Neuroabnormality of thalamus in secondarily generalized seizure: A diffusion tensor study at 3T

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Introduction

Secondarily generalized seizure (SGC) is due to the progression of partial seizure (PS) with unclear pathogenesis, and it was thought to be associated with the abnormalities of thalamo-cortical circuity[1]. Diffusion tensor imaging (DTI) allows noninvasive investigation into the neural networks of the human brain, and studies of interictal patients with PS and SGC had revealed increased apparent diffusion coefficient (ADC) and decreased fractional anisotropy (FA) in regions within and beyond epileptogenic areas which relate to the activation of seizure[2, 3]. However, to date no study compared the patterns of diffusion alteration between PS and SGC and this may improve our understanding of the disease progression. Present study aimed to use both voxel-based analysis (VBA) and region of interest (ROI) method to characterize the difference of diffusion alteration between PS and SGC.

Method

The study was approved by the local ethical committee and written informed consent was obtained from all subjects. 11 right handed patients with PS (mean age=18.1±3.6 years, 4 males and 7 females) and 11 age, sex, handedness, epileptogenic area and disease duration matched patients with SGC (mean age=20.3±5.6, 4 males and 7 females) were recruited. All patients had normal findings on conventional MRI and their diagnosis based on video, EEG telemetry and clinical manifestations. 15 right handed age and sex matched normal controls (mean age=18.5±5.5, 5 males and 10 females) were also recruited. DTI was acquired using a 3.0T MR scanner (GE EXCITE, Milwaukee, USA) by employing a spin echo single-shot EPI sequence with 15 directions (TR/TE =10000/70.8ms, slice thickness =3.0mm, FOV = 24cm2, matrix=128×128, b value = 0, 1000s/mm^2). ADC and FA maps were generated from each participant's DTI scan using DTI-Studio software (http://www. cmrm.med.jhmi.edu). VBA was carried out using SPM2 (http://www.fil.ion.ucl.ac.uk/spm/software/). Prior to the analysis, both ADC and FA maps were normalized using the parameters determined from the normalization of the b =0 image to MNI T2 template. All normalized maps were smoothed with a 6-mm FWHM isotropic Gaussian kernel. Statistical comparisons were performed using ANCOVA among PS, SGC and normal controls with the age being partialled out. A p value of less than 0.05 corrected after multiple comparisons was deemed to be significant. Based on VBA findings, the ROI analysis of bilateral thalami were performed among the three groups using two sample t test in SPSS11.5 and a p value of less than 0.05 was deemed to be significant.

Results

VBA analysis showed significantly increased ADC and decreased FA in both PS and SGC groups including bilateral superior longitudinal fasciculus, corpus callosum and bilateral temporal stem areas ($p_{corrected}$<0.05, Figure 1). No significantly decreased ADC and increased FA were observed in both PS and SGC groups. Only patients with SGC showed significantly increased ADC in bilateral thalami ($p_{corrected}$<0.05, Figure 1). Subsequent ROI analysis was performed in bilateral thalami in all participates and significantly increased ADC were observed in bilateral thalami in SGC group in comparison with either normal controls or PS group (p<0.05, Figure 2).

Discussion

We observed widely increased ADC and decreased FA in both PS and SGC groups. However, patients with SGC showed significant increased ADC in bilateral thalami than either normal controls or PS, agreeing with the notion that neuronal loss take place in these areas[4, 5] . This result supports the thalamo-cortical hypothesis[1] that the abnormal function of thalamus caused secondary activation of widespread regions of the brain in patients with generalized seizure. The imaging evidences obtained here provide a further insight into the pathophysiological evolution of SGC and may also be useful for monitoring the therapeutic interventions.

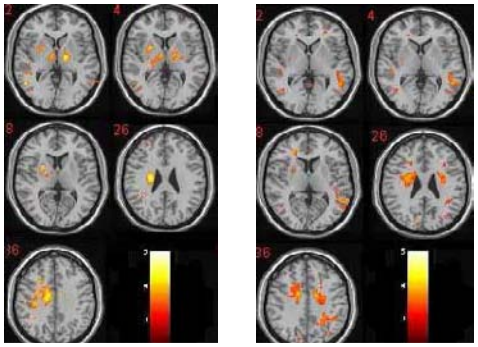

Figure 1. Statistical parameter images from voxel based analysis showed widely increased ADC in both SGC (left panel) and PS (right panel) across the whole brain. However, only SGC (left panel) showed significantly increased ADC in bilateral thalami (p < 0.05, corrected after multiple comparison).

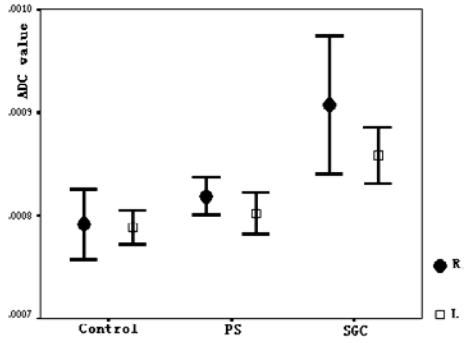

Figure 2. ROI analysis showed increased ADC in bilateral thalami of SGC when compared with either normal controls or PS (p<0.05). No difference were found between normal controls and PS (p>0.05).

Reference.

1. Avoli, M., M.A. et al., Epilepsia, 2001. **42**(4): p. 445-57.
2. Gross, D.W., et al., Epilepsia, 2006. **47**(8): p. 1360-3.
3. Kimiwada, T., et al., Epilepsia, 2006. **47**(1): p. 167-75.
4. Rugg-Gunn, F.J., et al., Brain, 2001. **124**(Pt 3): p. 627-36.
5. Assaf, B.A., et al., AJNR Am J Neuroradiol, 2003. **24**(9): p. 1857-62.