

External Ventricular Drainage as a Life Saving Bridge Therapy in Pediatric Tuberculous Meningoencephalitis with Acute Hydrocephalus: Improving Consciousness and Spasticity

Zacky Muttaqien¹, Andre Dwijaya Saputra²

¹Internship doctor, RSUD Bayu Asih, Purwakarta, Indonesia.

²Department of Neurosurgery, RSUD Bayu Asih, Purwakarta, Indonesia.

muttaqienzacky@gmail.com

Abstract. Tuberculous Meningoencephalitis (METB) is one of the most devastating Central Nervous System (CNS) infections in children, with hydrocephalus being the primary cause of high morbidity and mortality. Surgical management of acute hydrocephalus secondary to METB is critical but often involves clinical controversy, particularly regarding the choice and timing of cerebrospinal fluid (CSF) diversion. Case Presentation: Tuberculous Meningoencephalitis (METB) is one of the most devastating Central Nervous System (CNS) infections in children, with hydrocephalus being the primary cause of high morbidity and mortality. Surgical management of acute hydrocephalus secondary to METB is critical but often involves clinical controversy, particularly regarding the choice and timing of cerebrospinal fluid (CSF) diversion. Intervention and Outcome: Post-EVD, the patient showed significant neurological improvement: consciousness improved from somnolent to apathetic, and generalized spasticity reduced to being localized in the right extremities. This short-term improvement, specifically in GCS and spasticity, highlights the immediate efficacy of EVD in managing acute neurological deterioration. Discussion: This case illustrates the critical role of EVD as an effective life-saving bridge therapy for acute hydrocephalus in advanced METB stages. It underscores the importance of clinical and radiological judgment (TBM Stage III) when microbiological evidence is lacking, and demonstrates that timely CSF diversion can mitigate acute symptoms even in the presence of established chronic sequelae (cortical blindness and cerebral palsy). This finding aligns with the need for better evidence synthesis on this topic. Conclusion: EVD is a necessary and effective intervention for pediatric METB-associated acute hydrocephalus, providing crucial short-term neurological improvement and serving as an essential step toward patient stabilization and subsequent definitive management.

Keywords: *Tuberculous Meningoencephalitis, Hydrocephalus, External Ventricular Drainage, Neurological Outcome.*

A. Introduction

Tuberculous Meningoencephalitis (METB) represents the most severe form of extrapulmonary tuberculosis, particularly in the pediatric population, carrying significant rates of mortality and long-term neurological morbidity [1, 2]. Hydrocephalus is the most common complication of METB, occurring in up to 80% of cases, primarily due to obstruction of CSF pathways by thick inflammatory exudates and arachnoiditis in the basal cisterns [3, 4]. Uncontrolled increase in Intracranial Pressure (ICP) is the direct cause of acute neurological decline, cerebral ischemia, and eventual brain herniation.

The choice of intervention for METB-associated hydrocephalus remains a critical clinical decision, typically debated between conservative medical management (OAT and corticosteroids), timely CSF diversion using External Ventricular Drainage (EVD), or immediate placement of a permanent Ventriculoperitoneal Shunt (VPS) [5]. While VPS is often the definitive solution, its use in the acute, highly inflammatory phase of METB carries a high risk of shunt obstruction and infection [6].

B. Method

This Evidence-Based Case Report (EBCR) presents a challenging case of an 11-year-old child with METB-associated acute hydrocephalus who already exhibited severe chronic neurological deficits (cortical blindness and cerebral palsy). The case highlights a significant evidence gap in pediatric neurosurgery regarding the optimal management strategy for acute ICP.

To address this, our case serves as a foundation for a focused PICO inquiry, which reveals the scarcity of high-level evidence:

Table 1. PICOS CRITERIA

PICOS	
P	Pediatric patients with tuberculous meningoencephalitis (TBM) presenting with acute hydrocephalus
I	External Ventricular Drainage (EVD)
C	Conservative management or Ventriculoperitoneal Shunt (VPS)
O	Short-term neurological outcomes, including: - Level of consciousness (e.g., GCS) - Neurologic recovery or improvement - Spasticity - Mortality
S	Randomized controlled trials (if available), cohort studies, case-control studies, and case series describing EVD or VPS in pediatric TBM with hydrocephalus.

Source: Author's Original Work

The low yield from major databases (e.g., PubMed, Cochrane, OpenAlex, Willey Online Library and EuropePMC) indicates that available evidence primarily rests on retrospective *case series* and *single-center experiences* [6, 7], underscoring the necessity of publishing detailed case reports such as this one.

C. Result and Discussion

Case Report

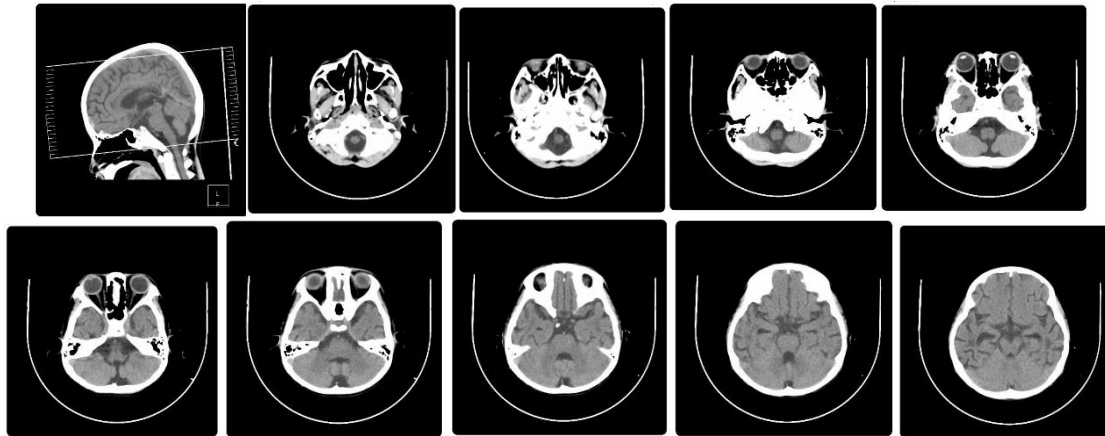
Clinical Presentation

An 11-year-old male patient (An. M.A.) was referred to our hospital with a four-month history of progressive decline in consciousness and generalized muscle stiffness. The patient had prior established diagnoses of cortical blindness (due to high-pressure complications) and chronic motor deficits consistent with cerebral palsy (CP). Neurological examination revealed the patient was somnolent with spasticity (generalized hypertonia). Vital signs were stable except for increased respiratory effort.

Diagnostic Workup

Cerebrospinal Fluid (CSF) analysis obtained via lumbar puncture showed highly elevated protein levels (120mg/dL), low cell count with mononuclear cell predominance, and normal glucose. The CSF was clear. Critically, both the TCM TBC (Xpert MTB/RIF) and Gram stain results were negative. However, chest X-ray suggested active pulmonary tuberculosis.

Head Ct Scan



Chest X-Ray



Figure 1. Pre Operative Diagnostic Evidence for Tuberculous Meningoencephalitis (METB)

(A) Axial view of the Cranial CT Scan demonstrating severe triventricular hydrocephalus with marked lateral ventricular dilation, indicative of obstructive pathology. Note the subtle meningeal enhancement along the basal cisterns, highly suggestive of active METB. **(B)** Chest X-Ray (CXR) showing patchy infiltrates consistent with active pulmonary tuberculosis, supporting the systemic nature of the infection. These critical findings established the METB Stage III diagnosis despite negative microbiological tests.

Management and Intervention

The patient was immediately started on standard anti-tuberculosis therapy (OAT) and high-dose corticosteroids. Due to persistent signs of increased ICP and the risk of imminent herniation (measured ICP >20 cm H₂O), the decision for urgent surgical CSF diversion was made. The patient underwent External Ventricular Drainage (EVD) placement in the right lateral ventricle.

Outcome and Follow-up

Post-operatively, continuous CSF drainage was achieved. The CSF drained was initially clear, with gradual normalization of biochemical parameters. Within days following EVD placement and ICP normalization, the patient exhibited significant neurological improvement:

- Consciousness: Improved from Somnolent to Apathetic.
- Motor Function (Spasticity): Generalized spasticity diminished, becoming localized primarily to the right extremities.

The EVD remained in place while the patient continued OAT. The improvement in acute signs of ICP allowed for patient stabilization and further planning for definitive shunt surgery upon controlling the inflammatory phase of the infection.

Table 2. Comparative Neurological and Physiologic Parameters Pre- and Post-EVD

Clinical Parameter	Pre-EVD (On Admission)	Post-EVD (Day 3)	Clinical Implication
Intracranial Pressure (ICP)	>20 cmH ₂ O	<15 cmH ₂ O	Successful ICP control, Preventing Ischemia.
Level of Consciousness (GCS)	Somnolent (GCS: 10-12)	Apathetic (GCS: 13-14)	Significant GCS increase; reduction of pressure effect.
Muscle Tone (Spasticity)	Generalized	Localized (Right Extremity)	Evidence of acute motor recovery following decompression.
CSF Appearance	Clear	Clear	Facilitates safer planning for definitive shunt procedure.

Source: Processed Clinical Data

The table quantifies the short-term neurological improvement following EVD placement. The direct relief of intracranial hypertension resulted in a measurable increase in the level of consciousness and a reduction in severe spasticity, confirming the EVD's immediate efficacy in controlling acute intracranial hypertension.

Discussion

This EBCR successfully demonstrates the critical efficacy of EVD in managing the acute crisis of METB-associated hydrocephalus, even when complicated by severe chronic deficits.

The Problem of Microbiological Negativity and Clinical Diagnosis.

The primary challenge in this case was the negative microbiological result for *M. tuberculosis* [2, 6, 8]. This phenomenon is common, as the sensitivity of TCM or culture for TBM can be low, particularly in paucibacillary forms or subacute stages. The decision to proceed with METB treatment and EVD was validated by the highly specific constellation of findings: (1) Clinical syndrome persisting for months, (2) CSF biochemistry showing high protein and mononuclear pleocytosis, and (3) Classic radiological findings of *meningeal enhancement* and hydrocephalus [2, 7, 9]. This emphasizes that clinical-radiological correlation, often requiring the application of diagnostic scoring systems, frequently supersedes microbiological testing in endemic areas, especially in advanced stages [10].

EVD as a Life-Saving Bridge Therapy and Evidence Synthesis

The decision to install EVD over immediate VPS placement was crucial, rooted in established neurosurgical principles for acute inflammatory conditions[3,5]. EVD serves two primary, inter-related roles in this context: Immediate ICP Control (to prevent cerebral ischemia and herniation) and CSF Quality Improvement (to clear inflammatory debris and highly proteinaceous fluid)[4,11]. The documented improvement in the patient's GCS and spasticity post-EVD directly confirms that the acute neurological deterioration was predominantly driven by elevated ICP rather than solely by the chronic effects of METB or CP. This highlights EVD's function as a bridge to stabilization, allowing OAT to control the underlying infection before considering definitive VPS placement[6]. Studies show that the timing of surgical intervention is the strongest predictor of recovery, suggesting EVD benefit is derived from its immediacy in preventing brain injury[6,12]. Furthermore, our finding is supported by comparative case series. Lin et al. Demonstrated that modified EVD was effective and safe, showing comparable CSF improvement to the VPS grouping pediatric TBM hydrocephalus while reducing shunt[2]. Ahmad et al[4] reported that preoperative neurological status (GCS) remains the strongest predictor of recovery following surgical intervention in this group, underscoring the imperative for timely intervention like EVD to prevent GCS decline. The overall risk of EVD-related

infection in pediatric TBM is reported to be highly variable, necessitating strict institutional protocols[7,14].

The scarcity of high-level evidence (RCTs) found in our PICO search strategy confirms that individual case reports and synthesis of retrospective data are vital for guiding clinical practice in this complex, high-mortality condition. The success achieved in our patient, even with pre-existing Cortical Blindness and Cerebral Palsy, offers high educational value, proving that the acute component (hydrocephalus/ICP) must be prioritized surgically, regardless of the poor chronic baseline.

D. Conclusion

The placement of External Ventricular Drainage (EVD) is an essential, highly effective, and life-saving intervention for pediatric Tuberculous Meningoencephalitis-associated acute hydrocephalus, particularly in advanced stages. This case, despite the confounding factor of negative microbiological results and severe pre-existing neurological deficits, confirms that timely EVD can reverse acute neurological deterioration (improving consciousness and motor spasticity). We recommend that EVD be prioritized as a bridge therapy to stabilize patients and improve short-term neurological prognosis before definitive shunt placement is considered.

Acknowledgement

During the preparation of this article, the authors used Gemini pro to enhance readability and language, aiding in formulating and structuring responsibility for the content of the publication.

References

- Thwaites GE, van Toorn R, Schoeman J. Tuberculous meningitis: more questions than answers. *Lancet Neurol.* 2013;12(10):993-1004.
- Lin J, Zhang N, Sheng H, et al. Role of modified external ventricular drainage (mEVD) in the management of children with tuberculous meningitis hydrocephalus. *Natl Med J China.* 2011;91(35):2488-2491.
- Wang K, Li S, Zheng Y, et al. Efficacy and safety of ventriculoperitoneal shunt in children with tuberculous meningitis: a systematic review. *Childs Nerv Syst.* 2021;37(4):1199-1206.
- Ahmad F, et al. Characteristics and surgical outcomes of tuberculous meningitis and of tuberculous spondylitis in pediatric patients at Dr. Hasan Sadikin Hospital, Bandung: A single center experience. *Asian J Neurosurg.* 2018;13(3):792-798.
- Qalab A, Asad R, Hakeem M, et al. Paediatric external ventricular drains: experience from a tertiary care hospital of a developing country. *JPMMA J Pak Med Assoc.* 2016;66(10 Suppl 3):S-72-S-74.
- Raghunandan P, Aravind BL, Sudhindra S, et al. Pediatric Tuberculous Meningitis: Clinical, Radiological, and Outcome Study in a Tertiary Care Center. *Pediatr Neurol.* 2022;127:26-33.
- Bisen S, Agrawal M, Yadav D, et al. External ventricular drain: a retrospective analysis of indications, outcome, and complications in a tertiary care centre. *Asian J Neurosurg.* 2021;16(2):332-337.

- Rajshekhar V, et al. Surgical Management of Tuberculous Meningitis-Related Hydrocephalus: An Updated Practical Review. *Neurosurgery*. 2022;91(1):16-24.
- Sharma D, Tripathi M, Shukla D. Prognostic Factors and Outcome in Children with Tuberculous Meningitis and Hydrocephalus. *J Pediatr Neurosci*. 2020;15(4):307-312.
- Kumar A, Shrestha A, Gurung G, et al. Clinical profile and outcome of tuberculous meningitis in children: a 5-year retrospective review. *J Neurosci Rural Pract*. 2020;11(2):292-297.
- Bhalla R, Aggarwal D, Bansal A, et al. Magnetic resonance imaging predictors of neurological outcome in pediatric tuberculous meningitis. *J Pediatr*. 2020;226:24-30.
- Shah I. Tuberculous meningitis in children: A five-year experience from India. *Paediatr Int Child Health*. 2021;41(4):258-261.
- Badi M, Abdo S, Khalil A, et al. Challenges in diagnosis and management of tuberculous meningitis in children: A retrospective study. *PLoS One*. 2020;15(6):e0234138.
- Jain S, Kumar S. Factors affecting outcome in pediatric tuberculous meningitis: A tertiary care center experience. *Int J Contemp Pediatr*. 2021;8(7):1063-1068.
- Kumar K, Mittal N, Sharma D, et al. Hydrocephalus in pediatric tuberculous meningitis: surgical outcomes and long-term prognosis. *Childs Nerv Syst*. 2023;39(12):3975-3982.