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Magnetic Resonance Imaging Radiomic Features Stability in Brain Metastases

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Purpose:
In radiomic studies, robustness of models can be challenging due to variations in feature values caused by different scanners and imaging protocols. This problem is most prominent in magnetic resonance imaging (MRI) due its high sensitivity to imaging parameters. This study aims to assess the impact of image preprocessing, and image-normalization on the stability of MRI-based radiomic features. We also report a radiomics model to classify primary cancer site based on radiomic characteristics of metastases.

Methods:
Twenty-five patients with brain metastases and two MRI scans at different time points were enrolled in this study. The images were discretized using fixed bin number (FBN) (16, 32, 64,128, and 256) or fixed bin size (FBS) (average volume of interest (VOIs) intensity/bin numbers). Four MRI intensity normalization techniques, including Nyul, Z-score, White Stripe, and an in-house developed method called N-Peaks, were applied to the images. Radiomics feature extraction was performed using Pyradiomics. Intra class correlation coefficients (ICC) were calculated for all analyzed preprocessing methods. Features with ICC>0.8 were considered stable. For the classification task, 64 brain metastases patients with primary lung (n=33) or melanoma (n=31) cancer were included and radiomic model performance for different preprocessing methods was evaluated.

Results:
The percentage of stable features increased with increasing bin number or decreasing bin sizes for all configurations. For the five normalization variants (non-normalized, Nyul, N-peaks, White Stripe and Z-Score), we found the following percentages of stable features. Using FBN = 64: 21%, 20%, 21%, 19%, and 19% respectively. Using FBS = (average VOIs intensities/64): 7%, 13%, 11%, 10%, and 12%. For the classification task, the model based on Nyul normalization and FBN gray level discretization had the highest AUC of 0.69 ±0.11.

Conclusion:
The effect of normalization on the stability of radiomic features highly depends on preprocessing methods. Using FBN resulted in a higher percentage of stable features and no clear benefit from intensity normalization. For FBS, the stability of features is improved after intensity normalization. FBN resulted in better classification performance.

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