



Rodrigues, J. C., Rohan, S., Dastidar, A. G., Burchell, A. E., Ratcliffe, L. E., Hart, E. C., ... MacIver, D. H. (2015). Are systolic function and ejection fraction interchangeable? New insights from cardiovascular magnetic resonance and in-vivo validation of mathematical models of LV function. Journal of Cardiovascular Magnetic Resonance, 17(1), 1-2. [P325]. DOI: 10.1186/1532-429X-17-S1-P325

Publisher's PDF, also known as Version of record

License (if available): CC BY Link to published version (if available): 10.1186/1532-429X-17-S1-P325

Link to publication record in Explore Bristol Research PDF-document

This is the final published version of the article (version of record). It first appeared online via BioMed Central at 10.1186/1532-429X-17-S1-P325.

University of Bristol - Explore Bristol Research General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available: http://www.bristol.ac.uk/pure/about/ebr-terms.html



POSTER PRESENTATION



Are systolic function and ejection fraction interchangeable? New insights from cardiovascular magnetic resonance and in-vivo validation of mathematical models of LV function

Jonathan C Rodrigues^{1,2*}, Stephen Rohan³, Amardeep Ghosh Dastidar¹, Amy E Burchell⁴, Laura E Ratcliffe⁴, Emma C Hart^{4,2}, Angus K Nightingale⁴, Julian F Paton^{2,4}, Chiara Bucciarelli-Ducci¹, Mark Hamilton¹, Nathan E Manghat¹, David H Maclver^{5,6}

From 18th Annual SCMR Scientific Sessions Nice, France. 4-7 February 2015

Background

Clinical studies have shown that many patients may have abnormally reduced myocardial shortening despite preserved ejection fraction (EF). Mathematical modeling explains this apparent paradox by demonstrating, that whilst myocardial shortening determines radial strain (RS), it is absolute wall thickness (AWT) rather than RS that determines EF. We sought in vivo cardiac MR (CMR) evidence to support the mathematical modeling theories.

Methods

We retrospectively analysed 39 CMR studies (28 hypertensive patients and 11 healthy volunteers [mean age: 47.4 ±13.0, male: 56.4%]) performed at 1.5T (Avanto, Siemens). Ventricular volumes and EF were measured using established CMR techniques. Left ventricular wall thickness was measured at end-diastole (ED) and end-systole (ES) in the long- and short-axis cine views at the mid-cavity at the level of the papillary muscles. Measurements were repeated twice, 1 day apart. Longitudinal strain (LS) was estimated using a modified 6-point mean annular plane systolic excursion of the mitral valve from 3-chamber, 2chamber and 4-chamber cines. Subgroup analysis was performed by EDWT (Group 1 <9mm [n= 19] and Group 2 >9mm [n=20]). Continuous variables were compared by Student *t* tests and categorical variables by Fisher exact test (setting p < 0.05 as significant).

¹CMR Unit, NIHR Cardiovascular Biomedical Research Unit, Bristol Heart Institute, Bristol, UK

Full list of author information is available at the end of the article

Definitions

AWT = ES thickness - ED thickness.

 $RS = (AWT / ED thickness) \times 100.$

Midwall circumferential fractional shortening (mFS) = ((LVIDd+EDWT)-(LVIDs+H))/(LVIDd+EDWT)x100(%), where H = $((LVIDd+EDWT)^3-(LVIDd)^3+(LVIDd)^3/$ ^{1/3}-LVIDs, LVIDd = left ventricular internal dimension in diastole, LVIDs = left ventricular internal dimension in systole and EDWT = end diastolic wall thickness.

Results

Intra-observer variability for wall thickness measurements was good both both long-axis and short-axis measurements (intra-class correlation coefficient=0.931).

Significant positive correlation was demonstrated between EDWT and AWT ($r^2=0.42$, p<0.0001). However, significant negative correlations were demonstrated between EDWT and RS ($r^2=0.13$, p<0.05), between EDWT and longitudinal strain ($r^2=0.62$, p<0.0001) and between EDWT and mFS ($r^2=0.16$, p<0.05). Subgroup analysis by EDWT is demonstrated in Figure 1. Despite significant reductions in LS, mFS and trend towards lower RS, ejection fraction is significantly higher and indexed stroke volume is similar between in ventricles with EDWT >9mm compared to those <9mm.

Conclusions

Myocardial systolic function and ejection fraction are not the same. Our study provides in-vivo validation of mathematical modeling predictions that significant LV



© 2015 Rodrigues et al; licensee BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.

	Group 1 (n = 19)	Group 2 (n = 20)	P value
End-diastolic wall thickness (mm)	< 9	>9	
Mean EDWT (mm)	6.6±1.2	11.7±2.5	< 0.0001
Ejection fraction (%)	61.9±5.9	67.6±8.6	< 0.05
ndexed stroke volume (ml/m2)	49.5±9.3	53.2±11.0	= 0.2622
Mean longitudinal strain (%)	14.1±1.9	9.5±2.8	< 0.0001
Vlean radial strain (%)	68.8±22.8	61.3±14.4	= 0.2304
Mean mFS (%)	20.0±3.6	17.6±3.4	< 0.05
Mean AWT (mm)	4.5±1.5	6.8±1.3	< 0.0001
EDWT = end-diastolic wall thicknes hickness)	s, mFS = midwall	fractional shortening,	AWT = absolute wa

systolic impairment (in the form of impaired LS, RS and mFS) can be compensated for by significant increases in AWT thus maintaining indexed SV and EF. This finding has implications for the understanding the pathophysiology of heart failure with preserved ejection fraction, and its potential treatment.

Funding

NIHR Bristol Cardiovascular Biomedical Research Unit, Bristol Heart Institute.

JCLR: Clinical Society of Bath Postgraduate Research Bursary.

ECH: BHF grant IBSRF FS/11/1/28400.

Authors' details

¹CMR Unit, NIHR Cardiovascular Biomedical Research Unit, Bristol Heart Institute, Bristol, UK. ²School of Physiology and Pharmacology, The University of Bristol, Bristol, UK. ³Medical School, The University of Bristol, Bristol, UK. ⁴Cardionomics Research Group, Bristol Heart Institute, Bristol, UK. ⁵Cardiology, Taunton and Somerset Hospital, Taunton, UK. ⁶Biological Physics, The University of Manchester, Manchester, UK.

Published: 3 February 2015

doi:10.1186/1532-429X-17-S1-P325

Cite this article as: Rodrigues *et al.*: **Are systolic function and ejection** fraction interchangeable? New insights from cardiovascular magnetic resonance and in-vivo validation of mathematical models of LV function. *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1): P325.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

BioMed Central

Submit your manuscript at www.biomedcentral.com/submit