

Graphogenic epilepsy: a variant of language-induced epilepsy distinguished from reading- and praxis-induced epilepsy

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We report a case of graphogenic epilepsy as a variant of language-induced epilepsy. A 25-year-old, right-handed woman had noticed for the previous 10 years that writing almost always provoked jerks or a jerking sensation in her right hand. No other triggers, including facets of language function such as reading and speaking, elicited any epileptic seizures. Ictal EEG demonstrated an initial left central abnormality. In our report, we stress that graphogenic seizures as an expression of language-induced epilepsy should not be confused with those that are manifestations of juvenile myoclonic epilepsy, and that writing and reading trigger different facets of motor manifestations.

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Key words: reflex epilepsy; writing-induced; language-induced epilepsy; praxis-induced epilepsy.

INTRODUCTION

Seizures triggered by writing have been known and described for the past few decades^{1–3}. However, the term, “writing” or “graphogenic” epilepsy is not as prevalent as reading epilepsy, which is now widely recognised as an independent clinical entity. This lack of recognition has multiple roots. First, cases termed as writing or graphogenic epilepsy have been a mixture of fundamentally different syndromes, obscuring the clinical picture. Further, patients with seizures precipitated by writing have often found reading to be a trigger to seizures as well. This has led to a well-known concept of language-induced epilepsy proposed by Geschwind and Sherwin¹, in which various facets of language function such as reading, writing, and speaking induce seizures. Finally, reading is a major predisposing factor in an overwhelming majority of reported cases, thus, graphogenic seizures have been treated only as an accessory finding to reading epilepsy^{4,5}.

The recent deepening of knowledge in the field of reflex epilepsy demands a re-examination of seizures precipitated by writing. Tasks that involve complex

mental involvement for activities performed with the hands, such as writing and calculation with an abacus, have been confirmed to precipitate myoclonic jerks in patients with juvenile myoclonic epilepsy^{6–8}. This categorisation of praxis-induced epilepsy enabled us to clarify cases called graphogenic epilepsy in literature, and divide them into either praxis-induced epilepsy or graphogenic epilepsy as a variant of language-induced epilepsy. Herein, we report a very rare case of language induced epilepsy elicited exclusively by writing. In addition to the academic interest, we especially stress that graphogenic epilepsy should not be confused with praxis-induced epilepsy, and that graphogenic seizures in the framework of language-induced epilepsy deserve special attention neurophysiologically in view of the exact correspondence between input (trigger) and output (seizure).

CASE REPORT

A 25-year-old, right-handed woman was referred to us. She had begun to have generalised tonic clonic

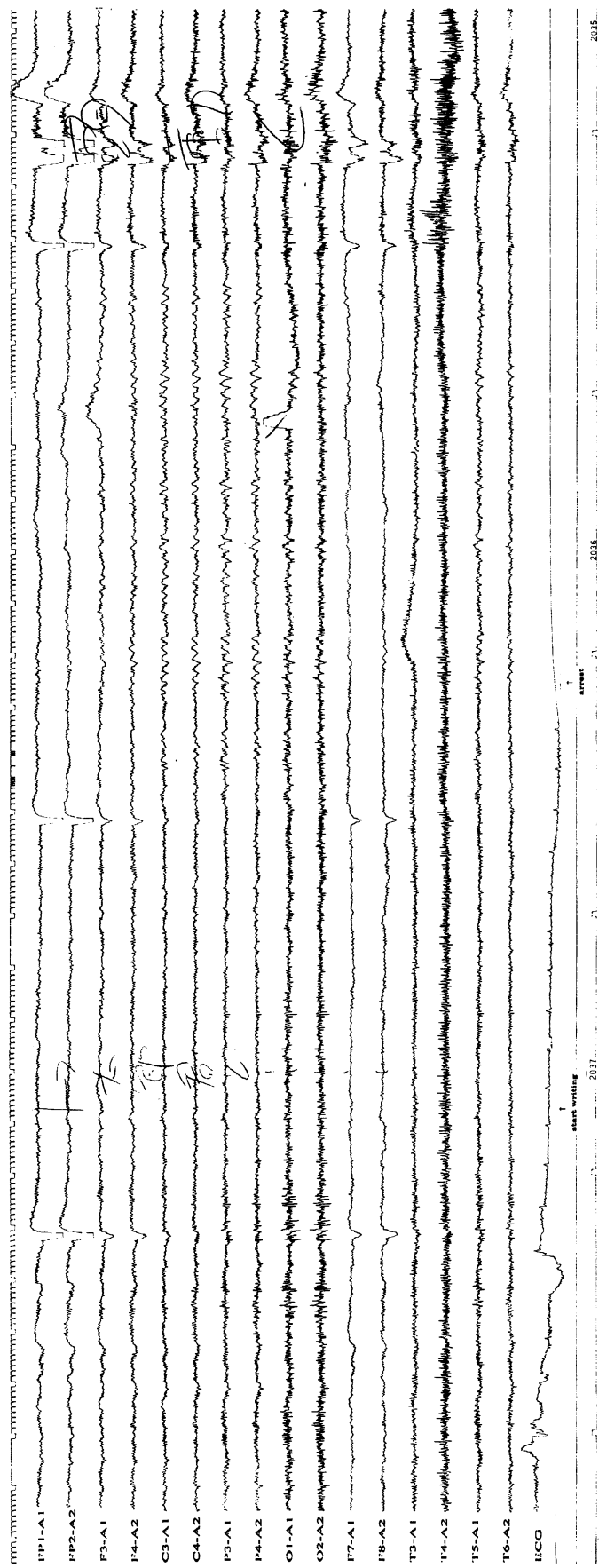


Fig. 1: Ictal EEG of a writing-induced seizure. The left arrow (start writing) indicates a start of dictation. The right arrow (arrest) corresponds to occurrence of motion arrest and jerking sensation of the right hand.

seizures at 12 years of age. After initial intensive drug therapy, the seizures had ceased for the next 3 years, though at age 16 they recurred with some modifications of symptoms. Since recurrence, the patient noticed that writing almost always provoked attacks, in which she would suddenly become frozen and alarmed by jerking sensations in her right hand, with or without precipitating actual jerks. She was repeatedly dismissed from work because every kind of daily writing behaviour, such as issuing a voucher, would elicit an arrest of motion. When she came to us, the patient was very upset and complained that countless freezing attacks would occur, either spontaneously or with writing, especially under psychological pressure. Prior to referral to us, her seizures were diagnosed as being psychogenic, because emotional stress apparently increased the seizure frequency. Our neurologic examination was normal, with no intellectual deficit found, and an MRI revealed no abnormality, while an interictal EEG showed no epileptiform discharge.

Electrodes were attached to the patient at the EEG laboratory of Aichi Medical University and the patient was examined by the final author. She was asked to write some four or five word passages with her right hand as dictated. Six or seven seconds later, low amplitude and irregular theta bursts appeared in the left centro-parietal EEG region. Within a few seconds, this EEG activity generalised into centro-parietal dominant diffuse theta activity, which concurred with the occurrence of motion arrest (Fig. 1). The arrest of speech and motion was accompanied by a jerking sensation in the right hand, however; it was neither visible nor palpable to the examiner. Further, jaw jerks were not sensed or observed during the investigation, just as in habitual seizures. During the spell, the patient was fully alert, however; she was unable to respond to verbal commands, though afterwards, she could recall the words verbally presented to her while she remained frozen.

As shown in Table 1, three clinical and two subclinical (or electrical) seizures were precipitated by either dictation or spontaneous writing of seasonal greetings. All of the clinical and subclinical manifested seizures proceeded in a surprisingly consistent manner. The spell was obviously disagreeable to the patient, and she required great urging by the examiner to con-

tinue the activity after a seizure had been provoked. Except for during the second trial, our investigation revealed that EEG changes occurred regularly every 6–7 seconds and clinical seizures every 8–9 seconds after the start of writing stimuli. Language stimuli, except for writing with the right hand, such as speaking (naming or spontaneous conversation), as well as reading (aloud or to herself) or writing with the left hand failed to provoke EEG changes or clinical symptoms. Other neuropsychological provocative measures, including mimicking finger posturing, gesturing, calculation, and copying complex figures, all had no effect. Further, attempts to induce electrographic or clinical seizures by various movements of the facial, jaw, and throat muscles as well as the extremities failed to induce any EEG or clinical seizure activity. Regrettably, the seizures remained uncontrolled even with a maximum drug therapy of clonazepam, carbamazepine, phenytoin, and valproate.

DISCUSSION

A survey of published literature revealed that seizures precipitated by writing presented two-step differential diagnostic problems. First, a distinction should be made between graphogenic epilepsy, as a variant of language- and praxis-induced epilepsy. Once this distinction is made, the interrelationship between writing- and reading-induced seizures in the framework of language-induced epilepsy needs to be considered.

According to a comprehensive study with neuropsychological EEG activation performed by Matsuoka *et al.*⁸, mental activities mainly associated with use of the hands, such as writing, written calculation, and drawing figures, most commonly provoked seizure or electroencephalographic seizure activity. In their series, seizures were precipitated 26 patients by writing. Interestingly, writing-precipitated mental activities were exclusively related to idiopathic generalised epilepsy, especially juvenile myoclonic epilepsy (in 17 of the patients). In all probability, some previous cases of writing-induced or graphogenic epilepsy, including a very early case termed graphogenic epilepsy reported by Asbury and Prensky³, fall into this category and should be referred to as praxis-induced epilepsy^{9–12}, sparing the unnecessary confusion of this type of reflex epilepsy with graphogenic epilepsy as a variant of language-induced epilepsy.

Lee *et al.*¹³, in agreement with Geschwind and Sherwin¹, pointed out that some patients with reading epilepsy were sensitive to writing or speaking as well. Thereafter, they expressed their doubt that language-induced epilepsy, including graphogenic epilepsy, could be clearly separated from reading epilepsy and concluded that an inclusive term of “language-induced

Table 1: Interval between stimuli (writing) and electro-clinical findings.

	Initial EEG change (second)	Freezing attack
First trial	6–7	8–9 seconds
Second trial	14	14 seconds
Third trial	6–7	8–9 seconds
Fourth trial	6–7	Subclinical
Fifth trial	7	Subclinical

Table 2: Previous and current cases of graphogenic epilepsy as a variant of language-induced epilepsy.

Authors	Induced seizure	Initial Ictal EEG	Other triggers
Geschwind and Sherwin (1967)	?	Not mentioned	Reading, speaking
Bennett <i>et al.</i> (1971) ^a	Jerking of the hand	RF/RC	Reading ^b , speaking
Forster and Daly (1973)	Freezing or jerking of the hand	Not mentioned	Reading ^b
Ohtaka and Miyasaka (1977)	Jerking of the hand, arrest of motion	Not mentioned	Reading ^b
Lee <i>et al.</i> (1980)	Freezing of the hand?	LC	Reading ^c
Saenz-Lope <i>et al.</i> (1985)	Jerks of the hand	Not mentioned	Reading ^b
Current	Jerking of the hand, arrest of motion	LC	

^aThe patient was a left-handed boy ^breading induced jaw jerks, whereas writing induced hand jerks ^cinitial EEG changes induced by reading and writing exhibited temporal and central foci, respectively.

epilepsy” was preferred. Indeed, a pair of monozygotic female twins reported by Forster and Daly¹⁴ both had seizures when writing, in addition to classical primary reading epilepsy characterised clinically by jaw-jerk vocalisation. However, they stressed that the motor manifestation of the seizure during writing was freezing or jerking of the writing hand, instead of the jaw jerk seen with reading. In Table 2, we have listed previous cases together with the current case in which either writing was a major trigger of seizures or writing-induced seizures were not described as an accessory finding to other facets of language function (reading or speaking), but rather independently in some detail^{13–16}. As Forster and Daly¹⁴ rightly pointed out, this list suggests a close link between writing as input and right-sided hand jerk as output (except in the case of a left-handed patient). This is in sharp contrast to prima reading epilepsy, in which jaw-jerk vocalisation is the main resulting output. It should also be noted that, preceding manifest motor symptoms, freezing of thinking and motion arrest with preserved consciousness were observed in the report of Ohtaka and Miyasaka¹⁵, as in the current case. Further, we find it interesting that if any emergence of focal epileptiform discharge was seen at the initial stage of seizures precipitated by writing, central EEG foci were also recorded^{2,5}. In contrast to seizures induced by reading, in which temporal EEG foci have been typically documented. In conclusion, graphogenic seizures seem to have a unique neuroanatomical basis, well demarcated from seizures triggered by reading.

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