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FCVB 2014: Atrial Defibrillation Without Electric Shock

Electric shocks are effective in treating atrial fibrillation (AF) but they are painful and eventually stop working when AF becomes chronic. A new shockless method of defibrillation returns sinus rhythms to normal using optogenetics. Depolarising ion channels are genetically inserted into the heart and can be activated by light during AF episodes. The findings were presented on 4 July at the Frontiers in Cardiovascular Biology (FCVB) conference in Barcelona.

Dangers of Atrial Fibrillation

Patients with atrial fibrillation experience the disquieting feeling of an irregularly beating heart, along with fatigue and an inability to exercise. Worse than the discomfort associated with AF, the condition can cause cardiomyopathy induced by tachycardia, and there is an increased risk of morbidity and death due to the possibility of thromboembolism.

Adverse Effects of Shock

Defibrillation works by depolarising the myocardium to return the heart to a regular rhythm. Electric shock treatments are one way to achieve a synchronised state during AF, but they have at least two disadvantages. First, patients must first receive anaesthesia, which comes with the possibility of adverse effects. Second, electric shocks lose their efficacy in patients with chronic AF, when the atrium has undergone structural changes from persistent episodes and arrhythmia is present continuously.

An Optogenetic Solution

By developing a unique 2D model of the heart using isolated muscle cells from rat hearts, Dr. Brian O. Bingen and his colleagues were able to peer into the dynamics of cardioversion. A total of 31 2D hearts were created by the formation of intercellular connections between the cardiac muscle cells, which were replated in culture dishes. It was necessary to have such a view, since the complex 3D heart hides subepicardial activity related to atrial fibrillation.

The researchers induced AF into the 2D hearts and inserted a gene called calcium-translocating channelrhodospin (CatCh) using a lentivirus. CatCh is a depolarising channel which is sensitive to light. When a light was switched on by the researchers, all 31 of the 2D hearts experienced a return to normal sinus rhythms.

From 2D to 3D

More research will be needed to evaluate whether the defibrillation-by-light method will work in 3D hearts. “In theory, the patient could be given an implantable device with a mesh of light emitting diodes (LEDs) and when AF occurs you turn the light on and the AF stops,” said Dr. Bingen. In addition to light, other externally-applied sources of energy might also be effective in penetrating the body. Avoiding the need for an implanted device would further reduce the invasive nature of current defibrillation treatments.

FCVB

The FCVB is organised by the European Society of Cardiology’s Council on Basic Cardiovascular Science in close collaboration with 13 cardiovascular science societies throughout Europe. It takes place every two years, most recently between 4 and 6 July at the Palau de Congressos de Catalunya in Barcelona, Spain.

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