Imaging: Systolic and Diastolic Function

Left ventricular ejection fraction as an imaging biomarker to guide cardiac resynchronisation therapy in heart failure patients: a multimodal comparison of 2D and 3D echocardiography and CMR

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Funding Acknowledgements: Type of funding sources: Public Institution(s). Main funding source(s): The authors acknowledge financial support from the Department of Health through the National Institute for Health Research (NIHR) comprehensive Biomedical Research Centre award to Guy's & St Thomas' NHS Foundation Trust in partnership with King's College London and King's College Hospital NHS Foundation Trust and by the NIHR MedTech Co-operative for Cardiovascular Disease at Guy's and St Thomas' NHS Foundation Trust. This work was supported by the Wellcome/EPSRC Centre for Medical Engineering [WT 203148/Z/16/Z]. MSN was funded by a clinical lectureship awarded by the NIHR. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, the DoH, EPSRC, MRC or the Wellcome Trust.

Introduction – Imaging derived left ventricular ejection fraction (LVEF) has an important role to guide initiation of medical therapy and device insertion in patients with heart failure and reduced ejection fraction (HFrEF). Previous studies have reported the correlation and agreement of LVEF in various patient populations, but sparse evidence exists on patients with heart failure referred for Cardiac Resynchronisation Therapy (CRT) using 2D and 3D echocardiography (2DE & 3DE) and cardiovascular magnetic resonance (CMR).

Objectives – To determine the correlation and agreement of LVEF as determined by 2DE, 3DE and CMR in a cohort of HF patients referred for assessment of CRT.

Methods – Patients with suspected HFrEF referred for assessment for CRT therapy were included in this single centre study. Patients underwent 2DE, 3DE and CMR to derive LVEF, LVESV and LVEDV. Correlation was determined with Pearson's correlation, agreement with Bland-Altman analysis and Cohen's kappa analysis for agreement using a dichotomous cut off of LVEF ≤35% as a threshold for CRT insertion (Ponikowski, 2016).

Results - 55 patients (mean age 71 ± 9.2, 76% male) were included. The mean LVEF for 2DE, 3DE, CMR and were 32.4 ± 8.6, 32.1 ± 9.6 and 30.3 ± 9.5 respectively. CMR had a significantly lower LVEF compared to 2DE ($p = 0.03$).

There was good correlation between 3DE & CMR and 2DE & CMR, and excellent correlation between 3DE and 2DE for LVEF (Table 1). There was for trend for CMR to underestimate LVEF compared to 2DE and 3DE, with small biases although wide limits of agreement (Figure 1). There was excellent correlation of LVEDV and LVESV across all 3 techniques. CMR underestimated volumes compared to 2DE and 3DE with large biases and wide LOA.

The kappa coefficient agreement at threshold level for CRT insertion (LVEF ≤35%) was fair for 3DE and CMR (0.379, $p = 0.004$) and 2DE and CMR (0.462, $p = 0.001$), and moderate for 3DE and 2DE (0.575, $p \leq 0.001$).

Conclusion – Whilst LVEF is not the only indicator to guide CRT insertion, it remains an important imaging parameter for clinical decision making. We observed large biases in left ventricular volumes between 2D, 3D and CMR. However, whilst the overall bias in LVEF is small, the wide limits of agreement (LOA) observed may represent an area of clinical uncertainty, which may impact on the dichotomous imaging threshold for CRT insertion.

Comparison of indices between modalities

	LVEF Correlation (r)	LVEF Bias & LOA (%±SD)	EDV Correlation (r)	EDV Bias & LOA (mL ± SD)	ESV Correlation (r)	ESV Bias & LOA (mL ± SD)
3DE vs CMR	0.676 ($p < 0.001$)	+1.75 ± 15.4	0.896 ($p < 0.001$)	-82.16 ± 42.8	0.937 ($p < 0.001$)	-61.3 ± 34.9
3DE vs 2DE	0.872 ($p < 0.001$)	+0.48 ± 4.5	0.909 ($p < 0.001$)	-10.31 ± 28.3	0.936 ($p < 0.001$)	-8.42 ± 20.5
2DE vs CMR	0.675 ($p < 0.001$)	+2.35 ± 14.6	0.876 ($p < 0.001$)	-67.35 ± 36.3	0.898 ($p < 0.001$)	-51.42 ± 30.1

Abstract Figure. Bland-Altman Plot LVEF by 3DE & CMR