Echocardiographic particle image velocimetry in a patient with severe diastolic dysfunction

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Particle image velocimetry (PIV echocardiography; software: Hyper Flow®, version 6.0.2.0), applied to contrast-enhanced echocardiographic images, is a new technique to display and quantify blood flow velocity and direction and allows new insights into typical cardiac blood flow patterns, such as vortices. A vortex is a mass of fluid with a circular motion containing kinetic energy.

The growing knowledge about the structure and function of the left ventricle (LV) was of high interest to us in the context of ventricular vortex development in patients with diastolic dysfunction. Vortex structures are supposed to increase cardiac efficiency by maintaining the momentum of the inflowing blood in diastole and, thus, facilitating systolic ejection of blood into the LV outflow tract. The demonstration of diastolic vortex formation in normal human hearts led to our study objective to what extent blood flow patterns in diastolic dysfunction are different from normal ones.

The figure demonstrates the comparison of the two-dimensional apical four-chamber view and location and morphology of the average left ventricular vortex flow pattern between a normal individual and a patient with hypertrophic cardiomyopathy with severe diastolic dysfunction. The centre of the average vortex flow was located near the apex in the normal. However, in the patient with diastolic dysfunction, more chaotic flow patterns could be observed without clear vortex formation, indicating a disturbed haemodynamic during diastole. The colour coded flow data represent a positive vorticity with a counterclockwise rotation of the blood (red). The blue colour represents negative vorticity with clockwise rotation.

Supplementary material is available at European Heart Journal online.

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