A new bioreactor for the development of beating cardiac patches


Abstract

Objectives:
The development of functional myocardial patches requires several different tools, the most complex currently being the bioreactor. An ideal bioreactor for this task imitates the conditions inside the beating human heart so that the conditioned cells begin to beat, mimicking cardiomyocytes.

Methods:
The bioreactor engineered in our laboratory addresses two important variables in tissuegenesis of cardiac tissue. Firstly, the cell-seeded patches are stimulated using an electrical circuit. The electrical current imitates the ECG of physiological heart tissue in-vivo. Secondly the flow, created by a piston inside the bioreactor, is programmed to mimic the flow in the living heart. To achieve this, an ideal biomimetic flow curve is produced by programming the piston movement. The bioreactor consists of a Plexiglas shell with a custom built piston in the medium chamber. At the top of this chamber there is a ring for patch fixation.

Results:
The architecture of the system allowed easy visualization of the medium flow as well as inspection of the ring for patch fixation. Seven day function testing showed that the bioreactor permits effective and sterile conditioning. Microbiological analysis of the used medium revealed no bacterial contamination. During this trial run various amplitudes and cardiac outflow rates were successfully tested.

Conclusion:
Unlike any other current bioreactor in myocardial tissue engineering our bioreactor achieves simultaneous electrical and mechanical stimulation. Both these stimuli as well as chemical signaling have been shown to be vital to cardiac tissue development. Combining chemical differentiation and electromechanical conditioning of stem cells in this bioreactor we hope to create a beating myocardial patch.