Observing the activity change of the baseline brain in Benign Essential Blepharospasm with fractional amplitude of low-frequency fluctuation

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Objective: To investigate the activity changes of the baseline brain in patients with Benign Essential Blepharospasm (BEB) by resting-state fMRIfractional amplitude of low-frequency fluctuation (fALFF) method.

Introduction: Benign essential blepharospasm (BEB) is a neurologic disorder characterized by an adult-onset focal dystonia that causes involuntary blinking and eyelid spasms[1].The pathophysiology of BEB remains unclear. A characteristic feature with diagnostic clue is the response to tactile stimuli factoring relaxation of involved muscles, which may suggest the sensorimotor dysfunction in BSP[2]. A previous functional imaging study using positron emission tomography demonstrated increased metabolism in the thalamus and striatum in BEB patients[3],and some functional magnetic resonance imaging (fMRI) has identified a number of brain areas with altered activity in patients with BSP in recent years[4,5],but they got different results due to the different tasks.Understanding the pathophysiology of BSP is important to achieving further advances in the therapy of BSP. This study investigated BEB patients with fractional amplitude of low-frequency fluctuation during resting state (rs) fMRI.

Methods: Twenty-eight patients(57±12years,GRSvalue=6.9±1.3)with BEB and 28 healthy controls group matched by gender,age,educational level were scanned on a3.0T MRIscanner (GE-SignaHDxt).The severity of BSP in all patients at the time just before MRI scanning was accessed according to the 0–4 scale Jankovic Rating Scale (JRS), which includes both severity and frequency of the involuntary orbicularis oculi muscle spasm[6]. Functional images were acquired using a single-shot, gradient-recalled echo planar imaging sequence (TR/TE = 3000/30ms, flip angle = 90°). 32 transverse slices (field of view [FOV] = 24 cm, in-plane matrix = 64×64 mm, slice thickness = 4mm, without gap, and voxel size =3.75 × 3.75 ×4mm^3), were acquired and aligned along the anterior commissure-posterior commissure line. For each subject, a total of 105 volumes were acquired, and the first 5 volumes were discarded to ensure steady-state longitudinal magnetization. The image data were analyzed with software SPM8, DPARSF and REST. Two sample t-test was used between the two groups (BEB patients and controls)，Correlation analyses were conducted to investigate the possible relationship between the fALFF within VOIs and clinical features—JRS total score, including JRS severity score and JRS frequency score.

Results & Discussion The whole brain analysis indicated that in comparison with the normal control group, there was a significantly increased fALFF in right caudate head，right precentral gyrus，right postcentral gyrus，left thalamus，left postcentral gyrus. Whileas, there was a significantly decreased fALFF in right superior frontal gyrus.In BSP patients, the fALFF in the left thalamus were positively correlated with the JRS total score. Our results demonstrated significantly increased fALFF in the major sensorimotor area(including the right precentral gyrus and postcentral gyrus, the left postcentral gyrus), the result was consistent with previous research, Suzuki Y[7] found that gray matter density of essential blepharospasm (EB) patients increased in the bilateral primary sensorimotor cortex by using voxel-based morphometry, the continuous movement or learning could increase gray matter density in corresponding regions. Our results also found significantly increased fALFF in the left thalamus, the fALFF in the left thalamus were positively correlated with the JRS total score. Suzuki Y[8] found Glucose hypermetabolism in the thalamus of patients with essential blepharospasmby positron emission tomography (PET) with (18)F-fluorodeoxyglucose (FDG) , hyperactivity in the thalamus may be a key pathophysiological change to EB.As the thalamus is connected with a wide region of cortex including parietal cortex, extrastriate cortices, temporal lobe and somatosensory cortex[9], the dysfunction of thalamus-cortical loops may lead to various symptoms of BSP patients. This study found a significantly increased fALFF in right caudate head and left thalamus. M. Obermann also reported that BSP patients had increased activation in the thalamus, caudate nucleus, putamen and lateral globuspallidus with functional magnetic resonance imaging (fMRI) performing a simple grip force forearm contraction task. Our study suggests that hyperactivity of the major sensorimotor area, the thalamus and basal ganglion may play a role in the pathophysiology of BEB. This increased activation might reflect an enhanced responsiveness or impaired inhibition of the basal ganglia to motor and sensory input resulting in excessive reinforcement learning in the basal ganglia-thalamo-cortical loops during repetitive motor possibly leading to maladaptive plastic changes.

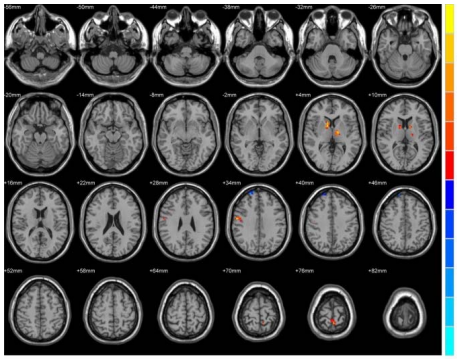

Fig 1 Table 1 Two sample t-test was used between the two groups (BEB patients and controls)

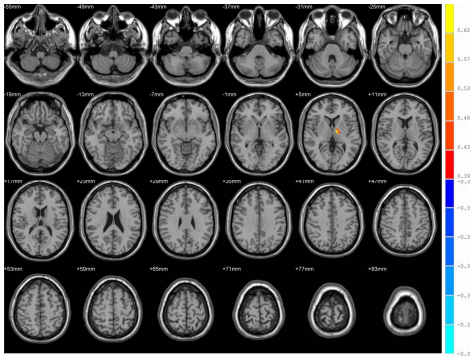

Fig 2 Correlation analyses between the fALFF within VOIs and clinical features—JRS total score

Table 1 Two sample t-test between the two groups (BEB patients and controls) andcorrelation analyses between the fALFF within VOIs and clinical features—JRS total score

Means	regions	BAPartrtion	Voxel	MNI Coordinates			T/R values
				X	Y	Z	
T-test	LT		43	-15	-12	3	4.07
	RCH		41	12	6	6	4.43
	RPreG/RPostG	4/3	27	57	-6	33	4.34
	LPostG	7	18	-3	-45	78	3.68
	RSFG	9	19	21	57	36	-4.82
fALFF	LT		18	-12	-12	6	0.67

Note: LT(Left Thalamus); RCH (Right Caudate Head); RPreG (Right Precentral Gyrus); RPostG(Right Postcentral Gyrus); LPostG(Left Postcentral Gyrus*); RSFG(* Right SuperiorFrontal Gyrus*)*

Conclusion: The present study suggests that the major sensorimotor area, the thalamus and basal ganglion may play a role in the pathophysiology of BEB.The method of fALFF can provide valuable information of the activity change of baseline brain in patients with Benign Essential Blepharospasm.

References:

1.Hallett M et al, Neurology 71(16):1275–1282. 2.Hallett M ,Ann Neurol 38(2):139–140. 3.Esmaeli-Gutstein B et al. *Ophthal Plast Recon Surg* 1999;15:23–7. 4. Baker RS et al. J Neuroophthalmol 23(1):11–15.5. Dresel C et al.Brain 129(Pt 1):36–46. 6. Jankovic J et al. Neurology 37(4):616–623. 7. Suzuki Y et al. NeuroImage, 2011, 56:1 –7.8. Suzuki Y et al Neurol, 2007, 254:890–896. 9. Behrens TE et al. Nat Neurosci,2003,6(7):750–757.