UC San Diego NEWS RELEASE University Archives. RSS 6020

UCSD experts team up to develop better models of turbulent flow in diseased hearts

November 16, 1988

Contact: Yvonne Baskin, (619) 534-3120

[EDITORS: Color slides of computer-enhanced images of turbulent flows are available.]

For PMS Release Wednesday, November 16, 1988

UCSD TEAM MODELING TURBULENT FLOW IN DISEASED HEARTS

Like the exhaust from a jet engine or the air streaming over an aircraft's wings, a jet stream of blood flowing through a damaged heart valve may shatter into turbulent whorls and eddies.

Through a stethoscope, a physician hears this turbulent flow as a heart murmur. The advent of ultrasound Doppler flow mapping and magnetic resonance imaging (MRI) techniques has enabled cardiologists to visualize complex flow patterns within the heart.

"But our clinical judgments are still based on a rather unsophisticated and oversimplified understanding of the physics of flow," said David J. Sahn, a pediatric cardiologist at the University of California, San Diego.

Sahn's team has begun a major collaboration with UCSD experts in fluid dynamics led by Morteza Gharib to develop better models for interpreting and making diagnoses from MRI and ultrasound data.

Results from the first stage of the project were reported November 16 at an American Heart Association meeting in Washington, D.C., by Dorian Liepmann, a graduate student in applied mechanics and engineering sciences (AMES) at UCSD.

"Physicians know that when you have turbulence, you lose the MRI signal," said Gharib, an associate professor of mechanical engineering in AMES. "But if you can understand the nature of the turbulence, you should be able to process the MRI signal in a way that allows you to interpret what is happening in the heart."

Improved clinical information from such tests is especially important in valvular heart disease such as mitral stenosis or regurgitation--a forward obstruction or a leaking backward of the flow through the mitral valve.

"This will help clinicians fine-tune the management of patients," Sahn noted, "by enhancing the use of these noninvasive techniques to monitor the impact of drug treatment on the efficiency of the heart and to make better predictions about the need for surgery."

Liepmann reported that the team has developed three new state-of-the-art methods for visualizing and measuring the velocity of complex flows. The techniques are not meant for use in the body but will be used on small-scale models containing various mechanical or bioprosthetic valves that the team is building to simulate various forms of heart malfunction. The same models will then be studied using MRI and ultrasound to better correlate the images a physician sees with the sophisticated information on flow patterns or behaviors obtained in the lab.

"Our goal is to broaden the clinical understanding of what our imaging tests are showing," Sahn said.

According to Liepmann, the three measurement techniques developed in Gharib's group are:

--A new automated particle tracking system that monitors the pattern and velocity of the flow by taking a series of snapshots of fluorescent particles released into the flow.

--A system using two jets of water, each a different temperature, color-coded by heat-sensitive liquid crystal particles. The dynamics of each jet and the interactions as the differently colored flows mix and swirl can be monitored photographically.

--A 10-point laser Doppler velocimetry technique to make precise measurements of the velocity of the flow.

"This collaboration between physical scientists and medical scientists at UCSD holds promise for advancing the applications of new noninvasive diagnostic techniques in heart patients," Sahn said.

University of California, San Diego engineers and physicians are using state-of-the-art methods for visualizing and measuring the velocity of complex flows in order to help clinicians make more precise diagnoses of heart disease from ultrasound and magnetic resonance imaging data. The color spectrum in these computer-enhanced images of turbulent flows represents the density of the fluid, from blue at the lowest density to red at the highest. (Photos attached).

TOP: Side view of a jet stream.

BOTTOM LEFT: Cross section of a jet stream.

BOTTOM RIGHT: MRI image of a torso (heart is center blue mass).

Slides of these images are available from University Communications at UCSD. Please call Yvonne Baskin at (619) 534-0362 or 534-3120.

(November 16, 1988)