

Structural and functional cerebellar alterations in Parkinson's disease with postural instability and gait disorders

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Introduction: Brain structures other than basal ganglia are likely to be involved in the pathophysiological process of Parkinson's disease (PD). The role of cerebellum in PD has been explored during motor tasks involving the hand, while few studies investigated its activity during gait-simulating tasks and dual-task situations.

Objectives: This study aimed at assessing structural and task-based functional cerebellar alterations in PD patients with postural instability and gait disorders (PD-PIGD).

Methods: Twenty-one PD-PIGD patients and 23 age and sex-matched healthy controls underwent clinical, structural and functional MRI, including a motor-task (foot anti-phase movements) and a dual-task (foot anti-phase movements while counting backwards by three). Regional grey matter cerebellar volumes were assessed automatically using an atlas propagation and label fusion strategy based on the freely available human cerebellum template and probabilistic atlas (SUIT). fMRI images were co-registered with structural images and cerebellar fMRI analysis was performed.

Results: PD-PIGD patients showed reduced volumes in several cerebellar motor and non-motor areas relative to controls. During the fMRI motor-task, patients showed greater activation of cognitive cerebellar areas (lobule VI and crus I-II) relative to healthy subjects. During the fMRI dual-task, PD-PIGD showed increased activity of cognitive areas (crus II) and a reduced activity of motor areas (lobules I-IV). Structural alterations of cerebellum were correlated with the increased activity of cerebellar cognitive areas. Moreover, the increased recruitment of cognitive areas during the fMRI motor task correlated with a better motor performance in PD-PIGD patients.

Conclusions: The increased activity of non-motor cerebellar areas might be a consequence of grey matter atrophy or an attempt to compensate the functional failure of cerebellar motor areas. Structural and functional MRI metrics focusing on cerebellum are useful to characterize brain correlates of motor and dual-task abilities in PD-PIGD patients.