Deep learning-based cognitive signature of brain FDG PET associated with outcome of rapid eye movement sleep behavior disorder

Abstract

Background: As rapid eye movement (REM) sleep behavior disorder (RBD) is frequently associated with cognitive decline at risk of progression to neurodegenerative disorders, an objective biomarker evaluating cognitive dysfunction is crucial. To this end, we evaluated deep learning (DL)-based cognitive signature of [^{18}F]fluorodeoxyglucose (FDG) brain positron emission tomography (PET) correlated with clinical features of RBD.

Materials and methods: Baseline FDG PET data acquired from prospectively enrolled patients with RBD and controls were analyzed between Jun 2017 and Dec 2019. A DL-based cognitive signature on FDG PET trained for differentiating Alzheimer's disease from normal controls using Alzheimer's Disease Neuroimaging Initiative database was used. The model was transferred to FDG PET data of patients with RBD with mild cognitive impairment (MCI) (RBD-MCI) (n=19), RBD without MCI (RBD-nonMCI) (n=31), and controls (n=20). The DL-based cognitive scores of RBD-MCI and RBD-nonMCI were compared using the Mann-Whitney test. The accuracy of differentiating RBD-MCI from RBD-nonMCI was evaluated by area under curve (AUC) of receiver operating characteristic (ROC) analysis. The DL-based cognitive score at the baseline of RBD patients with and without the cognitive score decline at 2-year follow-up was compared using the Mann-Whitney test.

Results: The DL-based cognitive score was significantly higher in RBD-MCI than RBD-nonMCI (-1.157 ± 2.126 vs. -0.202 ± 1.526, p=0.018). The AUC of ROC curve for differentiating RBD-MCI from RBD-nonMCI was 0.70 (95% CI 0.56 to 0.82). The DL-based cognitive score at the baseline was significantly higher in RBD patients who showed decreased CERAD scores during 2 years than those who did not (0.947 ± 1.989 vs -1.000 ± 1.480, p = 0.031).

Conclusion: The DL-based cognitive signature could be used to objectively evaluate cognitive dysfunction in RBD. We suggest that this approach could be extended to an objective biomarker reflecting neurodegeneration in RBD in terms of the cognitive domain.

References

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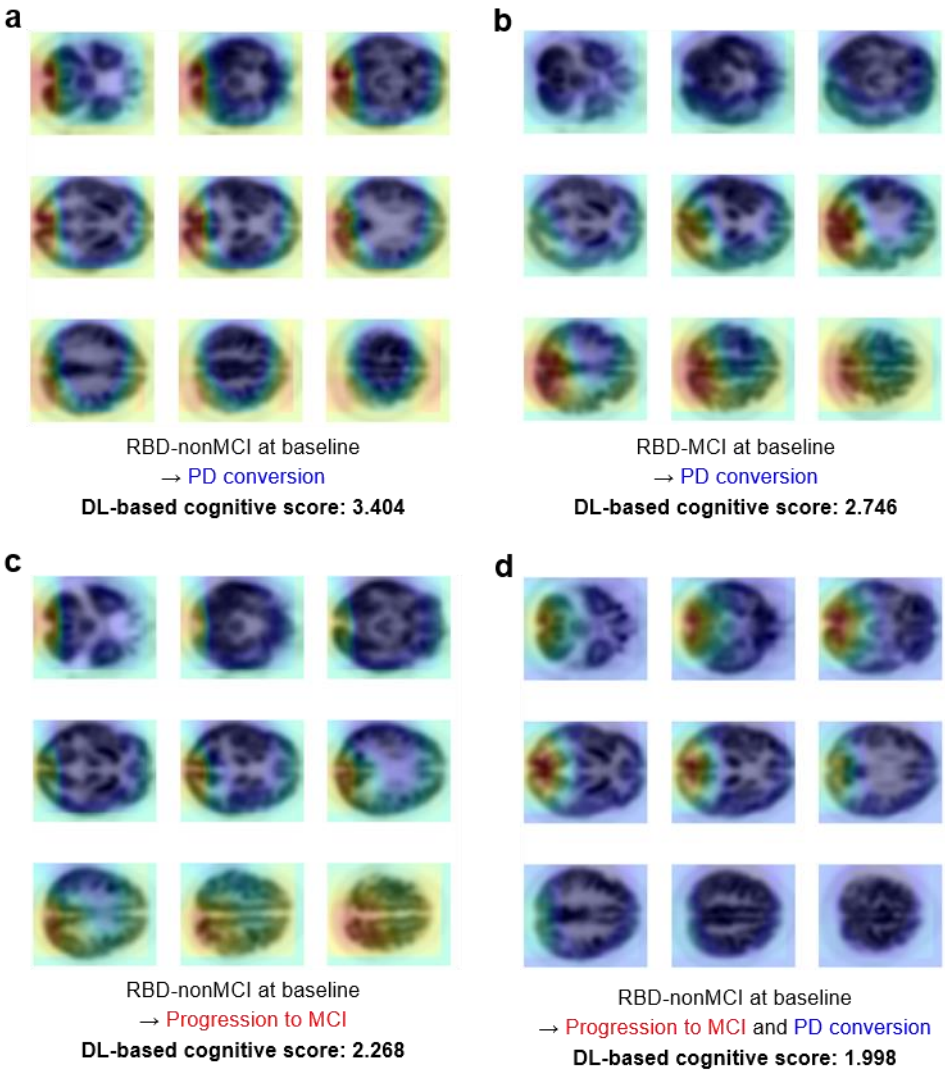
Supplementary figure



The regions related to cognitive dysfunction was represented by class activation map, which has been used for visualizing the location of pattern identified by CNN models. In our study, brain metabolic features related to the cognitive dysfunction-related regions of individuals were partly different from each other, but the regions mainly included posterior cortical regions: occipital, posterior parietal, and temporal areas.