T2-prepared TrueFISP :Application to myocardial BOLD contrast imaging

T-Y. Huang[1,2], K. K. Kwong[1], H-W. Chuang[2,3], B. P. Poncelet[1]

[1]MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, United States, [2]Department of Electrical Engineering, Taipei, Taiwan, Taiwan, [3]Dept. of Radiology, Tri-Service General Hospital, Taipei, Taiwan, Taiwan

Introduction

Recently, TrueFISP (FIESTA, Balanced FFE) sequences were used in many cardiac applications due to their sub-second scan time, high signal-to-noise ratio and inherent flow compensation[1]. **T2-prepared TrueFISP**, which combines driven equilibrium T2 magnetization preparation and ECG-triggered segmented TrueFISP, has been shown to be practical to assess myocardial T2 value change induced by BOLD effect [2] in several heart beats. In our study, ECG-triggered T2 preparation followed by continuous transient-state TrueFISP readout with particular phase-encoding order was proposed to acquire T2-weighted myocardial images **in one heart beat**. Comparison of different T2 preparation pulses was investigated.

Materials and methods

In our study, hard pulses and composite pulses were used to make a 90x-180y-90(-x) T2 preparation. For a hard-pulse preparation, all three pulses were rectangular non-selective pulses. For a composite-pulse preparation, the first 90x pulse was also a rectangular non-selective pulse. The second 180y pulse consisted of a 90x-180y-90x composite pulse and the third 90(-x) tip-up pulse consisted of a 270x-360(-x) composite pulse. The TrueFISP readout, which was a $-\alpha/2$ (α:flip angle) pulse followed by a continuos α RF pulse train with balanced gradient , was applied with linear phase-encoding and half-fourier acquisition (HF). The acquisition was done within one heart beat. This phase-encoding scheme was shown to acquire transient state signal with less image artifacts [3]. The acquisition started from the k-space center in order to have an image contrast close to the initial T2-prepared magnetization.

One healthy volunteer underwent a scan on the 1.5T system (Siemens, Sonata) using the ECG-triggered T2-prepared (TE: 16ms ,32 ms,48ms, 64ms) TrueFISP technique (TR/TE: 3.4/1.7 msec , Matrix:128x128,flip angle:70). One image without T2 preparation was also acquired. For each type of T2 preparation, 5 images with different TEs were acquired continuously with 4 seconds in-between during one breath-hold. All images were acquired during the end-systolic cardiac phase. Total scan time was ~18 seconds.

Results

The images in Fig.1 were acquired without T2 preparation (column 1) and with T2 preparation using different TEs (column 2,3, TE:32 ms, 64ms) . Upper row was acquired using a hard-pulse preparation and the lower row was acquired using a composite-pulse preparation. T2 maps (column 4) and zoomed T2 maps (colum 5) were also calculated using linear fitting pixel by pixel. Image brightness was windowed differently to have better visualization. Notice that T2 contrast varied according to TE change and flow artifacts were absent in the blood pool region. Also note that the banding artifacts, indicated by a red arrow, could be clearly seen in the image acquired using hard pulses (upper) but not in the images acquired using composite pulses (lower). Fig.2 shows myocardial signal decay according to the different TEs. The fitted T2 values are 46.50ms and 47.01ms with composite pulse and hard pulse, respectively.

Discussion and Conclusions

In this study, T2-weighted myocardial imaging was accomplished by a T2 preparation with hard pulses and composite pulses followed by HF phase-encoding TrueFISP readout. In our preliminary result, less image artifacts were found with the composite-pulse T2 preparation. T2 values measured by both preparation methods were in agreement with literature data [4]. Flow artifacts were not found in the blood pool region. The HF phasing-encoding scheme, which minimizes phase-encoding gradient jump, could suppress eddy-current induced signal oscillations [5] and thus reduce image artifact. In addition, using this scheme, data at center of k-space mainly consist of transient state signal which are close to initial longitudinal magnetization. Thus, the generated image contrast could be proton-density weighted without any preparation and T2-weighted image with T2 preparation. Using this method, T2 contrast could be acquired with relatively longer echo train and a T2-weighted image could be done in a single heart beat. Therefore, five TE-stepping images could be acquired during one breath hold (18 seconds) without prominent motion artifacts. However, long acquisition time (~200ms) limits the application to the subject with slower heart rate. Further investigation would focus on the precision of the measured T2 value and the comparison of different myocardial T2 measurement techniques.

Reference:

[1] Carr JC, et al. Radiology 2001;219:828 [2] Shea SM, ISMRM 2003 #640 [3] Huang TY, ISMRM 2003 #984 [4] Poncelet BP, ISMRM 2002 #0512 [4] Sheffler K, ISMRM 2003 #294

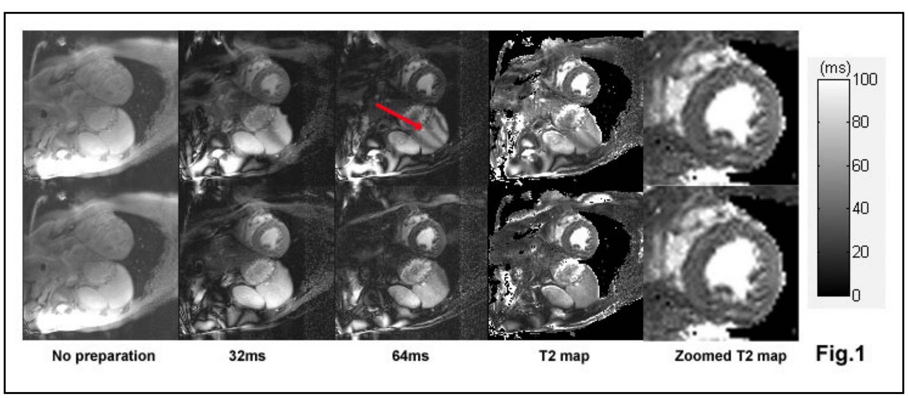

Fig.1

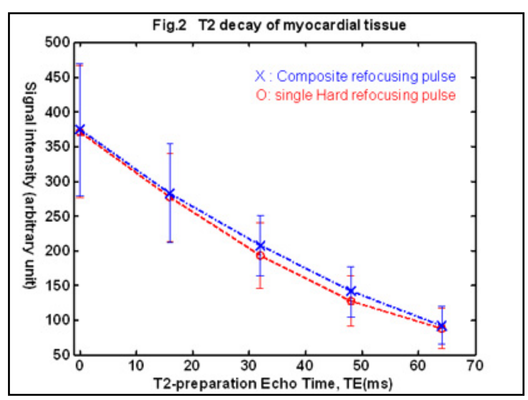

Fig.2 T2 decay of myocardial tissue