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# Versive seizures in occipital lobe epilepsy: Lateralizing value and pathophysiology

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**KEYWORDS**
Versive seizure;
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**Summary** To clarify the value of versive seizures in lateralizing and localizing the epileptogenic zone in patients with occipital lobe epilepsy, we studied 13 occipital lobe epilepsy patients with at least one versive seizure recorded during preoperative noninvasive video-EEG monitoring, who underwent occipital lobe resection, and were followed postoperatively for more than 2 years with Engel's class I outcome. The videotaped versive seizures were analyzed to compare the direction of version and the side of surgical resection in each patient. Moreover, we examined other motor symptoms (partial somatomotor manifestations such as tonic and/or clonic movements of face and/or limbs, automatisms, and eyelid blinking) associated with version. Forty-nine versive seizures were analyzed. The direction of version was always contralateral to the side of resection except in one patient. Among accompanying motor symptoms, partial somatomotor manifestations were observed in only five patients. In conclusion, versive seizure is a reliable lateralizing sign indicating contralateral epileptogenic zone in occipital lobe epilepsy. Since versive seizures were accompanied by partial somatomotor manifestations in less than half of the patients, it is suggested that the mechanism of version in occipital lobe epilepsy is different from that in frontal lobe epilepsy.


## Introduction

Eye and/or head deviation is frequently observed during epileptic seizures, and the lateralizing significance of these symptoms has been a topic of debate (Ochs et al., 1984; Robillard et al., 1983). Although version is also frequently observed in occipital lobe epilepsy (OLE), subjective symptoms such as visual auras are considered as hallmarks in the diagnosis of OLE, and detailed studies using video-EEG monitoring of objective seizure symptoms in OLE are rare

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**Table 1** Clinical characteristics of 13 patients.

| Patient | Age at onset (years) | Age at surgery (years) | Aura | EEG | | Laterality of lesion | Histology | Follow-up (years) | Outcome (Engel) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Interictal | Ictal | | | | |
| 1 | 15 | 28 | elementary visual | Lt O, Lt T | Lt T | Lt | cephalocele | 15 | Id |
| 2 | 9 | 17 | cephalic | Lt pT-O | Lt pT-O | Lt | CD | 12 | Ib |
| 3 | 6 | 17 | elementary visual, ocular sensation | Rt O | Rt O | Rt | CD | 12 | Ic |
| 4 | 7 | 17 | visual illusions | Rt T | Rt pT-O | Rt | ulegyria | 10 | Ic |
| 5 | 9 | 17 | none | Lt mT-pT, Rt O | Lt pT | Lt | CD | 8 | Id |
| 6 | 9 | 26 | blurred vision | Lt aT, Rt aT | Lt T-P | Lt | CD | 7 | Ia |
| 7 | 8 | 22 | amaurosis, blurred vision | Rt aT, Rt O | Nonlateralizing | Rt | ulegyria | 7 | Ia |
| 8 | 5 | 28 | cephalic, amaurosis(rare) | Rt O, Rt T | Lt T | Rt | ulegyria | 6 | Ic |
| 9 | 3 | 14 | amaurosis | Lt O-pT | Lt O-pT | Lt | CD | 5 | Id |
| 10 | 11 | 17 | epigastric, visual illusions, somatosensory | Lt aT-mT | Lt aT-mT | Lt | DNT | 5 | Ia |
| 11 | 9 | 35 | chilly feeling, nausea | Bil T | Lt T | Rt | ulegyria | 4 | Ic |
| 12 | 5 | 28 | none | Rt T | Rt hemisphere | Rt | ulegyria | 3 | Ia |
| 13 | 2 | 13 | visual illusions | Rt O | Rt hemisphere | Rt | ulegyria | 3 | Ia |

CD: cortical dysplasia, DNT: dysembryoplastic neuroepithelial tumor, Rt: right, Lt: left, Bil: bilateral, aT: anterior temporal, mT: mid temporal, pT: posterior temporal, T: temporal, O: occipital, P: parietal.

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**Table 2** The direction and character of version, and association of version with other motor activities.

| | Version | | | Other motor activities accompanying version | | | |
|---|---|---|---|---|---|---|---|
| Patient | Number of seizures | Direction | tonic or clonic | None | Partial somatomotor | Automatism | Blinking |
| 1 | 3 | contralateral[a] | clonic | 3 | 0 | 0 | 0 |
| 2 | 5 | contralateral | both | 3 | 2 | 0 | 0 |
| 3 | 2 | contralateral | both | 0 | 0 | 1 | 2 |
| 4 | 3 | contralateral | tonic | 3 | 0 | 0 | 0 |
| 5 | 4 | contralateral[a] | both | 0 | 4 | 0 | 0 |
| 6 | 5 | contralateral | tonic | 1 | 0 | 4 | 0 |
| 7 | 4 | contralateral | both | 0 | 4 | 0 | 0 |
| 8 | 4 | bidirectional, contralateral | both | 3 | 1 | 0 | 0 |
| 9 | 7 | contralateral | both | 0 | 7 | 0 | 1 |
| 10 | 4 | contralateral | tonic → clonic | 0 | 0 | 4 | 2 |
| 11 | 3 | contralateral[a] | clonic | 0 | 0 | 3 | 0 |
| 12 | 2 | contralateral | tonic | 0 | 0 | 0 | 2 |
| 13 | 3 | contralateral | both | 3 | 0 | 0 | 0 |

[a] Preceded by ipsilateral head turning.
None = without somatomotor manifestation, automatism, or blinking.

(Fogarasi et al., 2003; Munari et al., 1984; Williamson et al., 1992). The propagation of ictal discharges into the frontal eye field (FEF) is generally considered to be responsible for versive movements in OLE, however, the true pathophysiology and lateralizing significance of version has not been clarified. In this study, videotaped versive seizures in patients who were successfully treated by occipital lobe resection were analyzed retrospectively to confirm the value of version in lateralizing and localizing epileptogenic zone, and to clarify pathophysiology of version.

## Methods

A total of 40 patients in our Center underwent occipital lobe resection for the treatment of intractable epileptic seizures as of December 2008. Of the 40 patients, 13 who had at least one versive seizure recorded during preoperative non-invasive video-EEG monitoring, and were followed for more than 2 years with Engel's class I outcome were included in the present study (Table 1). The ages at seizure onset ranged from 2 to 15 (mean 7.5) years and ages at surgery from 13 to 35 (mean 21.5) years. The postoperative follow-up durations ranged from 3 to 15 (mean 8.7) years.

Nine patients had visual auras including amaurosis or blurred vision in four, illusions in three, and elementary visual hallucination in two. Two patients had no aura. In the remaining two patients without visual aura, one had cephalic auras, and another had autonomic auras characterized by chilly feeling and nausea. Interictal EEG revealed epileptiform discharges in the temporal or posterior regions on the lesion side in ten patients. In the remaining three patients, epileptiform discharges were seen bilateral independently. Ictal EEG showed regional or lateralized seizure activities on the lesion side in ten patients. In two patients, ictal discharges were predominant in the contralateral temporal region. Ictal discharges were nonlateralizing in the remaining patient.

Histopathology of resected specimens revealed ulegyria in six patients, cortical dysplasia in five, dysembryoplastic neuroepithelial tumor in one, and cephalocele in one. According to the definition by Wyllie et al. (1986), versive seizures are defined as clonic or tonic head and eye deviations, unquestionably forced and involuntary, resulting in sustained unnatural positioning of the head and eyes. Epileptic nystagmus (Beun et al., 1984) was excluded. The direction of versive movements and the side of surgical resection were compared in each patient. Moreover, other motor symptoms (partial somatomotor manifestations such as tonic and/or clonic movements of face and/or limbs, automatisms, and eyelid blinking) that preceded or appeared simultaneously with version were analyzed, and motor symptoms that appeared after versive movements were excluded from analysis.

## Results

Forty-nine versive seizures were analyzed. Table 2 shows the number of versive seizures in each patient, the direction and character (tonic or clonic) of versive movements, and the presence or absence of other motor symptoms.

Both head and eye versive movements were observed except one seizure of Patient 2 with isolated eye version.

In 12 patients, the direction of versive movements was always contralateral to the side of surgical resection. In three (Patients 1, 5, 11) of them, version was preceded by ipsilateral non-versive head and eye turning. For example, in Patient 5 who had an epileptogenic lesion in the left occipital lobe, his head was first turned to the left at about 90°. About 20 s later, this was followed by clonic movements of the right arm and face, and versive movements of

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the head and eyes to the right. Then generalized jerking started. In the remaining patient (Patient 8), four versive seizures were recorded. In two of the four seizures, versive movements were directed towards the side contralateral to the resection, whereas ipsiversive movements interrupted contraversive movements in the remaining two seizures.

As for the character of versive movements, it was both tonic and clonic in seven patients, tonic followed by clonic in one, tonic only in three, and clonic only in two.

Partial somatomotor manifestations (partial tonic and/or clonic movements of face and/or limbs) accompanying version were observed in five of 13 patients. In three of the five patients, versive movements were always accompanied by clonic movements of the arm on the side to which version was directed. Eight patients had no accompanying partial somatomotor manifestations. Automatisms were associated with versive movements in four patients: two showed manual automatisms, one had manual and oral automatisms, and one crossed his arms over his chest and wiggled his body during version. Partial somatomotor manifestations and automatisms never appeared simultaneously. In four patients, eyelid blinking preceded version or occurred simultaneously with version.

## Discussion

Wyllie et al. (1986) defined versive seizures as clonic or tonic head and eye deviations, unquestionably forced and involuntary, resulting in sustained unnatural positioning of the head and eyes. They studied 37 patients who had head and eye turning during 74 spontaneous epileptic seizures and correlated videotaped seizures with the EEG location of seizure onset. Contralateral versive head and eye movements occurred during 61 seizures in 27 patients comprising 10 with frontal foci, 14 with temporal foci, two with parietal foci, and one with occipital focus. No ipsilateral versive movements were observed. They suggested that version was primarily due to transcortical propagation of the seizure discharge to frontal contraversive centers in the hemisphere of seizure onset.

In OLE, the direction of version is generally considered to be contralateral to the epileptogenic zone. Ludwig and Ajmone-Marson (1975) reported that the direction of version was always contralateral to the EEG foci in the occipital region; however, their study was not based on video-EEG monitoring. Rosenbaum et al. (1986) studied a man with repeated seizures characterized by deviation of the head and eyes to the left, and demonstrated a right occipital focus on ictal EEG. Munari et al. (1984) reported 49 seizures with early ocular deviation during stereo-EEG investigations of 16 patients, and reported that the ocular deviation was contralateral to the discharge in 48 of 49 seizures. In the study of Williamson et al. (1992), however, eye deviation was observed in 16 of 25 patients who underwent OLE surgery; the direction was contralateral to the seizure foci in 13 cases, and ipsilateral in the remaining three. In our study, we carefully analyzed the videotaped versive seizures of 13 patients in whom location and laterality of the epileptogenic zone were proven by the results of surgery. In 12 of 13 patients, versive movements were always directed towards the side contralateral to the epileptogenic zone. Therefore, it can be concluded that version has lateralizing significance also in OLE. In the remaining patient (Patient 8), version was directed contralateral to the epileptogenic zone in two of four recorded versive seizures, whereas ipsiversive movements interrupted contralateral versive movements in the remaining two seizures. In another three patients, ipsilateral non-versive head and eye turning preceded contralateral version. Although the mechanisms of these phenomena are unknown, inhibition of the ipsilateral hemisphere may cause ipsilateral non-versive turning due to hemineglect (Kernan et al., 1993).

Version may be associated with seizures arising from any cortical region. The localizing value of version has not been clarified, and the character of version in OLE has not yet been identified. In the study of Munari et al. (1984), ocular deviation was 'tonic' in most cases (44 of 49 seizures). However, it is known that both saccadic and smooth eye movements are evoked by electrically stimulating FEF or supplementary eye field in monkeys (Tian and Lynch, 1996). The parietal lobe also plays a major role in both saccades and smooth pursuit (Shibutani et al., 1984; Goldberg, 2000). In our patients with OLE, both tonic and clonic components were observed. Therefore, the character of eye movements does not differentiate the location of seizure onset. As regards the timing of version onset, Bleasel et al. (1997) reported that version occurs earlier in extratemporal seizures than in temporal seizures. Early onset of version may suggest extratemporal seizure focus, but does not differentiate frontal lobe epilepsy from parietal or occipital lobe epilepsy. As for the accompaniment of other motor symptoms with version, of ten patients with frontal lobe foci included in the study of Wyllie et al. (1986), posturing and clonic movements of the arm were observed during version in six, and tonic or clonic contraction of the face was seen during version in eight. On the contrary, we observed partial somatomotor manifestations (partial tonic and/or clonic movements of face and/or limbs) accompanying version in only 5 of 13 patients with OLE, and partial somatomotor manifestations invariably accompanied version in only three patients. Partial somatomotor manifestations associated with version was much less frequent in patients with OLE than in those with frontal lobe epilepsy studied by Wyllie et al. (1986). Based on the findings from cortical stimulation, activation of the FEF (Foerster, 1931; Godoy et al., 1990) or the supplementary eye field is generally considered to be responsible for versive movements. Also in OLE, propagation of the ictal discharge into frontal contraversive areas has been suggested to be the most important mechanism of version. As regards the involvement of cortices posterior to the central sulcus, activation of intraparietal area (Muri et al., 1996) or striate cortex (Bodis-Wollner et al., 1997) during voluntary saccades has been reported using functional MRI. Penfield and Jasper (1954) elicited contralateral eye deviation by stimulating Brodmann's area 19. Our finding that versive movements were accompanied by partial somatomotor manifestations in less than half of our patients contradicts the theory that frontal propagation is the main mechanism of version in OLE. Horizontal ocular movements are mediated by the paramedian pontine reticular formation (PPRF), which receives parallel input from the FEF and the superior colliculus (Schiller et al., 1980). The superior colliculus receives converging inputs

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from frontal, prefrontal, parietal, temporal, and occipital cortices (Sparks and Nelson, 1987). Therefore, two pathways may convey impulses for conjugate eye movements during cortical stimulation or in seizures: (1) extrafrontal cortex → frontal cortex → PPRF; and (2) cortex → superior colliculus → PPRF (Blume, 2001). In seizures arising from the occipital lobe, version may be elicited via the superior colliculus and PPRF without engaging frontal contraversive areas, although frontal propagation may play a major role in some patients.

In conclusion, versive seizure is a reliable lateralizing sign indicating contralateral epileptogenic zone in OLE. Since versive seizures were accompanied by partial somatomotor manifestations in less than half of the patients, it is suggested that the mechanism of version in OLE is different from that in frontal lobe epilepsy.

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