Diffusion tensor imaging of refractory partial epilepsy at 3.0T

Q. Chen[1], D. Zhou[1], S. Lui[2], C. X. Li[3], L. Ouyang[3], W. Deng[4], H. F. Shang[1], L. Zou[2], H. F. Chen[3], and Q. Y. Gong[2,5]

[1]Department of Neurology, West China Hospital of Sichuan University, Chengdu, Sichuan, China, People's Republic of, [2]Huaxi MR Research Center (HMRRC), Department of Radiology, West China Hospital of Sichuan University, [3]School of Science and Technology, University of Electronic Science and Technology of China, [4]Department of Psychiatry, West China Hospital of Sichuan University, [5]Division of Medical Imaging, University of Liverpool

Introduction

It is important to identify the structural lesions of refractory partial epilepsy for pre-surgery evaluation. However, no any abnormalities can be detected in 20% of the patients with conventional MRI. Our aim is to test the hypothesis that voxel-based analyses of diffusion tensor imagine (DTI) is a non-invasively technique to identify focal abnormalities in patients with refractory partial epilepsy

Subjects and Methods

Fifteen patients (11 women and 4 men, mean age 31.9±12.4 years, rang: 16-53 yeas) with refractory partial epilepsy (temporal in 6, frontal in 4, occipital in 3, fronto-temporal in 2) but normal conventional MRI were included. Forty healthy volunteers (20 women and 20 men, mean age 30.5±9.7 years, rang: 16-52 years) without neurological disorder were included in the control group. DTI was performed at GE EXITE 3.0T MR scanning system by employing a spin echo single-shot EPI sequence in fifteen nonlinear directions at 30 slice position (TR/TE=10000/70.8 ms, slice thickness=3.0mm, FOV=24cm, matrix=128×128, b value=0, 1000s/mm2). Individual maps of mean diffusivity (MD) and fractional anisotropy (FA) were calculated from the DTI data based on the method proposed by baser and pierpaoli (1). After normalized to a standard EPI template available in statistical parametric mapping (SPM2), the maps were smoothed with 6-mm FWHM. The patients were compared individually with the control group on a voxel-based analysis in SPM with sex and age as covariates (2-3). Significant differences in diffusivity or anisotropy were defined at a threshold of $P<0.001$ (corrected for multiple comparisons with $P< 0.05$) (4).

Results

Voxel-based analysis of the 15 individual patients revealed significant MD increase in variant regions in 13 patients (Figure 1), eleven of which were consisted with electroclinical seizure localization (temporal in 3 patients, frontal in 4, fronto-temporal in 2 and occipital in 2). No patient exhibited regions of significant decreased MD. Regions of significant decreased FA were observed in 5 patients, 2 of which concurred with electroclinical seizure localization. Two patients exhibited the regions of significant increase in FA, which were distinct from the suspected seizure localization. (Detailed results in Table 1)

Discussion

Our finding revealed that MD is more sensitive than FA in detecting the diffusion abnormalities in patients with refractory partial epilepsy, which is agreeing with the findings of Lionel Thivard et al (5) and F.J.Rugg-Gunn et al (4). Most of the detected abnormal regions in MD were consisted with electroclinical seizure localization, suggesting that voxel-based analysis of DTI is a sensitive method in providing spatial information on the location and extent of the abnormalities in the normal appearing brain and could contribute to pre-surgical evaluation in vivo. However, a larger number of patients with refractory partial epilepsy should be included in the future study. The increased MD and decreased FA in the patient may result from gliosis, expansion of the extracellular space, loss of discreet microstructural organization and microstructural lesions secondary to the frequent seizures. The mechanism of increased FA in the study remains unclear. The underlying histopathology should be interested in the future study.

Table 1. Electroclinical localization and DTI findings in patients with refractory partial epilepsy.

Patient	Elctroclinical localization	DTI finding		
		MD increased	FA increased	FA decreased
1	L.front.temp.	L.front.temp. R.cerebellum	B.front.	none
2	B.temp.	R.front.par. B.temp.	none	none
3	R.temp.	B.temp.L.front.	none	R.front.par.
4	L.temp.	L.temp.;B.front. B.Thalamus	none	L.tempo
5	L.front.	L.front.;B.temp.	none	L.cerebellum
6	R.front.	L.temp.;cerebellum	none	None
7	L.occ.	B.occ.	none	None
8	L.temp.	none	none	None
9	R.temp.	none	none	None
10	R.front.temp.	B.temp.;Thalamus	none	None
11	R.front.	L.temp.;B.front.	none	None
12	R.front.	R.front.;L.thalamus	none	None
13	R.occ.	B.temp.(L>>R)	none	L.par.
14	R.temp.	B.temp.front.	R.tempo	R.temp.front. L.Thalamus
15	L.occ.	L.temp.;cerebellum	none	None

S/CPS=simple/complex partial seizure;GTC=generalized tonic-clonus seizure; R.=right;L=left;B.=bilateral;front.=frontal;temp.=temporal;par.=parietal; occ.=occipital;M=male;F=female.

Reference:

1. Pierpaoli C. Magn Reson Med 1996; 36:893-906.
2. Friston KJ. Human Brain Mapping 1995; 3:165-189.
3. Friston KJ. Human Brain Mapping 1995; 2:189-210.
4. Rugg-Gunn FJ. Brain 2001; 124:627-636.
5. Thivard L. Brain 2006; 129:375-385.

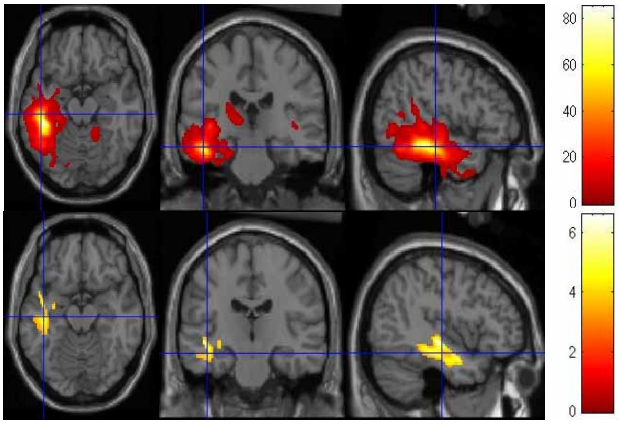

Figure 1. Statistic parametric maps of increased MD (upper row) and decreased FA (lower row) in Patient 4 exhibiting a good agreement between diffusion abnormalities and the suspected electroclinical localization in left temperal lobe (Talairach -42 -35 -10). Left of the image corresponds to the patient's left.