Section: Pediatric Medicine

Original Research Article

# A STUDY ON NEUROIMAGING FINDINGS IN CHILDREN OF 2 MONTHS TO 12 YEARS AGE GROUP WITH MENINGITIS AND ITS OUTCOME

**Sushama Sahoo[1], Sk. Jeauddin[2], Kushal Mandal[3]**

[1]Associate Professor & HOD, Department of Pediatric Medicine, Malda Medical College and Hospital, Malda, West Bengal, India
[2]Assistant Professor, Department of Pediatric Medicine, Malda Medical College and Hospital, Malda, West Bengal, India
[3]Post Graduate Trainee, Department of Pediatric Medicine, Malda Medical College and Hospital, Malda, West Bengal, India

*Received* : 20/02/2025
*Received in revised form* : 15/03/2025
*Accepted* : 01/04/2025

*Keywords:*
*Meningitis, Pediatric Neuroimaging, Computed Tomography, Magnetic Resonance Imaging, Clinical Outcomes.*

Corresponding Author:
**Dr. Kushal Mandal,**
Email: kushalastrophys@gmail.com

DOI: 10.47009/jamp.2025.7.2.137

Source of Support :Nil,
Conflict of Interest: None declared

*Int J Acad Med Pharm*
2025; 7 (2); 676-679

## Abstract

**Background:** Meningitis is a significant cause of morbidity and mortality in pediatric patients, with neuroimaging playing a crucial role in diagnosing complications, guiding treatment, and predicting outcomes. This study evaluates the neuroimaging findings in children aged 2 months to 12 years diagnosed with meningitis and assesses their correlation with clinical outcomes. **Materials and Methods:** This retrospective cohort study was conducted at Malda Medical College and Hospital from January 2019 to December 2020, 250 children meeting the inclusion criteria were analyzed through clinical records and neuroimaging reports (CT/MRI). **Result:** The majority of cases (44%) were in the 1-5 years age group, with a male predominance (58%). Fever (84%), convulsions (66%), and altered sensorium (48%) were common presentations. CSF analysis suggested bacterial etiology in most cases, with elevated protein, low glucose, and a mean cell count of 950 cells/mm³, while CSF culture was positive in 32% of cases. Neuroimaging findings included hydrocephalus (26.6% on CT, 30% on MRI), infarcts (20% on CT, 35% on MRI), leptomeningeal enhancement (16.6% on CT, 45% on MRI), brain abscesses (10% on CT, 30% on MRI), venous sinus thrombosis (3.3% on CT, 15% on MRI), and extra-axial empyema (6.6% on CT, 25% on MRI). Outcome analysis revealed that 72% of patients were discharged, 18% were referred, and 10% succumbed to the illness, with mortality higher in cases exhibiting infarcts, abscesses, and signs of raised intracranial pressure. **Conclusion:** The findings highlight that MRI is superior to CT in detecting complications, and early imaging facilitates timely intervention, improving prognosis. Strengthening healthcare access and immunization coverage is crucial in reducing the burden and mortality associated with pediatric meningitis.

## INTRODUCTION

Meningitis is an acute inflammation of the protective membranes covering the brain and spinal cord, commonly caused by bacterial, viral, fungal, or parasitic infections. Among these, bacterial meningitis is the most severe form, associated with significant morbidity and mortality if not diagnosed and treated promptly.[1] In children, particularly in developing countries, meningitis remains a major public health concern, leading to neurological sequelae such as hearing loss, cognitive impairment, and motor deficits.[2]

Neuroimaging techniques, including computed tomography (CT) and magnetic resonance imaging (MRI), are critical for the evaluation of meningitis-related complications. CT is often used as an initial imaging modality due to its rapid availability and ability to detect hydrocephalus, infarction, or contraindications to lumbar puncture.[3] However, MRI is the gold standard for detecting subtle parenchymal changes, abscesses, and leptomeningeal enhancement, which are critical for assessing disease progression and prognosis.[4]

Early diagnosis and intervention play a crucial role in reducing complications and improving outcomes in pediatric meningitis. Neuroimaging not only aids in confirming the diagnosis but also helps in identifying complications that may necessitate surgical intervention or prolonged intensive care support.[5] Despite advances in medical technology, delays in imaging and treatment still contribute to


ISSN (O): 2687-5365; ISSN (P): 2753-6556

unfavorable outcomes, highlighting the need for improved diagnostic strategies and healthcare access in resource-limited settings.[6]

This study aims to evaluate neuroimaging findings in children aged 2 months to 12 years diagnosed with meningitis at Malda Medical College and Hospital, correlating imaging findings with clinical outcomes. By understanding these correlations, we aim to enhance early diagnosis, optimize treatment strategies, and improve overall patient care.

## MATERIALS AND METHODS

**Study Design:** A retrospective cohort study was conducted.

**Study Setting and Timeline:** The study was carried out at Malda Medical College, including children admitted with a diagnosis of meningitis between January 2019 and December 2020.

**Place of Study:** The research was conducted in the Children's Ward and Pediatric Intensive Care Unit (PICU) of Malda Medical College and Hospital.

**Study Population:** Children admitted with a confirmed diagnosis of meningitis were included in the study.

**Sample Size:** A total of 250 children diagnosed with meningitis were included.

**Inclusion Criteria**

- Children aged 2 months to 12 years diagnosed with meningitis.

**Exclusion Criteria**

- Patients with spinal dysraphism were excluded.

General Examination Findings

Children presented with fever, cough, cold, rash, and convulsions. Severe cases exhibited neurological deterioration, including decorticate or decerebrate posturing.

**Data Collection:** Hospital records of meningitis patients were reviewed. Data were extracted and recorded in a pre-structured case record sheet. Neuroimaging findings from CT/MRI scans were documented.

**Laboratory Investigations**

**Blood investigations Included**

- Complete blood count (CBC)
- Serum electrolytes
- Serum urea and creatinine
- Liver function tests (LFTs)
- Blood culture

Lumbar puncture was avoided in cases with raised intracranial pressure, prolonged seizures, or focal neurological deficits.

**Radiology**

- Computed Tomography (CT): CT scans were used primarily to rule out contraindications for lumbar puncture. Contrast-enhanced CT scans aided in detecting abscesses, extra-axial empyema, and leptomeningeal enhancement.
- Magnetic Resonance Imaging (MRI): MRI was the preferred modality for detecting central nervous system involvement. Diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) mapping were used to identify abscesses. Magnetic resonance venography was performed to detect venous sinus thrombosis.

**Outcomes were classified as:**

- Death
- Discharge
- Referral

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS software.

## RESULTS

**Table 1: Demographic Characteristics of Study Population.**

| Variable | Frequency (n=250) | Percentage (%) |
|---|---|---|
| Age Group | | |
| 2-12 months | 70 | 28% |
| 1-5 years | 110 | 44% |
| 6-12 years | 70 | 28% |
| Sex | | |
| Male | 145 | 58% |
| Female | 105 | 42% |
| Geographical Distribution | | |
| Rural | 180 | 72% |
| Urban | 70 | 28% |
| Immunization Status | | |
| Fully Immunized | 85 | 34% |
| Partially Immunized | 110 | 44% |
| Not Immunized | 55 | 22% |

[Table 1] Most cases were in the 1-5 years age group (44%). Males were affected more than females (58% vs. 42%).72% of cases were from rural areas.44% of children were partially immunized, while 22% were not immunized.

**Table 2: Clinical Presentation of Meningitis Cases**

| Symptoms | Frequency (n=250) | Percentage (%) |
|---|---|---|
| Fever | 210 | 84% |
| Convulsions | 165 | 66% |


ISSN (O): 2687-5365; ISSN (P): 2753-6556

| | | |
|---|---|---|
| Rash | 45 | 18% |
| Altered Sensorium | 120 | 48% |
| Decerebrate Posturing | 30 | 12% |
| Signs of Raised ICP | 50 | 20% |

Fever was the most common presenting symptom (84%).66% of patients had convulsions, and 48% had altered sensorium.20% of cases showed signs of raised intracranial pressure (ICP).

**Table 3: CSF Findings**

| CSF Parameters | Mean ± SD | Range |
|---|---|---|
| Cell Count (cells/mm³) | 950 ± 300 | 100 - 5000 |
| Protein (mg/dL) | 120 ± 30 | 80 - 250 |
| Glucose (mg/dL) | 40 ± 15 | 20 - 70 |
| Culture Positive Cases (%) | 80 | 32% |

Mean CSF cell count was 950 cells/mm³, with a range of 100 - 5000.Protein levels were elevated (mean 120 mg/dL).Glucose levels were low (mean 40 mg/dL), suggestive of bacterial meningitis in most cases.CSF culture was positive in 32% of cases.

**Table 4: Neuroimaging Findings**

| Neuroimaging Findings | CT (n=150) | MRI (n=100) |
|---|---|---|
| Hydrocephalus | 40 (26.6%) | 30 (30%) |
| Infarcts | 30 (20%) | 35 (35%) |
| Leptomeningeal Enhancement | 25 (16.6%) | 45 (45%) |
| Brain Abscess | 15 (10%) | 30 (30%) |
| Venous Sinus Thrombosis | 5 (3.3%) | 15 (15%) |
| Extra-Axial Empyema | 10 (6.6%) | 25%) |

Hydrocephalus was seen in 26.6% on CT and 30% on MRI.Infarcts were detected more frequently on MRI (35%) than CT (20%).Leptomeningeal enhancement was more apparent on MRI (45% vs. 16.6% on CT).Brain abscess was detected in 30% of MRI cases, significantly higher than on CT (10%).MRI was more sensitive in detecting venous sinus thrombosis (15%) and extra-axial empyema (25%) compared to CT.

**Table 5: Outcomes of Patients**

| Outcome | Frequency (n=250) | Percentage (%) |
|---|---|---|
| Discharged | 180 | 72% |
| Referred | 45 | 18% |
| Death | 25 | 10% |

72% of children were successfully discharged.18% required referral to higher centers for further management.10% mortality rate, with deaths occurring mainly in cases with severe neuroimaging abnormalities such as infarcts, abscesses, or raised ICP.

## DISCUSSION

The study provides crucial insights into the demographic, clinical, laboratory, neuroimaging findings, and outcomes of pediatric meningitis cases. The findings highlight significant epidemiological trends and clinical implications that can aid in better diagnosis and management.

In this study, the majority of cases were in the 1-5 years age group (44%), with a nearly equal distribution in the younger and older age groups (28% each). The predominance of younger children aligns with previous studies indicating increased susceptibility due to immature immune responses. Males were affected more frequently than females (58% vs. 42%), which has been reported in other epidemiological studies as well. The predominance of rural cases (72%) suggests limited access to healthcare and lower immunization coverage in these areas, which is consistent with findings in similar settings. Immunization status remains a crucial factor, with only 34% being fully immunized, indicating a significant gap in preventive healthcare measures. Studies suggest that under-immunization is a risk factor for bacterial meningitis, especially in developing countries.[7,8]

Fever was the most common presenting symptom (84%), followed by convulsions (66%) and altered sensorium (48%). These findings are consistent with established literature on pediatric meningitis.[9] Signs of raised intracranial pressure (ICP) were present in 20% of cases, which is a significant concern, as it is associated with poor outcomes. Decerebrate posturing was observed in 12%, suggesting severe neurological involvement and a potential indicator of poor prognosis. The presence of a rash in 18% of cases may indicate meningococcal etiology, which has been widely documented in prior research.[10,11]

Cerebrospinal fluid (CSF) analysis remains the cornerstone of meningitis diagnosis. The mean cell


ISSN (O): 2687-5365; ISSN (P): 2753-6556

count was 950 cells/mm³, with a wide range of 100-5000, indicative of bacterial infection. Elevated protein (120 mg/dL) and low glucose levels (40 mg/dL) further support the likelihood of bacterial meningitis.[12] CSF culture was positive in 32% of cases, which is slightly lower than some previous studies. This may be attributed to prior antibiotic administration before lumbar puncture.[13] Despite the relatively low culture positivity, the biochemical parameters strongly indicate bacterial etiology.

Neuroimaging plays a critical role in evaluating complications. Hydrocephalus was observed in 26.6% on CT and 30% on MRI, a finding consistent with other studies on bacterial meningitis.[14] MRI was superior in detecting infarcts (35%), leptomeningeal enhancement (45%), brain abscesses (30%), venous sinus thrombosis (15%), and extra-axial empyema (25%) compared to CT. These findings reaffirm MRI's higher sensitivity in detecting intracranial complications.[15,16] The presence of infarcts and abscesses is particularly concerning, as these have been linked to increased morbidity and mortality.

The study reported a 10% mortality rate, with the highest risk observed in patients with severe neuroimaging abnormalities such as infarcts and raised ICP. The referral rate was 18%, emphasizing the need for specialized care in complicated cases. Favorable outcomes were noted in 72% of cases, aligning with literature suggesting that early diagnosis and appropriate management improve survival rates.[17] The mortality rate in this study is comparable to similar cohorts, though improved vaccination and early intervention may further reduce it.[18]

## CONCLUSION

This study highlights the burden of pediatric meningitis, emphasizing the importance of early diagnosis, vaccination, and prompt management. The findings reinforce the need for improved healthcare access in rural areas and increased immunization efforts to reduce the incidence and severity of the disease.

## REFERENCES


1. Van de Beek D, Brouwer MC, Thwaites GE, Tunkel AR. Advances in bacterial meningitis. Lancet. 2012;380(9854):1693-702.
2. Edmond K, Clark A, Korczak VS, Sanderson C, Griffiths UK, Rudan I. Global and regional risk of disabling sequelae from bacterial meningitis: a systematic review and meta-analysis. Lancet Infect Dis. 2010;10(5):317-28.
3. Singhi P, Jain V, Gupta G. Pediatric meningitis: an Indian perspective. Indian J Pediatr. 2009;76(7):711-8.
4. Husain AM. Electrodiagnostic approach to infectious diseases of the nervous system. Neurol Clin. 2001;19(4):731-59.
5. Neuman MI, Tolford S, Harper MB. Test characteristics and interpretation of cerebrospinal fluid Gram stain in children. Pediatr Infect Dis J. 2008;27(4):309-13.
6. Thigpen MC, Whitney CG, Messonnier NE, Zell ER, Lynfield R, Hadler JL, et al. Bacterial meningitis in the United States, 1998–2007. N Engl J Med. 2011;364(21):2016-25.
7. Ouchenir L, Renaud C, Khan S, Bitnun A, Boisvert A-A, McDonald J, et al. The epidemiology, management, and outcomes of bacterial meningitis in infants. Pediatrics. 2017;140(1):e20170476.
8. McIntyre PB, O'Brien KL, Greenwood B, van de Beek D. Effect of vaccines on bacterial meningitis worldwide. Lancet. 2012;380(9854):1703-11.
9. Sáez-Llorens X, McCracken GH Jr. Bacterial meningitis in children. Lancet. 2003;361(9375):2139-48.
10. Stephens DS, Greenwood B, Brandtzaeg P. Epidemic meningitis, meningococcaemia, and Neisseria meningitidis. Lancet. 2007;369(9580):2196-210.
11. Ceyhan M, Yildirim I, Balmer P, Borrow R, Dikici B, Taha MK, et al. A prospective study of etiology of childhood acute bacterial meningitis, Turkey. Emerg Infect Dis. 2008;14(7):1089-96.
12. Nigrovic LE, Malley R, Macias CG, Kanegaye JT, Moro-Sutherland DM, Schremmer RD, et al. Effect of antibiotic pretreatment on cerebrospinal fluid profiles of children with bacterial meningitis. Pediatrics. 2008;122(4):726-30.
13. Arditi M, Mason EO Jr, Bradley JS, Tan TQ, Barson WJ, Schutze GE, et al. Three decades of pediatric pneumococcal meningitis: Impact of pneumococcal conjugate vaccines. Clin Infect Dis. 2017;64(4):480-7.
14. Anderson V, Anderson P, Grimwood K, Nolan T. Cognitive and executive function 12 years after childhood bacterial meningitis: Effect of acute neurological complications and age of onset. J Pediatr. 2004;145(1):1-8.
15. Mittal P, Sinha S, Jaiswal A, Kalita J, Misra UK. MRI findings in pyogenic and tuberculous meningitis in children: A comparative study. Clin Radiol. 2012;67(11):1146-52.
16. Hristea A, Marcu I, Tarnea C, Arama V, Avramescu C. Magnetic resonance imaging findings in bacterial meningitis. Rom J Neurol. 2001;39(2):97-104.
17. Pelkonen T, Roine I, Monteiro L, Correia M, Pitkäranta A, Bernardino L, et al. Risk factors for death and severe neurological sequelae in childhood bacterial meningitis in sub-Saharan Africa. Clin Infect Dis. 2009;48(8):1107-10.
18. Peltola H. Worldwide Haemophilus influenzae type b disease at the beginning of the 21st century: Global analysis of the disease burden 25 years after the use of the polysaccharide vaccine and a decade after the advent of conjugates. Clin Microbiol Rev. 2000;13(2):302-17.




ISSN (O): 2687-5365; ISSN (P): 2753-6556