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RESEARCH ARTICLE

CHILDHOOD TUBERCULAR MENINGITIS: INSIGHTS INTO CLINICAL PRESENTATION, RADIOLOGICAL FINDINGS, AND OUTCOME DETERMINANTS

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Abstract

Introduction: Childhood tuberculosis (TB) in India affects around 342,000 children annually, with a detection gap of 56%, and includes significant cases of extra-pulmonary TB like tuberculous meningitis (TBM). TBM has high mortality and morbidity rates due to diagnostic challenges such as vague symptoms and difficulties in obtaining samples. This study aims to evaluate TBM's clinical and radiological profiles in children to improve diagnostic and therapeutic outcomes and enhance prognosis in high-burden settings.

Methodology: This prospective observational study at Government Medical College Srinagar enrolled 30 children under 18 years suspected of TBM, based on prolonged fever, cough, and neurological signs, excluding those already on treatment or with chronic illnesses. Diagnostic tests included chest X-ray, Mantoux test, hemogram, CSF analysis, neuroimaging, and HIV testing, with patients classified using the Marais et al. TBM scoring system. Statistical analysis identified mortality-related factors, using descriptive statistics, comparative analyses, and logistic regression to adjust for confounders.

Results: This study examined 30 pediatric patients with tubercular meningitis (TBM) at GMC Srinagar, revealing an average age of 6.65 years and a slight female predominance (53.3%). Common clinical features included fever (83.3%), altered sensorium (56.7%), and seizures (53.3%), with 93.3% showing meningeal irritation and 56.7% exhibiting raised intracranial pressure. CSF analysis showed elevated protein and decreased glucose levels; imaging revealed meningeal enhancement (70%) and hydrocephalus (46.7%). Key factors influencing outcomes included BCG vaccination reducing mortality and advanced TBM stages, seizures, and hydrocephalus increasing mortality risks.

Conclusion: our study highlights critical clinical, radiological, and socioeconomic insights into pediatric TBM. Key findings include the prominence of neurological symptoms, the crucial role of MRI in diagnosis, and the influence of socioeconomic status on disease burden. These insights emphasize the need for early diagnosis, vigilant monitoring, and targeted management to improve outcomes and reduce neurological complications.

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Introduction:-

Childhood tuberculosis (TB) poses a significant health challenge in India, with approximately 342,000 children (aged 0-14 years) contracting TB annually, accounting for about 6% of all TB cases(1). Despite extensive efforts, a detection gap of around 56% persists. Children under 14 years make up 35% of India's population and contribute to about 10% of the TB caseload. While pulmonary TB is predominant, extra-pulmonary TB (EPTB), including the severe form of tuberculous meningitis (TBM) is also significant(2).

TBM often results in high mortality and significant morbidity if not treated promptly. Diagnosis depends on cerebrospinal fluid (CSF) analysis and radiological imaging, such as CT and MRI, which show characteristic findings like basal meningeal enhancement and hydrocephalus. The main diagnostic challenges include vague symptoms and difficulty obtaining testing samples. Delays in diagnosis, inadequate treatment, and socioeconomic factors contribute to higher mortality rates. Radiological imaging is crucial but not well-defined, making accurate diagnosis of TBM in children difficult. This study aims to address research gaps by evaluating the clinical and radiological profiles of TBM in children and identifying mortality factors to improve diagnostic and therapeutic outcomes, thereby enhancing prognosis in high-burden settings.(3,4,5).

Methodology:-

This prospective observational cohort study was conducted at the Department of Pediatrics, Government Medical College Srinagar. 30 children under 18 years suspected of TBM were enrolled at diagnosis and followed for six months to assess outcomes. TBM suspicion was based on prolonged fever or cough (≥ 2 weeks) and neurological signs like irritability, headache, altered sensorium, seizures, and weight loss. Patients already on TBM treatment, those with chronic illness or malignancy, and non-consenting parents were excluded from the study. Demographic data, immunization history, TB contact, and socioeconomic status were recorded.

All enrolled children underwent diagnostic tests such as chest X-ray, Mantoux test, complete hemogram, and additional investigations like gastric aspirate for AFB and abdominal ultrasonography. CSF analysis, including AFB detection (CBNAAT), and neuroimaging (CT or MRI) were performed, with HIV testing as appropriate. Clinical assessments included neurological evaluations using the modified Glasgow Coma Scale. Patients were categorized using the Marais et al. TBM scoring system into definite, probable, or possible TBM. Statistical analysis identified mortality-associated factors, utilizing descriptive statistics for demographic and clinical summaries, comparative analyses of survivors and non-survivors, and logistic regression to determine independent mortality predictors, adjusting for potential confounders.

Results:-

In this study, we examined the clinical and radiological characteristics, as well as the outcomes, of 30 pediatric patients diagnosed with tubercular meningitis (TBM) at the Department of Pediatrics, GMC Srinagar, a tertiary care hospital. The average age of the patients was 6.65 ± 3.90 years, with a slight female predominance at 53.3%. Socioeconomic analysis revealed that 83.3% of the patients were from the lower middle class. Additionally, only 20% of the patients had a history of prior contact with individuals afflicted by tuberculosis, and slightly over half of the cohort had received BCG vaccination.

Clinically, the most common presentations included fever (83.3%), altered sensorium (56.7%), and seizures (53.3%). (Table 1).

Table 1:- Clinical Presentation.

Clinical features (Symptoms)		Frequency	Percent
Fever	Yes	25	83.3%
	No	5	16.7%
Altered sensorium	Yes	17	56.7%
	No	13	43.3%
Seizures	Yes	16	53.3%
	No	14	46.7%
Headache	Yes	11	36.7%
	No	19	63.3%
Vomiting	Yes	15	50.0%
	No	15	50.0%

Irritability	Yes	11	36.7%
	No	19	63.3%
Refusal of feeds	Yes	7	23.3%
	No	23	76.7%
Increasing Head Size	Yes	2	6.7%
	No	28	93.3%
Cough	Yes	3	10.0%
	No	27	90.0%
Paucity of movements	Yes	2	6.7%
	No	28	93.3%
Total		30	100%

The neurological assessment revealed that 93.3% of patients exhibited meningeal irritation and 56.7% showed signs of raised intracranial pressure (ICP). Abnormal posture was noted in 33.3% of the cohort. Neurological manifestations included quadriplegia, hemiplegia, and cranial nerve palsy in 10.0% to 13.3% of patients. Stage classification according to the severity of Tubercular meningitis (TBM) indicated that the majority of patients, accounting for 93.4%, fell within stages 2 to 3, highlighting the advanced nature of the disease in the cohort. (table 2)

Cerebrospinal fluid (CSF) analysis showed elevated protein levels averaging 304 mg/dl and decreased glucose levels averaging 35.8 mg/dl, with 36.7% testing positive for CBNAAT. Imaging studies revealed meningeal enhancement in 70% and hydrocephalus in 46.7% of patients. (Table 3)

Table 2: - Clinical Presentation.

Clinical features (signs)		Frequency	Percent
Meningeal irritation	Yes	28	93.3%
	No	2	6.7%
Sign of Raised ICP	Yes	17	56.7%
	No	13	43.3%
Abnormal Posture	Yes	10	33.3%
	No	20	66.7%
Quadriplegia	Yes	4	13.3%
	No	26	86.7%
Hemiparesis	Yes	3	10%
	No	27	90%
Cranial Nerve Palsy	Yes	3	10%
	No	27	90%
GCS	<7	12	40%
	7-10	7	23.3%
	>10	11	36.7%
Stage of TBM	STAGE 1	2	6.7%
	STAGE 2	14	46.7%
	STAGE 3	14	46.7%
Total		30	100%

Table 3:-Findings on Neuroimaging.

MRI /CT scan Findings		Frequency	Percent
Meningeal Enhancement	Yes	21	70%
	No	9	30%
Hydrocephalus	Yes	14	46.7%
	No	16	53.3%
Periventricular Edema	Yes	7	23.3%
	No	23	76.7%
Infra	Yes	5	16.7%
	No	25	83.3%

Tuberculoma	Yes	3	10
	No	27	90
Total		30	100

Table 4:-Association of various factors with outcome in TBM.

	Expired N(%)	Discharged N(%)	Total	p-value
Seizure	9(56)	7(44)	16	0.02
GCS<7	10(83)	2(17)	12	<0.001
Raised ICP	9(52)	8(48)	17	0.05
STAGE 3 TBM	10(71)	4(29)	14	0.001
Hydrocephalus	10(71)	4(29)	14	0.001
Periventricular Edema	6(85)	1(15)	7	<0.004

The study also investigated several determinants influencing the outcomes in patients with tubercular meningitis (TBM). Nutritional status showed a minor impact on mortality, with normal nutrition correlating to better outcomes. BCG vaccination significantly reduced mortality ($p < 0.02$), while the presence of seizures, Lower Glasgow Coma Scale scores (< 7), and stage 3 TBM was strongly associated with higher mortality rates ($p < 0.02$, $p < 0.001$, $p < 0.001$ respectively). Signs of raised intracranial pressure, irritability, and refusal of feeds also indicated poorer outcomes. (Table 4). Advanced TBM stages, hydrocephalus, and periventricular edema significantly increased mortality risks, emphasizing the importance of early diagnosis and intervention in improving patient survival.

Discussion:-

Our study on pediatric tubercular meningitis (TBM) revealed significant clinical, radiological, and socioeconomic insights. The cohort consisted of 30 patients, predominantly aged 1-5 years, with a slightly higher representation of females (53.3%), indicating possible biological or sociodemographic factors affecting susceptibility or diagnosis rates. The average age of 6.65 ± 3.90 years at diagnosis emphasizes the critical need for early detection and intervention in pediatric TB cases.

Socioeconomic status significantly impacted our study, with 83.3% of patients from lower to lower-middle classes, consistent with another study where all children were from low socioeconomic backgrounds. (6) Nutritional assessment showed 70% with normal status, while 26.7% had mild to moderate malnutrition. This highlights the link between socioeconomic factors and disease burden, emphasizing challenges in healthcare access, diagnosis, and treatment. Only 20% of patients reported prior contact with tuberculosis-afflicted individuals, indicating gaps in disease awareness or surveillance and suggesting a substantial burden of community-acquired infection. This underscores the need for targeted public health interventions for contact tracing and prevention.

Clinically, the most common presentations included fever (83.3%), altered sensorium (56.7%), and seizures (53.3%). Meningeal irritation was seen in 93.3%, raised intracranial pressure (56.7%), and abnormal posture in (33.3%) cases. The cohort exhibited a spectrum of neurological manifestations, including quadriparesis, hemiparesis, and cranial nerve palsy, each identified in 10.0% to 13.3% of the patients. These findings align with other studies showing children typically present with symptoms such as headache, fever, vomiting, and irritability, with advanced disease stages exhibiting meningeal irritation, raised intracranial pressure, cranial nerve palsies, neurological deficits, altered consciousness, and movement disorders. (7,8,9)

Laboratory findings revealed that 76.7% of patients had a normal white blood cell count, indicating no leukocytosis. Chest X-rays were normal in 83.3% of cases, while 16.3% showed bronchopneumonia, aligning with another study where most children with TBM did not show typical tuberculosis signs on chest X-rays, with only 24.9% showing parenchymal infiltration. (10). Blood cultures were sterile, indicating an absence of detectable bacterial growth in the bloodstream. The diagnosis of TBM remains challenging due to the low sensitivity of cerebrospinal fluid microscopy and the slow growth of *M. tuberculosis* in traditional cultures.

The neuroimaging findings from our study on TBM showed that 70% of patients had meningeal enhancement, underscoring the critical role of MRI in diagnosing TBM. Similar findings have been seen in other studies as

well.(11) Pertinently, several studies conducted over time have consistently demonstrated that MRI exhibits greater sensitivity compared to CT scans in detecting tuberculous meningitis (TBM). Initially, CT scans may appear normal in nearly 30% of cases, highlighting their limitations in early diagnosis. Therefore, the absence of abnormalities on initial neuroimaging does not exclude the possibility of TBM. Hydrocephalus was present in 46.7% of cases. Additionally, periventricular edema (23.3%), infarction (16.7%), and tuberculomas (10.5%) were observed, indicating the diverse neurological impacts and complexities of TBM that necessitate thorough imaging for effective management.

Nutritional status showed a minor impact on mortality, with normal nutrition correlating to better outcomes. BCG vaccination significantly reduced mortality ($p<0.02$), while the presence of seizures, Lower Glasgow Coma Scale scores (<7), and stage 3 TBM was strongly associated with higher mortality rates ($p<0.02$, $p<0.001$, $p<0.001$ respectively). Signs of raised intracranial pressure, irritability, and refusal of feeds also indicated poorer outcomes. The mortality rate was 83% for patients with GCS scores below 7, compared to a 57.9% survival rate for those with GCS scores above 10. Advanced TBM stages correlated with increased mortality, with 71% of non-survivors in stage 3. Abnormal chest X-rays and meningeal enhancement were linked to poor outcomes. Hydrocephalus, present in 71% of non-survivors, significantly impacted prognosis. Periventricular edema was associated with a 85.55% mortality rate among affected patients.

In conclusion, our study highlights critical clinical, radiological, and socioeconomic insights into pediatric TBM. Key findings include the prominence of neurological symptoms, the crucial role of MRI in diagnosis, and the influence of socioeconomic status on disease burden. These insights emphasize the need for early diagnosis, vigilant monitoring, and targeted management to improve outcomes and reduce neurological complications.

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