TISSUE ENGINEERING AND BIOFABRICATION – FUTURE OF CARDIAC REGENERATION

Rabbi Syeda[1], Badalyan Albert[1], Babuci Angela[2]
[1]Faculty of Medicine no.2, *Nicolae Testemitanu* State University of Medicine and Pharmacy, Chisinau, Republic of Moldova
[2]Department of Anatomy and Clinical Anatomy, *Nicolae Testemitanu* State University of Medicine and Pharmacy, Chisinau, Republic of Moldova

Background: Cardiovascular diseases represent the leading cause of morbidity and mortality worldwide. Engineering biomimetic cardiac tissue to regenerate the heart has been an ambition in tissue engineering. Recent advances in stem cell biology, particularly human pluripotent stem cells, combined with sophisticated biofabrication techniques including 3D bioprinting, offer unprecedented opportunities for cardiac regeneration. The aim of the current study was to examine how tissue engineering and biofabrication approaches can be used for cardiac regeneration and provide new treatments for cardiovascular diseases. It collectively addresses several key objectives like, developing functional cardiac tissues, advancing biofabrication techniques, improving cell sources, maturation and clinical translation.
Materials and methods: A systemic review of relevant publications from Web of Science, Scopus, MEDLINE, PubMed, Google Scholar and Semantic Scholar databases has been done. The papers are primarily reviews and experimental studies examining tissue engineering approaches.
Results: The results reported in tissue engineering and biofabrication for cardiac regeneration include both significant advances and persistent challenges. Human pluripotent stem cells provide an unlimited source of cardiomyocytes for cardiac tissue development. Patient-specific engineered heart tissues are now possible using induced pluripotent stem cells, opening possibilities for personalized medicine. 3D bioprinting has demonstrated ability to create complex scaffold structures with precision and encapsulate cells effectively. Multiple biofabrication approaches have been developed including biomaterial-based, cell-based, and hybrid methods. Some cell-based approaches have progressed to multiple ongoing clinical trials.
Conclusions: Research has shown that tissue engineering and biofabrication represent promising but still developing approaches for cardiac regeneration. Engineering functional cardiac tissues is feasible and holds great promise for heart regeneration, though the field remains in its infancy. Beyond regeneration, engineered cardiac tissues successfully serve as platforms for drug discovery, disease modeling, and toxicity screening. Advances in stem cell biology and biofabrication techniques have provided unlimited cell sources and sophisticated manufacturing capabilities. Critical challenges remain, including achieving mature cardiomyocytes and developing clinically translatable technologies. While promising, these techniques are still experimental and require further research.
Keywords: 3D-bioprinting, stem cells, biofabrication, regeneration