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CU Anschutz

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Combining Machine Learning and High-Resolution 9.4 Tesla MRI in Pediatric Brain Tumor Models

Brain tumors are the second most common malignancy in childhood. Magnetic resonance imaging (MRI) is the preferred clinical modality for the management of pediatric brain tumors due to its exquisite soft tissue contrast and non-ionizing radiation. Pediatric brain tumors have a diverse array of clinical manifestations, cellular and molecular phenotypes, and tumor habitats. There is an unmet need to develop human-faithful pediatric mouse models and fast high-resolution functional MRI to characterize biologically relevant structure-function relationships *in vivo*. Here, we report on non-gadolinium, Multiparametric Advanced Fast Imaging (MAFI) at an ultra-high 9.4T MRI scanner, followed by radiomics analysis, to detect, characterize and differentiate four distinct brain tumor subtypes of orthotopic patient-derived xenograft (PDX) mouse models. The total MAFI scan time (turboRARE T2-MRI, FLAIR, intrinsic susceptibility (IS)-MRI, and diffusion weighted imaging (DWI)) was 17 minutes. High-resolution T2-MRI detected lesions (> 0.2 mm^3) in the posterior fossa for medulloblastomas, in the pons for DIPG, and in the cerebellum for ependymomas and ATRT, with metastatic spread to cortex (medulloblastoma), spine (DIPG) and olfactory bulb (ependymoma), each n=12. MRI revealed increased tumor blood volume (mostly in medulloblastomas) at the early stage of tumor engraftment. High cellularity (indicated by low ADC on DWI) was characteristic of medulloblastomas and ependymomas, along with high peritumoral edema on DWI and FLAIR. For radiomics analysis, each image was segmented into three regions (with 360 radiomics features each): well-defined tumor, peritumoral edema and tumor necrosis. A subset of twelve tumoral, six peritumoral and two necrotic MAFI radiomics features was found to be predictive of the tumor subtype ($P<0.0002$) using machine-learning approach independent of tumor anatomical location. In summary, the 9.4 Tesla MAFI MRI protocol discriminates among specific radiological features for four distinct orthotopic models.

Short Bio

Natalie Julie Serkova, PhD
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Dr. Serkova is a tenured Professor of Radiology at the University of Colorado Anschutz Medical Campus. Her formal education includes training in Physics at the University of Grenoble (France, BS) and Biophysics/ Biochemistry the University of Kiev (Ukraine, MSc). After completing my Ph.D. in MR Physics, MRI Division, University of Bremen (Germany), she joined the Department of Biopharmaceutical Sciences at the University of California at San Francisco (UCSF) and Radiology at the Stanford University as a postdoctoral fellow in 1997. Before joining the CU SOM in 2002, Dr. Serkova was Assistant Professor in MR Division at the University of Bremen (Germany) and Visiting Professor at the UCSF. At the CU SOM, she serves as the Deputy Associate Director of the Cancer Center and founding director of the Colorado Animal Imaging Shared Resource (AISR), which is generously supported by the NIH/ NCI, the Cancer Center (UCCC) and the Colorado Clinical Translational Sciences Institute (CCTSI). Dr. Serkova's research interests are in the development of new imaging probes and acquisition protocols for oncology/ neurooncology animal models using the state-of-the-art preclinical scanners (Bruker 9.4 Tesla MRI, PerkinElmer IVIS Spectrum and Quantum CT, Siemens Inveon PET/CT, Mediso SPECT/CT). She have mentored 37 undergraduate students, 15 graduate students, 7 post-doctoral students and residents and published over 150 peer-reviewed publications in the area of oncologic imaging and metabolism.