# Adiabatic spin locking T1rho imaging for estimation of liver function

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**Introduction** : T1rho measurement is widely applied to assess disease of cartilage, prostate, disc and liver. Studies estimating liver fibrosis[1] and liver cirrhosis[2] using T1rho have been reported. In most of these clinical studies, a block pulse is used for spin locking. However, at 3T, severe artifacts caused by spin locking due to B0 and B1 inhomogeneity are observed. Purpose of this study is to use an adiabatic spin lock pulse for homogeneous spin locking and investigate the clinical usefulness of the improved locking for liver function.

**Material and Methods** :

Sixteen patients with Child-Pugh A (age range:43-83,mean:67.1), eight patients with Child-Pugh B or C(age range:48-71,mean:55.7) and eleven volunteers(age range:25-48,mean:34.3) were scanned on a 3T clinical scanner(Achieva TX, Philips Healthcare) using multi transmit RF system and 32 channel phased-array receiver coil. The block pulse used for spin locking had a RF amplitude 11.7uT and the spin lock times(TSL) were 1,10,20 and 40msec. The adiabatic pulse used is a hyperbolic secant pulse with maximum amplitude 13.3uT and frequency sweep from -472Hz to 472Hz. TSL were 0, 27msec and 54msec(Fig.1). Scan parameters of readout sequence were: 3D-T1-TFE, TE/TR=0.98/2.1ms, $2.25 \times 2.22 \times 10$mm, FA=10, number of slice=3, shot interval=5sec, SENSE factor=2, scan time was 12sec for each TSL, with one breath hold. The T1rho map was generated on a pixel-by-pixel basis on Philips Research Integrated Development Environment (PRIDE) software written in Interactive Data Language using mono-exponential decay model: $M(TSL) = M0^*exp(-TSL/T1rho)$. For evaluation of homogeneity of the T1rho maps, the maps were scored by visual evaluation done by two MR clinical scientists with 15-16 years experience. Visual score was categorized as, 1:Poor, 2:Fair, 3:Good,4:Excellent. The actual T1rho values acquired with block pulse and adiabatic pulse locking were compared. A paired t-test was used to test the average values obtained with block and adiabatic pulse. The values of Child-Pugh A, BorC and normal were statistically compared using Kruskal-Wallis method. A p-value <0.05 was considered significant.



Fig.1 Different of spin lock pulse
a) SL by Block pulse. 90(x)-(+y)-(-y)-90(-)
b) SL by adiabatic pulse.

**Results** : Typical source images and T1rho maps are shown in Fig.2. There were artifacts on most block spin locking images (white arrow on Fig.2).The visual evaluation of the homogeneity of the T1rho maps resulted in 2.8±0.9 for block pulse locking and 3.9±0.3 for adiabatic pulse locking. Adiabatic spin locking images scored significantly higher compared to block locking (p value<0.05). T1rho value obtained by adiabatic locking was significantly higher than obtained by block locking(paired t-test, p value<0.05). T1rho values were significantly different between normal and Child-PughA, normal and Child-PughBorC using block pulse, and between normal and Child-PughBorC using adiabatic pulse (Kruskal-Wallis method, p value<0.05)(Fig.3).

**Conclusion** : Adiabatic spin locking method provided homogeneous and artifact free liver T1rho images at 3T. This is expected to be useful for robust evaluation of liver function using T1rho.
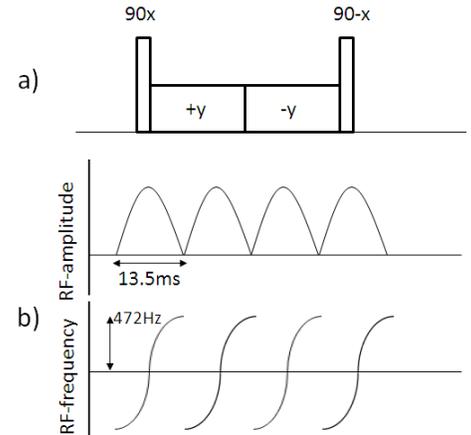
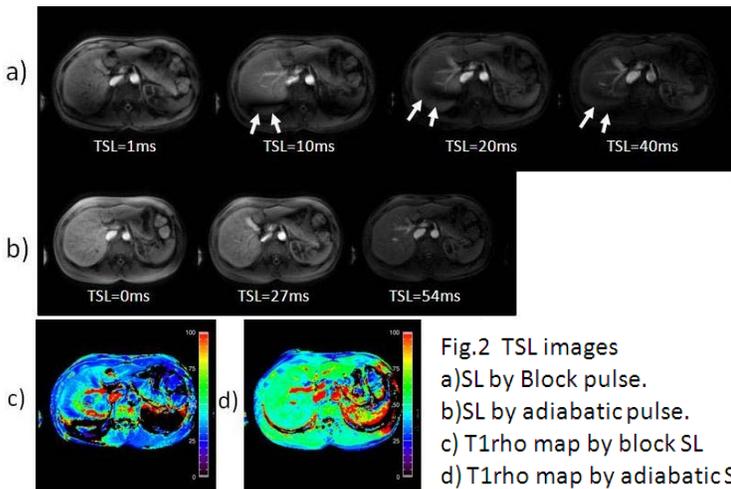**References** 1) Yi-Xiang J. Wang, et al. Radiology, 2011; 259:712-219,   2) Yi-Xiang Wang, et al. ISMRM2012,p.1289,

Fig.2 TSL images
a)SL by Block pulse.
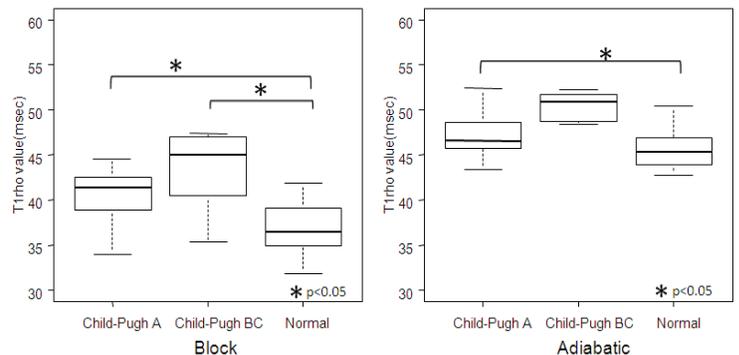b)SL by adiabatic pulse.
c) T1rho map by block SL
d) T1rho map by adiabatic SL



Fig.3 Comparison of T1rho values between block and adiabatic