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Index-finger pointing in generalized tonic–clonic seizures

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ABSTRACT

Objective: Most patients with localization-related epilepsy (LRE) and genetic generalized epilepsy (GGE) are classified based on semiology and video-EEG, but both features occasionally fail to provide a definitive diagnosis. Several reliable lateralizing signs have been described, although hand and finger posturing has received little attention. We sought to investigate the frequency of index-finger pointing (IFP) during generalized motor convulsions as a lateralizing semiology in LRE.
Methods: We retrospectively analyzed 98 videos of generalized convulsions in 64 consecutive patients who were admitted for diagnostic video-EEG (vEEG). Demographics were recorded, and IFP ipsilateral, contralateral, and bilateral to vEEG ictal correlate was compared between LRE, GGE, and nonepileptic attacks (NEAs). The angle of IFP was measured to quantify the mean degree of IFP in "pointers" versus "nonpointers". Statistical analysis was completed using JMP 9.0.
Results: Index-finger pointing was more common in epileptic GTC seizures than in convulsive NEAs (83.6% vs 12.0%; $p < 0.001$) and was more common in LRE compared with GGE (96% vs 56.6%; $p \leq 0.001$). The frequency of contralateral, ipsilateral, or bilateral IFP did not differ between LRE and GGE. The average angle at the MCP joint in "pointers" was 35.8° (SD 22.0°) and in "nonpointers" 3.0° (SD 7.2°).
Significance: This is the first study to examine hand and finger postures as a clinical sign to help classify epilepsy type. The presence of IFP was more common in patients with LRE than in patients with GGE and very rarely occurred in NEA. Index-finger pointing and other hand semiologies are potentially quantifiable localizing signs to aid in the characterization of patients with GTC seizures.

1. Introduction

Generalized convulsive seizures either rapidly engage bilaterally distributed networks at the onset (as in genetic generalized epilepsy [GGE]) or arise within a network that is limited to one hemisphere (as in localization-related epilepsy [LRE]) [1]. The correct diagnosis dictates the appropriate management and relies on clinical features and electroencephalography (EEG). In some cases, the final diagnosis is not straight forward because of focal and lateralizing semiologies in GGE [2] or generalized EEG patterns in LRE (e.g., secondary bilateral synchrony) [3–7].

Clinical semiology plays an important role in characterizing focal seizures. Reliable lateralizing signs in seizures include contralateral head and eye version prior to a convulsion [8–11], "figure-of-4" sign [8,12], asymmetric tonic limb extension, and asymmetric termination of the clonic phase [13]. Hand postures, however, have not been thoroughly investigated. Children can demonstrate finger "scissoring" during generalized motor seizures of focal onset, though with uncertain lateralizing significance [14]. Ictal hand automatisms (especially with contralateral hand dystonia) and postictal nose wiping suggest an ipsilateral seizure focus, though it is not helpful during GTC seizures [15–18].

Because of the lack of described and reliable ictal hand postures, we sought to address finger posturing; specifically, whether index-finger pointing (IFP) occurs during GTC seizures more frequently and as a lateralizing sign in patients with LRE.

2. Material and methods

We retrospectively analyzed the videotapes of 64 patients with 98 GTC seizures who were admitted for diagnostic video-EEG monitoring (VEM) in the Epilepsy Monitoring Unit (EMU) at Mayo Clinic in Florida from 2010 to 2014 (50 months). The study was approved by the Mayo Clinic institutional review board for human study as a minimal risk study.

The primary aim of this study was to evaluate hand signs and to determine whether IFP occurs as a posture during GTC seizures more frequently in patients with LRE than in patients with GGE or nonepileptic attacks (NEA). Localization-related epilepsy was further subclassified by location relative to the seizure onset zone: temporal, frontal, or parietal–occipital lobe epilepsies. In some cases, seizures were unable to be characterized more specifically than "extratemporal lobe" epilepsy. We analyzed the specific temporal, frontal, and parietal–occipital lobe epilepsies independently. Then, we combined the patients with frontal

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and parietal–occipital epilepsies with the patients with nonspecific "extratemporal lobe" epilepsy to analyze all extratemporal lobe seizures together.

The final epilepsy classification was made after vEEG monitoring and prior to this study. The final diagnosis was based upon a concordance of information, including clinical history, neurological examination, interictal and ictal 21-channel scalp video-EEG monitoring, and brain MRI [19]. Selected patients completed a comprehensive presurgical evaluation.

Every GTC seizure was analyzed as a single event. The semiology was reviewed by one author (JS) who was blinded to the patients' preadmission characteristics. The second reviewer (WOT) provided independent review on a case by case basis.

We defined IFP as the objective appearance of index-finger extension relative to the first metacarpophalangeal (MCP) joint of the middle finger for any amount of time (Fig. 1). Index-finger pointing was present when it occurred in isolation or when it occurred during the transition of fingers moving from extension (fanning) to flexion (fisting), as long as it was felt to be a "sustained" posture. The index finger's proximal and distal interphalangeal joints were not required to reach full extension.

The semiology of each GTC seizure was stratified into 3 phases: the seizure onset, the tonic phase, and the clonic phase. Within each phase, both the right and left hands were evaluated for the presence or absence of IFP. If the view of a hand was obstructed during any stage of the seizure, those data were removed from analysis.

Inclusion criteria included patients who experienced a habitual GTC seizure or event during VEM in the EMU, were 18 years or older, had technically adequate video-EEG during the episode to assess IFP, and had a definitive final diagnosis based on concordant lines of evidence. Patients were excluded if any of these conditions was not satisfied or patients declined general participation in future research activities upon admission to the EMU.

We compared PPV between IFP and previously described lateralizing findings: asymmetric seizure termination, head and eye version, tonic or dystonic upper extremity posturing, and "figure-of-4" posturing. Essential demographic information included patient age, gender, MRI, EEG, and relevant surgical history.

The secondary aim was to quantify the angle of IFP during the different phases of the seizure to address angles of significance. For quantitative angle analysis, we obtained digital screenshots of the maximal extension in each phase of the GTC. We used Microsoft Paint® software and an engineering protractor to measure the angle between the index and middle fingers at the metacarpophalangeal joint (Fig. 2). We used

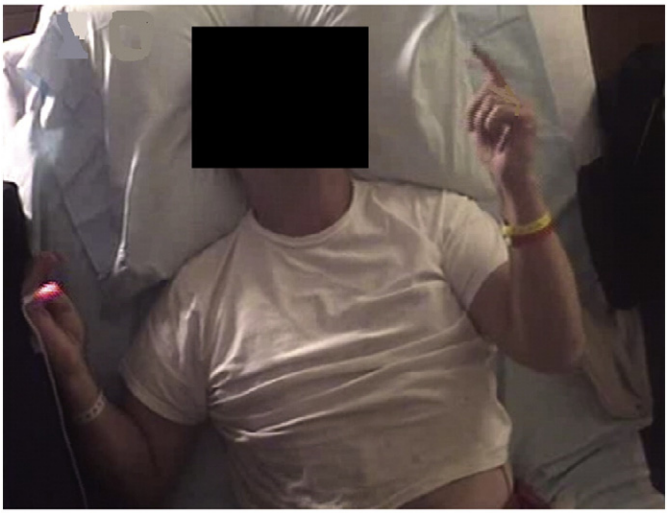

Fig. 1. This patient with a diagnosis of LRE demonstrates a pointing posture of the left hand.

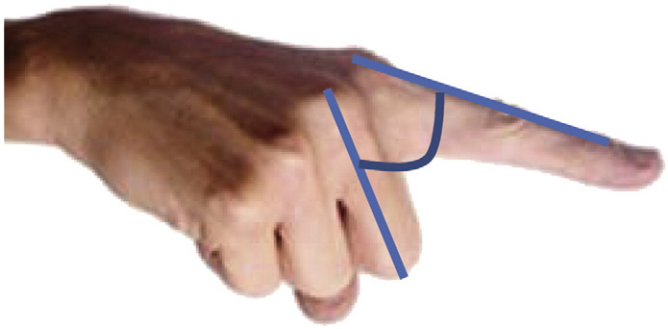

Fig. 2. Using basic computer graphing techniques, we generated a straight line between the MCP joint and the PIP joint on both the index and middle fingers (solid lines). Using a standard protractor, we measured the angle between these two lines (solid arc).

the receiver operating characteristic curve to determine the maximum area under the curve and found the optimum IFP angle cutoff for predicting LRE.

Data analysis was performed with the commercially available statistical software JMP, version 9.0 (SAS Institute Inc., Cary, NC, U.S.A.). In a univariate analysis, we tested all the clinical variables for an association with IFP. For each of these variables, we calculated IFP frequency and the positive predictive value (PPV), negative predictive value (NPV), sensitivity, and specificity. We used Fisher's exact test for analysis of categorical variables. Significance was set at a p-value of <0.05.

3. Results

Our cohort consisted of 98 GTC seizures observed in 64 patients with a median age of 32 years (IQR 17 years) and included 44 (69.8%) females (Table 1). The age of patients with NEAs was higher than those with epileptic seizures, as seen in previous studies [20].

Abnormalities were identified in 23/64 (35.9%) of high-resolution brain MRIs: heterotopic gray matter (6), encephalomalacia (8), previous lobectomy or intracranial surgery (4), hippocampal sclerosis (3), abnormal hippocampal size (4), abnormal amygdala size (2), neoplasm (1), and generalized atrophy (1). Five patients had more than one MRI pathology (one patient had 3 discrete abnormalities).

The final diagnosis was LRE in 33 patients (51.6%), GGE in 18 (28.1%), and NEA in 13 (20.3%). Of the LRE seizures, 19 (38%) were of temporal onset, 13 (26%) were frontal, 1 (2%) was parietal–occipital, and 6 (12%) were felt to be extratemporal without further specification. The remaining 11 (22%) of LRE seizures were unclassified with regard to single lobe localization (Table 1).

A presurgical evaluation was performed in 19 of the 33 patients with LRE, and at the time of this report, 7 patients (21%) have undergone surgery for LRE (1 responsive neurostimulator, 3 temporal thermal ablations, and 2 temporal and 1 frontal lobe resections). Two patients with

Table 1
The demographics of 98 seizures in 64 patients and epilepsy classification.

	Seizures (N)	Patients (N)	Female (%)	Median age (IQR)
GGE	23	18	15 (83.3)	28.5 (8.8)
LRE	50	33	20 (62.5)	27.0 (17.3)
TLE	19	13		
ETE[a]	20	13		
FLE	13	8		
NEA	25	13	9 (69.2)	38.0 (15.0)[#]

[a] ETE = FLE + PLE + not specified ETE. TLE = temporal lobe epilepsy. ETE = extratemporal lobe epilepsy. FLE = frontal lobe epilepsy. PLE = parietal lobe epilepsy.

[#] Median age of NEA statistically different than in epileptic seizures ($p \leq 0.001$).