Radiomics-Based Differentiation between Parkinson's Disease and Atypical Parkinsonism Using Fixed and Patient-Specific Regions on DaT-SPECT

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Abstract

Accurate differentiation between Parkinson's disease (PD) and atypical parkinsonism (AP) is clinically important, yet remains challenging because of their overlapping manifestations. Radiomics analysis of 123I-FP-CIT DaT-SPECT can provide quantitative imaging information, but radiomics characterization may depend on how the analysis region is defined. In this study, we evaluated a radiomics-based machine learning approach using fixed and patient-specific striatum-centered regions on DaT-SPECT. Two analysis regions were defined: a fixed bounding box applied consistently across subjects and a patient-specific bounding box determined from individual tracer uptake patterns. Following region-specific intensity scaling, 93 three-dimensional first-order and texture radiomic features were extracted from each region. Models were developed in 141 subjects (109 PD and 32 AP) using repeated nested cross-validation and subsequently evaluated in an independent test cohort of 36 subjects (27 PD and 9 AP). In the development cohort, the fixed-region random forest, patient-specific elastic-net logistic regression, and probability-level late-fusion models achieved ROC-AUCs of 0.715, 0.739, and 0.772, respectively. On independent testing, the corresponding ROC-AUCs were 0.753, 0.848, and 0.844, with the late-fusion model achieving the highest PR-AUC of 0.812. These results suggest that fixed and patient-specific regions may provide complementary radiomic information for PD–AP differentiation, highlighting analysis-region definition as an important methodological consideration in DaT-SPECT radiomics.

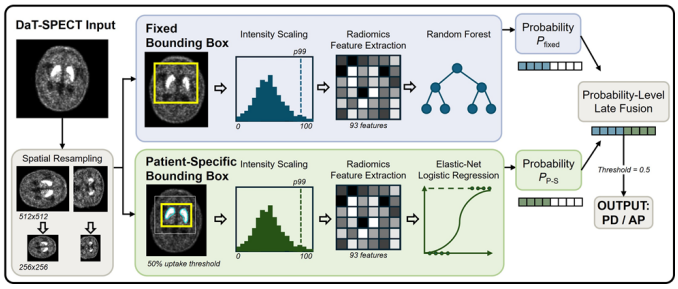

Figure 1. Overview of the DaT-SPECT radiomics workflow using fixed and patient-specific regions for PD–AP differentiation.

Index Terms

DaT-SPECT; Parkinson's Disease; Atypical Parkinsonism; Radiomics; Machine Learning