

CEREBROSPINAL FLUID LACTATE IN MENINGITIS IN CHILDRENBindu Krishnan Padma¹, Deepa Kunju Krishnan²¹Assistant Professor, Department of Paediatrics, Government Medical College, Kottayam, Kerala.²Associate Professor, Department of Paediatrics, Government Medical College, Kottayam, Kerala.**ABSTRACT****BACKGROUND**

Meningitis is an inflammation of meninges and subarachnoid space and is often associated with cerebritis. Acute bacterial meningitis is one of the most common serious infections in children. Viral meningitis has a much more favourable prognosis. Cerebrospinal fluid analysis has got an important role in the diagnosis of neurological disorders. CSF lactate can be elevated in disorders like subarachnoid haemorrhage, bacterial meningitis, status epilepticus and inborn errors of metabolism.

The aim of the present study is to evaluate the level of CSF lactate in bacterial and viral meningitis, its role in the assessment of early prognosis of bacterial meningitis and its relationship with CSF parameters like cellularity, glucose and protein in bacterial meningitis.

MATERIALS AND METHODS

This is a descriptive study conducted in a tertiary care hospital. In this study, 65 cases of meningitis admitted in the hospital under the Department of Paediatrics were included. Cases were grouped as bacterial meningitis and viral meningitis after clinical assessment and CSF analysis. CSF lactate estimation was done by the dry chemistry method. Using statistical methods, CSF lactate level was compared between viral and bacterial meningitis group and CSF lactate level was analysed for its association with the development of acute complications and its relationship with other routinely measured CSF parameters were analysed.

RESULTS

The level of CSF lactate in bacterial meningitis was higher than that in viral meningitis with statistical significance of $p < 0.01$. The mean CSF lactate value in bacterial and viral meningitis was 7.62 ± 2.07 mmol/L and 2.08 ± 0.35 mmol/L, respectively. The mean value of CSF lactate in patients who developed complication was 9.49 ± 1.65 mmol/L, whereas it was significantly lower in those without complication 6.38 ± 1.2 mmol/L, $p < 0.01$. The level of CSF lactate presented negative correlation with CSF glucose and positive correlation with CSF protein in bacterial meningitis, whereas no significant relation was found between CSF lactate and CSF cellularity.

CONCLUSION

Lactate level in CSF is significantly elevated in bacterial than that in viral meningitis. High CSF lactate level was associated with the development of acute complications and it showed a positive correlation with CSF protein and negative correlation with CSF glucose in bacterial meningitis.

KEYWORDS

CSF Lactate, Meningitis.

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BACKGROUND

Meningitis is an inflammation of meninges and subarachnoid space and is often associated with cerebritis. Bacteria, virus, fungus, protozoa and certain chemicals can cause it. Bacterial meningitis is one of the most potentially serious infections occurring in infants and older children.¹ It is associated with high rate of acute complications and risk of long-term morbidity. Early diagnosis and appropriate

antibiotic treatment and prompt care of life-threatening complications may reduce mortality and morbidity. Viral meningitis is usually a benign disease.² Definitive diagnosis of meningitis is made by CSF analysis.³

CSF parameters routinely analysed are total cell count, differential count, glucose, protein, Gram stain, culture and sensitivity. Other biomarkers analysed in CSF are CSF C-reactive protein, lactate dehydrogenase and cytokines like Tumour Necrosis Factor- α (TNF- α) and Interleukin-1 β (IL-1 β), procalcitonin and lactate. Lactate in CSF normally parallels blood levels, but with biochemical alteration of CNS, CSF lactate value changes independent of blood values. A number of factors may contribute to the elevated concentration of CSF lactate.⁴ The increase maybe due to any of the following- the presence of leucocytes, organisms or increased production by cerebral tissue secondary to hypoxia.

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Corresponding Author:

Dr. Bindu Krishnan Padma,

*Assistant Professor, Department of Paediatrics,
Government Medical College, Kottayam, Kerala.*

E-mail: drbindukp@yahoo.com

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Bacterial Meningitis

Clinical presentation of acute bacterial meningitis is variable and differs according to infecting microbes, age of the patient and resistance factors. In general, most of the infants present with fever, irritability or drowsiness, vomiting, high-pitched cry and other nonspecific signs of systemic illness.⁵ Older children may have headache, vomiting, neck rigidity and back pain. Acute complications of bacterial meningitis include ventriculitis, subdural effusion, neurologic deficits, hydrocephalus, electrolyte imbalance, circulatory failure, subdural effusion and raised intracranial pressure. Diagnosis rest on CSF examination. Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) are useful in patients with raised intracranial pressure or those with focal neurologic signs.

Viral Meningitis

Viral meningitis consists of fever, headache and meningeal irritation coupled with inflammatory CSF profile, typically consisting of lymphocytic pleocytosis, a normal or a slightly elevated protein level and a normal glucose level.

AIMS AND OBJECTIVES

The aim of the study is to evaluate the level of CSF lactate in bacterial and viral meningitis, its role in the assessment of early prognosis of bacterial meningitis and its relationship with CSF parameters like cellularity, glucose and protein in bacterial meningitis.

MATERIALS AND METHODS

This study is a descriptive study conducted in the Department of Paediatrics, Government Medical College, Kottayam. Clinically suspected cases of meningitis in children of age 2 months to 12 years were assessed by detailed history, general and neurological examination and CSF study after obtaining informed consent.

Inclusion Criteria

Clinically suspected cases of meningitis with following criteria were grouped as bacterial meningitis.

CSF Analysis

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 positivity.

Clinically-suspected cases of meningitis with the following criteria were taken as viral meningitis.⁶

CSF Analysis

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 <2 months and >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.

65 cases of meningitis were included in the study. 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 stain, 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. All the data collected were analysed statistically. Qualitative variables are expressed as number or percentage. Statistical method used to analyse quantitative variables are mean, range, standard deviation, t-test and correlation coefficient. Significance of association was analysed by calculating 'p' value and a 'p' value of <0.05 is taken as significant.

RESULTS

A total of 65 patients fulfilled the inclusion criteria. Twenty five cases were bacterial meningitis and forty cases were viral meningitis. Among cases of bacterial meningitis, 60% were males and 40% females and majority of the patients were in the age group 2 months to 1 year. Among cases of viral meningitis, gender distribution was equal. Among them, 45% cases were in age group 1-5 years and 55% of cases were in the 5-12 years age group. In bacterial meningitis, CSF cell count was in the range, 144-7200 cells/mm³ with neutrophils in the range of 89-6840 cells/mm³, while viral meningitis had predominant lymphocytes.

Gender	Bacterial Meningitis	Viral Meningitis
Male	15	20
Female	10	20
Total	25	40

Table 1. Gender Distribution in Meningitis

Age	Number of Patients	%
2 months - 1 year	13	52
1 year - 5 years	7	28
5 years - 12 years	5	20
Total	25	100

Table 2. Age Distribution in Bacterial Meningitis

Age	Number of Patients	%
1-5 years	18	45%
5 years - 12 years	22	55%
Total	40	100

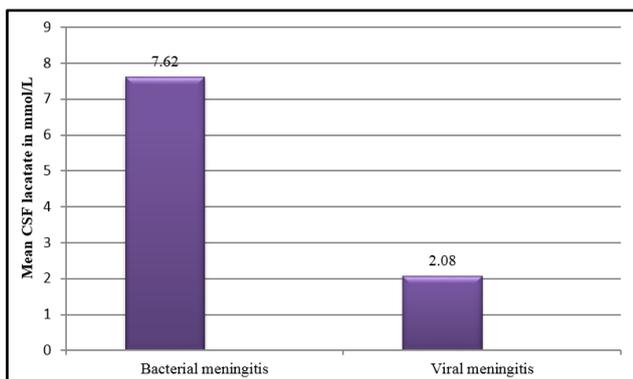
Table 3. Age Distribution in Viral Meningitis

Mean value of CSF lactate in bacterial meningitis was 7.62 ± 2.07 mmol/L (range 4.1-12 mmol/L) and that of viral meningitis was 2.08 ± 0.35 mmol/L (range 1.3-2.8 mmol/L) Among the cases of bacterial meningitis, 10 patients (40%) developed complications. Complications observed were hydrocephalus, focal neurologic deficit, seizure, subdural effusion and 2 patients died. Mean value of CSF lactate in patients with complication was 9.49 ± 1.65 mmol/L (range 7.6-12 mmol/L). 15 patients (60%) did not have any complications, the mean CSF lactate level in them was 6.38 ± 1.2 mmol/L (range 4.1 to 7.3 mmol/L).

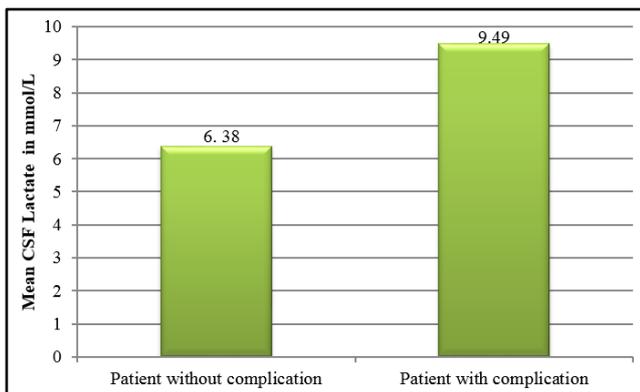
On assessment of the relationship between CSF lactate level (4.1-12 mmol/L) and CSF glucose (10-61 mg/dL) in bacterial meningitis, the correlation coefficient, $r = -0.5615$ showing a negative correlation, which is statistically significant with a 'p' value of <0.01 , whereas on assessing the relation between CSF lactate level (4.1-12 mmol/L) and CSF protein (50-350 mg/dL), the correlation coefficient, $r=0.4482$ showing a positive correlation, which is statistically significant $p <0.05$. Meanwhile, CSF lactate level and CSF cells (144-7200 cells/mm³) did not show any statistically significant correlation ($r = 0.0370$.)

Type of Meningitis	Mean ± Standard Deviation of CSF Lactate in mmol/L
Bacterial meningitis	7.62 ± 2.07
Viral meningitis	2.08 ± 0.35
t value = 13.26, p <0.01	

Table 4. CSF Lactate in Bacterial Meningitis and Viral Meningitis



Graph 1. CSF Lactate in Bacterial Meningitis and Viral Meningitis



Graph 2. CSF Lactate in Patients without Complications and Patients with Complications

Cases	Mean ± Standard Deviation of CSF Lactate in mmol/L
Patient without complication	6.38 ± 1.2
Patient with complication	9.49 ± 1.65
t value = 5.44, p <0.01	

Table 5. CSF Lactate in Patients Without Complications and Patients with Complications

DISCUSSION

Cerebrospinal fluid analysis is an important tool in the diagnostic workup of many neurological disorders.⁷ Meningitis is one of the most serious infections of central nervous system. This clinical entity require prompt diagnosis and management in order to reduce morbidity and mortality.⁸ The parameters analysed in CSF include CSF cell count, protein, glucose, Gram stain, culture and others like CSF, CRP, lactate dehydrogenase and lactate. The reference range for CSF lactate is generally set at 1.2-2.1 mmol/L, but ranges from 0.6-3.1 mmol/L are used as well. If CSF lactate is <3 mmol/L, viral meningitis is most likely.⁹ Levels of CSF lactate above 3.9 mmol/L are usually observed in bacterial meningitis.¹⁰

Sixty five cases of meningitis were included in the study. 25 cases of bacterial meningitis and 40 cases of viral meningitis were there. All the children with bacterial meningitis had highly elevated CSF lactate level. Among them, the lowest value of CSF lactate observed was 4.1 mmol/L. 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 7.62 ± 2.07 mmol/L, while that of viral meningitis was 2.08 ± 0.35 mmol/L. 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).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.¹² In the present study, there is significant difference in CSF lactate between 2 groups $p <0.01$. Among the 25 cases of pyogenic meningitis, 10 cases (40%) developed complications. It was observed that in patients who developed complications, the mean value of CSF lactate was 9.49 ± 1.65 mmol/L and in those without complication the mean value was 6.38 ± 1.2 mmol/L. There is statistically significant difference in CSF lactate level between these two groups $p <0.01$. It was also noticed that patient who died had higher CSF lactate level when compared to others with or without complications with a mean value 11 mmol/L. Similar observation was reported by Abro AH et al,¹³ Chang Y C et al reported that high CSF lactate level was associated with significant risks of early fatality.¹⁴

In this study, it was observed that the leucocyte count in the bacterial meningitis was in the range 144 to 7200 cells/mm³. No significant correlation was identified between CSF lactate level and CSF leucocytes in bacterial meningitis

in this study, whereas in the study by Cabeça H L et al,¹⁵ a positive correlation was found between CSF lactate levels and cellularity in CSF. CSF protein in the bacterial meningitis in this study was in the range of 50-350 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 10-61 mg/dL. CSF lactate level had negative correlation with CSF glucose level, which is statistically significant, $P < 0.01$. Similar results was also observed in study by Cabeça HL et al. In that study, CSF lactate level had a negative correlation with glycorrachia and positive correlation with CSF protein.¹⁵

CONCLUSION

CSF lactate level is significantly elevated in bacterial meningitis than that in viral meningitis. High CSF lactate level was found to be associated with increased incidence of acute complications. CSF lactate level has positive correlation with CSF protein and negative correlation with CSF glucose.

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