Assessment of Left Ventricular Volume and Mass at 3.0T using SSFP and FLASH Cine Imaging

N. Woodhouse[1], D. Hagger[1], and J. M. Wild[1]
[1]Academic Radiology, University of Sheffield, Sheffield, South Yorkshire, United Kingdom

Introduction: SSFP sequences have become the accepted standard for cine imaging of cardiac function at 1.5 T. Recent work at 3T suggested SSFP offers increased contrast to noise ratio (CNR) over spoiled gradient echo methods (FLASH) [1] and that the related off-resonance artefacts were tolerable despite the higher B_0.The purpose of this work was to investigate left ventricle (LV) mass and volume measurements at 3.0T in healthy volunteers using SSFP and FLASH sequences in the short axis plane.
Materials and Methods:6 healthy volunteers (3 male, 3 Female , median age 24) were scanned on a 3.0T whole body MRI system (Achieva, Philips, Best, Netherlands) using a flexible two part 4 channel SENSE body coil. SSFP and FLASH cine scans were acquired in the short axis plane after first localizing in the vertical and horizontal long axes. Slice geometry was identical for both sequences: FOV 320 x 320 cm, reconstruction matrix 256 x 256, 15 slices, thickness 7mm, SENSE acceleration 1.5, a volume localized shim was placed over the heart for both sequences.
SSFP parameters: TR 3.8ms, TE 1.92ms, flip angle 45^o, 1 NEX. Acquisition time 14sec breath hold for 2 slices (30 phases).
FLASH parameters: TR 5.6ms, TE 3.3ms, flip angle 20^o, 1 NEX. Acquisition time 14sec breath hold for 1 slice (26 phases).
Image analysis: LV volumes and mass were calculated using MASS software (Medis, Leiden, Netherlands), CNR and SNR evaluation was performed using a VIA 5.0 workstation (Philips, Best, Netherlands).
Results: Both examinations were tolerated well by all subjects. Both sequences exhibited some magnetic susceptibility artefact present in the left ventricular myocardium; the SSFP images were significantly more affected by the characteristic banding artefact with 75% of end diastolic (ED) and 72% of end systolic (ES) images exhibiting some artefact within the left ventricle, compared to 27% of ED and 28% of ES images having artefact present when the FLASH sequence was used. The most severe artefacts were seen at the interface between the LV, lung and liver (figure 1). This occurred in all subjects.

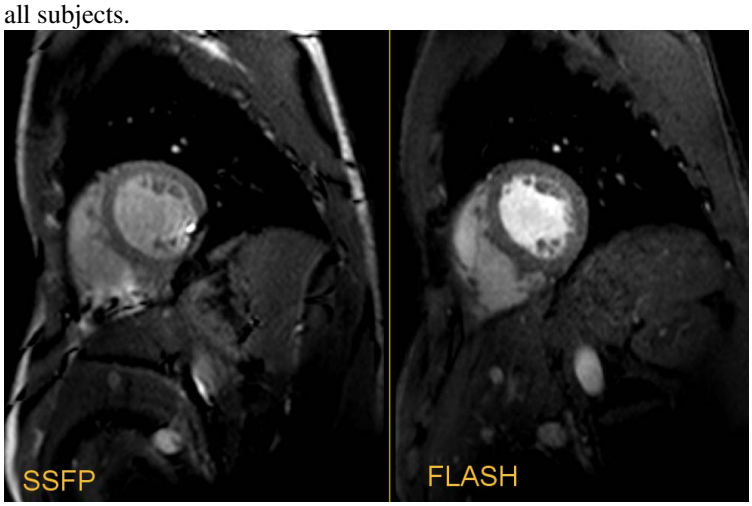

Figure 1. Mid ventricular short axis slice (subject 2). Magnetic susceptibility banding artefact in LV myocardium is seen adjacent to junction between LV, lung, liver and spleen in SSFP image. The artefact is not present in the FLASH image.

When ventricular masses were calculated, the FLASH sequence systematically gave a higher ED mass by a mean of 4g 95% C.I. (3, 6) p=0.003 and higher ES mass by a mean of 11g 95% C.I. (5, 17) p=0.015 when compared to the SSFP sequence. There was also a significant difference between LV volumes; the FLASH sequence systematically underestimating ED volume by a mean of 15ml 95% C.I. (10, 20) p=0.001 and ES volume by a mean of 9ml 95% C.I. (5, 13) p=0.005 when compared to SSFP. The contrast to noise ratio between myocardium and blood was significantly higher at ED (1.02) for the SSFP sequence when compared to the FLASH (CNR= 0.55) p=0.05. At ES the CNR for SSFP (0.78) was still higher than FLASH (0.47) but not significantly so p=0.08.
Discussion:
Both sequences produced diagnostic scans that were able to be reliably segmented in order to evaluate cardiac function. However the SSFP images were considerably more affected by magnetic susceptibility artefact than the FLASH and were more time consuming to visually assess even though the CNR was significantly higher. Each sequence produced significantly different results for both mass and volume and this should be borne in mind when comparing future studies at this field strength. In conclusion the FLASH sequence appears more robust for the assessment of mass and volume at 3.0T,
References [1] J Cardiovasc Magn Reson. 2006;8(5):709-15.