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Case Report

Neuroendoscopic Lavage in Hydrocephalus with Ventricular Empyema: A Case Report

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Abstract

Introduction: Ventricular empyema, or pyogenic ventriculitis, is a severe condition characterized by pus accumulation in the cerebral ventricles due to intracranial infection, often caused by Gram-negative bacteria. Early diagnosis and treatment are crucial to prevent fatal neurological damage.

Case Report: A 3-month-old infant with severe hydrocephalus and ventricular empyema was admitted with symptoms of seizures, fever, and diarrhea. Initial examination showed decreased consciousness and significant leukocytosis. CT scans confirmed severe hydrocephalus and ventricular empyema. Despite resistance to standard antibiotics, neuroendoscopic lavage (NEL) and bilateral external ventricular drainage (EVD) were performed, leading to substantial improvement.

Discussion: The patient's condition improved significantly post-surgery, with a decrease in leukocyte count and resolution of empyema as shown in follow-up imaging. This case demonstrates the efficacy of NEL in treating complex pediatric neurosurgical conditions.

Conclusion: NEL proves to be an effective treatment for intraventricular empyema in pediatric patients, improving clinical outcomes and reducing hospital stays. The success of this approach emphasizes the need for tailored neurosurgical interventions and regular follow-ups to ensure patient recovery and prevent recurrence.

Keywords: ventricular empyema, neuroendoscopic lavage (NEL), hydrocephalus, pediatric neurosurgery, gram-negative bacteria

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1. Introduction

Ventricular empyema is a serious condition characterized by the accumulation of pus within the brain's ventricular system [1]. It often results from a severe infection that leads to the formation of an abscess or empyema within the ventricles. The progression typically begins with a primary infection that can be hematogenous or direct, such as from a postoperative or post-traumatic source [2]. The infection triggers an inflammatory response, leading to the accumulation of pus and the formation of granulation tissue [3]. This process can obstruct cerebrospinal fluid (CSF) flow, resulting in hydrocephalus and increased intracranial pressure [4]. The presence of biofilm-forming microbes or slow-growing pathogens complicate the diagnosis and treatment, as these micro-organisms may not be easily detected by standard CSF cultures [5, 6].

Ventricular empyema also known as ependymitis or pyogenic ventriculitis is defined as a collection of pus in the ependymal lining of the cerebral ventricle caused by intracranial infection typically by the Gram-positive bacteria such as *Staphylococcus* [2, 4]. Although the prevalence is not that clear, it is estimated that the cases of ventricular empyema are likely to increase considering the increasing incidence of bacterial meningitis caused by nosocomial infections [5, 6]. However, the incidence of ventricular empyema caused by catheter insertion ranges from 0 to 45% and 4-41% due to CSF shunt infection [7-9]. It is important to early diagnose ventricular empyema because some studies report that over the past 10 years, this disease has caused a serious impact due to its subtle clinical manifestations and can give rise to other complications that are not easy to be eradicated [6, 10-11]. Catheter-related ventriculitis is commonly associated with three risk factors, such as patient's characteristics and the underlying condition, other causes that break the integrity of the closed system, and the environment. Meanwhile, CSF shunt-related ventriculitis commonly occurs during surgery. Other mechanisms include retrograde infection from the distal shunt, the skin, and hematogenous [4]. In particular, the Gram-negative bacteria might be resistant to standard antibiotics. The early treatment of ventriculitis is crucial because fatal neurological damage can occur, even in patients in whom the infection is ultimately eradicated [6]. Intraventricular empyema has been reduced by neuroendoscopic surgery with cannula nasogastric tube (NGT) lavage and aspiration through a single burr hole. After performing lavage and aspiration, antibiotics were able to reach the affected area. Follow-up imaging and CSF cultures indicated positive outcomes, including improved results and shorter hospital stays.

Infant shunt-related bacterial ventriculitis can be treated safely and effectively by neuroendoscopy. This report's approach may treat intraventricular empyema [12]. The infection is often resistant to antibiotic treatment alone. Continuous intraventricular irrigation has been suggested but the technique is cumbersome, increases the risk of secondary infection, and is inadequate in removing adherent purulence [8]. Neuroendoscopic lavage (NEL) for intraventricular hematoma eradication is popular. NEL is safe and may treat neonatal IVH. For those who need CSF diversion, the treatment may lessen shunt reliance

and enhance survival. Good neurodevelopmental motor and cognitive outcomes are possible [5]. The NEL technique allows for the removal of the pus, irrigation of the ventricle, and evacuation of the intraventricular hemorrhage for the same reason. NEL is applicable based on the source control clause for abscess/pus/empyema. The ventricular pus makes IV antibiotics hard to reach. This NEL approach allows pus samples to be cultured for definitive antibiotic therapy.

In managing ventricular empyema, surgical intervention with external ventricular drainage (EVD) and NEL is often preferred over antibiotics alone. While antibiotics are crucial, their efficacy can be reduced by pus that obstructs drug delivery. EVD and NEL not only remove pus to improve antibiotic penetration but also provide direct pus sampling for targeted therapy. This approach effectively controls the infection, reduces intracranial pressure, and lowers the need for frequent shunt revisions, offering both immediate and long-term benefits.

2. Case Report

A 3-month-old infant weighing 3.5 kg was admitted to pediatric care with severe hydrocephalus. The individual experienced repeated episodes of seizures, fever, and diarrhea for a period of three days prior. Examination showed decreased consciousness (GCS 6 score) and bulging of major Fontanella, leukocytosis, and pneumonia. At the time of CT scan, there was severe hydrocephalus, and ventricular empyema in both lateral ventricles and the third ventricle (Figure **1**). The patient also developed complex complications and was diagnosed with severe hydrocephalus, ventricular empyema, hyponatremia, anemia, hypoalbuminemia, acute kidney injury (AKI), and marasmus. The patient presented with leukocytosis of 34.93 cells/µL and lumbar cerebrospinal fluid (LCS) analysis of the sample before obtaining NEL leukocytes of 10,400∧2 cells/µL with PMN cells of 95% and protein 1800 mg/dl. The LCS culture results showed *Pseudomonas aeruginosa* which was resistant to ciprofloxacin and meropenem (Table **1**).

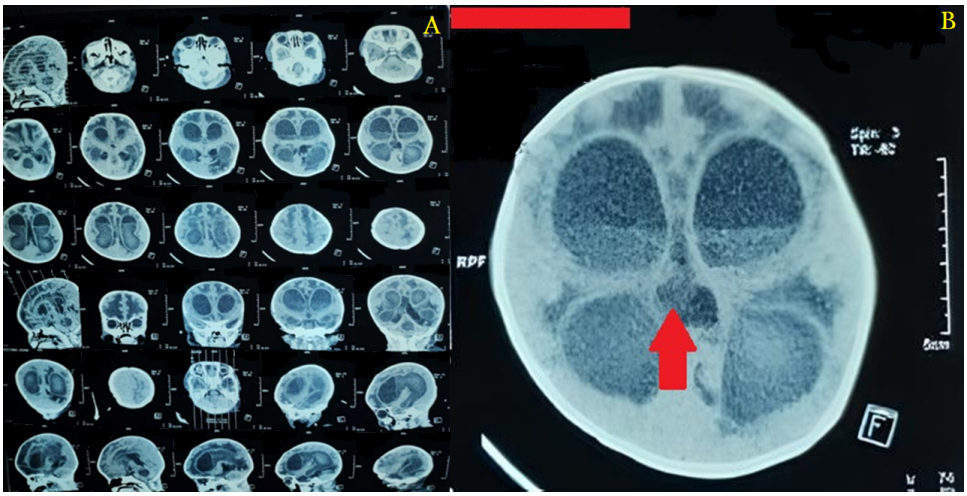

Figure 1: CT scan imaging before NEL and EVD show severe hydrocephalus and intraventricular empyema in both lateral ventricles and third ventricles.

Table 1: Leukocytes monitoring for nonconsecutive days of increase within a 30-day observation period.

Day	5th	8th	13th	17th
Result	35.93 cell/µL	15.83 cell/µL	11.63 cell/µL	7.83 cell/µL

In addition to medical management by the pediatrics department, the patient underwent immediate NEL and bilateral EVD the next day. NEL was performed using Aesculap neuroendoscopy, MINOP® system. Due to empyema in the right and left lateral ventricles, entry points were made at the right and left *cocher* points, pus evacuation was performed with a suction tube using NGT Fr 6 through the working channel by adjusting the balance between irrigation and suction strength.

2.1. Post-surgery

After NEL and EVD surgery, the patient had an improved level of consciousness with a GCS score of 9, although still with ventilator support. After drainage through EVD and meropenem therapy, an improvement was observed with LCS analysis, and leukocytes dropped to 226.5 cells/µL, PMN 56.7%. Anesthesia therapy was continued by the pediatrics department. Both EVDs were removed on the 7th postoperative day after EVD weaning. Two days after EVD removal, a head CT scan was performed and the empyema was evacuated, and no active hydrocephalus was observed (Figure **2**). Medical therapy was continued by neuropediatric, and the patient was discharged in the need for long-term follow-up, particularly regarding neurodevelopmental outcomes.

3. Discussion

Ventricular empyema management carries risks such as postoperative infections, bleeding, and ventricular wall damage. Complications can include worsening hydrocephalus or recurrent empyema if the infection is not fully resolved. Key signs to monitor are persistent fever, altered mental status, and neurological changes. Regular imaging and CSF analysis are essential for the early detection of complications. Red flags include lack of improvement, sudden clinical deterioration, or new neurological symptoms.

Patients experience higher mortality and functional impairment as a result of intraventricular empyema, which can have devastating consequences. When no pathogen is isolated from the CSF, diagnosis can be difficult, which is commonly due to prior antimicrobial treatment or infections with slow-growing, biofilm-forming microbes [7]. Results from the lab present that this patient had an increase in leukocytes of 22.00 103/mm^3 after EVD. Adhikari [1] and Marinelli [9] show the importance of screening leukocytes from the patient with intraventricular empyema immediately. CSF showed increased leukocytes (1000/mm^3, normal values 0-5), 2 weeks later the neurological examination was negative, and the leukocytes count in the CSF was decreased to 64/mm [1, 9].

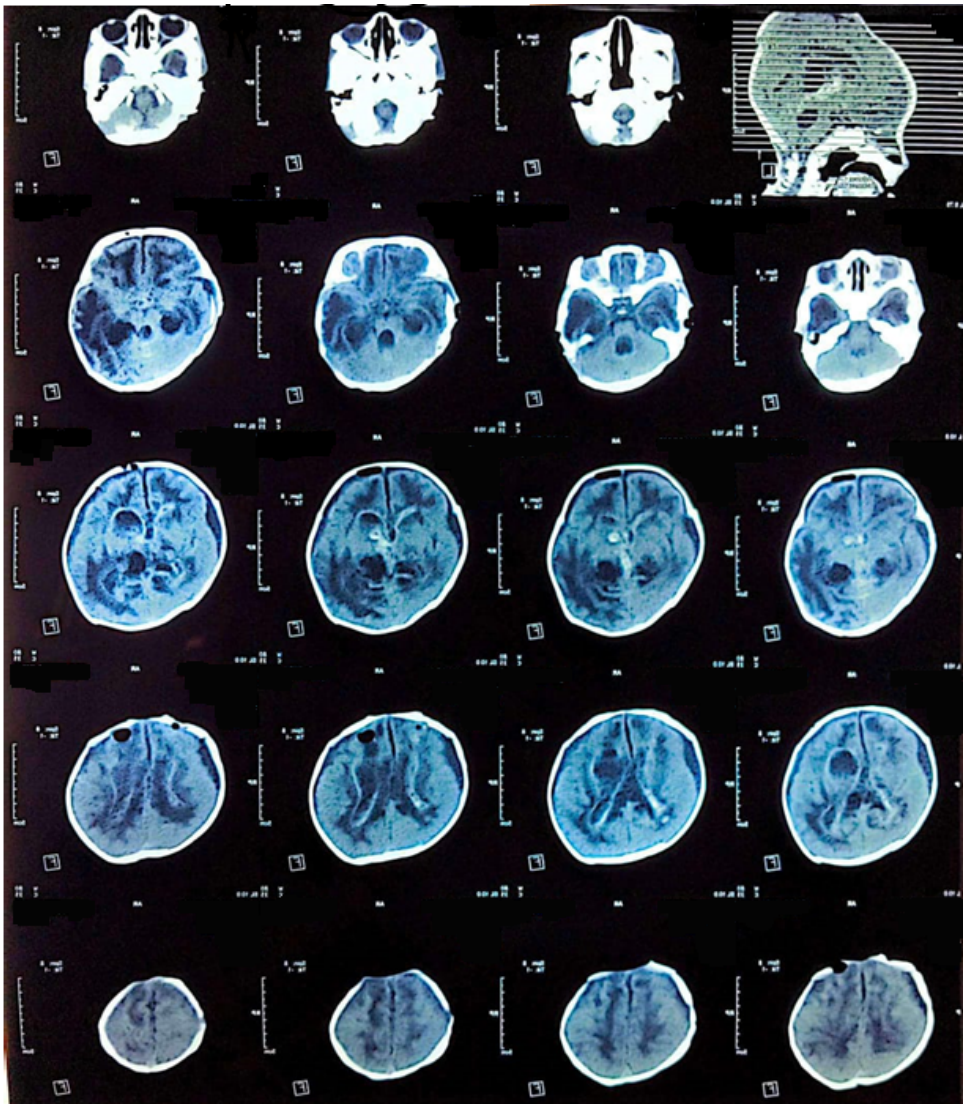

Figure 2: Post NEL and EVD surgery shows no active hydrocephalus, and significant reduction of empyema IV ventricular system.

CSF analysis was consistent with bacterial infection including neutrophilic leukocytosis (2300/mm^3 of leukocytes with 83% PMNs), after 3 days of antimicrobial therapy, the patient improved significantly and leukocytosis was back to baseline. The patient had hydrocephalus and EVD. After multiple laboratory tests, the patient required NEL for intraventricular empyema. After undergoing EVD, this patient went on to NEL. The patient needed to be monitored constantly, even though his NEL score was neurodevelopmentally good motor and cognitive outcome [3]. The use of NEL has potentially reduced the need for frequent subsequent shunt revisions4. Nevertheless, it is essential to have routine examinations in order to detect the return of infection, hydrocephalus, or other issues including changes in ventricle size or limitation. Physical exams and imaging studies (CT or MRI) could form the basis of a checkup. Schulz [5] postoperatively, close monitoring of patients' clinical status, head circumference measurements, and serial ultrasonography examinations were conducted to assess the effectiveness of the NEL in managing posthemorrhagic hydrocephalus in neonates.

The case reports under review encapsulate a broad spectrum of pediatric neurosurgical conditions, distinguished by their age diversity and clinical intricacies. The study by Tandean [12] is noteworthy for its focus on a 2-month-old infant suffering from severe hydrocephalus and empyema (Table **2**). This case underscores the unique challenges posed by treating very young patients with complex medical issues. In a contrasting perspective, Schaumann's study [10] examines a group of 14 infants with posthemorrhagic hydrocephalus. Similarly, Gaderer's research [3] presents a more varied age demographic, all receiving NEL alongside other treatments. The Tandean [12] study stands out for its emphasis on a particularly young patient facing multifaceted complications (Table **2**).

Table 2: NEL for ventriculitis for pediatric.

Author	Age (range)/ Gender	Before NEL	Main description of procedure	Outcome	Follow up
Tandean, et al. [12]	2 months old boy	Twice EVD procedure and administration of intrathecal antibiotic	LOTTA ventriculoscopes were used for active aspiration and irrigation. With warm saline irrigation and aggressive pus aspiration through a nasogastric tube (NGT), a right frontal burr hole was created. Septostomy and ventriculoscope cleaning of the contralateral ventricle followed infection clearance. Assessment and intrathecal antibiotic therapy were done with an EVD. Post-op Amikacin was given IV 100 mg and intrathecal 10 mg.	DWI brain MRIs on day 5 post-surgery indicated considerable improvement without limits. Patients' clinical conditions improved, and CSF culture was negative. Another DWI imaging 3 days later showed continuing recovery and unchanged ventricular size.	Ventricle size was reduced by VP shunt 2 months after discharge. The patient was released 5 days after VP shunt with good prognosis
Schaumann [10]	14 of infants with a median age of 29 weeks	NEL was used once the infant was medically stable and under appropriate antibiotic treatment.	Neuroendoscopic lavage procedures (NEL, 90%) were performed, which included clearance of the ventricular system from remnant of previous intraventricular hemorrhage or infectious debris.	The group included 80 infants with intraventricular hemorrhage who underwent NEL for posthemorrhagic hydrocephalus. A CSF diverting shunt was inserted in 47 of these children (58.8%). 41.2% of these kids were shunt free.	
Gaderer et al. [3]	49.7 weeks (range) / Male (n = 14) and Female (n = 9)	-	NEL + septostomy + EVDor ventricular accessdevice (reservoir) orshunt + aspiration	All patients survived, Shunt success rate reached 91%	Within 24 months

EVD: External ventricular drain, LOTTA: Lateral orbitally tractable transnasal arthroscope, DWI: Diffusion-weighted imaging, MRI: Magnetic resonance imaging, CSF: Cerebrospinal fluid

The varied interventions across these case studies highlight the adaptability and effectiveness of neuroendoscopic techniques. Tandean [12] utilizes an integrated approach combining an EVD, NEL, and ventriculoperitoneal (VP) shunt to address severe hydrocephalus and empyema. Schaumann [10] primarily employs NEL for treating posthemorrhagic hydrocephalus, while Gaderer [3] integrates NEL with additional

procedures like septostomy, EVD, or shunt placement and aspiration. The nuanced application of these techniques, particularly in Tandean's case [12], demonstrates a comprehensive and tailored strategy for managing complex conditions. The success rates of shunt procedures in these studies, in particular, says it all. Tandean [12] reports a successful NEL and EVD implementation with a notable reduction in ventricle size. Schaumann [3] and Gaderer [10] both exhibit impressive shunt success rates of 91% within a 24-month timeframe. This consistency not only underlines the effectiveness of neuroendoscopic interventions but also affirms their viability in diverse pediatric neurosurgical contexts.

In terms of postoperative outcomes, Tandean's study [12] details a significant improvement in the Glasgow Coma Scale (GCS) scores, successful weaning from ventilator support, EVD removal, and a 30-day discharge. While Schaumann [10] and Gaderer [3] reports offer valuable insights into successful recovery and the overall efficacy of the intervention. The study reported by Tirado [13] investigates NEL for posthemorrhagic hydrocephalus in preterm neonates, involving 46 patients with severe cerebral ventricular hemorrhage, NEL demonstrated safety and effectiveness by improving postoperative conditions, enhancing brain imaging results, and reducing the need for permanent shunts, with most patients subsequently exhibiting good motor and cognitive skills in future assessments. This illustrative case report of pediatric neurosurgical interventions highlights the adaptability and efficacy of integrating NEL, EVD, and VP shunts in managing complex cases, showcasing significant improvements in patient outcomes across varied age demographics and clinical conditions. This case report highlights the effectiveness of NEL combined with EVD in treating ventricular empyema in pediatric patients. By demonstrating successful outcomes and reduced hospital stays, it adds value to existing literature and underscores the benefits of integrating surgical and medical management. The report provides insights into procedural efficacy, pathogenesis, and potential complications, offering a comprehensive approach to managing this challenging condition and guiding future treatment strategies.

4. Conclusion

The results of this case report and the accompanying research demonstrate that NEL is an effective treatment for intraventricular empyema in children, showcasing significant improvements in outcomes regardless of age or clinical environment. These findings underscore the importance of tailored neurosurgical approaches and frequent follow-ups to avoid complications, ensure patient well-being, and highlight the need for future research to compare longitudinal results and enhance pediatric neurosurgical care.

Author Contributions

Farhad Bal'afif: Corresponding author, responsible for communication with the journal during submission, peer-review, and publication processes. Contributed to study design, data collection, and manuscript

preparation. Tommy A Nazwar: Study design, data analysis, and interpretation of results. Donny W Wardhana: Data collection and drafting the manuscript. Oei Thomas Sanjaya: Study design and provided critical revisions to the manuscript. Keneysha Naomi Mataniari: Data collection and performed statistical analyses. Farahiyah Sharfina Saputri: Interpretation of data and manuscript editing. Liliana Dewi: Data collection and literature review. Hisanifa Arifani: Data collection and manuscript preparation. Ni Nyoman Triana: Data collection and administrative support. Mustofa: Oversight of the research process, study design, and critical revisions of the manuscript.

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None.

Statement of Ethics

The case report was conducted in accordance with the World Medical Association (WMA) Declaration of Helsinki.

Ethical Approval

Is not required in accordance with policies of the Hospital's Ethics Committee.

Patient Consent Statement

Written informed consent was obtained for publishing the case and any accompanied images.

Conflict of Interest

The authors declare that there is no conflict of interest.

Artificial Intelligence (AI) Disclosure Statement

AI-unassisted work.

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Data Sharing Statement

All data and images generated from this case report are published in this article.

References

[1] Adhikari P, Antala D, Pyakuryal B, Muhammed A, Pudasainee P, Friedman H, et al. Community-acquired meningitis complicated by pyogenic ventriculitis: A case report. Cureus. 2022 Apr;14(4):e23907.

[2] Bajaj S. Newer antidiabetic drugs in Ramadan. J Pak Med Assoc. 2015 May;65(5 Suppl 1):S40–S43.

[3] Gaderer C, Schaumann A, Schulz M, Thomale UW. Neuroendoscopic lavage for the treatment of CSF infection with hydrocephalus in children. Childs Nerv Syst. 2018 Oct;34(10):1893–1903.

[4] Harris L, Munakomi S. Ventriculitis. StatPearls. StatPearls Publishing; 2023. http://www.ncbi.nlm.nih.gov/books/NBK544332/

[5] Honeyman SI, Boukas A, Jayamohan J, Magdum S. Neuroendoscopic lavage for the management of neonatal post-haemorrhagic hydrocephalus: A retrospective series. Childs Nerv Syst. 2022 Jan;38(1):115–121.

[6] Hong JT, Son BC, Sung JH, Kim IS, Yang SH, Lee SW, et al. Significance of diffusion-weighted imaging and apparent diffusion coefficient maps for the evaluation of pyogenic ventriculitis. Clin Neurol Neurosurg. 2008 Feb;110(2):137–144.

[7] Karvouniaris M, Brotis A, Tsiakos K, Palli E, Koulenti D. Current perspectives on the diagnosis and management of healthcare-associated ventriculitis and meningitis. Infect Drug Resist. 2022 Feb;15:697–721.

[8] Lang M, Habboub G, Moore NZ, Recinos VM, Mohammadi AM, Nagel S, et al. Neuroendoscopic evacuation of intraventricular empyema using a side-cutting aspiration device. J Clin Neurosci. 2018 Jan;47:323–327.

[9] Marinelli L, Trompetto C, Cocito L. Diffusion magnetic resonance imaging diagnostic relevance in pyogenic ventriculitis with an atypical presentation: a case report. BMC Res Notes. 2014 Mar;7(1):149.

[10] Schaumann A, Bührer C, Schulz M, Thomale UW. Neuroendoscopic surgery in neonates - indication and results over a 10-year practice. Childs Nerv Syst. 2021 Nov;37(11):3541–3548.

[11] Shah GS. Pyogenic ventriculitis and meningitis caused by *Streptococcus acidominimus* in humans: A case report. Am J Case Rep. 2018 Mar;19:329–334.

[12] Tandean S, Hendriansyah L, Djokomuljanto S, Saputra NA, Juliansen A, Valentina S, et al. Neuroendoscopic aspiration and lavage of intraventricular empyema following shunt infection in infants. Pan Afr Med J. 2018 Sep;31:15.

[13] Tirado-Caballero J, Rivero-Garvia M, Arteaga-Romero F, Herreria-Franco J, Lozano-Gonzalez Á, Marquez-Rivas J. Neuroendoscopic lavage for the management of posthemorrhagic hydrocephalus in preterm infants: Safety, effectivity, and lessons learned. J Neurosurg Pediatr. 2020 May;26(3):237–246.