Department of Surgery
Division of Trauma Surgery

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Research Focus
- Validation of a ceramic total knee replacement system
- Gait and motion analysis
- Mechanisms of chondrocyte differentiation and ossification
- Cartilage and meniscus repair
- Magnetic resonance imaging of joint structures
- Traumatic lesions of thoracic bone structures

Structure of the Division
Professorships: 2
Personnel: 88
- Doctors (of Medicine): 19
- Scientists: 2 (thereof funded externally: 2)
- Graduate students: 6

Clinical focus areas
- Polytrauma and treatment of severe injuries
- Extremity and joint surgery
- Total joint arthroplasty of all large joints (primary and revision)
- Spine surgery
- Sports trauma and arthroscopic surgery
- Pediatric trauma surgery

Research
The Division of Trauma Surgery covers a broad spectrum of research activities including novel diagnostic technologies and innovative strategies for the treatment of musculoskeletal pathologies. Novel three-dimensional motion analyses and imaging methods contribute to earlier detection of injuries and pathologies as well as a better definition of the underlying pathomechanisms. In a therapeutic point of view, research projects are focused on the establishment of joint-preserving and joint-replacing therapeutic concepts. As a supraregional trauma center with a focus on the treatment of severely injured patients, health services research also plays an essential role for the Division of Trauma Surgery.

Validation of a ceramic total knee replacement system
Pt: Prof. Dr. F. Hennig
This study investigates the safety and clinical outcome of a novel ceramic total knee replacement system. Besides favorable tribological properties, the complete ceramic implant seems advantageous in particular for patients with known hypersensitivities against metal ions. In first one-year results, we could demonstrate an excellent clinical outcome without occurrence of any adverse events or safety concerns (such as failure or loosening). Two-year results also demonstrate a high durability of the total ceramic implant system which encourages the continuation of long-term studies focusing on wear and loosening.

Gait and motion analysis
Pt: Dr. S. Krinner
This research group focuses on a subproject of the Emerging Fields Initiative (EFIMoves) with the aim to identify the biomechanical forces that interact with the human musculoskeletal system of athletes and patients with osteoarthritis. Dynamic forces during walking, running, and climbing stairs are associated with high strain for the musculoskeletal system. The biomechanical analysis of these dynamic strains and their integration into proper situations provide the opportunity to assess strategies for reducing the loading of joints. So far, we could demonstrate that special shoe insoles could reduce the adduction moment of the knee joint, thus reducing the stress on medial knee joint structures.

Mechanisms of chondrocyte differentiation and ossification
Pt: Prof. Dr. K. Gelse
The identification of the mechanisms of chondrocyte differentiation and endochondral ossification is one central issue to establish novel strategies for cartilage repair. Microarray analyses of osteophytic cartilage and articular cartilage identified PEDF as one of the most differentially expressed gene. PEDF is particularly expressed in terminally differentiated chondrocytes within the growth plate, osteophytes and repair cartilage. Transcriptome analyses (RNA-Seq) in chondrocytes demonstrated that PEDF stimulates the expression of cartilage-degrading enzymes (among those MMP13), but simultaneously suppresses the expression of typical chondrocyte-specific genes. These results indicate that PEDF is importantly involved in remodeling processes during endochondral ossification and repair.

Cartilage and meniscus repair
Pt: Prof. Dr. K. Gelse
This project evaluated the intrinsic regeneration potential of articular cartilage with a focus on integration and chondrocyte-outgrowth from native cartilage autografts transplanted in cartilage defects in an ovine model. The cartilage autografts showed no relevant cellular outgrowth and insufficient integration with surrounding intact cartilage when transplanted into defects. This study outlines the highly limited endogenous repair capacity of adult articular cartilage and the prerequisite of an additional cell population. A further project investigated the transplantation of chemically-processed, decellularized meniscal allografts in an ovine model. Transplanted allografts were characterized by a high biocompatibility and tightly integrated with surrounding tissue of the joint capsule without any signs of rejection. However, repopulation of repair cells was only observed at the surface and the meniscal basis. Current experiments investigate the potential of different chemotactic stimuli to enhance migration of endogenous repair cells into defects or tissue. In this respect, platelet-rich plasma (PRP), PDGF and TFF3 proved to be very efficient chemotactic factors.

Magnetic resonance imaging of joint structures
Pt: Dr. M.L. Pachowsky
This research project focuses on the evaluation of articular cartilage (repair tissues and osteoarthritis) as well as meniscal tissue by MR-imaging with the goal to validate novel biochemical Magnetic Resonance (MR)-techniques. In experimental models, healthy articular cartilage was compared with degenerated articular cartilage and cartilage repair tissues. Additionally, biochemical MR-methods were used to assess the associated joint structures in a multiparametric approach (i.e. meniscus tissue). The MR-methods non-invasively attained detailed information on the composition of articular cartilage that correlated with histology. So far, “molecular” MR-imaging allowed adequate characterization of the ultrastructure of cartilage and repair tissue together with visualization of the proteoglycan content, alignment of collagen fibers, hydration status of cartilage as well as remodeling processes of
Selected Publications


The Division of Trauma Surgery supervises numerous MD theses.

Traumatic lesions of thoracic bone structures

Pt: Dr. S Schulz-Drost

This research group focuses on the epidemiology, pathogenesis, and therapeutic options of serial fractures of the ribs and fractures of the sternum. The current treatment concepts were analyzed according to the Trauma register DGU® and the prevalence of fractures of the ribs and sternum were determined in the cohort of severely injured trauma patients. The different types of sternal fractures were characterized, and different methods for operative treatment were analyzed using cadaver models. This led to the establishment of definitive treatment recommendations. For this purpose, specific locking plates were developed in cooperation with AO Foundation for fixation of different fracture types. Additionally, surgical concepts for correcting and stabilizing the chest wall were optimized based on the clinical relevance of instable injuries of thoracic bone structures with severely restricted respiration biomechanics. Furthermore, the influence of locking plates for stabilization of combining sterno-vertebral injuries and the possibilities for minimalizing surgical approaches to the chest wall were evaluated in human anatomical studies. Basic recommendations could be incorporated into the S3-guidelines for polytrauma treatment. Currently, recommendations for the classification of injuries of the bony chest wall are established and evaluated based on the present knowledge.

Teaching

The Division of Trauma Surgery participates with elective and compulsory courses in the curricular teaching of students of medicine, dental medicine and of medical engineering. The interdisciplinary teaching for the purposes of preparation for examinations has to be outlined.