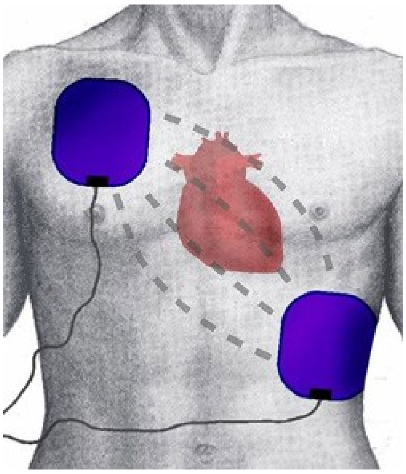
New method defibrillates heart with much less electricity - and pain

Cornell scientists, in collaboration with physicists and physician-scientists in Germany, France and Rochester, N.Y., have developed a new - and much less painful and potentially damaging - method to end life-threatening heart fibrillations.



(Image: Wikimedia Commons)

The new technique, which is reported in the 14 July issue of the journal *Nature*, cuts the energy required for defibrillation by 84%, compared to conventional methods.

In healthy hearts, electrical pulses propagate across the heart muscle in an orderly fashion to control the heart's contraction and relaxation cycle at regular intervals. However, when the electrical pulses propagate throughout the heart chaotically, it disables the regular heartbeat and prevents the body from getting fresh supplies of blood.

One of these rhythm disturbances, called atrial fibrillation, is the most common sustained cardiac arrhythmia worldwide, affecting about 1% of the population, mostly people older than 50 years.

Defibrillation

Patients who suffer repeatedly from atrial fibrillation are typically treated with a large electrical pulse (defibrillation), which forces the heart back into its regular beating but is painful and can damage the surrounding tissue.

The new method, LEAP (Low-Energy Anti-fibrillation Pacing), developed by a team co-led by Cornell College of Veterinary Medicine researcher Flavio Fenton, uses a heart catheter to create a sequence of five weak electrical signals in the heart.

"Only a few seconds later, the heart beats regularly again," said the team's other co-leader, Stefan Luther of the Max Planck Institute for Dynamics and Self-Organisation (MPI DS) and a Cornell adjunct professor in biomedical sciences.

"The energy applied to the heart per pulse is on average 84% less than in conventional methods," added Fenton.

Seem similar, but...

Even though both methods seem to function similarly at first sight, they stimulate completely different processes within the heart, explains co-author Robert Gilmour, professor of physiology at Cornell. "The classical defibrillator excites all cells of the organ at the same time. For a short moment they can no longer transmit any electrical signals; the life-threatening chaotic activity is terminated. Afterward, the heart resumes its normal, regular beating. The situation can be compared to turning a malfunctioning computer off and on again," said Gilmour.

The new method terminates the turbulent electrical activity within the heart step by step. In experiments and computer simulations, the researchers showed that natural heterogeneities within the heart, particularly blood vessels, can act as the origins for synchronising waves. "The weak electrical signals are enough to create "virtual electrodes" that stimulate the cells in these regions," said Eberhard Bodenschatz, director at MPI DS and Cornell adjunct professor of physics and mechanical and aerospace engineering.

A giant LEAP

With every additional pulse, more heterogeneities in the heart are activated and gradually suppress the chaotic activity and "reprogram" the heart.

Because the researchers consider LEAP groundbreaking, they are working to get it to patients as quickly as possible.

Other collaborators include researchers at the Ecole Normale Supérieure de Lyon (France), University Medicine Göttingen (Germany), Rochester Institute of Technology and the Laboratoire Non-Linéaire de Nice (France) collaborated on the work.

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