Efficacy of MR Indicators for Cardiac Resynchronization Therapy (CRT)

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Introduction: Cardiac resynchronization therapy (CRT) for treatment of resistant dilated cardiomyopathy (DCM) with disconjugate cardiac contractility (DCC) defined indirectly by ECG (qrs>130ms), is beneficial in 68% but ineffective in 32% of patients.[1] Directly demonstrating DCC before treatment might improve outcome.[2] MR is superior to echo in observing DCC and offers several means for its accurate quantitation.[3] We evaluated three quantitative MR measures of DCC, asymmetery (I_s), asynchrony (I_a), and circumferential strain (ECC), with the principal aim of generating a robust numerical DCC index for use in future trials of CRT.

Methods and Patients: Standard cardiac MRI acquired on a 1.5T (GE LX 9.0) clinical MR scanner were analyzed by MASS (Medis Inc) and HARP (Diagnosoft Inc.). Figure 1 illustrates the principal indices of wall thickness (mm), mean maximum and minimum thickening (Δ) and asymmetry ($\Delta\Delta$), DCC indices $I_a\%= (\Delta\Delta/\Delta)x100$; $I_a=\%\Delta\Delta/\Delta_{min}$ and asynchrony (A_s=peak Δ 1-2ms). I_s was determined from the spread of phases over which individual segments of the left ventricle achieved their maxima, averaged over two short axis slices. DCC in tagged data was determined as circumferential strain, ECC, using HARP. The methods were evaluated in 10 DCM (EF<35%), 10 CRT candidates (EF<35%, QRS>120ms,and 11 age-matched normal subjects, using t-test and standardized differences (SD=sd/diff; Power (N) = number of patients to reach P<0.05) to determine efficacy.

Results: Illustrative examples of normal, asymmetric and asynchronous wall motion are shown (Figure 2). Measurements of asymmetry, asynchrony, and circumferential strain in left ventricular heart contraction distinguished control subjects from DCM patients in all subjects. I_a measures were on average thirty-five times higher in patients with DCM than in control subjects (P<0.05). Measures of I_s and ECC also distinguished control from DCM patients (P<0.0005 and P<0.001 respectively). Patients qualified by current criteria for CRT were within the ranges measured in DCM patients.

Discussion: I_a % and I_a proved capable of distinguishing DCM from control. The power of I_a to determine DCC reduced from 458 (1) to 20 the number of patients required for a future trial of DCC in CRT. Inclusion of I_s (and strain) reduce the number still further as shown in Figure 3. CRT candidates were readily defined by CVMR measurements of DCC.

Conclusion: 1. CVMR analysis by MASS and HARP permits quantification of DCC for the individual patient. 2. Assuming that DCC is the critical component of chronic heart failure to be corrected by CRT, MR may be efficacious in screening patients to improve outcome for this valuable but costly therapy. 3. A study of the predictive value of DCC using clinical outcome (6 min. walk) after CRT is in progress.

References: 1. Abraham WT et al. (2002) NEJM 346, 1845. 2. Bax JJ et al (2002) NEJM 347, 1803. 3. Enriquez CM et al. (2003) ISMRM (Late Breaking #7).

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Figure 1. Measures of Asymmetry (Ia) and Asynchrony (Is)

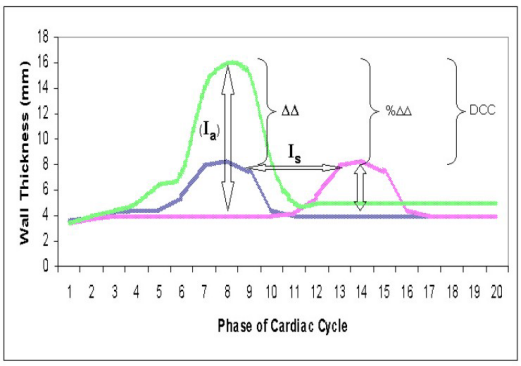

Figure 2. Normal (left) versus asymetrical and asynchronous (right) wall motion.

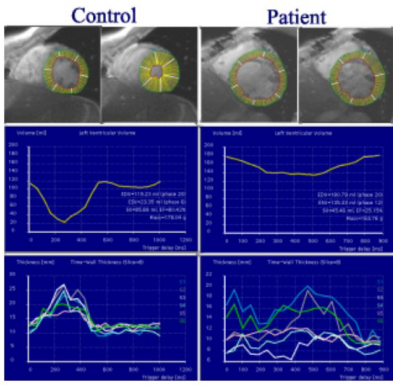

Figure 3. Correlation of Asymmetry and Asynchrony

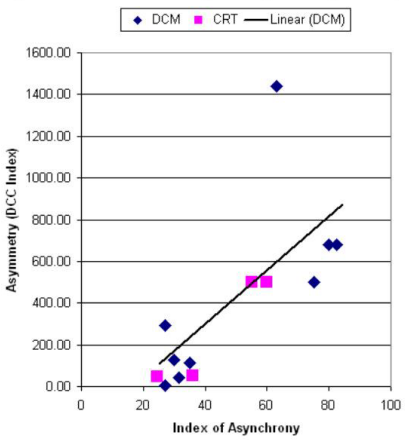

Table 1. Summary of LV function and wall motion analysis.

	Normal (11)	DCM (10)	CRT (4/10)$^+$
$\Delta\Delta$ (mm)	4.44 ± 1.8	3.26 ± 2.5	2.60 ± 1.6
% $\Delta\Delta$	36.9 ± 14.9	107.2 ± 60.6*	313.7 ± 423.8
Asymmetry I_a	10.9 ± 14.9	388.2 ± 453.5*	275.0 ± 259.8
Asynchrony Value	2.3 ± 0.8	9.9 ± 4.5**	9.0 ± 2.9*
ECC (strain)	-14.6 ± 3.3	-6.0 ± 5.3**	1.8 ± 2.6**

*p<0.05; **p<0.005; $^+$ to be completed