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Inline non-rigid motion-corrected t2 mapping of myocardium

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Introduction

Myocardial T2 is altered in certain pathologies like acute coronary syndrome (ACS), myocarditis and allograft rejection, which have traditionally been detected using T2-weighted (T2W) techniques. These T2W techniques suffer from several drawbacks [1], most of which can be addressed by a quantitative T2 mapping approach. Single-shot T2-prepared SSFP (T2prep-SSFP) has been proposed for T2 Mapping [2]; however, image mis-registration due to failed breath-hold or inconsistent cardiac rhythm degrades the accuracy of pixel-wise curve fitting. We propose a comprehensive T2 mapping technique that includes automatic registration of T2prep images with an inline implementation to enable clinical application.

Purpose

To design and implement a rapid motion corrected inline T2 mapping technique for myocardium.

Methods

Three T2prep times were used (Table 1). The non-selective T2prep pulse combined with a fast SSFP readout makes each T2P acquisition insensitive to motion. To correct for motion between images, a fast variational non-rigid registration algorithm [3] was employed which aligned all T2prep frames to the center frame. T2 maps were then computed by fitting intensities of corrected images to the mono-exponential decay curve: Signal = M0 * exp(-T2prep/T2). Finally, color-coded T2maps were generated inline; the entire post-processing is unsupervised and typical processing time was less than 1 s.

T2 maps were acquired from a mid-ventricular short-axis (SAX) slice in each of 5 healthy subjects using breath-hold and free breathing to assess the performance of motion correction. Typical imaging parameters are listed in Table 1. Additionally, to demonstrate the ability of the technique to detect edema, T2Map, STIR and LGE images were acquired in a canine model of acute myocardial infarction (AMI) and in a patient diagnosed with ACS.

Results

T2 of normal human myocardium was measured to be 56.1 ms. T2 values did not show any significant difference with and without free breathing (p-value = 0.55). Figure 1 shows a T2 map acquired with (a) and without (b) breath-hold and after applying motion correction to free-breathing images (c). Ischemic region had a significantly higher T2 than the remote region in dog (65 vs. 46.8 ms) and in patient (69.6 vs. 48.4 ms), shown in figures 2 and 3 respectively.

Conclusion

We have demonstrated a rapid T2 Mapping technique with integrated unsupervised motion correction and inline colormap generation.

Table 1:

Imaging Parameters	
Parameter name	**Value**
Number of T2Preps	3
T2P times	0 (no prep), 24, 55 ms
Acquisition window	~ 150 ms
Total acquisition time	9 RR intervals
Acquisition mode	Single shot
Resolution	2.5 × 2.75 × 8 mm
Parallel acquisition/acceleration/reference lines	GRAPPA/2/24
Flip angle	70 degrees
Field strength	1.5 T

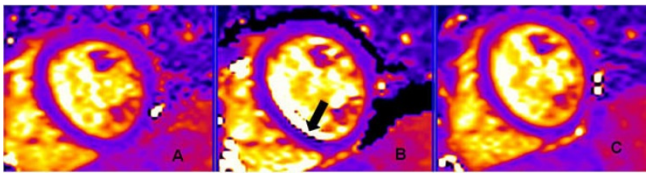

Figure 1
T2 Maps acquired with breath-hold (A), without breath-hold (B&C). The motion-correctionis applied only in C. Note the motion-related (loss of pixels) artifact in B (arrow) whereas in C, the motion correction has corrected for this.

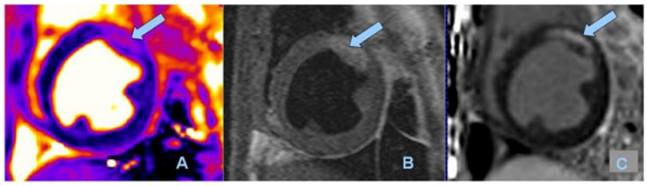

Figure 2
Canine model of AMI. T2 Map (A), Short-inversion Time Inversion Recovery (STIR) (B) and Late Gadolinium Enhancement (LGE) (C) images showing the ischemia and infarct (arrows) in the anterior region (perfusion bed of LAD).

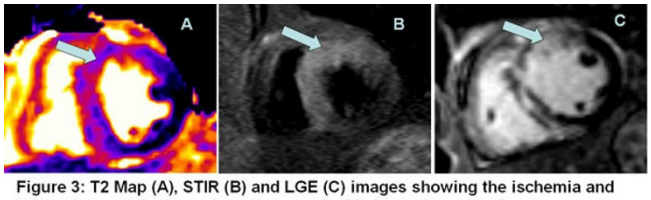

Figure 3: T2 Map (A), STIR (B) and LGE (C) images showing the ischemia and infarct (arrows) in the patient diagnosed with Acute Coronary Syndrome.

Figure 3
T2 Map (A), STIR (B) and LGE (C) images showing the ischemia and infarct (arrows in the patient dianosed with Acute Coronary Syndrom.

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