Engineers develop novel ultrasound technology to screen for heart conditions

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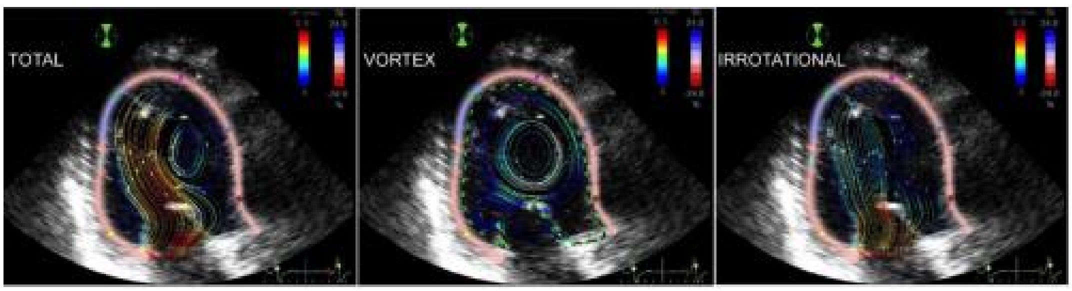

Researchers separeted the total 2D-velocity field of intra-ventricular flow (left) into a vortex field (center) and an irrotational field (right). Credit: Jacobs School of Engineering

Engineers at the University of California, San Diego have determined for the first time the impact of a ring-shaped vortex on transporting blood flow in normal and abnormal ventricles within the human heart. They worked with cardiologists at the Non-Invasive Cardiology Laboratory at Gregorio Marañon Hospital, in Madrid, Spain.

In order to make the study possible, researchers have developed a novel ultrasound technology that makes screening cheaper and much easier, making it possible to reach a large number of people and even infants. Intra-ventricular flow imaging is currently done with MRI scans, which is expensive and not suitable for patients with implanted devices such as pacemakers.

The findings could have an impact on the tests and measurements that physicians rely on to diagnose and treat two heart conditions: hypertrophic cardiomyopathy, in which the heart muscle becomes abnormally thick, and non-ischemic dilated cardiomyopathy, in which the heart's ability to pump blood decreases as the organ's main pumping chamber, the left ventricle, is enlarged and its muscle thinned.

Nearly one million Americans suffer from either one of these conditions.

So far, physicians only take into consideration the geometry of the left ventricle and the thickness and contractility of its walls when they assess how the heart fills itself with blood. But the way the blood flows into the heart's chambers is important too, researchers argue. "This isn't like toothpaste coming out of a tube," said Juan Carlos del Alamo, professor of mechanical and aerospace engineering at the Jacobs School of Engineering at UC San Diego, who led a multidisciplinary team for this study, together with postdoctoral researcher Pablo Martinez-Legazpi and Dr. Javier Bermejo's group of cardiologists at Gregorio Marañon Hospital.

They reported their findings in the Oct. 21 issue of the *Journal of the American College of Cardiology*.

"We are trying to shape the view of diastolic dysfunction to include flow patterns as a mechanism that modulates the chamber's resistance to filling—in addition to the wall's own stiffness," said del Alamo.

People suffering from hypertrophic and dilated cardiomyopathies often don't show symptoms of the condition until it's too late— making early screening of paramount importance. When patients are not diagnosed early, these conditions have unfavorable prognosis— worse than a number of cancers—with most of the patients dying within five years.

For this study, the team of cardiologists recruited 60 subjects, including 20 patients with non-ischemic dilated cardiomyopathy; 20 patients with hypertrophic cardiomyopathy; and 20 healthy subjects as a control group.

All subjects underwent comprehensive 2D echocardiographic exams. Then, engineers processed the images with methods typically used to create flow simulations for the aeronautical and naval industries, capturing the blood flow inside each subject's hearts.

Researchers found that the ring-shaped vortex helps to allocate about 15 percent of the blood flow within the left ventricle in healthy patients; roughly 20 percent in patients with non-ischemic dilated cardiomyopathy; but only about 5 percent for patients with hypertrophic cardiomyopathy.

"It is always difficult to determine if the heart is filling properly," del Alamo explained. "This new method will bring physicians a step closer to doing so." Treatment therapy for cardiomyopathies often includes devices implantation, such as pacemakers, to regulate blood flow within the heart. The data from these new imaging modalities could be instrumental, helping physicians to properly set up the devices, optimizing blood flow.

Provided by University of California - San Diego