Hydrogels for Cardiac Tissue Engineering

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Technology description

Myocardial infarction (MI) is one the highest causes of mortality among cardiovascular diseases (CVD) in the United States. Promising approaches for treatment of MI include cell-based therapy and cardiac tissue engineering. In particular, cardiac tissue engineering, which is capable of mimicking the extra cellular matrix of myocardium structure, is a promising approach to try and recover the tissue or organ loss. Hydrogel-based scaffolds provide excellent 3D cross-linked matrices for specific applications in cardiac repair and regeneration. Unfortunately, inadequate cell adhesion points, and electrically insulated structure of conventional hydrogels ultimately lead to poor patch-myocardium integration. Incorporation of nanomaterials into the hydrogels having similar electrical characteristics and higher biocompatibility may provide ideal solution for applications in cardiac tissue engineering.
Researchers at Arizona State University have developed crosslinkable hydrogels with improved electrical and structural properties for cardiac tissue engineering and restoring loss of function. These hydrogels incorporate superior nanomaterials to enhance the electrical conductivity of the structure, facilitating signal propagation and cell-cell coupling within the hydrogel constructs. This electrically- and structurally-mediated cellular communications directly influences cell phenotype and eventually leads to enhanced tissue functionality. Testing of the materials showed that cardiomyocytes in in the hydrogels exhibited greater cell retention as well as maintained a high level of viability over the whole duration of culture. Further, the hydrogels demonstrated a robust synchronized tissue-level beating from day 3 to 7 of culture.
These hydrogel-based cardiac tissue patches provide a desirable microenvironment for cardiac cells to grow and integrate to the native heart tissue with superior electrical and structural properties.

Application area

Cardiac tissue patch
o Myocardial infarction
o Congenital heart defects

Advantages

• High electrical conductivity of the hydrogel constructs
• Easy fabrication and modification process for the hydrogel constructs and nanomaterials
• Diverse nanoscale architecture of nanomaterials
• High biocompatibility and minimized cytotoxicity
• High affinity for cell adhesion and spreading
• Improved cell-matrix interaction on the hydrogels
• Proper accommodation of cardiac cells resulting in excellent cell retention, spreading, homogeneous distribution of cardiac specific markers and cell-cell coupling
• Robust synchronized (tissue-level) beating behavior

Institution

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