Diffuse axonal injury in Mild Traumatic Brain Injury:A Diffusion Tensor Imaging study

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Background

Diffuse axonal injury (DAI) is a major complication of traumatic brain injury (TBI) leading to functional and psychological deficits. DAI is frequently under-diagnosed by conventional imaging but can be quantified using diffusion tensor imaging (DTI). The aim of this study was to assess the presence and the extent of DAI in patients with mild TBI.

Methods

Forty-six patients with mild TBI and 29 healthy controls underwent dual spin-echo, T2*-weighted gradient-echo and DTI sequences. In 20 of the patients MRI was performed at an average of 4.05 days after injury. In the remaining 26 MRI was performed at an average of 5.7 years after injury. In each subject, mean diffusivity (MD) and fractional anisotropy (FA) were measured using both whole-brain histograms and regions of interest analysis. No differences in any of the histogram-derived measures were found between patients and controls. Compared to controls, patients displayed significant reduction of FA in the corpus callosum (CC), internal capsule (IC) and centrum semiovale (CS) and significant increases of MD in the CC and IC. Neither histogram-derived nor regional DTI metrics differed between the two groups of patients.

Results

Histogram analysis

No statistically significant differences were found in any of the average MD and FA histograms-derived measures between any of the groups (p values ranging from 0.4 to 0.9).

ROI analysis

Compared to controls, the average MD in the splenium of CC was significantly higher in Group I (early imaging) and Group II (late imaging) ($p<0.001$ in both) and in the two groups combined ($p<0.001$). MD in the posterior limb of the internal capsule was significantly higher in Group II ($p=0.05$) and in the two groups combined ($p=0.008$) but not in Group I considered alone ($p=0.1$). Compared to controls, significantly lower FA values were found in the splenium of CC in all patients groups ($p<0.001$ for all three) and in the internal capsule (Group I, $p=0.02$; Group II $p=0.05$; Groups I and II combined, $p<0.001$). FA values of the centrum semiovale were significantly lower ($p=0.03$) only when both patients Groups were combined. TBI patients at early and late times of injury (Group I and Group II) did not differ in terms of MD and FA values (p values ranging from 0.2 to 0.9).

Conclusion

Although MD and FA abnormalities of our TBI patients were too subtle to be detected with the whole-brain histogram analysis, they are present in brain areas that are frequent sites of DAI. Since DTI changes are present at both early and late time points following injury they may represent an early indicator and a prognostic measure of subsequent brain damage.

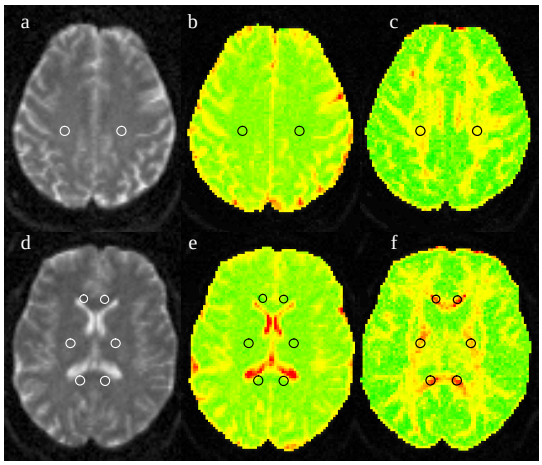

Fig 1. Top Axial T2-weigheted image (**a**), color-coded MD map (**b**) and color-coded FA map (**c**) from a patient with mild TBI and no MRI-visible abnormalities. Circular regions of interests are placed in centrum semiovale bilaterally. **Bottom** Axial T2-weigheted image (**c**), color-coded MD map (**d**) and color-coded FA map (**e**) from the same patient. Circular regions of interests are placed in the posterior limb of the internal capsule, genu and splenium of CC bilaterally