CASE REPORT

Bilateral Paramedian Thalamo-midbrain Infarction Showing Electroencephalographic Alpha Activity

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Abstract

A 57-year-old man became unresponsive and mute with bilateral ophthalmoplegia and quadriplegia. Magnetic resonance imaging (MRI) showed bilateral infarctions at the ventral midbrain and the dorsomedial nucleus of the thalamus. Serial studies with MR and vertebral angiography disclosed hypoperfusion and spontaneous reperfusion of the bilateral posterior cerebral arteries at their origin from the basilar artery. Electroencephalographically, a posteriorly distributed alpha rhythm was clearly recorded and it was reactive in response to external stimuli. The findings seen in the present patient suggest that the ventral midbrain and medial dorsal thalamus are not necessary to produce posterior electroencephalographic alpha activity.

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Key words: akinetic mutism, alpha coma, EEG, MRI, SPECT

Introduction

Even in deep coma, the alpha rhythm can dominate the scenery, and this condition is known as the "alpha coma" state (1). The alpha rhythm persists during deep coma and could be distinguished from normal posterior alpha by the lack of reactivity to external stimuli and distribution of it. However, patients with brainstem stroke show reactive or non-reactive alpha activity (1). Classic neurophysiological and histopathological studies suggest that the neuronal population responsible for generating the alpha-pattern lies in the rostral region to the pontomesencephalic junction (2-4). Recent advances of neuroimaging allow us to evaluate discrete intracranial lesions. Here, we report a patient with the top of basilar syndrome who showed a reactive electroencephalographic alpha pattern.

Case Report

A 57-year-old, right-handed man was transferred to our hospital due to paralysis of his left upper and lower limbs. Although the event occurred in his house, the exact time of the onset was uncertain. He had been diagnosed as atrial fibrillation and hypertension for 20 years, but neither anticoagulation nor antiplatelet agents were administered. On admission, neurological examination revealed right ptosis, right total external ophthalmoplegia with dilated pupil and left hemiplegia (Weber syndrome). At this time, he was awake and responded to verbal commands using his right hand. Brain CT on admission disclosed low density areas (LDA) at the right ventral midbrain and the medial part of the right thalamus. Blood examinations did not show any abnormalities. One hour after the admission, the patient became comatose. Left total external ophthalmoplegia with ptosis and right hemiplegia developed. Bilateral pupils were dilated and did not react to light. Vestibuloocular reflex was partially preserved horizontally. Divergent eye position was seen in primary gaze. All voluntary movements including bilateral limbs, face and ocular muscles were completely lost. Deep tendon reflexes were also lost bilaterally, as seen in the comatose state on the day of admission. Brain CT on the day of the admission after the second attack showed new LDAs at the left ventral midbrain and medial thalamus. After the admission, the patient was treated by intravenous continuous heparin to prevent new thrombus formation and glycerol for edema. Magnetic resonance imaging (MRI) on the 3rd day after admission disclosed infarctions at the midbrain and bilateral thalami (Fig. 1). At the level of midbrain, the area ventral to the aqueduct including the cerebral peduncle, substantia nigra, red nucleus, central tegmental tract and medial lemniscus was bilaterally involved. The superior and inferior colliculus were spared. As for the thalamus, bilateral dorsomedial nuclei were predominantly involved. Magnetic resonance angiography (MRA) showed hypoperfusion of the right and left posterior cerebral arteries (PCA) (Figs. 2A and B). On the same day of MRI/MRA, electroen-
Figure 1. Brain MR images on the third day after the onset [Top: FLAIR (TR/TE: 9,000/110), Bottom: T2-weighted image (TR/TE: 4,000/99)]. The ischemic lesions are identified at the bilateral midbrain ventral to aqueduct, medial part of thalami (bilateral medial dorsal nuclei), and mesial temporal lobes (amygdalo-hippocampus formation). Sagittal sections of this figure are consecutively arranged from right to left of the patient’s brain, i.e., right side of the figure is the left side of the brain. Lt.: left, Ant.: anterior.

Cephalogram (EEG) was performed to evaluate the patient’s cerebral function (Fig. 3). The dominant rhythm was posteriorly distributed, 7–8 Hz slow alpha rhythmic waves and generalized irregular theta waves were occasionally intermixed. No lateralized abnormality was found in the EEG recording. The alpha waves were definitely attenuated by forced eye-opening (Fig. 3). Auditory brainstem responses (ABR) were clearly recorded without abnormality. Cortical auditory response, auditory N100, was also evoked maximally at the vertex area. Early cortical components of somatosensory evoked potentials (SEP) stimulating the bilateral median nerves at the wrists were also identified (Fig. 4), and no laterality was found in either peak latency or amplitude (not shown). On the 10th day after the onset, conventional angiograms (AG) of the bilateral carotid and left vertebral arteries were done and bilateral PCAs were clearly shown on a vertebral angiogram (VAG) (Figs. 2C, D). Single photon emission computed tomography (SPECT) using $^{99m}$Tc-ethylcystainate dimer (ECD) was performed on the 13th day after the onset. Cerebral blood flow (CBF) was globally preserved in the cortex, but focal deficits were seen at the left mesial temporal lobe and bilateral thalami (arrows in Fig. 5). The hypoperfusion areas of regional CBF corresponded to the lesions seen in the previous MRI. Brain MRI was repeated one month after the onset, and EEG was also recorded one and eight months after the onset. Brain SPECT was repeated four months after the onset. The findings of follow-up MRI, EEGs and SPECT were essentially the same as the first ones. However, bilateral PCAs became visible in MRA at one month after the onset as shown by previous VAG (arrows in Figs. 2E, F).

One year after the onset, the patient continued to be unresponsive and mute. Eyelids were always closed and voluntary eyeball movements were not recognized in forced eye-opening. Primary position of eyeballs showed divergent position, more severe in the right eye. Bilateral increased deep tendon reflexes and pathological reflexes of all limbs appeared. Cough, yawn and gag reflexes were observed. Whenever inserting nasogastric tube for feeding, swallowing was seemingly pre-
Alpha Coma in the Top of Basilar Syndrome

Figure 2. Magnetic resonance angiography (MRA) on the third day (A, B), conventional vertebral angiography on the 10th day (C, D), and MRA on the 1 month after the onset (E, F). Bilateral posterior cerebral arteries (PCA) are difficult to delineate by MRA on the 3rd day. On the 10th day after onset, left vertebral angiography clearly shows bilateral PCAs without any stenotic lesion. One month after the onset, MRA discloses the improved perfusion of bilateral PCAs (arrows). A, C, E: frontal view, B, D, E: lateral view. Lt.: left, Post.: posterior.

Discussion

Clinically, the present patient showed typical Weber syndrome due to ischemic lesions of the right midbrain and thalamus in his first attack, and finally became unresponsive and mute following the second attack which resulted in the bilateral ventral midbrain and thalami. Neuroradiological studies in the present patient suggested arterial occlusion and spontaneous reperfusion at the "top of basilar" site in a broad sense, i.e., right and left PCAs were consecutively diminished in perfusion at their origin from the top of the basilar artery, respectively. Spontaneous reperfusion of this site is not rare (5), and it was reported that the prognosis of basilar artery embolization was better than that of basilar stenotic occlusion when the occlusion was recanalized (5). Normal ABR and cortical auditory N100 suggested preserved function of the auditory conduction pathways between the ear and the auditory cortex. This is compatible with the MRI findings, because the structures responsible for auditory conduction such as the inferior colliculus and medial geniculate nucleus were obviously spared. In addition, electrical SEP recording also showed the normal somatosensory conduction via the dorsal column-medial lemniscus pathway to the sensory cortex (6). Although MRI suggested possible involvement of medial lemniscus at the midbrain, SEP findings confirmed that the medial lemniscus was not completely affected.

The unsolved important problem in the present patient was whether the consciousness was preserved (locked-in state) or he was comatose. Castaigne et al (7) reviewed the clinical symptoms of bilateral paramedian thalamic and midbrain infarction

served and no aspiration pneumonia occurred. The patient showed rhythmic spontaneous respiration and he appeared to have a rhythm of arousal and asleep. However, since the polysomnogram was not performed, it was not conclusive of the sleep architecture in the present patient.
Figure 3. EEG on the third day after the onset showing posterior dominant alpha activity. Posterior dominant, 8-9 Hz rhythmic activity is attenuated by eye-opening. No laterality of either amplitude or amount of alpha activity is observed. In this recording, eye-closure was passively performed by the examiner, and electrooculogram (EOG) and frontopolar derivations show partially preserved Bell phenomenon in the present patient. ECG: electrocardiogram.

and classified them by pathological site of lesions. In their study, 19 out of 28 patients with bilateral thalamopeduncular infarcts showed marked disturbances of consciousness including hypersonnia, deep coma and akinetic mutism (7). In addition, Tomimoto et al (8) reported a patient who finally displayed akinetic mutism, and the patient’s autopsy findings disclosed bilateral medial dorsal thalamic infarction extending to the reticular formation in unilateral midbrain. In the present patient, at the level of midbrain, reticular formation including the tegmental tract was certainly, at least in part, involved bilaterally. Taking the clinical signs and anatomical sites of the lesions into account, the present patient was regarded as comatose in the acute stage followed by akinetic mutism.

The initial condition seen in the present patient was comatose with EEG alpha activity. The origin of alpha waves in healthy humans has not yet been completely clarified. Recent neurophysiological evidence in normal subjects has shown that scalp-recorded, spontaneous EEG rhythms with alpha frequency are regarded as the summation of independent various cortical activities; so-called “occipital alpha” in the narrow sense, mu from sensorimotor and tau from temporal cortices (1, 9, 10). These tend to desynchronize in response to external stimuli, and the reactivity of the rhythm is considered as an important feature of thalamocortical function (1, 9, 10). EEG alpha activity in comatose patients, alpha coma, is well known and it can be seen in the patients with cerebrovascular accident (CVA), cerebral concussion, cerebral hypoxia, and drug intoxication (4). Among them, alpha coma caused by brainstem CVA and cerebral severe hypoxia usually show poor prognosis. The major etiology of alpha coma is cerebral hypoxia following cardiac arrest, and an unconscious state by brainstem lesions is also reported (1–3). It is known that alpha activity seen in comatose patients with drug-intoxication is poorly reactive to external stimuli with good prognosis and that it distributes predominantly over the frontal area (11). In contrast, alpha activity in patients with vascular brainstem lesions is more similar to the features of healthy normal subjects (4, 12). In the present patient, the alpha activity had the same characteristics as those seen in vascular brainstem lesions. The lesion responsible for alpha coma was evaluated by post-mortem evaluation and the most likely site of lesion was the pontomesencephalic junction. Real-time functional activity of each brain structure show-
Figure 4. Somatosensory evoked potential by stimulating right median nerve. Short-latency early cortical responses (N20, indicated by ***) are clearly recorded at the left centroparietal area (CP3) with the latency of 18.7 msec. Erb (*) and cervical (**) potentials are recorded at 8.8 and 12.1 msec from the stimulus onset, respectively. Averaged waveforms obtained from 3 different sessions (200 sweeps in each session) are superimposed. Ref: Erb point contralateral to the stimulated site.

ing alpha coma has not been sufficiently studied. Hayashi et al (4) recently reported on the MRI lesion in a patient with fatal pontine hemorrhage showing transient alpha coma, and they concluded that the thalamic-thalamocortical-cortical circuits rostral to the pontomesencephalic junction were essential for the appearance of alpha coma. In their case, alpha activity was finally lost and the authors speculated that the disappearance of the alpha activity might have been caused by diminution of thalamocortical activity due to the lack of the ascending sensory afferent input (4). Preservation of at least half of midbrain tegmentum with its ascending pathways to the cortex is sufficient to maintain an alpha pattern, but it is considered to be insufficient to maintain full consciousness (3). As for the present patient, bilateral dorsomedial thalami were apparently affected but ventral posterior nuclei were not involved. Neurophysiologically, the somatosensory pathway was preserved as supported by normal SEP findings. The speculation is acceptable for the present patient who showed persistent alpha activity for at least eight months in contrast to the case shown by Hayashi et al (4). The dorsomedial nucleus is known to be a relay nucleus receiving input from the amygdaloid nuclear complex and hypothalamus, and it projects to prefrontal cortices (13). Thus, the findings in the present patient suggest that discrete bilateral lesions of the ventral midbrain and the dorsomedial nucleus of the thalamus do not affect the generator mechanism of reactive EEG alpha activity.

References

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Figure 5. Brain ECD-SPECT images on the 14th day after the onset. The CBF is regionally diminished at the bilateral thalami (black arrows) and left mesial temporal lobe (white arrow). There is no deficit of CBF in the cortex. Lt.: left.