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Original article

# Clinical spectrum of epileptic spasms in children

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**Abstract**

*Purpose:* To compare etiologic, semiologic, and electrographic features of epileptic spasms (ES) in children with West syndrome (WS) vs. in children with other epilepsy syndromes and nonsyndromic epilepsies. *Methods:* The 24 h-video/EEG recordings of consecutive children with ES were reviewed for etiology, ictal semiology, and interictal and ictal EEG features. We created three objectively-defined groups for interictal EEG: (A) background voltage >300 μV with multiple independent spike foci (MISF) and disorganization consistent with hypsarhythmia; (B) voltage between 200 and 300 μV with MISF and moderate disorganization, similar but not identical to hypsarhythmia; (C) voltage <200 μV ± MISF , not consistent with hypsarhythmia. *Results:* We identified 161 children (group A, 70; group B, 32; group C, 59). The greatest difference between the groups A, B, and C, respectively was in age (in months) both at onset (6.4 ± 4.4, 15.3 ± 22.1 and 31.6 ± 38.1, $p < 0.0001$) and at EEG (10.8 ± 6.9, 22.9 ± 26.2 and 45.6 ± 42.1, $p < 0.0001$). The groups also showed some differences in the frequency of preceding or admixed seizures, and in seizure semiology. By contrast, there were no significant differences in the underlying causes or in patterns of ictal discharges between the groups. *Conclusion:* ES clearly exist outside of the confines of WS with some phenomenological variations. The causes and ictal patterns, however, are remarkably similar among all patients with ES. The subtle difference in seizure semiology may reflect maturational changes. These findings support the concept of a spectrum of ES with a degree of age-dependency in its manifestations rather than entirely different clinical entities.


*Keywords:* Spasms; Children; Electroencephalography; Etiology; Seizures

## 1. Introduction

Epileptic spasms (ES) are unmistakable seizures with unique characteristics. They consist of brief axial and rhizomelic contractions lasting usually less than one second often associated with a slow wave transient and an after-going period of attenuation [1]. On polygraphic recording the muscle component often reveals a brief rhomboid-shaped appearance, which is distinct from the very short duration myoclonic jerk and the rectangular, prolonged appearance of a tonic seizure. ES are most frequently

*Abbreviations:* ES, epileptic spasms; WS, West syndrome; MISF, multiple independent spike foci; LGS, Lennox–Gastaut syndrome; EMU, epilepsy monitoring unit; PDR, posterior dominant rhythm; AP, anterior–posterior; SS, sleep spindle; GSW, generalized slow wave; ED, electrodecrements; IIED, interictal epileptiform discharge

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associated with West syndrome (WS), a specific electroclinical epilepsy syndrome with onset in infancy. It has a characteristic electrographic pattern, hypsarhythmia. Hypsarhythmia is a chaotic EEG pattern characterized by high voltage (>300 μV) slow waves and multiple independent spike foci (MISF) [2]. ES in this setting are frequently called infantile spasms and the two terms are sometimes used interchangeably. While spasms are an obligatory feature of WS, they may occur in other clinical settings and are not confined to infancy, hence our preference for the term "epileptic spasms" [3]. Lennox–Gastaut syndrome (LGS) and Ohtahara syndrome are two such settings in which spasms are known to occur. Both are relatively rare, however [4].

ES have been described outside of WS but the associated epilepsy syndromes are still to be elucidated. In 1987, Gobbi and co-workers described a particular type of ES termed periodic spasms which differ from the typical WS as they usually occur during childhood and consist of a series of spasms following a focal seizure, without hypsarhythmia on EEG recording [5]. Camfield and colleagues [6] later documented the continued occurrence of ES into adolescence in children who presented with WS in infancy. Eisermann and colleagues [7] reported 22 children with "cryptogenic late-onset ES" and we reported a group of children with similar electroclinical features [8]. These children had onset starting after 12 months of age of brief tonic or myoclonic seizures that resembled spasms based upon review of the video features and polygraphic tracings without typical hypsarhythmia, and we proposed the term "late-onset infantile epileptogenic encephalopathy". Auvin et al. [9] reported 19 patients with late-onset ES. ES are acknowledged in an International League Against Epilepsy (ILAE) Commission report as a seizure type and are clearly described by others [10,11].

The purpose of our study was to review the spectrum of ES in a large series of infants and young children and determine whether there was evidence of etiologically or electrophysiologically distinct patterns beyond hypsarhythmia that might provide a basis for further differentiation between WS (onset of <12 or 13 months and high voltage slowing waves with MISF) vs. everything else with ES. The alternative possibility would be that WS is part of a spectrum of ES-related epilepsies.

## 2. Patients and methods

### 2.1. Patients

Patients were retrospectively identified by reviewing the 24-h video/EEGs of children seen at our hospital between January 2000 and October 2009. We searched the reports for any description consistent with ES. Inclusion criteria were (a) age less than 18 years at the time of video/EEG monitoring, (b) occurrence of ES with or without other seizure types, and (c) video/EEG recording capturing the spasms. To propose a comprehensive notion of a clinical spectrum of ES, we included children with relatively rarer syndromes known to be associated with spasms including LGS and Ohtahara syndromes, and those with non-syndromic epilepsies other than WS. Once we identified the cases we reviewed the video/EEG studies to reaffirm the diagnosis of ES and to characterize the EEG and clinical features.

### 2.2. Methods

Clinical data were extracted from medical charts and included gender, age at epilepsy onset, epilepsy syndrome at onset, age at occurrence of ES (which may have been different from epilepsy onset), epilepsy syndrome and age when monitored in the epilepsy monitoring unit (EMU), and underlying causes of epilepsy. Y.-J. Lee performed a detailed analysis of ES semiology, the ictal electrographic correlates, and interictal features.

All video/EEG monitoring was conducted on the same equipment (XLTEK, Ltd., Canada). We evaluated the ictal semiology, frequency and intervals of spasms, symptoms between spasms, and relation to sleep-wake cycle. The data is available in detail as Appendix I. Because others [12] have noted the diversity of the movements (i.e., flexion, extension, or mixed) within or between clusters, we focused on the body parts involved at the onset of the spasms. We defined an irregular interval between spasms as those in which the difference between the maximum and minimum values of spasm-to-spasm intervals had a range of more than 30 s. We also considered the existence of other seizure types with ES, their temporal relation to the spasms, and associated lateralizing features (Appendix II). We reviewed the background, interictal and ictal activity of each 24 h-video/EEG monitoring study.

### 2.3. Statistical analysis

Data were stored in a dedicated access database and verified for accuracy. Analyses presented here focus on comparisons among the three electrographically defined groups A, B and C. Statistical comparison of the continuous and categorical variables was tested by means of *t*-tests and chi-square tests as appropriate for the data. A $p$-value $< 0.05$ was regarded as statistically significant.

### 2.4. Standard protocol approvals, registration, and patient consents

Ethics permission for this study was granted (number: 2010-14075) by the Institutional Review Board of Children's Memorial Hospital at Chicago, and a Waiver for informed written consent was permitted.