Research links damaged organs to change in biochemical wave patterns

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By examining the distinct wave patterns formed from complex biochemical reactions within the human body, diseased organs may be more effectively identified, says Zhengdong Cheng, associate professor in the Artie McFerrin Department of Chemical Engineering at Texas A&M University, who has developed a model that simulates how these wave patterns are generated.

His findings, which appear in the October issue of the journal *"Physical Review E,"* detail Cheng's work with a system designed to model cells in a biochemical environment, similar to what occurs inside the human body.

His system utilizes two types of resin beads to represent cells. Those beads loaded with a catalyst are referred to as active and represent living cells. Those beads that are not loaded with a catalyst are referred to as inactive and represent diseased or dead cells.

In contrast to previous experiments that have only focused on the effects of active beads, Cheng's system is the first to examine the effects of inactive beads, particularly the effects of significant increases in the inactive bead population within a system.

Because the beads within the sample represent cells, the increase in inactive beads, Cheng explains, simulates a higher percentage of dead or diseased cells within an organ, such as the heart.

What Cheng found is that as the population of inactive beads increases, the resulting wave patterns transform from target-shaped to spiral-shaped. The inference, Cheng notes, is that as tissue of an organ becomes more diseased and greater numbers of cells die, the biochemical reactions involving that organ will produce spiral wavelets instead of target wavelets.

This corresponds, Cheng notes, to observations made with electrocardiograms that reveal a change from pane-wave to spiral wavelets accompanying the procession from normal sinus rhythm to ventricular fibrillation, a cause of cardiac arrest.

Recognizing these wave patterns and what they represent, Cheng says, may lead to a better and more timely understanding of the structure of a diseased organ. This knowledge, he adds, could help determine whether an organ is becoming diseased as well as the extent of damage to an organ once it is diseased.

"For example, fibrotic nonexcitable 'dead' tissue normally presents as a small percentage of normal heart tissue," Cheng says. "As a result of aging, after a heart attack, or in the case of cardiac myopathies, the percentage of fibrotic tissue increases dramatically, up to 30 or 40 percent.

"In a scenario such as this, given our findings, we would expect to see more spiral-shaped wavelets when examining an organ that has incurred structural damage. A further increase in spiral wavelets could potentially signal an even greater percentage of structural damage to the heart," Cheng says.

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