NUS-05 Diffusion tensor imaging in the evaluation of Wallerian degeneration in paediatric stroke: work-in-progress

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Introduction: Wallerian degeneration, the anterograde degeneration of axons and myelin sheaths after proximal axonal or cell body injury, is known to occur after cerebral infarction. In this pilot study, we aim to evaluate if diffusion tensor imaging (DTI), using the indices of fractional anisotropy (FA) and mean diffusivity (MD), can detect and quantify Wallerian degeneration in paediatric middle cerebral artery (MCA) strokes and to compare the findings with conventional MR imaging.
Methods: Nine children with unilateral MCA infarctions were studied. Axial T1-weighted, proton density and T2-weighted images, as well as DTI were performed using a Signa 1.5 Tesla imager. Quantitative values of FA and MD were obtained by manually placing regions-of-interest (ROI) in the infarction, and selected areas along the ipsilateral corticospinal tract, i.e. the posterior limb of the internal capsule (PLIC) and cerebral peduncle (CP). Identical ROIs were placed in the matched contralateral regions. The corticospinal tract FA was derived by the mean value of PLIC FA and CP FA. The presence of signal intensity changes in the internal capsule and cerebral peduncles on T2-weighted images were recorded. Statistical comparisons between two sides were performed using the Student's t-test.
Results: WD was detected on conventional T2-weighted imaging by hyperintense signal in the PLIC in 4 children and CP in 1 child. The FA of the infarction, PLIC and CP were reduced, and the MD of the infarction and PLIC were increased on the ipsilateral side compared to the contralateral side in all children, whilst the MD of the CP was increased in six children. The mean FA ratio of the ipsilateral to the contralateral side in the infarction, PLIC, CP was 0.45, 0.77 and 0.79 respectively and the differences were statistically significant in all sites ($p=0.029$, $p=0.014$ and 0.008 respectively). The mean MD ratio of the ipsilateral to the contralateral side in the infarction was 2.55 and this difference was statistically significant ($p<0.001$). The differences in MD in the other sites were not statistically significant.
Conclusion: DTI is more sensitive than conventional MRI and can be used to detect and quantify WD. Further studies are required to determine if the measurement of FA in Wallerian degeneration can be used as an indicator of neuromotor outcome.

NUS-06 Diffusion tensor imaging for the evaluation of treatment-induced neurotoxicity in childhood medulloblastoma

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Introduction: We propose the use of diffusion tensor MR imaging (DTI) to evaluate treatment-induced white matter (WM) injury in childhood medulloblastoma survivors and also aim to determine if fractional anisotropy(FA) can be used as an index for evaluation of treatment-induced neurotoxicity.
Methods: 13 medulloblastoma survivors who were treated with surgery, cranial irradiation and chemotherapy were evaluated. Conventional MR imaging and DTI were performed using a 1.5 Tesla imager. FA maps were generated using the FUNCTOOL software. Voxel-based comparison between the patient and control groups was performed with SPM99. Contrasts (1 –1) and (–1 1) were employed for the detection of positive and negative activations. FA of selected supratentorial WM sites (frontal periventricular WM, parietal periventricular WM and corona radiata) were also measured by placement of regions-of-interest (ROI). ROIs of similar size were placed on identical sites as far possible in the healthy age-matched controls. FA (sum of frontal and parietal WM and corona radiata FA) was compared with age at treatment, time interval after treatment and intellectual outcome (deterioration of school performance). Two-tailed paired t-test was used for detection of statistical significance.
Results: Patients were between 3 -17 yrs of age at treatment (mean: 8.2 yrs) and time-interval between treatment and MR imaging ranged between 1–11 yrs (mean: 3.7 yrs). Voxel-based comparison showed areas of activation in the periventricular WM, especially parietal WM, and corona radiata. Using ROIs, mean FA of patients was reduced in all sites compared to controls, with a reduction of between 15.6% and 19.2%. The reduction was statistically significant in the parietal WM and corona radiata ($p=0.011$ and $p=0.040$ respectively) FA reduction of the groups £ 5 years ($n=5$) and >5 years of age ($n=8$) at treatment was 61.1% and 34.8% respectively and FA reduction in the group with < 5 years ($n=8$) and ≥ 5 years interval ($n=5$) since treatment was 35.4% and 60.3% respectively. These differences were however, not statistically significant. Comparing school performance, FA reduction of those with mild deterioration ($n=5$) and those with moderate/severe deterioration ($n=8$) was 19.9% and 60.6 % respectively and this difference was statistically significant ($p=0.041$).
Conclusion: Loss of anisotropy occurs in the periventricular white matter of post-treatment medulloblastoma survivors and this loss is significantly greater in those with poor intellectual outcome. DTI is therefore useful in detection and monitoring of treatment-induced neurotoxicity.