

Role of Computed Tomography Scan in the Management of Pediatric Acute Bacterial Meningitis: An Experience from a Tertiary Care Hospital in Lahore

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ABSTRACT

Background: Acute Bacterial Meningitis (ABM) is not an uncommon ailment seen both in developing and developed countries. For the patients presenting with fever and seizures, the trend of doing CT scan brain is on the rise, which may not be justifiable in all cases.

Objective: To determine the frequency of radiological findings on computed tomography (CT) of the brain among children presenting with acute bacterial meningitis.

Materials & Methods: This cross-sectional study was conducted in Department of Pediatrics KEMU/Mayo Hospital Lahore after IRB approval. Patients with CSF-proven ABM whose CT brains had been performed were enrolled retrospectively, and the presence of hydrocephalus, cerebral infarct, edema and abscess as per CT report were recorded. Data were stratified for age, gender and duration of symptoms. Chi-square test was applied to compare findings in stratified groups.

Results: A total of 165 ABM patients with a mean age of 6.2 ± 1.3 years; 68.5% (113) males and 31.5% (52) females were included. CT brain was normal in 92 (55.8%), while 29 (17.6%) had cerebral edema, 20 (12.1%), 11 (6.7%) and 13 (7.9%) had cerebral infarct, hydrocephalus and cerebral abscess respectively.

Conclusion: Computed Tomography is a useful tool for detecting intracranial complications of ABM. But routine use of CT-brain in every patient without clear indications should be avoided to decrease the risk of radiation exposure as well as to save resources.

Keywords: Acute bacterial meningitis, Children, Cerebrospinal fluid, Computed tomography, complications

INTRODUCTION

Acute bacterial meningitis (ABM) is a devastating disease in children with many deaths and significant long-term sequelae in survivors and remains a major global public health challenge.¹ It is one of the major causes of fever and fits among young children, with an average of one million children being diagnosed with ABM worldwide. The World Health Organization (WHO) has reported a mortality rate of around 12-15% among the patients diagnosed with ABM.² In a study, the incidence of ABM was reported as 4.5% among the children presenting with fever and fits.³ The field of diagnostics declares microscopy and culture of the cerebrospinal fluid (CSF) as the gold standard for the diagnosis of ABM. This, however, has its pros and cons regarding sensitivity and specificity. There are chances of false-negative results because a small number of microbes are usually present in the specimen.⁴

Early management of meningitis is the key to decrease mortality and morbidity. Many recently developed investigations may aid in the diagnosis as well as prognosis of the disease but controversies still exist.⁵ Doing CT scan brain has been proposed to be carried out before doing a diagnostic lumbar puncture (LP) to rule out the contraindications and other etiologies like an intracranial bleed or any space-occupying lesion.⁶ Anyhow prompt diagnosis and early antibiotic therapy are crucial and should not be delayed to obtain neuroimaging.⁷ In a study, the reported sensitivity and specificity of CT scans were 89.2% and 100%, respectively especially in detecting basal meningeal enhancement and tuberculomas, hence differentiating ABM and tuberculous meningitis.⁸ According to another study, CT scan brain performed on patients with ABM showed that 78.94% of cases had normal CT scans.⁹ Because of inherent fears and lack of physician experience and expertise, there has been a rising trend in doing CT brain in children with ABM, which may not be always justifiable in all cases. Keeping in mind these observations this retrospective study was planned to determine the frequency of radiological findings on computed tomography (CT) of the brain among children presenting with acute bacterial meningitis.

MATERIALS AND METHODS

After approval of the synopsis, this cross-sectional observational study was conducted in the Department of Pediatrics, Mayo Hospital Lahore. One hundred and sixty-five diagnosed cases of

ABM, whose CT brain had been performed (at the discretion of the treating medical team), were included retrospectively by non-probability sampling technique using 95% confidence level, 5% margin of error and taking an expected percentage of cerebral infarct as 12.2% in infants with ABM.¹⁰ Children aged 2 months to 12 years of either gender diagnosed as ABM on CSF examination were included. CSF analysis report was labeled as suggestive of acute bacterial meningitis if CSF white cell count was $>1000/\mu\text{L}$ with predominance of neutrophils, CSF proteins were above 80mg/dL, CSF/blood glucose ratio was less than 0.4. Children with a congenital anomaly like neural tube defect (on clinical examination), known cases of partially treated meningitis or post meningitis sequelae, those with brain tumors, intracranial bleed and cerebral malformation were excluded. Demographic details were documented. CT findings, as reported by a trained radiologist, including hydrocephalus, cerebral infarct, edema, abscess scan were recorded.

Data was entered and analyzed through SPSS v23.0. For quantitative variables like age mean and standard deviation were calculated. While frequencies and percentages were calculated for qualitative variables like gender, duration of symptoms and CT findings (hydrocephalus, cerebral edema, infarct, and abscess). Data was stratified for age, gender and duration of symptoms. Post-stratification, the chi-square test was applied to compare findings in stratified groups. A p-value of ≤ 0.05 was taken as significant.

RESULTS

For a total of 165 patients, the mean age was 6.2 ± 1.3 years. Fifty (30.3%) patients had age <1 year, while 60 (36.4%) and 55 (33.3%) had ages between 1 - 5 years and >5 years respectively. Gender distribution showed that 113 patients (68.5%) were males while 52 (31.5%) were females. Among 165 patients, 72 (43.6%) had symptoms for ≤ 7 days duration, while 93 (56.4%) had symptoms for >7 days when CT brain was performed. According to CT findings, 92 (55.8%) had normal CT brain, 29 (17.6%) had cerebral edema, while 20 (12.1%), 11 (6.7%) and 13 (7.9%) had cerebral infarct, hydrocephalus and cerebral abscess respectively. There was no statistically significant difference in CT findings among both genders ($p=0.856$), various age groups ($p=0.927$) or different duration of symptoms ($p=0.507$).

Table-1: Frequency of CT Findings in Both Genders

Gender	CT findings					Total	p-value
	Normal	Cerebral Edema	Cerebral Infarct	Hydrocephalus	Cerebral Abscess		
Male	65 70.7%	19 65.5%	14 70.0%	6 54.5%	9 69.2%	113 68.5%	0.856
Female	27 29.3%	10 34.5%	6 30.0%	5 45.5%	4 30.8%	52 31.5%	
Total	92 100.0%	29 100.0%	20 100.0%	11 100.0%	13 100.0%	165 100.0%	

Table-2: Frequency of CT Findings in Patients with Different duration of symptoms

Duration of symptoms	CT findings					Total	p-value
	Normal	Cerebral Edema	Cerebral Infarct	Hydrocephalus	Cerebral Abscess		
≤7 days	41 44.6%	13 44.8%	10 50.0%	2 18.2%	6 46.2%	72 43.6%	0.507
>7 days	51 55.4%	16 55.2%	10 50.0%	9 81.8%	7 53.8%	93 56.4%	
Total	92 100.0%	29 100.0%	20 100.0%	11 100.0%	13 100.0%	165 100.0%	

Table-3: Frequency of CT Findings in Different Age Groups

Age groups	CT findings					Total	p-value
	Normal	Cerebral Edema	Cerebral Infarct	Hydrocephalus	Cerebral Abscess		
≤1 year	31 33.7%	7 24.1%	7 35.0%	2 18.2%	3 23.1%	50 30.3%	0.927
>1-≤5 years	31 33.7%	13 44.8%	7 35.0%	4 36.4%	5 38.5%	60 36.4%	
>5 years	30 32.6%	9 31.0%	6 30.0%	5 45.5%	5 38.5%	55 33.3%	
Total	92 100.0%	29 100.0%	20 100.0%	11 100.0%	13 100.0%	165 100.0%	

DISCUSSION

Acute Bacterial Meningitis is not an uncommon disease seen in the pediatric emergency as well as in the pediatric intensive care units of developing as well as developed countries. In the management of patients presenting with fever and fits, the trend of CT scan brain is on a rise to rule out differential diagnoses of fever with fits, which may not be justifiable in all cases.¹¹

As there is controversy in the literature and the experiences of clinicians regarding the initial CT brain in children without any clear guidelines available, it is quite difficult for physicians to decide whether the patient requires a CT scan of the brain before going for lumbar puncture. Studies have shown that around eighty percent of the patients with fever and fits have a normal CT scan brain.¹²⁻¹³ The Infectious Disease Society of America guidelines also recommend CT brain to be done before lumbar puncture only if there is a history of CNS disease, immune-compromised state, papilloedema or focal neurological deficit in the patient.¹⁴

Most of the cases of meningitis have various non-specific clinical features, which can overlap with other diseases making it difficult for the treating physician to diagnose and to make decisions. A study from India also had similar findings where infants presented with fever, irritability, drowsiness and vomiting, while older children presented with headache, vomiting, neck rigidity and back pain.¹⁵ Studies have concluded that the decision regarding doing the LP should be made on clinical grounds and local guidelines or recommendations of senior consultants should be followed. Kumar et al have reported sensitivity and specificity of CT scans to detect abnormality as 89.2% and 100%, respectively and more so in differentiating between acute bacterial and tuberculous meningitis.⁸

In our study, 55.8% had a normal CT brain, while 17.6%, 12.1%, 6.7% and 13(7.9%) had cerebral edema, cerebral infarct, hydrocephalus and cerebral abscess respectively. A study by Fayyaz et al showed that CT scan was normal in 78.94% of cases, whereas cerebral edema, infarct and hydrocephalus was seen in 14.03%, 5.26% 1.75% cases.⁹ Eze et al showed that hydrocephalus was present in 36.36%, cerebral abscess in 12.12%, cerebral infarction in 12.12% and subdural empyema in 9.09% as CT scan findings of complicated bacterial meningitis

patients.¹⁰ In a study done in Israel, CT scan results showed that 217 (69.8%) patients had no abnormal findings, while amongst the rest, more than half had hydrocephalus (57.4%) and one-third had cerebral edema (30.9%).¹⁶ Costerus et al found that generalized cerebral edema was detected in 30% of patients, being the most common finding detected on CT brain of ABM patients.¹⁷ Comparison with these studies suggests that CT brain is not being done excessively in our setup, whereas the complication rates as detected by CT brain are comparable to most of them.

CONCLUSION

Computed Tomography is a useful diagnostic tool for detecting intracranial complications of bacterial meningitis like hydrocephalus, cerebral abscess and cerebral edema. But routine use of CT-brain in every patient with CSF-proven meningitis should be avoided to decrease the risk of hazardous radiation exposure as well as to save resources.

Conflict of Interest: There exists no conflict of interest between the authors.

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