Comparison of new late enhancement MR imaging techniques for myocardial infarction lesion assessment at 1.5 T

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Introduction

Differentiation between injured non-viable from normal myocardium using the delayed enhancement technique relies on inversion-recovery (IR) gradient-echo sequences (1). Steady state free precession SSFP/TruFISP pulse sequences combined with inversion-recovery magnetization preparation and more recently phase-sensitive (2) variants of these sequences have also been proposed as alternative techniques. The goal of this study was to compare these new emerging 2D and 3D, breathold and non-breathhod techniques to the 2D IR turboFlash established one (1) and evaluate their respective theoretical, practical and clinical benefits.

Materials and methods

8 breathhold late-enhancement techniques: IR turboFlash 2D and 3D, IR trueFISP 2D and 3D, 2D phase-sensitive IR (PSIR) turboFlash and trueFISP, and singleshot (SSH) 2D trueFISP and PSIR trueFISP technique were consecutively and randomly performed in 30 CAD patients with known myocardial infarction (> 2 weeks). In addition, SSH techniques were repeated with and without breath-holding. Patients were recruited and MR imaging was performed in 3 different centers using 1.5T Sonata (40mT/m - 200mT/m/msec) or 1.5T Symphony (30mT/m - 130mT/m/msec) scanners. The FOV of all the T_1 contrast enhanced MR images varied between subjects (350-500 mm) but was similar in all techniques performed in a same patient. Late-enhancement imaging was performed at least 10 minutes after 0.2 mmol/kg injection of gadolinium chelates. Optimal nulling of normal myocardium signal was achieved using IR trueFISP TI (inversion time) scouting sequence. Qualitative assessment was performed by 3 observers. Quantitative assessment was based on percent signal intensity elevation between injured and normal myocardium and CNR measurements. An additional phantom study with various Gd concentrations and using the same coils configuration as used in the patient study was designed to quantitatively compare all sequences performances.

Results

Image quality of IR turboFlash 3D images appeared superior to other 2D/3D sequences with a better delineation of complex or non-transmural lesions with a significantly higher %SI elevation and CNR ($p<0.05$). CNR ratios were lower with the Truefisp sequences than with the TurboFlash sequences, probably due to the higher bandwidth used in the sequences (2D TurboFlash BW=135 Hz/pixel, 2D TurboFlash BW=355 Hz/pixel, 2D/3D TrueFISP BW=955Hz/pixel). PSIR techniques may be limited in differentiating sub-endocardial lesions and intracavitary blood pool. Singleshot trueFISP appears a valuable alternative technique when breathholding cannot be achieved.

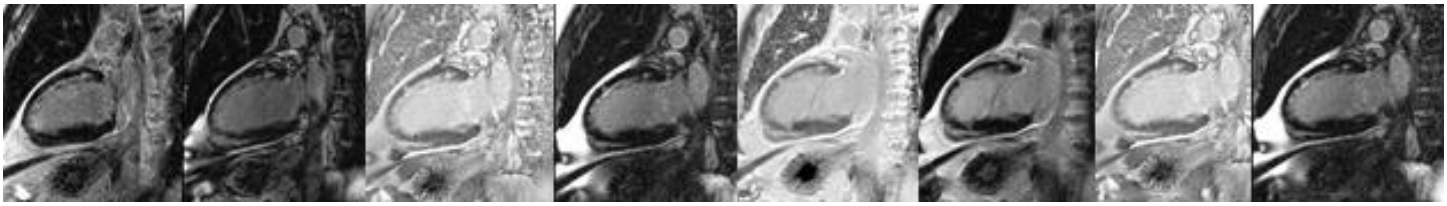

Figure: Comparison of the different IR sequences in a patient with a subendocardial anterior wall myocardial infarction (2 chamber LA view): turboFlash 3D, TrueFISP 3D, PSIR TrueFISP 2D, TrueFISP 2D, PSIR turboFlash 2D, turboFlash 2D, SSH PSIR TrueFISP 2D, and SSH TrueFISP 2D sequences (from left to right)

Discussion

The best compromise for image quality and SNR was achieved with IR turboFlash 3D sequences. As expected, the inherent advantage of a 3D approach in term of SNR gain allowed for a better characterization of lesions due to the high intrinsic contrast between injured and normal myocardium. 3D techniques provide extensive coverage of the myocardium that seems to be of particular interest for small lesions screening or lesions limited to the sub-endocardium. Their drawback as well as for non-PSIR techniques remains an optimal nulling of the normal myocardium that can be properly achieved with TI scouting sequences.

References

(1)Simonetti et al. Radiology 2001;218:215-223; (2) Kellman et al. MRM 2002;47:372