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Vortices formed on the mitral valve tips aid normal left ventricular filling

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For the left ventricle to function as an effective pump it must be able to fill from a low left atrial pressure. However, this ability is lost in patients with heart failure. We investigated the fluid dynamics of the left ventricle filling by imaging the blood flow in patients with healthy and impaired diastolic function, using 2D phase contrast magnetic resonance imaging and we quantified the intraventricular pressure gradients and the strength and location of the formed vortices. We found that during early filling in normal subjects, prior to the opening of the mitral valve the flow moves towards the apex and subsequently at the time of the opening of the valve the rapid movement of the mitral annulus away from the left ventricle apex enhances the formation of a vortex ring at the mitral valve tips. Instead of being a passive byproduct of the process as was previously believed, this vortex ring facilitates filling by reducing convective losses and enhancing the function of the left ventricle as a suction pump. Impairment of this mechanism contributes to diastolic dysfunction, with the left ventricle filling becoming dependent on left atrial pressure, and eventually leading to heart failure.

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