Institute of Radiology

Division of Neuroradiology

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Research focus
- 7 Tesla high-field-neuroimaging
- Multiple sclerosis
- Glaucoma
- Parkinson's disease and multisystem atrophy
- Epileptic seizures
- Preoperative diagnosis of pituitary adenomas
- Clinical and experimental validation of flat-panel volume CT
- Multimodal imaging of cerebrovascular diseases
- Preoperative multimodal imaging of epilepsy
- Functional and metabolic MR-imaging
- Holistic assessment of optical tract in glaucoma patients using diffusion tensor imaging
- Simulation of hemodynamics and fluid dynamics in cerebral aneurysms

Structure of the Division

Professorship: 1
Personnel: 46
- Doctors (of Medicine): 16
- Scientists: 7 (thereof funded externally: 7)
- Graduate students: 3

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

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 with 3 and 7 Tesla field strength are performed. In addition, there are several third-party research collaborations.

7 Tesla high-field neuroimaging

As part of a research collaboration with Siemens Healthineers, various scientific research projects are being carried out in close cooperation with the Department of Radiology and the Department of Neurology to validate and optimize clinical ultrahigh-field MRI.

Multiple sclerosis

In patients with multiple sclerosis (MS), 7 Tesla imaging will be used to validate reproducible, independent, and sensitive imaging markers that will allow clinical trials of progressive MS to be completed in less time and with fewer resources, and that can be promptly brought into clinical routine for follow-up and therapy monitoring. Using ultra-high-field MRI, surrogate parameters (QSM, CEST, myelin-water imaging, Na-imaging, K-imaging) will be validated in multiple sclerosis patients in correlation to the clinical course (outcome measures). The Na- and K-measurements are funded by the German MS Society. There is also an industry grant from Novartis AG.

Glaucoma

The aim is to detect pathological protein deposits in the brain tissue in patients with pseudoexfoliatoin glaucoma (PEXG), using high-field molecular CEST MRI, to measure the effect of these proteins on neuronal and axonal integrity and resulting cell death by means of Na-imaging, and to measure the damage along the intracranial visual pathway by diffusion tensor imaging. Molecular CEST and Na-MRI signatures as well as structural DTI patterns will be used to characterize PEX glaucoma subtypes. Imaging markers will be correlated with ophthalmologic measurements and location of damage to the visual pathway in a hollistic approach.

Parkinson's disease and multisystem atrophy

Idiopathic Parkinson's syndrome (IPS) can be differentiated from atypical Parkinson syndromes. The atypical Parkinson syndromes are characterized by a rapidly progressive course and a worse prognosis. Clinically, reliable imaging diagnostics for the early detection and differentiation of these entities is desirable. Hereby, ultrahigh-field MRI with high-resolution morphological sequences and new image contrasts for the direct visualization of the substantia nigra can improve early differential diagnosis. Additionally, QSM (quantitative susceptibility mapping) will be evaluated in patients with IPS and atypical parkinsonian syndromes compared with age-matched control subjects as functional surrogate parameters for early diagnosis and differentiation.

Epileptic seizures

In close cooperation with the Epilepsy Center, multimodal diagnostics using 3 and 7 Tesla high field MRI (morphological high field MRI, functional MRI, MR spectroscopy, diffusion tensor imaging, MR volumetry and voxel-based morphometry) correlated to physiological parameters (EEG, MEG, WADA-Test, SPECT, PET) will be evaluated in the pre-surgical localization diagnostics of epileptogenic brain areas.

Preoperative diagnosis of pituitary adenomas

In cooperation with the Department of Neurosurgery, we develop and validate high-resolution morphological and functional sequences for the preoperative delineation of micro- and macroadenomas of the pituitary gland in correlation to intraoperative findings. The aim is the exact preoperative delineation of the tumor spread in the cavernous sinus, as well as the relationship of the tumor to cranial nerves and vessels and improved detection of very small adenomas by dynamic T1-weighted flooding imaging.

Clinical and experimental validation of flat-panel volume CT

Projects are funded in part by the Bayerisches Förderprogramm Medizintechnik "Stroke Machine" and the EU-grant EIT 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 cooperation with Siemens Healthineers and the Pattern Recognition Lab, we further evaluate intravenous and intraarterial flatpanel 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 advanced 3D visualization 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. Hereby, a main focus is set on CT- and MR-derived patient selection for mechanical thrombectomy. Another clinical and scientific focus is the evaluation and validation of mechanical devices for mechanical thrombectomy in acute cerebral stroke.

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 to medical treatment. Hereby, a major focus is on correlation of high-resolution 3T and 7T morphologic and functional MR imaging (MR spectroscopy, diffusion tensor imaging, functional MRI, perfusion- and diffusion-weighted MRI, MR volumetry/voxel-based morphometry) 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 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, DTI can be used to distinguish between different forms of glaucoma that require diverse treatment.

Simulation of hemodynamics and fluid dynamics in cerebral aneurysms

In cooperation with the Computer Science Department 5 (Pattern Recognition Lab), the Institute of Fluid Mechanics (Faculty of Engineering), and Siemens Healthineers, 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- and long-term strategy is to develop and clinically implement an automated software-platform that can be used within the endovascular 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.

In addition to the training of medical students in accordance with ÄAppO, the Division of Neuroradiology also conducts courses for the degree program in Medical Technology (Biological and Technical Vision) and the Chair for Pattern Recognition. In addition, the Division of Neuroradiology offers the lecture „Clinical Neuroimaging“ since 2014.

Together with the Institute of Diagnostic Radiology, the education of physician spezialized in Diagnostic Radiology is carried out. For neuroradiology, there is full training authorization.

Selected publications

Huhn K, Mennecke A, Linz P, Tschunko F, Kästle N, Nagel AM, Uder M, Dörfler A, Linker RA, Engelhorn T. (23)Na MRI reveals persistent sodium accumulation in tumefactive MS lesions. J Neurol Sci. 2017 Aug 15;379:163-166

Stadlbauer A, Zimmermann M, Kitzwögerer M, Oberndorfer S, Rössler K, Dörfler A, Buchfelder M, Heinz G. MR Imaging-derived Oxygen Metabolism and Neovascularization Characterization for Grading and IDH Gene Mutation Detection of Gliomas. Radiology. 2017 Jun;283(3):799-809

Mennecke A, Svergun S, Scholz B, Royalty K, Dörfler A, Struffert T. Evaluation of a metal artifact reduction algorithm applied to post-interventional flat detector CT in comparison to pre-treatment CT in patients with acute subarachnoid haemorrhage. Eur Radiol. 2017 Jan;27(1):88-96

Hoelter P, Lang S, Weibart M, Schmidt MA, Kott FX, Engelhorn T, Essig T, Kloska S, Dörfler A. Prospective intraindividual comparison of gadoterate and gadobutrol for cervical and intracranial contrast-enhanced magnetic resonance angiography. Neuroradiology. 2017 Dec;59(12): 1233-1239

Stadlbauer A, Zimmermann M, Doerfler A, Oberndorfer S, Buchfelder M, Coras R, Kitzwögerer M, Roessler K. Intratumoral heterogeneity of oxygen metabolism and neovascularization uncovers 2 survival-relevant subgroups of IDH1 wild-type glioblastoma. Neuro Oncol. 2018 Oct 9;20(11): 1536-1546

Schmidt MA, Knott M, Heidemann R, Michelson G, Kober T, Dörfler A, Engelhorn T. Investigation of lateral geniculate nucleus volume and diffusion tensor imaging in patients with normal tension glaucoma using 7 tesla magnetic resonance imaging. PLoS One. 2018 Jun 7;13(6):e0198830

International cooperations

Prof. C. Strother, Department of Radiology, University of Wisconsin, Madison: USA

Prof. Dr. A. Valavanis, Klinik für Neuroradiologie, Universitäts-Spital, Zurich: Switzerland

Prof. Dr. M. Essig, Department of Radiology, University of Manitoba, Winnipeg: Canada

Prof. Dr. A. El-Rafei, Faculty of Engineering, Ain Shams University, Cairo: Egypt