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Workshop

Generation of a biologically and mechanically suitable 3D structure for Heart Valve Tissue Engineering?



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Heart valve disease is one of the most important causes of mortality in the world. Although prosthetic valves have been widely used, prosthetic which grows with patient, maintains normal valve mechanical properties and hemodynamic flow has not been innovated. Tissue engineering offers exciting opportunity to engineer heart valves using biodegradable scaffolds and patients own cells. Heart valves are made up of spatially organized extracellular matrix (ECM) which consists of fibrous collagen and elastin and highly hydrated glycosaminoglycans. Valve interstitial cells (VICs) are the major cell types responsible for ECM remodeling in healthy valves. Elastin, proteoglycan and collagen-rich layers are the most important components of the ECM of valves. These elements due to distinct biomechanical properties to the leaflets and supporting structures

Objective: The objective of this workshop is generation of a proper 3D scaffold by mimicking heart valve structure.

Procedures: We want to show how integrated electrospun poly(glycerol sebacate) (PGS)-poly(ϵ -caprolactone) (PCL) microfiber scaffolds -reinforce hydrogel scaffolds for heart valve tissue engineering by use of methacrylated hyaluronic acid (HAMA) and methacrylated gelatin (GelMA). Hyaluronic acid is selected because it plays an important role during in heart valve morphogenesis. To enhance cellular properties, denatured collagen in form of GelMA will be added to HAMA. Hypothesis of this technique is that hydrogels provide an ECM in vivo mimicking environment and is an efficient means of encapsulating cells in desired density on the fibrous scaffolds. On the other hand, elastomeric PGS-PCL scaffolds will provide appropriate mechanical properties to otherwise weak hydrogel scaffolds. Presence of HA will promote secretion of elastin by valve interstitial cells (VICs). After teaching how to design and make this kind of composite and how to encapsulate VICs necessary biological and mechanical tests and analyses will be taught and discussed.

Conclusions: The composite scaffold synthesis in this workshop will overcome some of the limitations of current materials used for heart valve tissue engineering. The participants will observe that the hydrogel component provides an ECM-mimicking environment and efficient means of VICs cell delivery to the scaffold, while the fibrous PGS-PCL mesh maintains the cells' viability, allowing them to spread and distribute themselves within the hydrogel by providing appropriate mechanical properties to the otherwise weak hydrogel scaffolds. Furthermore, adding the hydrogel component will not adversely affect the scaffold's mechanical properties based on the similar values of both Young's modulus and the ultimate tensile strength of the bare PGS/PCL scaffolds and the composites. The mechanical and biological advantages of this composite scaffold can motivate further studies using this technology for potential application in heart valve tissue engineering. We hopefully look forward the participants to learning more about design of heart valve scaffolds and will be motivated to generate the most useful scaffold for the patients.

The following parts will be taught in this workshop:

- Design and synthesis of proper composite
- Encapsulation of VICs by composite
- Performance of appropriate biological and mechanical test
- Analysis of results of results