Department of Cardiac Surgery
Chair of Cardiac Surgery

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Research Focus
- Chronic rejection of allografts
- Therapy of end-stage heart failure: Heart transplantation or support with a left or right ventricular assist device
- Neuropeptide release of the heart
- Hospital-economics and management
- Tissue engineering of cardiovascular implants
- Development of a non-blood contacting heart actor
- High speed camera investigations on heart valves in a pulse duplicator

Structure of the Department
Professorships: 1
Personnel: 100
- Doctors (of Medicine): 15
- Scientists: 3 (thereof funded externally: 0)

Clinical focus areas
- Adult cardiac surgery
- Heart transplantation in adults and children
- Mechanical circulatory support
- Wound management
- Heart insufficiency therapy
- Rhythm surgery
- Surgery in grown-up with congenital heart disease
- Interventionell heart valve surgery
- Interventionell aortic surgery

Research
Main research topics are on the one hand basic research in transplantation and on the other hand clinical research in mechanical circulatory support and the development of new heart assist devices in close cooperation with the Faculty of Engineering.

Chronic rejection of allografts
PI: Dr. C. Heim
Transplant arteriosclerosis is the main reason for late graft failure. In order to develop effective therapeutic strategies and translate them into clinical success, a detailed understanding of the mechanisms responsible for the development of transplant arteriosclerosis is essential. We have recently established and characterized the abdominal aortic allograft model as a suitable tool to study the development of transplant arteriosclerosis. Ongoing projects involve the role and importance of chemokines and chemokine receptors, in particular CCR7 and CXCR5, in the development of transplant arteriosclerosis. CCR7, the major homing receptor for trafficking of T and B cells, plays a crucial role in leukocyte homing. Experiments using CCR7-/-mice as recipients of aortic allografts showed increased amounts of transplant arteriosclerosis during the absence of this receptor and suggest an interesting role of this receptor in this disease. Recent findings implicate an important role of human cytomegalovirus infection (HCMV) for the development of inflammatory-proliferative vascular lesions in transplanted vascularized allografts. Therefore, the major aim of this project is to develop a human peripheral blood lymphocyte (hu-PBL)/severe combined immunodeficiency (SCID) mouse xenograft-model to investigate the immunological and pathological mechanisms of HCMV in the modulation and progression of transplant arteriosclerosis.

Therapy of end-stage heart failure: Heart transplantation or support with a left or right ventricular assist device
PI: Dr. R. Tandler
Orthotopic cardiac transplantation is the therapy of choice for cardiac insufficient patients. Due to an increasing shortage of donor organs, these cardiac insufficient patients need to be bridged with an implantable ventricular assist device until a suitable donor organ is available. In some cases heart disease has already progressed to such an extent that the patients need to be stabilized with a left ventricular assist device or – in case of additional right heart failure – with a biventricular assist device.

Neuropeptide release of the heart
PI: PD Dr. T. Strecker
Calcitonin-Gene Related Peptide (CGRP) is a neuropeptide consisting of 37 amino acids and its biological action results in a strong vasodilation. CGRP is mainly produced by the sensoric A-d- and C-fibres. Recent data suggests that it may play an important role in myocardial ischaemia. Neural fibres with a high CGRP content are found in both atria, the pericardium and within the adventitia of coronary arteries. Changes in CGRP production correlate with increased activity within cardiac afferent fibres. It was shown in vitro that elevated CGRP concentrations were able to increase the coronary blood flow and reduce the coronary resistance and the mean arterial blood pressure. Furthermore, CGRP was demonstrated to be cardio-protective and reduce the infarct size of myocardial infarction. The aim of our project (cooperation with Prof. Dr. K. Messlinger, Institute of Physiology and Pathophysiology) is to develop an experimental mouse model in order to investigate the effects and kinetics of CGRP production in greater detail. In addition, analyses of human CGRP production are planned by using tissue from the right ventricle or ascending aortic tissue.

Hospital-economics and management
PI: Prof. Dr. R. Feyrer
One of the main tasks of this group has been to face the changes in hospital reimbursement from retrospective payment to a prospective flat rate payment. Other current projects involve the development of the so called ‘clinical pathways’ in order to improve cost unit calculations and enable us to create computer-simulated scenarios of complex problems of hospital cost management. In cooperation with the Department of Anesthesiology, we perform a study analyzing the costs involving intensive care patients, and together with the German Heart Center in Berlin, we are trying to set up a database regarding long-term costs of patients on cardiac assist devices.

Tissue engineering of cardiovascular implants
PI: Prof. Dr. C. Heim
The background for these studies is the development of an ingrowth matrix within the tissue engineering of cardiovascular grafts. The purpose of these investigations is to show whether it is possible to influence the mobility of endothelial cells, smooth muscle cells, and fibroblasts within a fully synthetic matrix by incorporating bioactive peptides. The purpose is to define a matrix which provides optimal mobility for those cells needed for a functional cardiovascular implant. Such a matrix could be integrated into a cardiovascular prosthesis in order to facilitate and direct the ingrowth of the patient’s own tissue. A single cell migration model was used to compare the influence of different cell
interactive peptides on the mobility of vascular cell lines as microvascular endothelial cells (MVEC) and aortic vascular smooth muscle cells (SMC). In previous studies it could already be shown that selectively MVEC, but not SMC accelerate on a PEG matrix covered with RGD (fibronectin) and YIGSR (laminin) in comparison to a matrix covered only with RGD. These experiments were extended to the peptide sequences SIKVAV, RYVVLPR (both laminin), and DGEA (collagen) also known from the literature as being vascular cell interactive. For sufficient cellular adhesion, RGD was added to the matrix again. At an average migration speed, both cell lines showed a reduced cell speed on RGD plus RYVVLPR and RGD plus DGEA. For the combination of SIKVAV and RGD, only MVEC showed a small, but not significant increase in mobility whereas SMC did not show any difference.

**Development of a non-blood contacting heart actor**

Pt: Prof. Dr. M. Weyand

The support of the insufficient heart muscle function by artificial support systems is worldwide an intensive field of research and an aim seeks for for about 60 years. Rising life expectancy and the growing number of heart-insufficient patients on the one hand as well as restricted availability of donor organs and damping of the increase of the health costs will further raise the need in innovative support systems in the future. On account of the risks of the existing, invasive, clinical methods, a care-fully implantable technology is necessary. It must be functioning reliably as well as permanently and intervene not invasive in the heart-circulatory system. Within a clinical-medical setting, the investigation of a research project pursues from the interpretation over the production up to the clinical validity of the system function more new, actoric, and patient-individual heart muscle support systems for the purposes of an external compression of the heart. Therefore the main focuses are the investigation of a biomechanically efficient, mechanical system as well as the development of di- or piezo-electric based actor material patterns.

**High speed camera investigations on heart valves in a pulse duplicator**

Pt: Dr. M. Kondruweit

High-speed camera investigations on heart valves in an animal model are an already established model. In this project these proceedings are applied into a pulse duplicator to be able to compare several heart valve types in a stan-
dardized procedure. Special situations, as for example the Ventricle Assist Devices support and the effect on the hemodynamic on the heart valves, are examined. The results should show possible reasons for heart valve attrition by measuring power vectors. If possible, these reasons shall be corrected by changing the valve design.

**Teaching**

The Department of Cardiac Surgery takes part in compulsory and elective subjects for the curricular teaching of the human medicine and dentistry. Bachelor’s and Master’s theses especially from the Faculty of Engineering are supervised as well as MD and PhD theses.

**Selected Publications**


