The Evolution of Diffusion Tensor Imaging in Parkinson’s Disease Research

I read with great interest the thorough and well written review by Duncan and colleagues on magnetic resonance imaging (MRI) as a biomarker for cognitive impairment in Parkinson’s disease (PD).1 The authors accurately discuss the difficulties of direct comparison across MRI studies. These include patient heterogeneity, different neuropsychological tests and cutoff scores, widely differing definitions for PD with dementia (PDD) and PD with mild cognitive impairment (PD-MCI), as well as image analysis choices and the diversity of statistical methods used. I agree that the Movement Disorders Society PD-MCI criteria2 are a positive step in the process toward standardization. The reviewed studies employing diffusion tensor imaging (DTI) illustrate another potential confound when comparing across studies—DTI data quality. In fact, the articles cited in the review provide a beautiful example of the evolution of DTI data in the field of PD research.

Early DTI studies (published in 20043 and 20074) used what was then cutting-edge technology to investigate PD and produced informative findings. However, the quality of DTI data has improved substantially over the past decade. Multiple advances, including the increase in field strength to 3 Telsa, the use of multi-channel head coils, the increase in the number of diffusion-encoding directions, and improved postprocessing methods to minimize the effects of head motion and eddy current distortions, have combined to yield superior fractional anisotropy and mean diffusivity images. Figure 1 provides a visual example of the impressive increase in data quality over the lifetime of DTI studies in PD. Thus, raw DTI data quality also contributes to the variability of findings that range from normal to highly abnormal in early PD and PD with normal cognition.

Although numerous MRI studies have increased our knowledge of the imaging signature of cognitive impairment in PD, Duncan and colleagues conclude that a validated MRI biomarker does not currently exist. Nevertheless, with continued refinement of DTI techniques and more novel methods of quantifying tissue microstructure, such as high angular resolution diffusion imaging (HARDI), Q-ball vector analysis, and diffusion kurtosis imaging, diffusion MRI may yet provide a key component in the armamentarium of a useful, multimodal biomarker of cognitive decline in PD.

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References


