Endoscopic Third Ventriculostomy for the Management of Obstructive Hydrocephalus in Pregnancy: A Case Report and Review of the Literature

Alejandro Durán-Ojeda[1,2] Santiago Campos-Fajardo[1] Silvia Suárez-Monsalve[1,3]
Carlos Alberto Lindado-Pacheco[1,4] Jaime Eduardo Becerra-Ospina[1,4]

[1] Neurosurgery Research Group, NeuroAxis SAS, Bogotá, Colombia
[2] Department of Clinical Epidemiology, Universidad de los Andes, Bogotá, Colombia
[3] Department of Clinical Epidemiology, Pontificia Universidad Javeriana, Bogotá, Colombia
[4] Department of Neurosurgery, Pontificia Universidad Javeriana, Bogotá, Colombia

Address for correspondence Alejandro Durán-Ojeda, MD, Department of Clinical Epidemiology, Universidad de los Andes, Bogotá 111711, Colombia (e-mail: a.durano@uniandes.edu.co).

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Abstract

Introduction Hydrocephalus is a condition characterized by the abnormal accumulation of cerebrospinal fluid within the brain's ventricular system. It can stem from obstructive and nonobstructive causes. Pregnancy introduces physiopathological changes that may heighten the risk of developing or worsening symptomatic hydrocephalus. Nevertheless, comprehensive reports on this aspect, especially regarding surgical interventions, remain scarce.

Case Report A young woman with a history of recurrent headaches experienced a worsening of her symptoms at the onset of her pregnancy. A magnetic resonance imaging (MRI) in the first trimester revealed increased ventricular dilation, indicating an obstructive cause due to aqueduct stenosis. During a neurosurgical board meeting, treatment options were discussed, considering the identifiable obstruction, the heightened intra-abdominal pressure associated with pregnancy, and the risk of ventricular shunt dysfunction. The patient underwent an endoscopic third ventriculostomy (ETV) without complications, leading to both symptom relief and a successful conclusion to the pregnancy.

Discussion Neurosurgical procedures in pregnant women are uncommon due to the increased risks to both the mother and the fetus. However, when performed by a qualified multidisciplinary team, they can lead to positive outcomes. In cases of hydrocephalus during pregnancy, ETV appears to be a viable alternative for surgical intervention, particularly when hydrocephalus becomes symptomatic and an obstructive cause is identified, whether in patients with existing shunts or those with newly developed hydrocephalus.

Keywords
- obstructive hydrocephalus
- pregnancy
- endoscopic third ventriculostomy
- ventriculoperitoneal shunt
- case report

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Introduction

Hydrocephalus is defined as an abnormal accumulation of cerebrospinal fluid (CSF) within the brain's ventricles. It results from either subnormal CSF reabsorption or, less frequently, CSF overproduction,[1] typically resulting in elevated intracranial pressure, which generates symptoms such as cephalea, emesis, and papilledema. Hydrocephalus can be classified according to its etiology or according to its functionality. The two main functional subdivisions of subnormal CSF dynamics are attributed to obstructive (noncommunicating) and nonobstructive (communicating) hydrocephalus.[1,2] Stenosis of the sylvian aqueduct is the most common cause of intraventricular blockage of the CSF, accounting for 5% to 49% of cases of obstructive hydrocephalus.[3]

During pregnancy, various physiological changes occur, such as increased intracranial pressure due to heightened blood flow and fluid retention, which can elevate the risk of symptomatic hydrocephalus.[4] These alterations may exacerbate common pregnancy symptoms such as nausea and vomiting, potentially leading to headaches caused by elevated intracranial pressures. Additionally, pregnancy induces significant physiological adaptations, including ventricular enlargement and altered cardiovascular parameters, such as elevated heart rate and reduced blood pressure.[4] Neurologically, resistance to vasoconstrictor metabolites increases, resulting in a notable rise of approximately 20% in cerebral blood flow. Radiological changes, such as reduced brain volume (4.1–6.6%) and enlarged ventricular size (17.3–29.5%), further characterize the impact of pregnancy on the central nervous system. These alterations typically normalize postpartum.[3,5]

Typically, the management of hydrocephalus involves two primary options: shunts (such as ventriculoperitoneal, ventriculoatrial, ventriculopleural, or a lateral ventricle-cisterna magna shunt), and endoscopic third ventriculostomy (ETV). The ventriculoperitoneal shunt (VPS), considered the conventional treatment, entails inserting a catheter connected to a valve that can either be programmable or allow free drainage, directing CSF into the peritoneum. ETV offers an alternative CSF flow pathway, establishing communication between the third ventricle and adjacent compartments near the brainstem.[6–8] This procedure demands precision in identifying anatomical landmarks such as the foramen of Monro and the basilar artery to prevent complications such as hemorrhage and neurological injury. Moreover, factors such as ventricular thickening or scarring may impede stoma creation and diminish ETV success rates.[9]

Currently, there are no studies exclusively assessing the benefits and complications of each intervention in a pregnant population. Nonetheless, it is generally recognized that the physiological changes during pregnancy pose challenges for shunt placement and function. Recent comparisons between these interventions in adult and pediatric populations have shown that ETV has lower complication rates, particularly in postoperative infections and hematomas, although no differences were noted in mortality or postoperative success rates.[7,8]

In pregnant patients, ETV appears to offer several advantages over shunt placement. First, it eliminates the need for foreign body implantation, reducing the risk of infection. Additionally, ETV does not involve manipulation, thus lessening the risk of intra-abdominal complications.

We present a case report of a woman who required surgical management for obstructive hydrocephalus during her first trimester of pregnancy, aiming to explore management options in this specific scenario.

Case Report

Initial Assessment

A 30-year-old woman presented to our outpatient clinic with a long-standing history of recurrent migraines. She complained of a severe right-sided hemicranial headache associated with intense retro-ocular pain, photophobia, phonophobia, and nausea. An initial brain magnetic resonance imaging (MRI) reported a moderate enlargement of the ventricular system without evidence of transependymal migration. Hydrocephalus was suspected; however, she did not return for further follow-up. Five years later, at 35 years of age, she presented to the emergency room during the 15th week of her pregnancy with worsening migraines that had been exacerbated since the beginning of her pregnancy. Hydrocephalus had not been further evaluated since her initial outpatient consultation. Her medical history also included pregestational hypothyroidism. Due to her comorbidities and age, she was under the care of a high-risk pregnancy specialist.

Upon initial examination, the patient presented no focal deficits except for mild proptosis of the left eye. Motor strength and sensory examination were normal. Given the patient's prior medical history and severe headache, a consultation with a neurologist was requested. Initial pain management was attempted with acetaminophen and tramadol, and the patient was advised to undergo a repeat neuroimaging study.

Due to the progression of the patient's condition and her pregnancy status, a consultation with a neurosurgeon was sought. Subsequent MRI (►**Fig. 1**) revealed an increase in the dilation of the ventricular system along with associated transependymal migration (periventricular edema), indicative of obstructive hydrocephalus and stenosis of the sylvian aqueduct.

Based on these imaging findings and the patient's condition, a neurosurgical board meeting was held to deliberate on the appropriate course of action. Notably, considering the risk of elevated intra-abdominal pressure associated with the patient's increase in uterine size in the next semesters, there was a heightened probability of valvular or VPS dysfunction. However, an alternative approach involving ETV was also considered, primarily due to favorable anatomical conditions and the obstructive cause. The gynecologist, recognizing the high-risk nature of the patient's pregnancy, conducted a comprehensive evaluation and, following a careful assessment of the benefits and risks, approved the neurosurgical intervention.

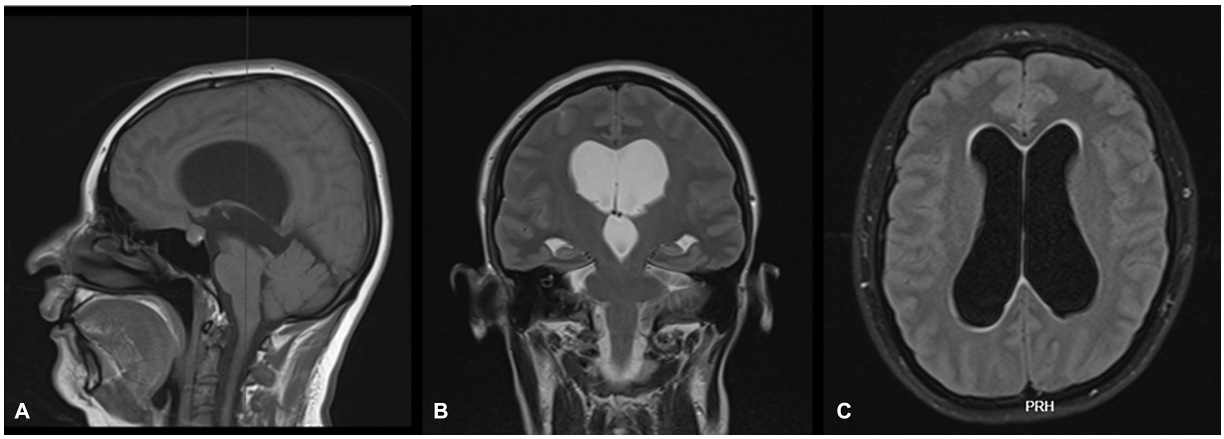

Fig. 1 (**A**) MRI sagittal T1 sequence showing marked dilation of the lateral and third ventricles. (**B**) Coronal T2 sequence, which confirms obstructive hydrocephalus as evidenced by aqueductal stenosis. (**C**) Axial T2 fluid-attenuated inversion recovery (FLAIR) sequence reveals mild transependymal migration visible surrounding the frontal horns of the lateral ventricles.

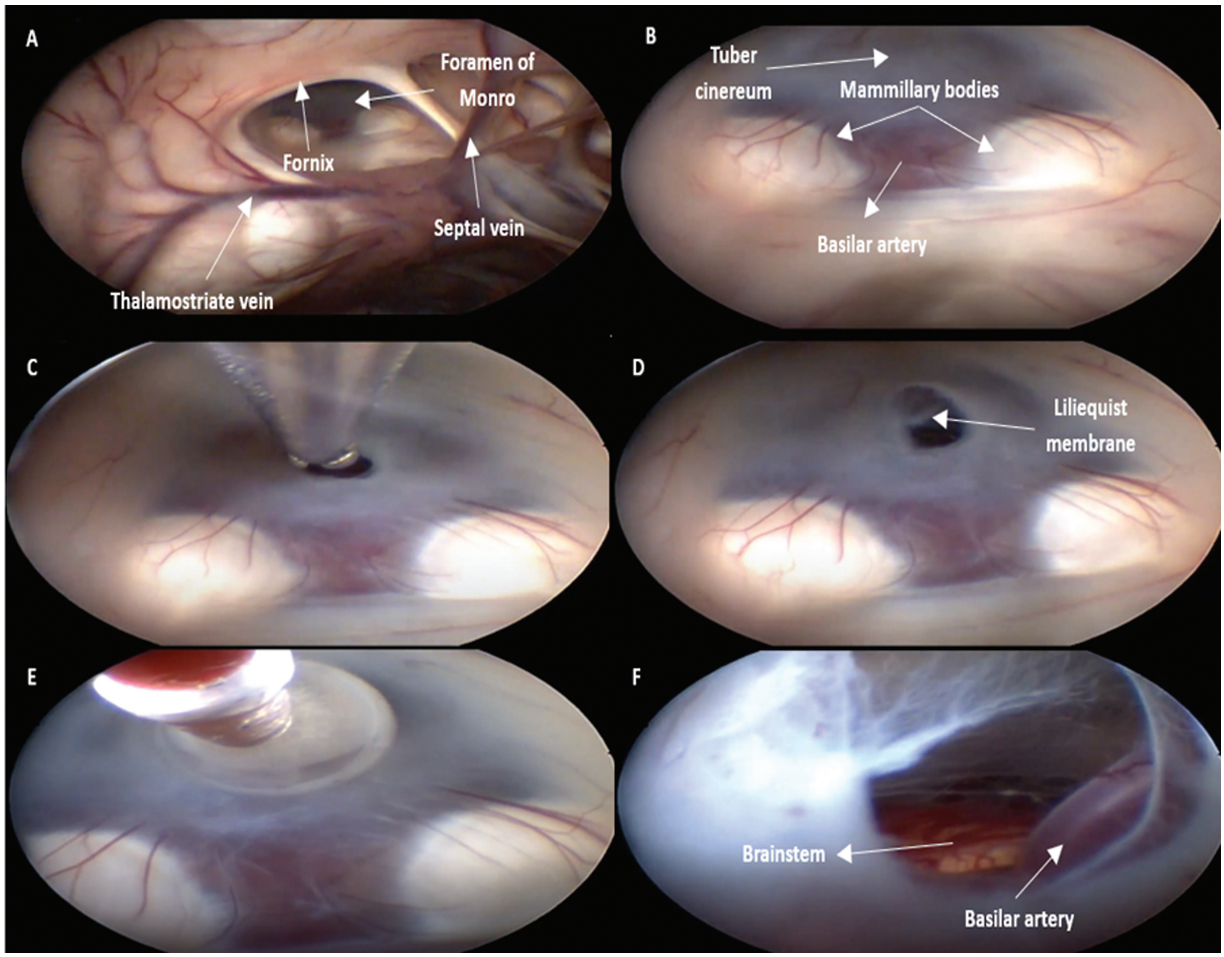

Fig. 2 Photographic illustration of the ETV technique performed by our surgical team. (**A**) Visual of the foramen of Monro, fornix, septal vein, and thalamostriate vein from the lateral ventricle. (**B**) Observation of the tuber cinereum, mammillary bodies, and basilar artery from the infundibulum. (**C**) Expansion of the floor of the third ventricle using blunt dissection endoscopic forceps. (**D**) Postretrieval of the forceps, revealing a partially fenestrated Liliequist membrane. (**E**) Widening of the stoma using a 4-French caliber Fogarty catheter. (**F**) Direct inspection of the basilar artery and its branches, alongside the brainstem. This, combined with the detection of pulsatile CSF flow through the fenestrated membrane, confirms a successful ventriculostomy and shunt.

Surgery and Perioperative Process

The patient was positioned supine under general anesthesia. Trichotomy was performed, followed by an arc-shaped incision on the right side at the Kocher point.[10] A 5-cm neuroendoscopy sleeve was introduced to visualize the ventricular structures. The lateral ventricles were markedly dilated.

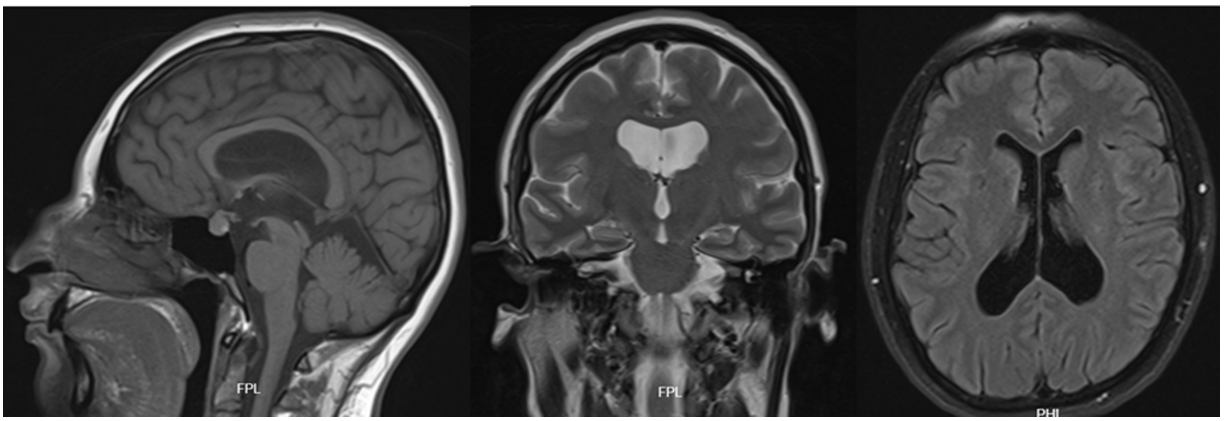

Fig. 3 Postoperative MRI sagittal T1 sequence depicting a fenestrated Liliequist membrane after ETV, resulting in a substantial reduction in ventricular dilation. The presence of hypophyseal hyperplasia is consistent with the patient's pregnancy. The axial T2 FLAIR sequence displays no signs of active hydrocephalus, as evidenced by the absence of transependymal migration.

The neuroendoscope was introduced through the foramen of Monro into the third ventricle, revealing a thinned tuber cinereum with a narrow prepontine space and a central basilar artery. Fenestration of the tuber cinereum was performed using cup forceps. The Liliequist membrane was fenestrated and dilated using a 4-French Fogarty catheter until adequate flow between the ventricular system and the prepontine cistern was established.

ETV was successfully achieved, establishing communication between the third ventricle, prepontine cistern, and cervical subarachnoid space to ensure optimal CSF flow. The surgical site was then closed in layers. ►**Fig. 2** shows intraoperative photographs illustrating the ETV technique employed by our surgical team.

The immediate postoperative course was uneventful. The patient reported near-immediate resolution of the headache, and left eye proptosis promptly resolved. She underwent strict observation for the following 48 hours with regular evaluation by the OB-GYN and Neurosurgery teams. An ultrasound was performed confirming a 16-week pregnancy with no fetal distress. The patient was deemed fit for discharge, having verified fetal and maternal well-being. Follow-up appointments were scheduled with OB-GYN, Neurosurgery, and Endocrinology.

Follow-up

The patient returned for a follow-up appointment 10 days postoperation. Her headache had resolved and no neurological deficits were documented. A postoperative MRI revealed expected changes (►**Fig. 3**), such as hypophyseal hyperplasia, which was considered acceptable given the patient's pregnancy. Importantly, there was a significant reduction in hydrocephalus following ETV, with no evidence of transependymal migration in any of the imaging sequences.

The patient was scheduled for monthly follow-up appointments to monitor her progress. With the satisfactory resolution of her symptoms, further neuroimaging studies were deemed unnecessary. She resumed her regular occupational activities and continued with routine check-ups under the care of a high-risk OB-GYN specialist, with no significant changes observed in her health status. The pregnancy progressed to term (38 weeks), resulting in a cesarean delivery due to a podalic version of the fetus. The baby was delivered successfully and was healthy. At 7 months postsurgery, the patient attended her last follow-up appointment, with no recurring symptoms. Regrettably, she did not return for further follow-up.

Literature Review

In conjunction with the case report, a comprehensive review of the literature was undertaken to examine the management of hydrocephalus during pregnancy utilizing ETV. A search was conducted using the Embase search engine, employing keywords such as "third ventriculostomy," "pregnancy," and "hydrocephalus." A total of 56 results were retrieved. These articles were then imported into the Rayyan AI database system, where title, abstract, and full text were carefully screened. Articles deemed irrelevant to our review were excluded, resulting in a final selection of seven manuscripts, as summarized in ►**Table 1**.

As previously mentioned, pregnancy could be an independent risk factor for VPS failure. In such cases, ETV could be a viable and safe alternative for managing resultant hydrocephalus, with no reported complications associated with the procedure during pregnancy, regardless of the trimester in which it was performed.[11–13] Additionally, ETV proves to be a reasonable option for cases of aqueductal stenosis secondary to tectal/mesencephalic tumoral pathology, enabling direct biopsy of the lesion and treatment of hydrocephalus, as documented by Ravindra et al and Riffaud et al.[12,14] Furthermore, ETV has demonstrated efficacy in treating de novo obstructive hydrocephalus secondary to primary aqueductal stenosis.[15–17] Importantly, postoperative and pregnancy outcomes do not appear to differ significantly when compared with patients with a preexisting diagnosis of hydrocephalus. However, it is noteworthy that literature on this subject remains limited, and more structured studies are needed to provide definitive recommendations regarding ETV in pregnant patients.

Table 1 Characteristics and main results of manuscripts regarding endoscopic third ventriculostomy in pregnant women

Author, year	Study type	Number of patients	Results	Notes
Sahoo et al, 2023	Case series	4	Four pregnant patients underwent awake ETV under local anesthesia during the second trimester. Aqueductal stenosis was the etiology of hydrocephalus in all cases, and no complications were reported	Awake ETV
Alhaj et al, 2022	Case report	1	ETV was performed in the third trimester (31 wk) of pregnancy for a patient with preexisting hydrocephalus and VPS malfunction. The pregnancy progressed to term without any complications	Preexisting condition with VPS malfunction
McKie et al, 2018	Case report	1	A 25-year-old woman developed symptomatic hydrocephalus due to aqueductal stenosis in her third trimester (38 wk) of pregnancy. She underwent emergency external ventricular drain placement followed by ETV. An Ommaya reservoir connected to the ventricular catheter managed intracranial pressure during labor, allowing for a complication-free vaginal delivery	The onset of aqueductal stenosis during the third trimester of pregnancy with ETV as primary management
Ravindra et al, 2015	Case report	1	A 27-year-old pregnant woman presented in the second trimester (26 wk) with a 2-mo history of headaches, blurry vision, and left-sided weakness attributed to a 1-cm pineal region mass causing obstructive hydrocephalus. ETV was performed for both biopsy and hydrocephalus treatment, revealing a WHO grade II ependymoma. The pregnancy proceeded without complications, culminating in a cesarean section delivery at 39 wk. Postpartum imaging indicated tumor growth, requiring subtotal resection and subsequent radiotherapy. Unfortunately, this resulted in the patient's passing 2 years later	Obstructive hydrocephalus secondary to ependymoma
Yoshida et al, 2007	Case report	1	A 33-year-old experienced an altered mental state and dizziness in her second trimester (29 wk). She had a preexisting VPS since age 17 for aqueductal stenosis and obstructive hydrocephalus. Imaging showed active triventricular hydrocephalus. At 32 wk, she underwent ETV and placement of an Ommaya reservoir, resolving her symptoms. She delivered vaginally at 40 wk	Preexisting condition w/ VPS malfunction
Riffaud et al, 2006	Case series	5 (2 de novo and 3 preexisting)	Case 1: A 36-year-old experienced seizures in her third trimester of pregnancy (28 wk). MRI revealed a large tectum tumor causing obstructive hydrocephalus and left temporal cavernoma. ETV managed hydrocephalus. She delivered via cesarean section at 39 wk. Surgery for the cavernoma and tectal tumor followed 4 and 8 mo later Case 2: A 22-year-old had headaches, vomiting, and seizures in her first trimester (8 wk). MRI showed a tectal hemorrhagic lesion causing obstructive hydrocephalus. ETV resolved symptoms. Delivery via cesarean section occurred at 37 wk Case 3: A 33-year-old experienced headaches, vomiting, and visual disturbances in her second trimester (20 wk). She had a preexisting VPS since age 12 for aqueductal stenosis. ETV and shunt removal resolved	1 de novo tectal mass; 1 hemorrhagic lesion, and 3 with/ malfunction of preexisting VPS

(*Continued*)

Table 1 (*Continued*)

Author, year	Study type	Number of patients	Results	Notes
			symptoms. She delivered vaginally at 37 wk Case 4: A 26-year-old had headaches and visual disturbances in her second trimester (15 wk). She had a preexisting VPS since 6 months old for aqueductal stenosis, with two revisions at age 11. Neuroimaging revealed triventricular hydrocephalus. ETV and shunt removal resolved symptoms. She delivered vaginally at 39 wk Case 5: A 27-year-old had headaches in her first trimester (8 wk). She had a preexisting VPS for obstructive hydrocephalus concerning a small tectal lesion. MRI showed hydrocephalus with no change in the tectal lesion. ETV and shunt removal resolved symptoms. She delivered vaginally at 39 wk	
Watanabe et al, 2005	Case report	1	A 39-year-old experienced headache, nausea, and altered mental state in her second trimester (19 wk). Imaging showed acute hydrocephalus. Emergency EVD improved symptoms, but POP-MRI revealed persistent triventricular enlargement and membranous aqueductal occlusion. ETV was performed successfully. The pregnancy continued without complications, and delivery via cesarean section occurred at 36 wk	ETV as second option after EVD

Abbreviations: ETV, endoscopic third ventriculostomy; EVD, external ventricular drainage; MRI, magnetic resonance imaging; POP, pelvic organ prolapse; VPS, ventriculoperitoneal shunt; WHO, World Health Organization.

Discussion

During pregnancy, physiological changes such as increased intracranial pressure may elevate the risk of symptomatic hydrocephalus.[3,5] This review highlights the potential implications of these changes and underscores the importance of vigilant monitoring and appropriate management strategies in pregnant individuals presenting with hydrocephalus.

In this case report, it is noteworthy that hydrocephalus can manifest with symptoms during pregnancy due to systemic changes, particularly in early pregnancy.[12] Women with a history of surgical interventions before pregnancy may face an increased risk of VPS dysfunction, primarily attributable to heightened intra-abdominal pressure in late pregnancy.[11,12]

The decision for this patient to undergo an ETV was influenced by several favorable factors, including aqueductal stenosis and the absence of a prior shunt placement. ETV emerges as a safe and effective alternative to VPS replacement during the late stages of pregnancy, also serving as a valuable option for addressing VPS malfunction.[11]

Pregnancies complicated by hydrocephalus raise discussions on the ideal delivery mode. Some advocate for vaginal delivery in cases without neurological complications,[18] while others favor cesarean delivery because of concerns about increased intracranial pressure during the second stage of labor.[14]

This case involves a pregnant patient with symptomatic obstructive hydrocephalus resulting from aqueductal stenosis, a common issue in adults typically managed with VPS, or ETV as an alternative, in the general population.[19] It is widely recognized that prepregnancy VPS placement is a safer and more efficient strategy in women with the diagnosis of hydrocephalus. While ventriculoperitoneal shunting proves a highly effective strategy, increased intracranial pressure and increased intraperitoneal pressure during pregnancy can lead to catheter obstruction and subsequent neurologic symptoms.[13] This approach allows vaginal delivery in patients without neurological deficits.[11]

Although ETV presents a potential alternative for the management of hydrocephalus in pregnant patients, not all individuals may be suitable candidates for the procedure. Patient selection criteria must consider factors such as the etiology of hydrocephalus and anatomical feasibility—including ventricular height and infundibulochiasmatic angle[20]—as well as intrinsic risks associated with pregnancy.

The dilemma lies in deciding the appropriate management approach for women who develop hydrocephalus during pregnancy. Concerns about abdominal surgery, the effects of anesthesia on both the mother and fetus, and the potential risk of VPS dysfunction prompt consideration of ETV as an alternative treatment option for obstructive hydrocephalus in any trimester of pregnancy.[10] Early initiation of treatment during pregnancy, especially when hydrocephalus typically manifests

symptoms, is ideal.[8] The article's novelty and significance primarily stem from the utilization of ETV during pregnancy to enhance hydrocephalus care in pregnant women.

However, it should be noted that we cannot advocate for the use of ETV as first-line management of hydrocephalus in pregnancy or draw large conclusions based on case reports. Further research, including prospective cohort studies, is needed to establish the safety, efficacy, and optimal patient selection criteria.

Finally, we want to highlight the successful multidisciplinary approach, which integrated expertise from neurosurgery and OB-GYN, who played a pivotal role in the effective management of both the neurological and obstetric aspects of the patient's care.

Conclusion

This article delves into the nuanced management of hydrocephalus in pregnant patients, underscoring the role of ETV as an alternative to conventional shunting procedures. While ETV offers advantages such as reduced infection risk and avoidance of abdominal surgery, it is imperative to consider anatomical, pathological, and physiological factors before opting for surgical intervention. Individualized patient assessment, thorough surgical planning, and interdisciplinary collaboration are essential for optimizing patient outcomes. Further research is warranted to elucidate the safety, efficacy, and optimal patient selection criteria for ETV in pregnant patients with hydrocephalus. While ETV may offer promise in specific cases, particularly those with aqueductal stenosis, caution is advised against its indiscriminate use or definite conclusions based on limited evidence.

Ethical Considerations

We addressed ethical considerations in the publication of this case report in adherence to the Declaration of Helsinki. Patient confidentiality is preserved, and the patient fully understands the nature, benefits, and risks of the research, as well as the academic interest in publishing her medical history. Any potentially identifying information has been omitted or altered. Informed consent was obtained from the patient.

Conflict of Interest

None declared.

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