Chapter VI

Appendix III

CardioPulse: first evidence for shockless atrial fibrillation treatment

Cardiac optogenetics achieve defibrillation without the pain of electric shocks.

Taylor J.

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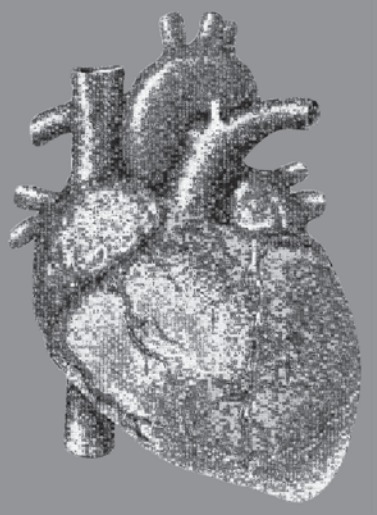

The first evidence for a shockless treatment for atrial fibrillation (AF) was presented at Frontiers in CardioVascular Biology 2014 in Barcelona, Spain. Electric shocks are the quickest way to bring AF patients back to normal sinus rhythm and prevent symptoms and complications. But shocks are very painful and require anaesthesia, which comes with its own possible adverse effects. Atrial fibrillation usually progresses froma paroxysmal form, in which episodes of AF last fromseveralminutes up to 7 days, to a persistent and eventually a chronic form. People with the latter are in AF 24 h a day, 7 days a week, and shock treatment no longer works. Dr Brian O. Bingen, first author, said: 'AF causes structural changes to the atrium which make patients more prone to subsequent induction of AF. That's another reason toget patients back into sinus rhythmas soon as possible'. The researchers devised a method of shockless defibrillation. They used optogenetics to genetically insert depolarizing ion channels into the heart that can be activated by light. Dr Bingen said: 'The theory was that we could just turn a light switch on and depolarize the entire myocardium without needing a shock. 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'. During arrhythmias there is subepicardial activity, but the heart is a complex three-dimensional structure and it is only possible to directly observe the epicardium. To see howtheir method worked subepicardially, the researchers developed two-dimensional (2D) hearts. They isolated cardiac muscle cells from the rat atrium, replanted them in a culture dish and allowed the cells to form intercellular connections, creating a 2D heart. Atrial fibrillation was induced in 31 of these 2D hearts. The researchers used a lentivirus to insert a gene into the 2D hearts called calcium-translocating channelrhodopsin, which is a lightsensitive depolarizing channel. Dr Bingen said: 'Then it was just a matter of switching on the light and seeing what happened.We found that in all 31 of these 2Dhearts we were able to achieve the2Dequivalent of cardioversion into sinus rhythm. The mechanismwe sawwas slightly different than the normal defibrillation but was equally effective'. He continued: 'We nowhave to test our method in the 3D setting. In that scenario we won't be able to see the defibrillating mechanism in as much detail, but we hope that it will be possible to terminate AF in the complete heart.We will also test other types of light or energy sources that penetrate the body more deeply and could be applied externally, avoiding the need for an implanted device'. Dr Bingen concluded: 'This is the first evidence of a shockless defibrillation. Ourmethodof using optogenetics to defibrillate by light is completely painless and looks promising, but more research is needed before it can be applied in patients'.

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CONFLICT OF INTEREST

None declared.