

Bulk motion independent analyses of water diffusion change in brain during cardiac cycle

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INTRODUCTION:

ADC value during cardiac cycle is not significantly altered with ECG triggered or non-triggered single-shot EPI [1]. Is water diffusion in the brain constant at all cardiac phases? If not, what affects it, and how does it change? The objective of our study is to precisely evaluate dynamic changes in water diffusion in the brain during cardiac cycle using ECG-triggered single-shot EPI with high temporal resolution and momentaneous data sampling.

METHODS:

On a 1.5-T MRI, multislice ECG-triggered single-shot diffusion EPI was used with sensitivity encoding and half-scan techniques to minimize the bulk motion effect such as brain pulsatile, i.e., data sampling window of approximately 3 ms. Apparent diffusion coefficient (ADC) and fractional anisotropy (FA) in the white matter zone were determined in 15 healthy volunteers, and then compared with displacement of the brain parenchyma and intracranial volume change (ICVC) [2] determined by phase contrast cine MRI during the cardiac cycle.

RESULTS AND DISCUSSION:

ADC and FA values in the cerebral white matter zone changed significantly during the cardiac cycle ($p < 0.001$) despite momentaneous data sampling. The ADC wave in the cardiac cycle was synchronized with that of the ICVC: i.e., same phase. On the other hand, the phase between FA and ICVC wave was inverted: i.e., opposed phase. Thus the ICVC affected the ADC and the FA because of the regional volume loading. However, there was no correlation between displacement of the brain parenchyma and ADC, i.e., independent of bulk motion.

CONCLUSION:

Dynamic changes of water diffusion during the cardiac cycle make it possible to assess the intracranial condition, and may be useful as new diagnostic information.

REFERENCES:

- [1]. Brockstedts S, et al, *Acta Radiologica*, 1999; 40: 263-269, (1999).
- [2]. Alperin N, et al, *Radiology*, 217: 877-885, (2000).

Table 1 Changes and relations in each value during the cardiac cycle

	Cerebral white matter zone		ICVC (ml)
	ADC ($\times 10^{-3} \text{mm}^2/\text{s}$)	FA	
1) Maximum value	0.778 ± 0.033	0.440 ± 0.039	0.482 ± 0.296
2) Minimum value	0.708 ± 0.026	0.358 ± 0.048	-0.155 ± 0.201
3) Range of change [= maximum value - minimum value]	0.070 ± 0.027	0.082 ± 0.028	0.637 ± 0.372

Data are shown as means \pm SD.

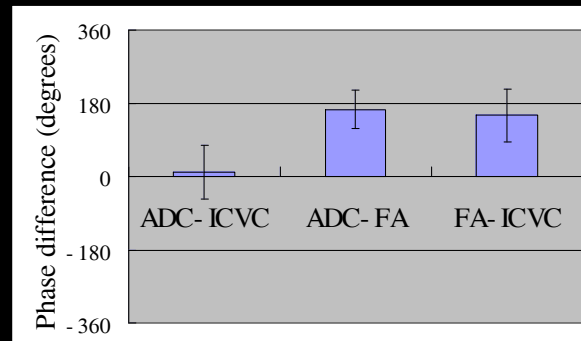


Fig. 1. Phase difference between main wave components (1st, 2nd, 3rd or 4th harmonic) of ADC, FA, and ICVC

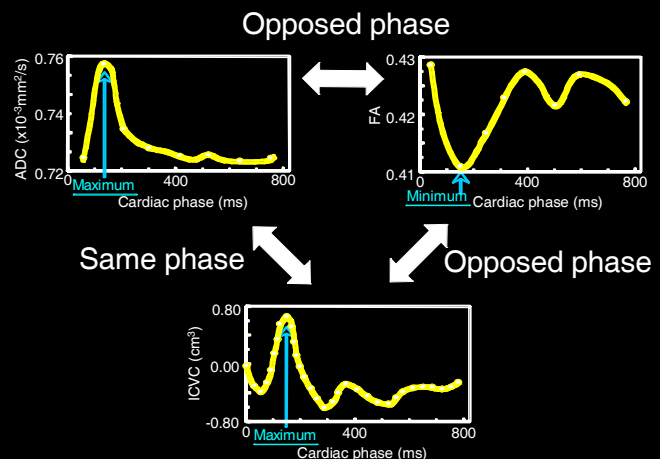


Fig. 2. An example of relationship between ADC, FA, and ICVC