Department of Oral and Cranio-Maxillofacial Surgery
Chair of Dental, Oral, and Maxillofacial Medicine – especially Oral and Cranio-Maxillofacial Surgery

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Research Focus
- Infection and inflammation
- Tumor research
- Biomedical technics

Structure of the Department
The Department of Oral and Cranio-Maxillofacial Surgery is responsible for teaching oral and maxillofacial surgery, including dental surgery and dental radiology, research as well as patient care. The Department employs 17 medical doctors/dentists, one biologist and three technical assistants. Research mainly focuses on biomedical technology, infection, and inflammation as well as tumors of the head and neck. Topics of particular interest are augmentation of osseous defects by transplantation of autogenous tissues or specific bone substitutes, the pathobiology of osteonecrosis of the jaw as well as the evaluation of therapeutic options in sites displaying compromised healing, and the identification of indicators of prognosis in patients undergoing resection of oral squamous cell carcinoma (SCC). Innovative research focuses on the evaluation and development of laser-assisted surgery. The research laboratory (ST-facility) of the Department of Oral and Cranio-Maxillofacial Surgery allows a wide range of immunohistochemical and molecular biological techniques. For experimental trials concerning bone histology and biomedical technology, a specialized facility is shared with the Department of Prosthodontics. The clinical focus is on the surgery of malformations of the head/neck and cleft lip palate in particular, oncopathology and reconstructive surgery for tumors of the head and neck, orthognathic surgery, traumatology of the facial skeleton, esthetic surgery as well as dental implantology.

Research
Infection and inflammation
Research addresses etiology, pathogenesis, and therapeutic options in inflammatory reactions of the facial skeleton. Also the osseous regeneration of bone defects in sites displaying compromised wound healing is being investigated. A relevant focus is on the bisphosphonate-associated osteonecrosis of the jaw (BONJ). As BONJ is restricted to craniofacial bone structures, research focuses on jaw bone specific signal transduction processes during development, bone remodeling, and disease. Cranial neural crest derived pluripotent progenitor cells are of scientific and clinical interest in experimental approaches to develop regeneration strategies in craniofacial bone structures. In addition, patient-related factors are being evaluated which may promote onset and course of bisphosphonate-associated osteonecrosis of the jaw. An animal model in pigs serves a study to answer the question whether there is an influence of bisphosphonate exposed bone in osseo-integration of dental implants. For functional and esthetic long-term success of dental implants, a sufficient amount of peri-implant hard and soft tissues is indispensable. The research especially focuses on modulation and optimization of peri-implant tissues in the context of rehabilitation of severe atrophic edentulous jaw and jaw segments with implant fixed dentures. This refers particularly to preclinical and clinical examination of new techniques and materials for the augmentation of non-space making vertical bony defects and the long-term stability of vertical bone grafts. Furthermore, research focuses on the regeneration of peri-implant soft tissues and their impact on peri-implant health.

Tumor research
Treatment of advanced carcinoma of the oral cavity involves tumor-surgery and reconstruction of defects by using microsurgical tissue transfer. In the context of tumor recurrence or pronounced bone necrosis after irradiation, patients usually experience repeated microsurgical reconstruction. Pre-irradiated tissues contain compromised anastomosis vessels with atherosclerotic lesions and increased cellular pro-inflammatory and procoagulatoric infiltration of the vessel walls. In a clinical study the functional and morphological changes in endothelial cells and their influence on the postoperative perfusion within microvascular grafts are studied in previously irradiated versus non-irradiated patients. The postoperative perfusion of microvascular grafts is monitored using laser Doppler spectrophotometry, and intraoperative fluorescence angiography for flow measurement of graft blood flow (Zeiss surgical microscope Pentero 900 with Flow 800). To determine perioperative endothelial dysfunction, a noninvasive, ultrasonographic measurement methodology (blood flow controlled vasodilation) is performed on the patients. The aim of this research project is the improved understanding of the pathomechanistic perfusion of microvascular grafts as a basis for the future application of e.g. pharmacological treatment for the reduction of perioperative complications. In the field of cancer research another focus was set on the influence of the immune system on tumor progression. We were able to show that there is an association of histomorphological parameters with the macrophage polarization in oral SCC and in the regional lymph nodes. According to the cancer stem cell hypothesis, a small population of cells with stem cell characteristics, so-called cancer stem cells (CSC), is responsible for the tumor genesis and progression. CSC, which were also described in SCC, are considered virtually resistant to current treatments. The aim of the current research is to determine the expression of various CSC markers in cell cultures and biopsies of SCC. The research team thus hopes to derive innovative immune and gene-specific therapies.

It has been hypothesized that the expression levels of stem cell-specific markers are increased in leukoplakia, the most common precursors of SCC of the oral cavity as compared with normal oral mucosa of healthy subjects. These changes can be attributed to the presence of cells with stem cell properties that are responsible for tumor formation. Leukoplakia of the oral cavity which increasingly has cells with stem cell properties should therefore pose an increased risk for malignant transformation. The aim of this study is to examine whether overexpression of stem cell genes in tissues indicating the development of SCC of the oral cavity in a five-year period. The aim of another project is to develop a minimally invasive method for diagnosis, prognosis, and clinical monitoring of the oral cavity SCC.

Biomedical technics
The focus "biomedical technology" comprises research projects on regeneration of soft and hard tissues, intraoperative imaging, and laser applications. Bone substitutes promote formation of new bone in pre-existing osseous defects
by different biologic mechanisms, including inflammatory and proliferative cellular reactions. The project aims at creating, applying, and evaluating the biomimetic materials and biofunctional surfaces in implant dentistry. In cooperation with the Bavarian Laser Center, a sensor-assisted laser system for selective bone ablation was tested in cadaver bone as well as in an in vivo setting. By connecting the Er:YAG laser to a process control for material-specific ablation, the system is able to differentiate cortical and cancellous bone as well as soft tissues. In oral and maxillofacial surgery, the selective bone ablation offers a new perspective to preserve neural structures during surgery, such as the nervus mandibularis during osteotomy of the lower jaw. A second research approach is to transfer the system of optical tissue differentiation towards tumor tissue to allow high selective tumor resection in the future.

Teaching

Oral and maxillofacial surgery is a part of both, medical and dental curriculum. The Chair of Oral and Cranio-Maxillofacial Surgery provides compulsory and elective courses for medical and dental students during clinical education. In clinical dentistry, these involve oral and maxillofacial surgery, dental surgery, and dental radiology. Apart from traditional methods of teaching (lectures, lectures with case demonstrations, practical training for medical and dental students), problem-based and interdisciplinary approaches are also used. Topics of interdisciplinary education include among others emergency medicine, electivum implantology for dental students (I-LECT), classes as part of the Graduate School in Advanced Optical Technologies (SAOT), and automated analysis of speech disorders in cooperation with the Chair of Pattern Recognition of the Faculty of Engineering.

Selected Publications


International Cooperations

Dr. E. Felszeghy, Semmelweis-University, Budapest: Hungary

Prof. Dr. Dr. E. Vairaktaris, University of Athens, Athens: Greece

Dr. J. Wolfardt, Ph.D., University of Alberta, Alberta: Canada

Research Equipment

Zeiss surgical microscope Pentero 900 with Row 800