Case Report

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A newborn with hemorrhagic meningoencephalitis due to *Proteus mirabilis*

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Summary **Neonatal meningoencephalitis is a severe condition for the developing brain of a newborn. Radiologic findings of necrosis and liquefaction due to hemorrhagic meningoencephalitis may be confused with brain abcess. In this article, we report a neonate having liquefaction necrosis due to hemorrhagic meningoencephalitis mimicing intracranial abscess due to *Proteus mirabilis*. We would like to describe the clinical course and evolution of brain imaging and emphasize the importance of the serial MR imaging (MRI).**

Keywords: Brain abscess, hemorrhagic meningoencephalitis, newborn, serial MR imaging

1. Introduction

Although *Proteus mirabilis* is a common cause of urinary tract infections, it has been reported that approximately 4% of neonatal meningitis may be caused by this microorganism and it also can cause hemorrhagic meningoencephalitis. Group B streptoccocus and *Escherichia coli* are the most common causes of meningoencephalitis in the neonatal period. *Serratia marcescens* and *Citrobacter* may be considered a causal microorganism in cases of hemorrhagic meningoencephalitis. Necrosis and liquefaction are the complications of the hemorrhagic meningoencephalitis. The differantial diagnosis of the brain abcess and the liquefaction necrosis should be done by serial magnetic resonance imaging (MRI).

In this article, we report a newborn with hemorrhagic meningoencephalitis due to *Proteus mirabilis*, whose cranial MRI findings mimic brain abscess. The authors also emphasize the importance of early and serial brain MRI for the differential diagnosis of brain abscess and sequelea of hemorrhagic meningoencephalitis.

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2. Case Report

A 6-day old female was admitted to the emergency room for grunting for 2 days and poor feeding on the morning of the admission.

The baby was born full term by Caesareal section as the first child of 34-year-old mother. Her mother had no history of radiation exposure, drug ingestion, alcohol use, smoking during pregnancy, family history was unremarkable for congenital anomalies and there was no consanguinity. On the second day of the birth she was discharged from the hospital.

On presentation to the hospital, her body temperature was 36.3°C, with blood pressure of 65/40 mmHg, heart rate of 138 beats per minute, and respiratory rate of 64 breaths per minute. On physical exam, she was hypotonic, she had depressed reflexes and poor sucing and swallowing reflexes. Capillary refill time was 5 seconds. Her anterior fontanelle was soft and nonbulging. Her breath sounds were equal, she had grunting, nasal flaring, tachypnea, subcostal retraction, central cyanosis and the other system findings were normal. Laboratory data on admission showed a white blood cell count of 17.770 cell/μL with 72.4% neutrophils, the hemoglobin was 13.9 g/dL and platelet count was 187.000 cell/μL. C-reactive protein was 12.36 mg/dL (N:0-8.2 mg/dL). Cerebrospinal fluid (CSF) had glucose of < 5 mg/dL, protein of 299.9 mg/dL and 6,500 leucocytes. Gram strain of the CSF showed no bacteria. At 24 hours, the blood culture grew *Proteus mirabilis*, but the CSF culture, the urine culture and the endotracheal aspirate culture had no growth of

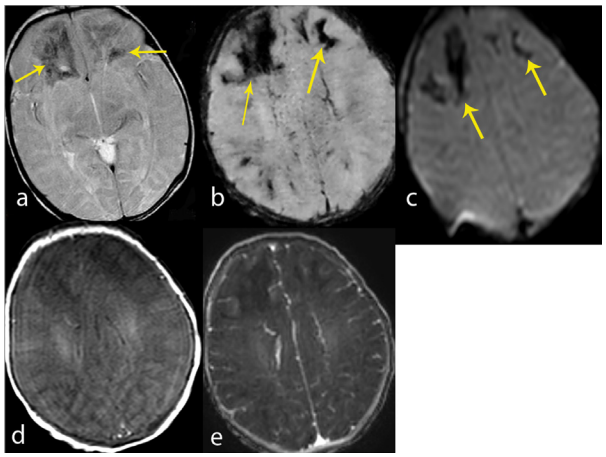

Figure 1. Acute phase of the proteus mirabilis hemorrhagic meningoencephalitis MRI findings. Axial T2W1 **(a)**, SWI **(b)** and DWI **(c)** show dark signal intensities suggestive of hemorrhagies within the frontal lobes (arrows). Unenhanced axial T1WI **(d)** demonstrates hypointense signals in the frontal lobes with sulcal effacement. Contrast-enhanced axial T1WI **(e)** shows diffuse leptomeningeal enhancement.

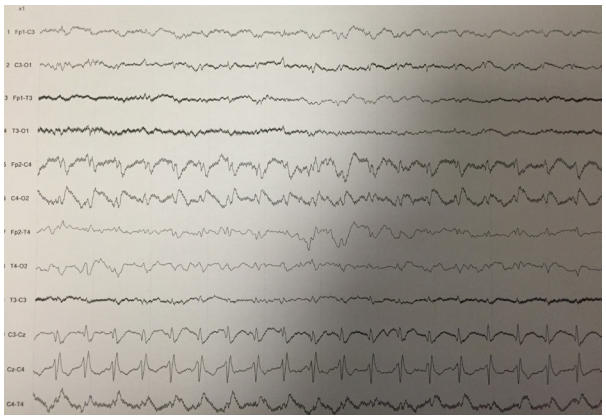

Figure 2. Electroencephalogram (EEG) findings. Background activity disorganization and epileptic activity in the central region.

bacteria.

Upon admission, patient was started on ampicilline and amicasin. While following up on continuous positive airway pressure (CPAP) mode, the blood gases revealed hypercarbia and respiratory acidosis. At the second hour of the admission, she was intubated because of respiratory failure. One hour later the patient had multifocal clonic seizure. The seizure was controlled with midazolam and phenobarbital. Her antibiotics were switched to vancomycine and meropenem. Acyclovir was added because the patients' mother had a herpes lesion on her lip. Blood and urine samples collected for metabolic disease screening. Cranial MRI findings showed acute phase of the *Proteus mirabilis* hemorrhagic meningoencephalitis. It showed dark signal intensities suggestive of hemorrhagies within the frontal lobes, hypointense signals in the frontal lobes with sulcal effacement and diffuse leptomeningeal enhancement (Figure 1).

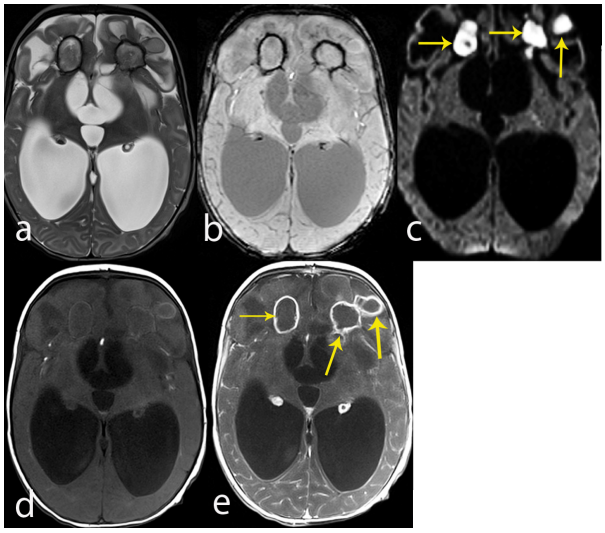

Figure 3. Intermediate phase of the proteus mirabilis hemorrhagic meningoencephalitis MRI findings. Axial T2W1 **(a)** and SWI **(b)** demonstrate severe hydrocephalus and subcortical white matter lesions that have peripheral hemosiderin deposits and central liquefactive necrosis within the atrophic frontal lobes. These lesions show high signals on DWI due to marked restricted diffusion (arrows) **(c)**. They show peripheral high signals and central low signals on unenhanced axial T1W1 **(d)**, and marked peripheral enhancement on contrast-enhanced axial T1W1 (arrows) **(e)**. There is also ependymal and periventricular enhancement.

The electroencephalogram (EEG) findings showed background activity disorganization and epileptic activity in the central region (Figure 2). She was treated with antibioteraphy for 21 days for neonatal sepsis and meningitis. During the follow up she needed mechanical ventilaton for 11 days. On the 10th day of the treatment, she reached to full enteral feeding. According to the cranial ultrasound (USG) she didn't have hydrocephalus. EEG was normal at the second week of admission. At the 23th of her admission, she was discharged from the hospital with phenobarbital therapy. Two weeks after the discharge, she was feeding well and had a stable clinical course other than the rapidly increasing head circumference. A cranial MRI was performed when she was 1.5 months old. The cranial MRI findings showed the intermediate phase of the proteus mirabilis hemorrhagic meningoencephalitis. It demonstrated severe hydrocephalus and subcortical white matter lesions that have peripheral hemosiderin deposits and central liquefactive necrosis within the atrophic frontal lobes and ependymal and periventricular enhancement (Figure 3). In the differential diagnosis brain abscess couldn't be ruled out, CSF tap was performed. CSF had glucose of 24 mg/dL, protein of 730 mg/dL and no cells were seen. Gram strain of the CSF showed no bacteria. Vancomycine and meropenem was started untill the CSF culture was obtained as sterile for 7 days. With her physical examination, the cranial MRI findings and the sterile CSF culture, brain abscess was ruled out. During her follow ups, her head circumference increased 1 cm in 3 days. Her neurological examination showed

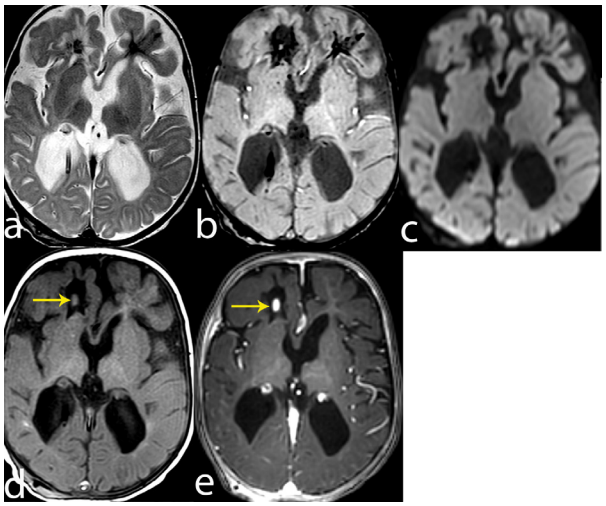

Figure 4. Late phase of the proteus mirabilis hemorrhagic meningoencephalitis MRI findings. Axial T2W1 **(a)** and SWI **(b)** demonstrate severe cerebral atrophy and encephalomalacia that contain chronic hemorrhagic signals in the frontal lobes. There is no restricted diffusion on DWI **(c)**. Encephalomalacia on right frontal lobe contains a central hyperintensity on TIWI (arrow) **(d)** and shows only a nodular enhancement contrast-enhanced image due to regression (arrow) **(e)**.

limited eye tracking, strabismus, axial hypotonia, increased deep tendon reflexes and clonus bilaterally. So ventriculoperitoneal shunt (VPS) placement was performed for her hydrocephalus when she was 69 days old. After VPS placement her head circumference remained stable and her neurological examination findings improved. Increased eye tracking, head control, decreased strabismus and mild hemiparesis were seen. When she was 4 months old, one more time cranial MRI was repeated to check the changes of the crainal pathology. The cranial MRI showed the late phase of the proteus mirabilis hemorrhagic meningoencephalitis. It demonstrated cerebral atrophy and encephalomalacia that contain chronic hemorrhagic signals in the frontal cerebral atrophy and encephalomalacia that contain chronic hemorrhagic signals in the frontal lobes (Figure 4).

3. Discussion

Neonatal sepsis is an important cause of mortality and morbidity among infants, with a incidence of culture-proven early-onset neonatal sepsis in the United States is estimated to be 0.77 to 1 per 1,000 live births (*1*). Acute bacterial meningitis is more frequent in the neonatal period than in any other time of life due to immaturity of humoral and cellular immunity, with the incidence of 0.8 and 6.1 cases every 1,000 live births (*2,3*). The absence of specific clinical sign and symptoms makes the diagnosis of neonatal meningitis more difficult (*4*). Brain abcess is a rare disorder in neonates (*5*). It is most commonly located periventricularly in the white matter of the frontal or parieto-occipital region. In the neonatal period bacterial meningitis is commonly caused by group B streptococci and *Escherichia coli* and rarely complicated by the brain abscess, however bacterial meningitis due to infections with *Proteus* species, *Citrobacter diversus*, *Enterobacter sakazakii* and *S. marcescens* often complicated by intracranial abscess formation in up to 13% of cases (*6,7*). *Proteus mirabilis* is a non-lactose fermenting gram-negative bacillus. There are several species of *Proteus*, but *Proteus mirabilis* and *Proteus vulgaris* are more common among clinical isolates. It is the causative organism of urinary tract infections, osteomyelitis, mastoiditis and wound infection as well as neonatal gram-negative meningitis with an incidence of 4% (*8*). As a complication, intracranial abscess has an increased risk of neurologic sequelae, developmental delay, visual and audiologic impairment or death (*9*).

Cranial imaging in neonates with meningitis is not routine, it is usually performed for complications. Each causitive organism for the neonatal meningitis has identifiable patterns of complications on MRI. Recognition of these patterns can help the radiologist propose the possible diagnosis and helps the clinician for the early management (*10*). Neuroimaging findings in pyogenic meningitis showes leptomeningeal enhancement as the most common finding present in 57% of the cases (*11*). Vasculitic infarcts, hydocephalus and abscess formation are other common findings. Jaremko *et al*. reported that, during culture positive menengitis, 35% of patients had subdural collection, 32% patients had ventriculomegaly, 19% had ventriculitis and overall 86% had some parenchymal abnormality, including edema 43%, infarction 52%, parenchymal abscess 13%, hemorrhage 24% and sinus thrombosis 6% (*9*). In our patient, in the first cranial MRI (hemorrhagic phase) which was the early period MRI, dark signal intensities suggestive of hemorrhagies within the frontal lobes, hypointense signals in the frontal lobes with sulcal effacement and diffuse leptomeningeal enhancement was detected. The hemorrhagic focuses and ischemic areas were thought as the result of sepsis and septic trombus however the differential diagnosis was suggestive of hemorrhagic meningoencephalitis. In the second cranial MRI (liquefaction abscess phase) which was the intermediate phase, severe hydrocephalus and subcortical white matter lesions that have peripheral hemosiderin deposits and central liquefactive necrosis within the atrophic frontal lobes and ependymal and periventricular enhancement were detected. The necrosis and liquefaction areas in the frontal lobes seen in the second cranial MRI which look like the lessions seen in brain abscess was due to hemorrhagic meningoencephalitis. The third cranial MRI (encephalomalacia phase) which was taken during the late period, showed cerebral atrophy and encephalomalacia that contain chronic hemorrhagic signals in the frontal lobes. These findings revealed

the same lesions as the sequele of the hemorrhagic meningoencephalitis.

In conclusion, *P. mirabilis* can cause liquefaction necrosis on the late-onset of severe hemorrhagic meningoencephalitis. We emphasize the importance of early and serial brain MRI imaging in neonates. In our opinion, cranial MRI is the imaging modality of choice in infants with the diseases of the central nervous system especially in the differential diagnosis of brain abscess and sequelea of hemorrhagic meningoencephalitis.

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