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VENTRICULITIS ASSOCIATED WITH AN INTRACRANIAL DEVICE: A CASE REPORT

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Palabras clave: Derivaciones del Líquido Cefalorraquídeo; Neurocirugía; Síndrome del Ventrículo Colapsado; Ventriculitis Cerebral; Ventriculostomía

Luis Alejandro García-Rairan
Kevin Guillermo Castro-Gómez
Kevin José Navarro-Jaimes
Jaime Andelfo Arias-Guatibonza
Universidad Nacional de Colombia -
Bogotá Campus - Faculty of Medicine -
Department of Neurosurgery -
Bogotá D.C. - Colombia.

Kiliam David Mora-Herrera
Universidad Nacional de Colombia -
Bogotá Campus - Faculty of Medicine -
Department of Neurosurgery -
Bogotá D.C. - Colombia.
Hospital El Tunal - Neurosurgery Service -
Bogotá D.C. - Colombia.

Corresponding author
Luis Alejandro García-Rairan.
Departamento de Neurocirugía, Facultad de Medicina,
Universidad Nacional de Colombia.
Bogotá D.C. Colombia.
E-mail: lugarciara@unal.edu.co.

ABSTRACT

Introduction: Ventriculitis is the inflammation of the ependymal lining of the cerebral ventricles, commonly caused by infection and often associated with the use of intracranial devices such as external ventricular drains (EVDs). It is characterized by high morbidity and mortality, high clinical costs, and the risk of serious neurological sequelae.

Case presentation: A 20-year-old female was admitted to the emergency department of a tertiary care health care center in Bogotá, Colombia, in 2024 due to headache, phosphenes, tinnitus, vomiting, and a seizure episode. During her hospital stay, she was diagnosed with agenesis of the corpus callosum, hypoplasia of the right lateral ventricle, and ventriculomegaly due to obstructive hydrocephalus secondary to aqueductal stenosis, which required the placement of a ventriculoperitoneal shunt (VPS). Since the patient developed ventriculitis due to methicillin-resistant *Staphylococcus aureus* during the postoperative period, targeted antibiotic treatment and eight additional surgical procedures were necessary. After 60 days of hospitalization, during which she received prolonged antimicrobial treatment and physical and occupational therapy, she was discharged with the indication of anticonvulsant therapy.

Conclusion: This case demonstrates the complexity of ventriculitis management in patients with severe neurological conditions. Despite her multiple complications, the patient achieved a favorable neurological outcome, highlighting the importance of preventing ventriculitis and providing timely care to improve clinical outcomes.

RESUMEN

Introducción. La ventriculitis se define como la inflamación del revestimiento endimario de los ventrículos cerebrales, habitualmente de origen infeccioso y con frecuencia asociada al uso de dispositivos intracraneales como los drenajes ventriculares externos (DVE). Se caracteriza por una elevada morbimortalidad, altos costos hospitalarios y el riesgo de secuelas neurológicas graves.

Presentación del caso. Mujer de 20 años que en 2024 ingresó al servicio de urgencias de una institución de salud de tercer nivel de atención ubicada en Bogotá, Colombia, por cefalea, fosfenos, tinnitus, vómito y un episodio convulsivo. Durante su estancia hospitalaria fue diagnosticada con agenesia del cuerpo calloso, hipoplasia de ventrículo lateral derecho y ventriculomegalia por hidrocefalia no comunicante secundaria a estenosis del acueducto de Silvio, por lo que requirió colocación de una derivación ventriculoperitoneal (DVP). Debido a que durante el posoperatorio la paciente desarrolló ventriculitis por *Staphylococcus aureus* resistente a meticilina, fue necesario iniciar manejo antibiótico dirigido y la realización de ocho procedimientos quirúrgicos adicionales. Tras 60 días de hospitalización en los que recibió

tratamiento antimicrobiano prolongado y rehabilitación por fisioterapia y terapia ocupacional, fue dada de alta con manejo anticonvulsivo.

Conclusión. Este caso subraya la complejidad del manejo de la ventriculitis en pacientes con afecciones neurológicas graves. A pesar de las múltiples complicaciones, la paciente se recuperó satisfactoriamente, lo que evidencia la importancia de la prevención de la ventriculitis y su intervención oportuna para optimizar los resultados clínicos.

INTRODUCTION

Ventriculitis is the inflammation of the ependymal lining of the cerebral ventricles. It is usually caused by infections such as meningitis but can also be secondary to conditions such as head trauma, cerebral abscesses with intraventricular rupture, cerebrospinal fluid (CSF) leak, complications from neurosurgery, or the placement of intracranial devices (1). Although ventriculitis can occur in various contexts, it is particularly associated with the use of external ventricular drains (EVD), which can lead to various complications (1,2).

The incidence of ventricular catheter-related ventriculitis varies between 0% and 45%, depending on the insertion technique and subsequent management (1). CSF shunt infection rates range from 4% to 41%, with a typical range of 4% to 17%, while EVD-related ventriculitis rates vary from 0% to 22% (1).

Ventriculitis is a serious complication with a hospital mortality rate of 30% and neurological sequelae in survivors of 60% (3). Moreover, catheter-related ventriculitis caused by Gram-negative organisms, which accounts for about 58% of cases, is associated with significant morbidity and mortality (1).

In terms of biochemistry, ventriculitis is characterized by a progressive decrease in glucose in the CSF, as well as an increase in protein concentration inside of it, along with lymphocytic pleocytosis (4,5). While no specific definition or diagnostic criteria have been established (1), ventriculitis can be diagnosed on the basis of a positive CSF culture or Gram stain in the presence of a high fever and clinical signs of meningitis, such as neck stiffness, photophobia, altered mental status, or seizures (4,5). It is fundamental to ensure that these clinical symptoms are attributable exclusively to ventriculitis, ruling out other possible causes (4,5).

The management of ventriculitis is established based on the patient's age, the cause of the infection, and the choice of antibiotic depending on the results of the CSF culture. Intravenous antibiotics are the most commonly used, but their use to treat a central nervous system infection is limited in these cases because of the blood-brain barrier (6).

Ventriculitis is a significant complication in neurosurgery due to its high morbidity and mortality rates and the neurological sequelae it causes. The following is the case report of a young female patient with ventriculitis who required a prolonged hospital stay and multiple surgical interventions due to the

severity of her condition. The patient made a satisfactory recovery as a result of the comprehensive therapeutic approach undertaken and timely surgical intervention.

CASE PRESENTATION

A 20-year-old woman with no significant medical history was admitted to the emergency department of a tertiary care health care institution in Bogotá, Colombia, in 2024, due to occipital neuralgia, phosphenes, tinnitus, and vomiting during the past year. Her symptoms had intensified two days prior to admission, and she also had a seizure the day before admission. During the physical assessment upon admission, no abnormal findings were reported in the neurological examination.

The computed tomography (CT) scan of the skull (Figure 1) requested upon admission showed agenesis of the corpus callosum, right lateral ventricle hypoplasia, and ventriculomegaly, with no signs of acute hydrocephalus. The follow-up CT scan of the skull, performed 12 hours later, revealed noncommunicating hydrocephalus secondary to stenosis of the aqueduct of Sylvius. Therefore, two days after admission, when the patient's neurological condition deteriorated (total score of 7 on the Glasgow Coma Scale [eye opening: 2, verbal response: 1, motor response: 4]), she required mechanical ventilation. An urgent ventriculoperitoneal shunt (VPS) was made using a programmable valve set at 100 mmHg (Figure 2). During this procedure, a CSF analysis was performed, with negative results for infection.

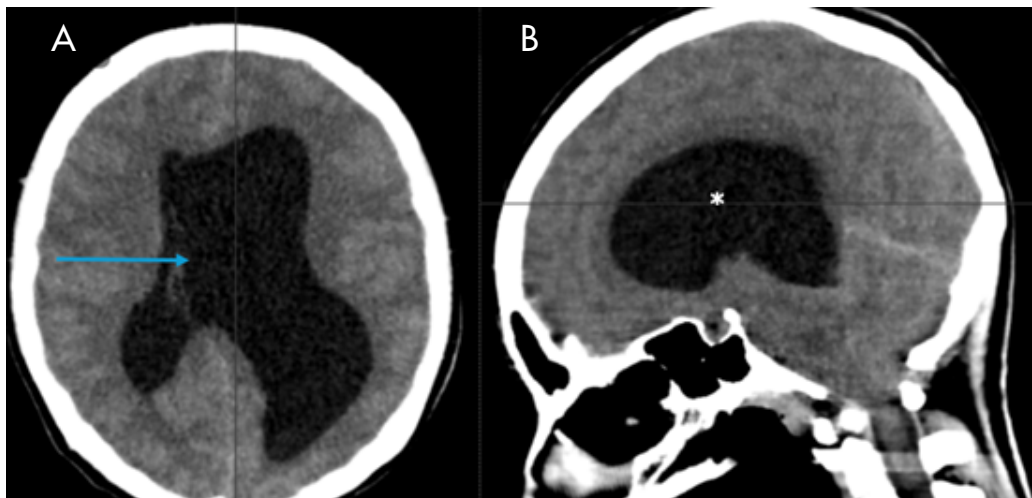


Figure 1. Non-contrast computed tomography scan of the skull (A: axial view; B: sagittal view) showing hypoplasia of the right lateral ventricle (arrow) and dilation of the supratentorial ventricular system (asterisk), findings consistent with stenosis of the aqueduct of Sylvius.

Source: Images obtained while conducting the study.

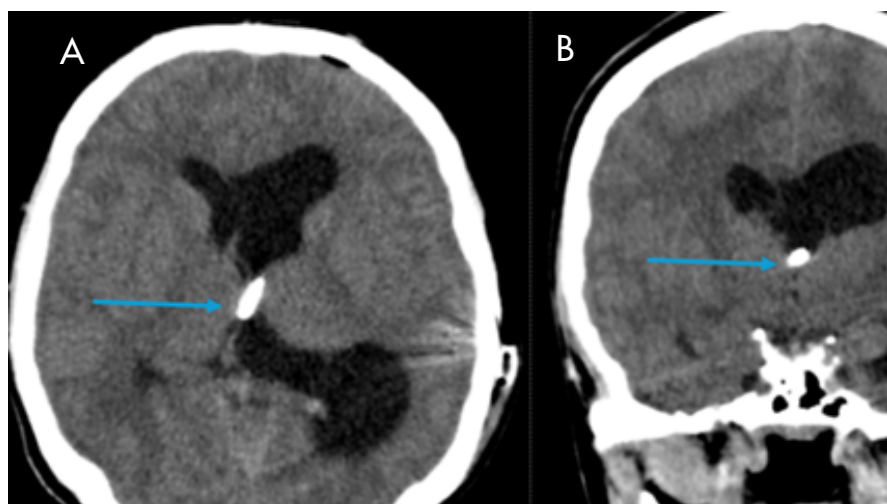


Figure 2. Postoperative non-contrast computed tomography of the skull (A: axial view, B: coronal view), showing a ventriculoperitoneal shunt catheter with the proximal end positioned in the interventricular foramen (foramen of Monro) (arrows).

Source: Images obtained while conducting the study.

The patient progressed positively and was discharged six days after the surgery with instructions to take acetaminophen (500 mg orally every 8 hours for 10 days) and levetiracetam (500 mg orally every 12 hours for 90 days). However, eight days later, she was readmitted to the emergency department of the same institution complaining of vomiting and diarrhea for the past three days and headache for the past 24 hours. Physical examination revealed tenderness on palpation in the right iliac fossa and a positive Blumberg's sign.

Upon admission, a complete blood count was performed, revealing leukocytosis ($17\,000\text{ cells/mm}^3$) and neutrophilia ($12\,300\text{ cells/mm}^3$). Neither the abdominal ultrasound nor the CT scan of the skull requested afterwards revealed any significant abnormalities, with the latter also showing that the EVD catheter was correctly positioned. Given the suspicion of a gastrointestinal infection, hospitalization and initiation of empirical antibiotic treatment with piperacillin/tazobactam (4.5 g intravenously every 6 hours for 7 days) were indicated.

On the second day of hospitalization, the patient developed a fever (39°C) and reported that her headache had worsened and was now accompanied by abdominal pain. Given the suspicion of an infectious complication related to the shunt system, a puncture of the VPS valve drip chamber was performed, showing cloudy CSF, pleocytosis (100 cells/mm^3), hypoglycorrhachia (10 mg/dL), and hyperproteinorrhachia (124 mg/dL), findings consistent with central nervous system infection.

In light of the above, empirical antibiotic treatment was replaced with vancomycin (1 g intravenously every 12 hours) and cefepime (1 g intravenously

every 8 hours). However, the patient's neurological condition progressively deteriorated, presenting with drowsiness, disorientation, persistent headache, and bradycardia, suggesting a dysfunction of the conduction system. Based on this suspicion, surgery was recommended to remove the VPS system and replace it with an EVD, a procedure that was performed two weeks after the VPS was placed.

At first, the patient's neurological condition improved; however, seven days after the procedure she developed a headache associated with an obstruction of the EVD system by purulent material. A contrast-enhanced CT scan of the skull was then requested, revealing ventriculitis (Figure 3). Based on these findings, a third surgical procedure was scheduled (6 days after the second) to perform ventricular lavage and replace the EVD. During the procedure, a CSF sample was obtained in which methicillin-resistant *Staphylococcus aureus* (MRSA) was isolated. Consequently, antibiotic treatment was adjusted to vancomycin (1 g intravenously every 12 hours) and rifampicin (300 mg intravenously every 12 hours).

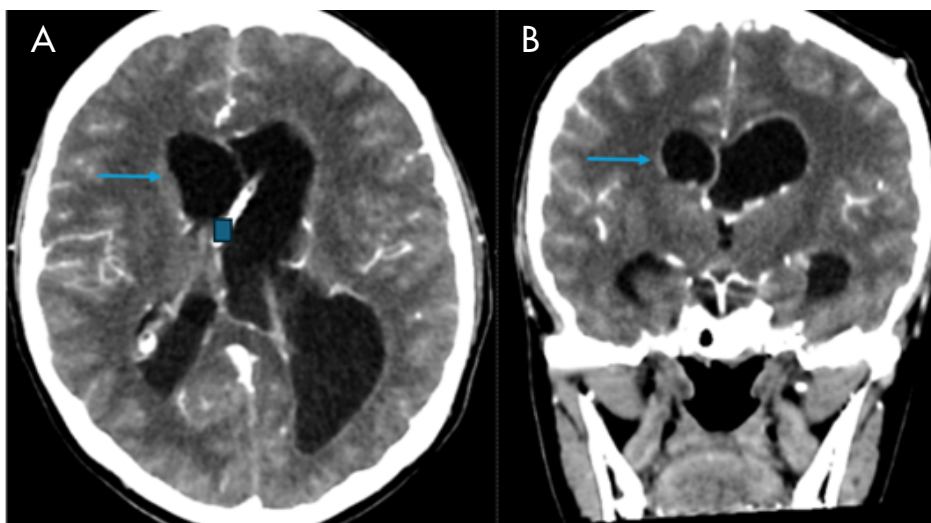


Figure 3. Contrast-enhanced computed tomography scan of the skull (A: axial view; B: coronal view) showing ependymal enhancement after contrast administration (arrow) and the distal end of the external ventricular drain catheter positioned in the right lateral ventricle (box).

Source: Images obtained while conducting the study.

Seven days after EVD replacement, the patient presented with headache and fever once again. Following the reappearance of these symptoms, a new CT scan of the skull was performed, revealing trapped right lateral ventricle. Consequently, on the same day, she underwent a fourth surgical procedure involving neuroendoscopic septostomy, ventricular lavage, resection of intraventricular septations, and replacement of the EVD system.

Although the patient's progress was favorable during the first postoperative week, eight days after the procedure she presented with increased intracranial

pressure (ICP) and recurrence of headache. Another CT scan of the skull revealed entrapment of the temporal horn of the left lateral ventricle, resulting in the placement of an EVD on the left side 9 days after the fourth surgical procedure (Figure 4).

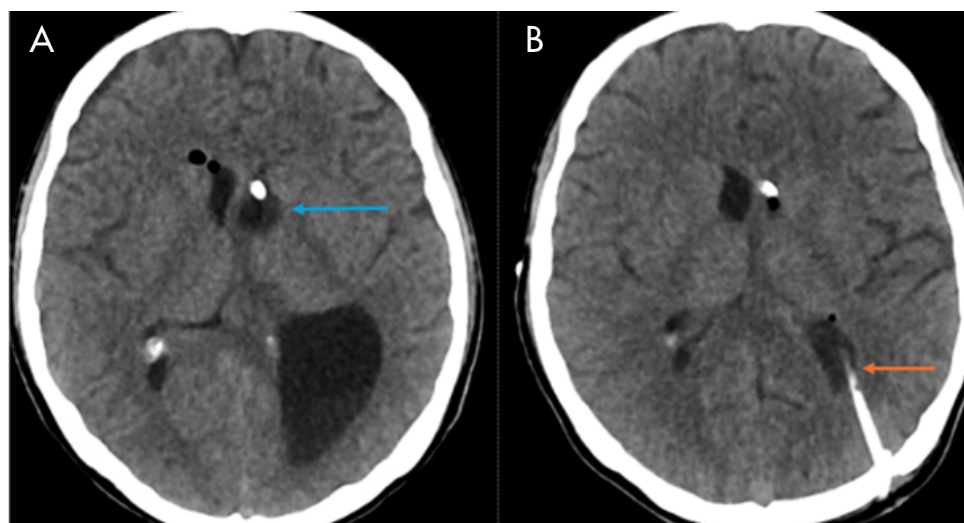


Figure 4. Postoperative non-contrast CT scan of the skull (axial view). A) entrapment of the temporal horn of the left lateral ventricle (arrow); B) external ventricular drain catheter in the temporal horn of the left lateral ventricle (arrow).

Source: Images obtained while conducting the study.

Given the irregular evolution of the patient's neurological condition, seven days after the fifth surgery, it was decided to perform a new surgical intervention in which the right EVD was replaced. Three days later, it was necessary to replace the left EVD due to neurological deterioration secondary to shunt system obstruction. During this procedure, a CSF sample was taken for cytochemical analysis and culture; the former showed improvement in inflammatory parameters, while the latter was negative for bacterial growth.

On day 41 of hospitalization, the patient's neurological condition deteriorated again, so a follow-up CT scan of the skull was ordered, showing findings consistent with dilation of the temporal horn of the left lateral ventricle, as well as the presence of septa in the right lateral ventricle. Given these findings, an eighth surgical procedure was performed (7 days after the seventh), consisting of the removal of the bilateral ventriculostomies, the placement of a programmable shunt valve set to an initial pressure of 110 mmH₂O, and endoscopic resection of multiple adhesions (synechiae) in the left temporal horn of the lateral ventricle and bilateral inter- and intraventricular synechiae (Figure 5).

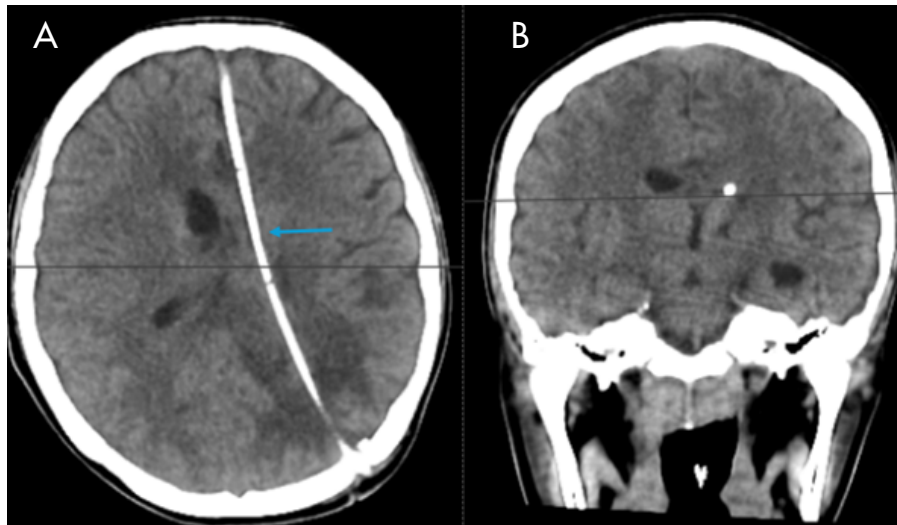


Figure 5. Non-contrast CT scan of the skull (a: axial view; b: coronal view) showing an external ventricular drain catheter lodged in the interhemispheric fissure (arrow), with no evidence of hydrocephalus.

Source: Images obtained while conducting the study.

The patient remained under observation and received comprehensive physical therapy and occupational therapy in the general ward. Following the instructions of the infectious disease department, she completed a 32-day course of antibiotics with vancomycin (1 g intravenously every 12 hours) and linezolid (600 mg intravenously every 12 hours). During this period, she had an adequate functional recovery, both in terms of motor function and deglutition, with a favorable clinical outcome. Her neurological condition continued to be stable, and she did not develop any relevant clinical manifestations. On day 60 of hospitalization, she was discharged with anticonvulsant treatment (levetiracetam 500 mg orally every 8 hours for 90 days). The timeline of the case is shown in Figure 6.

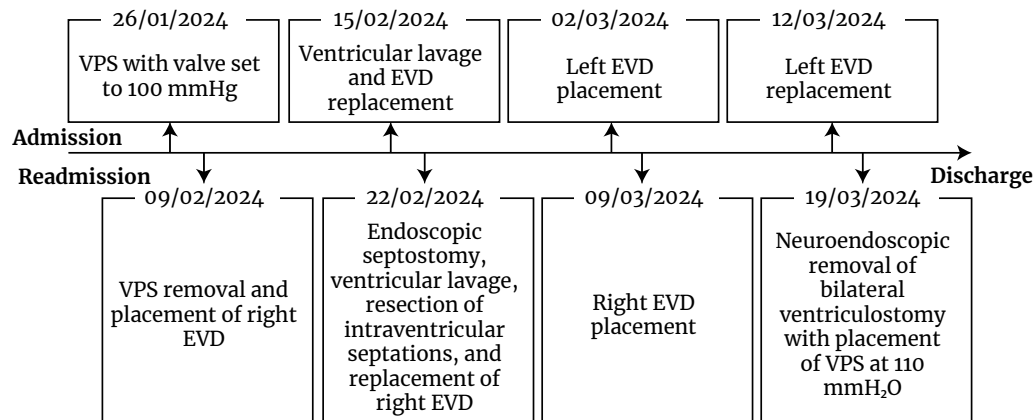


Figure 6. Case timeline.

VPS: ventriculoperitoneal shunt; EVD: external ventricular drain.

Source: Own elaboration.

DISCUSSION

Ventriculitis is an inflammation of the brain ventricles usually caused by an infection of the ventricular system (1). However, this complication is also associated with trauma, brain abscess, infection, and neurosurgical procedures such as EVD placement or permanent intraventricular shunts that allow CSF drainage (6,7). Ventriculitis caused by Gram-negative bacteria is a serious complication associated with high morbidity and mortality rates (1), prolonged hospital stays, high hospitalization costs, and an increased need for reoperations and readmissions (8), as in this case.

Risk factors for developing ventriculitis include subarachnoid hemorrhage, neurosurgical procedures, concurrent infections, external catheter placement, frequent manipulation of the EVD system, nonadherence to EVD insertion and maintenance protocols, and extended EVD placement duration (1). Regarding these latter factors, it has been reported that the infection rate associated with the use of EVD can be reduced to 0.80% by implementing strict disinfection and asepsis protocols, including the use of subcutaneous tunnels and disinfectant films; however, using these protocols can be challenging during emergency surgeries (8).

Four mechanisms involved in CSF shunt infection have been described, the most common being colonization during initial surgical placement. The other three include retrograde infection from the distal end of the catheter (e.g., intestinal perforation), insertion of a needle through the skin into the drip chamber for CSF sample collection, and hematogenous spread (1,9). In the case of EVDs, infection is usually acquired during surgery, although retrograde infection also plays a significant role (1).

Ventriculitis can cause symptoms such as low-grade fever, changes in CSF characteristics, and clinical manifestations of hydrocephalus secondary to obstruction of the drainage system, such as headache, nausea, vomiting, and behavioral changes, all of which were observed in the patient in this case report. When inflammation is more severe, signs of meningitis may be found, such as altered consciousness, focal neurological deficits, unexplained seizures, neck stiffness, fever without apparent infectious focus, photophobia, cranial nerve dysfunction, and irritability (4,5,9). The presence of inflammatory signs or purulent exudate in the tunneled course of the catheter or at its skin exit site is also relatively common (9).

When patients with VPS present with abdominal pain, it is recommended to perform a CT scan of the abdomen with and without contrast or an abdominal ultrasound, in order to identify CSF leaks at the distal end of the shunt (10). During the diagnosis process, a contrast-enhanced CT scan may reveal subtle meningeal enhancement; however, parenchymal lesions are not easily visualized, except in areas of ischemia associated with secondary vasculitis, making magnetic resonance imaging (MRI) the most reliable method for diagnosing ventriculitis (11).

MRI scans of patients with ventriculitis commonly show intraventricular debris, pus, abnormal ependymal signal intensity, and enhancement of the ventricular lining. FLAIR sequences show an elevated signal along with ependymal enhancement. Moreover, in most cases, pial or dura-arachnoid alterations are also found. Diffusion-weighted imaging is particularly useful due to its high sensitivity for detecting lesions (11,12).

The standard treatment for infectious ventriculitis is the administration of intravenous antibiotics, timely removal of CSF drains, the use of antimicrobial-impregnated devices (9), and ventricular drainage with or without continuous intraventricular irrigation (12). Recent guidelines from the Infectious Diseases Society of America (IDSA) recommend vancomycin with trough concentrations of 15–20 µg/mL as first-line antibiotic treatment for MRSA infections. Nonetheless, if the minimum inhibitory concentration of the microorganism is ≥ 1 ng/µL, daptomycin, ceftaroline, or linezolid are recommended as second-line treatments; the latter has a good penetration profile in the blood-brain barrier, making it a reasonable alternative in cases of allergy to vancomycin or therapeutic failure (13). In this case, the initial antibiotic scheme consisted of vancomycin and cefepime. This choice was made taking into account the initial recommendations for empirical treatment of ventriculitis of possible nosocomial origin. However, given the persistence of symptoms, it was decided to replace cefepime with linezolid (while continuing vancomycin), bearing in mind what is stated in the literature for refractory cases or when the response to initial treatment is unsatisfactory. Intraventricular administration of antibiotics may be considered in cases of refractory ventriculitis.

Neuroendoscopy, widely used in the treatment of noncommunicating hydrocephalus, is an alternative that offers several advantages for the management of ventriculitis (7,12), including reduced incision size, tissue retraction, and better postoperative healing time. In addition, neuroendoscopy allows high-flow irrigation with accurate control of flow direction, facilitating the safe removal of infection-induced membranes that may adhere to the ventricular wall (12).

This case report had some limitations. First, the patient's postoperative course was complex, marked by multiple surgical interventions and adjustments to antimicrobial treatment, making it difficult to associate clinical improvement with a specific intervention. Secondly, the inability to conduct long-term follow-up prevented a comprehensive assessment of the patient's neurological progress and functionality, as well as the risk of infection recurrence. Despite these limitations, the case illustrates the considerable therapeutic challenges involved in ventriculitis, especially in the context of prolonged hospitalizations. It is also a significant contribution to the literature, as it highlights the importance of effective prevention of this type of infection, as this could substantially reduce the duration and costs of hospitalization, as well as the

associated morbidity and mortality rates.

With the abovementioned in mind, further research is needed to systematically evaluate the incidence and risk factors associated with VPS system infections in young patients with congenital malformations of the central nervous system. Similarly, it is necessary to further develop and validate intraoperative strategies aimed at reducing the risk of infection during these procedures.

CONCLUSIONS

Ventriculitis is an inflammation of the brain ventricles with high morbidity and mortality rates and a considerable burden of long-term sequelae. Prevention is essential during procedures such as VPS or EVD placement as well as timely identification and treatment, considering that failure to treat it promptly can lead to prolonged hospitalizations and multiple surgical interventions. In this regard, it is fundamental to promote follow-ups that allow determining with greater precision the long-term neurological and functional sequelae of ventriculitis, with the aim of designing more specific, effective, and evidence-based rehabilitation protocols.

ETHICAL CONSIDERATIONS

The patient's informed consent was obtained for the preparation of this case report.

CONFLICTS OF INTEREST

None stated by the authors.

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