Artificial Organs Engineering (CardioVascular Device Engineering)

1. Staff and Students (April 2009 through March 2010)

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	Yohei Anzai	
Research Students	Hitomi Shibasaki	

2. Purpose of Education

Artificial organ is an inter-disciplinary science aiming to treat patients who require therapy beyond treatments by internal medicine and/or surgical medicine. It requires knowledge from basic medical sciences to engineering technologies. Artificial organs assist or replace functions of failing organs till their recovery, bridge to transplantation, actively promote recovery by combining with other advanced treatment methodologies, or permanently support the organ function.

In surgical area, especially for treatment of profound heart failure patients, mission of our laboratory aims to educate students efficient methodologies for research and development of replacement and assist type mechanical circulatory support devices, for effective maintenance of circulation using artificial heats, and for clinical applications of artificial hearts as well as research on next generation modalities for cardiovascular diseases.

3. Research Subjects

3.1 Research and Development of Advanced CardioVascular Devices: Advanced mechanical circulatory support devices applicable from infants to adults, from extracorporeal to implantable systems will be researched and developed to treat end-stage heart failure patients. Through CAD/CAM design and precision machining, in vitro performance and durability testing, and ex vivo and in vivo biological performance studies, clinically applicable devices will be obtained.

3.2 Basic Research on Cell Biomechanics, Biorheology, and Thrombosis Studies: The research focuses upon blood cells and device interaction, specifically mechanical effects of the cardiovascular devices upon blood cell elements including RBCs, WBCs and platelets, cell aggregation and adhesion phenomena, lysis and coagulation process on the artificial surface. The study will lead to understanding of mechanism leading to hemolysis, coagulation in the cardiovascular devices to attain biocompatible devices.

3.3 Research and Development of Sensors and Control Algorithm: This study aims at development of sensors for cardiovascular dynamics measurement and possible application in controlling the artificial organs. The optical interaction with blood cells, tissues and organs will be investigated to develop an appropriate sensing technique and sensors. This study will be conducted in connection with the basic research of (2) to understand mechanical effects of blood pumps upon blood cell elements leading to hemolysis and arteriosclerosis process. In relation to understanding the recovery process of myocardium during ventricular unloading with the mechanical circulatory devices, a semi-conductor micro-pressure sensor that can used for prolonged duration in biological environment will be researched and developed.

3.4 Research and Development of Optimal Methods for Promoting Myocardial Recovery, Understanding of Recovery Process and Next Generation Devices: Aiming at understanding recovery process of myocardium during mechanical unloading, this study constructs a global model of cardiovascular system covering from molecular level to organ level. Next generation optimal therapy by combining mechanical circulatory support device with regenerative medicine, cell transplantation and pharmaceutical regimens will be researched.

4. Clinical Services

We plan to contribute to treatment of acute as well as chronic heart failure patients through short or prolonged applications of pulsatile and/or continuous flow circulatory support devices.

5. Publications

Original articles

1. Honjo O, Merklinger SL, Poe JB, Guergurian AM, Alghandi AA, Takatani S, and Van Arsdell GS. Mechanical cavopulmonary assist maintains pulmonary and cerebral blood flow in a piglet model of a bidirectional cavopulmonary shunt with high pulmonary vascular resistance. ***The Journal of Thoracic and Cardiovascular Surgery*** 2009; 137(2): 355-361.
2. Sakota D, Sakamoto R, Yokoyama N, Kobayashi M, and Takatani S. Glucose Depletion Enhances Sensitivity to Shear Stress-induced Mechanical Damage in Red Blood Cells by Rotary Blood Pumps. ***Artif Organs*** 2009; 33(9):733-739.
3. Someya T, Kobayashi M, Waguri S, Ushiyama T, Nagaoka E, Hijikata W, Shinshi T, Arai H, and Takatani S. Development of a Disposable Maglev Centrifugal Blood Pump Intended for One-Month Support in Bridge-to-Bridge Applications: In Vitro and Initial In Vivo Evaluation. ***Artif Organs*** 2009; 33(9):704-713.

Conference Presentations

Overseas

Invited Lectures

1. Takatani S, Shinshi T, Hijikata W, and Nagaoka E, Mag-lev, disposable centrifugal pump MedTech Dispo, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
2. Takatani S, Yoshikawa M, Kitao T and Ando Y, Engineering aspect of pediatric TinyPump, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.

General Presentations

1. Yokoyama N, Sakota D, Yasuda T, Watanabe N and Takatani S. Age Dependant Deformability Changes of RBCs Evaluated using a Cyclically Reversing Shear Flow Generator. ***The 4th International symposium on Biomechanics in Vascular Biology and Cardiovascular Disease,*** April 16-17, 2009, Rotterdam, The Netherland.
2. Crandall D, Nagaoka E, Shinshi T, Turitto V, Constance H, Takatani S, The effect of a Mag-Lev Rotally Blood Pump on Platelets and microparticles in an In Vivo Two Week Survival Study, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
3. Sakamoto R, Nagaoka E, Yokoyama Y, Ohta S, Takatani S, Autonomic nerve study of animals on support of Mag-Lev centrifugal blood pump, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
4. Ohsawa H, Kitao T, Yoshikawa M, Kobayashi M, Ishihara K, Yamaguchi R, Takatani S. Computational Fluid Dynamics Analysis of an Ultra-miniature Centrifugal Blood Pump "TinyPump". ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
5. Yokoyama Y, Kitao T, Kimura T, Steinseifer U, Ohta S, Kawaguchi O, Takatani S. Prediction of the external works of the native heart from the dynamic H-Q curves of the rotally blood blood pump during left heart bypass. ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
6. Machida S, Yokoyama Y, Kitao T, Yokoyama N, Yamaguchi R, Takatani S. A New Inflow Cannula System for Paediatric Blood Pump, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
7. Shibasaki H, Crandall DL, Sakota D, Nagaoka E, Shinshi T, Arai H, Takatani S, Quantification of Effects upon Blood Cell Elements by a Rotary Blood Pump using Flow Cytometry, ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.
8. Nagaoka E, Someya T, Hijikata W, Ushiyaka T, Shinshi T, Arai H Takatani S. Development of a Disposable Mag-Lev Centrifugal Blood Pump (MedTech Dispo) Intended for Bridge-to-Bridge Applications - In vitro and Initial In vivo Evaluations. ***17th Congress of the International Society for Rotary Blood Pumps (ISRBP) 2009,*** October 1-3, 2009, Singapore.