Advanced neuroimaging methods and their use in evaluation of structural changes of the brain and their cognitive correlates in early diagnosis of neurodegenerative disorders

Abstract

Neurodegenerative diseases are a heterogeneous group of diseases characterized by the loss of specific neuronal populations caused by the deposition of pathologically altered proteins into the brain tissue. The structural corelate of these pathological changes is a brain atrophy. The most common neurodegenerative disease is Alzheimer's disease (AN). The cholinergic deficit, caused by atrophy of the basal telencephalon (BF), and atrophy of the medial temporal lobe (MTL) are among the hallmarks of AN. Recent advances in imaging methods and image processing techniques have made it possible to measure atrophy at the level of substructures. The aim of this dissertation was to evaluate the potential utility of imaging methods in the assessment of structural changes and their cognitive correlates in the early diagnosis of neurodegeneration, in particular to evaluate the utility of segmentation of the BF nuclei and MTL substructures in the early and differential diagnosis of AN, their mutual relationships and cognitive correlates. We confirmed that differences in atrophy of individual BF and MTL substructures may be utilized in the diagnosis of early stages of AN, and that assessment of atrophy of the posterior hippocampus and posteromedial entorhinal cortex may help in the differential diagnosis of neurodegenerative diseases. We have shown that there is a close correlation between atrophy of the BF nuclei Ch1-2 and Ch4p and MTL structures, and that the role of these structures in the processes of allocentric spatial navigation and spatial pattern separation is fully mediated by the hippocampus, particularly its posterior part. Our findings suggest that segmentation of BF and MTL substructures may be utilized in early and differential diagnosis of AN. In conjunction with atrophy pattern analysis and machine learning techniques, it could become the basis for the development of sensitive, accessible and non-invasive diagnostic tools allowing early detection of AN.

Keywords: Alzheimer's disease, basal forebrain, entorhinal cortex, hippocampus, mild cognitive impairment, spatial navigation, spatial pattern separation, structural MRI