Regional MRI Left Ventricular Ejection Fraction Compared to Wall Motion Scoring and Late Enhancement Scar Imaging

Avan Suinesiaputra[1], Brett R Cowan[1], Pau Medrano-Gracia[1], Daniel C Lee[2], and Alistair A Young[1]
[1]*Anatomy with Radiology, The University of Auckland, Auckland, New Zealand,* [2]*Feinberg Cardiovascular Research Institute, Northwestern University, Chicago, IL, United States*

Introduction: Cardiovascular MR is the gold standard for global left ventricular (LV) function. However, it remains a challenge to assess this function regionally. This study investigated regional ejection fraction (R-EF) derived automatically from a 4D LV mathematical model, and compared this to visual wall motion scores (VWMS) and infarct transmurality by late gadolinium enhancement (LGE).

Methods: We retrospectively studied 105 patients (age: 62±11.9 years, male/female: 86/20) with coronary artery disease and mild-to-moderate LV dysfunctions (mean±SD of EDV: 195±52ml, ESV: 113±50ml, EF: 44±12%, LVM: 163±39g) from the DETERMINE cohort[1]. Short- and long-axis cine-MR images were used to generate the LV finite-element models (FEM) by using customised software (CIM version 7.1, University of Auckland). The LV FEMs were registered spatially into a common cardiac coordinate system, and temporally using a periodic spline interpolation method. Models were divided into the 17-segment model (Fig. 1), according to the standard AHA recommendations, and R-EF was computed for each segment. Segment 17 was excluded in the analysis because of unreliable endocardium definition at the apical tip. Comparison was made with expert VWMS from cine-MRI and scar analysis from LGE.

Figure 1. An LV model with 16 segments on endocardium.

Results: R-EF decreased progressively as the infarct transmurality increased (Fig. 2). Fig. 2 also indicates several non-scar segments with low R-EF, suggesting remote myocardial dysfunction due to stunning or ischemia. Fig. 3 shows the correlation between R-EF and VWMS for each segment. R-EF decreased as segments became more dysfunctional for all segments. Normal R-EF values varied between segments with basal septal segments (S2 and S3) the lowest and lateral segments (S6, S12 and S16) the highest. Unpaired t-tests between abnormal and each dysfunctional regions were all significantly different ($p<0.05$), except for mild-hypokinetic in S2, S4 and S10.

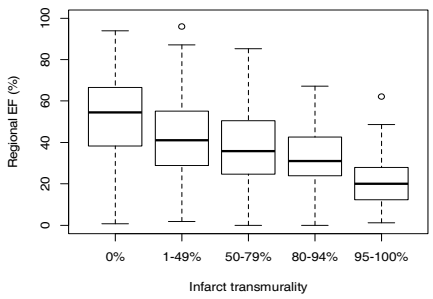

Figure 2. Correlation between R-EF and infarct transmurality from LGE.

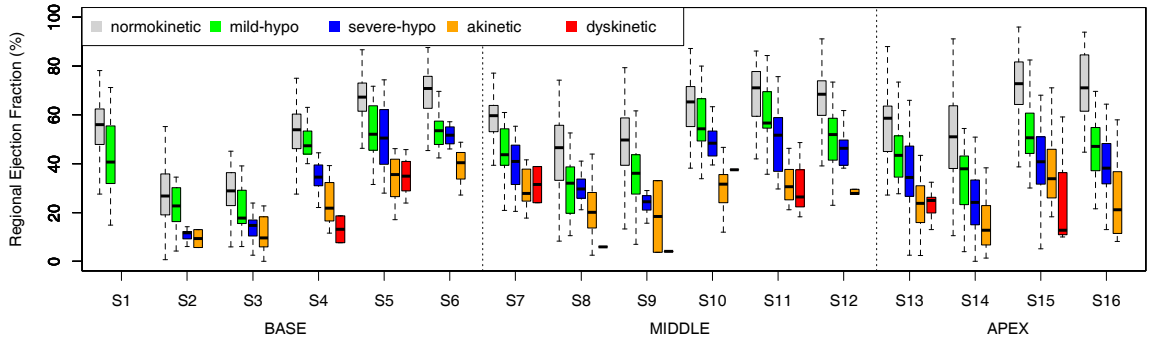

Figure 3. R-EF in each AHA segment, grouped by VWMS.

Conclusion: R-EF derived from a 4D LV mathematical model is a useful indicator of regional dysfunction. Once the cine MR images have been segmented into a 4D model, the calculation of R-EF is automatic and could be used to guide the visual scoring of regional dysfunction. R-EF correlates well with VWMS and LGE. The normal R-EF varies regionally, so a single R-EF reference is not sufficient for all segments.

References: 1. Kadish, et al., J. Cardiovasc. Electrophysiol., 2009.