The correlation between diffusion weighted imaging at 3.0T MR and histopathology for pancreatic ductal adenocarcinoma

Poster No.: C-0292
Congress: ECR 2015
Type: Scientific Exhibit
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Keywords: Pancreas, Abdomen, MR, Imaging sequences, Neoplasia
DOI: 10.1594/ecr2015/C-0292

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Aims and objectives

The prognosis of pancreatic ductal adenocarcinoma (PDA) shows the correlation with tumor grades of differentiation, degree of tumor fibrosis, the expression of vascular endothelial growth factor (VEGF), the expression of Ki-67 and the tumor microvessel density (MVD) [1-3]. However these indice above usually are evaluated in vitro. This study is to discuss the correlation between diffusion weighted imaging (DWI) at 3.0T MR and histopathology for PDA.
Methods and materials

2. Materials and methods

2.1 Patient population

28 PDAs were included in this study.

2.2 Magnetic Resonance Imaging

All MRI examinations were performed on a 3.0-T MRI system with a torso-phased array multicoil (Sigma HDx;GE Healthcare, Milwaukee, WI, USA). There was a fasting period of at least 6h before imaging, and no oral contrast material or antiperistaltic agents were used.

The sequences of DWI included respiratory triggered DWI(RT-DWI) and breath-hold DWI (BH-DWI), which were performed with two b values (0,500 s/mm\(^2\) and 0, 1000 s/mm\(^2\)).

2.3 Image analysis

Images were analyzed on the manufacturer’s Advantage Windows workstation (Version ADW 4.3; GE Healthcare,Milwaukee, WI, USA). All MR images were analyzed retrospectively by two experienced radiologists. When there was a discrepancy between the two radiologists' reads, the result was discussed, and a consensus reached. The pancreatic lesions were identified on the T1-/T2-weighted images and/or contrast-enhanced images. All regions of interest (ROIs) were placed within the confines of the lesions. For heterogeneous lesions, the ROIs included the solid part. Apparent diffusion coefficient (ADC) values of the lesions were assessed three times within the same area, and an average was calculated. All ROIs were first established in each lesion on the diffusion-weighted images of b=500s/mm\(^2\) RT-DWI and then copied and pasted onto other diffusion-weighted images.

2.4 Histopathology

Mean (range) interval between magnetic resonance examination and operation was 12 (range, 1-25) days. All histopathologic analysis was performed by 1 senior pathologist with 10 years of experience, who was unaware of the radiologic results. The final diagnosis, the localization and the size of the lesion and the surgical procedures were recorded for each patient.

According to magnetic resonance images, tissue sections of 5mm were cut from each block and were to assess tumor differentiation, tumor fibrosis, MVD, the expression of
VEGF and Ki67 by stained for hematoxylin-eosin (HE), anti-CD34 antibodies, anti-VEGF antibodies, and anti-Ki67 (Mib-1) antibodies (DAKO, Glostrup, Denmark).

2.5 Statistical Analysis

Statistical analysis was calculated in Statistical Package for the Social Sciences16.0 (SPSS Inc, Chicago, Ill). ADC values are shown as mean ± SD. Normal distribution was tested using Shapiro-Wilk test. Spearman correlation analysis was used to correlate the ADC value with tumor differentiation, tumor fibrosis, MVD, and the expression of tumor VEGF and Ki67. ADC values were compared among all groups of tumor differentiation and tumor fibrosis by Kruskal-Wallis H test. In 2-tailed tests, P < 0.05 was considered statistically significant.
The ADC values of PDA among different grades of differentiation did not show statistically significant difference ($P=0.528$ for RT-DWI(b500), $P=0.644$ for RT-DWI(b1000), $P=0.808$ for BH-DWI(b500), $P=0.885$ for BH-DWI(b1000))(Fig 1-3).

The ADC values of PDA among different grades of fibrosis did not show statistically significant difference ($P=0.284$ for RT-DWI(b500), $P=0.653$ for RT-DWI(b1000), $P=0.796$ for BH-DWI(b500), $P=0.286$ for BH-DWI(b1000))(Fig 1-3).

The ADC values of PDA did not show the correlation with the grades of differentiation ($P=0.266$ for RT-DWI(b500), $P=0.881$ for RT-DWI(b1000), $P=0.860$ for BH-DWI(b500), $P=0.266$ for BH-DWI(b1000)) (Fig 1-3).

The ADC values of PDA did not show the correlation with the grades of fibrosis ($P=0.838$ for RT-DWI(b500), $P=0.371$ for RT-DWI(b1000), $P=0.905$ for BH-DWI(b500), $P=0.162$ for BH-DWI(b1000)) (Fig 1-3).

The ADC values of PDA did not show the correlation with VEGF expression ($P=0.146$ for RT-DWI(b500), $P=0.174$ for RT-DWI(b1000), $P=0.324$ for BH-DWI(b500), $P=0.052$ for BH-DWI(b1000)) (Fig 1-3).

The ADC values of PDA did not show the correlation with tumor MVD ($P=0.399$ for RT-DWI(b500), $P=0.196$ for RT-DWI(b1000), $P=0.108$ for BH-DWI(b500), $P=0.078$ for BH-DWI(b1000)) (Fig 1-3).

The ADC values of PDA did not show the correlation with Ki-67 expression ($P=0.356$ for RT-DWI(b500), $P=0.332$ for RT-DWI(b1000), $P=0.280$ for BH-DWI(b500), $P=0.287$ for BH-DWI(b1000)) (Fig 1-3).
**Fig. 1:** Fig 1. A 61-year-old man with poor-differentiated PDA of the pancreatic head. The DWI (a) and ADC maps (b) of RT-DWI (b=500 s/mm²) showed the ADC value of lesion is $1309.68 \times 10^{-6} \text{mm}^2/\text{s}$, The DWI (c) and ADC maps (d) of RT-DWI (b=1000 s/mm²) showed the ADC value of lesion is $1123.55 \times 10^{-6} \text{mm}^2/\text{s}$.

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Fig. 2: Fig 2. The DWI (a) and ADC maps (b) of BH-DWI (b=500 s/mm²) showed the ADC value of lesion is 1215.11×10⁻⁶ mm²/s. The DWI (c) and ADC maps (d) of BH-DWI (b=1000 s/mm²) showed the ADC value of lesion is 1035.60×10⁻⁶ mm²/s.

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**Fig. 3:** The tumor showed a mild fibrosis (a), VEGF expression score of 3 (b), MVD of 15 (c), and Ki67 labeling score of 15% (d).

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Discussion

Though the ADC value shows the correlation with pathologic differentiation of liver cancer, cervical cancer\,[4, 5]\, the correlation by tumor fibrosis of PDA\,[6]\, a negative correlation with Ki-67 of astrocytoma and pancreatic neuroendocrine tumor \,[7, 8]\, a negative correlation with MVD of prostatic carcinoma \,[9]\, a negatively correlation with VEGF expression of esophageal squamous cell carcinoma \,[10]\, our results appeared the ADC values of PDA among different grades of differentiation and fibrosis grade did not show statistically significant difference and the ADC values of PDA did not show the correlation with the grades of differentiation, fibrosis grade, Ki-67 expression, and expression of VEGF, MVD. The reason maybe that there are many factors which can influence ADC value because the composition of PDA tissue is complex.

There are several limitations in this study. First, a small study sample was used, the further study with a larger sample size is needed. Second, only two b-values (500 and 1000 s/mm$^2$) were compared in our study, in order to restrict the total examination time. The impact of multiple b-values needs to be evaluated in further studies.

In conclusion, the ADC of PDA can not be used to reflect grades of differentiation, degree of tumor fibrosis, the expression of VEGF, the expression of Ki-67 and the tumor MVD.
Personal information

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References


