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Quantitative assessment of myocardial edema using a breath-hold T2 mapping pulse sequence

Mansi Shah, Monvadi B Srichai and Daniel Kim*

Address: New York University School of Medicine, New York, NY, USA
* Corresponding author

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Introduction

An inflammatory response to various diseases, including acute myocardial ischemia, cardiac transplantation rejection and acute myocarditis, results in water accumulation in the myocardium. Excess water accumulation results in myocardial edema, which can lead to various conditions including myocardial stiffness, diastolic dysfunction, and tissue swelling [1]. Conventional T_2-weighted (T_2w) MRI can be used to qualitatively detect myocardial edema, but often yield non-uniform signal due to surface coil effects [2]. We propose to quantitatively detect myocardial edema using a breath-hold T2 mapping pulse sequence based on multi-echo, spin-echo (ME-SE) imaging [3].

Purpose

To quantitatively assess myocardial edema using a breath-hold, ME-SE T_2 mapping pulse sequence in patients with clinical evidence of cardiac disease.

Methods

We imaged 7 female patients with various types of heart disease (see Table 1 for clinical history) on a 1.5 T MR scanner (Siemens;Avanto), using both the conventional T_2w and ME-SE T_2 mapping pulse sequences in 3 short-axis views of the heart. The relevant imaging parameters for the T_2 mapping pulse sequence are: spatial resolution = 2 mm × 2 mm × 8 mm, echo-spacing = 4.5 ms, turbo-factor = 4, number of images = 8, and breath-hold duration = 13 s.

Conventional T_2w images were qualitatively evaluated by a cardiologist for presence of myocardial edema. For the ME-SE data, myocardial contours were segmented manually using short-axis planes, and the corresponding pixel-by-pixel T_2 maps were calculated by non-linear least square fitting of the mono-exponential relaxation curve. T_2 values were averaged over the entire myocardium. The clinical reading and T_2 data analysis were performed independently.

For the ME-SE data, an upper limit cutoff T_2 value of 62.9 ms (5 standard deviations above the mean) was chosen based on prior ME-SE data obtained from a control group [3]. The accuracy of quantitative detection of myocardial edema was correlated with qualitative evaluation.

Results

Figure 1 shows T_2w images and corresponding T_2 maps from a patient diagnosed with myocardial edema compared to those from a patient without edema. Three out of seven patients were diagnosed with myocardial edema based on increased signal intensity on conventional T_2w images and based on increased T_2(Table 1).

Conclusion

This study demonstrates the feasibility of quantitatively detecting myocardial edema using a breath-hold ME-SE T_2 mapping pulse sequence. Clinical evaluation for myocardial edema is challenging with conventional T_2w imaging due to surface coil effects and lack of a normal myocardium reference signal. Future directions for this research include correlating increased T_2 values with specific cardiac conditions and evaluating the clinical utility of this quantitative technique for assessment of myocardial edema.

Table 1: Clinical history, T2 measurement, and diagnosis of myocardial edema

Patient age (years)	Disease	T2 (ms)	Diagnosis of myocardial edema (T2w/T2)
23	sarcoidosis	60.9	No/No
65	acute coronary syndrome	67.1	Yes/Yes
78	chronic coronary artery disease	56.0	No/No
62	sarcoidosis	88.1	Yes/Yes
58	sarcoidosis	57.9	No/No
69	myocarditis	71.1	Yes/Yes
21	mildly elevated troponin with normal coronary arteries	57.4	No/No

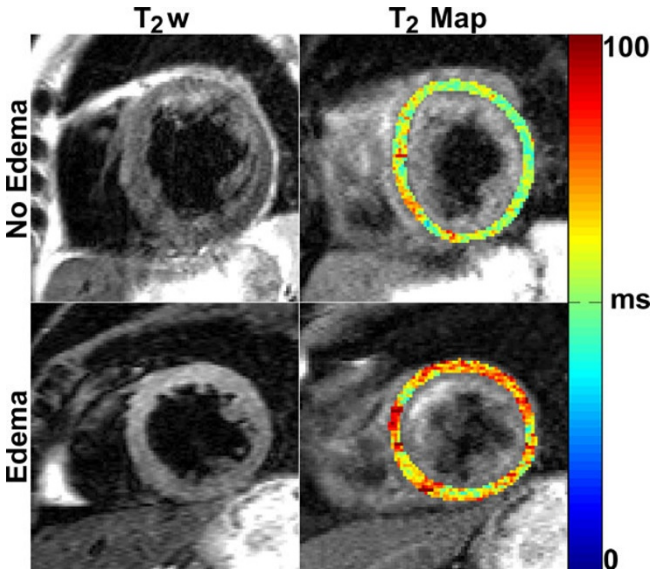

Figure 1
(Left column) T_2 w images and (right coulmn) T_2 maps: (top row) patients without edema; bottom row) patient with edema.

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