Institute of Radiology
Chair of Diagnostic and Interventional Radiology

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Research focus
- Optimization of radiation dose and image quality in computed tomography
- Interventional radiology
- Cardiovascular imaging
- Breast imaging and gynecological radiology
- Information technology in radiology
- Experimental radiology and small animal imaging
- Musculoskeletal imaging research
- MR-physics

Structure of the Chair
Professorships: 4
Personnel: 156
- Doctors (of Medicine): 33
- Scientists: 11 (thereof funded externally: 11)
- Graduate students: 13

Clinical focus areas
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)
- Angiography (including therapies)
- Conventional radiography
- Imaging
- Ultrasound
- Mammography
- Biopsies with imaging guidance

Special structural feature
Four locations (departments of Internal Medicine, Surgery, Gynecology and Obstetrics, Pediatrics and Adolescent Medicine)

Research
Scientific focus of the Institute of Radiology is clinical and translational research. Within different study groups and research projects, the clinical impact of various imaging procedures or novel technical developments is evaluated. Furthermore, the Imaging Science Institute (ISI; compare own report) is operated in cooperation with Siemens Healthcare to integrate new developments in diagnostic imaging and novel IT-solutions into the clinical routine and the academic research. Finally, experimental and pre-clinical studies are well-established in our scientific activities.

Optimization of radiation dose and image quality in computed tomography
PI: PD Dr. M. May, Dr. M. Brand, PD Dr. W. Wüst, Prof. Dr. M. Uder
CT is the major contributor to overall medical x-ray exposition. Radiation induced DNA-dou-blestrand-breaks (DSB) can be detected by immuno- fluorescence microscopy. Recent studies have shown a strong correlation between DSB levels and the dose deposited in blood lymphocytes of patients. A different approach for radiation dose estimations is the mathematical Monte-Carlo-Simulation that provides detailed dose distribution for each individual. The knowledge from these monitoring techniques is used to establish methods for optimization of radiation dose and image quality. Studies evaluate the performance of modern technological developments for modulation of the x-ray spectra (organ based tube current modulation, tube voltage adaptation, spectral shaping, dual energy), for rapid examinations (high-pitch), for image reconstruction (iterative reconstructions, metal artifact reduction) and post-processing (dual energy techniques, anatomic landmark detection).

Interventional radiology
PI: PD Dr. A. Schmid, PD Dr. W. Wüst, Prof. Dr. M. Uder, Prof. Dr. R. Janka
Clinical studies are performed in cooperation with the departments of Surgery, Nuclear Medicine, Medicine 1, Medicine 4 and the divisions of Vascular Surgery and Nephropathology. Research foci include the establishment of endovascular radiofrequency ablation of sympathetic nerve fibers in renal arteries of patients with resistant hypertension, of endovascular therapies in dysfunction of av-fistulas, of selective internal radiotherapy and CT-guided tumor ablation techniques (irreversible electroporation, radiofrequency, and microwave). In patients with contraindication to the standard percutaneous biopsy of kidney transplants, an alternative transvenous biopsy procedure via a transfemoral approach is established.

Cardiovascular imaging
PI: PD Dr. W. Wüst, PD Dr. M. May, Dr. C. Treutlein, Dr. R. Heiss, Dr. J. Roth, Prof. Dr. M. Uder
One of the main limitations of cardiac MRI are long examination times. Especially for older, ill patients an examination with multiple breathholds is very demanding. In the last couple of years, real time sequences were developed to speed up the examination time. Focus of studies in children and adults is the reproducibility and comparability to the standard sequence. Real time imaging not only shortens examination times, but also gives the opportunity to examine patients with arrhythmia to improve image quality compared to the standard sequence. Another development in the last couple of years are sequences for quantitatively characterization of cardiac tissue. One of the main drawbacks of this new technique is that published values are highly dependent on scanner and sequence type, thus leading to low comparability. Up to now, published values cannot be compared to each other and further studies are mandatory to increase the clinical acceptance of this new technique.

Breast imaging and gynecological radiology
PI: Prof. Dr. R. Schulz-Wendtland, Prof. Dr. E. Wenkel, Prof. Dr. R. Janka, Prof. Dr. F. Laun, Dr. S. Ohlmeyer
In this group, new methods for digital mammography are developed in cooperation with different medical systems manufacturers. Based on substantial experimental and clinical studies, the work includes development, implementation, and comparison of different digital mammography and ultrasound systems including tomosynthesis, 3D and CAD (fusion- and hybrid systems). In addition, detection and volumetric analysis of tumors by mammography, (automated) ultrasound and the further characterization of breast masses by sonographic elastography are under investigation. Another focus lies in breast MRI and the development of new MRI sequences for better differentiation between malignant and benign breast disease at 1.5T, 3T and – in cooperation with the unit of experimental imaging – at 7T.
Finally, we are cooperating with the Institute of Medical Physics to develop a breast CT scanner.

Information technology in radiology
PI: Prof. Dr. A. Cavallaro, PD Dr. M. Hammon, Dr. P. Daneker, Dr. H. Seub
The joint project Clinical Data Intelligence of the Federal Ministry of Economics and Technology was successfully completed. By linking the con-
Preliminary analysis of changes in diffusion and perfusion parameters in cartilage and subchondral bone - a retrospective study of patients with knee osteoarthritis.

MR-physic

The focus of this group is on the development of new imaging acquisition, image reconstruction, and post-processing techniques for MRI. These techniques are evaluated in close collaboration by physicists and clinicians. The aim is to provide improved clinical radiological diagnostics. Among others, techniques are developed to acquire in vivo images of the sodium (23Na)- and potassium (39K)-distribution. These nuclei play an important role in many physiological processes. For example, the 23Na- and 39K-concentrations are closely related to the physiological status of the cells. An additional focus is on the development of new methods to measure susceptibility and diffusion of water molecules in vivo. The measurement of diffusion coefficients provides information about the tissue structure and integrity. Clinical applications of diffusion-weighted imaging are, for example, the diagnostics of ischemic stroke and prostate carcinomas. In addition, high-gradient methods (e.g. dedicated breast gradients, G > 1 T/m) are being developed in a DFG-funded project to determine tissue microstructure. In order to enable a quantitative evaluation, suitable validation and reference objects, so-called phantoms, are also being developed. There are numerous national (e.g. German ultra-high field imaging (GUFI) network, DKFZ Heidelberg, MDC Berlin) and international collaborations (including Harvard Medical School, Boston, and Institut Médical, Paris). In addition, various projects involve a very close cooperation with Siemens Healthcare.

Teaching

Besides the standard lectures and practical courses, innovative clinically orientated courses are regularly offered including interactive discussions of clinical cases. In these courses the students are taught a much more analytic and clinical rather than a systematic approach towards the interpretation of radiologic images. A new online course was established for students to prepare effectively for the state examination. Students of the degree program Medicine can always perform clinical electives or internships at our Institute. Students striving for a doctor’s degree are supervised closely when writing their experimental or clinical thesis. Furthermore, the Institute of Radiology participates in degree programs Medical Process Management and Molecular Medicine (Faculty of Medicine) as well as Medical Technology (Faculty of Engineering). In addition, a joint seminar “Physics in Medicine” is offered in cooperation with the Department of Physics (Faculty of Sciences).

Selected publications


Gast LV, Gerharter T, Hensel B, Uder M, Nagel AM. Double quantum filtered 3 Na MRI with magic angle excitation of human skeletal muscle in the presence of B0 and B1 inhomogeneities. NMR Biomed. 2018 31(12):e4010


International cooperations

Prof. A. Bogdanov, PhD University of Massachusetts, Worcester: USA

Prof. S. Strattnig, MD, Universitätshklinikum Wien, Vienna: Austria

Prof. A. Guermazi, MD, PhD, Boston University School of Medicine, Boston: USA

Prof. Y. Rathi, PhD, Harvard Medical School, Boston: USA

Prof. J. Titze, MD, Duke National University, Singapore: Singapore