Vortex flow energy loss reflects therapeutic effect in dilated cardiomyopathy

Takeru Nabeta1, Keiichi Itatani2,3, Kagami Miyaji3, and Junya Ako1

1Department of Cardiovascular Medicine, Kitasato University School of Medicine, 1-15-1 Kitasato, Minami-Ku, Sagamihara 252-0374, Japan; 2Department of Cardiovascular Surgery, Kitasato University School of Medicine, Sagamihara, Japan; and 3Department of Hemodynamic Analysis, Kitasato University School of Medicine, Sagamihara, Japan

* Corresponding author. Tel: +81 42 778 8111; Fax: +81 42 778 8441, Email: keiichitatani@gmail.com.

A 52-year-old man was emergently admitted to our hospital for the treatment of congestive heart failure. Cardiac magnetic resonance imaging (CMR) showed left ventricle (LV) dilatation (LV end-diastolic volume: LVEDV 287 mL) and severe LV systolic dysfunction (LV ejection fraction: LVEF 18%). Enlarged heart size and interstitial fibrosis were observed in endomyocardial biopsy. Coronary angiography showed no stenosis or obstruction. Dyskinesia was observed and endomyocardial biopsy showed mild interstitial fibrosis leading to the diagnosis of idiopathic dilated cardiomyopathy (DCM). After 1 year of medication, LVEDV was deceased to 171 mL and LVEF improved to 34% by follow-up CMR.

From the two CMR studies, intramural LV geometry was extracted with Steady-State Free Precession series, and phase-contrast CMR was superposed. Blood flow was visualized and flow energy loss (EL) with viscous dissipation was calculated in-house code. Before the medication, LV inflow showed a large vortex during diastole. Inside the well-organized vortex, flow dissipated small EL, but around the vortex, EL was prominently high (Panels A–D). After the medication, the size of vortex during diastole decreased, and located in the basal portion, and the vortex facilitated the smooth outflow. Energy loss in this improved LV was significantly low especially in the mid and apical portion (Panels E–H). Total EL during one cardiac cycle reduced from 0.403 to 0.322 W/m (Panels I and J).

Blood flow patterns can change with the improvement LV muscular condition, resulting in EL decrease. Blood flow analysis and EL can be a novel parameter that reveal the clinical status in patients with DCM.

Supplementary material is available at European Heart Journal online.

doi:10.1093/eurheartj/ehu394
Online publish-ahead-of-print 29 September 2014

Issue @ a Glance