Ruprecht-Karls-Universität Heidelberg
Medizinische Fakultät Mannheim
Dissertations-Kurzfassung

Quantitative diffusion-weighted magnetic resonance imaging in prostate and rectal cancer

Autor: Barbara Daria Wichtmann
Institut / Klinik: Klinik für Radiologie und Nuklearmedizin
Doktormutter: Prof. Dr. U. Attenberger

Advances in magnetic resonance imaging (MRI) are enabling cancer diagnostics with precise and quantitative measurements that can be leveraged to develop image-based biomarkers for data-driven medicine using modern computational analysis techniques.
Diffusion-weighted imaging (DWI) is an advanced quantitative MRI technique that has evolved to provide increasingly sophisticated investigations of tumor tissue microstructure in vivo. In this work, I will reflect on various DWI techniques and discuss their potential to describe microstructural changes of prostate cancer (PCa) with increasing accuracy and specificity. Herein, I will introduce our new analysis framework for DWI data, called Linear multi-scale modeling (LMM). In a research setting, employing a state-of-the-art 3T MRI scanner equipped with 300mT/m gradients and cutting-edge acquisition techniques, LMM has been shown to enable a detailed characterization of tissue microstructure with greater specificity to diffusion in intra- and extracellular compartments. In this work, I present the first ever results of a clinical application of LMM on a conventional 3T MRI scanner equipped with 45mT/m gradients for the development of distinct diffusion microstructural signatures of PCa to aid in the diagnosis of clinically significant PCa lesions.
In addition to advanced imaging techniques, modern computational analysis techniques have opened new avenues for obtaining and evaluating analyzable, high-dimensional data from large medical databases using artificial intelligence methods such as Deep Learning (DL). These methods allow radiologists to expand their value beyond just image interpretation, e.g., for predicting response of locally advanced rectal cancer (LARC) to neoadjuvant chemoradiotherapy (nCRT). However, before such DL approaches can be adopted in routine clinical practice, their predictive performance has yet to be evaluated in a multicenter setting with heterogeneous data. Facing the challenge of varying data quality and uniformity, I will conclude my work by presenting our multicenter study on assessing the generalizability of a promising state-of-the-art multitask DL model for response prediction of LARC to nCRT.
A modern personalized oncology approach depends on precise and quantifiable data. Radiology, formerly a qualitative discipline, is evolving into a quantitative science, with imaging biomarkers at the center of this transformation. With this work, I hope to contribute to this exciting transformation.