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Meeting abstract

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# 1100 Phase contrast imaging: a novel way of assessing left ventricular diastolic function

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## Background

Diastolic left ventricular (LV) intracavitary blood flow is recognized to be complex and involves multiple streamlines oriented in different directions. Phase contrast magnetic resonance imaging (PC-MRI) with its 3-dimensional evaluation of proton phase shifts, is well-suited and validated for hemodynamic assessment of cardiac output, shunt ratio and valvular function. We hypothesized that PC-MRI could be used to assess LV diastolic intracavitary blood flow.

## Methods

15 patients with varying degrees of LV diastolic dysfunction who had a recent 2-D Doppler echocardiogram underwent PC-MRI evaluation. Participants were imaged in the supine position with a 1.5-T whole-body clinical scanner (Avanto, Siemens Medical Solutions, Erlangen, Germany). Velocity in 3 separate directions (through-plane, in-plane anterior-posterior, and in-plane right-to-left) were assessed in the 4-chamber view using a time to repeat (TR) of 92.45 ms, a time to echo (TE) of 2.88, a flip angle of 30, and a velocity-encoding (VENC) ranging from 100 to 150 cm/s.

Images were then analyzed off-line using a 4D flow program (Siemens Medical Solutions, Philadelphia, PA) which allowed color-coded vector imaging of blood flow streamlines were assessed throughout diastole. The distance of intact flow propagation was measured from the mitral annulus to the end of the jetstream. The fractional propagation was the ratio of this distance to the entire length of the left ventricle. Echo Doppler analyses of diastolic function were based on mitral annular velocities (E', in cm/s) and mitral inflow pattern (relative peak E and A velocities in cm/s), and patients were graded as either normal (normal E velocity and normal E'), mildly impaired (low E velocity and low E') or severely impaired (high E velocity and low E'). These two methods of diastolic assessment were then compared among groups using the 2-tailed unpaired t-test.

## Results

Representative examples of the vector images and measurement techniques for 3 patients with different degrees of diastolic dysfunction are shown in Images 1–3. The color vector analysis allows for a visual assessment of diastolic flow and shows a generally vigorous flow propagation in normal patients that extends all the way to the apex and high blood velocities (corresponding to the red color) even distal to the mid-ventricle (Figure 1). In contrast, flow propagation is clearly less vigorous in patients with mild and severe diastolic dysfunction (Figures 2 and 3). Table 1 lists both the echocardiographic and phase contrast features of all 3 groups of patients. With regard to Doppler findings, the group with severe diastolic dysfunction had a statistically significantly higher E/E' than both

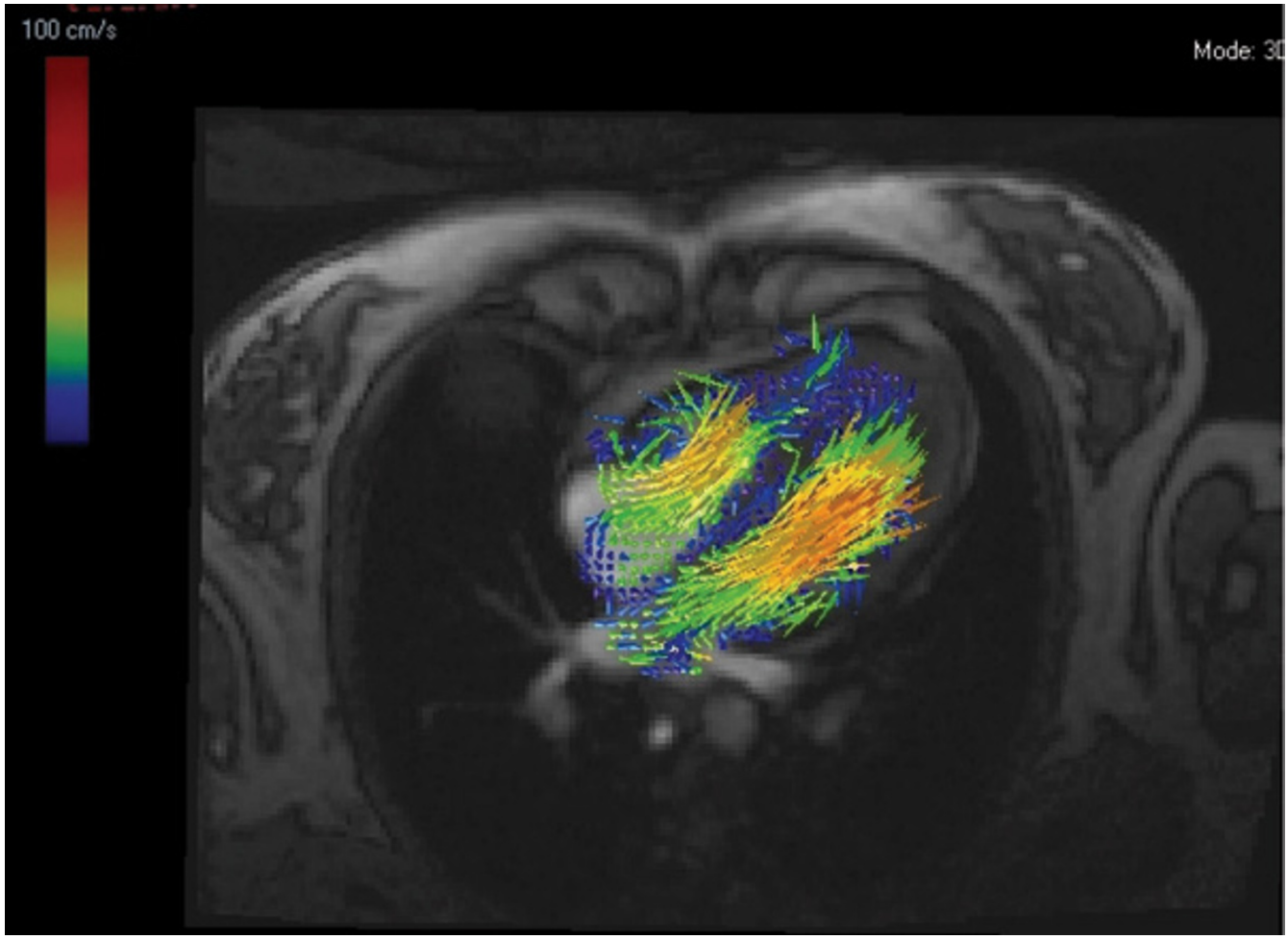


**Figure 1**

other groups and a higher E/A than the group with mild diastolic dysfunction ($p < 0.05$). The fractional propagation was significantly lower in the two groups with diastolic dysfunction than in the normal group ($p < 0.05$). The difference in fractional propagation between the groups with mild and severe diastolic dysfunction however did not reach statistical significance ($p = 0.86$).

## Conclusion

Based on this data, phase contrast analysis can potentially differentiate between normal and abnormal diastolic function, specifically with respect to flow propagation throughout the ventricle. Further studies are warranted that involve a greater number of patients and that attempt to differentiate between degrees of diastolic dysfunction.

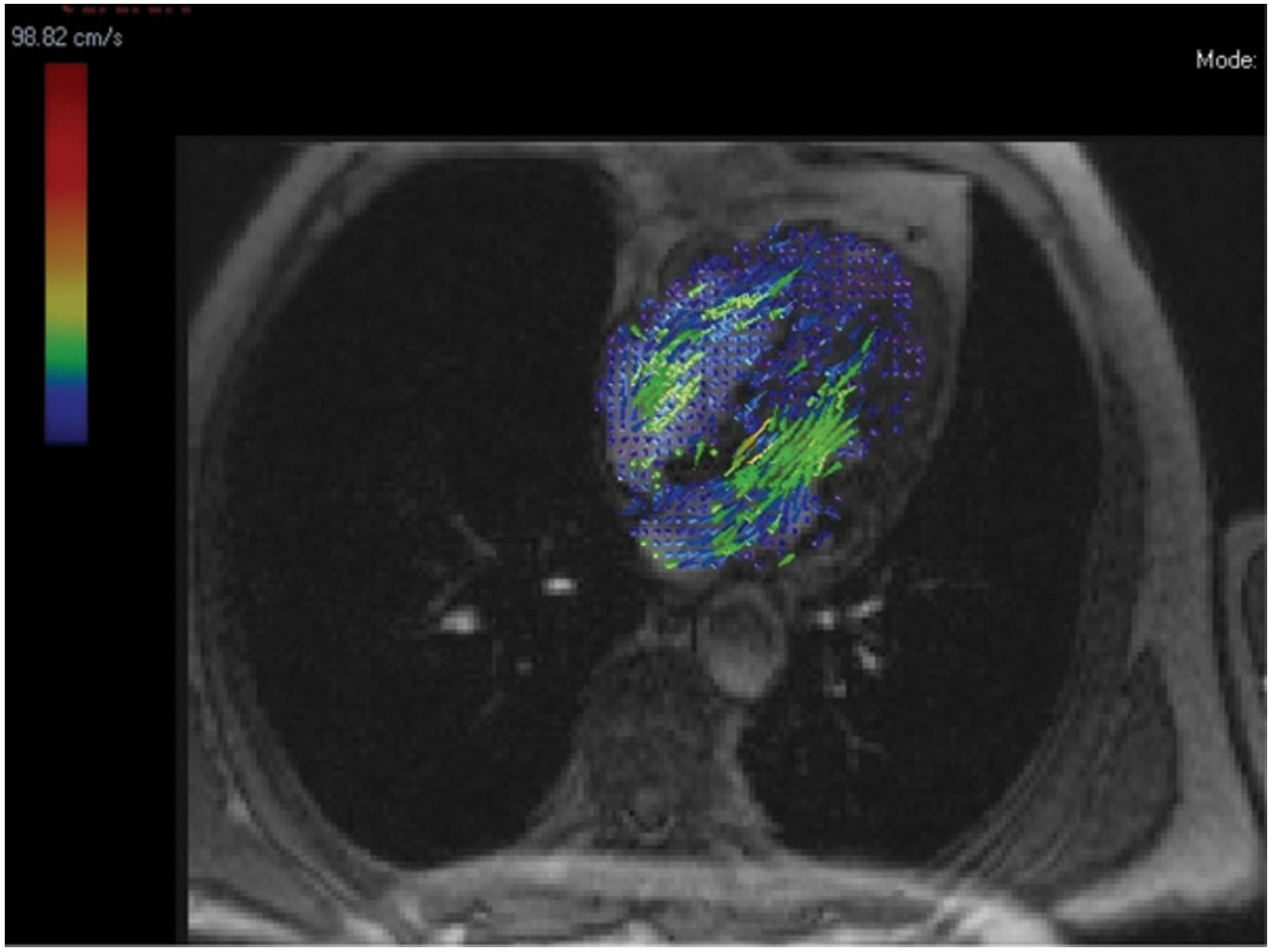


**Figure 2**

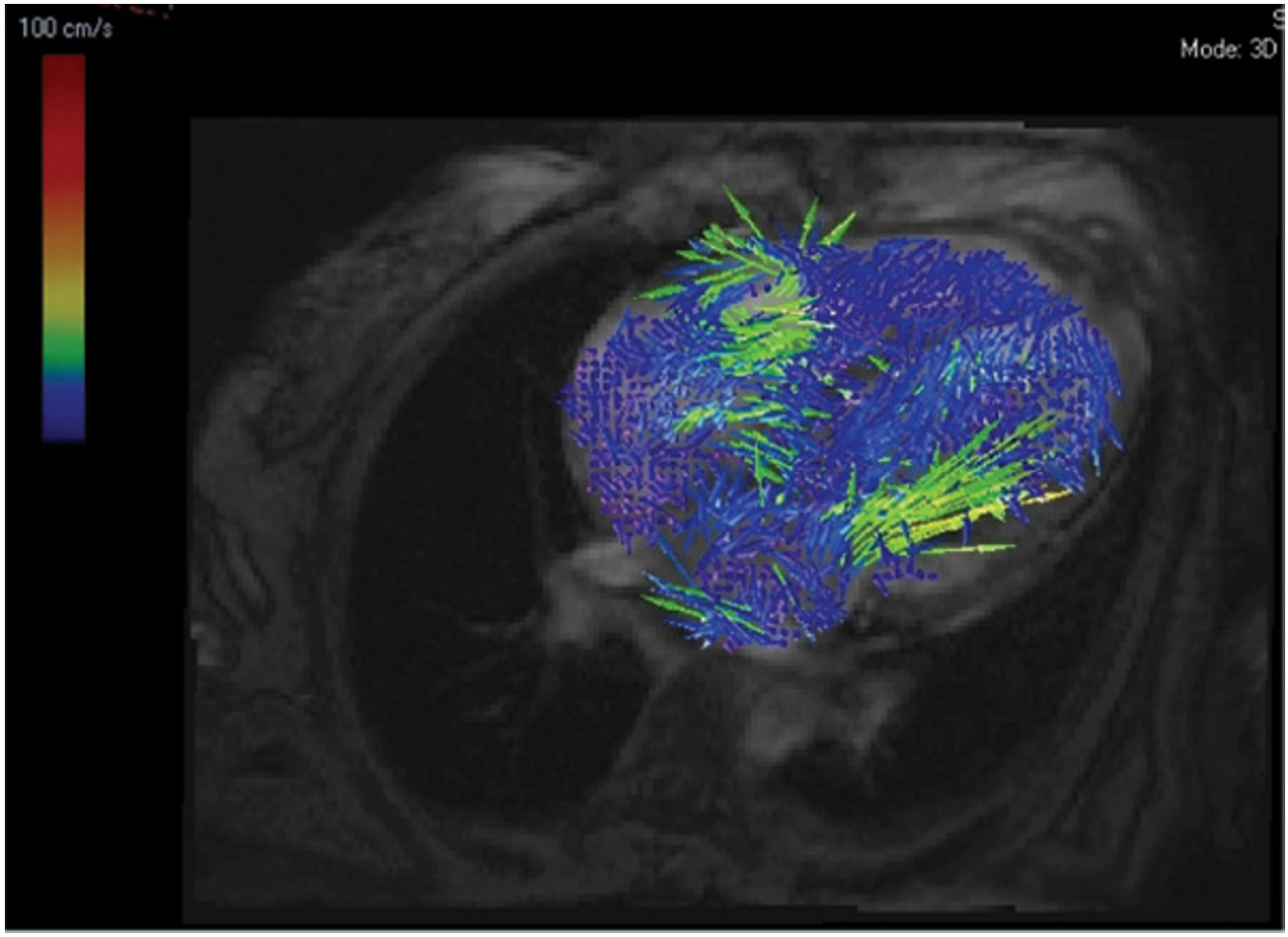


**Figure 3**

**Table 1: Doppler and MRI-PC comparison between patients with varying degrees of diastolic dysfunction**

| | N (number) | Age (mean) | Echo Doppler Peak E velocity/peak A velocity (mean ± SD) | Echo Doppler peak E velocity/peak annular tissue Doppler velocity (mean ± SD) | Phase contrast MRI fractional propagation (mean ± SD) |
|---|---|---|---|---|---|
| **Normal** | 2 | 43 | 1.81 ± 0.97 | 7.66 ± 1.40 | 1 ± 0 |
| **Mild Diastolic Impairment** | 6 | 55 | 1.09 ± 0.41 | 8.50 ± 2.11 | 0.58 ± 0.06* |
| **Severe Diastolic Impairment** | 7 | 45 | 2.36 ± 1.15** | 14.79 ± 2.71*, ** | 0.59 ± 0.21* |