Scientists devise gentle technique to study heart tissue functioning

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Biophysicists from the Moscow Institute of Physics and Technology and their colleagues have proposed a simple way to observe the heart tissue. Besides being relatively uncomplicated, the new method is cheaper and produces results that are more independent, compared with the analogs

currently in use. The study came out in *Annals of Biomedical Engineering*.

Heart tissue is a special kind of muscle. When excitation waves propagate through it, this causes the constituent fibers to contract. The excitation waves coordinate the work of the heart compartments to ensure the organ functions correctly.

Many heart diseases, among them arrhythmias, are associated with disruptions in excitation wave conduction or with some peculiar propagation regimes taking over. This is why fundamental research into the mechanisms of excitation wave propagation in the heart is important. Such studies provide insights into how the heart functions, how arrhythmias arise, and how various drugs and substances affect the processes in the cardiac tissue.

One of the staple methods for observing excitation waves is optical mapping. It involves the use of fluorescent dyes to visualize the propagation of excitations in the heart tissue. The process is monitored with sensitive video cameras, and the resulting data are then subjected to analysis.

Optical mapping has certain drawbacks. For one thing, the dyes and cameras suitable for the technique are fairly expensive. Another disadvantage is that the dye may interact with drugs and thus disturb the experiment. The dyes also affect the cells in the heart tissue sample, reducing their lifetimes.

"We found that if you grow the cardiac tissue culture on an elastic substrate made of polydimethylsiloxane, it is possible to observe wave propagation with a microscope, and no dyes are needed," said Konstantin Guria, a senior researcher at the MIPT Laboratory of the Biophysics of Excitable Systems.

This idea laid the foundation for the new method. In it the heart tissue is cultivated on an elastic substrate. As a result, when an excitation wave propagates across the sample in the experiment, the substrate deforms. This process can be optically registered via oblique illumination. The technique eases camera requirements, because even a GoPro provides sufficient quality.

"We have proposed a method that is simpler and cheaper than conventional mapping. That said, an even greater competitive advantage is being sure that the analyzed substance does not interact with a dye, since it becomes redundant for visualization," commented Konstantin Agladze, who heads the Laboratory of the Biophysics of Excitable Systems at MIPT.

The new method can be used for affordable testing of various processes on tissue cultures grown from stem cells. The process lends itself to automation and is suitable for longer observations than those that rely on regular mapping.

In addition to MIPT staff, this study involved researchers from Vladimirsky Moscow Regional Research and Clinical Institute and the Institute of Theoretical and Experimental Biophysics of the Russian Academy of Sciences.

More information: Viktor A. Balashov et al, Muscular Thin Films for Label-Free Mapping of Excitation Propagation in Cardiac Tissue, *Annals of Biomedical Engineering* (2020). DOI: 10.1007/s10439-020-02513-0

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