Meningitis due to Enterobacter aerogenes in the community associated with congenital dermal sinus in a Japanese infant

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ABSTRACT

Congenital dermal sinus is associated with meningitis caused by atypical pathogens. Although nosocomial infections with Enterobacter aerogenes in limited settings have been reported, community-acquired infections associated with congenital dermal sinus are rarely observed. We present the first non-neonatal case of a 3-month-old boy with meningitis due to Enterobacter aerogenes associated with congenital dermal sinus. The patient visited our hospital with fever and a skin dimple with lumbosacral hemangioma. He was diagnosed with meningitis based on cerebrospinal fluid (CSF) examination, which showed a cell count of 5717/µL. Subsequently, antimicrobial therapy with meropenem, cefotaxime (CTX), and vancomycin was initiated. His fever subsided, and the number of CSF cells decreased. Magnetic resonance imaging was performed for the dimple of the lumbosacral region, revealing the congenital dermal sinus. Enterobacter aerogenes was isolated from CSF and stool cultures, and treatment was adjusted to CTX alone based on susceptibility testing. However, the CSF culture remained positive. Although CTX was effective, the response to treatment was partial, and a switch to meropenem was required to achieve negative CSF cultures. In conclusion, Enterobacter aerogenes, although atypical, can cause community-acquired meningitis associated with congenital dermal sinus. Consistent with previous reports, in this case, a hemangioma on the back led to the diagnosis of congenital dermal sinus. Hence, systemic examination, including the back, is important. In addition, use of a third-generation cephalosporin (e.g., CTX) may not negate the CSF culture, even if it is effective. Thus, a switch to another drug (e.g., carbapenem) may be required.

Introduction

Most sacral skin dimples are benign; however, some may be associated with spinal dysraphism (e.g., a congenital dermal sinus), which may lead to bacterial meningitis caused by atypical organisms (e.g., Staphylococcus aureus, Escherichia coli, Proteus species, and anaerobes) [1]. The presence of atypical pathogens, rather than typical pathogens such as Streptococcus pneumoniae or Haemophilus influenzae, suggests the presence of causative complications. Enterobacter spp. cause opportunistic and nosocomial infections in the intensive care unit (ICU) [2]. Moreover, pediatric meningitis due to Enterobacter aerogenes has been reported in neonates in the neonatal ICU (NICU) [3]. However, community-acquired infections due to Enterobacter aerogenes associated with congenital dermal sinus in non-neonates have rarely been reported. We present the case of a 3-month-old boy with meningitis due to Enterobacter aerogenes associated with congenital dermal sinus.

Case report

A 3-month-old boy (height: 61.5 cm; weight: 8.0 kg) without any significant medical history, except for a lumbosacral hemangioma, was admitted to our hospital for fever and deteriorating condition. He has received all vaccinations up to the age of 3 months in Japan. He was admitted with body temperature of 38.7 °C, heart rate of 213 beats/min, respiratory rate of 56 breaths/min, and blood pressure of 104/44 mmHg. There was intermittent eye-rolling, he disliked recumbency, and preferred vertical holding, which were suggestive of meningeal irritation. At the center of the lumbosacral hemangioma, a dimple was observed for the first time at admission. His hematological values included a white blood cell count of 13,180/µL (74 % neutrophils),...
hemoglobin levels of 11.2 g/dL, and platelet count of 77.5 × 10^9/µL. Additionally, serology reports revealed C-reactive protein levels of 0.06 mg/dL, and procalcitonin levels < 0.05 ng/mL; urinalysis was normal. Chest X-ray and head computerized tomography did not show abnormalities. CSF examination yielded the following findings: cell count = 5717/µL; protein = 352 mg/dL; glucose < 10 mg/dL; and chloride = 120 mEq/L (Table 1). Therefore, we suspected bacterial meningitis associated with the congenital dermal sinus.

On day 1, we initiated treatment with intravenous meropenem (MEPM) (120 mg/kg/day), cefotaxime (CTX) (300 mg/kg/day), and vancomycin (45 mg/kg/day). Dexamethasone 0.60 mg/kg/day was administered for 2 days. His fever subsided the next day, and ocular deviation was also improved. Other vital signs were gradually normalized thereafter. There was no evidence of immunodeficiency in the patient’s past history and blood tests for immunoglobulin and complement.

Blood cultures on admission were negative, whereas Enterobacter aerogenes was isolated from CSF and stool cultures. The trend of antimicrobial susceptibility testing of Enterobacter aerogenes isolated from CSF is shown in Table 2 (days 1, 3, and 6). On day 3, the CSF cell count decreased to 259/µL, glucose levels were elevated to 53 mg/dL, and Gram staining of the smear was negative. Accordingly, on day 4, we adjusted the treatment to CTX alone based on antimicrobial susceptibility testing of Enterobacter aerogenes (minimum inhibitory concentration [MIC]: CTX ≤ 1, susceptible [S]; MEPM ≤ 1, S). On day 6, T2-weighted magnetic resonance imaging (MRI) revealed a congenital dermal sinus communicating with the spinal cord (Fig. 1), which was the probable entry portal for bacteria. Enterobacter aerogenes is an enterobacterium, and this organism was isolated from the stool and CSF cultures in the present case. MRI did not show any abnormal findings or malformations including brain abscess. CTX appeared to be effective, leading to improvement in clinical symptoms. Nevertheless, the CSF cell count decreased to 120/µL, glucose levels were 34 mg/dL, and the CSF culture became negative for the first time. The patient was transferred to another hospital for surgical management of the sinus.

**Table 2**

Trend in the antimicrobial susceptibility test for Enterobacter aerogenes isolated from cerebrospinal fluid.

| Antibiotics    | MIC, mg/ml | Susceptibility |
|---------------|------------|---------------|
|               | day1       | day3          | day6          |
| ABPC          | ≧ 32       | R             | ≧ 32          |
| ABPC/SBT      | ≦ 8        | R             | ≦ 8           |
| CEZ           | ≦ 32       | R             | ≦ 32          |
| CTM           | 16         | I             | 8             |
| CTX           | 1          | S             | 1             |
| CAZ           | 4          | S             | 4             |
| CTX           | 1          | S             | 1             |
| CFPM          | ≦ 2        | S             | 2             |
| CMZ           | 64         | R             | 64            |
| AZT           | ≦ 4        | S             | 4             |
| FMOX          | 32         | I             | 8             |
| MEPM          | ≦ 1        | S             | 1             |
| GM            | 2          | S             | 2             |
| LVFX          | ≦ 0.5      | S             | 0.5           |
| ST            | 38         | S             | 38            |

MIC: minimum inhibitory concentration. S: susceptible; I: intermediate; R: resistant.

Blood cultures on admission were negative, whereas Enterobacter aerogenes was isolated from CSF and stool cultures. The trend of antimicrobial susceptibility testing of Enterobacter aerogenes isolated from CSF is shown in Table 2 (days 1, 3, and 6). On day 3, the CSF cell count decreased to 259/µL, glucose levels were elevated to 53 mg/dL, and the CSF culture became negative for the first time. The patient was transferred to another hospital for surgical management of the sinus.

**Table 1**

Laboratory findings in blood, urine, and cerebrospinal fluid (CSF) at admission.

| Blood test | Biochemical test | CSF examination |
|------------|------------------|-----------------|
| WBC        | TP               | 5717/µL        |
| Neutrophils| Alb              | 6.2 g/dL       |
| Lymphocyte | BUN              | g/dL            |
| Monocyte   | Cre              | 4.2 mg/dL      |
| Eosinophils| AST              | Protein         |
| RBC        | ALT              | U/L 30         |
| Hb         | LDH              | U/L 354        |
| Pt         | CK               | U/L 255        |
| Na         | Cl               | U/L 136        |
| K          | Glu              | mEq/L 105      |
| Glu        | CRP              | mEq/L 352      |
| procalcitonin | CRP          | Protein        |

Ab, albumin; ALT, alanine aminotransferase; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CK, creatine kinase; Cl, chloride; Cre, creatinine; CRP, C-reactive protein; Glu, glucose; Hb, hemoglobin; K, potassium; LDH, lactate dehydrogenase; Pt, platelet; RBC, red blood cells; TP, total protein; WBC, white blood cells.
Bacterial meningitis associated with congenital dermal sinus is often caused by atypical bacteria, such as *Staphylococcus aureus*, *Escherichia coli*, *Proteus* species, and anaerobes [1]. A literature review of reports concerning patients with congenital dermal sinus disease who developed abscesses showed similar causative bacteria; however, there were no cases linked to *Enterobacter aerogenes* [8]. Meningitis due to *Enterobacter aerogenes* has been reported only in specific conditions, such as patients undergoing surgical procedures [9–11] and neonates in the NICU [3]. In the present case, we considered that the hematogenous infection was negative, since the blood culture was negative. Therefore, we suspected that the pathogen entered through the congenital dermal sinus. In the presence of skin findings (e.g., lumbosacral hemangioma) in the midback, an OSD (e.g., congenital dermal sinus) should be added to the differential diagnoses. In conclusion, *Enterobacter aerogenes*, an atypical pathogen, can also cause community-acquired infection in meningitis associated with congenital dermal sinus. In addition, in the course of antibiotic therapy for bacterial meningitis caused by *Enterobacter aerogenes*, a third-generation cephalosporin (e.g., CTX) should not be used for severe, life-threatening or high inoculum *Enterobacter* infections and as such, carbapenem (e.g., MEPM) should have been the better choice of antimicrobial in this setting.

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**Ethical approval**

This report was approved by the Ethics Committee of Showa University School of Medicine (No. 21–067-A). Informed consent to publish this article was provided by the patient’s family.

**Consent Statement**

Informed consent was obtained from the patient’s parent for the publication of this report.

**CRediT authorship contribution statement**

Y.S., H.S., and T.W. treated the patient and Y.S. drafted the manuscript. Y.W., H.S., T.W., and H.I. contributed to the writing and critical review of the manuscript. All authors have read and approved the manuscript.

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**Conflict of interest**

None.

**Author statement**

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