Thavendiranathan *et al. Journal of Cardiovascular Magnetic Resonance* 2011, **13**(Suppl 1):O33
http://jcmr-online.com/content/13/S1/O33

Journal of Cardiovascular Magnetic Resonance

ORAL PRESENTATION **Open Access**

CMR real-time, free-breathing, phase contrast flow quantification: a novel approach to assess ventricular coupling in constrictive pericarditis

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From 2011 SCMR/Euro CMR Joint Scientific Sessions
Nice, France. 3-6 February 2011

Background/objective

Constrictive pericarditis (CP) is an important cause of heart failure; however, with accurate diagnosis and directed treatment it is potentially curable. Cardiac magnetic resonance imaging (CMR) has played a diagnostic role, primarily by allowing assessment of pericardial morphology but with limited depiction of physiological changes. We sought to examine the feasibility of a novel CMR approach that enables real-time phase contrast (RT-PC) assessment of discordant respirophasic changes in trans-mitral and tricuspid flow velocity - the signature findings in CP - due to enhanced ventricular interdependence.

Method

Patients referred to the CMR lab pre-pericardectomy or for assessment of suspected CP were included. Following routine CMR examination for CP, transmitral (MV) and tricuspid valve (TV) flow velocities were simultaneously obtained by through-plane RT-PC imaging during unrestricted respiration using a slice position to include both valves (Figure 1) with the following parameters: TR/TE=13.7ms/2.5ms, water excitation pulse with flip angle=25°, 10mm slice thickness, 160x120 matrix, EPI factor=15, TSENSE rate=2, slice thickness=10mm, and VENC=150cm/s. Shared velocity encoding was used to achieve an effective temporal

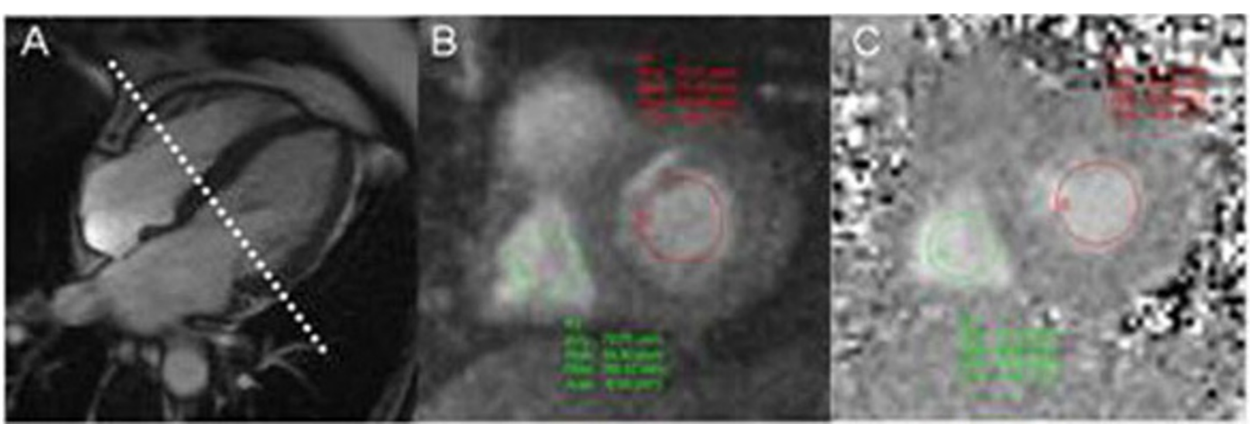

Figure 1 (A) Horizontal long axis cine image used for selection of RT-PC imaging plane. (B) Magnitude and (C) phase images obtained with RT-PC acquisition. Regions of interest for mitral inflow (red) and tricuspid inflow (green) are illustrated in both the magnitude and phase images.

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resolution of 55ms and typically, 200-400 phases were obtained. The diagnosis of CP was confirmed using a combination of clinical history, diagnostic imaging, invasive hemodynamic measurements, intra-operative findings, and histopathology. Regions of interest at the mid-portion of the MV and TV were chosen on the PC images (Figure 1). Peak velocity data from average of 4 neighboring pixels for both valves were displayed simultaneously (Figure 2). The percentage change in velocity were calculated for MV as (MV expiratory E velocity - inspiratory E velocity)/(inspiratory E velocity) and for TV as (TV inspiratory E velocity - expiratory E velocity)/(expiratory E velocity).

Results

9 patients (7 men, age 56±17 years) and 9 healthy volunteers (6 men, age 31±10) were included. All patients had increased pericardial thickness (6.3 ±1.5mm), a respirophasic shift of the interventricular septum, and inferior vena cava enlargement. Discordant

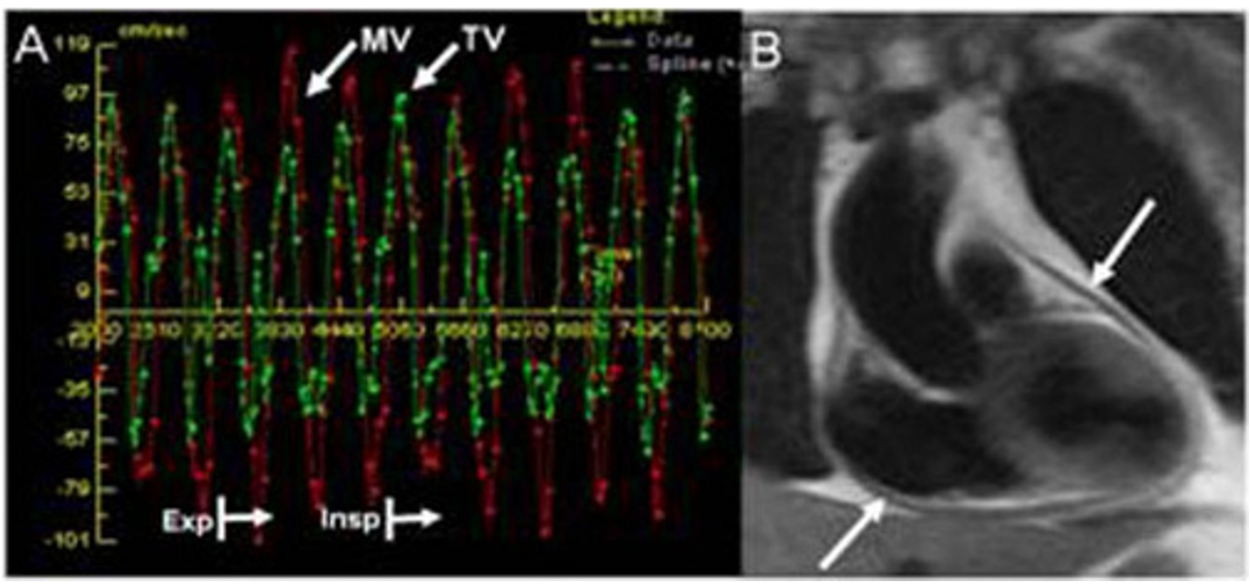

Figure 2 (A) RT-PC trans-mitral and tricuspid flow illustrating significant resiprophasic variation. (B) Dark blood turbo spin echo image illustrating pericardial thickening (arrows).

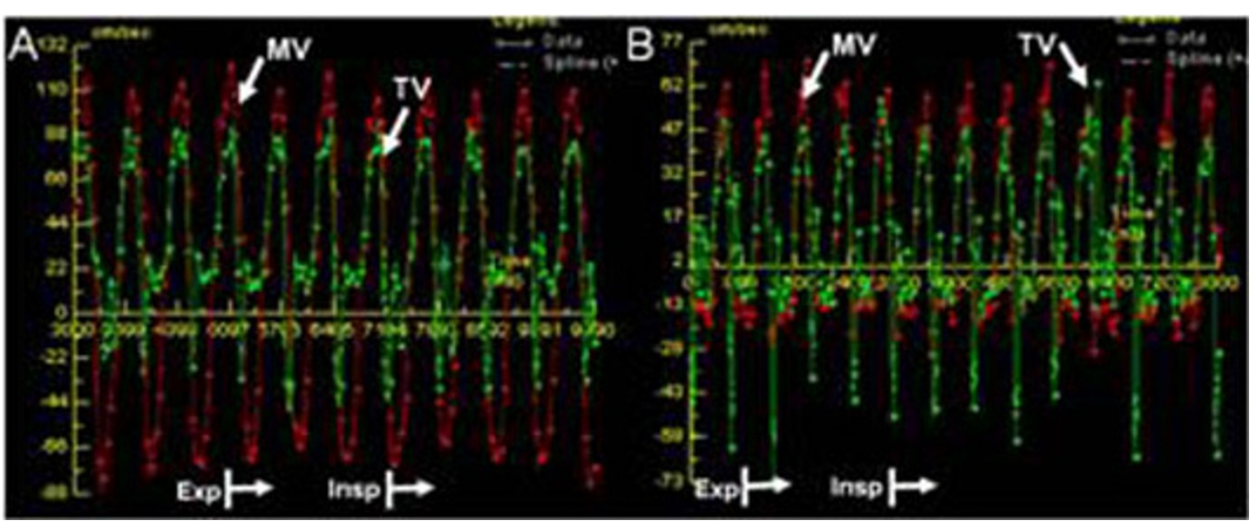

Figure 3 (A)RT-PC flow post pericardectomy in the same patient as Figure 2 illustrating absence of significant respirophasic variation. (B) RR-PC trans-mitral and tricuspid flow in a healthy volunteer illustrating lack of significant respirophasic variation.

respirophasic flow velocities across the mitral and tricuspid valves were recorded in all CP patients (Figure 2), with mean trans-mitral and tricuspid flow velocity variation measuring 46±21% and 60±16% respectively, compared to 17±5% ($p=0.003$) and 30±13% in controls ($p<0.001$) (Figure 3).

Conclusions

Reciprocal respirophasic changes in mitral and tricuspid inflow velocity in CP can be simultaneously displayed by RT-PC imaging. This provides essential hemodynamic information, which in conjunction with other morphological and functional changes is a useful addition to the diagnostic armamentarium of CMR for the diagnosis of CP.

Published: 2 February 2011

doi:10.1186/1532-429X-13-S1-O33
Cite this article as: Thavendiranathan *et al.*: CMR real-time, free-breathing, phase contrast flow quantification: a novel approach to assess ventricular coupling in constrictive pericarditis. *Journal of Cardiovascular Magnetic Resonance* 2011 **13**(Suppl 1):O33.