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The relation between loss of consciousness, severity of TBI and injury of ARAS in patients with TBI

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Objectives

We investigated the relation between loss of consciousness (LOC), the severity of traumatic brain injury (TBI), and injury of the ascending reticular activating system (ARAS) on diffusion tensor tractography (DTT) in patients with TBI. Design: Retrospective survey. Participants: We enrolled 120 consecutive patients with TBI and 30 healthy control subjects.

Methods

In three components of the ARAS (lower dorsal, lower ventral, and upper), fractional anisotropy (FA) and tract volume (TV) were measured.

Results

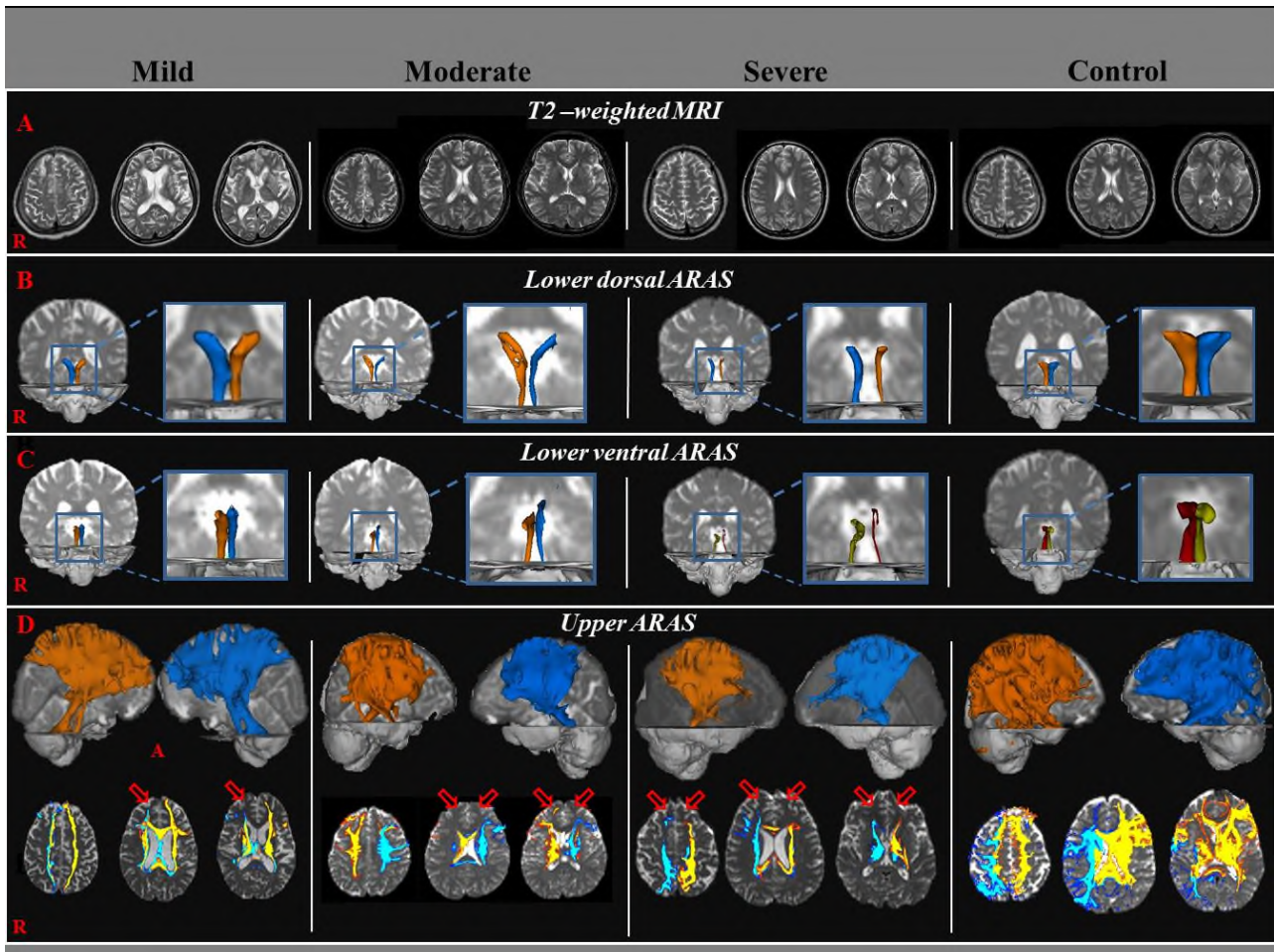
The values of FA and TV were lower in the three TBI groups compared with the control group ($p < 0.05$). In the lower dorsal and ventral ARAS, the values of FA and TV in the mild group were higher than those of the moderate and severe groups, and there was no difference between the moderate and the severe groups ($p < 0.05$). In the upper ARAS, the FA value in the mild group was higher than in the moderate group, and in the moderate group was higher than in the severe group ($p < 0.05$). The TV value in the mild group was higher than that of the severe group ($p < 0.05$). The LOC showed moderate negative correlations with the TV value of the lower dorsal ARAS ($r = -0.348$), the FA value of the lower ventral ARAS ($r = -0.343$), and the FA value of the upper ARAS ($r = -0.416$).

Conclusions

We found injury of three components of the ARAS in all three TBI groups. Injury severity was different among the three TBI groups in the upper ARAS but did not differ between the moderate and severe groups in the lower dorsal and ventral ARAS. In addition, LOC could be an indicator for injury severity of the ARAS.

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Brain MR images and diffusion tensor tractography of the three components of ascending reticular activating system in representative patients from mild, moderate, severe traumatic brain injury, and control groups.

Table 1. Demographic characteristics of the patient and control groups

	Patient group			Control group
	Mild	Moderate	Severe	
Age (years)	47.4±10.01	46.09±12.5	39.9 ±13.09	46.8±17.5
Number (N)	75	20	25	30
Male : Female	26 : 49	14 : 6	23 : 2	19 : 11
LOC (Hours)	11±2.45	5.8±5.25	171.1±26.1	
	(min)*			
GCS score	14.57±0.69	10.14±1.15	4.85±1.51	
Duration (Months)	2.89±1.52	2.809±1.65	2.305±1.605	

Values are presented as number or mean ± standard deviation, LOC: loss of consciousness, *LOC of the mild group is measured by minutes, Duration: duration from onset to diffusion tensor imaging.

Demographic characteristics of the patient and control groups

Table 2. Comparison of diffusion tensor tractography parameters for three components of ascending reticular activating system between the patient and control groups

			FA	TV
Lower dorsal ARAS	TBI severity	Mild	0.372±0.03	523.31±136.5
		Moderate	0.354±0.62	350.76±153.96
		Severe	0.341±0.03	309.9±134.39
	Control group		0.411±0.29	614.4±125.9
	p-value	†	0.040*	0.000*
		‡	0.357	0.486
		§	0.000*	0.000*
		∫	0.001*	0.021*
		∫∫	0.010*	0.000*
		∫∫∫	0.000*	0.000*
		FA	TV	
Lower ventral ARAS	TBI severity	Mild	0.343±0.086	203.09±125.54
		Moderate	0.2935±0.12	89.81±56.88
		Severe	0.241±0.11	99.76±84.31
	Control group		0.392±0.036	255.6±78.8
	p-value	†	0.042*	0.000*
		‡	0.108	0.876
		§	0.000*	0.000*
		∫	0.049*	0.002*
		∫∫	0.010*	0.000*
		∫∫∫	0.000*	0.000*
		FA	TV	
Upper ARAS	TBI severity	Mild	0.383±0.035	16753.38±1139.6
		Moderate	0.359±0.025	14458.95±2676.78
		Severe	0.323±0.049	11719.94±4057.08
	Control group		0.408±0.044	19525.56±559.4
	p-value	†	0.000*	0.124
		‡	0.000*	0.165
		§	0.000*	0.003*
		∫	0.001*	0.000*
		∫∫	0.000*	0.000*
		∫∫∫	0.000*	0.000*

Values are presented as mean ± standard deviation, ARAS: ascending reticular activating system, FA: fractional anisotropy, TV: tract volume, *Significantly different compared to the each group at $p < 0.05$. Bonferroni and Dunnett T3 post-hoc test were used for comparisons of diffusion tensor tractography parameters.

†: between the mild and moderate groups, ‡: between the moderate and severe groups, §: between the mild and severe groups, ∫: between the mild and control groups, ∫∫: between the moderate and control groups, ∫∫∫: between the severe and control groups

Comparison of diffusion tensor tractography parameters for three components of ascending reticular activating system between the patient and control groups