Imaging of the Right Ventricular Wall at 3T in suspected ARVD: Black-blood Proton density and T1-w imaging both with and without fat-saturation compared with multi-echo Dixon technique

C. Daly[1], T. Osuntokun[1], M. Knox[1], D. Ward[1], R. Murphy[1], R. Dunne[1], P. Beddy[1], J. F. Meaney[1], G. Boyle[1,2], M. Clemence[3], and A. J. Fagan[1,2]
[1]Centre for Advanced Medical Imaging, St. James's Hospital / Trinity College, Dublin, Ireland, [2]School of Medicine, Trinity College University of Dublin, Ireland,
[3]Philips Healthcare, Reigate, United Kingdom

INTRODUCTION: Fibrofatty infiltration of the myocardium is a feature of Arrhythmogenic Right Ventricular Dysplasia (ARVD) which until recently could only be diagnosed by biopsy. Cardiac Magnetic Resonance offers comprehensive depiction of the anatomy and function of the right ventricle, and characterisation of fat within the wall. RV wall depiction is well established at 1.5T, however, many challenges must be overcome for high quality diagnostic imaging at 3T. In order to determine the optimal protocol at 3T for ARVD assessment we evaluated the image quality for depiction of the RV wall using proton density and T_1-weighted imaging both with and without fat saturation imaging.

METHODS: 20 patients with suspected ARVD were scanned at 3.0 T (Philips Achieva, Philips Medical Systems, Best, NL). A 6-channel SENSE cardiac array coil was used for signal reception. 12-14 images were acquired in the axial plane from base to RVOT, black blood spin-echo images were acquired with and without fat saturation. Four non-contiguous images spanning the extent of the RV wall from base to RVOT were graded on a standard visual analog scale (1 = non-diagnostic, 2 = poor quality (minimal diagnostic value), 3 = satisfactory, 4 = good, 5 = excellent) at the same location for all sequences. Criteria applied were absence of motion artefact, clarity of interface between the ventricular blood and endocardial surface, and between the epicardial fat and outer surface of RV. The scan parameters are given in Table 1.

Table 1: Scan parameters

sequence	PD Black Blood	T1 TSE Black Blood	Dixon – TFE MultiEcho T_2*
TR / TE [ms]	2000 / 11	1000 / 5.4	6.7 / 2.4
Flip angle [°]	90	90	25
Time per breath-hold	14s	12s	20s
Total acquisition time (not including time between BHs)	3:16min	2:48min	4:40min
Acq Voxel Resolution [mm]	1.5 x 1.6 x 4 mm	1.5 x 1.6 x 4 mm	1.5 x 1.5 x 4 mm
Reco Voxel Resolution [mm]	0.8 x 0.8 x 4 mm	0.7 x 0.7 x 4 mm	0.65 x 0.65 x 4 mm
Number of slices / gap between slices	14 / 2mm	14 / 2mm	14 / 2mm
Turbo factor	11	11	5
Fat Suppression	SPAIR, 90ms inversion delay	No	No
SENSE factor	-	1.3	2
			ΔTE = 0.8 ms, 4 echoes acquired

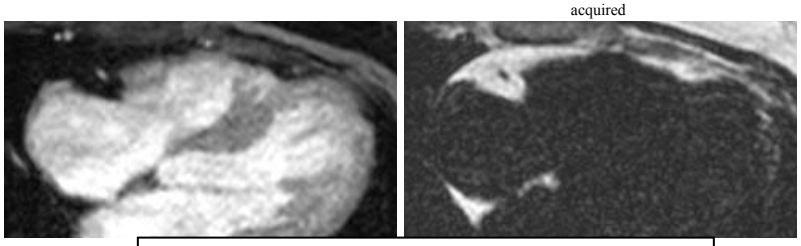

Fig. 2: Dixon Imaging: Magnified view of RV wall

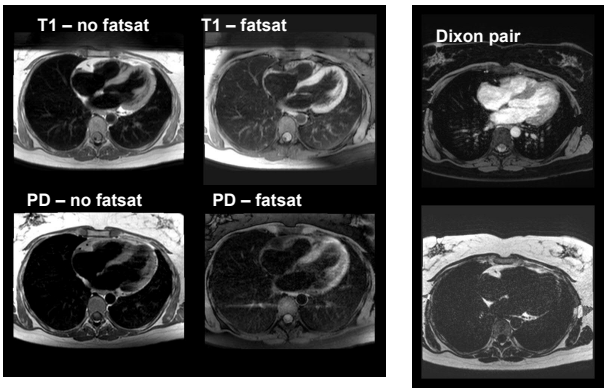

Fig. 1: Representative example through mid RV

RESULTS: All patients completed the study. Overall there was excellent visualisation of the RV free wall on all pulse sequences with minimum of artefacts. Average scores are given in Table 2. Spin-echo images gave better anatomic definition of the myocardium; however, the high signal intensity of fat against its complete elimination of the paired Dixon images allowed the reader to evaluate fat within and around the RV wall with a high degree of confidence. Higher scores with fewer low scores were consistently recorded for PD fat-sat images and Dixon technique.

Table 2: Individual scores for 5 approaches

T1 No Fat-sat	T1 Fat-sat	PD No Fat-sat	PD Fat-sat	Dixon
3.4	3.75	3.5	4.25	4.65

DISCUSSION: Diagnosis of ARVD with CMR relies heavily on accurate definition of the RV wall and confident demonstration of fatty infiltration of the myocardium. We have shown that RV wall imaging can be achieved at 3.0T without significant artefact. Conventional T_1 and PD approaches with and without Fat-saturation are highly effective and give excellent depiction at 3T with minimal artefacts.

CONCLUSIONS: The Dixon technique is ideally suited for imaging of the RV wall in patients with suspected ARVD. It offers a useful adjunct to conventional T_1- and PD spin-echo imaging. The clear artefact free fat signal and fat suppression offered by this technique suggests a role in clarifying intramyocardial fat in suspected ARVD.

ACKNOWLEDGEMENTS: The work was financially supported by an institutional grant from the Health Research Board (HRB) Ireland to the Centre for Advanced Medical Imaging (CAMI), Dublin.

REFERENCES:

1. Role of cardiovascular magnetic resonance imaging in arrhythmogenic right ventricular dysplasia. Jain A, Tandri H, Calkins H, Bluemke DA. J Cardiovasc Magn Reson. 2008 Jun 20;10:32. Review.
2. Arrhythmogenic right ventricular dysplasia/cardiomyopathy diagnostic task force criteria: impact of new task force criteria. Cox MG, van der Smagt JJ, Noorman M, Wiesfeld AC, Volders PG, van Langen IM, Atsma DE, Dooijes D, Houweling AC, Loh P, Jordaens L, Arens Y, Cramer MJ, Doevendans PA, van Tintelen JP, Wilde AA, Hauer RN. Circ Arrhythm Electrophysiol. 2010 Apr 1;3(2):126-33.