

Myocardial T1 mapping with a Saturation Recovery method using composite RF pulse - preliminary study

Kosuke Morita^{1,2}, Daisuke Utsunomiya³, Seitaro Oda³, Tomohiro Namimoto², Masanori Komi¹, Mika Kitajima², Toshinori Hirai², Masahiro Hashida¹, and Yasuyuki Yamashita²

¹Radiology, Kumamoto university hospital, Kumamoto, Kumamoto, Japan, ²Diagnostic Radiology, Faculty of Life Sciences, Kumamoto university, Kumamoto, Kumamoto, Japan, ³Diagnostic Imaging Analysis, Faculty of Life Sciences, Kumamoto university, Kumamoto, Japan

TARGET AUDIENCE Clinicians and scientists with interest in the detection of myocardial damage with no contrast agent.

INTRODUCTION

T1 mapping has garnered increasing attention as a basic tool for MR in the research and clinical settings. It holds the promise of a method for scanner independent T1 contrast, and provides useful quantitative tissue information. T1 mapping is expected to detect myocardial damage (fibrosis) in quantitative values without contrast [1,2]. Recently, several myocardial T1 mapping methods have been proposed previous studies showed the usefulness of Modified Look Locker Inversion Recovery (MOLLI) sequence, but its availability is limited in small number institutions and MRI systems [3]. Moreover, MOLLI has increased errors in estimated T1 for short T2 tissues and imperfect inversion pulses [4,5]. Therefore, we used the precise excitation RF pulse to acquire precise T1 values for myocardium. We optimized the myocardial T1 mapping technique using a composite RF pulse [6] which is widely available for usual in clinical practice. The purpose of our study was to acquire precise T1 mapping by saturation recovery (SR) with composite RF pulse for phantom and evaluate the usefulness of non-contrast T1 mapping in clinical cardiac MR.

MATERIALS and METHODS

(Phantom teen volunteers study). Eight cylindrical phantoms (T1 230 -1900 ms; T2 40 - 110 ms) were used. All studies were performed with 3.0T MR scanner (Philips, Achieva 3.0T X-series TX) and 32-channel torso cardiac coil. Reference T1 measurement was performed with single-slice Look-Locker method. scan parameters of 2D TFE using SR method with conventional and composite RF pulse were as follows: TR/TE = shortest / shortest, slices thickness = 10 mm, number of slices = 1, field-of-view = 36 × 36 cm², acquisition matrix = 128 × 128 (reconstruction matrix = 256 × 256), NSA = 1, startup echo = 50, SENSE factor = 2.0, Saturation time delay = 5000 and 500 ms, with ECG trigger and breath holding (only volunteer studies). Mean T1 values were measured in the regions of interest (ROI) on T1 maps with conventional RF pulse and composite RF pulse. A ROI of at least 80% of whole area was drawn on the center of the phantom.

(Human study) Informed consent was obtained from fifteen volunteers and amyloidosis patients and the study was approved by the ethics committee. SR method with composite RF pulse optimized by phantom study was used for volunteer- and clinical studies including 2 amyloidosis patients. or T1 mapping using the composite RF pulse, mean T1 values were measured in ROIs on T1 maps with composite RF pulse. The locations of ROIs were drawn on the anterior-, septal-, lateral-, and inferior myocardial mid wall of the LV.

Statistical analyses (paired t-test) were performed.

RESULTS

Fig. 1 shows the phantom study results. With SR method using conventional RF pulse, reference T1 value becomes higher as the standard deviation (SD) becomes higher (800 ms or more). Compared with conventional RF and composite RF pulse, the conventional RF pulse could not be excited at short saturation time delay (Fig. 1). Fig. 2 shows collations of the reference T1 value and measured T1 value with conventional or composite RF pulse. Decision coefficients with conventional RF pulse and composite RF pulse were 0.99605 and 0.99385, respectively (not significant). Fig. 3 and 4 show T1 mapping images of a volunteer and amyloidosis patient. Mean T1 values were 1354.5 ± 129.0 ms in volunteers, and 1780 ± 34.1ms in amyloidosis patients (p < 0.05).

CONCLUSION

A T1 mapping with SR method using composite RF pulse provides more accurate quantification of T1 values. It may facilitate the detection of even the smallest fibrosis with no contrast agent in cardiomyopathy patients.

REFERENCE

[1] Puntmann VO P et al., JACC 6:475-484; 2013. [2] Kellman P et al., JMRI 36:529-542; 2012. [3] Messroghli DR, et al. MRM 52:141-146; 2004. [4] Gai ND et al., MRM 69:329-336; 2013. [5] Chow K et al. ISMRM 2012. [6] Xavier G et al., MRM 53:15-21; 2005.

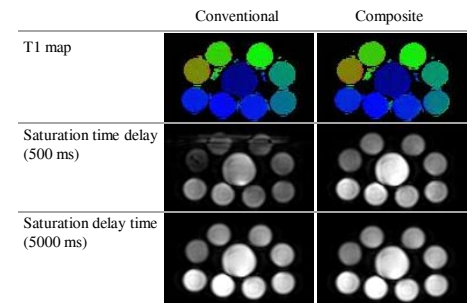


Fig. 1 Phantom images. Conventional RF pulse (left), Composite RF pulse (right).

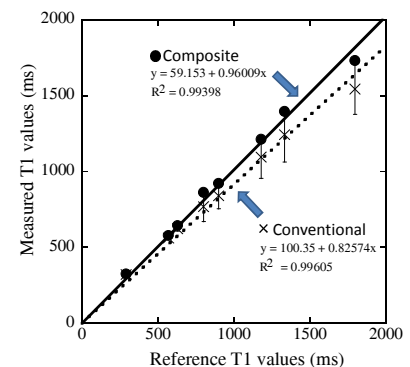


Fig. 2 Collation of reference T1 value and measured T1 value with conventional RF pulse (dot line) and composite RF pulse (solid line).

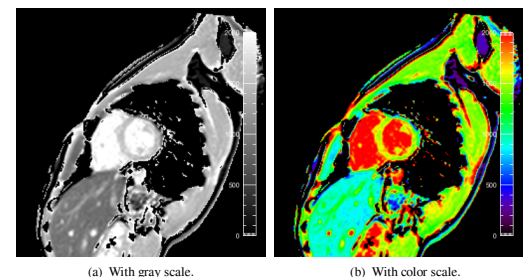
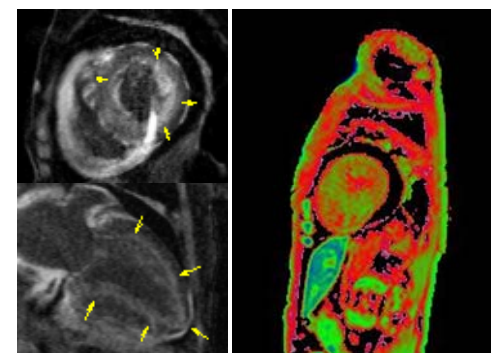


Fig. 3 Myocardial T1 mapping (a, b) for a healthy volunteer. Mean T1 value for fifty healthy volunteers was 1354.5 ± 129.0 ms (mean ± SD).



Late Gd enhancement image. Short axis image (top), Long axis image (bottom). T1 mapping with color scale. Fig. 4 A patient with myocardial amyloidosis. Late Gd enhancement image (left), T1 mapping with pre-contrast image(right).