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Developing a Mechanical and Electrical Stimulation Apparatus in a Perfusion Bioreactor for Reseeded Decellularized Porcine ECM/h1

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The successful reseeding of tissue-engineered constructs, with regenerative cells, remains a substantial obstacle in achieving a functional tissue; especially when dealing with complex and thick cardiac constructs, such as decellularized porcine cardiac ECM (pcECM) that is largely investigated by our group. As such, any bioreactor system intended to perfuse and feed the pcECM should necessarily provide mechanical and electrical stimuli, which have been show to support and direct cell growth, differentiation and the overall tissue functionality. A bi-functional apparatus providing mechanical and electrical stimuli was incorporated into a perfusion bioreactor that was reported by us before to support the survival of mesenchymal stem cells, endothelial cells and cardiomyocytes reseeded onto decellularized pcECM. The high mechanical pressure required on the interior side of the heart wall is provided by a balloon placed under the tissue that is inflated and deflated using a syringe pump connected with a linear actuator mimicking the circulatory beating. The electrical action-potential, of the left ventricle, is simulated using an electrical output device attached to carbon electrodes placed into the perfusion chamber and creating an alternating electrical field. To achieve precise balance between the two rhythms, a computer-controlled input/output device collects data and controls both stimuli while monitoring other parameters such as the pH, oxygen, temperature etc. Future applications of this system, that are supported by preliminary results, include culturing pcECM scaffolds with regenerative cells and assessing the effect of the various stimuli on cell growth, differentiation and ECM remodeling by various single and co-cultures.