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Original Research Article

# Cerebrospinal Fluid Lactate as a Biochemical Marker for the Diagnosis of Meningitis in Pediatric Patients

**Jyoti Kumari[1], Dev Kant[2], Anant Prasad[3]**

[1]Assistant Professor, Department of Biochemistry, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India.
[2]Associate Professor, Department of Ophthalmology, AIIMS, Patna, Bihar, India.
[3]Associate Professor & Head, Department of Biochemistry, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India.

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**Corresponding author: Dr. Dev Kant**
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**Abstract**

**Objectives:** This present study was to compare the cerebrospinal fluid lactate as a biochemical marker to distinguish for the diagnosis of bacterial and viral Meningitis in Pediatric Patients.

**Methods:** All the investigation were done in all patients include complete blood count, serum electrolytes, blood culture, random blood sugar, chest x-ray and Mantoux test. CSF sample was analysed for cell count, glucose, protein, Gram statin, culture and sensitivity and lactate. CSF lactate estimation was done using dry chemistry method. Neuroimaging studies like CT scan and MRI scan were done in indicated cases. Patients were examined daily to assess clinical progress. At the time of discharge, children were subjected to thorough physical examination to assess the presence of any neurologic deficit.

**Results:** Out of 55 cases, majorities of cases 31(56.36%) were males. Majorities of cases were males in both bacterial 13(65%) and viral meningitis 18(51.43%). The mean ± S.D. of CSF lactate level of bacterial and viral meningitis were 8.01 ± 2.12 and 2.45 ± 0.47 mmol/L respectively. P- value was found to be <0.0001, which is statistically extremely significant. Out of 20 cases of meningitis, 11(55%) patients were without complication and 9(45%) patients were with complications.

**Conclusions:** CSF lactate was significantly higher in bacterial meningitis as compare to viral meningitis. High CSF lactate level in meningitis patients were associated with increased incidence of acute complications. Hence, CSF lactate level is one of the best diagnostic biochemical markers of bacterial meningitis and it should be used in hospital setting as a routine assay to distinguish bacterial meningitis from viral meningitis.

**Keywords:** CSF Lactate, Bacterial Meningitis, Viral Meningitis.



## Introduction

Meningitis is considered one of the serious and grave clinical conditions associated with morbidity and mortality in any age group. Differentiating the type of meningitis, bacterial, viral and tubercular is essential and a key point in management [1]. Rapid differentiation between bacterial and aseptic meningitis allows early initiation of appropriate therapy for children at risk for having bacterial

meningitis without overtreating low-risk children. Although available conjugate vaccinations against Streptococcus pneumoniae and Neisseria meningitidis have decreased the bacterial meningitis incidence, incomplete vaccine uptake as well as infections caused by bacterial serogroups not included in the vaccine makes bacterial meningitis a clinical concern in children, especially in resource-poor settings [2].

Culture remains the gold standard for diagnosis, the results are only available after several days [3]. Rapid diagnosis is carried out through assessment of conventional markers in cerebrospinal fluid (CSF): leukocyte counts, sugar, protein, and Gram-staining [4]. However, meningitis sometimes presents with atypical CSF manifestations and cultures may not always be positive or available for early diagnosis [5]. In recent years, it has been proposed that CSF lactate may be a good marker that can differentiate bacterial meningitis from partially treated meningitis and aseptic meningitis [6].

CSF lactate levels are high in children with bacterial meningitis as lactate is produced by both bacterial anaerobic metabolism as well as ischemic brain tissue [7]. Objectives of our study was to compare the cerebrospinal fluid lactate as a biochemical marker to distinguish for the diagnosis of bacterial and viral Meningitis in Pediatric Patients.

## Material & Methods

This present study was conducted in the Department of Biochemistry, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India during a period from March 2022 to December 2022. Attendants of entire subjects signed an informed consent approved by institutional ethical committee SKMCH, Muzaffarpur was sought.

## Methods:

A total of 55 Clinically suspected cases of meningitis with age 2 months to 12 years were included in this study.

A complete assessment like detailed history, general and neurological examination and CSF study were performed to all cases.

Criteria for bacterial and viral meningitis were confirmed by the CSF analysis.

**CSF Analysis criteria for bacterial meningitis: (**1). Neutrophilic pleocytosis (100-10,000 cells/mm3 ). (2). Raised protein (100-500 mg/dL). (3). Low glucose (40 mg/dL). (4). CSF culture and Gram stain negative.

**CSF Analysis criteria for viral meningitis:** (1). Pleocytosis with lymphocyte predominance (10-500 cells/mm3). (2). Normal protein. (3). Normal glucose (>40 mg/dL). (4). CSF culture and Gram stain negative.

**Exclusion Criteria:** (1). Age 12 years. (2). Cases of tuberculous meningitis. (3). Partially-treated meningitis. (4). Children having inborn errors of metabolism. (5). Children having neurodevelopmental delay. (6). Children with seizure disorder.

**Procedures**: The investigations done in all patients include complete blood count, serum electrolytes, blood culture, random blood sugar, chest x-ray and Mantoux test. CSF sample was analysed for cell count, glucose, protein, Gram statin, culture and sensitivity and lactate. CSF lactate estimation was done using dry chemistry method. Neuroimaging studies like CT scan and MRI scan were done in indicated cases. Patients were examined daily to assess clinical progress. At the time of discharge, children were subjected to thorough physical examination to assess the presence of any neurologic deficit.

## Statistical Analysis

Data was analysed with the help of latest version of SPSS software. Mean ± Standard deviation were observed. P-value

was taken less than or equal to 0.05 for significant differences ($p \leq 0.05$).

**Observations**

A total of 55 cases were included in this study, among them 20 cases were bacterial meningitis and 35 cases were viral meningitis. In bacterial meningitis, majorities of cases 10(50%) were in age group of 2 months to 1 year. In viral meningitis, majorities of cases 19(54.29%) were in age group of >5 years to 12 years.

**Table 1: Age wise distributions of bacterial meningitis**

| Age | No. of patients | Percentages |
|---|---|---|
| 2 months - 1 year | 10 | 50% |
| 1 year – 5 years | 6 | 30% |
| 5 years – 12 years | 4 | 20% |
| Total | 20 | 100% |

**Table 2: Age wise distributions viral meningitis**

| Age | No. of patients | Percentages |
|---|---|---|
| 1-5 years | 16 | 45.71% |
| >5 years to 12 years | 19 | 54.29% |
| Total | 35 | 100% |

**Table 3: Gender wise distributions**

| Gender | Bacterial Meningitis | Viral Meningitis | Total |
|---|---|---|---|
| Male | 13(65%) | 18(51.43%) | 31(56.36%) |
| Female | 7(35%) | 17(48.57%) | 24(43.63%) |
| Total | 20(100%) | 35(100%) | 55(100%) |

Out of 55 cases, majorities of cases 31(56.36%) were males. Majorities of cases were males in both bacterial 13(65%) and viral meningitis 18(51.43%).

**Table 4: Mean comparison of CSF lactate level (mmol/L) in bacterial meningitis and viral meningitis**

| | Bacterial(20) | Viral (N=35) | t-Value | P- value |
|---|---|---|---|---|
| **Meningitis** | **Mean ± S. D.** | **Mean ± S. D.** | | |
| | 8.01 ± 2.12 | 2.45 ± 0.47 | -14.982 | < 0.0001 |

When we compared the mean ± S.D. of CSF lactate level of bacterial and viral meningitis. P-value was found to be <0.0001, which is statistically extremely significant.

**Table 5: CSF lactate level (mmol/L) in patients without complications and patients with complications.**

| Patients (N=11) without complications (Mean ± S. D. of lactate level) | Patients (9) with complications (Mean ± S. D. of lactate level) | t-value | p-value |
|---|---|---|---|
| 7.13 ± 1.5 | 10.14 ± 1.87 | 5.443 | <0.0001 |

Out of 20 cases of meningitis, 11(55%) patients were without complication and 9(45%) patients were with complications. When we compared the mean ± S. D. of lactate level of patients without complication and with complications. P value was found to be <0.0001. which is statistically extremely significant. Complications observed were hydrocephalus, focal neurologic deficit, seizure, subdural effusion and 1 patient was expired.

## Discussions

Cases of acute bacterial meningitis (BM) require prompt diagnosis and treatment due to significant mortality rates. A delay in starting appropriate therapy may worsen the prognosis. While BM causes significant morbidity and mortality despite advances in antibiotic therapy, aseptic meningitis is essentially a benign condition requiring only supportive care [8]. Therefore, rapid differentiation between BM and aseptic meningitis is important to allow early initiation of appropriate therapy. Despite the availability of vaccines against prevalent organisms, BM continues to be a health problem with long-term sequelae in children and adults, especially in low-income countries [9,10].

In recent years, it has been proposed that CSF lactate may be a good marker that can differentiate bacterial meningitis (> 6 mmol/l), from partially treated meningitis (4 to 6 mmol/l) and aseptic meningitis (< 2 mmol/l) [11]. However, other researchers have suggested that CSF lactate offers no additional clinically useful information over conventional CSF markers [12,13]. Other markers, such as C-reactive protein (CRP) [14] and procalcitonin [15], may allow differentiation of patients with bacterial meningitis from those with aseptic meningitis. However, neither of these markers is routinely used in clinical practice [16]. The reported diagnostic accuracy of CSF lactate for the differential diagnosis of BM from AM has varied across studies [12,13]. To adequately evaluate its accuracy, a comparative study was performed that had investigated the CSF lactate concentration as a differential marker in both BM and AM patients.

In this study, 55 cases of meningitis were included. 20 cases of bacterial meningitis and 35 cases of viral meningitis were enrolled. All the children with bacterial meningitis had highly elevated CSF lactate level. In this study, we noticed a significant difference in the CSF lactate level between bacterial and viral meningitis. Mean lactate level in bacterial meningitis was 8.01 ± 2.12 mmol/L, while that of viral meningitis was 2.45 ± 0.47 mmol/L. and p value was <0.0001, which is extremely significant. Similar results were observed in other studies. In the study by Cameron P D et al, the mean CSF lactate in bacterial meningitis was 6.5 mmol/L (range 4.5-10.2) and that of viral meningitis was 2.6 mmol/L (range 1.1 to 4) [17]. 11 In the study by M. Keyhani, he observed that all the patients with bacterial meningitis had a mean CSF lactate level over 12.90 mmol/L and patients with nonbacterial meningitis had a mean CSF lactate level over 1.89 mmol/L [18].

In this study, CSF protein in the bacterial meningitis was in the range of 48-352 mg/dL. There is positive correlation between total protein level and CSF lactate, which is statistically significant, $p<0.05$. CSF glucose level was decreased in this study and was in the range 9- 60 mg/dL. CSF lactate level had negative correlation with CSF glucose level, which is statistically significant, $P <0.02$. Similar results was also observed in study by Cabeca HL et al. In that study, CSF lactate level had a negative correlation with glycorrhachia and positive correlation with CSF protein [19]. leucocyte count in the bacterial meningitis was in the range 141 to 7200 cells/mm3 . No significant correlation was identified between CSF lactate level and CSF leucocytes in bacterial meningitis.

In this present study, among the 20 cases of bacterial meningitis, 9(45%) cases developed complications. It was observed that in patients who developed complications, the mean value of CSF lactate was 10.14 ± 1.87 mmol/L and in those without complication the mean value was 7.13 ± 1.5 mmol/L. p-value was less than 0.0001, which is statistically significant difference. It was also seen that patient who died had higher CSF lactate level when compared to others with or without complications with a mean value

>10 mmol/L. Similar observation was reported by Abro AH et al, [20] Chang Y C et al reported that high CSF lactate level was associated with significant risks of early fatality [21,22].

## Conclusions

This present study concluded that the CSF lactate was significantly higher in bacterial meningitis as compare to viral meningitis. High CSF lactate level in meningitis patients were associated with increased incidence of acute complications. Hence, CSF lactate level is one of the best diagnostic biochemical markers of bacterial meningitis and it should be used in hospital setting as a routine assay to distinguish bacterial meningitis from viral meningitis.

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