

Corpus callosum in moderate and severe traumatic brain injury: A longitudinal study of the apparent diffusion coefficient values in diffusion MRI during the first year post-injury

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Introduction

- The use of diffusion weighted imaging (DWI) and diffusion tensor imaging (DTI) has increased the sensitivity for detecting white matter lesions.
- Corpus callosum is one predilection site for traumatic axonal injury (TAI), and any region could be affected (Chang et al. 2010).
- Longitudinal DTI studies have demonstrated increased ADC values in normal appearing corpus callosum in the chronic phase, but there exist no large scale longitudinal studies of the ADC values from DWI sequences from traumatic brain injury (TBI) patients.

AIM: to prospectively explore the regional differences and the temporal changes of the ADC values in apparently healthy corpus callosum of TBI patients throughout the first year and relate the findings to cognitive and global outcome.

Methods

- 60 patients (mean age 33.2, range 11-64 years) - examined with diffusion MRI at three time points (median 8 days, 3 and 12 months) during the first year post-injury
- Control group (n=47) matched on age and sex were examined once.
- The corpus callosum was subdivided into five regions (Figure 1) and the mean ADC-values computed in 10 regions of interests (ROIs) without any visible lesions. This was done blinded for clinical information.
- Glasgow Outcome Scale Extended (GOSE) and neuropsychological function were assessed 12 months post-injury.

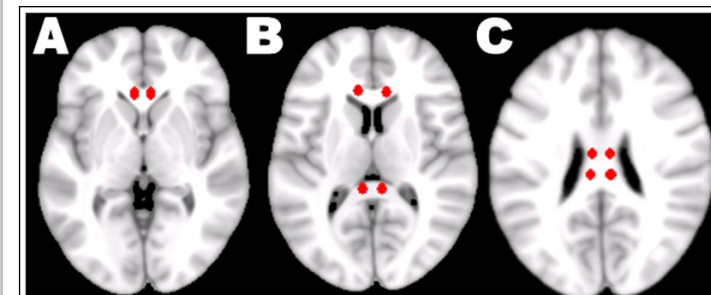
Results

- In the early stage, no significant differences in mean ADC values were observed when compared with healthy controls (Table 1).
- The mean ADC values in region IV, corresponding to the posterior truncus, were significantly increased in normal appearing corpus callosum at 3 months and at 12 months also in regions I and III (Table 1).
- The increased mean ADC values of the genu were only present for moderate TBI patients, for severe TBI patients only the mean ADC values in region IV were increased.
- We observed no differences between the mean ADC values of moderate and severe TBI patients at 12 months (p=0.49-0.97).
- Longitudinal models for repeated measurements demonstrated increase of the mean ADC values in region IV (p=0.025).
- The 12 month mean ADC values of region IV were negatively correlated with motor function score (r=-0.29, n=45, p=0.049).

Table 1: Mean ADC values in corpus callosum (mADC ± SD; x10⁻³mm²/sec) of TBI patients and controls

Corpus callosum region	Early MRI (n=59)			3 months MRI (n=60)			12 months MRI (n=59)			Controls (n=47)		
	mADC	SD	p value	mADC	SD	p value	mADC	SD	p-value	mADC	SD	
All TBI's	Region I	71.1	9.4	0.53	71.1	11.2	0.43	73.6	11.8	0.024	70.2	6.1
	Region II	69.0	10.6	0.79	68.7	11.7	0.57	71.4	11.7	0.26	68.8	5.9
	Region III	74.3	9.8	0.25	74.1	9.5	0.17	75.7	10.1	0.027	72.9	5.9
	Region IV	73.2	12.3	0.20	75.2	9.9	0.008	77.5	10.0	0.001	72.6	7.0
	Region V	69.5	8.7	0.36	70.8	9.1	0.62	71.9	9.7	0.82	71.2	5.4
Total	70.9	7.7	0.22	71.5	8.9	0.19	73.3	9.2	0.008	71.0	3.4	
Moderate TBI	n=33			n=33			n=32					
	Region I	71.2	9.0	0.62	72.0	8.7	0.31	74.0	11.2	0.013		
	Region II	69.9	11.6	0.79	67.7	8.8	0.57	71.1	11.1	0.29		
	Region III	74.6	11.4	0.19	73.3	7.1	0.33	75.3	10.2	0.060		
	Region IV	72.4	14.3	0.16	74.8	7.7	0.033	77.5	9.2	0.002		
Region V	68.8	9.7	0.49	70.1	7.4	0.89	71.3	8.9	0.60			
Total	70.8	8.6	0.42	71.3	6.3	0.37	73.3	8.5	0.007			
Severe TBI	n=26			n=27			n=27					
	Region I	71.0	10.2	0.59	70.1	13.8	0.83	73.0	12.6	0.24		
	Region II	67.8	9.3	0.43	69.9	14.5	0.72	71.8	12.7	0.43		
	Region III	73.9	7.3	0.60	75.0	12.0	0.18	76.1	10.2	0.076		
	Region IV	74.3	9.3	0.52	75.6	12.3	0.021	77.5	11.1	0.008		
Region V	70.4	7.3	0.41	71.7	10.9	0.29	72.6	10.7	0.86			
Total	71.1	6.5	0.65	71.7	11.4	0.20	73.4	10.2	0.10			

In this table all the comparisons are done with the control group, tested by Mann-Whitney U test



The 10 individual ROIs are indicated in a axial T1 MRI template. In figure A the two individual ROIs of the Hofer & Frahm region I of the corpus callosum are indicated (genu). The two most anterior ROIs in figure B indicate region II, while the two posterior ROIs indicate region V (splenium). In figure C the two anterior ROIs and the two posterior ROIs indicate regions III and IV.

Conclusions

- This is the first large scale longitudinal DWI study of TBI patients where mean ADC values in corpus callosum are followed for one year.**
- We observed gradually increased diffusion in genu and posterior truncus, indicating a slowly disruption of the microstructure in normal appearing corpus callosum.**
- The degree of injury in region IV (posterior truncus) was negatively associated with motor function, but no relationship to global outcome or injury severity were found.**

References

- Chang MC, Jang SH. Corpus callosum injury in patients with diffuse axonal injury: a diffusion tensor imaging study. *NeuroRehabilitation* 2010;26(4):339-45.
- Hofer S, Frahm J. Topography of the human corpus callosum revisited - comprehensive fiber tractography using diffusion tensor magnetic imaging. *Neuroimage* 2006;32(3):989-94