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Abstract

Towards Advanced Ultrasound Image Analysis by Combining Radiomics and Artificial Intelligence in Brain Tumors †

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Abstract: Background: Intraoperative ultrasound (ioUS) images of brain tumors contain information that has not yet been exploited. The present work aims to analyze images in both B-mode and strain-elastography using techniques based on artificial intelligence and radiomics. We intend to assess the capacity for differentiating glioblastomas (GBM) from solitary brain metastases (SBM) and also to assess the ability to predict the overall survival (OS) in GBM. Methods: We performed a retrospective analysis of patients who underwent craniotomy between March 2018 to June 2020 with GBM and SBM diagnoses. Cases with an ioUS study were included. In the first group of patients, an analysis based on deep learning was performed. An existing neural network (Inception V3) was used to classify tumors into GBM and SBM. The models were evaluated using the area under the curve (AUC), classification accuracy, and precision. In the second group, radiomic features from the tumor region were extracted. Radiomic features associated with OS were selected employing univariate correlations. Then, a survival analysis was conducted using Cox regression. Results: For the classification task, a total of 36 patients were included: 26 GBM and 10 SBM. Models were built using a total of 812 ultrasound images. For B-mode, AUC, and accuracy, values of the classification algorithms ranged from 0.790 to 0.943 and from 72 to 89%, respectively. For elastography, AUC and accuracy values ranged from 0.847 to 0.985 and from 79 to 95%, respectively. Sixteen patients were available for the survival analysis. A total of 52 radiomic features were extracted. Two texture features from B-mode (Conventional mean and GLZLM_SZLGE) and one texture feature from strain-elastography (GLZLM_LZHGE) were significantly associated with OS. Conclusion: Automated processing of ioUS images through deep learning can generate high-precision classification algorithms. Radiomic tumor region features in B-mode and elastography appear to be significantly associated with OS in GBM.

Keywords: ultrasound; elastography; brain tumor; radiomics; artificial intelligence

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