뇌신경재활

게시일시 및 장소 : 10 월 18 일(금) 13:15-18:00 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 15:45-16:30 Room G(3F)

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Relationship between Cognition and White Matter Integrity in Mild Traumatic Brain Injury Patients

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Introduction

Tract-based spatial statistics (TBSS) is a way to implement an image of multiple fiber tracts from diffusion tensor imaging (DTI) by projecting the fractional anisotropy (FA) skeleton. It is highly reproducible and has the advantage of analyzing various tracts. Since traumatic brain injury (TBI) causes white matter disruption in complex patterns such as diffuse axonal injury, analyzing the DTI in TBI patients with TBSS is a good way to identify the loss of integrity of multi-subject fiber tracts. We used TBSS in TBI patients with mild to moderate cognitive impairment to analyze the correlation between cognition and indices reflecting white matter integrity of multi-subject fiber tracts. The purpose of this study is to determine which fiber tract plays an important role in each cognition domain.

Method

From September 2015 to September 2018, data of TBI patients who were hospitalized at CHA Bundang rehabilitation center were reviewed. Patients who (1) had previous brain lesions (2) underwent ventriculoperitoneal shunt (3) were not able to perform Wechsler Adult Intelligence Scale (K-WAIS-IV) were excluded. All twenty patients underwent DTI and cognitive assessments with K-WAIS-IV and Rey-Kim memory test. In DTI analysis, voxel-wise statistical analysis of the FMRIB Software Library (FSL version 4.1, Oxford, UK) was done with the standard procedure. Diffusion tensor values were calculated for each voxel and individual FA and mean diffusivity (MD) metrics were derived from the 3D map using the FMRIB Diffusion Toolbox. The MNI152 space was used as a standard-space template. The atlas-based regions of interest were automatically generated using the JHU White-Matter Tractography Atlas. Spearman correlation coefficient was used as an analysis for correlation between the cognitive assessments and FA and MD values of multi-subject fiber tracts.

Result

Table 1 summarizes the baseline characteristics of 20 patients. FA is a summary measure of microstructural integrity. MD is an inverse measure of the membrane density. In most

tracts, FA values were negatively correlated with age, and MD values were positively correlated with age. Overall cognitive assessments showed moderate correlation with integrity of anterior thalamic radiation and cingulum. According to cognitive domains, verbal comprehension showed moderate correlation with integrity of left uncinate fasciculus, perception reasoning showed moderate correlation with integrity of corpus callosum and right superior longitudinal fasciculus, and memory showed moderate correlation with integrity of hippocampal cingulum (Table 2, 3).

Conclusion

Analyzing the DTI with TBSS in TBI patients with mild to moderate cognitive impairment showed close relationship between IQ and anterior thalamic radiation and cingulum, between verbal comprehension and left uncinate fasciculus, between perception and corpus callosum and right superior longitudinal fasciculus, and between memory and hippocampal cingulum.

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Table 1. Demographic Characteristics of the Patients

	Mild to Moderate TBI Patients (N=20)
Age (years, mean± standard deviation)	56.5 ± 17.3
Gender (Male / Female)	19 / 1
Lesion (n)	
Subdural hemorrhage	14
Epidural hemorrhage	7
Subarachnoid hemorrhage	9
Intracerebral hemorrhage	16
No intra or extra cranial hemorrhage	0
Initial GCS (mean± standard deviation)	13.8 ± 2.1
Initial GCS ≥ 13 (n)	19
Initial GCS < 13 (n)	1
GDS (mean± standard deviation)	12.1 ± 7.1
GDS ≥ 11 (n)	10
GDS < 11 (n)	10
Index Score from Cognitive Assessment (mean± standard deviation)	
FSIQ	83.3 ± 21.7
VCI	92.3 ± 18.8
PRI	84.3 ± 21.7
WMI	91.7 ± 16.6
PSI	80.2 ± 18.1
MQ	79.2 ± 19.6
Dominant hand (Right / Left, n)	20 / 0

TBI, Traumatic Brain Injury; GCS, Glasgow Coma Scale; GDS, Geriatric Depression Scale; FSIQ, Full-Scale Intelligence Quotient; VCI, Verbal Comprehension Index; PRI, Perceptual Reasoning Index; WMI, Working Memory Index; PSI, Processing Speed Index; MQ, Memory Quotient Index score FSIQ, VCI, PRI, WMI, and PSI were assessed by Korean Wechsler Adult Intelligence Scale-IV, and MQ was assessed by Rey-Kim Memory Test

Table 2. Correlations between cognitive assessments and FA in multi-subject fiber tracts

	Age	FSIQ	IQ-VCI	IQ-PRI	IQ-WMI	IQ-PSI	MQ
ATR-L	**-0.475***	**0.607****	0.430	**0.724****	**0.545***	**0.493***	**0.505***
ATR-R	-0.381	0.154	0.032	0.279	0.136	0.097	0.185
CC	**-0.570****	**0.468***	0.293	**0.602****	0.419	0.366	0.383
CG-L	-0.270	**0.509***	**0.487***	**0.524***	**0.573****	0.386	**0.479***
CG-R	-0.294	**0.596****	**0.611****	**0.537***	**0.598****	0.449*	**0.500***
HC-L	0.026	-0.098	0.111	0.008	-0.041	-0.141	**0.452***
HC-R	-0.088	-0.012	0.213	0.020	0.029	-0.080	0.428
IFO-L	**-0.473***	0.364	0.264	0.419	0.358	0.300	0.281
IFO-R	-0.434	-0.014	-0.058	0.106	0.009	-0.007	0.227
ILF-L	**-0.544***	0.209	0.139	0.340	0.129	0.159	0.205
ILF-R	**-0.534***	-0.111	-0.114	-.047	-0.119	-0.080	0.208
SLF-L	**-0.548***	0.166	0.008	0.270	0.214	0.063	0.010
SLF-R	**-0.576***	**0.498***	0.351	**0.646****	0.385	**0.450***	0.409
UF-L	-0.441	**0.637****	**0.502***	**0.615****	**0.653****	**0.529***	0.411
UF-R	-0.411	0.273	0.126	0.403	0.176	0.240	0.279

Spearman correlation coefficient (rho) was used as an analysis for correlation. * $p < 0.05$, ** $p < 0.001$ FA, Fractional Anisotropy; IQ, FSIQ, Full-Scale Intelligence Quotient; VCI, Verbal Comprehension Index; PRI, Perceptual Reasoning Index; WMI, Working Memory Index; PSI, Processing Speed Index; MQ, Memory Quotient; ATR, Anterior Thalamic Radiation; CC, Corpus Callosum; CG, Cingulum; HC, Hippocampal Cingulum; IFO, Inferior Fronto-Occipital; SLF, Superior Longitudinal Fasciculus; UF, Uncinate Fasciculus Index score FSIQ, VCI, PRI, WMI, and PSI were assessed by Korean Wechsler Adult Intelligence Scale-IV, and MQ was assessed by Rey-Kim Memory Test

Table 3. Correlations between cognitive assessments and MD in multi-subject fiber tracts

	Age	FSIQ	IQ-VCI	IQ-PRI	IQ-WMI	IQ-PSI	MQ
ATR-L	**0.763****	**-0.486***	-0.273	**-0.666****	-0.293	-0.438	-0.374
ATR-R	**0.690****	**-0.485***	-0.300	**-0.644****	-0.299	**-0.463***	**-0.457***
CC	**0.603****	-0.256	-0.088	-0.405	-0.139	-0.241	-0.336
CG-L	**0.709****	-0.277	-0.100	-0.440	-0.196	-0.179	-0.247
CG-R	**0.549***	-0.178	-0.062	-0.161	-0.144	-0.152	-0.067
HC-L	0.163	0.160	0.153	-0.058	0.339	0.233	0.027
HC-R	**0.458***	0.020	0.017	-0.072	0.100	-0.032	-0.184
IFO-L	**0.714****	-0.145	-0.004	-0.343	-0.039	-0.067	-0.153
IFO-R	**0.637****	**-0.550***	-0.415	**-0.632****	-0.444	**-0.546***	**-0.477***
ILF-L	**0.716****	0.011	0.161	-0.177	0.062	0.049	-0.035
ILF-R	**0.552***	-0.166	-0.082	-0.213	-0.120	-0.158	-0.168
SLF-L	**0.784****	-0.148	0.041	-0.375	0.023	-0.131	-0.116
SLF-R	**0.677****	-0.271	-0.162	-0.390	-0.226	-0.165	-0.292
UF-L	**0.667****	-0.172	-0.038	-0.338	-0.004	-0.134	-0.156
UF-R	**0.485***	**-0.553***	-0.373	**-0.708****	-0.461	**-0.444***	**-0.448***

Spearman correlation coefficient (rho) was used as an analysis for correlation. * $p < 0.05$, ** $p < 0.001$ MD, Mean Diffusivity; IQ, FSIQ, Full-Scale Intelligence Quotient; VCI, Verbal Comprehension Index; PRI, Perceptual Reasoning Index; WMI, Working Memory Index; PSI, Processing Speed Index; MQ, Memory Quotient; ATR, Anterior Thalamic Radiation; CC, Corpus Callosum; CG, Cingulum; HC, Hippocampal Cingulum; IFO, Inferior Fronto-Occipital; SLF, Superior Longitudinal Fasciculus; UF, Uncinate Fasciculus Index score FSIQ, VCI, PRI, WMI, and PSI were assessed by Korean Wechsler Adult Intelligence Scale-IV, and MQ was assessed by Rey-Kim Memory Test