Clinical importance of the magnitude of left ventricular suction in heart failure: quantitative evaluation by vector flow mapping

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Background: Newly developed software Vector Flow Mapping (VFM, Hitachi) enables us to assess the blood flow velocity vectors that are computed from conventional color Doppler (CD) imaging data at any phase of a cardiac cycle without angle dependency. Previous studies reported that the blood flow toward the left ventricular (LV) apex during isovolumic relaxation (IR) was observed using CD imaging; a phenomenon of LV suction. Therefore, we measured the pressure gradient in the LV cavity to produce LV suction using VFM and investigated the clinical importance of LV suction in heart failure (HF).

Method: Study subjects consisted of 63 patients who underwent echocardiography for the assessment of LV function. Twenty seven of them had a history of HF hospitalization. CD images were acquired in the apical 3-chamber view using an echo equipment PROSOUND F75 Premier™(Hitachi). The analyses for flow velocity vector were performed offline using an echo image analyzer (DAS-RS1TM, Hitachi). A sampling line was set parallel to blood flow stream during IR from the level of mitral annulus to the apex, and the intraventricular pressure gradient during IR (IVPG-IR) was obtained. We also measured LV end-diastolic volume (LVEDV), LV end-systolic volume (LVESV), LV ejection fraction (LVEF) using modified-Simpson method, peak early-diastolic mitral annular velocity (e’), and propagation velocity of early-diastolic filling flow (Vp) using Doppler imaging.

Results: The IVPG-IR had significant correlations with LVESV, LVEF, e’ and Vp (r=0.55, p<0.0001; r=0.62, p<0.0001; r=0.27, p=0.03; and r=0.39, p=0.003, respectively). The average of IVPG-IR was significantly different between patients with and without HF (0.6±0.7 vs 1.8±1.4 (mmHg), p<0.0001). The cutoff value of IVPG-IR to detect the patients with HF was <0.5 mmHg (AUC=0.84, p <0.0001), and to detect patients with HF with preserved LVEF (=40%) was also <0.5 mmHg (AUC=0.72, p =0.01).

Conclusion: IVPG-IR is a surrogate parameter that reflects the magnitude of LV suction, and useful to detect patients with HF.