Non-invasive measurements of tricuspid valve anatomy can predict severity of valve leakage

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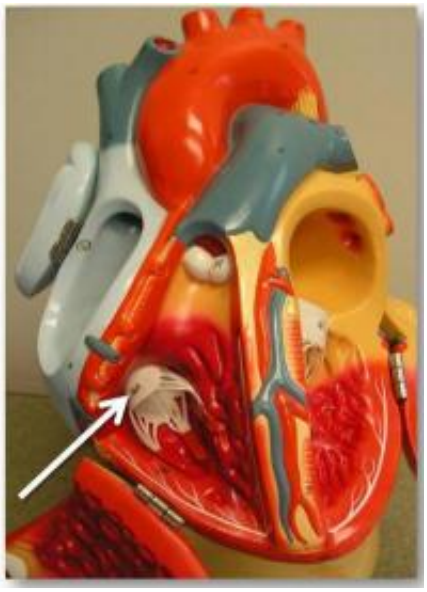

A heart model with an arrow pointing to the white tricuspid valve. A new study found that the anatomy of the heart's tricuspid valve can be used to predict the severity of leakage in the valves, which is a condition called tricuspid regurgitation. Credit: Robert Swatski

An estimated 1.6 million Americans suffer moderate to severe leakage through their tricuspid valves, which are complex structures that allow blood to flow from the heart's upper right chamber to the ventricle. If left untreated, severe leakage can affect an individual's quality of life

and can even lead to death.

A new study finds that the anatomy of the heart's tricuspid valve can be used to predict the severity of leakage in the valve, which is a condition called tricuspid regurgitation. The study, conducted by researchers from the Georgia Institute of Technology and Emory University, found that pulmonary arterial pressure, the size of the valve opening and papillary muscle position measurements could be used to predict the severity of an individual's tricuspid regurgitation.

"By being able to identify and measure an individual's particular tricuspid valve anatomical features that we have shown are correlated with increased leakage, clinicians should be able to better target their repair efforts and create more durable repairs," said Ajit Yoganathan, Regents' professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University.

The study was published in the January issue of the journal *Circulation: Cardiovascular Imaging*. Funding for this work was provided by the American Heart Association and a donation from Tom and Shirley Gurley.

Yoganathan and recent Coulter Department doctoral graduate Erin Spinner teamed with Stamatios Lerakis, a professor of medicine (cardiology), radiology and imaging sciences at Emory University, to non-invasively collect 3-D echocardiograms from 64 individuals who exhibited assorted grades of tricuspid leakage. Subjects included 20 individuals with "trace," 13 with "mild," 17 with "moderate" and 14 with "severe" tricuspid regurgitation. The subjects with "mild" to "severe" leakage exhibited a mix of isolated right, isolated left, and both right and left ventricle dilation.

From the 3-D echocardiography images of the heart they collected, the

researchers measured (1) the area of the annulus, which is the fibrous ring that surrounds the tricuspid valve opening; (2) the distance between the annulus and the three right ventricle papillary muscles, which keep the valve shut when the ventricle contracts; and (3) the position of the papillary muscles with respect to the center of the annulus. The clinicians also measured pulmonary arterial pressure using standard clinical methods and assessed the grade of tricuspid regurgitation from "trace" to "severe" with color Doppler imaging.

In collaboration with Emir Veledar, an assistant professor and statistician in the Rollins School of Public Health at Emory University, the researchers found statistical differences between individuals with ventricular dilation and the control subjects in the parameters of pulmonary arterial pressure, annulus area and papillary muscle displacement. They also found that all three factors were correlated with the grade of tricuspid regurgitation.

"This study's use of advanced cardiovascular imaging, and more specifically 3-D echocardiography, provided new insight into the pathophysiology of tricuspid regurgitation and a good understanding as to why current surgical treatments for tricuspid regurgitation are not good enough," explained Lerakis. "I believe this study will change the focus and direction of future surgical therapies for tricuspid regurgitation only to make them better and more durable."

Based on the findings of this study, said Lerakis, future surgical therapies should not only be focused on the tricuspid annulus, but on the entire tricuspid valve apparatus, including the tricuspid valve papillary muscles and their three-dimensional location within the apparatus.

Individuals in the study with left ventricle dilation exhibited significant displacement of one of the papillary muscles and patients with both ventricles dilated had significant displacement of two papillary muscles.

Subjects with right ventricle dilation showed significant displacement of all three papillary muscles.

The researchers also found that patients with a dilated right ventricle were more likely to have a dilated annulus and exhibited the highest pulmonary arterial pressures and highest levels of tricuspid regurgitation. However, not all patients with a dilated right ventricle had significant increases in annulus area, providing evidence that the right ventricle may become dilated without the annulus being affected.

"We think an increase in pulmonary arterial pressure caused geometric changes in the ventricle, which resulted in alterations to the annulus and papillary muscles," explained Yoganathan. "The combination of displacement of all three papillary muscles and annular dilatation may account for the patients with isolated right ventricle dilatation having the largest percentage of severe tricuspid regurgitation."

Knowing which parameters are responsible for significant tricuspid regurgitation and having a non-invasive imaging technique to measure these parameters should help clinicians target repairs to the specific cause of an individual's tricuspid leakage, according to Yoganathan.

In future studies, the researchers plan to study papillary muscle displacements in individuals with specific diseases to see if different disease manifestations exhibit different characteristics.

"Although it has long been accepted that pulmonary hypertension may result in tricuspid regurgitation, this study is one of the first to provide a clinical correlation between the two," said Yoganathan, who is also the Wallace H. Coulter Distinguished Faculty Chair in Biomedical Engineering. "We want to know whether treating an individual's pulmonary hypertension, and thus decreasing one's pulmonary arterial pressure, can reverse the geometric changes that are causing tricuspid

regurgitation and return the annulus and papillary muscles to their original positions."

Provided by Georgia Institute of Technology