Three Dimensional Phase Sensitive Inversion Recovery (PSIR) Turbo FLASH for Evaluation of Left Ventricular Myocardial lesions in infiltrative and non-ischemic cardiac diseases

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***INTRODUCTION*:**

Infiltrative myocardial disease (sarcoidosis, amyloid, hypertrophic cardiomyopathy) and non-ischemic inflammatory cardiomyopathy (myocarditis) demonstrate atypical patterns of enhancement on LGE-cMRI, in that they are typically not related to a coronary artery territory and often show a diffuse or patchy hyperenhanced pattern throughout the myocardium [1]. Such hyperenhanced lesions may be missed by conventional 2D imaging due to non-contiguous slices and limited slice coverage. A 3D approach could be more effective for assessing hyperenhanced lesions due to the complete coverage of the left ventricle (LV) with isotropic spatial resolution. The purpose of this study was to compare a navigator gated free breathing 3D Phase Sensitive Inversion Recovery (PSIR) TurboFLASH [2] to an established 2D PSIR turboFLASH method for detecting myocardial hyperenhanced lesions caused by non-ischemic cardiomyopathy.

MATERIALS AND METHODS:

Under an IRB approved protocol, 19 patients with suspected infiltrative myocardial heart disease and cardiomyopathy [hypertrophic cardiomyopathy (HCM) n= 5, sarcoidosis n= 4, and myocarditis, n=8, amyloid, n=1] were examined on a 1.5T MR scanner (MAGNETOM Avanto, Siemens AG, Erlangen, Germany) were evaluated. The protocol consisted of segmented cine SSFP and delayed enhanced imaging. Delayed images were acquired ten minutes after the administration of contrast agent [0.2 mmol/kg Gadolinium-DTPA (Magnevist, Schering AG, Berlin, Germany)] using a segmented 2D PSIR TurboFLASH sequence followed by a navigator-gated 3D PSIR TurboFLASH sequence [3]. Segmented 2D PSIR TurboFLASH paremeters were: TR/TE: 205/3.2 msec, TI: 270 msec, flip angle: 25°, FOV: 380 x 309 mm^2, matrix: 156 x 256, pixel size 2.0 x 1.5 mm^2; slice thickness of 6 mm, bandwidth of 600 Hz per pixel, GRAPPA acceleration factor of 2, k-lines per segment = 25 and for free breathing 3D PSIR parameters were: TE = 1.6 ms, TR = 3.7 ms, TI: 300 msec, flip angle =20°, near isotropic voxels of 1.9 x 1.9 x 2.0 mm acquisition of 40 *k*-space lines per heartbeat, bandwidth of 500 Hz/pixel with GRAPPA acceleration factor of 2. Quantitative evaluation was carried out by measuring the volume of hyperenhaced lesions for both techniques using scar quantification software -VPT (Viability Processing Toolkit, Siemens Corporate Research, Princeton, NJ) that considered areas with 6 standard deviations above the normal myocardial signal intensity as abnormal. Images were assessed qualitatively by 2 reviewers using the AHA 17-segment model. Image quality was scored using a four point Likert scale (0-poor, non-diagnostic; 1-fair, diagnostic maybe be impaired; 2-good with some artifacts and 3-excellent without artifacts). The total number of lesions per segment was counted. Transmural extent of lesions (subepicardial, midmyocardium, subendocardium) and area per segment were also evaluated. Student t test was used to compare both methods.

Sequence	2D PSIR	3D PSIR	P value
Mean mass of scar volume (grams)	29.70	46.25	0.003
Total number of scar	64	79	-

***Table 1**: comparison between scar volumes calculated with VPT tool. The mean scar volume was significant higher during the 3D PSIR images.*

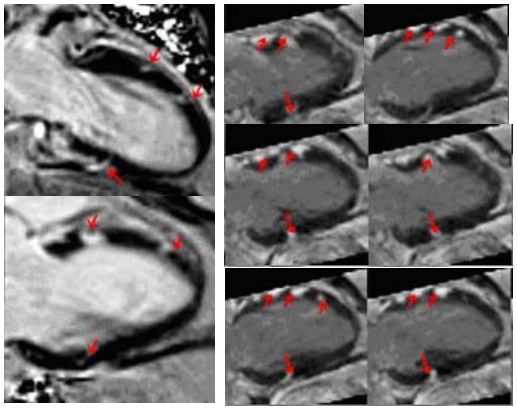
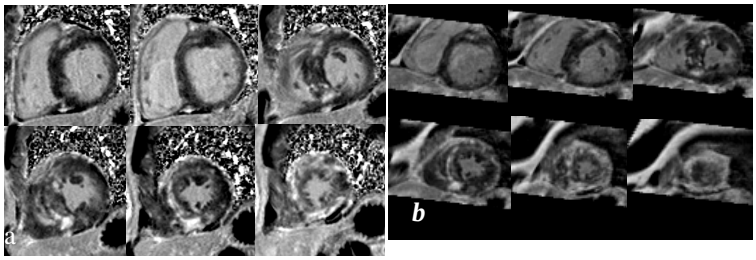


***Figure 1:** 55 years-old male with sarcoidosis 2D PSIR images (left row) and reformatted 3D PSIR images (right row) that demonstrated more lesions with the myocardium.*



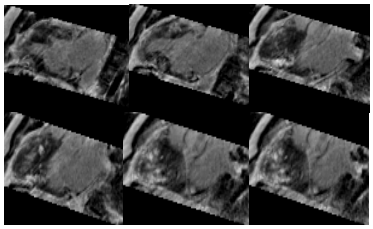


***Figure 2**: 37 years-old male with hypertrophic cardiomyopathy 2D PSIR images (2a) and reformatted 3D PSIR images (2b) that demonstrated asymmetrical left ventricular hypertrophy and multiple scattered hypernhanced lesions that can be better appreciated on 3D PSIR reformatted images.*

RESULTS: Average total scan time for the 19 patients was 7:44 minutes for a stack of 2D PSIR images and 6:19 minutes for 3D PSIR, respectively. The mean navigator efficiency was 58%. Image quality score 2.0 for 2D PSIR and 2.5 for 3D PSIR and did not differ significantly ($p<0.05$) for both techniques. The total number of hyperenhanced regions detected using 3D PSIR was larger than at 2D PSIR (Table 1 and Figures 1, 2). Qualitative analysis of area of lesions (p= 0.35) and location (p= 0.94) were similar for both techniques. Quantitative analysis with VPT tool did find significant difference between the scar volumes between the sequences (p=0.003) Table1.

CONCLUSION: Free breathing 3D PSIR viability imaging detects more scars than conventional 2D imaging for assessment of infiltrative cardiomyopathies. Preliminary results suggest that the 3D approach may be the method of choice for LGE CMRI in this clinical setting due to its complete isotropic coverage of the LV and improved detection of smaller lesions compared to 2D imaging.

References:

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