Institute of Radiology
Division of Neuroradiology

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Research Focus
- Clinical and experimental validation of flat-panel volume CT
- Multimodal imaging of cerebrovascular diseases
- 7 Tesla high-field-neuroimaging
- Preoperative multimodal imaging of epilepsy
- Functional and metabolic MR-imaging
- Holistic assessment of optical tract in glaucoma patients using diffusion tensor imaging
- Standardization of acquisition and post-processing MRI perfusion techniques (SAPP)
- Experimental neuroradiology – multimodal imaging in glioma and validation of new interventional therapies
- Simulation of hemodynamics and fluid dynamics in cerebral aneurysms

Structure of the Division
Professorships: 1
Personnel: 45
- Doctors (of Medicine): 15
- Scientists: 7 (thereof funded externally: 7)
- Graduate students: 4

Clinical focus areas
- Diagnostic and interventional neuroradiology
- Multimodal diagnostics in cerebrovascular diseases, brain tumors and epilepsy
- Functional and metabolic neuroimaging

Research
The scientific focus of the Division of Neuroradiology is on multimodal imaging, especially in stroke, brain tumors and focal epilepsies. Hereby, a paramount scientific focus is on the evaluation of new imaging modalities, in particular „interventional imaging“. In cooperation with various partners, validation and optimization of intravenous and intraarterial flat detector angiography, flat detector volume CT and high-field MRI are performed. In addition, there are several third-party research collaborations, among others with Siemens Healthineers, Bayer Pharma AG and the Faculty of Engineering of the FAU.

Clinical and experimental validation of flat-panel volume CT
Projects are funded in part by the Bayerisches Forderprogramm Medizintechnik "Stroke Machine" and the EU-grant EIF Health “P3 Stroke – Predictive prevention and personalized multimodal interventional stroke therapy”. "Stroke Machine" evaluates the potential of multimodal angiography as “one-stop-shopping” tool for acute stroke. In "P3 Stroke" together with Siemens Healthineers and the Pattern Recognition Lab we develop, implement and validate an integrated hybrid Angio-MRI system. In cooperation with Siemens Healthineers and the Pattern Recognition Lab, we further evaluate and further develop intravenous and intraarterial flat-panel volume CT, angiographic techniques, and postprocessing algorithms in cerebrovascular disease. Hereby, a focus is set on the optimized visualization of cerebral microimplants, such as stents, coils, clips, new perfusion techniques, and 3D visualizations in stroke patients.

Multimodal imaging of cerebrovascular diseases
In cooperation with the Department of Neurology, we participate in several acute stroke studies. Using multimodal MR imaging algorithms, including perfusion and diffusion-weighted imaging, diffusion tensor imaging, susceptibility-weighted imaging, arterial spin labeling, and contrast-enhanced angiographic imaging, we evaluate the individual indication for acute stroke therapies, such as intravenous thrombolysis, intraarterial thrombectomy, and/or other neuroprotective therapies. Here, a main focus is on the MR-derived patient selection for mechanical thrombectomy. Another clinical and scientific focus is the evaluation and validation of mechanical devices for revascularization strategies in acute cerebral stroke.

7 Tesla high-field neuroimaging
Within the scope of a research collaboration on a clinical 7T prototype installation with Siemens Healthineers, various scientific research projects are carried out in close cooperation with the Department of Neurology and the Institute of Radiology for the validation and optimization of X-nuclear spectroscopy, high-resolution structural imaging, diffusion tensor imaging and fMRI in epilepsy, multiple sclerosis, brain tumors and neurodegenerative diseases.

Preoperative comprehensive imaging of epilepsy
In cooperation with the Epilepsy Center, we evaluate different multimodal imaging strategies in the preoperative workup of patients with focal seizures refractory for best medical treatment. A major focus is put on high-resolution 3T and 7T morphologic and functional MR imaging (MRI spectroscopy, diffusion tensor imaging, functional MRI, perfusion- and diffusion-weighted MRI, MR volumetry/voxel-based morphometry) in conjunction with physiological parameters (EEG, MEG, WADA test, SPECT, PET).

Functional and metabolic MR-imaging
There are several ongoing research projects in cooperation with departments and institutes at the Faculty of Medicine (Department of Psychiatry and Psychotherapy, Division of Child and Adolescent Mental Health, Division of Psychosomatics and Psychotherapy, Department of Medicine 3, Department of Neurology, Institute of Physiology and Pathophysiology, Institute of Experimental and Clinical Pharmacology and Toxicology) and at the Faculty of Business, Economics, and Law (Institute of Marketing) involving functional and metabolic MR-imaging (e.g. patients with major depressive disorders, anxiety and eating disorders, chronic pain syndromes, and rheumatoid arthritis). Together with the Department of Neurosurgery and funded by the DFG, we evaluate and optimize multimodal imaging protocols to distinguish diffuse tumor cell spread in glioma patients.

Holistic assessment of optical tract in glaucoma patients using diffusion tensor imaging
In cooperation with the Department of Ophthalmology and the Computer Science Department 5 (Pattern Recognition Lab; Faculty of Engineering) and funded by the IZKF, we evaluate diffusion tensor imaging (DTI) using 3 and 7 Tesla MRI to assess quantitative and qualitative changes within the optical fiber tracts in glaucoma patients at a very early stage. Disorders in optical fiber tracts result in reduced fractional anisotropy (FA) and atrophy of the tracts which can be used for non-invasive and fast screening, staging and to evaluate therapeutic strategies in glaucoma. Moreover, first results indicate that DTI can distinguish at an early stage between different forms of glaucoma that require diverse treatment.
Standardization of acquisition and post-processing MRI perfusion techniques (SAPP)

Broad clinical application of cerebral MR perfusion is limited due to heterogeneous MR protocols used in the investigations published up to date and due to limited size of study collectives. Therefore an international, prospective, blinded crossover multicenter trial lead by the Division of Neuroradiology was designed in cooperation with Bayer AG and four international centers (Mailand/Italy, Upsala/Sweden, Ontario/Canda, and Los Angeles/USA). In a first step, the research team developed a standardized MR-perfusion protocol. As next step, a large database will be generated based on sequence and contrast media parameters. Collected data will be investigated by means of technical and radiological parameters and clinical outcome.

Experimental neuroradiology – multimodal imaging in glioma and validation of new interventional therapies

In cooperation with the Department of Neurosurgery, the Preclinical Imaging Platform Erlangen (PIPE; Institute of Radiology), and the Department of Nuclear Medicine, we evaluate and optimize multimodal imaging and new therapy strategies in experimental brain gliomas, using micro-CT, high-field and ultra-high-field MRI (3 and 7 Tesla), and micro-PET. Additionally, using an elastase-induced and a surgical aneurysm model, we evaluate different imaging techniques such as flat-panel volume CT, conventional CT, MBI, and angiography as well as new materials and techniques for endovascular treatment and follow-up.

Simulation of hemodynamics and fluid dynamics in cerebral aneurysms

In cooperation with the Computer Science Department S (Pattern Recognition Lab), the Institute of Fluid Mechanics (both Faculty of Engineering) and Siemens Healthcare, we evaluate the hemodynamic and fluid dynamics in cerebral aneurysms and malformations. A special focus is put on the effects of different endovascular therapies using new endovascular microimplants, such as stents, flow diverter stents, bifurcation devices and coils. Medium-term strategy is to develop and clinically implement an automated software-platform that can be used within the perinterventional setting.

Teaching

The Division of Neuroradiology is widely involved in the training of medical students. In addition, we train residents in neuroradiology and general radiology and radiological technicians.

Selected Publications


International Cooperations

Prof. C. Stromer, Department of Radiology, University of Wisconsin, Madison: USA
Dr. A. Rose, Department of Radiology and Neurology, Lenox Hill Hospital New York, New York: USA
Prof. Dr. Anton Valavanis, Klinik für Neuroradiologie, Universitäts-Spital, Zurich: Switzerland
Prof. Dr. Marco Essig, Department of Radiology, University of Manitoba, Winnipeg: Canada
Prof. Dr. A. El-Rafei, Faculty of Engineering, Ain Shams University, Cairo: Egypt