Ultrafast Viability Imaging in Less than 10 Minutes

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Introduction

Delayed enhanced magnetic resonance imaging (DE-MRI) is increasingly being recognized as the gold standard technique for assessment of myocardial viability [1][2]. The conventional viability protocol typically involves scanning the heart from base to apex, first with segmented cine steady-state free precession (SSFP) imaging and then with segmented inversion recovery TurboFLASH (IR-TFL) post contrast injection. The entire protocol can take 30-40 minutes per patient thus limiting the patient throughput in a busy cardiac imaging practice. Acceleration strategies, such as iPAT, can now be implemented with conventional cine SSFP resulting in significant improvements in acquisition speed. Similarly, single-shot techniques such as inversion recovery TrueFISP (IR TrueFISP)[3], can be used instead of segmented IR-TFL to further reduce the scan times. By combining real-time cine SSFP with delayed enhanced IR-TrueFISP, it may be possible to drastically reduce the overall length of time it takes to carry out a viability study.

Purpose

To evaluate an ultrafast viability protocol using real time cine TrueFISP and single shot IR TrueFISP and compare it to the conventional segmented viability techniques.

Methods

22 patients with suspected myocardial scar underwent assessment of left ventricular viability on a 1.5T Siemens Avanto. Initial functional imaging of the heart was carried in the short axis plane from base to apex using segmented cine TrueFISP (TR/TE 3.0/1.5; flip angle 70^0; matrix 144 x 192; pixels 2.8 x 2.1 mm^2; 55 msec per frame. GRAPPA, with acceleration factor of 2, was used to reduce the acquisition time to 5 seconds per slice. Real-time short axis cine TrueFISP images (TR 2.3/TE 1.0; flip angle 55^0; FOV 250 x 340 mm; matrix 86 x 192; pixels 3.0x 1.6 mm^2; 65 msec per frame) were then obtained from base to apex in a single 20 second breath-hold. TSENSE, with acceleration factor of 3, was used to speed up the acquisition. Gadolinium-DTPA (0.2mmol/kg) was injected via an 18G intravenous cannula. Approximately 10 minutes post contrast injection, single-shot IR TrueFISP (TR/TE: 3.2/1.6; flip angle 55^0; TI 250-350msec; 6 mm thick slice) images were obtained in a short axis orientation from base to apex. The entire stack of images was acquired in a 20 second breath-hold. The entire left ventricle was then imaged with segmented IR TurboFLASH (TR/TE: 8.0/4.0; flip angle 25^0; TI 250-350msec). Each slice was acquired in a 10 second breath hold.

For the purposes of analysis, a 16-segment model was used according to the American Heart Association classification. 2 experienced observers evaluated each short axis image separately. For the cine images, each segment was scored for wall motion (1=normal; 2=mild/moderate hypokinesia; 3=akinesia; 4=dyskinesia) and wall thickness (1=normal; 2=thinning). For the delayed enhanced imaged, each segment was assessed for the presence of hyperenhancement and the transmural extent of myocardial enhancement was noted. The acquisition time was noted for each sequence.

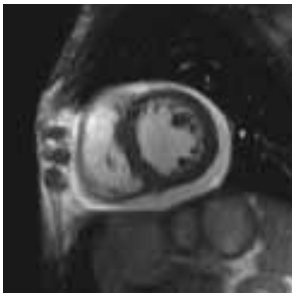

Fig 1 (a): Short axis segmented cine TrueFISP showing pericardial effusion

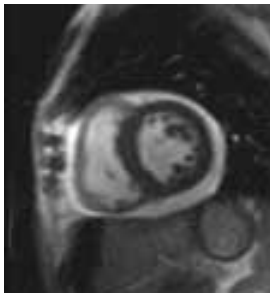

Fig 1 (b): Short axis real-time cine TrueFISP with TSENSE showing pericardial effusion

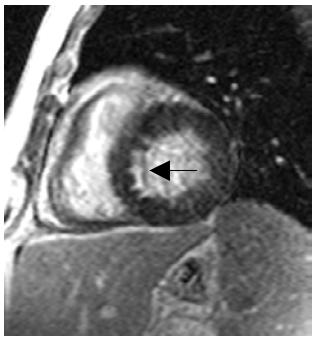

Fig 2 (a): Short axis IR TurboFLASH showing subendocardial infarct in septal wall (arrow)

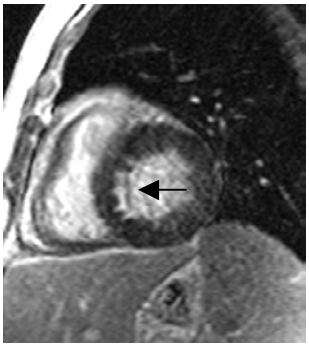

Fig 2 (b): Short axis IR TrueFISP also showing subendocardial infarct in septal wall (arrow). Conspicuity of abnormality and image quality are similar to IR TurboFLASH.

Results

The average total acquisition time for real-time cine TrueFISP (fig 1b) was 19 seconds and segmented cine TrueFISP (fig 1a) was 49 seconds. The average total acquisition time for single-shot IR TrueFISP (fig 2c) was 21 seconds and segmented IR-TFL (fig 2a) was 88 seconds. There was high correlation between real time cine TrueFISP and segmented cine TrueFISP for wall motion (r=0.82) and wall thinning (r=0.79). Single-shot IR TrueFISP identified 95% of the hyperenhancing regions detected with segmented IR TurboFLASH.

Discussion

Ultrafast viability imaging using real-time cine TrueFISP and delayed-enhanced IR TrueFISP is considerably faster than a conventional viability protocol and can produces comparable result. This strategy may have significant impact on patient workflow in a busy cardiac MRI practice.

References

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[3] Carr JC et al. ISMRM 2003