The Influence of Blood Perfusion on Apparent Diffusion Coefficient of normal renal tissues: Evaluation with a SE-EPI DWI Sequence with Multiple b Values

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Synopsis

The aim of this study is to investigate how blood perfusion will influence the apparent diffusion coefficient (ADC) of the normal renal tissues and how to erase this influence. Diffusion-weighted imaging (DWI) with multiple b values was performed in 27 healthy volunteers. On DWI with small b values, the signal reduction of the tissues was markedly influenced by blood perfusion, and the renal tissue got incredibly high ADCs. On DWI with reasonable b values (b1 = 200 sec / mm^2, b2 = 1000 sec / mm^2), however, the influence of blood perfusion on ADCs was almost erased.

Introduction

Diffusion-weighted imaging (DWI) can detect the Brownian motion of water molecular in vivo and has been recently used to improve the detection and characterization of ischemic lesions of the brain [1]. DWI has also been used to characterize hepatic or renal lesions [2-5], and it has been noticed that perfusion will influence ADCs of normal or abnormal tissues [4,5]. However, to our knowledge, how perfusion will affect ADC of renal tissues and how to erase this influence has never been reported.

Methods

The study population included 27 healthy volunteers. MR images were obtained at a 1.5 T MR scanner (TwinSpeed Excite, GE), and a 4-channel phased array coils was used to receive MR signal. DWI was performed with a breath-hold single shot SE-EPI sequence, and 8 b values (0, 20, 50, 100, 200, 500, 800, 1000 sec / mm^2) were used in this sequence. The scanning range (7 axial slices) covered the gallbladder and the kidneys. The slice thickness was 10 mm with a gap of 5 mm. The repetition time was 1800 ms, and 2 averages and minimum TE for given b values was used. ADCs of the renal tissue and the gallbladder were measured between DWI with different b values.

Results and Discussion

The mean ADCs of the renal tissue between DWI with different b values were showed in the table 1. On DWI with small b values (b1=0 sec / mm^2, b2= 20 or 50 or 100 sec / mm^2), ADCs of the renal tissues were affected by blood perfusion, and the mean ADC was significantly higher than that on DWI with high b values (b1=200, b2=500 or 800 or 1000 sec / mm^2). When low b value (b1) was increased to 200 sec / mm^2, the mean ADCs of the renal tissues was decreased to a stable level (about 1.6×10^{-3} mm^2/sec). The mean ADC of the gallbladder was not influenced by b value. The mean ADC was 3.02×10^{-3} mm^2/sec on DWI with small b values, while it was 2.99×10^{-3} mm^2/sec on DWI with high b values.

On DWI with small b values, in addition to Brownian motion of water molecule, other facts especially blood perfusion will play an important role in the reduction of signal intensity of tissue. However, to our knowledge, how perfusion will affect ADC of renal tissues and how to erase this influence has never been reported. In this study, On DWI with small b values, the mean ADC was significantly higher than that on DWI with high b values. While the gallbladder, without blood supply in its cavity, its mean ADC did not show significant change on DWI with different b values. When low b value was increased to 200 sec / mm^2, the mean ADCs of the renal tissues was decreased to a stable level.

Our results indicate that blood perfusion will influence ADC of the renal tissue, particularly on DWI with small b values. In order to erase this influence and get relatively accurate ADCs, reasonable high b values (b1=200, b2= 800 or 1000 sec / mm^2 in this stud) should be used to perform DWI of the kidney. On the other hand, however, DWI with small b values will reflect the perfusion of the renal tissue, and provide useful functional information of the kidneys.

Table1. The mean ADCs of the renal tissue between DWI with different b values

b1	b2	Mean ADC	b1	b2	Mean ADC	b1	b2	Mean ADC	b1	b2	Mean ADC	b1	b2	Mean ADC
0	20	11.92	20	50	3.08	50	100	2.81	100	200	1.92	200	500	1.67
0	50	6.64	20	100	2.77	50	200	2.37	100	500	2.13	200	800	1.59
0	100	4.43	20	200	2.65	50	500	2.42	100	800	1.94	200	1000	1.62
0	200	3.69	20	500	2.51	50	800	2.33	100	1000	1.77			
0	500	2.74	20	800	2.11	50	1000	1.99						
0	800	2.19	20	1000	2.09									
0	1000	1.83												

Notes: 1. b1 and b2 (sec / mm); 2. mean ADC ($\times 10^{-3}$ mm^2/sec)

References

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