

Feasibility of T2* Estimation with Chemical Shift-Based Water-Fat Separated Cardiac Imaging

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Introduction

T2* mapping has been investigated in cardiac MRI for imaging the myocardial BOLD effect [1] and in iron overload assessment [2]. Advanced T2* estimation techniques in the context of chemical shift-based water-fat decomposition have recently been developed for iron detection in organs such as the liver, while simultaneously estimating fat content [3]. Separately, chemical shift-based water-fat decomposition techniques are being developed for cardiac MRI [4-6]. Myocardial T2* measurements that account for the effects of fat on the T2* decay curve have been described [7]. In this work, we investigate the feasibility of chemical shift-based water-fat decomposition using an advanced IDEAL T2* estimation method with fat spectral peak correction [3].

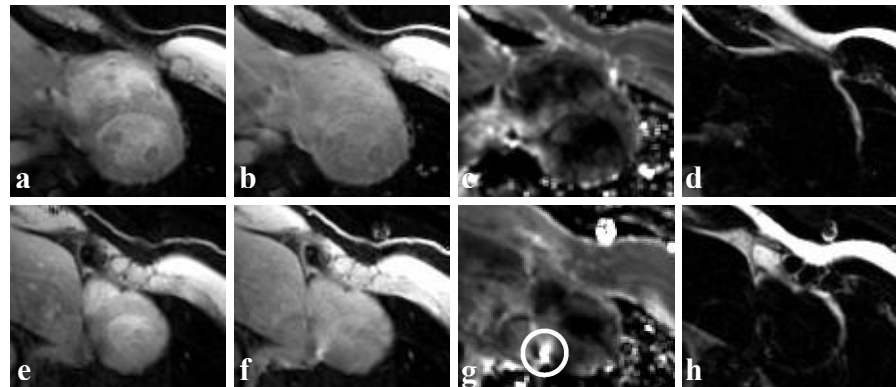
Methods

A cardiac-gated, breath-held multi-echo gradient echo sequence with 10 positive (fly-back) readout echoes was implemented at 1.5T (Signa HDx, GE Healthcare, Waukesha, WI) using an 8-channel phased array cardiac coil. Acquisition parameters included TR/TE₁/ΔTE/BW = 27.3ms/1.6ms/1.8ms/±100kHz; FOV/Matrix/Slice Thickness = 35cm/192x192/8mm; 16 views per segment; and one segment every 2 cardiac cycles, requiring 25 cardiac cycles per slice. Imaging was performed in five normal volunteers; informed consent was obtained according to a protocol approved by the local Institution Review Board. For each acquisition, three short-axis LV slices were acquired, one each at basal, mid-ventricular, and apical locations. Water- and fat-separated images were generated with an investigational version of 10-pt IDEAL algorithm [8-9], and an advanced method for simultaneous multi-spectral water-fat decomposition and T2* estimation [3] was used to generate T2*-corrected water and fat images and R2* maps on-line.

Results

Figure 1 shows mid-ventricular (Fig. 1a-d) and apical (Fig. 1e-h) slice locations in one volunteer. Conventional IDEAL images (without T2* correction), are effectively a linear combination of all 10 echo source images and show some T2* weighting (Fig. 1a,e) and superior SNR. The T2* contrast was corrected with the advanced algorithm [3] (Fig. 1b,f), with estimated R2* maps (Fig. 1c,g). Fat-only images (Fig. 1d,h) helped demonstrate the excellent water-fat separation.

Figure 1 Mid-ventricular slice (a-d), and a more apical slice (e-h) from a normal subject are shown. Water-only images not corrected for T2* (a,e) show some T2* weighting, which is subsequently corrected in multipeak T2* IDEAL (b,f). R2* maps (c,g) show an area of high R2* (g, circle) often seen in apical inferior segments. T2*-IDEAL fat images (d,h) are also shown.



R2* maps were converted to T2* maps, and regions of interest (ROI's) were drawn on 4 myocardial wall segments (septal, inferior, lateral, and anterior) in each slice with the aid of the conventional IDEAL images (Fig. 1a,e). (The basal slice on two subjects was discarded due to poor breath-holding). Estimated T2* values for each segment across all subjects is shown in Table 1; values are similar to previously published measurements that range from 26 to 40ms [7,10].

ROI \ Slice	Base	Mid-LV	Apex
Septum	45±9ms	35±6ms	43±8ms
Inferior	34±5ms	30±10ms	30±14ms
Lateral	34±2ms	52±26ms	43±7ms
Anterior	37±5ms	40±13ms	36±4ms

Table 1: Estimated T2*, averaged across subjects.

In all subjects, a region of low T2* (high R2*) was noted (e.g. circled region in Fig. 1g), an effect that has been described previously [10]. In this study, the segment in each subject with the lowest T2* was the inferior wall ROI in the apical slice in 2 subjects, and the inferior wall ROI in the mid-LV slice in 3 subjects.

Discussion

In this work, T2* estimation in cardiac MRI using a T2* corrected chemical-shift based water-fat decomposition method was demonstrated in a series of normal volunteers. Estimated T2* values were similar to previously published values, and good water-fat separation using the IDEAL method was simultaneously achieved.

References [1] Li D, *et al.*, *Magn Reson Med* **36**: 16-20 (1996). [2] Anderson LJ, *et al.*, *Eur Heart J* **22**: 2171-9 (2001). [3] Yu H, *et al.*, *Magn Reson Med* **60**: 1122-34 (2008). [4] Kellman P, *et al.*, *Magn Reson Med* **61**: 215-21 (2009). [5] Vigen KK *et al.*, *Proc. 17th ISMRM* 2775 (2009). [6] Goldfarb JW, *et al.*, *Radiology* **253**: 65-73 (2009). [7] O'Regan D, *et al.*, **18**: 800-5 (2008). [8] Reeder SB, *et al.*, *Magn Reson Med* **51**: 35-45 (2004). [9] Yu H, *et al.*, *Magn Reson Med* **54**: 1032-9 (2005). [10] Reeder SB *et al.*, *Magn Reson Med* **39**: 988-98 (1998).