Traumatic axonal injuries in patients with moderate to severe traumatic brain injury: The relationship between non-hemorrhagic MRI findings in early phase with diffusion tensor imaging findings in chronic phase.

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Introduction

- Diffusion tensor imaging (DTI) has demonstrated injuries to the microstructural integrity in all grades of traumatic brain injury (TBI), as seen by decreased fractional anistropy (FA).
- Longitudinal DTI studies do exist, but this is the first study relating lesions in early and chronic MRI with chronic DTI findings.

AIM: The aim of this study was to detect traumatic axonal injury (TAI) lesions depicted in conventional MRI in early and chronic phases, compare FA values in persisting and attenuating non-hemorrhagic (NHL) and micro hemorrhagic lesions (MHL) and relate them with global and neuropsychological outcome.

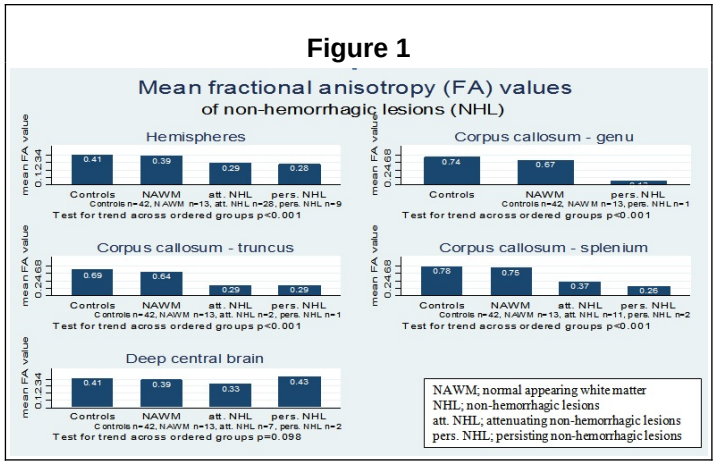
Methods

- 38 patients (mean age 24.7, range 13-63 years) with moderate-severe TBI and 42 age and sex matched controls were enrolled in the study.
- Patients underwent MRI including fluid-attenuated inversion recovery (FLAIR) and T2* gradient echo (GRE) in the early phase (median 7 days) and FLAIR, T2*GRE, T1 and DTI in the chronic phase (1-5 years).
- TAI lesions (NHL and MHL) were characterized based on location (hemispheres, corpus callosum and deep central brain) in the early images. NHL and MHL were depicted in FLAIR and T2*GRE sequences, respectively and thereby linearly registered to the chronic FA images via T1-weighted images (FSL). The lesions were manually segmented on the FA-registered images and mean FA calculated for each lesion.
- Global outcome was measured with Glasgow Outcome Score Extended (GOSE) scores and neuropsychological tests: trail making tests [TMT] and grooved pegboard tests.

Results

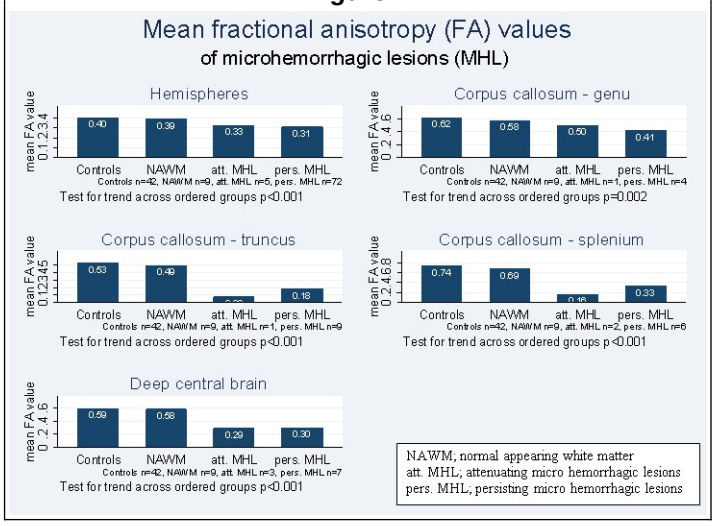
- 63 NHL were depicted in 25 patients and 104 MHL were depicted in 29 of the patients.
- Histogram analyses of individual voxel values demonstrated reduced mean FA both in the hemispheres and the corpus callosum in the persisting NHL compared with those attenuating ($p<0.001$).
- For the same regions we observed a statsitically signficant linear trend of the mean FA values ($p<0.001$) in the following order: controls > normal appearing white matter (NAWM) patients > attenuating NHL > persisting NHL (Fig. 1).

Figure 1



- For the MHL we could not demonstrate any differences in FA between attenuating and persisting lesions, but we observed the same significant linear trends for all three brain regions ($p<0.001$, Fig. 2).

Figure 2



- Ordinal logistic regressions with age ajustment showed that decreased mean FA values in NHL and MHL in the hemispheres and corpus callosum could predict worse GOSE category ($p<0.001$).
- Linear regression analyses with age adjustment showed a negative relationship between mean FA values and TMT scores ($p<0.001$) and grooved pegboard test ($p<0.042$) respectively.

Conclusions

- **We observed a linear relationship with a gradual higher destruction of the microstructure from normal appearing white matter via attenuating to persisting non-hemorrhagic and micro hemorrhagic TAI lesions.**
- **The degree of destruction predicts both global and neuropsychological outcome post-injury.**