

## Reproducibility improvement of ADC measurement on left lobe of liver

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**Introduction:** Body diffusion weighted image (DWI) has been proposed recently as a sensitive tumour detection method. Apparent Diffusion Constant (ADC) is promising as an index for early cancer therapy response. One of the major issues with abdominal DWI is signal loss that notably appears in the left lobe of the liver due to cardiac pulsation. Another major issue is image blur caused by respiratory motion. On conventional MR imaging, triggering techniques (cardiac or respiratory) are widely used to eliminate motion effects. However, due to severe scan time prolongation, only respiratory triggering (RT) DWI is performed in clinical studies. A recent study [1] shows that cardiac motion affects not only the left lobe but also the right lobe, which may cause artificially elevated value and poor reproducibility of the measured ADC. The purpose of this study is to demonstrate a method that compensates both respiratory and cardiac motion effects with clinically feasible scan time.

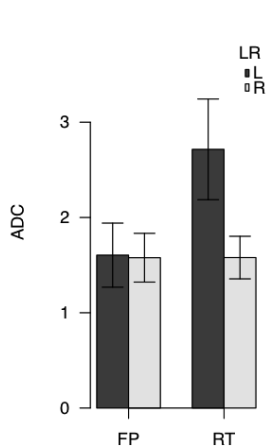
**Methods:** For above purpose, peripheral pulse unit (PPU) triggering [2] and slice tracking with respiratory navigator (RNAV) echo method [3] are implemented on a 3.0T scanner. PPU is preferred to ECG due to ease of use. After certain delay time (TD), RNAV is performed followed by two DW-SE-EPI slices. RNAV slice tracking is employed to correct location shift in free breathing scan. High SNR of 3.0T scanner allows reducing the number of acquisitions to 1. As a fat suppression method, combined method of SPIR and SSGR (Slice Selection Gradient Reversal)[4] was employed. Abdominal DWI was performed in 7 healthy volunteers on a 3.0T Philips Achieva TX system. Scan parameters were: single shot SE-EPI, thickness/gap = 5/3 mm, 20 slices, FOV 350mm, 1 NSA, 112x88 matrix, SENSE factor 2.0, TE=47.6ms, TR=10beats. PPU TD=400ms. Conventional RT-DWI was also performed for comparison. TE for RT scan =47.6ms and trigger delay = 600ms. A set of scans with two methods was repeated 5 times for all 7 subjects. ADC map was calculated from acquired DW images. 5 small ROIs were set among 5 slices in both left and right lobe of liver. Mean and SD values among 5 ROIs are measured. Left and right lobes of liver ADCs are compared for each subject and each method (PPU+RNAV, RT).

**Table 1. Mean and SD of ADC: 7 subjects x 5 repeats** (ADC unit 10<sup>-3</sup>mm<sup>2</sup>/sec)

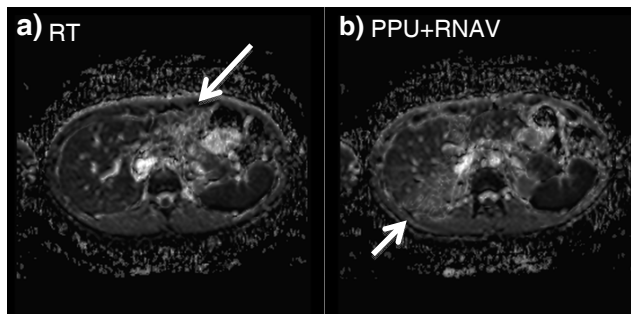
Method	Left ADC			Right ADC			L-R
	Mean	SD	p	Mean	SD	p	p
RT	2.72	0.53	7E-16	1.58	0.22	0.979	2E-15
PPU-NAV	1.60	0.34		1.58	0.34		0.708
F test		0.05	8E-14		1.31	0.43	

ADC difference between RT and PPU-NAV is significant on left lobe of liver. Left-Right ADCs are apparently equal for PPU-NAV.

**Results:** SDs of ADC for 7 subjects x 5 repeated scans are compared with F-test (Table 1-bottom row and Fig. 2). On the left lobe, variance of ADC was significantly lower with PPU+RNAV than RT (F-factor=0.05). On the right lobe, variance of ADC was larger on right lobe but statistically insignificant. Mean ADCs among 7 subjects with two methods are compared by t-test (Table 1, Fig. 1). PPU+RNAV ADCs were significantly smaller than RT ADC on the left lobe and apparently equal on right lobe. With PPU+RNAV, left and right lobes ADCs were apparently equal. With RT, left lobe ADC was significantly larger than right lobe by a factor of 1.7.



**Fig.1 Left/Right ADC**



**Fig. 2 ADC map with a) RT and b) PPU+RNAV**

High ADC value due to low signal DWI is frequently observed on the left lobe of liver with RT and occasionally appeared on posterior region of right lobe.

respect to total scan time, nominal PPU+RNAV scan time was 40sec (10beats / 60 bpm x b=0 and b=500) for 20 slices. Actual scan time was up to twice longer than nominal time. This suggests that total scan time for 30 slices to cover the whole liver would be up to 2 min, which is clinically feasible.

**Conclusion:** The Proposed method improves liver ADC measurement in clinically feasible scan time. Additional respiratory motion compensation method, e.g. breath holding, is expected to improve ADC accuracy more.

**References:** [1] T. C. Kwee, et al. (2009). *Magma* 22 (5) 319-325, [2] Ogino, T, et al. ISMRM 2011 traditional poster #839, [3] Ivancevic, M. K., et al. *JMRI* 30 (5) 1027-1033. [4] Horie, T et al. ISMRM 2009 e-poster #4035 [5] Nasu K et al. (2007) *MAGMA* 20:205-211