

Department of Plastic and Hand Surgery

Chair of Plastic and Hand Surgery

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Research focus

- Tissue engineering
- Interaction of regenerative strategies and tumor progression
- Clinical experimental research
- Clinical retrospective studies

Structure of the Department

Professorship: 1

Personnel: 29

- Doctors (of Medicine): 16
- Scientists: 7 (thereof funded externally: 7)
- Graduate students: 35

Clinical focus areas

- Reconstructive microsurgery
- Esthetic surgery
- Burn surgery
- Breast surgery
- Hand surgery
- Body contouring
- Lymphedema/lipedema
- Laser
- Hyperhidrosis

Research

Research interests of the Department of Plastic and Hand Surgery are the engineering of bioartificial tissue, tumor biology as well as clinical experimental research and clinical retrospective studies.

Tissue engineering

PI: Prof. Dr. R.E. Horch¹⁻⁵, Prof. Dr. J. Beier¹, Prof. Dr. A. Arkudas²⁻⁹, PD Dr. A.M. Boos^{2,10}, Dr. A. Kengelbach-Weigand^{2,9,10}, Dr. D. Steiner³⁻⁵, Dr. A. Cai^{1,8}, M. Hessenauer⁶, Dr. W. Müller-Seubert⁷

1) Tissue engineering of skeletal muscle

The final aim of this project is the generation of axially vascularized, innervated skeletal muscle tissue.

2) Generation of axially vascularized bone tissue in the large animal

The transplantation of engineered bone will be evaluated in combination with angiogenic and osteogenic cells in clinically relevant dimension in the sheep tibia defect model.

3) Tissue engineering of axially vascularized bone in a small animal model

The aim of this study is to generate axially vascularized bioartificial bone tissue using bioactive matrices in combination with endothelial cells (EC) and adipose derived stem cells (ADSC).

4) Investigation of the specific cell-cell interactions between ADSC and EC concerning osteogenic differentiation

5) Biofabrication of cellularized and AV loop vascularized tissue containers for the transplantation of drug-producing cells

6) Intravital microscopy in the AV loop model
To understand the mechanisms of de novo tissue formation in the AV loop model, we developed a suitable chamber model which allows intravital microscopic evaluation.

7) Ischemic tolerance of different tissues

By using the model of rat hindlimb amputation, extracorporeal perfusion, and replantation, we analyze and try to prolong the critical ischemia time of different tissues.

8) Perfusion-based de- and recellularization of a whole skeletal muscle

A skeletal muscle will be decellularized, thereafter recellularized and the construct implanted *in vivo* by vascular and nerve anastomoses to engineer a skeletal muscle.

9) Differences in functional cell properties of ADSC affected by patient factors

10) Skin tissue engineering by the use of ADSC
Current treatment options for chronic wounds will be optimized using growth factors and ADSC.

Interaction of regenerative strategies and tumor progression

PI: Prof. Dr. R.E. Horch¹⁻⁷, Prof. Dr. A. Arkudas⁷, PD Dr. A.M. Boos¹⁻⁶, Dr. A. Kengelbach-Weigand¹⁻⁷, Dr. R. Götzl⁶

1) Effects of tumors on a developing blood vessel network

The goal of the project is the characterization of the influence of tumor cells on the development of a blood vessel network and the role of endothelial progenitor cells (EPC) in tumor associated angiogenesis.

2) Therapeutic approaches on the lymphatic vessel system in the context of regenerative medicine and tumor progression

The goal of the project is the characterization of the interaction of lymphatic endothelial cells

and stem cells from the bone marrow and adipose tissue as well as the establishment of a lymphatic vessel network in the rat AV loop model.

3) Tumor angiogenesis and vasculogenesis in breast cancer

This study investigates the effect of mammary carcinoma cells on the angiogenic properties of EPC.

4) Paracrine and cell-cell interaction of ADSC and mammary epithelial cells in the focus of development of breast cancer

This study evaluates the influence of ADSC on the behavior of cells in the breast and breast cancer tissue.

5) Significance of tumor-associated fat stem cells in breast cancer progression

The surrounding adipose tissue of mammary carcinomas is probably changed by the influence of the tumor and may play a role in tumor progression. This will be investigated by analyzing stem cells from tumor-associated adipose tissue compared to stem cells from healthy adipose tissue.

6) Characterization of ADSC from different harvesting methods

This project aims at investigating the impact of different surgical procedures during the harvesting of ADSCs on their behavior and functionalities.

7) Using biofabrication, a 3D tumor model will be developed, serving for the investigation of different aspects of tumor progression in a controlled manner both *in vitro* and in the vascularized *in vivo* AV loop model.

Clinical experimental research

PI: Prof. Dr. R.E. Horch¹⁻⁸, Prof. Dr. J. Beier¹, Prof. Dr. A. Arkudas^{2,3,8}, PD Dr. Boos⁵, Dr. I. Ludolph^{1,4-7}, Dr. A. Cai², Dr. G. Bühner⁷, J. Grüner², F. Fried³

1) Intraoperative fluorescence imaging of tissue perfusion in free flap transplantation using the SPY Elite® system

To improve the knowledge of tissue perfusion in free tissue transfer and free flap autonomization in the long term follow-up, intraoperative fluorescence imaging of tissue perfusion using a laser camera was performed.

2) Prospective analysis of grip force in common hand conditions

Hand conditions may be accompanied by a loss of hand function or grip force. This prospective study evaluates the effect of a surgical procedure on hand grip force.

3) Evaluation of carpal instability regarding scapholunate ligament injuries

The aim of this study is to evaluate wrist mobility between carpal bones using CT analysis in

order to invent new strategies to treat ligament injuries.

4) Influence of different silicone surface textures to prevent capsular fibrosis of the breast

Capsular fibrosis represents a significant complication following implantation of silicone breast implants, necessitating further surgical intervention. Experimental *in vitro* studies are conducted to investigate diverse silicone surface textures and their influence on capsular fibrosis.

5) Evaluation of an innovative negative pressure dressing in postbariatric patients

To improve postoperative wound healing and achieve better scar quality, this study compares an innovative negative pressure dressing to a standard wound dressing.

6) Comparison of thermography and ICG-angiography in the perfusion analysis of free flaps for autologous breast reconstruction

Intraoperative perfusion of free flaps from the abdomen for autologous breast reconstruction is assessed by using thermography and ICG-angiography.

7) Analysis of skin elasticity before and after body contouring procedures

In a prospective trial different skin elasticity parameters are assessed in patients after massive weight loss. Data are collected before and after body contouring procedures to gain more insight in the characteristics of the skin.

8) Comparison of shoulder function of patients after muscle-sparing and complete latissimus dorsi harvest

The aim of this study is the evaluation of the relevance of muscle-sparing latissimus dorsi flap harvesting regarding shoulder functionality and strength.

Clinical retrospective studies

PI: Prof. Dr. R.E. Horch¹⁻⁸, Dr. M. Schmitz⁸, Dr. I. Ludolph²⁻⁶, Dr. A. Cai⁴, Dr. W. Müller-Seubert¹, Dr. T. Hauck⁷

1) Retrospective analysis of surgical therapy in cubital tunnel syndrome

In this study, outcomes and complications after partial medial epicondylectomy in cubital tunnel syndrome are analyzed.

2) Retrospective analysis of body contouring procedures after massive weight loss in patients with body mass index greater 35

In this retrospective study, complications after body contouring procedures in patients with a BMI greater 35 are analyzed.

3) Negative pressure wound therapy with instillation in chronic-infected wounds

The aim of this retrospective study is to investigate an effect of negative pressure wound ther-

apy with instillation with regard to a reduction of the bacterial load as well as the bacterial count in chronically infected wounds.

4) Analysis of quality of life and physical activity of postbariatric patients

The impact of body contouring procedures on quality of life and physical activity of patients that have undergone massive weight loss is retrospectively analyzed.

5) Negative pressure wound therapy in the treatment of chronic ulcers of the lower leg

In this study patients with problem wounds of the lower leg are investigated with regard to the use of negative pressure wound therapy and the defect reconstruction.

6) ICG-angiography for analysis of the zonal perfusion of free flaps from the abdomen in autologous breast reconstruction

By using ICG-angiography intraoperatively, the zonal perfusion of DIEP/msTRAM flaps is analyzed to gain further insight in the vascular anatomy and the perforasome theory and to optimize the outcome of such procedures.

7) The role of the pedicled gastrocnemius flap in covering defects in the knee and proximal lower leg area

This retrospective study evaluates the outcome of pedicled gastrocnemius flaps. The results are evaluated using a self-created and a validated questionnaire (Knee Outcome Survey).

8) Dupuytren s disease

Retrospective analysis of severe, advanced and relapsing Dupuytren s disease with actual evaluation by DASH-Score. Evaluation of the Erlangen distraction device.

Teaching

With compulsory and elective subjects, the Department of Plastic and Hand Surgery is involved in the curriculum-based teaching in medicine. In this context, besides a preclinical conjoint course together with the Institute of Anatomy, a microsurgical suture course is offered besides theoretical courses.

Furthermore, MD and PhD theses are supervised.

Selected publications

Witt R, Weigand A, Boos AM, Cai A, Dippold D, Boccaccini AR, Schubert DW, Hardt M, Lange C, Arkudas A, Horch RE, Beier JP. Mesenchymal stem cells and myoblast differentiation under HGF and IGF-1 stimulation for 3D skeletal muscle tissue engineering. *BMC Cell Biol*, 2017. 18(1): p. 15

Rottensteiner-Brandl U, Distel L, Stumpf M, Fey T, Köhn K, Bertram U, Lingens LF, Greil P, Horch RE, Arkudas A. Influence of Different Irradiation Protocols on Vascularization and Bone Formation Parameters in Rat Femora. *Tissue Eng Part C Methods*, 2017. 23(10): p. 583-591

Cai A, Hardt M, Schneider P, Schmid R, Lange C, Dippold D, Schubert DW, Boos AM, Weigand A, Arkudas A, Horch RE, Beier JP. Myogenic differentiation of primary myoblasts and mesenchymal stromal cells under serum-free conditions on PCL-collagen I-nanoscaffolds. *BMC Biotechnol*, 2018. 18(1): p. 75

Steiner D, Lingens L, Fischer L, Köhn K, Detsch R, Boccaccini AR, Fey T, Greil P, Weis C, Beier JP, Horch RE, Arkudas A. Encapsulation of Mesenchymal Stem Cells Improves Vascularization of Alginate-Based Scaffolds. *Tissue Eng Part A*, 2018. 24(17-18): p. 1320-1331

Schmid R, Wolf K, Robering JW, Strauß S, Strissel PL, Strick R, Rübner M, Fasching PA, Horch RE, Kremer AE, Boos AM, Weigand A. ADSCs and adipocytes are the main producers in the autotaxin-lysophosphatidic acid axis of breast cancer and healthy mammary tissue in vitro. *BMC Cancer*, 2018. 18(1): p. 1273

An R, Schmid R, Klausung A, Robering JW, Weber M, Bäuerle T, Detsch R, Boccaccini AR, Horch RE, Boos AM, Weigand A. Proangiogenic effects of tumor cells on endothelial progenitor cells vary with tumor type in an in vitro and in vivo rat model. *Faseb Journal*, 2018. 32(10): p. 5587-5601

International cooperation

Prof. S. Jiaming, Tongji Medical College, Huazhong University of Science and Technology, Wuhan: China