Stretched type adiabatic pulse with flexible TSL setting for estimation of liver function

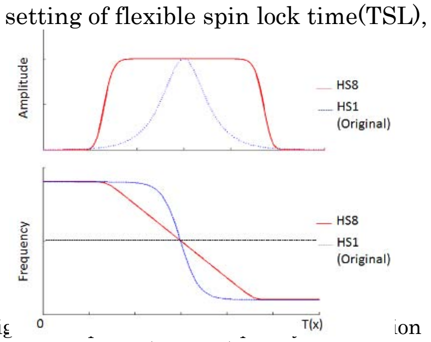
Tomoyuki Okuaki[1], Yukihisa Takayama[2], Akihiko Nishie[3], Makoto Obara[4], Tetsuo Ogino[4], Hiroshi Honda[3], and Marc Van Cauteren[1]
[1]*Philips Healthcare APAC, Tokyo, Japan,* [2]*Department of Molecular Imaging and Diagnosis, Kyushu University, Graduate School of Medical Sciences, Fukuoka, Japan,* [3]*Graduate School of Medical Sciences, Department of clinical Radiology, Kyushu University, Fukuoka, Japan,* [4]*Philips Electronics Japan, Tokyo, Japan*

Target Audience Researchers and clinicians interested in body/liver imaging and disease

Introduction: T1rho measurement is widely applied to estimate 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 a stretched type adiabatic spin lock pulse for homogeneous spin locking and setting of flexible spin lock time(TSL), moreover, to investigate the clinical usefulness of the improved locking for liver function.

Material and Methods: Stretched type adiabatic spin locking is described[3),4)] as HSn pulse, where n denotes the stretching factor. The "n" was set 8 in this study for flexible TSL setting. Fig. 1 shows the difference in amplitude and frequency modulation functions for HS8 and the original hyperbolic secant .

Thirty-three patients with Child-Pugh A (age range:40-83, mean:63.4), seven patients with Child-Pugh B or C (age range:43-74, mean:61.3) and five normal volunteers (age range:29-44, mean:34.8) were scanned on a 3T clinical scanner (Achieva TX, Philips Healthcare) using a multi transmit RF system and 32 channel phased-array receiver coil. The block pulse used for spin lock frequency offset was set as 500Hz and the TSL were 1, 20 and 40 ms. Stretched type adiabatic pulses of two different setting were used (Table 1). HS8_10 had a pulse duration of 10 ms and a maximum amplitude of 6.73 μT. HS8_5 had a pulse duration of 5 ms and a maximum amplitude of 13.48 μT. Spin lock frequency sweep of HS8_10 and HS8_5 were 636.62 Hz and 1273.2 Hz, respectively.



Fig[illegible]ion function for HS1(original) and HS8

Pulse type	Pulse duration (ms)	Frequency sweep(Hz)	B1max (μT)
HS8_10	10	636.6	6.73
HS8_5	5	1273.2	13.48

Table 1 SL amplitude and frequency of HS8_10 and HS8_5

TSL were 0, 20 and 40 ms; the same as for the block pulse. Scan parameters of readout sequence were: 3D-TFE, TE/TR=0.98/2.1ms, 2.25×2.22×10mm, FA=10, number of slice=3, shot interval=5sec, SENSE factor=2, scan time was 15sec 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 a 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 16-17 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 stretched type adiabatic pulse. The values of Child-Pugh A, B or C, and normal were statistically compared using Kruskal-Wallis method. A p-value < 0.05 was considered significant.

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 2.0±1.1 for block pulse locking, 3.8±0.2 for HS8_10 pulse locking and 3.8±0.1 for HS8_5 pulse locking. Both types of adiabatic spin locking derived maps scored significantly better than the block pulse locking derived ones (Tukey-Kramer, p value < 0.01). T1rho values were significantly different between normal and Child-Pugh B or C using block pulse, and between normal and Child-Pugh B or C using HS8-10 pulse, and between normal and Child-Pugh A, normal and Child-Pugh B or C using HS8-5 pulse (Kruskal-Wallis method, p value < 0.05)(Fig.3)

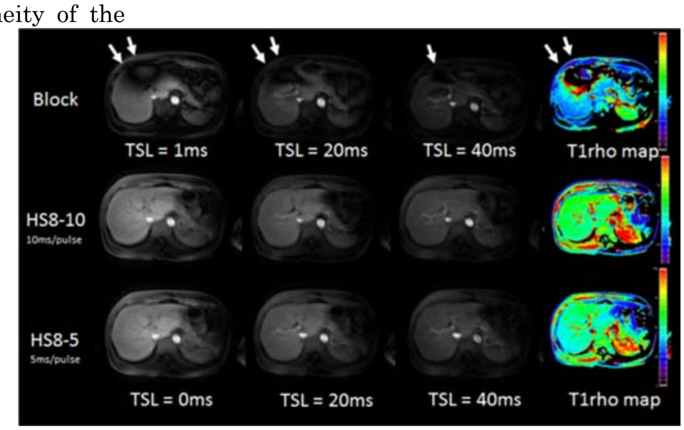


Fig.2 TSL images and T1rho maps

Conclusion: Stretched type adiabatic spin locking method provides homogeneous and artifact free liver T1rho images at 3T. Flexible TSL settings allow the generation of homogeneous T1rho maps. This is useful for robust evaluation using T1rho of liver function at 3T. This technique can be applied to other organs too.

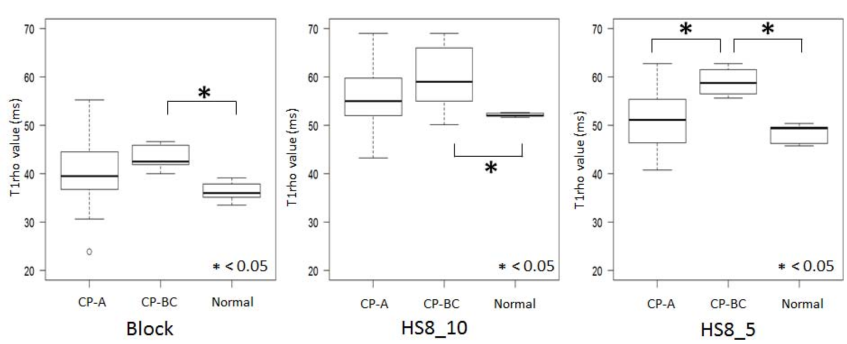


Fig.3 Comparison of T1rho values between block, HS8_10 and HS8_5

References: 1) Yi-Xiang J. Wang, et al. Radiology, 2011; 259:712-219 2) Yi-Xiang Wang, et al. ISMRM2012,p.1289 3)Tannus Alberto, Garwood Micheel, J Magn Reson A 1996;120:133-137 4) A. Sierra et al. MRM, 2008;59:1311-1319