Department of Trauma Surgery – Orthopedic Surgery

Chair of Trauma Surgery and Orthopedics

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Research focus
- Development of a modular hybrid concept for the reconstruction of the joint surfaces
- Cartilage regeneration and meniscus transplantation
- Gait and motion analysis
- MRI-imaging of the skeletal system
- Lesions of the anterior chest wall in combination with fractures of the spine

Structure of the Department

Professorships: 2
Personnel: 20
- Doctors (of Medicine): 20
- 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 Department of Trauma Surgery – Orthopedic Surgery (until 1/2019: Division of Trauma Surgery) covers a broad spectrum of research activites 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 Department.

Development of a modular hybrid concept for the reconstruction of the joint surfaces

PI: Prof. Dr. K. Gelse

The project "MoJo 3D – Modular composite Joint 3D" focuses on a complete novel technology for the reconstruction of a functional joint surface for the treatment of osteoarthritis or traumatically-induced cartilage defects (compare own report).
The purpose is the generation of a resilient and low-friction joint surface by an individualized, modular concept. The interdisciplinary work comprises research capacities of the materials science, cellular biology, stem cell research, tissue-engineering, orthopedics, trauma surgery, and rheumatology. Current work focuses on the establishment of a composite, modular structure of different materials, which is adapted to the biological and biomechanical demands of the human joint. This project brings the expertise of above mentioned research fields of the FAU together in order to establish a complete novel concept for assembling and application for regenerative therapies.

Cartilage regeneration and meniscus repair

PI: 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, PDGF and TFF3 proved to be very efficient chemotactic factors.

Gait and motion analysis

PI: Dr. S. Krinner

This research group focuses on a subproject of the Emerging Fields Initiative (EFI-Moves) 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. Furthermore, two different running techniques were compared with respect to the biomechanical joint forces. We could demonstrate significant differences in ground reaction forces and loading rates for the large joints of the lower extremities between forefoot and rearfoot running.

MRI-imaging of the skeletal system

PI: Dr. M. Pachowsky, Dr. S. Söllner

Magnetic Resonance Imaging (MRI) is able to non-invasively depict structural and ultra-structural changes in different diseases without radiation. MRI has become the gold-standard in some cerebral and joint diagnostics.
Besides morphological description of anatomy and pathology, modern MR protocols assess additionally quantitative aspects of joint tissue. This conclusive information has the unique potential to assess and quantify changes of different tissues at very early stages of the disease. Thus, by using these quantitative MR imaging methodologies (i.e. T2 mapping), pathophysiological pathways are longitudinally visualized, representing options for early diagnosis, prevention approaches, or therapy monitoring.
Current projects focus among others on the assessment of cartilage regions at risk in the knees of young athletes, on changes in intervertebral discs after kyphoplasty, and on new approaches on visualizing tissue metabolites in ultra-high-field MR sequences.

Lesions of the anterior chest wall in combination with fractures of the spine

PI: Dr. S. Krinner

Fractures of the anterolateral chest wall, especially sternal fractures are rather rare. However, in the presence of such injuries, there may be concomitant injuries directly associated with sternal fractures, such as fractures of the anterolateral bony chest wall and spine injuries. The aim of this work is to provide a systematic analysis of mechanisms, which may lead to injuries of the anterolateral chest wall in combination with spinal injuries and thus destabilization of the torso in the sagittal plane. There are particularly critical anatomic regions that must not be overlooked during initial diagnostics. After appropriate assessment, you should always keep in mind the biomechanical relationships that exist in the area of the bony thoracic wall, including the spinal column, with regard to further therapeutic steps. A corresponding sagittal instability can be addressed by various stabilization methods and the osteosynthesis of the anterolateral chest wall should definitely be included in the therapy consideration.

Teaching

The Department of Trauma Surgery – Orthopedic Surgeryparticipates with elective and compulsory courses in the curricular teaching of students of Medicine and Dentistry, as well as medical engineering. The interdisciplinary teaching for the purposes of preparation for examinations has to be outlined.
The Department of Trauma Surgery – Orthopedic Surgerysupervises numerous MD theses.

Selected publications

Gelse K, Körber L, Schöne M, Raum K, Koch P, Pachowsky M, Welsch G, Breiter R. Transplantation of Chemically Processed Decellularized Meniscal Allografts. Cartilage. 2017 Apr;8(2):180-190

Kluge F, Hannink J, Pasluosta C, Klucken J, Gaßner H, Gelse K, Eskofier BM, Krinner S. Pre-operative sensor-based gait parameters predict functional outcome after total knee arthroplasty. Gait Posture. 2018 Oct;66:194-200

Knorz S, Kluge F, Gelse K, Schulz-Drost S, Hotfiel T, Lochmann M, Eskofier B, Krinner S. Three-Dimensional Biomechanical Analysis of Rearfoot and Forefoot Running. Orthop J Sports Med. 2017 Jul 24;5(7):2325967117719065

Klinger P, Lukassen S, Ferrazzi F, Ekici AB, Hotfiel T, Swoboda B, Aigner T, Gelse K. PEDF Is Associated with the Termination of Chondrocyte Phenotype and Catabolism of Cartilage Tissue. Biomed Res Int. 2017;2017:7183516

Soellner ST, Goldmann A, Muelheims D, Welsch GH, Pachowsky ML. Intraoperative validation of quantitative T2 mapping in patients with articular cartilage lesions of the knee. Osteoarthritis Cartilage. 2017 Nov;25(11):1841-1849

Pachowsky ML, Kleyer A, Wagner L, Langenbach A, Simon D, Janka R, May M, Welsch GH. Quantitative T2 Mapping Shows Increased Degeneration in Adjacent Intervertebral Discs Following Kyphoplasty. Cartilage. 2018 Mar 1:1947603518758434