Opinion
Volume10:01, 2024

Journal of Clinical Respiratory Diseases & Care: Open Access

ISSN: 2472-1247 Open Access

Modeling Duchenne Muscular Dystrophy Cardiomyopathy Using Induced Pluripotent Stem Cell-derived Cardiomyocytes: Advancements and Applications

Bfrtyu Herpoi*

Department of Clinical Medicine, Clinical Hospital Centre Rijeka, 51000 Rijeka, Croatia

Introduction

Duchenne Muscular Dystrophy (DMD) is a debilitating genetic disorder primarily characterized by progressive muscle degeneration. However, one of the critical complications of DMD is cardiomyopathy, which significantly contributes to morbidity and mortality in affected individuals. Traditional animal models and cell culture systems have provided valuable insights into DMD pathogenesis, but they often fail to fully capture the human-specific aspects of the disease. With the advent of induced pluripotent stem cell technology, researchers now have a powerful tool to model DMD cardiomyopathy using patient-derived cardiomyocytes. Duchenne Muscular Dystrophy (DMD) is an X-linked recessive disorder caused by mutations in the DMD gene, resulting in the absence or dysfunction of the dystrophin protein. While DMD is primarily characterized by skeletal muscle degeneration and weakness, cardiac involvement, in the form of cardiomyopathy, is a significant complication that affects the morbidity and mortality of patients [1].

Cardiomyopathy in DMD typically manifests as progressive myocardial fibrosis, hypertrophy and eventual heart failure, contributing to the reduced life expectancy of affected individuals. Traditional animal models, such as the mdx mouse, have been instrumental in elucidating the pathophysiology of DMD. However, these models often do not fully recapitulate the human disease phenotype, particularly in terms of cardiac involvement. Additionally, primary human cardiomyocytes derived from cardiac biopsies have limited availability and are challenging to maintain in culture. Therefore, there is a pressing need for more physiologically relevant human-based models to study DMD cardiomyopathy. Induced pluripotent stem cells offer an unprecedented opportunity to generate patient-specific cell models for studying genetic diseases, including DMD [2].

Description

IPSCs are reprogrammed from somatic cells, such as skin fibroblasts or peripheral blood cells, using defined factors, typically transcription factors such as Oct4, Sox2, Klf4 and c-Myc. These cells possess the unique ability to differentiate into virtually any cell type in the body, including cardiomyocytes, providing a limitless source of human-specific cells for disease modeling and drug screening. In recent years, significant progress has been made in the generation and characterization of iPSC-derived cardiomyocytes [3]. These cells closely resemble primary human cardiomyocytes in terms of morphology, electrophysiology and contractile function, making them an ideal model system for studying cardiac diseases. Researchers have successfully employed iPSC-CMs to model various aspects of DMD cardiomyopathy. By reprogramming fibroblasts or blood cells from DMD patients into iPSCs and subsequently differentiating them into cardiomyocytes, investigators can directly study the cellular and molecular mechanisms underlying cardiac dysfunction in DMD.

One of the hallmark features of DMD cardiomyopathy is the dysregulation of calcium handling, leading to impaired contractility and arrhythmias. iPSC-CMs derived from DMD patients exhibit aberrant calcium signaling and contractile dysfunction, recapitulating key aspects of the disease phenotype observed in patients' hearts. These cellular abnormalities can be further characterized using techniques such as calcium imaging, patch-clamp electrophysiology and contractility assays, providing valuable insights into the pathophysiology of DMD cardiomyopathy. Furthermore, iPSC-CMs allow researchers to investigate the effects of different DMD mutations on cardiac function and drug responses in a patient-specific manner. By generating iPSC lines from individuals with distinct DMD mutations, researchers can compare the phenotypic differences between different genotypes and screen potential therapeutic compounds for their efficacy in rescuing or ameliorating DMD-associated cardiac abnormalities [4].

While iPSC-CMs offer immense potential for modeling DMD cardiomyopathy, several challenges remain to be addressed. One significant limitation is the immaturity of iPSC-CMs compared to adult cardiomyocytes, which may influence their physiological relevance and disease phenotype. Efforts are underway to enhance the maturation of iPSC-CMs through various strategies, such as mechanical and electrical stimulation, co-culture with other cell types and genetic manipulation. Another challenge is the variability observed between iPSC lines and differentiation protocols, which can impact the reproducibility and reliability of experimental results. Standardization of protocols and rigorous quality control measures are essential to ensure the consistency and validity of iPSC-CM-based studies [5].

Conclusion

In conclusion, iPSC-derived cardiomyocytes hold great promise as a valuable tool for modeling DMD cardiomyopathy and advancing our understanding of the disease mechanisms. By recapitulating key aspects of the disease phenotype in a patient-specific context, iPSC-CMs offer new opportunities for drug discovery, personalized medicine and therapeutic development in DMD and other genetic cardiac disorders. Continued research efforts aimed at improving the fidelity and robustness of iPSC-CM models will be crucial for realizing their full potential in translational medicine.

Acknowledgement

None.

Conflict of Interest

None.

***Address for Correspondence:** Bfrtyu Herpoi, Department of Clinical Medicine, Clinical Hospital Centre Rijeka, 51000 Rijeka, Croatia; E-mail: herpoib@gmail.com*

Received: 01 February, 2024, Manuscript No. jcrdc-24-129363; **Editor Assigned:** 03 February, 2024, Pre QC No. P-129363; **Reviewed:** 17 February, 2024, QC No. Q-129363; **Revised:** 22 February, 2024, Manuscript No. R-129363; **Published:** 29 February, 2024, DOI: 10.37421/2472-1247.2024.10.293

References

1. Eisen, Binyamin and Ofer Binah. "Modeling duchenne muscular dystrophy cardiomyopathy with patients' induced pluripotent stem-cell-derived cardiomyocytes." *Int J Mol Sci* 24 (2023): 8657.
2. Piga, Daniela, Sabrina Salani, Francesca Magri and Roberta Brusa, et al. "Human induced pluripotent stem cell models for the study and treatment of duchenne and becker muscular dystrophies." *Therape Adv Neurol Dis* 12 (2019): 1756286419833478.
3. Pioner, Josè Manuel, Alessandra Fornaro, Raffaele Coppini and Nicole Ceschia, et al. "Advances in stem cell modeling of dystrophin-associated disease: Implications for the wider world of dilated cardiomyopathy." *Fron Physiol* 11 (2020): 368.
4. Huang, Juan, Qi Feng, Li Wang and Bingying Zhou. "Human pluripotent stem cell-derived cardiac cells: Application in disease modeling, cell therapy and drug discovery." *Fron Cell Devell Biol* 9 (2021): 655161.
5. Smith, Alec ST, Jesse Macadangdang, Winnie Leung and Michael A. Laflamme, et al. "Human iPSC-derived cardiomyocytes and tissue engineering strategies for disease modeling and drug screening." *Biotechnol Adv* 35 (2017): 77-94.

How to cite this article: Herpoi, Bfrtyu. "Modeling Duchenne Muscular Dystrophy Cardiomyopathy Using Induced Pluripotent Stem Cell-derived Cardiomyocytes: Advancements and Applications." *J Clin Respir Dis Care* 10 (2024): 293.