Medical Journal of the
Islamic Republic of Iran

Volume 19
Number 3
Fall 1384
November 2005

CEREBROSPINAL FLUID FINDINGS IN NEONATAL BACTERIAL MENINGITIS

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ABSTRACT

Background: Meningitis is more common during the neonatal period than other periods of life and has a prevalence of one in 1000 live births. The similarity of its clinical manifestations with other infectious diseases makes it difficult to diagnose. The aim of the current study was to determine the relationship between age, sex, clinical signs and symptoms and laboratory test results of newborns in which bacterial meningitis had been confirmed by positive CSF culture.

Methods: This cross-sectional study was performed by a non-randomized simple sampling method, in which the medical files of neonates hospitalized between March 1994 and Oct. 1999 were reviewed.

Results: A total of 294 files (16 boys, 127 girls; 54 preterm, 240 full-term infants) were reviewed. Fifteen newborns (8 girls, 7 boys) had positive CSF culture results. A significant statistical relationship was not found between sex and pre-term cases with meningitis. The most common results in newborns with positive CSF culture were poor feeding, lethargy and hyperthermia, followed by seizures, jitteriness, hypothermia and vomiting. Blood culture was positive in only 6 (40%) of the 15 neonates with positive CSF cultures. Leukocytosis (3 cases, 20%), thrombocytopenia (2 cases, 13.3%) and positive direct CSF smear (9 cases, 60%) were also present. Group B Streptococcus (GBS), *E. coli* and gram-negative bacteria were the leading causes of neonatal sepsis and meningitis. A significant difference was found in the WBC count, CSF protein and glucose levels with bacterial meningitis. A significant relationship was also found to exist between CSF glucose-simultaneous blood glucose ratio and neonatal meningitis.

Conclusion: There was a significant difference between CSF protein and glucose, WBC count and bacterial meningitis. A significant relationship was also found between CSF and blood glucose ratio $(\frac{CG}{BG})$ and neonatal bacterial meningitis.

MJIRI, Vol. 19, No. 3, 241-245, 2005.

Keywords: Neonatal, meningitis, CSF

INTRODUCTION

Mortality rates in infants and neonates are among the most important indices used to assess the health status of a community. A large proportion of neonatal mortalities are caused by infections. Intrauterine infections account for about 2% of fetal deaths and 10% of newborns during the process of birth or during the first six months of life.[1] Infections cause the majority of deaths in newborns weighing less than 1500 g.[2] The incidence of sepsis is from 2 to 8 cases per 1000 live births.[3,4] Although the prevalence of bacterial meningitis is low in

newborns, it remains a serious event because of its high mortality and morbidity rates (10%-25%).[1] Septicemia can involve specific organs and generally about one-fourth of septicemia cases are associated with meningitis. Meningitis is more common during the first month of life (1 in 1000 live births).[5,6] The most frequently encountered bacterial causes of neonatal meningitis are group B streptococci, *E. coli* and listeria. Exact diagnosis of bacterial meningitis is made by positive cerebrospinal fluid (CSF) analysis and culture or by detecting specific antigens. Early diagnosis and prompt treatment is the basis of management of neonatal meningitis. Thus, there are two very important points in the treatment of neonatal meningitis; first, correct and early diagnosis, and second, prompt treatment enabling physicians to withhold antibiotics if unnecessary while preventing over-treatment. In case of proper treatment, neonatal meningitis does not lead to complications, otherwise high mortality and irreversible complications one common.[6,10] On the other hand, false diagnosis and over-treatment can lead to other problems such as side effects of antibiotic therapy and complications associated with prolonged intravenous catheterization (thrombosis, opportunistic bacterial infections, possibility of performing a cut down).[9,10] In this way, in addition to saving much budget, time and energy, unnecessary mother and child separation and problems in breastfeeding will be overcome. Regarding the above reasons, we decided to determine the criteria for acute bacterial meningitis.

MATERIAL AND METHODS

This retrospective descriptive analytical study investigated all newborns (aged less than 28 days) hospitalized in the neonatal ward of Bahrami Hospital (Tehran, Iran) between March 1994 and October 1999 and lumbar puncture for sepsis workup was done for them. Exclusion criteria included absence of CSF culture report in the child's medical file, maternal use of antibiotics before delivery and antibiotic therapy in the child before lumbar puncture. The newborns were enrolled into the study by the non-randomized simple sampling method. Data were extracted from the medical files and entered into special forms. Ethical considerations did not limit our study. Data analysis was performed by use of SPSS software using chi-square test.

RESULTS

A total of 294 neonates [167 (56.8%) males, 127 (43.2%) females; age: 10-28 days; 54 (18.4%) preterm, 240 (81.4%) full term infants] who had been hospitalized for sepsis work up and had undergone lumbar puncture, were enrolled into our study. Diagnosis of bacterial meningitis was confirmed by positive CSF culture (5.1%); (8 (53.3%) females; 7 (46.7%) males). CSF culture was negative in the remaining cases. Of these 15 newborns, 4 (26.7%) and 11 (73.3%) were preterm and full term, respectively. A significant statistical difference was not found between either sex or being pre- or full- term (p= 0.406) and positive CSF culture. The most common micro-organisms detected on CSF culture were group B streptococcus (n= 5; 33.3%), *E. coli* (n= 3; 20%), klebsiella (n= 2; 13.3%), followed by pneumococcus, *Streptococcus viridans*, moraxella and *Hemophilus influenzae* (each one case); CSF culture was equivocal in one case. The most common clinical manifestations of bacterial meningitis were poor feeding (14; 93.3%), lethargy (66.6%), hyperthermia (66.6%), seizures (20%), restlessness (20%) and hypothermia or vomiting (each 6.6%). Simultaneous blood culture was positive in 6 cases (40%) and negative in 9 cases. Complete blood count showed leukocytosis (WBC>21000) in 3 cases (20%), thrombocytopenia (platelet<150000) in 2 cases (13.3%) and elevated ESR in 5 cases (33.3%); none had leukopenia. Direct CSF smears were positive in 9 cases (60%); 4 cases with gram-positive diplococci (group B streptococci on culture), 4 cases with gram-negative bacilli (*E. coli* and Klebsiella), and one case with gram-positive cocci (pneumococci). Mean CSF WBC count of culture-negative cases was 6.99/mm^3, which was much lower than CSF culture-positive cases (WBC count =2894/mm^3). If the highest cut-off value considered as normal WBC count is 32 for full-term and 29 for pre-term infants, a significant statistical difference will exist between CSF WBC count and CSF culture (p value<0.001). Mean CSF protein level was 40.46 mg/dL and 203 mg/dL in neonates without and neonates with meningitis, respectively. If the highest value considered as normal CSF protein level is 150 mg/dL for full-term and 170 mg/dL for pre-term infants, a significant statistical relationship will exist between CSF protein level and neonatal meningitis (p value<0.001). Mean CSF glucose was 68.3 mg/dL and 24.8 mg/dL in newborns without and newborns with meningitis. If the highest CSF glucose level considered as normal is 34 mg/dL in full-term and 24 mg/dL in pre-term infants, a significant relationship will be present between CSF glucose level and neonatal meningitis (p value<0.001). The mean CSF-blood glucose ratio was 82.12% and 24.46% in newborns without and newborns with bacterial meningitis, respectively. If simultaneous blood and CSF glucose levels are 70% in pre-term and 50% in full-term infants, there is a significant statistical relationship between CSF glucose/blood glucose and neonatal menin-

gitis (p value<0.001).

DISCUSSION

In this study, a significant relationship was not found between sex and CSF culture results in bacterial meningitis, whereas male sex has been considered as a risk factor in septicemia and neonatal meningitis.[1,5] We did not find a significant relationship between pre-term neonates and bacterial meningitis, whereas this condition is considered as a risk factor in reference books. The abnormal distribution of preterm infants in our study may explain our results; 18.6% of our cases were pre-term infants while this figure is much lower in the normal group. Regarding gender, 46.7% of our subjects were male, while males constitute 55% of our society. This also shows the abnormal sex distribution in our study population. Regarding etiologic organisms in bacterial meningitis, our findings were in accordance with those stated in reference books. We found *E. coli* and group B streptococci as the most common organisms (around 75% of cases) followed by listeria and gram-negative species. Regarding clinical manifestations; poor feeding was the most common clinical finding followed by lethargy and hyperthermia.[1] Simultaneous blood cultures obtained from newborns with meningitis was positive in 70%-85% of cases whereas in our study only 40% of cases were positive, which may be due to poor paraclinical methods or incorrect method of blood specimen collection for culture purposes and failure to repeat the test (at least three times). Blood culture was performed only once for all subjects in our study. CSF examination (maximum, minimum and mean glucose levels and WBC count) was the same as stated in reference books.[11,14] Also CSF below 103 mmol/L is highly specific for neonatal meningitis.[11] On the other hand, mean, maximum and minimum CSF protein levels in subjects of our study were lower than those stated in reference books. However, statistical analysis showed high protein level is a valuable criterion for diagnosing neonatal meningitis, which has been stated in other studies and reference books.[12,18] In men-

Table I. CSF results of 279 newborns without meningitis hospitalized in Bahrami Hospital from September 1994 to September 1999.

CSF results		Full term (n=279)	Pre-term (n=50)
WBC count (cells/mm^3)	Mean	6.72	7.88
	Range	0-32	0-50
Protein level (mg/dL)	Mean	45.93	59.51
	Range	14-150	10-180
Glucose level (mg/dL)	Mean	68.8	66.3
	Range	41-125	35-92
CSF glucose/blood glucose (%)	Mean	82.51	81.47
	Range	52-153	62-108

Table II. CSF results in 15 newborns with meningitis hospitalized in Bahrami Hospital from September 1994 to September 1999.

CSF Findings		Results
WBC count (cells/mm^3)	Mean	2894
	Range	145-16400
Protein level (mg/dL)	Mean	203
	Range	62-450
Glucose level (mg/dL)	Mean	24.8
	Range	0-52
CSF glucose/blood glucose (%)	Mean	24
	Range	0-79

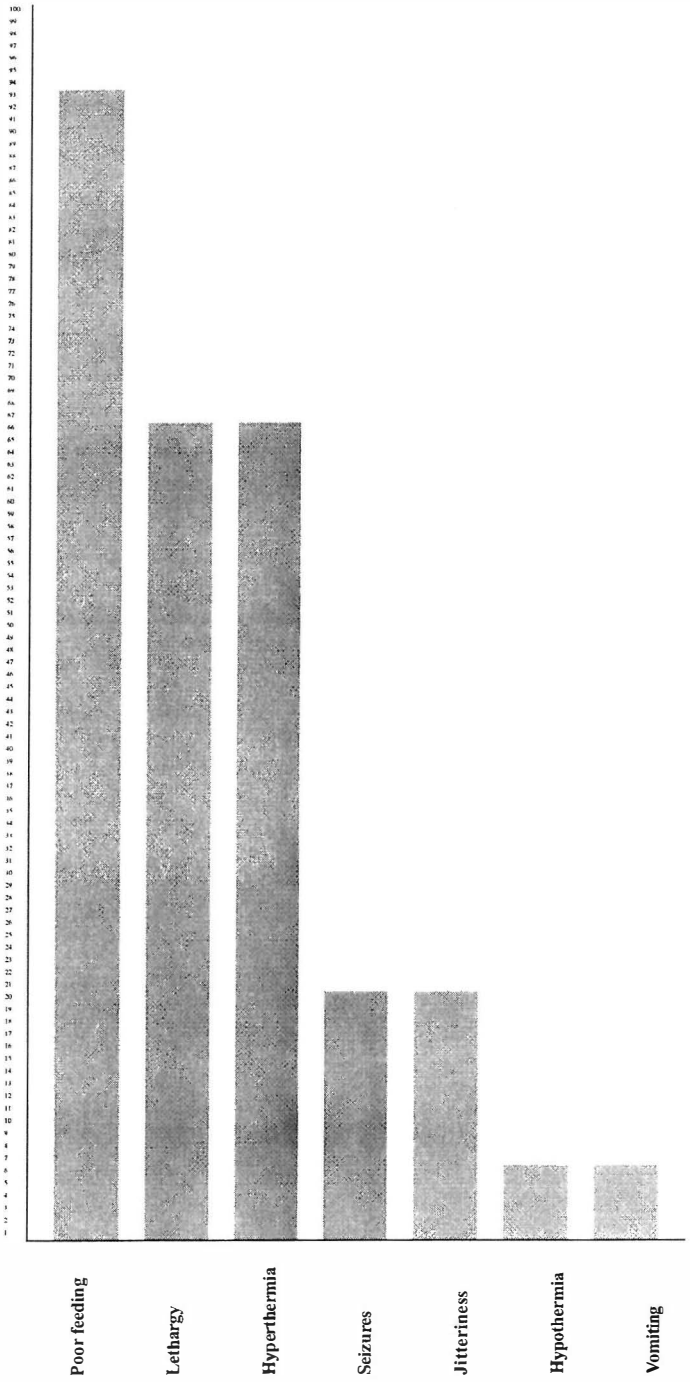

Fig 1. Prevalence of different clinical manifestations in 15 newborns with meningitis hospitalized in Bahrami Hospital from September 1994 to September 1999.

ingitis caused by group B streptococci, leukopenia is considered as a poor prognostic factor, but none of our subjects had leukopenia.[13] In meningitis caused by gram negative organisms, thrombocytosis is a poor prognostic factor; two of our subjects with gram-negative meningitis were found to have thrombocytopenia.[19,20] In addition, none of our subjects had meningitis without pleocytosis (elevated CSF WBC count), whereas in other neonatal care centers, pleocytosis was absent in 10%-15% of neonates, and less than 2% of cases were aged more than our studied population.[15]

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