Velocity Vector Imaging as a new approach for cardiac magnetic resonance: Comparison with echocardiography

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BACKGROUND

- Cardiac magnetic resonance (CMR) is a powerful tool to quantify left ventricular (LV) function, however previous strain methods have usually required complicated and time-consuming tagging.
- Velocity vector imaging (VVI) is a novel quantitative technique that has been applied previous to speckle tracking echocardiography (Echo).

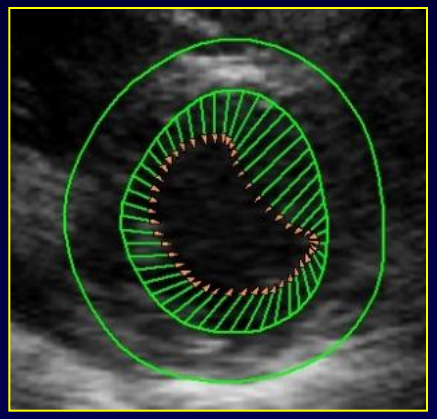
OBJECTIVE

- To test the hypothesis that VVI can be applied to routine CMR DICOM images to quantify cardiac function similar to Echo.

METHODS

- Consecutive 51 subjects with suspected heart failure who had both CMR and echocardiography
  - Age 53±15 years
  - 33 male (65%)
- Standard Echocardiography (Echo)
  - Echocardiography was performed with either a Vivid 7 (GE Vingmed, Horten, Norway) or an iE33 (Philips Medical Systems, Andover, Mass).

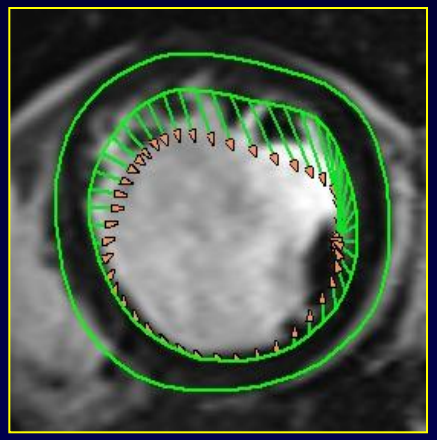
- Velocity Vector Imaging by Echo



- Echocardiographic images were used from the parasternal short-axis view, mid-LV level using the papillary muscles as an internal anatomic landmark.
- VVI was measured from routine DICOM data sets using a software (2D Cardiac Performance Analysis©, TomTec, Germany).
- A region of interest was manually placed on endocardial and epicardial borders.

- Cardiac magnetic resonance (CMR)
  - CMR was performed on a 1.5 Tesla scanner (Siemens, Germany).
  - The scanning parameters were as follows: echo time (TE) 1.8ms, repetition time (TR) 3.6ms, spatial resolution $1.8 \times 1.5 mm^2$, slice thickness 6mm, temporal resolution of 30 frames per RR-interval.
  - Ejection fraction was calculated by assessment of the volumes of the endocardial contours in diastole and systole of the short-axis images using Argus Viewer (Siemens, Germany).

Velocity Vector Imaging by CMR



- CMR images were selected from the digital DICOM data set to correspond to the mid-LV short axis plane using papillary muscles as an internal anatomic landmark.

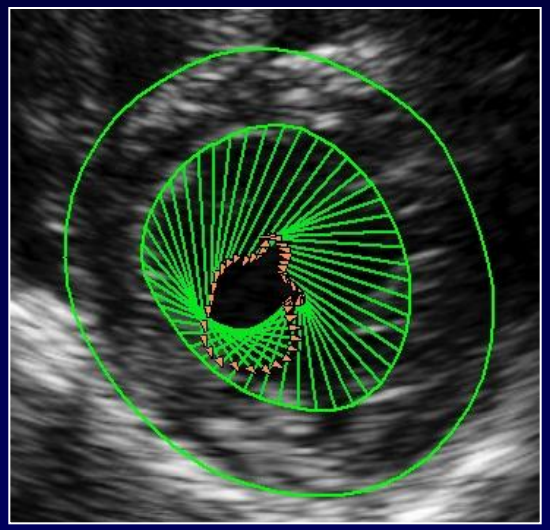
- VVI was measured from Routine digital DICOM data sets using the novel software (2D Cardiac Performance Analysis MR©, TomTec, Germany).
- A region of interest was manually placed on endocardial and epicardial borders.

- Patients were divided as those having systolic dysfunction (LVEF<50%: Group 1) or having normal systolic function (LVEF≥50%: Group 2).

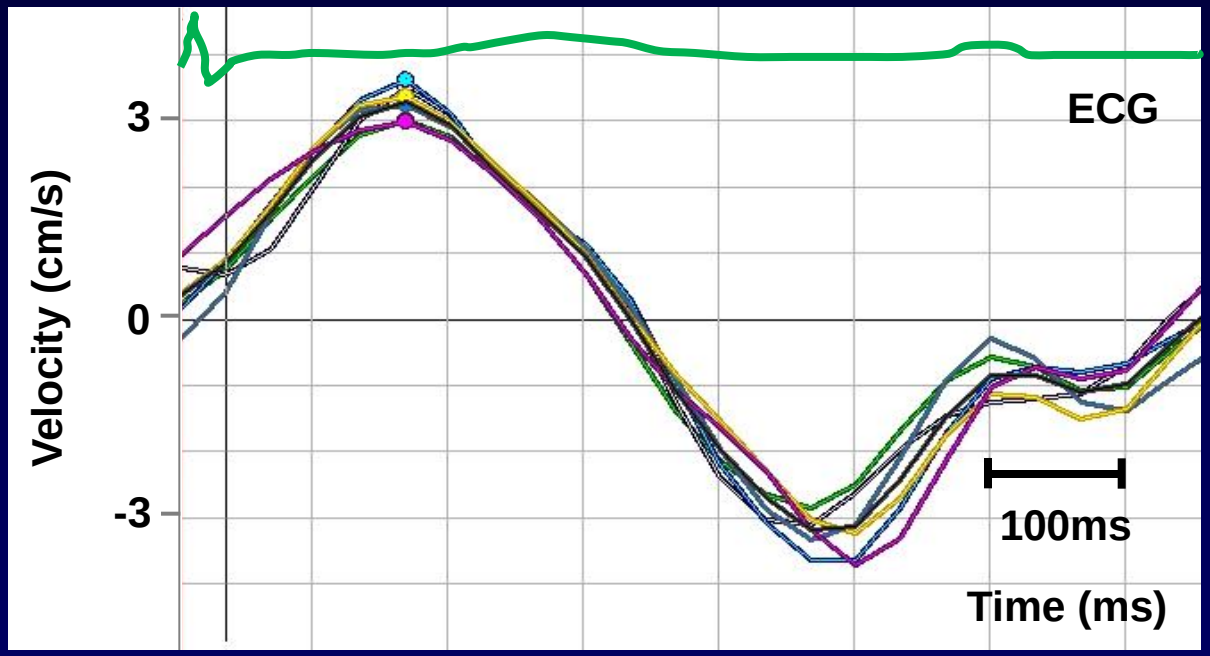
Velocity Vector Imaging by Echo

Normal systolic function patient (EF=60%)

Echo (VVI)



Radial Velocity by Echo

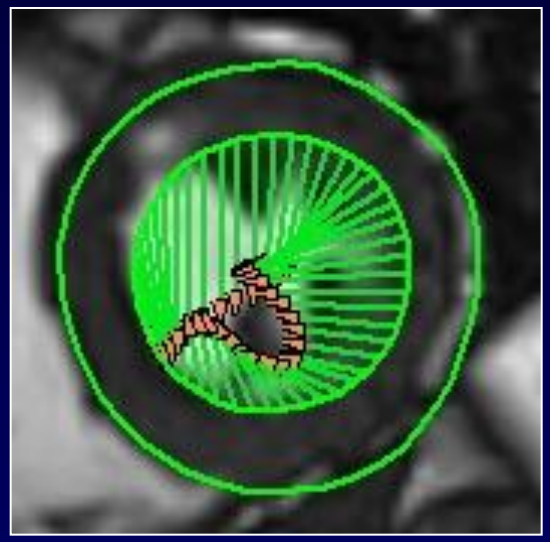


Ant-Sep
Anterior
Lateral
Posterior
Inferior
Septal
Average Velocity

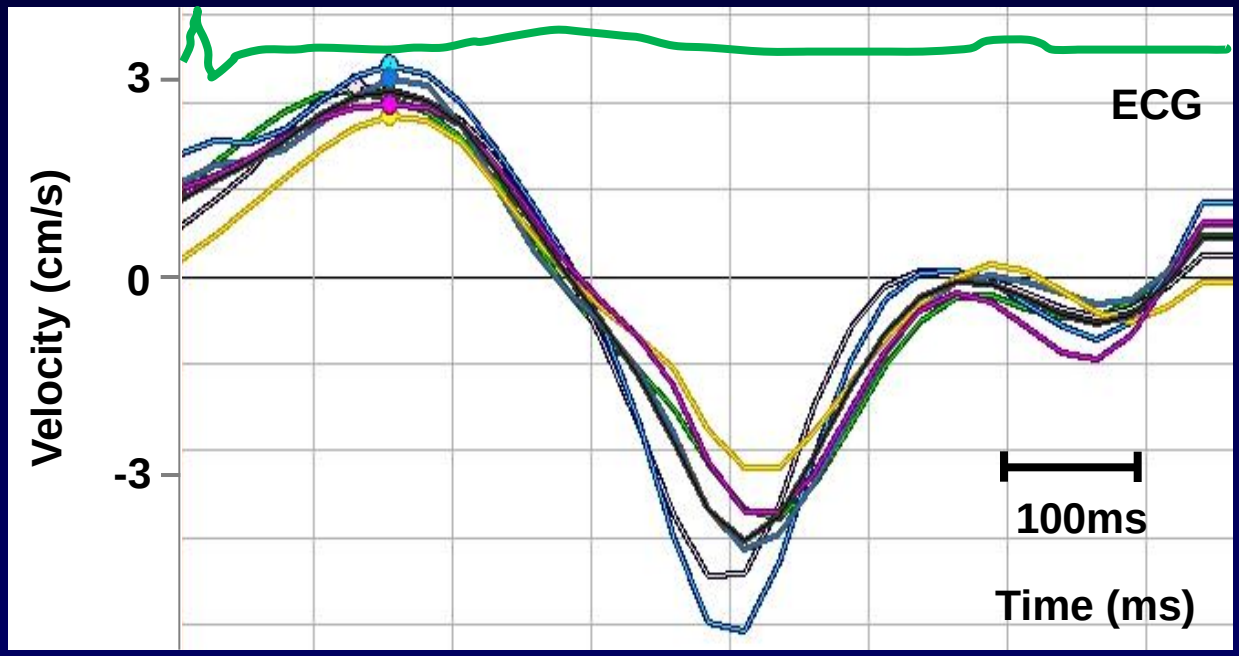
Velocity Vector Imaging by CMR

Normal systolic function patient (EF=60%)

CMR (VVI)



Radial Velocity by CMR



Ant-Sep
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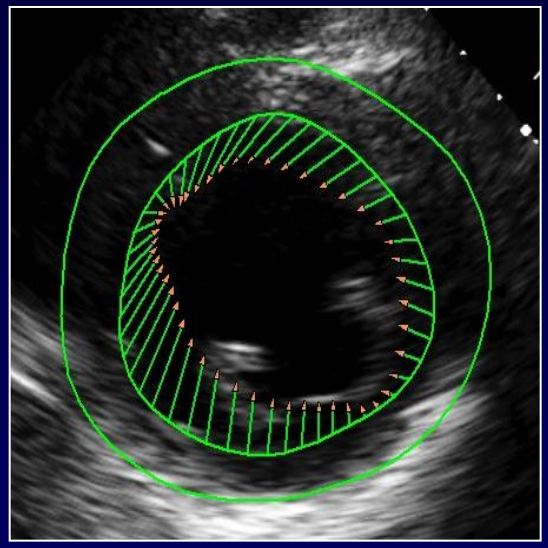
Septal
Average Velocity

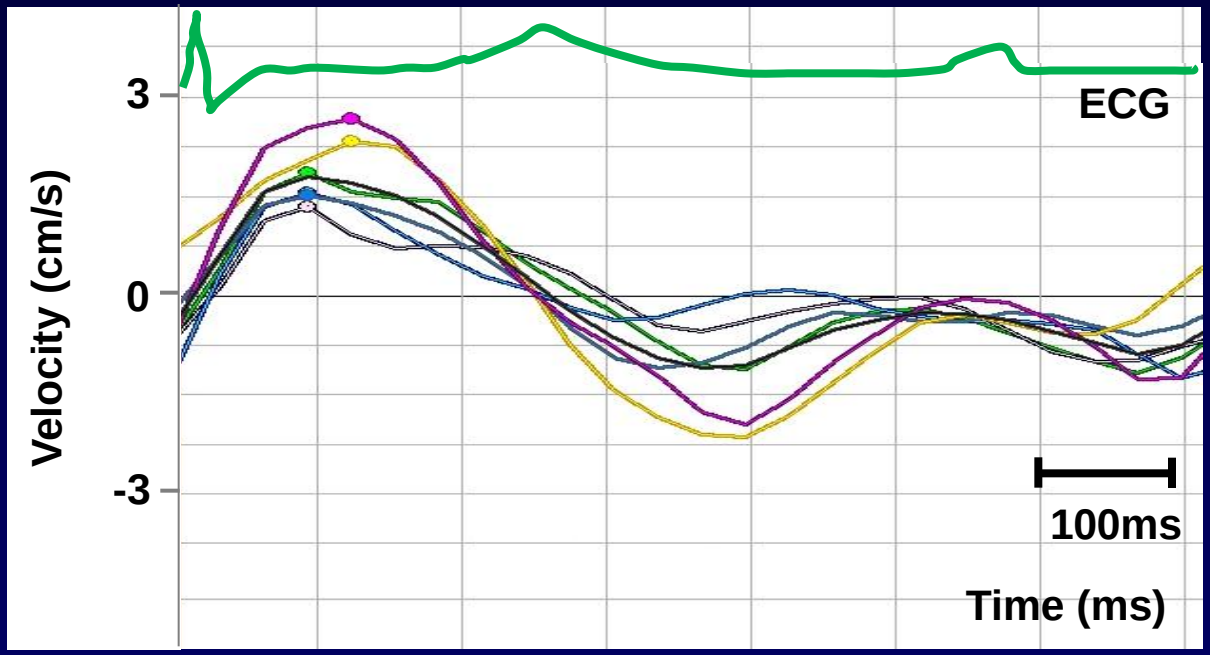
Velocity Vector Imaging by Echo

Systolic dysfunction patient (EF=17%)

Echo (VVI)



Radial Velocity by Echo



Ant-Sep
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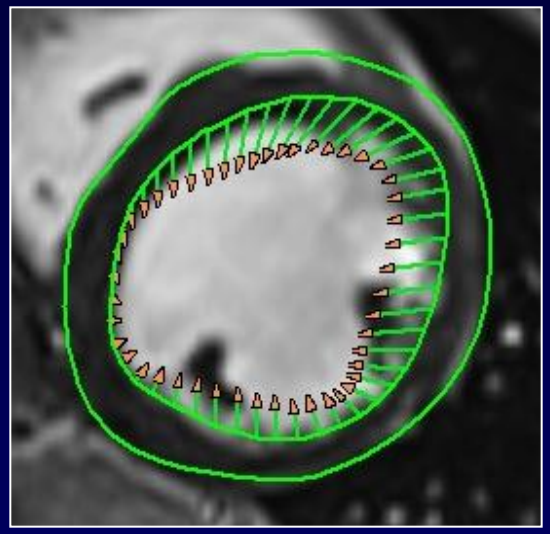
Average Velocity

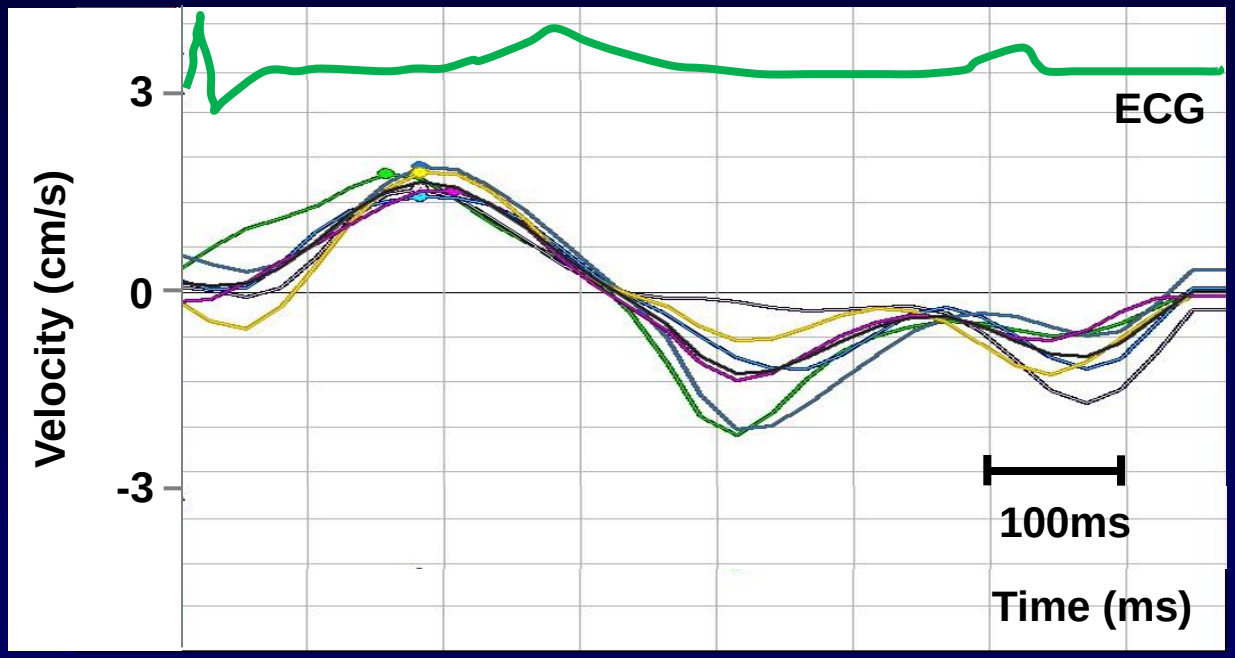
Velocity Vector Imaging by CMR

Systolic dysfunction patient (EF=17%)

CMR (VVI)



Radial Velocity by CMR



Ant-Sep
Anterior
Lateral
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Inferior
Septal
Average Velocity

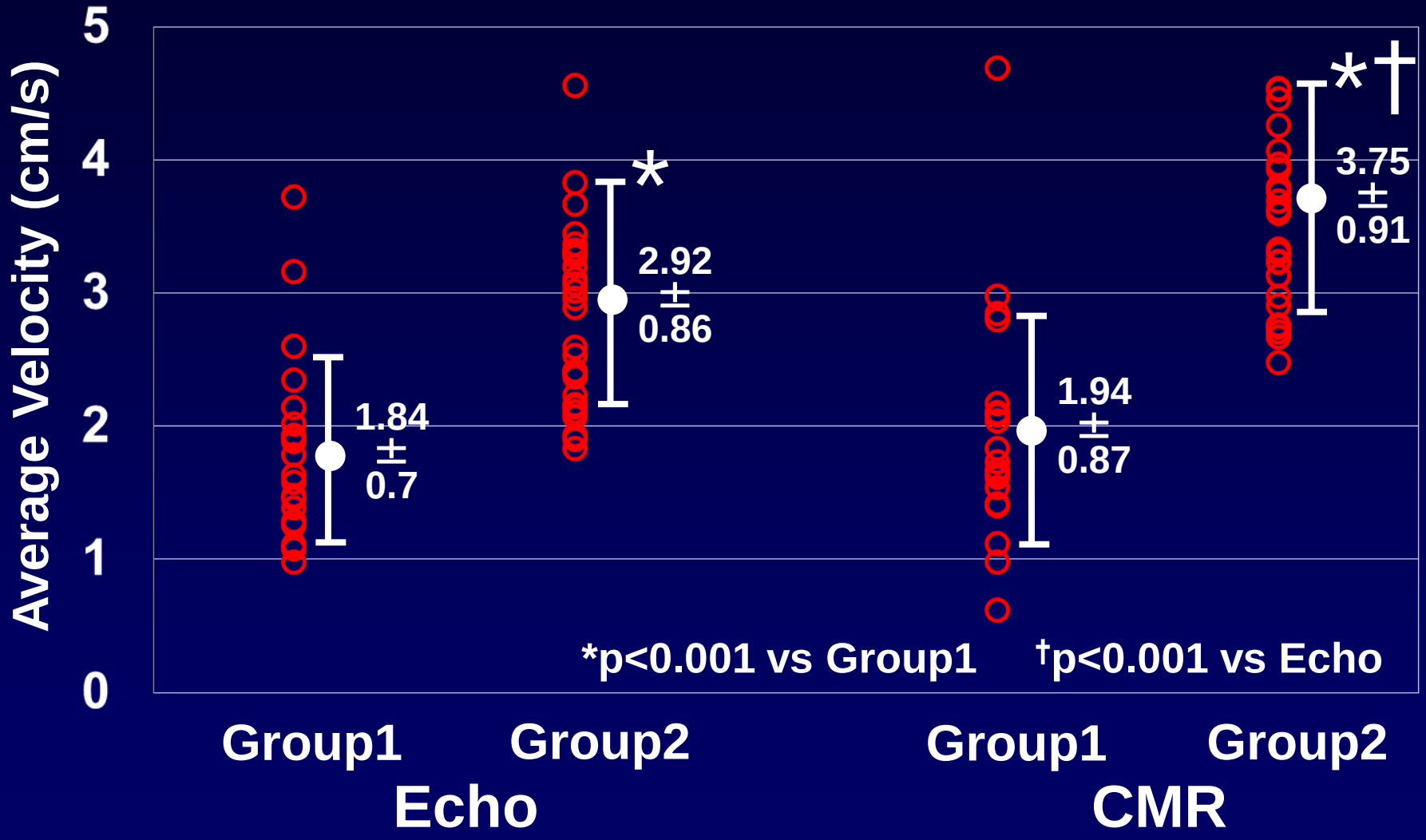
RESULTS

- Imaging data were suitable for quantitative analysis in 100% (51/51) of CMR images and 90% (47/51) of echo images.

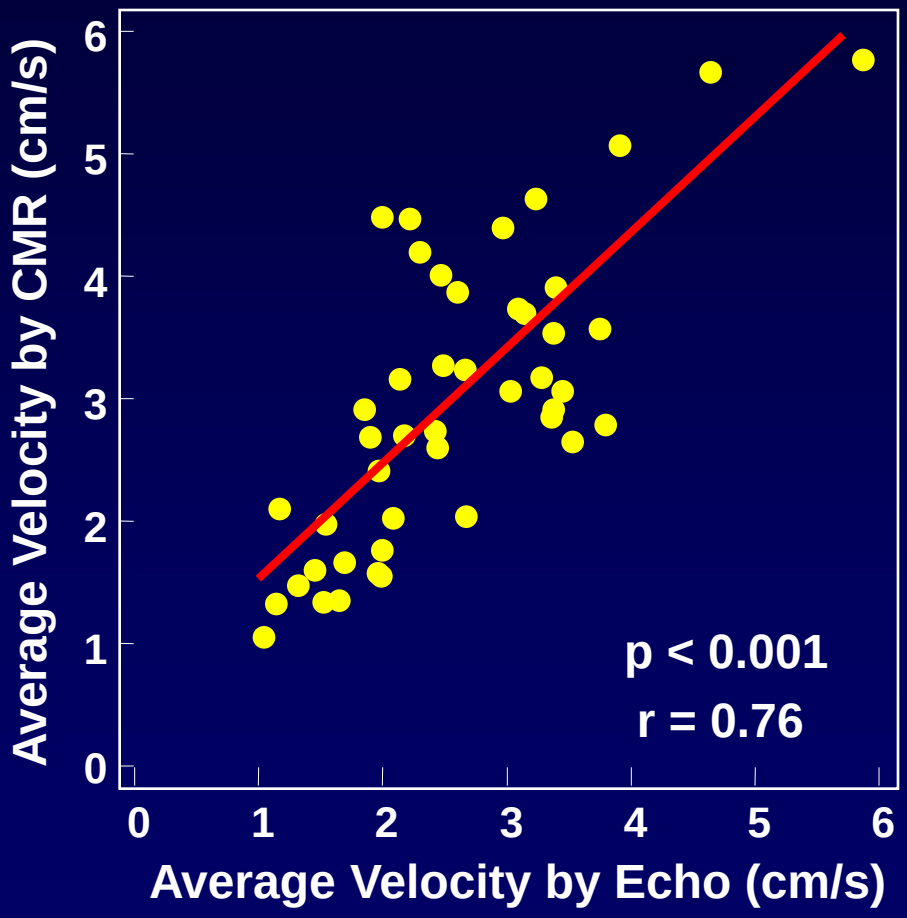
- Patients Data

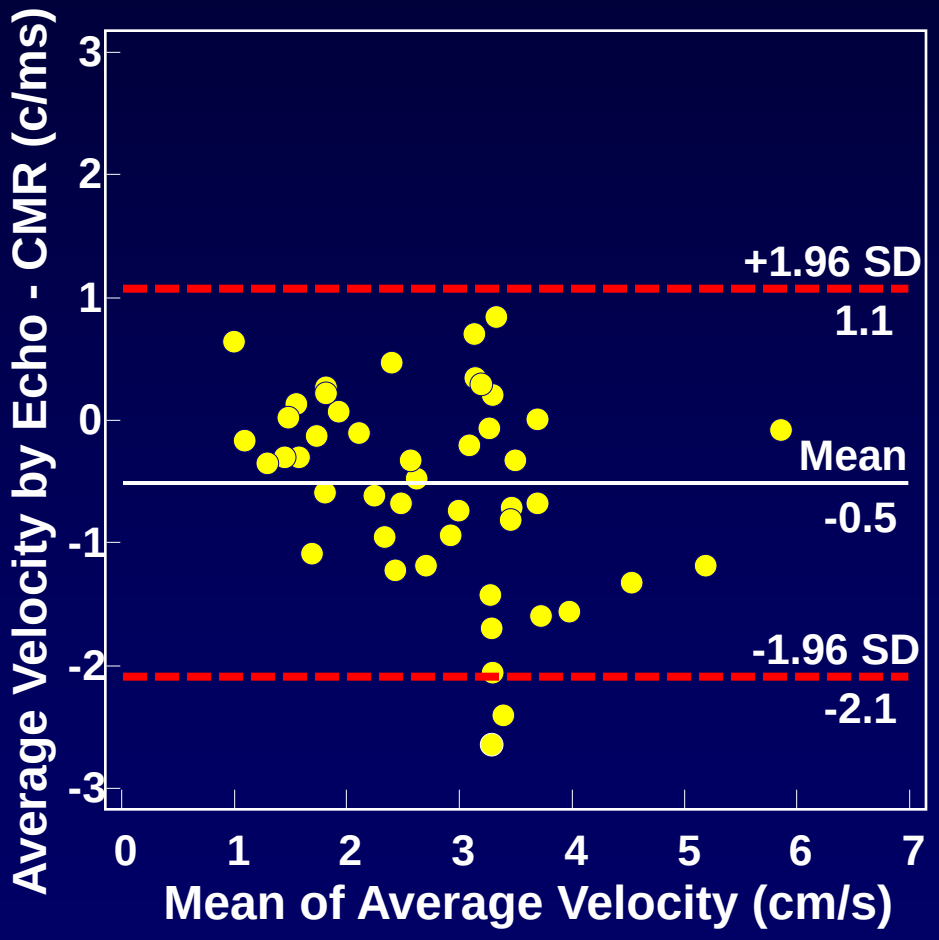
- Group1: Systolic dysfunction patients (LVEF<50%)
  - 22 patients
    - 6 ischemic cardiomyopathy
    - 16 non-ischemic cardiomyopathy
- Group2: Normal systolic function patients (LVEF≥50%)
  - 29 patients
    - 5 ischemic heart disease
    - 3 hypertrophic cardiomyopathy
    - 1 hypertensive heart disease
    - 6 paroxysmal atrial fibrillation
    - 14 non-cardiac disease

Comparison Between the Groups by Echo and CMR



Variability of Average Velocity Between CMR and Echo





CONCLUSIONS

- A novel simple VVI software approach can be applied to CMR to quantify myocardial function, and compares favorably with similar strain measures by speckle tracking Echo.

- VVI by CMR has potential for clinical applications.