, as a person ages, the pancreas would show several age-related changes such as atrophy, fatty infiltration, and fibrosis, which can have significant influence on the wide spread of ADCs in the pancreas. To the best of our knowledge, studies taking into account the age differences on ADC values in healthy pancreas have not been previously reported. Thus, the purpose of this study is to characterize the ADCs with regards to the aging process in healthy pancreas.

MATERIALS AND METHODS:

A total of 559 patients without prior history related to pancreas disease or diabetes mellitus and without abnormalities of routine blood tests and MRI exams of the pancreas, were included in this study. All exams were performed on a 3.0 Tesla MRI with Breath-hold Single-shot echo-planar diffusion weighted imaging (DWI; b-value 500 s/mm^2) in single-direction sequence. Four average ADCs with the standard deviation (SD) in different ROIs from the head to tail of the pancreas were calculated. The arithmetical mean ADC of each pancreas was calculated by the four values. To confirm the generality of single-direction DWI for pancreatic imaging as compared to that of the three orthogonal directions DWI, 10 healthy control subjectswere recruited in a separate experiment to evaluate the isotropic nature of water diffusion in pancreas. Shapiro-Wilk statistics and left-sided paired t tests were used to access ADC values obtained from diffusion weighted images using one diffusion gradient direction and three orthogonal directions in 10 normal control subjects. Dependency of the mean ADCs on age/age groups was characterized using a Spearman rank-order correlation test.
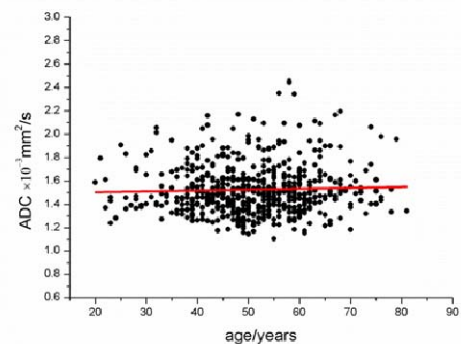

Figure 1. Linear analysis of the data of mean ADCs with ages, the equation of the line is y = 1.49 + 0.00075x.
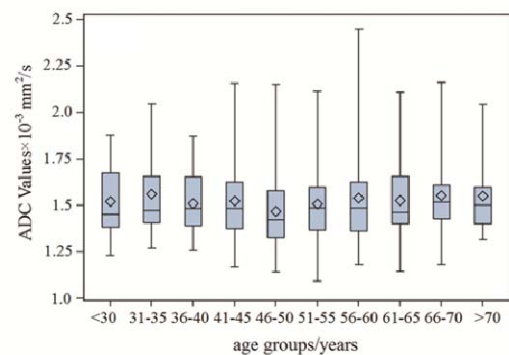

Figure 2. Mean ADC values of whole pancreas in comparison of age groups. Average, median, lower, and upper quartiles and 1.5 IQR (interquartile range) are indicated, respectively.

RESULTS:

Within the control group of 10 normal subjects, analysis of mean ADC values demonstrated that the difference in ADC values between the two DWI sequences (single-axis weighting and trace-weighting) was less than the clinical marginal value with left-sided paired t test (Student t = -2.25285, P=0.0254 < 0.05). The mean (± SD) ADCs were: $1.63 \pm 0.28 \times 10^{-3}$ mm^2/s using DWI with one diffusion gradient, and $1.64 \pm 0.26 \times 10^{-3}$ mm^2/s using trace DWI with three orthogonal diffusion gradients. The normality test of the difference in ADCs between two DWI sequences was performed with Shapiro-Wilk statistics (Shapiro-Wilk W = 0.9053, P=0.2503 > 0.1). The clinical marginal value is 0.26×10^{-3} mm^2/s which was determined by the standard deviation of ADC obtained from DWI with three orthogonal diffusion gradients. Across the age spectrum, it is shown that there is no significant correlation between the mean ADCs with age (correlation values = 0.03706, P = 0.3818>0.05) or with age groups (correlation values = 0.03048, P = 0.4721>0.05).

CONCLUSIONS:

It is worth noting that our results indicate that water diffusion in the normal pancreas is grossly isotropic. Our findings suggest that the effect of age can be excluded from the clinical diagnosis of pancreatic diseases, and that changes in ADCs are likely indicative of pancreatic pathology.

REFERENCES:

1. Wang Y, Miller FH, Chen ZE, et al. RadioGraphics 2011; 31:E47–E65. 2. Schoennagel BP, Habermann CR, Roesch M, et al. *J Magn Reson Imaging* 2011;34:861-865. 3. Yoshikawa T, Kawamitsu H, Mitchell DG, et al. *Am J Roentgenol* 2006;187:1521-1530. 4. Fukukura Y, Takumi K, Kamimura K, et al. Radiology 2012; 263:732–740.