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Cephalic Aura after Frontal Lobe Resection

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Abstract

A cephalic aura is a common sensory aura typically seen in frontal lobe epilepsy. The generation mechanism of cephalic aura is not fully understood. It is hypothesized that to generate cephalic aura more extensive cortical areas need to be excited. Here we report a patient who started to have cephalic aura after right frontal lobe resection. MEG showed interictal spike and ictal change during cephalic aura, both of which were distributed on right frontal region, and the latter involved much more wide spread areas than the former in MEG sensor wise. The peculiar seizure onset pattern may indicate that modification of epileptic network by surgery is related to the appearance of cephalic aura. We hypothesize that generation of cephalic aura may be associated with more extensive cortical involvement of epileptic activity than that of interictal activity, in at least a subset of cases.

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We hope that Fig 1 would be shown in color style only in the Web.

Keywords

Cephalic aura; Electroencephalography; Magnetoencephalography; Fast activity

Introduction

A nonspecific cephalic sensation, known as cephalic aura, is a common sensory aura seen in some cases with frontal lobe epilepsy, although its magnetoencephalographic profile remains unknown.

Case Report

We present a 23-year-old female who suffered from perinatal cerebral infarction. Her seizures started at 7 years and were characterized by bilateral asymmetric tonic seizures as well as dialeptic seizures. The interictal scalp EEG showed no clear epileptiform spikes, and ictal scalp EEG recordings revealed either seizure patterns arising from bilateral fronto-central regions, or non-localizable change during seizures. MRI showed focal encephalomalacia in the right fronto-parietal operculum as well as generalized parenchymal volume loss. At 15, the patient received surgical evaluation with intracranial subdural EEG recording. The study identified the dialeptic seizure with focal EEG onset arising from right anterior lateral frontal region. The evaluation with intracranial subdural recording led to the consensus that resection of structural lesion (right frontal operculum) and the right lateral frontal seizure onset zone would provide a chance of seizure freedom. The patient received a tailored resection of right frontal premotor area. Surgery decreased the frequency of her seizures, but she was not seizure-free. Additionally, the patient began to have a brand-new cephalic aura, expressed as “a bolt of electricity all over her head”, accompanied by peculiar eye movements such as eye blinks or eyelids opening, which typically lasted 1 to 2 sec. This aura could be followed by a bilateral asymmetric tonic seizure. The scalp EEG showed interictal spikes in right posterior temporal region as well as non-localizable ictal activities. Ictal single-photon emission computed tomography (SPECT), when the patient had a cephalic aura followed by a bilateral asymmetric tonic seizure, showed hyperperfusion in the medial frontal area (Fig. 1A). Subsequently, we performed simultaneous EEG and MEG recordings in a magnetically shielded room. While EEG showed no clear interictal epileptiform discharges (EDs), MEG uniquely detected EDs (Fig. 1B) whose sources were estimated over the right inferior frontal to insular region, which was at the margin of previous surgical resection (Fig. 1b). When the patient had a habitual cephalic aura during this simultaneous recording, the EEG did not show any clear abnormalities. However, MEG detected beta paroxysmal fast activity in the right frontal region (Fig. 1C) which was consistent with interictal EDs captured at other times during the recording. This ictal paroxysmal fast activity was more extensively distributed than interictal activity (Fig. 1B, 1C – circled area of images for magnetic distribution of interictal and ictal activities). Images showing distribution of the power of beta band activity also support that most of the activated area was still on right frontal region (Fig. 1b, 1c). Based on these investigations, we concluded that a source for cephalic aura was in the right inferior to middle frontal gyrus, at the margin of the previous surgical resection.

Discussion

We believe that the characteristic manner of onset of cephalic aura and ictal MEG finding would provide an important clue about generation mechanism of cephalic aura. Its generation could be associated with modification of the epileptic network and more extensive cortical involvement than in interictal spike, which may reflect an inhibition mechanism to epileptogenic region.¹

Aura of this patient came up after epilepsy surgery. This peculiar profile of the onset of her aura reminds us of the fact that aura frequency could increase after epilepsy surgery, even after providing adequate control of complex partial and secondary generalized tonic-clonic seizure.² In addition, the comparison of interictal and aura-related ictal EDs at the right frontal region revealed differences in their morphological profile (spike for the former, fast activity for the latter) and their extent in MEG sensor level (the latter involved more wide spread area than the former). We speculate that mechanisms for generating interictal spike and aura was different, the latter involved more extensive area than the former did. Aura generation may be on a complicated network. Palmmini indicated that resecting an epileptogenic region could “disinhibit” other areas, related to cephalic auras, that might be previously dormant but are potentially epileptogenic.³ Devinsky et al. also pointed out that the region from which electrographic discharges arise may not be the only area that can produce simple partial seizures.² Additionally, it should be considered possibility of residual epileptogenic tissue even after surgical removal.⁴ MEG captured neurophysiological changes of the cephalic aura where EEG failed, suggesting that we believe MEG could be a tool to clarify a neurophysiological profile of cephalic aura.

Detecting epileptic activity associated with auras in the scalp EEG has been a challenge. Devinsky et al. reported low detectability of scalp EEG for auras. They compared detectability of aura-related change between scalp EEG and subdural electrodes recordings in 7 cases. Only 11% of all spells were associated with scalp EEG change, which was significantly lower than subdural electrode recordings (90%).² In MEG, Canuet et al. reported a single case with cephalic aura, in which MEG detected ictal activity in the frontal lobe.⁵ Although simultaneous EEG was not recorded in their study, previously repeated EEGs failed to detect any aura-related epileptiform activity. As in our case, MEG was more sensitive than EEG to detect aura-related ictal activity.

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Fig. 1.

A. Representative ictal SPECT on the patient's MRI

Note that, hyperperfusion is shown on right mesial and lateral frontal region.

B. Interictal (Left; #1) and ictal state (Right; #2) of simultaneous EEG-MEG recording

EEG and MEG waveform (top), magnetic distribution of the activities (middle), and source localization (bottom) are shown. For interictal spikes, electrical current dipoles (ECTs) model is applied (a). The circle and bar on the MRI scans indicate the dipole location and orientation, respectively. For ictal state, frequency band analysis is performed (b, c).

Distribution of power of beta band activity is shown (circle indicates the area having highest power).

MEG uniquely detected interictal spikes whose dipoles are estimated on right inferior frontal to insular region (a). MEG also uniquely detects ictal change. Note that, interictal spike and aura-related ictal activity showed similar distribution pattern, but the latter shows wider distribution than the former in MEG sensor level; (see circled areas in middle column). The appearance of fast activity supports the fact that the mainly activated area is still on right frontal region (b, c).