



Title	Characteristics of EEG Seizure-Onset Patterns Recorded From Subdural Electrodes Over MRI - Visible Frontal Focal Cortical Dysplasia Type II b Lesion
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Citation	大阪大学, 2018, 博士論文
Version Type	
URL	https://hdl.handle.net/11094/69413
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論文審査の結果の要旨及び担当者

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論文審査の結果の要旨			
本研究は前頭葉のFCD2b型のMRI病変の直上から記録された発作起始時頭蓋内脳波を解析することで、てんかん原性領域の発作時頭蓋内脳波の特徴の抽出を試みたものである。解析の結果、てんかん原性領域の発作時頭蓋内脳波はLow voltage fast activity (LVFA) またはFast spike activity (FSA) の2種類のみ認められ、抑制系、興奮系いずれの機序でも発作は起こりうると考えられた。LVFAには必ずpreictal spikeが認められた。また、てんかん原性領域のバイオマーカーと従来から指摘されているHFOとIctal DC shiftのいずれも発作起始時脳波の種類によらず認められた。LVFAは外側前頭葉の症例に特徴的に認められ、基盤となる病理が同一であっても、てんかん原性領域の部位により発作時脳波変化が異なっている可能性が示唆された。以上の研究内容は博士(医学)の学位授与に値する。			

論文内容の要旨

Synopsis of Thesis

氏 名 Name	廣澤 太輔
論文題名 Title	Characteristics of EEG Seizure-Onset Patterns Recorded From Subdural Electrodes Over MRI-Visible Frontal Focal Cortical Dysplasia Type IIb Lesions (限局性皮質形成異常2b型の前頭葉のMRI病変直上から硬膜下電極で記録した発作起始時脳波の特徴)
論文内容の要旨 〔Purpose〕 Focal cortical dysplasia (FCD) is intrinsically epileptogenic, and an MRI-visible lesion typically constitutes the core part of the epileptogenic zone. We aimed to identify ictal EEG patterns that represent the epileptogenic zone by using subdural electrodes placed over the MRI-visible FCD lesion. 〔Methods/Results〕 Methods : ①Patients: We identified seven consecutive patients who fulfilled the following criteria: (1) a presurgical MRI showing typical characteristics of FCD type II in either a lateral or mesial frontal lesion; (2) multiple seizures recorded by intracranial EEG, using subdural electrodes; (3) a frontal corticectomy including the MRI lesion and a pathological specimen indicating FCD type IIb; and (4) postsurgical seizure outcome of Engel class Ia with $\geq$two year follow-up. Depending on the location of the MRI lesion, patients were separated into the lateral frontal lesion (LFL) group (four cases) and the mesial frontal lesion (MFL) group (three cases). ②Intracranial EEG recordings: Intracranial EEG recordings were obtained from all patients by using subdurally implanted platinum-iridium alloy electrodes. Analyses were performed on the referential montage. The EEG signals were digitally recorded by an EEG-1100 at a sampling rate of 200 Hz and a time constant of 10 s for conventional EEG analysis. For detecting HFOs, EEG signals were sampled at a higher rate of 1 kHz. For detecting ictal DC shifts, the signals were recorded with a time constant of 10 s and viewed off-line at a compressed time scale (60 s/page). ③Selection of electrode contacts: Electrode locations in relation to the MRI-visible FCD lesion were determined on the post-implantation MRI. Alternatively, these data were obtained by combining information from the reconstructed position of the electrodes from the StealthStation S7, a post-implantation computed tomography image, as well as presurgical and postsurgical MRIs. Finally, two of the authors (K.M. and D.H.) identified the electrode contacts located directly above the MRI lesions. ④EEG analysis: The ictal and preictal EEG patterns, interictal/ictal HFOs, and ictal DC shift only at the aforementioned electrode contacts were visually analyzed. An ictal EEG pattern was defined as a sustained rhythmic change in the EEG subsequently accompanied by a pattern of clinically typical seizure activity—one not explained by the level of arousal and clearly distinct from background and interictal EEG patterns. After the seizure-onset patterns were determined, 20 typical waves were sampled to measure signal frequencies and amplitudes. A preictal pattern was defined as a waveform that was (1) observed before the stereotypical ictal EEG pattern, (2) clearly distinct from background and interictal EEG patterns, and (3) clearly distinct from the ictal EEG pattern. HFOs were defined as patterns of fast oscillatory activity at a frequency greater than 100 Hz. Ictal HFOs were defined as sustained or repeated activity distinct from the background activity after ictal EEG onset. To visualize HFOs, the horizontal (time) and vertical (amplitude) axes of the EEG display were expanded, and the EEG signal was digitally high-pass filtered at 50 Hz and low-pass filtered at 300 Hz. The frequencies and amplitudes of both interictal and ictal HFOs were measured. An Ictal DC shift was defined as either a negative or positive potential sustained for more than 3 s with an amplitude greater than 0.5 mV. The occurrence rate and polarity of ictal DC shifts as well as their amplitudes were analyzed. RESULTS : ①Ictal EEG onset patterns: A total of 354 seizures were recorded in seven patients. In each patient, the EEG onsets for all seizures were observed at the same electrodes over the MRI lesion. Two EEG patterns were identified at seizure onset in this series: low voltage fast activity (LVFA) and fast spike activity (FSA). LVFA was a low, fast (beta or gamma range) sinusoidal activity that lasted 8.9 ± 2.7 s. The mean frequency was 56.8 ± 14.2 Hz, and the mean amplitude was 36.4 ± 16.4 μV. FSA was a non-sinusoidal burst of spikes with a mean frequency of 24.0 ± 8.2 Hz and a mean amplitude of 224.5 ± 136.9 μV. The spikes, which lasted 24.2 ± 11.0 s, increased in amplitude and gradually decreased in frequency. LVFA was seen in five patients (four in the LFL group and one in the MFL group), whereas FSA occurred in two patients (both in the MFL group). The amplitude and frequency of LVFA were significantly lower and higher, respectively, than those of FSA. ②Preictal patterns: Preictal EEG patterns preceded LVFA but were not evident before FSA. There were four preictal EEG patterns: (1) spike-and-wave, (2) spike-and-wave accelerating, (3) spike burst, and (4) leading spike. ③Ictal HFOs: Ictal HFOs were observed in all of the seizures recorded at 1000Hz. In the LFL group, they started at the end of the preictal spikes and at the beginning of ictal EEG onset, lasting 4.6 ± 1.7 s. The mean frequency and amplitude of the ictal HFOs were 175.9 ± 54.7 Hz and 22.1 ± 14.2 μV, respectively. In the MFL group, ictal HFOs appeared intermittently 0.55 ± 0.25 s after seizure onset. The mean duration and interval of HFOs were 20.5 ± 8.3 ms and 40.3 ± 22.3 ms, respectively. The mean frequency was 168.0 ± 45.3 Hz, and the mean amplitude was 24.7 ± 10.3 μV. ④Ictal DC shifts: Ictal DC shifts were detected in all patients. They were observed in 80.8% (286/354 seizures) of the seizures; they had a mean amplitude of 1030.2 ± 465 μV and negative polarity in all patients. The occurrence rate and amplitude of ictal DC shifts in the LFL group was significantly higher than those in the MFL group. All ictal DC shifts preceded clinical seizure onset and started almost simultaneously with ictal EEG onset. Conclusion: The epileptogenic zone of frontal FCD type IIb may be characterized by EEG seizure-onset patterns consisting of low voltage fast activity and fast spike activity accompanied by ictal high-frequency oscillations and ictal direct current shifts. Further study is needed to determine whether other seizure-onset patterns exist in patients with FCD type IIb.	