Young adults born with very low birth weight demonstrate widespread white matter abnormalities on brain DTI

L. Eikenes[1], J. Skranes[2], A-M. Brubakk[2], and A. Håberg[3]
[1]Department of circulation and medical imaging, Norwegian University of Science and Technology, Trondheim, Norway, [2]Department of Laboratory Medicine, Children's and Women's Health, Norwegian University of Science and Technology, Trondheim, Norway, [3]Department of Neuroscience, Norwegian University of Science and Technology, Trondheim, Norway

Introduction

Preterm birth with very low birth weight (VLBW, ≤ 1500 g) is associated with reduced white matter integrity and connectivity in childhood and adolescence. These changes in white matter are correlated to motor, sensory and neuropsychological impairments. CNS myelination continues into the early twenties, but the consequences of this for white matter integrity in young adults with VLBW have not been explored.

Materials and Methods

Forty-nine persons with VLBW and 59 term born controls with normal birth weight were scanned on a 1.5 T Siemens Magnetom Symphony at ages 18-22. The protocol consisted of a T1-weighted MPRAGE, and a DTI single-shot balanced-echo EPI acquired in 12 non-collinear directions with b=1000 s/mm^2 and an isotropic resolution of 2.2 mm. Tract-Based Spatial Statistics (TBSS) was carried out to test for voxelwise statistical significant differences in fractional anisotropy (FA), eigenvalues and mean diffusivity (MD) between the two groups. In addition, the relationship between FA and different perinatal data: birth weight, gestational age, APGAR score, number of days on mechanical ventilator, total number of days of in neonatal intensive care, was also explored, with gender and age at MRI examination as covariates.

Results

In the young adult VLBW group all major central and posterior white matter tracts had significantly reduced FA, mainly caused by an increase in the two lowest eigenvalues (Figure 1A). MD was significantly increased in the VLBWs, with a 50% overlap with the regions with reduced FA, but also encompassing more peripheral white matter. Significantly increased FA values were present in the right hemisphere; the posterior limb of the internal capsule, corticopontine - /corticospinal tract, superior thalamic radiation and (mid-) superior longitudinal fasciculus (Figure 1B) in the VLBW group compared to the controls. The increased FA in the VLBW group was linked to an increase in the principal eigenvalue. In the VLBW group, FA was found to correlate positively with birth weight and negatively with number of days on mechanical ventilator and days in intensive care unit, particularly in the corpus callosum.

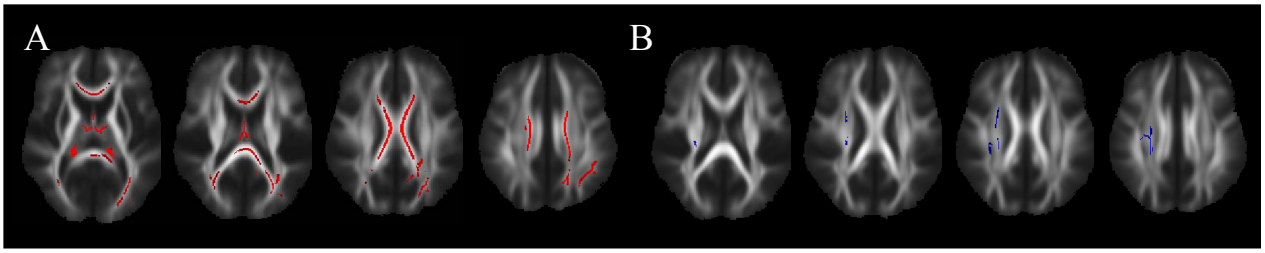

Figure 1. TBSS analysis demonstrated areas with significantly decreased FA (RED) (A) and significantly increased FA (BLUE) (B) in the VLBW group compared to the control group ($p<0.05$, nonparametric permutation test, corrected for multiple comparisons). Background image is the mean FA map of all subjects in the study. Images are shown in radiological convention, i.e. the right side of the subjects is on the left side of the images.

Conclusion

This study demonstrates that preterm birth with VLBW results in significant and long-term irreversible changes in white matter microstructure that may interfere with neuropsychological functioning. Lower birth weight and perinatal problems requiring prolonged treatment on mechanical ventilator and/or intensive care have permanent negative effects on white matter integrity.