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Movement induces suppression of interictal spikes in sensorimotor neocortical epilepsy

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Summary Epileptic activities are known to be modulated by cortical excitability, which is altered with normal brain functioning such as movement. However, the relationship between the epileptic activity and movement has not been well studied. Here, we investigated movement-induced modulation of interictal spikes to reveal the relationship between epileptic activity and the movement-induced modulation of cortical activity. Two patients (three cases) with focal cortical dysplasia (FCD) of the pre- and/or post-central gyrus performed voluntary movements of their hands or mouths. During the movement, the interictal spikes of the sensorimotor cortex, which were measured by electrocorticograms (ECoG), were significantly reduced. This reduction strongly correlated with the event-related desynchronization (ERD) of the cortical oscillatory activity at the lower frequency bands (<25 Hz) during movement. The epileptic activity was suggested to be modulated by the movement, which correlates with the ERD of the cortical oscillatory activity.

Introduction

Voluntary movement is associated with an increased excitability of the primary motor cortex (M1) (Chen et al., 1998), which is linked to the power spectral changes of electrocorticograms (ECoG) (Pfurtscheller, 1992). Notably, event-related desynchronization (ERD) of alpha and beta rhythms correlates with cortical excitability (Leocani et al., 2001; Neuper and Pfurtscheller, 2001; Rau et al., 2003). The cortical excitability is also associated with pathological states of the brain such as epileptogenesis. Some investigations in animals and humans have shown that modulation of the cortical excitability have a modulatory effect on epileptic activity (Chen et al., 1997; Matsumoto et al., 2005).

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Though, the relationship between the epileptic activity and the modulation of cortical excitability during movement has not been well studied.

In this study, we investigated the modulation of epileptic activity associated with the movement-induced alteration of cortical activity. In three cases of intractable epilepsy with focal cortical dysplasia (FCD) of the pre- and/or post-central gyrus, the modulation of the epileptic activity during movement was evaluated by counting interictal spikes recorded by ECoG. The power spectral changes of ECoG were analyzed to evaluate cortical activity. A relationship between the modulation of interictal spikes and the power spectral changes of ECoG was analyzed.

Methods

Subjects and electrode implantation

The two patients (representing three cases) in this study were suffering from medically intractable epilepsy with FCD of the pre- and/or post-central gyrus (Fig. 1). The clinical profiles of the patients are summarized in Table 1. Patient 1 was a 31-year-old male suffering frequent medically refractory seizures immediately after his birth. His seizure consisted of a rapid bending of his head and raising both of his arms that progressed to a secondarily generalized tonic-clonic seizure. He underwent surgeries to remove epileptic foci twice due to the frequent recurrence of seizures (1A, first operation; 1B, second operation). Patient 2 was a 24-year-old woman suffering from frequent medically refractory seizures from 3 years old. Her seizure consisted of the convulsion of her right oral angle and right limbs that progressed to a secondarily generalized tonic-clonic seizure. Both patients were orally administered the therapeutic dose of anti-epileptic drugs throughout the study period (Table 1). Although the two patients had FCD of M1, no motor deficit was observed even after the removal of the epileptic foci with FCD. The brain tissue resected from the epileptic lesion was histologically diagnosed as cortical dysplasia in both patients. Before removing the epileptic lesion, subdural electrodes were temporarily implanted to determine the epileptogenic areas by simultaneous monitoring of video and ECoG. High-frequency stimulation was performed for cortical functional mapping. We explained the purpose and possible consequences of this study to both patients, and obtained written informed consent (approved by the Ethics Committee of Osaka University Hospital).

Each patient had a total of 40—56 planar-surface platinum electrodes (configured in grids, 4×5, 3×5 or 3×7 arrays; Unique Medical Co., Tokyo, Japan) placed over the sensorimotor and temporal cortices for presurgical evaluation (Fig. 1). Each electrode had

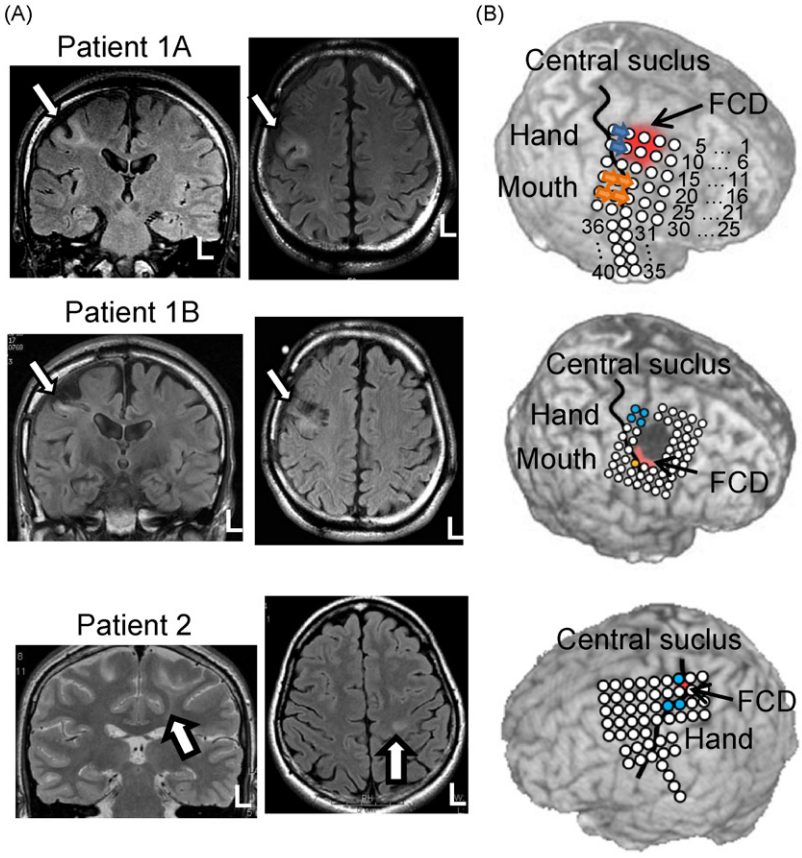

Figure 1 Location of focal cortical dysplasia and implanted subdural electrodes. (A) Magnetic resonance (MR) images of the three cases (FLAIR, coronal, sagittal, except for the left panel of Patient 2 which is a T2-weighted image). A well-demarcated high-intensity lesion in the precentral gyrus (white arrow) was diagnosed as focal cortical dysplasia (FCD). (B) Reconstructed individual MR images with superimposed white circles indicating the position of the 40- to 56-channel grid electrodes. A red colored brain surface indicates the suspected cortical lesion with FCD. Bipolar (arrow) or monopolar (circle) electrical stimulation of the cortex induced muscle contraction of the hand (blue) or the mouth (orange). The black line indicates the location of the central sulcus.