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Opinion Article

Enhancing Stem Cell Engraftment in Cardiac Bone Marrow Transplantation

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DESCRIPTION

Mortality and morbidity rates from heart disease are high. Major heart disease known as Myocardial Infarction (MI) results in significant cardiac cell death and partial loss of heart function. Due to adult cardiomyocytes' inability to proliferate and the fact that only a few numbers of cardiomyocytes can be produced by cardiac stem cells on their own, the infarcted heart tissue cannot effectively recover on its own. As a result, heart function cannot be recovered. Another approach is stem cell treatment. It seeks to repair damaged heart tissue or enhance cardiac performance. For cardiac therapy, various cell types have been examined in both animal models and clinical studies.

Some stem cell varieties have the capacity to differentiate into cardiomyocytes in order to restore heart tissue, restoring heart function. These cells include cardiovascular progenitor cells produced from pluripotent stem cells as well as cardiac stem cells. Despite the fact that some stem cell types cannot develop into functional cardiomyocytes, they can have paracrine effects that improve heart function overall by vascularizing infarcted heart tissue, enhancing resident cardiac cell survival, and modulating immunological response. These stem cells come from a variety of sources, such as the bone marrow, adipose tissue, and Cardio Spheres (CDCs).

The infarcted heart receives a direct injection of stem cells in the bulk of recent animal research and clinical trials. However, about 90% of the cells are squeezed out of the injection site, leak into the bloodstream, or are lost to the circulation. Most of the cells that are still present in the infarcted tissue die during the first few weeks. Overall, the therapeutic efficacy of current stem cell therapy is restricted due to low cell engraftment. Inadequate cell attachment to the host tissue, severe ischemia, and extreme inflammation are the main causes of transplanted cell death. Anoikis is a type of adherent cell programmed cell death brought on by a poor or ineffective contact between the cell and the Extracellular Matrix (ECM). Adherent cells firmly stick to the surrounding ECM in healthy cardiac tissue. However, the ECM does not support robust cell attachment in the infarcted tissue. Additionally, the saltwater utilised for cell transplantation doesn't give the transplanted cells a matrix to connect to. Improving cell retention and survival is required to promote cell engraftment in infarcted hearts. Low viscosity saline cannot keep cells in tissue effectively; hence the former can be accomplished by employing viscous, injectable hydrogels as cell carriers. Biocompatible and biodegradable biomaterials should be used in stem cell transplants. They should, specifically, have a controlled rate of biodegradation that, ideally, matches the rate of new tissue regeneration. The degradation byproducts ought to be harmless. The ideal biomaterials would replicate the mechanical characteristics of the heart tissue, such as rigidity. Both natural and synthetic polymers have been used for stem cell transplantation. This will reduce the high wall stress and improve cardiac performance. Natural polymers are products of biological origin. Some of them have been utilised to transfer stem cells into infarcted hearts, including fibrin, alginate, collagen, Matrigel, hyaluronic acid, and chitosan. Although most growth factors have a rather brief half-life, this poses a problem for their use in stem cell transplantation. Approaches to solve this issue include genetically altering stem cells to encourage the secretion of prosurvival and proangiogenic growth factors as well as the prolonged release of growth factors *via* biomaterials. For cells to survive, oxygen is essential. Significant cell death occurs in the infarcted heart due to the abnormally low oxygen content. To increase cell survival, stem cell transplantation with an oxygen release system is seen to be a workable solution.

CONCLUSION

For cardiac therapy, stem cell therapy is regarded as a powerful and promising strategy. Only a small portion of the transplanted cells engrafted in the infarcted tissue, limiting the effectiveness. The limited cell engraftment is primarily caused by low cell retention and poor cell survival. Scaffolds and hydrogels can be used to increase cell retention. Because injectable hydrogels may be administered using a minimally invasive injection technique, they may be more practical for cell administration than scaffolds. The high viscosity of injectable hydrogels increases cell retention. However, a lengthy gelation period might prevent the hydrogels from significantly increasing cell retention because the cells might be forced out of cardiac tissue or flushed into the bloodstream before gelation.

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