UKE Paper of the Month April 2022

Evaluation of magnetic resonance image-based radiomics characteristics for differentiation of benign and malignant peripheral nerve sheath tumors in neurofibromatosis type 1

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ABSTRACT:

Background: Patients with neurofibromatosis type 1 (NF1) develop benign (BPNST), pre-malignant atypical (ANF), and malignant (MPNST) peripheral nerve sheath tumors. Radiological differentiation of these entities is challenging. Therefore, we aimed to evaluate the value of an MRI-based radiomics machine learning classifier for differentiation of these three entities of internal peripheral nerve sheath tumors in NF1 patients.

Methods: MRI was performed at 3T in 36 NF1 patients (20 male; age: 31±11 years). Segmentation of 117 BPNSTs, 17 MPNSTs, and 8 ANFs was manually performed using T2w SPAIR sequences. One hundred seven features per lesion were extracted using PyRadiomics and applied for BPNST vs. MPNST differentiation. A 5-feature radiomics signature was defined based on the most important features and tested for signature-based BPNST vs. MPNST classification (random forest (RF) classification, leave-one-patient-out evaluation). In a second step, signature feature expressions for BPNSTs, ANFs and MPNSTs were evaluated for radiomics-based classification for these three entities.

Results: The mean AUC for the radiomics-based BPNST vs. MPNST differentiation was 0.94, corresponding to correct classification of on average 16/17 MPNSTs and 114/117 BPNSTs (sensitivity: 94%, specificity: 97%). Exploratory analysis with the 8 ANFs revealed intermediate radiomic feature characteristics in-between BPNST and MPNST tumor feature expression.

Conclusion: In this proof-of-principle study, machine learning using MRI-based radiomics characteristics allows sensitive and specific differentiation of benign and malignant peripheral nerve sheath tumors in NF1 patients. Feature expression of pre-malignant atypical tumors were distributed in-between benign and malignant tumor feature expressions, which illustrates biological plausibility of the considered radiomics characteristics.

STATEMENT:

This interdisciplinary work of the Department of Radiology and the Institute of Computational Neuroscience shows for the first time that an AI-empowered radiomics-based approach in NF1-associated tumors is feasible and allows for differentiation and characterisation of tumors of different malignancy.

BACKGROUND:

This collaborative project was performed at the Department of Diagnostic and Interventional Radiology and Nuclear Medicine and the Institute for Computational Neurocience, bAIome (UKE Center for biomedical AI). Dr. Inka Ristow is a fourth-year-resident at the Department of Radiology with a research interest in quantitative imaging methods in magnetic resonance imaging. PD Dr. René Werner is a principal investigator and head of the UKE group of Image Processing and Medical Informatics at the Department of Computational Neuroscience and bAIome (UKE Center for biomedical AI). This work was funded by the Werner-Otto-Stiftung.