Assessment of Pericardial Enhancement in Pericarditis with a Novel Fat-Water Separated 3D Dixon Delayed Enhancement Pulse Sequence

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Introduction: Pericardial enhancement has been correlated with pathologic evidence of inflammation, and therefore MRI delayed enhancement (DE) techniques should be useful for identifying patients with pericarditis as well as assessing therapeutic response. Standard 2D Fast Gradient Echo (FGRE) delayed enhancement pulse sequences performed without fat suppression can be problematic for delineation of pericardial enhancement in the presence of prominent epicardial fat. We investigated the use of a novel breath-held 3D Dixon fat-water separated delayed enhancement pulse sequence in 21 patients with known or suspected pericarditis and compared the results with conventional, non fat-saturated 2D delayed enhancement imaging.

Methods: A novel k-space segmentation scheme was employed to enable breath-hold imaging as well as for optimal IR contrast. Ky-Kz space was segmented into radial sectors. Each sector was sorted in increasing k_r and obtained in an R-R interval. An ECG gated 3D dual-echo bipolar-readout DE pulse sequence generated in-phase and opposed phase images which were then processed using a robust Dixon separation algorithm to yield fat and water volumes. A high receiver bandwidth ($\pm$ 125 KHz) enabled optimal placement of the opposed-phase and in-phase echoes at 2.4/4.8 ms at 1.5T, achieving compact TRs and reducing the overall acquisition time. Imaging parameters were as follows: 2D DE sequence: 15° flip, $\pm$32 kHz bandwidth, TR/TE 4.5/4.8 ms, 256x160 matrix, 35-38 cm FOV, 8 mm thickness, TI 200-250 ms; 3D BH Dixon DE sequence: 12-15° flip, $\pm$125 kHz bandwidth, TR/TE_1/TE_2 6.6/2.4/4.8 ms, TI 200-250 ms, 256x128 matrix, 35-38 cm FOV, 16 sections of 4-5 mm thickness.
21 patients with known or suspected pericarditis undergoing clinical cardiac MRI exams had 3D Dixon DE and conventional 2D DE images obtained in the same (either short axis or axial) orientation 7-15 minutes following administration of 0.2mM/kg gadolinium contrast. DE images were assessed for pericardial visualization, confidence in the presence or absence of pericardial enhancement, overall image quality, and image artifact on a scale of 1 (poor) to 5 (ideal). The quality of fat suppression was also rated on 3D Dixon DE images. Statistical comparisons were performed using the paired t-test.

Results: Pericardial enhancement was present in 17/21 patients. Pericardial thickening was noted in 12 patients, with mean pericardial thickness 3.3mm (2.0 – 4.6mm). Image scores are shown in the table below. Ratings for pericardial visualization and confidence in the presence or absence of pericardial DE were significantly higher for the Dixon DE sequence (p<.05)

	3D Dixon DE	Conventional 2D DE
Pericardial visualization	4.2*	3.6
Confidence in pericardial DE	4.6*	4.0
Image quality	3.9	4.0
Artifacts	3.8	4.0
Fat suppression	4.5	

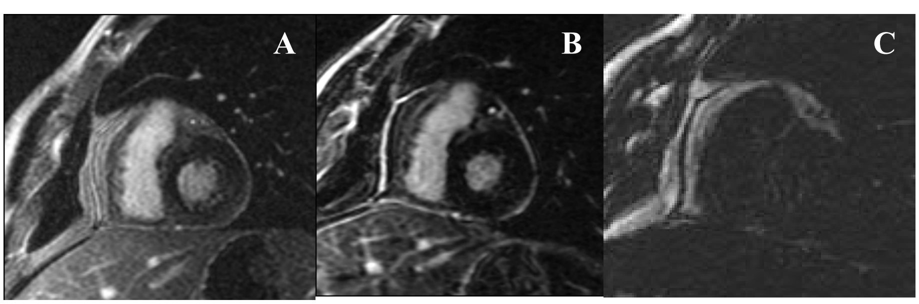

Fig. 1. A: 2D DE image without fat suppression illustrates difficulty in visualizing the anterior pericardium. B: Water image from 3D Dixon DE at the same location demonstrating excellent fat suppression and improved visualization of pericardial enhancement. C: Fat image from 3D Dixon DE confirming location of pericardium within the epicardial fat.

Conclusions: The proposed 3D Dixon DE technique provides robust fat suppression and reliable image quality which aids in detection of pericardial enhancement. Fat suppression was good-excellent in all patients, including those with sternotomy wires. This pulse sequence may have clinical utility for assessment of patients with pericarditis. Current limitations of the 3D Dixon DE technique include a relatively long breath hold for complete coverage of the myocardium or pericardium (typically 25 seconds) which could be alleviated using navigator gating or respiratory triggering.