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Cell sheet-based tissue engineering for myocardial tissue repair

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Recently, regenerative medicine has rapidly progressed as a new approach to treat various types of diseases that can't be cured with conventional drugs or surgical techniques. Although isolated cell injection therapy is clinically performed, its application is limited due to significant cell loss and difficulties for controlling graft size and shape. Therefore, tissue engineering technology has been expected to complement the efficacy of cell therapy. We have developed novel technology "cell sheet-based tissue engineering", which has realized cell-dense tissue fabrication without any scaffolds. Confluently cultured cells are harvested as contiguous cell sheets from temperature-responsive culture surfaces only by lowering temperature. Cell sheets are directly transplanted onto damaged tissues or stacked into multi-layer constructs. Autologous myoblast cell sheet transplantation has been clinically applied for the patients suffering from severe heart failure. Some patients have recovered and clinical study is now on going. For industrializing cell sheet-based therapy, we have now started to develop safe and automated tissue fabrication systems including the units for cell isolation, mass subculture, cell sheet harvest and stacking.

As next step, the technology development for fabricating pulsatile cardiac tissue and scaling-up the construct has been requested to treat more severe heart diseases and, in future, to replace donor organ implantation. Mass culture of ES/iPS cells, sorting of cardiac cells and sufficient vascularization within multiple layers of cell sheets are key technologies to be broken through. We are now challenging to fabricate functionally pulsatile human heart tissues for future transplantation.

Biography

Tatsuya Shimizu is the Professor of Department of Tissue Regeneration, Institute of Advanced Biomedical Engineering and Science, Tokyo Women's Medical University. He graduated from Faculty of Medicine, the University of Tokyo and got medical doctor (MD) in 1992. After two-year clinical training, he made a specialty of cardiovascular medicine including catheterization and got Ph.D. in 1999. After that, he moved to ABMES of TWMU and have developed myocardial tissue engineering research based on "cell sheet technology". His recent work is especially concentrated on neovascularization in myocardial tissue graft to reconstruct more functional tissue.

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