Evaluation of Liver Cirrhosis with Diffusion-weighted MR Imaging: An Experimental Study in Animal Model with Half-liver Cirrhosis

Z. Yang1, C. Zhou1, M. Chen1, W. Zhao1, W. Wang1, Y. Tan1, M. Zhang1, X. Ye1, G. Li1

1Beijing Hospital, Beijing, Beijing, China, People's Republic of

Synopsis
The purpose of this study is to investigate the mechanism of ADC value reduction in the cirrhotic liver. DWI was performed in 12 dogs with half-liver cirrhosis before and after the blood flow of both portal vein and hepatic artery was blocked. The mean ADC value in the half-liver with cirrhosis was lower than that in the half liver without cirrhosis. After block of liver blood supply, the difference of ADC value between the two half-liver disappeared. Our results indicate that the reduction of ADC value in the cirrhotic liver is mainly due to the decreased blood perfusion in the hepatic parenchyma.

Introduction
Diffusion-weighted imaging (DWI) has been the unique method to detect the Brown motion of water molecule in vivo. DWI has been recently used to improve the detection and characterization of ischemic lesions of the brain and gotten great success. To our knowledge, DWI has not show such success in the organs outside the brain. DWI has been used to evaluate liver cirrhosis in few reports, and reduction of ADC value in cirrhotic liver has been found. However, the mechanism of decreased ADC value in cirrhotic liver is unclear and controversial. This study is designed to evaluate the affection of hepatic blood perfusion on ADC value in cirrhotic liver.

Methods
With a 4F catheter, 50-100 ul carbon tetrachloride was selectively injected into right or left hepatic artery of 12 dogs fortnightly. As the times of injection increased, cirrhosis aggravated. In each dog, cirrhosis was more serious in the half liver (study side, SS) that carbon tetrachloride was injected than in the other half liver (study control side, SCS). With a SE-EPI sequence, DWI of the liver was performed the 12 dogs with half-liver cirrhosis. The b values used in this study were 1.6 sec/mm2, 16 sec/mm2 and 55 sec/mm2. Two balloon catheters were inserted into the hepatic artery and portal vein, then the blood flow of the liver was blocked, and DWI with the same parameters was repeated. ADC values of the hepatic parenchyma were measured.

Results and Discussion
No obvious reduction of ADC was found in mild cirrhotic liver ($P > 0.05$). The mean ADC value in the SS with moderately serious cirrhosis was lower than that in the SCS ($3.64 \times 10^{-3} \text{mm}^2/\text{sec}$ versus $4.89 \times 10^{-3} \text{mm}^2/\text{sec}$, $P < 0.05$). After block of liver blood supply, the ADC value decreased significantly in both the SS ($3.64 \times 10^{-3} \text{mm}^2/\text{sec}$ versus $1.76 \times 10^{-3} \text{mm}^2/\text{sec}$, $P < 0.001$) and the SCS ($4.89 \times 10^{-3} \text{mm}^2/\text{sec}$ versus $1.77 \times 10^{-3} \text{mm}^2/\text{sec}$, $P < 0.001$), and the difference of ADC value between the SS and the SCS disappeared ($1.76 \times 10^{-3} \text{mm}^2/\text{sec}$ versus $1.77 \times 10^{-3} \text{mm}^2/\text{sec}$, $P > 0.05$).

As we all know, DWI can detect the Brown motion of water molecule in vivo. However, many other factors than Brown motion of water molecule will affect the ADC value of the tissue in vivo. When small b values are used, blood perfusion will play an important role in the decay of signal intensity in the tissue on DWI. DWI has been used to evaluate liver cirrhosis. Decreased ADC value has been found and some authors believe it is the results limitation of water motion by fibrosis in the cirrhotic liver. In this study, DWI with small b values was performed in animal models with half-liver cirrhosis before and after the blood flow of both portal vein and hepatic artery was blocked. The mean ADC value in the half-liver with cirrhosis was lower than that in the half liver without cirrhosis. After block of liver blood supply, the difference of ADC value between the two half-liver disappeared. Our results indicate that the reduction of ADC value in the cirrhotic liver is mainly due to the decreased blood perfusion in the hepatic parenchyma.

References

Figure A-B. Diffusion-weighted images obtained at 24th week after the 1st injection of carbon tetrachloride into left hepatic artery. Figure A is DWI with a b value of 55 sec/mm² obtained before the hepatic perfusion is blocked. Figure B is DWI with a b value of 55 sec/mm² obtained after the hepatic perfusion is blocked. Before the hepatic perfusion is blocked, The ADC value of the SS (yellow arrow) is $3.65 \times 10^{-3} \text{mm}^2/\text{sec}$, and the ADC value of the SCS (red arrow) is $5.14 \times 10^{-3} \text{mm}^2/\text{sec}$. After the hepatic perfusion is blocked, The ADC value of the SS (yellow arrow) is $1.72 \times 10^{-3} \text{mm}^2/\text{sec}$, and the ADC value of the SCS (red arrow) is $1.69 \times 10^{-3} \text{mm}^2/\text{sec}$. 