Case Report

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An unusual imaging presentation of pediatric bacterial meningoencephalitis: a case-report study

Maryam Kachuei, MD[a], Ramin Zare, MD[a], Shirin Sayyahfar, MD[b], Mitra Khalili, MD[c], Hamidreza Movahedi, MD[d], Mobin Naghshbandi, MD[d], Shayan Eghdami, MD, MPH[e,*]

Background: Bacterial meningoencephalitis is a serious infection affecting the brain and its surrounding membranes. While imaging studies play a crucial role in diagnosing this condition, the typical radiological findings are well-documented. However, this case report describes an unusual imaging presentation that deviates from the expected patterns, emphasizing the need for awareness of such variations.

Case presentation: A 7-year-old female with no prior medical history was referred to our hospital with fever, seizure, and loss of Consciousness. She had mild flu a week before admission. The duration of seizure episodes were 2–3 min, with tonic-clonic uncontrollable jerky movements. Brudzinski and Kernig signs were positive and plantar reflex was upward bilaterally in the physical examination. The computed tomography (CT) scan showed brain ventriculomegaly/hydrocephalus, and MRI findings indicated multiple foci located at cerebellum, basal ganglia, and thalamus alongside intensely restricted diffusion of the layering debris, suggesting pyogenic ventriculitis. Cerebrospinal fluid (CSF) analysis showed severe hypoglycorrhachia, despite non-significant increase of protein. The patient was undergone antibiotic therapy with ceftriaxone, vancomycin and rifampin, resulting in normalization of CSF values.

Conclusion: This case report highlights the importance of recognizing and interpreting unusual imaging presentations of bacterial meningoencephalitis in paediatric patients. It emphasizes the need for a comprehensive diagnostic approach, including clinical evaluation, laboratory tests, and imaging studies, to ensure accurate diagnosis and appropriate management of this potentially life-threatening condition. Further research and awareness of atypical imaging findings are warranted to enhance our understanding and improve patient outcomes.

Keywords: bacterial meningitis, hydrocephalus, paediatric neurosurgery, streptococcal infection

Introduction

Streptococcal meningitis is an acute inflammation of the membranes surrounding the brain and spinal cord caused by bacteria from the streptococcal species[1]. Bacterial meningitis is a severe and life-threatening infection that may lead to death, especially when treatment initiation is overdue[2]. The microorganisms causing this particular form of meningitis have the potential to also cause deeper infections that lead to encephalitis[3]. Encephalitis is typically characterized by mild flu-like symptoms in affected individuals[4]. However, in more severe cases, symptoms may include difficulties with speech or hearing, double vision, hallucinations, changes in personality, and loss of consciousness[5]. In Iran, the occurrence rate of paediatric bacterial meningoencephalitis is documented to reach up to 0.09 per 100 000 individuals. However, it is important to note that the actual number of cases may be significantly higher, as many individuals may experience mild or even no symptoms[6,7].

Bacterial meningitis and encephalitis are medical emergencies and need urgent attention and treatment. Any delay in diagnosis and treatment has been shown to increase morbidity and mortality[8]. Some of the survivors also have neurological sequel

HIGHLIGHTS

- Bacterial meningoencephalitis significantly contributes to mortality and morbidity among children.
- The development of hydrocephalus, a potential complication of bacterial meningoencephalitis, necessitates neurosurgical interventions.
- Prompt initiation of antibiotic treatment is crucial.
- Gaining knowledge about the various radiological presentations of this disease is essential.

[a]Firoozabadi Clinical Research Development Unit (FACRDU), School of Medicine, Iran University of Medical Sciences, [b]Research Center of Pediatric Infectious Diseases, Institute of Immunology and Infectious Diseases, School of Medicine, Iran University of Medical Sciences, [c]Department of Radiology, Shahid Beheshti University of Medical Sciences, [d]Student Research Center, Iran University of Medical Sciences and [e]Cellular and Molecular Research Center, Iran University of Medical Sciences, Tehran, Iran

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*Corresponding author. Address: IUMS: Iran University of Medical Sciences, Tehran, Iran, Islamic Republic of. Tel.: +144 961 4535. E-mail: seghdami33@gmail.com (S. Eghdami).

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with a need for long term physical and occupational rehabilitation[9]. Various methods are employed to diagnose meningoencephalitis, including physical examinations, blood analysis, analysis of cerebrospinal fluid (CSF), and interpretation of radiological findings. These are the primary tests utilized in the diagnostic process for this condition. In this report, we present a case of streptococcal meningoencephalitis that was challenging to diagnose due to the presence of uncommon radiological findings.

Case presentation

A previously healthy 7-year-old female with a history of a common cold a week prior to the admission, was referred to our hospital with fever, vomiting and loss of consciousness. Beforehand, the patient was admitted in a further health care centre with the same complaints. At the mentioned medical facility, the patient was treated with serum therapy and antibiotic therapy (details unspecified). After experiencing some improvement in symptoms, the patient's family decided to discharge the patient with their consent. However, two days later, the patient experienced a relapse and a deterioration of their symptoms. Additionally, the patient experienced two occurrences of seizure episodes within a time span of one day. As a result, the patient was referred to our medical centre.

The seizure episodes lasted around 2–3 min, with tonic-clonic uncontrollable jerky movements. Moreover, On the first examination upon arrival, the patient had high fever (39°C), was ill and in a stupor state, suffering from respiratory distress and subcostal retraction. Moreover, subsequent to performing neurological evaluations, it became apparent that the patient displayed amplified deep tendon reflexes and heightened muscle tones. The patient also exhibited neck rigidity. Moreover, a positive sign of Brudzinskis and Kernigs signs and bilateral upward plantar reflex were observed. A funduscopy and eye examination revealed no abnormal findings or papilledema. The first obtained results from paraclinical exam of the patient presented in Table 1.

The chest radiography of the patient on the first day of visit did not indicate pneumonia or other respiratory disorders e.g. pleural effusion, pneumothorax (Fig. 1).

The brain computed tomography (CT) scan was implemented which showed brain ventriculomegaly/hydrocephaly. Additionally, periventricular low density and thin uniform enhancement of the ependymal lining of the ventricles were observed (Fig. 2).

Based on the patient's symptoms of fever, loss of consciousness, and neck rigidity, empirical antibiotic treatment protocol

Table 1

Laboratory findings of the patient at the first examination

WBC (cells/mm$^{3)}$	16.8 × 1000 Mixed 5.7% Segment 67.2% Lymphocyte 27.2%
RBC (Million cells/mm$^{3)}$	2.94
Hb (gm/dl)	7.6
M.C.V (fl)	82.99
Platelet (cells/mm^{3})	670 × 1000
CRP (mg/l)	66
ESR (mm/h)	64
Blood culture	No growth after 2 days
PCR COVID.19	Not detected

CRP, C reactive protein; ESR, Erythrocytes sedimentation rate; Hb, haemoglobin; M.C.V, Mean corpuscular volume; PCR, polymerase chain reaction; RBC, red blood cell; WBC, white blood cell.

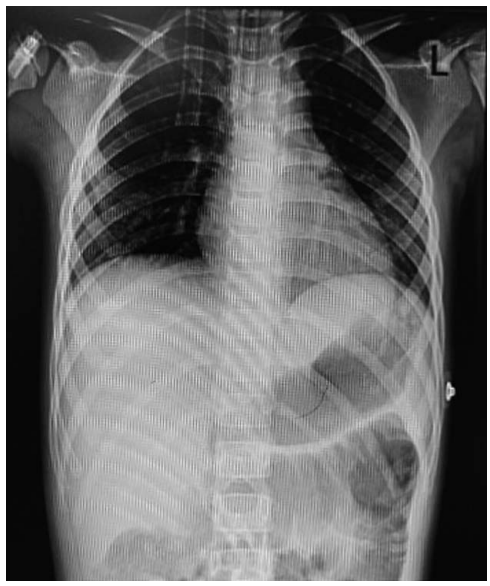

Figure 1. Chest X-ray of the patient upon arrival.

involved the administration of ceftriaxone at a daily dosage of 2.5 g, divided into multiple doses. Additionally, Vancomycin was administered at a daily dosage of 1.5 g, also divided into multiple doses. Rifampin was prescribed at a daily dosage of 500 milligrams, also divided into multiple doses. This treatment regimen was followed for a duration of ~28 days. This decision was made due to the parents' refusal of lumbar puncture and the potential presence of bacterial meningoencephalitis. Additionally, a brain

Magnetic resonance angiography (MRA) and venography (MRV) were conducted, which revealed the presence of significant stenosis in the internal carotid arteries within the cavernosal and Supraclinoid regions on both sides. Additionally, evidence of stenosis in the middle cerebral artery was observed. (Figs. 3 and 4).

Furthermore, MRI was performed. The results of the MRI revealed the presence of multiple foci located at cerebellum, basal ganglia, and thalamus. Furthermore, minimal ependymal

Figure 2. The initial brain computed tomography scan of the patient, which demonstrates the presence of ventriculomegaly.

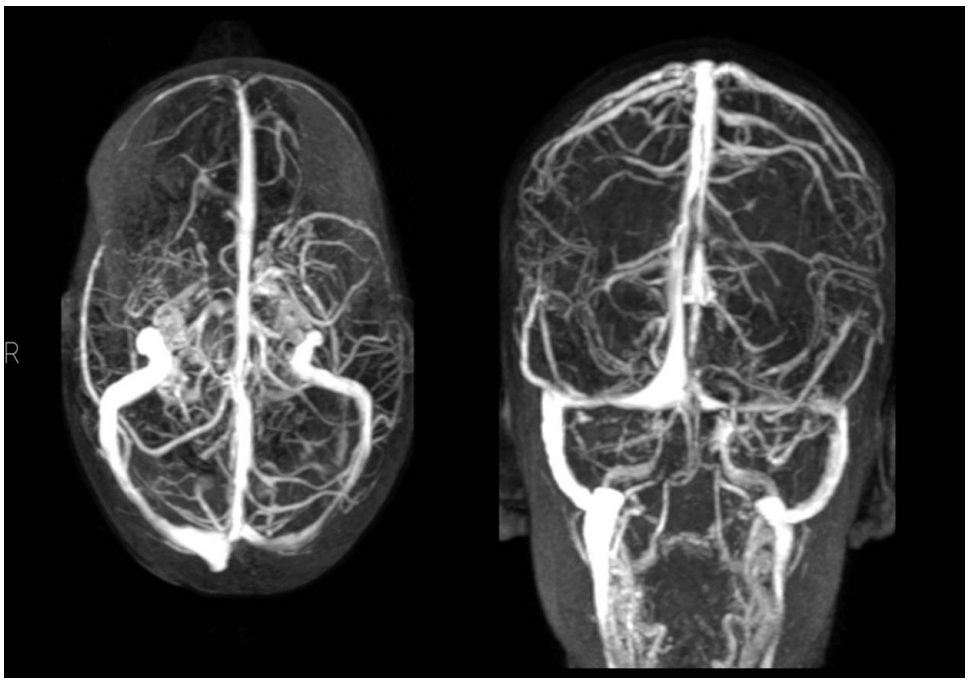

Figure 3. Magnetic resonance venography of the patient.

enhancement and intensely restricted diffusion of the layering debris, suggesting pyogenic ventriculitis were noted (Fig. 5A). Moreover, cerebellar infarcts in the territory of the right superior cerebellar artery and small lacunar infarcts were evident in the basal ganglia of the left side (Fig. 5B).

Based on the presence of hydrocephalus determined through evidence, a therapeutic intervention was implemented for the patient in the form of an external ventricular drain placement and the CSF analysis findings is presented in Table 2.

the presence of low glucose levels in the cerebrospinal fluid strongly indicated a bacterial infection, even though there was no significant increase in protein levels. Further analysis using polymerase chain reaction (PCR) revealed the presence of Gram-positive Streptococci in the cerebrospinal fluid sample. Subsequent daily analysis of the cerebrospinal fluid showed a normalization of values, indicating a positive response to the antibiotic therapy. Therefore, the final diagnosis is confirmed as Streptococcal meningitis.

The patient was hospitalized for a duration of four weeks and subsequently discharged after their laboratory data, CSF analysis returned to normal, and level of consciousness elevated. However, the patient continued to experience ataxia, leading to a referral for physiotherapy and occupational therapy.

Discussion

Infectious meningitis and encephalitis are associated with significant morbidity and mortality worldwide. Acute bacterial meningitis is rapidly fatal and early recognition and institution of therapy is imperative[6,10]. Despite treatment, meningitis and encephalitis remain potentially life-threatening infections in children with mortality rates reaching up to 25%[11]. On the other hand, according to recent research, there has been an increase in cases of bacterial meningitis following the Covid-19 pandemic compared to before. This could be attributed to a potential decrease in focus on other vaccines during that time, as more attention was given to the Covid-19 vaccination program[12].

Most prevalent bacterial agents leading to bacterial meningoencephalitis are Actinomyces sp, Bartonella henselae, Brucella sp, Chlamydia sp, Staphylococcus aureus, and streptococcus sp[13,14]. most children (more than 80%) with meningococcal disease present with some evidence of septicaemia. Other early symptoms include vomiting, diarrhoea, and myalgia. Some children (about 5%) present with features of septic shock but no rash.

In order for meningitis to occur, Streptococcus needs to infiltrate the human brain microvascular endothelial cells, which form a single-cell layer known as the blood-brain barrier. In vitro studies have demonstrated the ability of streptococcus to invade these cells intracellularly and undergo transcytosis within tissue culture monolayers of human brain microvascular endothelial cells[15]. Furthermore, in vitro investigations demonstrated that streptococcal bacteria necessitate the presence of the fibrinogen receptor

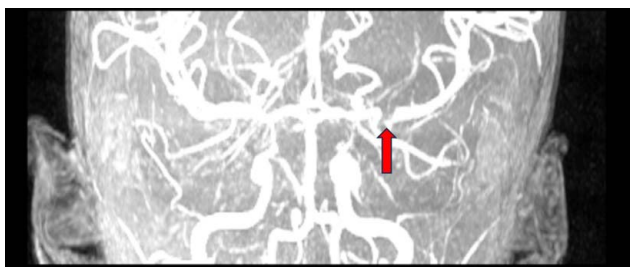

Figure 4. Magnetic resonance angiography of the patient revealing the stenosis of middle cerebral artery.

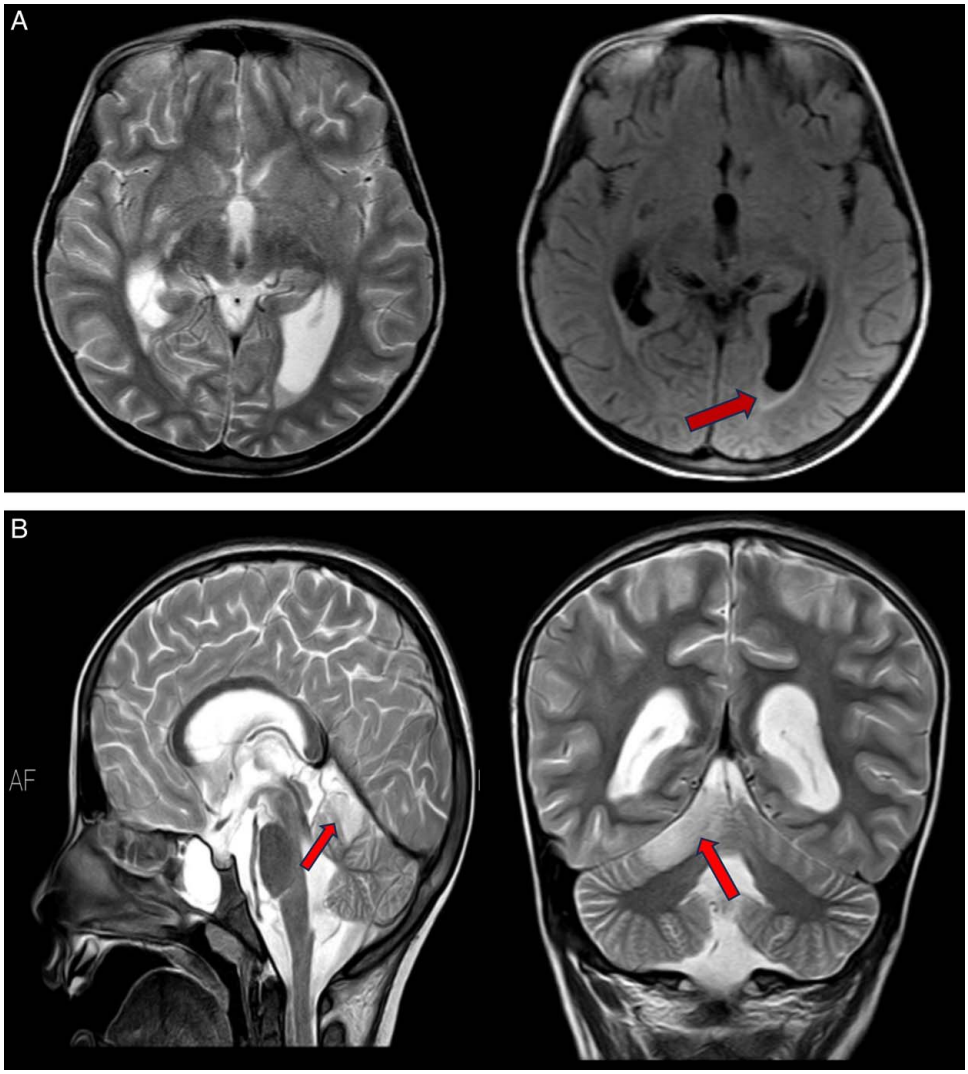

Figure 5. (A) Magnetic resonance imaging of the patient in favour of ventriculitis. (B) Magnetic resonance imaging of the patient revealing infarcs.

FbsA, laminin-binding protein Lmb, or pilus backbone subunit protein PilB to invade human brain microvascular endothelial cells[16]. More recent studies have indicated that the surface-anchored serine-rich repeat motif glycoprotein Srr-1 is diminished in its ability to invade brain endothelial cells and contribute to meningitis production[17]. The body's immune response to streptococcus plays a significant role in the development of meningitis and injury to the central nervous system. The inflammatory response is initiated by the blood-brain barrier endothelium, which activates specific genes involved in recruiting neutrophils, such as chemokines (e.g. IL-8, Groa), endothelial receptors (intercellular adhesion molecule-1), and neutrophil activators (granulocyte-macrophage colony-stimulating factor)[18]. In neonatal rats with streptococcal meningitis, the presence of cortical lesions primarily in the vascular distribution suggests that disruptions in cerebral blood flow contribute to neuronal damage[19].

Children who are affected by meningoencephalitis can experience a rapid onset of illness[20]. During this time, the levels of bacteria in their blood escalate rapidly. It is important to note that while most of these bacteria are no longer alive, they release fragments of their outer membrane known as blebs[21].

CSF lactate is produced by bacterial anaerobic metabolism and is not affected by blood lactate concentration, an advantage over CSF glucose in differentiating bacterial meningitis from aseptic

Table 2

CSF analysis of the patient

Fluid type	CSF
Appearance	Semi clear
Colour	Colourless
WBC (cells/μl)	90 PMN predominant
RBC (cells/μl)	300
Glucose (mg/dl)	13
Protein (mg/dl)	10
LDH (IU/l)	2568

CSF, cerebrospinal fluid; LDH, Lactate dehydrogenase; RBC, red blood cell; WBC, white blood cell.

meningitis[22]. CSF lactate's high negative likelihood ratio may make it useful for ruling out bacterial meningitis though pretreatment with antibiotics reduces clinical accuracy. CSF lactate of 35 mg/dl could be optimal cut-off value for distinguishing bacterial meningitis from aseptic meningitis[23]. CSF cytology, protein and glucose levels are normal in most cases, but mild pleocytosis or elevated protein levels are occasionally seen. Serum and CSF proinflammatory cytokines, such as interleukin-6, may be increased[24].

Despite progress in prevention by vaccination, the global impact of bacterial meningitis is enormous. Before the COVID-19 pandemic, the incidence of viral encephalitis in childhood was increasing also due to the growing incidence of emerging pathogens, such as enterovirus (EV)-A71 and West Nile virus in temperate climates as well as the wider use of immunosuppressive treatment and stem cell transplantation in childhood[23]. Neuroimaging studies may show diffuse or focal swelling of the brain parenchyma[25]. Among the clinical radiographic encephalopathy syndromes associated with meningitis, acute necrotizing encephalopathy is considered the most severe, associated with severe neurologic morbidity and mortality[26].

The interpretation of radiological findings in this particular case posed challenges due to the presence of overlapping features with other potential diagnoses. The onset of the disease following an upper respiratory infection could potentially be misinterpreted as viral meningoencephalitis. Additionally, the presence of internal carotid stenosis and the sudden deterioration of the patient's condition raised the possibility of inherited syndromes like moyamoya disease[27].

Moreover, if a patient residing in an area with a high prevalence of tuberculosis exhibits symptoms of both loss of consciousness and hydrocephalus, it could indicate the potential presence of tubercular meningoencephalitis[28]. Therefore, it becomes crucial to thoroughly comprehend various uncommon radiological findings in order to differentiate and identify possible alternative diagnoses.

The treatment of bacterial meningoencephalitis is mostly supportive, antibiotically and may include intensive care. Understanding the underlying mechanisms of bacterial meningoencephalitis and septic shock has been crucial in advancing treatment options. Septic shock is mediated peripherally and centrally, the second of these through myocardial depression. This improved understanding has led to more rational inotropic prescribing and fluid management for the microcirculation. So better support for the microcirculation may also be beneficial[29]. Regarding our patient's condition, the effectiveness of corticosteroids, IVIG, plasmapheresis and hypothermia needs further study[30].

Conclusion

Paediatric bacterial meningoencephalitis is a medical emergency that requires a high index of clinical suspicion, rapid diagnosis, and early treatment. New vaccination programs have led to changes in the epidemiology of this disease. Advances in clinical and research techniques aid in the diagnosis of bacterial meningitis, and a combination of techniques is useful in confirming or rejecting the diagnosis. One method that can assist in refining our differential diagnosis is utilizing radiological findings. The case discussed in this report demonstrated that certain findings, such as arterial stenosis, hydrocephalus, ventriculitis, and widespread brain infarction, may indicate the presence of streptococcal meningoencephalitis

While antibiotics, steroids, and supportive care remain the mainstays of treatment, more research needs to be done on the role of adjuvant therapy.

Ethical approval

Firoozabadi Clinical Research Development Unit (FACRDU), Iran University of Medical Sciences, Tehran, Iran.

Consent

Written informed consent was obtained from the patient's parents/legal guardian for publication and any accompanying images. A copy of the written consent is available for review by the Editorin-Chief of this journal on request.

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Author contribution

M.Kachuei and R.Z. admitted the patient. S.S., M.Kachuei and R.Z. planned the treatment, M.Khalili reported the radiological findings, S.E., M.N., and H.M. gathered the data and wrote the draft. M.Kachuei and S.E. completed the manuscript. All authors finalized the manuscript and confirmed the final outcome.

Conflicts of interest disclosure

The authors declare no relevant conflicts of interest.

Research registration unique identifying number (UIN)

Not applicable.

Guarantor

Maryam Kachuei.

Data availability statement

Not applicable.

Provenance and peer review

The paper was not invited.

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