Contralateral head leading turning accompanied by ipsilateral eye staring in a patient with seizure onset from posterior inferior temporal sulcus, a SEEG case report

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Abstract

The epileptic eye and head movements during epileptic seizures may be much more complicated than people originally understood, which can be ipsilateral or contralateral to the electroencephalography focus. Here, we describe a male patient with drug resistant focal seizures associated with a directional separation between head and eye movement before evolving into generalized tonic-clonic seizure. His contralateral head leading turning showed forced, sustained, and unnatural features companied by ipsilateral eye staring. Stereoeletroencephalography monitoring was performed, and 4 habitual seizures were recorded over 5 days. Three seizures showed left head leading turning and generalized tonic-clonic seizure, and only one showed dizziness and ringing in the ears. All the seizures showed that the ictal onset contacts were located in the posterior inferior temporal sulcus which borders on the anterolateral part of medial superior temporal area. The patient underwent a resection including temporooccipital region, and the histopathology showed focal cortical dysplasia type Ic. He has been seizure free for two years after operation. The scores of the intelligence and memory quotient improved half year after operation.

Keywords: Versive seizure, eye movement, MT/MST complex, inferior temporal sulcus, temporal lobe epilepsy, stereoeletroencephalography

INTRODUCTION

Ictal versive head movement is thought to reflect spread of epileptic activity to the frontal eye field (FEF). In epileptic seizures from different brain regions, this spread of epileptic activity may occur sooner or later and after ictal activation of other cortical areas and subsequent spread to the FEF. Although both ipsilateral and contralateral head and eye movement can be observed during epileptic seizures of patients with temporal lobe epilepsies (TLE), according to the definition from Wyllie et al., only forced, sustained, and unnatural turning of the eyes and head to one side are versive seizures. Contralateral version is considered as one of the most valuable semiological signs for lateralization of epileptogenic zone, and eye leading turning account for about 90%. Here, we report a case with contralateral forced, sustained head leading turning accompanied by ipsilateral eye staring, and discuss its fundamentals of functional anatomy and localization significance.

CASE REPORT

An 18-year-old young man with pharmacoresistant epilepsy was referred for presurgical evaluation. His mother described that he had two types of seizures for 5 years: type 1 was convulsion of the limbs with left head turning, which occurred 2-5 times a month; type 2 was blank gaze without smacking lips and fumbling, which occurred 10 times a week. Rarely did he have déjà vu or auditory aura. He had no perinatal complications and exhibited normal psychomotor development. He was treated with levetiracetam, topiramate,
This study was performed in accordance with “The Code of Ethics of the World Medical Association”, approved by the ethics committee of Capital Medical University Sanbo Brain Hospital, and consent for publication of this case report was obtained from the patient’s mother.

The patient underwent scalp video-electroencephalogram (EEG), magnetic resonance imaging (MRI), inter-ictal positron emission tomography (PET) and magnetoencephalography (MEG). Three seizures were available for review after scalp video-EEG monitoring was performed. A small number of irregular right hemispheric dominant spike and waves could be found during the inter-ictal stage. The seizures showed short blank gaze on the right, contralateral head leading turning to the left accompanied by the eyes staring ahead on the right for 7–8 seconds, bilateral asymmetric tonic posturing of arms, left arm tonic-clonic jerks, and GTCs in the end. The ictal discharge began with diffuse low voltage fast activities lasting 4–5 seconds, and gradually evolved into right dominant spike and waves. Clinical seizures occurred 9-11 seconds after EEG ictal onset. MRI was negative. Inter-ictal PET showed decreased uptake in the right temporoparietal region (Figure 1A). MEG showed a moderate number of epileptic discharges around the right lateral sulcus (Figure 1B). In addition, the Wechsler Adult Intelligence Scale Revised for China (WAIS-RC) and Wechsler Memory scale Revised for China (WMS-RC) were used for neuropsychological evaluation, and the results showed that the verbal intelligence quotient was (VIQ) 91, the performance intelligence quotient (PIQ) was 97, the full intelligence (FIQ) was 93 and the memory quotient (MQ) was 66.

Based on the history and the clinical findings, 13 stereotactic electrodes were mainly implanted in his posterior temporal and parietal lobes. Stereoelectroencephalography (SEEG) monitoring was performed (schematic diagram shown in Figure 1C), and 4 habitual seizures were recorded during 5 days following partial withdrawal of antiepileptic drugs. Three seizures showed left head leading turning and generalized tonic-clonic seizure (GTCs), and only one showed dizziness and ringing in the ears. All seizures were associated with an ictal discharges in the posterior inferior temporal sulcus (PITS).

Three seizures with head leading turning were analyzed by two electroencephalographers. All the seizures occurred in wakeful state. The contacts D’(12-14) located in the PITS firstly showed polyspike and waves, and 400-500 milliseconds later, the contacts G’(4-6), M’(3-4, 9-10), W’ (8-9), C’ (3-4), E’(2-3), S’ (2-3), Q’ (1-2), R’ (1-2), N’ (12-13), X’ (3-4) and H’ (11-12) were involved in varying degrees. The clinical seizures appeared 9-11 seconds after EEG ictal discharges, when the patient opened his eyes, and 2-4 seconds
later, he turned his head forcedly to the left side with the eyes staring ahead on the right side. At that moment, low voltage fast activities (LVFA) could be observed in the contacts Q’ (12-14) located in the right FEF. With the amplitude of the LVFA gradually increased, the head leading turning to the left rapidly finished within 1 second accompanied by his eyes remaining staring on the right side, which was succeeded by a GTCs (Figure 2). Electric cortical stimulation was performed on the electrode C’, D’, E’, G’, H’, K’, M’, S’, W’ and X’. No seizure or head and eyes turning could be induced.

The patient underwent a resection including temporooccipital region around the electrode D (Figure 3). The histopathology showed focal dysplasia type Ic. He has been seizure free for two years after operation. Three postoperative scalp EEGs did not show any epileptic discharges. The scores of the WAIS-RC and WMS-RC improved half year after operation (VIQ: 91 to 109, PIQ: 97 to 98, FIQ: 93 to 105 and MQ: 66 to 96).

**DISCUSSION**

This case showed contralateral forced head leading turning which should not be simply attributed to the initial involvement of FEF where the seizure should be that first the eyes turn contralaterally and then the head follows.7 The supplementary eye field (SEF) was also eliminated although stimulation of this region may evoke early head or head alone contralateral movements.8 Finally, the seizures were confirmed to originate from the PITS that was associated with smooth pursuit eye movement.9,10 Eyes pursuits are smooth tracking movements which maintain foveal fixation when viewing a moving object and hence stabilize the retinal image, and the stimulus for pursuit is motion of an object.11 According to previous studies, the stimulation of pursuit eye areas which includes the middle temporal (MT) and medial superior temporal (MST) area during epileptic seizures causes ipsilateral ocular deviation.12,13 MST is on the anterior/dorsal bank.
of the ascending limb of the ITS, while area MT typically locates on the posterior/ventral bank of the ascending limb of the ITS. A recent case report described two cases characterized by ipsiversive eye deviation as initial clinical sign during the habitual epileptic seizures. The localization of the epileptogenic zone of both of the cases has been confirmed as inferoposterior temporal region. We noticed that both of the cases showed an ipsilateral eye leading forced deviation followed or not followed by ipsilateral head turning. It suggests that head can be static or follow the direction of eye movement when MT/MST is activated by epileptic discharges, but the simultaneous contralateral forced head turning is still an unexplainable semiology according to this mechanism. Therefore, we think there should be other networks of head turning involved in the seizure evolution. At the beginning of the seizures, the epileptic discharges spread rapidly to the neighboring areas within 400-500ms after ictal onset from PITS, including superior temporal gyrus, inferior parietal lobule, superior parietal lobule, parietal eye field (PEF), occipital, etc. The directional separation of the eye and head movement did not occur until the right FEF was activated by discharges spreading from EZ. In brief, the network of pursuit eye movement may be only part of the whole epileptic network of this patient.

The order of eye and head movements during epileptic seizures varies depending on different mechanisms, saccade or smooth pursuit eye movement. In fact, each of the cortical eye fields is composed of two distinct subregions which are devoted to the control of these two eye movements, and has direct projections to neural centers in the brain stem which are involved in eye movement control. The typical versive seizure is more commonly associated with evolution into generalized convulsive seizures than ipsilateral head turning. Therefore, we think that saccadic
network might be also involved in the seizure development of our case because his contralateral head turning was succeeded by GTCs.

The contact N'(12) and N'(13) lied in the intraparietal sulcus of this patient, and 5-6 Hz spike and waves could be found at the lead of these two contacts 2-3 seconds before the low voltage fast activities appeared at the PEF. The PEF located in the lateral intraparietal area (LIP) is known to be involved during visually guided saccades.14 The LIP has a signal that describes a saccade target, maintains the memory of a saccade plan during a delay.15 However, the PEF is not only involved during visually guided saccades, but also pursuit eye movement. A pursuit-related area in human PEF is posterior to the saccade-related PEF.16 In our case, we speculated that the network of smooth pursuit eye movement (MT/MST and posterior PEF) was activated earlier than that of saccade (anterior PEF), accordingly, eye ipsilateral staring occurred slightly earlier than head contralateral turning, see supplement.

However, although the PITS was activated at the seizure onset, the ipsilateral staring did not appeared immediately. This is because that the area MT neurons are also needed to activate. MT neurons respond only when retinal motion is present, and lesions of MT produce retinotopic deficits in the initiation of pursuit eye movement. In contrast, MST neurons maintain their responses to object motion even when there is no retinal counterpart and play a critical role in the maintenance of smooth pursuit.17 Therefore, continuously activating of MST in our case may withstand the contralateral eye version induced by FEF activating, but not for the contralateral head turning. We also recognize that the early spreading regions around the MT/MST are associated with multisensory integration based on visual, auditory, and perhaps, vestibular information. A recent study showed that listening to an auditory stimulus moving in a specific direction prior to the presentation of a visual stimulus increased the probability that one perceived the visual stimulus as moving in the opposite direction relative to the preceding auditory stimulus.18 Our case sometimes had an auditory aura before ictal discharges spreading to the MT area. Accordingly, why could not we infer that the network of sound localization was also involved in this case? Auditory and visual motion perceptions rely on shared neural representations that dynamically impact modality-specific perception.19 Visual motion area MT/V5 responded to auditory motion in blind patients20, and visual motion capture of auditory motion is reflected in increased activity in area MT/V521. It has been proved that visual motion aftereffect elicits smooth pursuit eye movements.22 Accordingly, the separated movement of the patient’s eyes and head can be well explained by the mechanism of auditory motion eliciting a visual motion after effect in the opposite direction. Another evidence is that MST in turn, can be separated into two adjacent parts, a posteromedial part that is activated by optic flow in the peripheral contralateral and ipsilateral visual field and an anterolateral part that is activated during nonvisual pursuit eye movement.9 The ictal onset of our patient was just located in the PITS which can be deemed as anterolateral part of MST.

This is a case with contralateral forced head leading turning which were confirmed to originate from the PITS by SEEG recordings. Different from previous studies, our case showed a seemingly opposite eye movement strikingly separated from head turning, which was mostly associated with smooth pursuit eye movement guided by visual, or also associated with multisensory integration based on visual, auditory, and perhaps, vestibular information. However, we cannot exclude the involvement of saccade eye movement because the patient underwent GTCs soon after the contralateral head leading turning.

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DISCLOSURE

Conflict of interest: None

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