Evidence for Brain White Matter Damage and Atrophy With Aging: A Diffusion Tensor MRI Tractography Study

F. Agosta[1], S. Sala[1], E. Pagani[1], D. Caputo[2], and M. Filippi[1]

[1]Neuroimaging Research Unit, Institute of Experimental Neurology, Division of Neuroscience, Scientific Institute and University Hospital San Raffaele, Milan, Italy, [2]Department of Neurology, Scientific Institute Fondazione Don Gnocchi, Milan, Italy

Introduction. Diffusion tensor (DT) MRI allows to obtain indices of white matter (WM) integrity. A method to obtain estimates of WM fiber bundle volumes using DT MRI has also been developed [1]. Investigating the relationship between simultaneous age effects on different diffusivity parameters could provide more insight into the mechanisms of WM aging [2]. In this study, we investigate linear and nonlinear microstructural and volumetric changes of WM tracts with aging, using DT MRI-based tractography

Methods. Conventional and DT MRI was obtained in 84 healthy volunteers (age range=13–70 years). DT MRI tractography was performed to segment the major brain WM tracts, bilaterally. Mean diffusivity (MD), fractional anisotropy (FA), axial diffusivity (AD), and radial diffusivity (RD) of each tract were measured. WM tract volume was assessed measuring the Jacobian determinant of the transformation between an FA atlas and subjects' FA maps [3]. Linear and quadratic relationships between age and DT MRI metrics were tested.

Results. A linear correlation was found between age and MD increase and FA decrease in all WM tracts, except for the right cingulum and bilateral uncinate fasciculus where a linear correlation with age was found for FA, only. The quadratic regression model better fitted MD increase and FA decrease in several WM tracts. Age-related MD increase and FA decrease were associated with region-specific patterns of RD increase and both decrease and increase in AD. A linear negative correlation was found between age and WM tract volumes in the left cingulum and fornix, while the quadratic model better fitted age-related volume decline in the corpus callosum and right inferior fronto-occipital fasciculus.
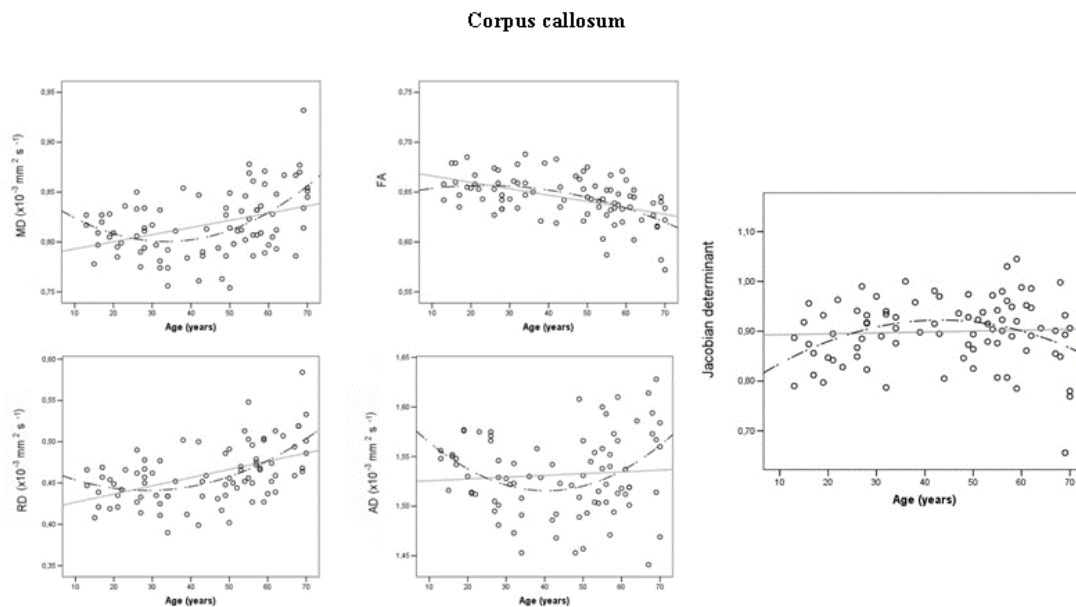

Corpus callosum

Figure. The figure shows the scatterplots of the linear and quadratic correlations between subject's age and the different DT MRI metrics of the corpus callosum.

Conclusions. WM loss of integrity and volume varies with age by WM tract and may reflect different degrees of severity of changes in microstructural and macrostructural WM properties.

References. [1] Pagani E., Horsfield MA, Rocca MA, Filippi M. Magn Reson Med 2007; 58:527-34. [2] Burzynska AZ, Preuschhof C, Bäckman L, et al. NeuroImage 2009 [Epub ahead of print]. [3] Rohde GK, Aldroubi A, Dawant BM. The adaptive bases algorithm for intensity-based non-rigid registration. IEEE Trans Med Imaging 2003;22:1470-1479.