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The Potential Role of Human Induced Pluripotent Stem Cells (Hipsc) - Derived In Cardiomyocytes in Cardiovascular Disease – Review

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Abstract

Cardiovascular disease (CVD) is a disturbing health problem accounts for a huge proportion of mortality worldwide. Existing treatment is restricted and research is ongoing to discuss this severe health problem. As mortality rates rise, the demand for innovative therapeutics has pressed the pharmaceutical engineering to discover unconventional methodologies for CVD drug development. The beginning of human induced pluripotent stem cell (hiPSC) technology has rejuvenated the efforts in the previous decade to recognize more completely the prospective of human embryonic stem cells for scientific research. From these cells, cardiac progenitors and Cardiomyocytes can be resultant by numerous procedures and most current developments as well as outstanding restrictions are presently discussed. Adding to the opportunity of generating an unconstrained amount of several cell types of interest, hiPSC technology now aids the beginning of cells with patient-specific phenotypes. Given the overview and application of the large-scale Precision Medicine Resourcefulness, hiPSC technology will undoubtedly have an important role in the progression of cardiovascular research and treatment. Because iPSCs transport the indistinguishable genetic anomalies associated with those disorders, iPSCs are an ideal platform for medical research. This broadsheet gives a summary of the present applications of induced pluripotent stem cells in cardiovascular drug improvement and highlights active parts of research in the direction of functional restoration of the damaged heart.

Keywords: Cardiac Function; Cardiovascular disease

Introduction

Cardiovascular disease (CVD) remains one of the major causes of morbidity and mortality worldwide, leading to more than 17.5 million death cases is documented global per annum [1]. CVD is capable to terminate for all diseases of the cardiac muscle and circulatory system, including heart failure, stroke, deposition of cholesterol containing plaques in the arterial wall, resulting in vessel wall-thickening and narrowing of the vascular lumen [2]. The narrowing of coronary arteries leads to decreased blood flow and causes cardiomyocyte ischemic injury. Due to the cardiomyocyte, with unexpected loss of oxygenated blood to the heart, a complete blockage of the vessel causes myocardial infarction (MI), leading to cell necrosis and massive loss of cardiomyocytes and leads to massive cell death, a transient pro-inflammatory environment and permanently injured myocardium [3]. Due to the spectrum of ischemic cardiomyopathy, encompassing acute myocardial infarction to congestive heart failure is a significant clinical issue in the modern era. This group of disease patients frequently shows unresponsive to current medical treatments, which are limited in both availability and effectiveness is an enormous source of morbidity and mortality and underlies significant healthcare expenditure worldwide [4].

On the other hand, developing new technology research in the field of stem cell-based approaches, stem cell therapy and cardiac tissue engineering have been thus studied with the goal of better maintaining myocardial disease [5]. The intriguing and exciting prospects for stem cells with properties of self-renewal, clonogeneticity, and multi-potentiality, have been held for several years to present huge potential in the study of disease and have generated enormous prospects in relation to achievable applications. Widespread preclinical and clinical trials have investigated a number of cell types for cardiac rejuvenation including skeletal myoblasts, Mesenchymal stem cells (MSCs) (bone marrow derived and adipose derived), Embryonic stem cells (ESCs), and cardiac stem cells [6]. Although most cell types have produced promising results in vitro and in preclinical

studies, and have been exposed to be safe in clinical trials, and cardiac stem cells have shown the most assure in terms of efficacy. Stem cell technology also allows the proliferation of cardiomyocytes to a high quantity, providing a readily available source of human cardiomyocytes opening new doors for the study of cardiovascular disease [7].

Due to the successful generation of human induced pluripotent stem cells (iPSCs) was recognized autonomously in 2006 by the scientists Takahashi and Shinya Yamanaka [8]. The scientists successfully acknowledged a minimum number of nuclear factors that possibly will reprogram terminally differentiated fibroblasts to pluripotent cell lines by exogenously expressing separate yet overlapping sets of transcription factors through retroviral transduction. The grouping of four transcription factors used for cellular reprogramming is Sex Determining Region Y-Box 2 (Sox2), Kruppel-Like Factor 4 (Klf4), c-Myc Avian Myelocytomatosis Viral Oncogene Homolog (cMyc) and POU Class 5 Homeobox 1 (Oct3/4) into terminally differentiated murine fibroblasts. The four types of factors also called as also known as the Yamanaka factors. The nature of these iPSCs had growth properties, morphology and gene expression characteristics similar to ESCs [9]. In 2007, iPSCs were generated from human origin, using the same combination of transcription factors (KLF4, SOX2, cMYC and OCT3/4) or mediated via SOX2, OCT3/4, Lin-28 Homolog A (LIN28) and Nanog Homeobox (NANOG) [10]. Scientist's efforts to develop such technique have yielded iPS cells derived from human CD34+ blood stem cells and T lymphocytes [11]. However, ESCs, iPSCs has a membrane of growth factors like BMP4, Activin/Nodal and Wnt signalling pathways plays an important role in cardiomyogenesis. The cardiogenic possible of the iPSC inhabitants has been extensively deliberate with iPSCs derived from mice and human. These considerable innovations have opened up new frontiers in medical science in scores of compliments. More interestingly, iPSCs administered to the injured heart of mice differentiated and resembled a cardiac phenotype [12]. Although iPSCs have quite a lot of characteristics in common with ESCs, genome-wide analyses exposed significant differences between both cell types regarding gene expression profiles, methylation signatures and microRNA patterns. Moreover, iPSCs circumvent the ethical and allogeneic transplantation problems in cardiac regenerative therapy. As iPSCs acquire specific description of pluripotent stem cells, including infinite self-renewal and multi potency, they are expected to be used in a broad assortment of applications such as in cell replacement regenerative therapies, developmental biology research, disease modelling, and drug screening. Although less than 10 years have passed since iPSCs were first generated, iPSC research now spans the globe in a wide range of fields [13]. Capable of differentiating into a lot of specialized cell types necessary for research-including cardiomyocytes, hepatocytes, neurons and muscle cells. The ability to make different stem cells into human cardiomyocyte cells with cardiac-specific types, together with structural, practical and molecular properties, has led to unique opportunities in the empire of cardiovascular research [14].

Conclusion

The field of cardiovascular research is advancing quickly and investigate into the progress of successful remedial drug behaviour is ongoing. The progress of human pluripotent stem cells for use in the field of therapeutic and pharmaceutical research has revolutionized, with promising applications for primary phenotypic screening, elucidation of novel targets, and physiological assays for evaluating cardiotoxicity and optimization of patient-specific therapies. iPSCs and iPSC-derived cardiomyocytes newly emerge as a powerful apparatus to representation of cardiac development and congenital cardiac disorders. Although iPSC-derived cardiomyocytes do not exhibit a completely mature phenotype, there is on the increase confirmation supporting their effectiveness in drug screening. As a model classification they may also increase very useful insights in the re - activation of inhabitant stem cells. However, a number of chief enquiries concerning the application of the iPSC cardiovascular disease replica hang about to be answered. Most importantly, to what scope will physiological studies on iPSC derivatives calculate the consequence of a medicine on the experimental condition, in particular given that the cells might not be specifically the accurate cell type accountable for the disease, are preserved in vitro, and perhaps show signs of an immature physiological reaction to the drugs. Although investigate into the uses of stem cells in drug discovery, and more particularly cardiovascular research, is still underneath investigation, the high reproducibility, readily accessible resource of cells and possibly to generate into many cell types suggests promising conclusion for the expectations of stem cell research.

References

1. Haider HKh, Lei Y, Ashraf M (2008) MyoCell, a cell-based, autologous skeletal myoblast therapy for the treatment of cardiovascular diseases. Curr Opin Mol Ther 10(6): 611-621.
2. Angion Biomedica Corp, Study to Evaluate the Safety and Activity of BB3 to Treat Heart Attack.
3. van Berlo JH, Kanisicak O, Maillet M, Vagnozzi RJ, Karch J, et al. (2014) c-kit+ cells minimally contribute cardiomyocytes to the heart. Nature 509(7500): 337-341.
4. Nunes SS, Miklas JW, Liu J, Aschar-Sobbi R, Xiao Y, et al. (2013) Biowire: a platform for maturation of human pluripotent stem cell-derived cardiomyocytes. Nat Methods 10(8): 781-787.
5. Song M, Jang H, Lee J, Kim JH, Kim SH, et al. (2014) Regeneration of chronic myocardial infarction by injectable hydrogels containing stem cell homing factor SDF-1 and angiogenic peptide Ac-SDKP. Biomaterials 35(8): 2436-2445.
6. Chachques JC (2011) Development of bioartificial myocardium using stem cells and nanobiotechnology templates. Cardiol Res Pract 2011: 806795.
7. Behfar A, Latere JP, Bartunek J, Homsy C, Daro D, et al. (2013) Optimized delivery system achieves enhanced endomyocardial stem cell retention. Circ Cardiovasc Interv 6(6): 710-718.

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8. Takahashi K, Yamanaka S (2006) Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. Cell 126(4): 663-676.

9. Okano H, Nakamura M, Yoshida K, Okada Y, Tsuji O, et al. (2013) Steps toward safe cell therapy using inducedpluripotent stem cells Circ Res 112(3): 523-533.

10. Takahashi K, Tanabe K, Ohnuki M, Narita M, Ichisaka T, et al. (2007) Tomoda, S.Yamanaka. Induction of pluripotent stem cells from adult human fibroblasts by defined factors. Cell 131(5): 861-872.

11. Seki T, Yuasa S, Kusumoto D, Kunitomi A, Saito Y, et al. (2014) Generation and characterization of functional cardiomyocytes derived from human t cell-derived induced pluripotent stem cells. Plos One 9: e85645.

12. Chimenti I, Smith RR, Li TS, Gerstenblith G, Messina E, et al. (2010) Relative roles of direct regeneration versus paracrine effects of human cardiospherederived cells transplanted into infarcted mice. Circ Res 106: 97-980.

13. Zhang J, Lian Q, Zhu G, Zhou F, Sui L, et al. (2011) A human iPSC model of Hutchinson Gilford Progeria reveals vascular smooth muscle and mesenchymal stem cell defects. Cell Stem Cell 8: 31-45.

14. Sullivan KE, Quinn KP, Tang KM, Georgakoudi (2014) Extracellular matrix remodeling following myocardial infarction influences the therapeutic potential of mesenchymal stem cells. Stem Cell Res Ther 5: 14.

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