Neonatal Apneic Seizure of Occipital Lobe Origin: Continuous Video-EEG Recording

abstract

We present 2 term newborn infants with apneic seizure originating in the occipital lobe that was diagnosed by video-EEG. One infant had ischemic infarction in the distribution of the posterior cerebral artery, extending to the cingulate gyrus. In the other infant, only transient occipital hyperechogenicity was observed by using neurosonography. In both cases, although the critical EEG discharge was observed at the occipital level, the infants presented no clinical manifestations. In patient 1, the discharge extended to the temporal lobe first, with subtle motor manifestations and tachycardia, then synchronously to both hemispheres (with bradypnea/hypopnea), and the background EEG activity became suppressed, at which point the infant experienced apnea. In patient 2, background EEG activity became suppressed right at the end of the focal discharge, coinciding with the appearance of apnea. In neither case did the clinical description by observers coincide with video-EEG findings. The existence of connections between the posterior limbic cortex and the temporal lobe and midbrain respiratory centers may explain the clinical symptoms recorded in these 2 cases. The novel features reported here include video-EEG capture of apneic seizure, ischemic lesion in the territory of the posterior cerebral artery as the cause of apneic seizure, and the appearance of apnea when the epileptiform ictal discharge extended to other cerebral areas or when EEG activity became suppressed. To date, none of these clinical findings have been previously reported. We believe this pathology may in fact be fairly common, but that video-EEG monitoring is essential for diagnosis. Pediatrics 2012;129:e1616–e1620

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KEY WORDS
EEG, neonatal, apnea, seizure (neonatal), stroke

ABBREVIATIONS
aEEG—amplitude-integrated EEG
GA—gestational age
SpO2—pulse oxygen saturation

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Although neonatal apnea may be found in the course of several neurologic and non-neurologic disorders, seizure is a relatively infrequent cause. Hemorrhagic or ischemic injuries in the temporal lobe more commonly lead to apnea rather than extratemporal damage. Perinatal stroke usually is located in the region of the middle cerebral artery and is found in 95% of cases, and only 5% originate from other vascular territories. The literature contains few or no references to neonatal stroke located in the posterior cerebral artery, and to our knowledge, there are no previous reports relating neonatal or infant apneic seizure with ischemic or other lesions in the region of this cerebral artery. We also have not found any studies reporting the capture of apneic seizure in a video-EEG recording, only by using standard EEG monitoring with the description of clinical findings based solely on observational data.

**CASE REPORT 1**

A term male infant (40 weeks' gestational age [GA]) presented with no relevant family history; his mother had an uneventful pregnancy and normal Doppler ultrasound findings before giving birth via vaginal delivery assisted with forceps, with meconium-stained amniotic fluid. His Apgar score was 7/9 at 1 and 5 minutes, respectively. Physical examination findings by the attending registered nurse were strictly normal. At 28 hours after birth, sudden cyanosis was observed, requiring admission to the NICU. The infant recovered after oxygen therapy but was hypotonic, pale, and lethargic, with a heart rate of 80 to 100 beats per minute. Blood test (pH, PO$_2$, bicarbonate, complete blood cell count, and biochemistry) and electrocardiography results were normal. Then 3 new episodes of cyanosis with pulse oxygen saturation (SpO$_2$) percentage <50% occurred.

The observational description by the attending nurse was that all of these episodes of cyanosis were accompanied by regurgitation with slow desaturation, bradypnea, apnea, and bradycardia and hypotonia, which required resuscitation with tactile stimulation, oxygen therapy, and intermittent positive pressure ventilation, resulting in full recovery. Complementary examination findings, including echocardiography, basic biochemistry and metabolic studies, and neurosonography, were also normal. Continuous video-EEG recording (Fig 1) showed a rhythmic discharge of rapid sharp waves (>1 per second) in the occipital area.

![EEG Recording](image)

**FIGURE 1**
EEG recording of patient 1. A, Video-EEG when discharge was limited to left occipital area. B, Discharge has spread to left temporal area (tachycardia, eyes open, and head turned to the left). C, Generalized discharge, which is synchronous in 2 hemispheres (bradypnea/hypopnea). D, Generalized attenuation of background EEG and apnea.
left occipital area lasting for >15 seconds, without clinical manifestations. One discharge suddenly extended to the left temporal lobe and the infant sequentially presented: (1) eye opening and tachycardia; (2) tonic eye deviation to the left; (3) slow blinking, mouth movements, and right arm abduction with clenched fist and eye deviation to the right; and (4) after 60 seconds, the discharge became slower (<1 per second) and synchronously spread to both hemispheres during 25 seconds, with bursts of polyspike-waves, slow waves, and depressed background EEG activity between bursts until total suppression; this phase was accompanied by hypopnea/bradypnea and prolonged apnea followed by cyanosis. After the administration of bolus and continuous infusion midazolam, no new episodes of cyanosis or electrical seizure were recorded.

MRI (Fig 2) revealed an ischemic lesion in the occipital lobe that affected ~14 mL of brain parenchyma and involved striate and extrastriate visual cortices, the retrosplenial and neighboring areas of the posterior cingulate gyrus and the cingulum, and the splenium of the corpus callosum. MRI with angiography results confirmed the presence of a vascular occlusion located in the terminal occipital artery proximal to its branching into parieto-occipital and calcarine arteries and also involving the posterior pericallosal artery.

**CASE REPORT 2**

A term female infant (39 weeks’ GA) presented, with no relevant family history; the mother had an uneventful pregnancy. Spontaneous vertex delivery was incident-free, without meconium staining. Apgar score was 9/9 at 1 and 5 minutes, respectively. Physical examination findings by the attending registered nurse were strictly normal, except for mild macrosomia (birth weight was 3910 g and head circumference was 37 cm). At 48 hours, the infant presented sudden cyanosis, with SpO_2_ level <50% while in the nursing room. After tactile stimulation, she fully recovered within seconds but was transferred to our NICU for continuous monitoring of SpO_2_, electrocardiogram, and video-EEG (Fig 3). The background EEG tracing was normal at all times except for a single discharge of rapid sharp waves limited to the left occipital region lasting 30 seconds and not accompanied by any clinical manifestation. On spontaneous cessation of these sharp waves, the whole EEG tracing showed decreasing activity to the point of total suppression; at this point, central apnea appeared without any change in heart rate. The apnea lasted ~35 seconds and resolved spontaneously. No further episodes were recorded during the following 3 days, and the need for antiepileptic treatment was ruled out. Complementary test results were normal; the tests included echocardiography, complete blood cell count, cerebrospinal fluid analysis (cell biochemistry, culture, and testing for enteroviruses and herpes viruses, by using polymerase chain reaction), basic biochemistry and metabolic studies, and neuroimaging (computed tomography, MRI with angiography). Only neurosonography on day 5 showed transient left parieto-occipital hyperechogenicity.

The 2 infants involved, currently aged 14 and 12 months, have normal development and are seizure-free.

**DISCUSSION**

We report 2 cases of term neonates with apneic seizures of occipital origin, and to our knowledge, there are no previous
references to these lesions in this localization as a possible cause of apneic seizures. We believe, however, that this situation may be under-reported, for the following reasons: (1) when ictal EEG discharge is located in the occipital region, it may not manifest in clinical signs or they are so subtle as to be overlooked or misinterpreted by observers, and (2) amplitude-integrated EEG (aEEG) is used increasingly in the NICU. Many authors indicate that aEEG is not an accurate method for the detection of neonatal seizures, however. There are reports of both over- and underdiagnosis of neonatal seizure, especially by nonexperts. Occipital seizures may be missed on single-channel aEEG monitoring. Multichannel aEEG is better than single-channel aEEG for the detection of seizures; however, the sensitivity of multichannel aEEG for the detection of individual seizures remains unsatisfactory. In the present cases, the initial occipital discharge and its propagation to the temporal area would have been missed by using aEEG. Generalization of the seizure to both hemispheres was also too short to be captured. The seizures would have been left untreated.

The gold standard for evaluating brain function and electrographic seizure is continuous video-EEG monitoring. It indicates the need for treatment according to the quantity and duration of EEG discharges as well as the response to anticonvulsants. In our first case, treatment was successful with midazolam.

The capture of apneic seizure by video-EEG has not been reported previously. To date, published cases of apnea have involved the use of standard EEG, and many of these recordings failed to include the ictal episode. There are published cases of apnea as the only manifestation of neonatal seizure and of apneic seizure associated with bradycardia or without changes in heart rate. Most have relied on observational descriptions alone, however. Moreover, in our case, the clinical description of the attending nurse did not coincide with the video-EEG findings.

To our knowledge, these are the first reports of apneic seizure arising from the occipital lobe. In addition, generalized propagation of a focal electrical seizure to synchronous bilateral discharge in a neonatal EEG recording has not been described previously.

It is well known that both the cortical organization and degree of myelination required for the propagation and generalization of seizures are not present in the human newborn. Relevant developmental aspects of the functional wiring in the human brain, such as pruning of synaptic terminals and myelination, occur during postnatal life. Interestingly, however, subcortico-cortical, corticosubcortical, and most large corticocortical connections, including the cingulum bundle, are drawn before 36 weeks' GA. Although there is no anatomic evidence of the actual target of posterior cingulate projections in newborn humans, data obtained from different imaging techniques, together with hodological studies using...
anterograde tracers in adult monkeys,\textsuperscript{11} show that retrosplenial and adjacent posterior cingulate regions project to the hippocampal formation (presubiculum, parasubiculum, and entorhinal cortex) in the medial temporal cortex through the cingulum bundle, and thereafter to midbrain respiratory centers through descending projections (Fig 4), probably involving the medial forebrain bundle from the amigdalar and hippocampal formation, as previously proposed for epileptic apnea associated with mesial temporal lesions.\textsuperscript{2}

With respect to prognoses, the 2 infants show normal development and are free of seizures. We are not aware of any other neonates with single-lesion ischemia in the occipital area. It is probable that both infants will have normal outcomes, without cognitive impairment, as in cases with perinatal stroke in the territory of the middle cerebral artery (MCA) without motor deficit or seizures.\textsuperscript{12}

CONCLUSIONS

This report contains various novel features that may have clinical and neuroanatomic implications. It also strongly supports the use of video-EEG monitoring of term newborns with neonatal apnea of unknown etiology.

REFERENCES


FIGURE 4

Schematic drawing showing the localization of lesions (case 1 and case 2) and the hypothetical pathways involved in development of neonatal apneic seizures of occipital origin. AC, amygdaloid complex; CeF, calcarine fissure; CC, corpus callosum; CeF, central fissure; H, hippocampus; IV, fourth ventricle; PHC, parahippocampal cortex; POF, parieto-occipital fissure.
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