




Endoscopic Septostomy for Treatment of Complex Hydrocephalus: A Single Center Retrospective Cohort

Septostomia Endoscópica para tratamento da Hidrocefalia Complexa: Uma coorte retrospectiva de um único centro

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Abstract

Objective The objective was to present the initial experience with endoscopic septostomy in a Brazilian public hospital.

Methods A retrospective analysis was conducted on patients who underwent neuro-endoscopic septostomy at the Department of Neurosurgery of Cristo Redentor Hospital in Porto Alegre from 2015 to 2021.

Results In the period analyzed, 14 patients underwent endoscopic septostomy. The mean age of the patients was 41.86 years; 11 were male and 3 were female. The etiologies of hydrocephalus included ventricular inflammatory conditions, neoplasms, neurocysticercosis, and intraventricular cysts. Following septostomy, 64% of the patients exhibited clinical and radiological improvement. Complications occurred in 29% of the cases, including intraventricular hemorrhage and thalamic contusion. Four deaths were observed, all related to clinical complications or progression of the underlying disease.

Conclusion Endoscopic septostomy is an effective and safe procedure for treating complex hydrocephalus of different etiologies. Surgical outcomes are related to the learning curve with neuroendoscopy, and the benefits for patients are evident, considering the possibility of safely and effectively performing simultaneous endoscopic procedures with septostomy.

Keywords

- neuroendoscopy
- hydrocephalus
- Foramen of Monro
- septum pellucidum

Resumo

Objetivo O objetivo foi apresentar a experiência inicial com septostomia endoscópica em um hospital público brasileiro.

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Palavras-chave

- neuroendoscopia
- hidrocefalia
- Forame de Monro
- septo pelúcido

Métodos Uma análise retrospectiva foi conduzida em pacientes submetidos à septostomia neuroendoscópica no Departamento de Neurocirurgia do Hospital Cristo Redentor em Porto Alegre, de 2015 a 2021.

Resultados No período analisado, 14 pacientes foram submetidos à septostomia endoscópica. A média de idade dos pacientes foi de 41,86 anos; 11 eram do sexo masculino e 3 do sexo feminino. As etiologias da hidrocefalia incluíram condições inflamatórias ventriculares, neoplasias, neurocisticercose e cistos intraventriculares. Após a septostomia, 64% dos pacientes apresentaram melhora clínica e radiológica. Complicações ocorreram em 29% dos casos, incluindo hemorragia intraventricular e contusão talâmica. Quatro óbitos foram observados, todos relacionados a complicações clínicas ou à progressão da doença subjacente.

Conclusão A septostomia endoscópica é um procedimento eficaz e seguro para o tratamento da hidrocefalia complexa de diferentes etiologias. Os resultados cirúrgicos estão relacionados à curva de aprendizado com a neuroendoscopia, e os benefícios para os pacientes são evidentes, considerando a possibilidade de realizar procedimentos endoscópicos simultâneos com a septostomia de maneira segura e eficaz.

Introduction

Complex Hydrocephalus promoting mono or biventricular hydrocephalus is usually caused by obstruction, congenital or acquired, from one or both foramen of Monro. Tumors, vascular malformations, infections, and inflammatory diseases are acquired pathologies associated with this form of hydrocephalus.^{1–5} The spread of neuroendoscopy in the last decades has allowed its use as an alternative to shunt in treating obstructive hydrocephalus of different etiologies.^{6–12}

Endoscopic septostomy (ES) allows for bypass a mono-lateral obstruction of the foramen of Monro creating a cerebrospinal fluid (CSF) circulation between the obstructed ventricle and the opposite, communicating with the third ventricle by the normal foramen of Monro.¹³ It could also be proposed in case of bilateral obstruction of the foramen of Monro when followed by foraminoplasty or a ventriculoperitoneal shunt (VPS).¹⁴

In this study, we aim to present our initial experience with endoscopic septostomy in a Brazilian public hospital.

Methods

Patients Review

A retrospective analysis was conducted on patients who underwent neuroendoscopic septostomy at the Department of Neurosurgery of Cristo Redentor Hospital in Porto Alegre from 2015 to 2021. Fourteen patients who underwent endoscopic septostomy procedures were included in the study. The medical records of these patients were retrospectively analyzed to collect the following data: age, sex, etiology of hydrocephalus, radiological findings, previous shunt history, simultaneous endoscopic procedures, clinical and radiological improvements, postoperative complications, and reoperations.

Patients presenting with clinical symptoms such as headache and/or altered state of consciousness, along with imaging findings indicative of mono or biventricular hydrocephalus, were selected for the procedure. Simultaneous procedures performed alongside endoscopic septostomy included monroplasty, endoscopic third ventriculostomy (ETV), tumoral biopsy, removal of previously implanted ventricular catheters, and opening of intraventricular cysts.

Endoscopic Septostomy Technique

Various techniques have been described for performing septostomy to treat univentricular hydrocephalus. The most commonly used approach for accessing the lateral ventricle is through coronal trepanation in the mid-pupillary line.¹³ Alternatively, lateral access about the Kocher point can be utilized, allowing for a more perpendicular trajectory about the septum pellucidum (SP), thereby facilitating visualization of midline structures.^{5,15,16} When accessing the frontal horn, it can be done through both normal and incarcerated ventricles, although caution must be exercised to avoid inadvertent injury to the contralateral ventricle wall during procedures conducted through incarcerated ventricles.¹⁶

The identification of avascular areas of the septum pellucidum is essential for successful fenestration. The ideal point for fenestration via frontal access is described as 1.0 cm superior and 2.0 cm anterior to the superior margin of the foramen of Monro.^{15,16} Some authors describe the ideal location generically as the region above and before the Monro foramen.^{14,16} According to Vinas et al.,¹³ there are only 2 to 3 vascular areas susceptible to the procedure, with the ideal area often found in the frontal segment limited by the inferior septal vein, frontal horn floor, and corpus callosum. This area is often transparent and allows, through translucency, a view of the other ventricle. However, other

authors argue that there is no specific area for fenestration.¹⁷ The anatomical individuality must be respected, looking for the best area according to the instant analysis.

Incisions in the septum close to the fornix and corpus callosum increase the risk of damaging structures and may not create effective communication between the ventricles. Fenestrations placed more posteriorly are associated with a higher risk of failure or complications.¹⁷

The occipital horn of the normal lateral ventricle can also be accessed through occipital trepanation, allowing fenestration of the septum pellucidum and establishing communication with the incarcerated ventricle.^{15,18}

Regarding the ideal size of the perforation, there is no defined consensus. Descriptions range from 7 mm to 1.5 to 2.0 cm.^{15,18} Schroeder et al. describe the ideal size as 1 cm in diameter, especially in thick septa where the chances of closing the stoma are higher.¹⁹

Details of The Septostomy Performed

Following general anesthesia and proper positioning, the surgery is performed based on radiological exams. In most of our cases, a more lateral burr hole than the standard Kocher's

point was utilized to achieve a more perpendicular angle to the SP.^{5,15,16,20}

When performing ESP alongside ETV or Biopsy, the trajectory is planned according to MRI findings. Neuronavigation was not available in our institution; therefore, all approaches were performed using the largest ventricle available. After ventriculostomy and identification of anatomical landmarks, openings are made in the septum pellucidum in the avascular area at the level of foramen de monro.^{14,16,20}

The chosen area of the SP is coagulated using a monopolar to create a small opening, (►Fig. 2B) followed by the careful introduction of a Fogarty catheter to complete the ostomy after it is filled (►Fig. 2C). Visualization of anatomical structures of the contralateral lateral ventricle is considered essential to ensure the adequacy of the opening (►Fig. 2D).

Results

Between 2015 and 2021, 14 endoscopic septostomy procedures were performed at our institution. The mean age of the patients was 41.86 years (median 1.9 years, range 1 week to 18 years); 11 were male and 3 were female.

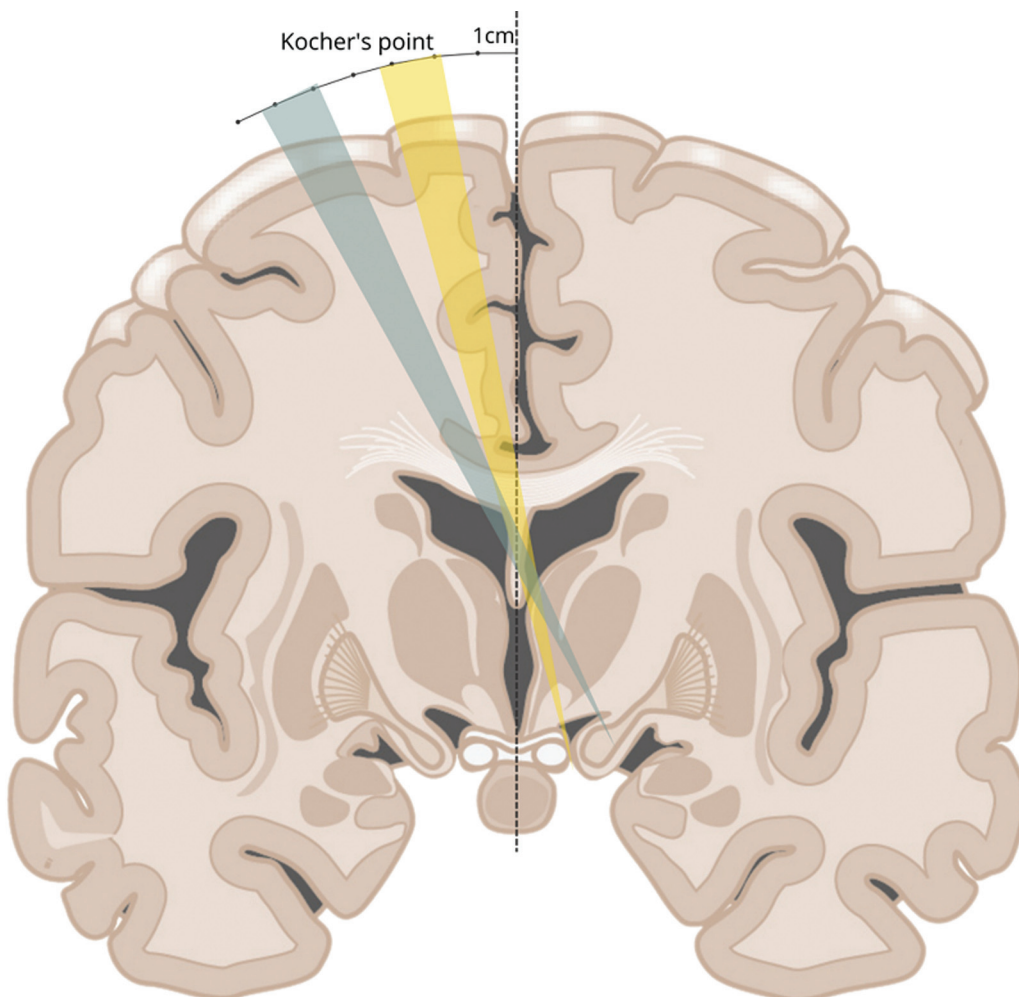


Fig. 1 Illustration of the surgical approach. Trepanation 2 cm lateral to Kocher's point (blue triangle). Image modified from "Slagter - Drawing Coronal section of the brain - no labels" by Ron Slagter, license: CC BY-NC-SA.²¹

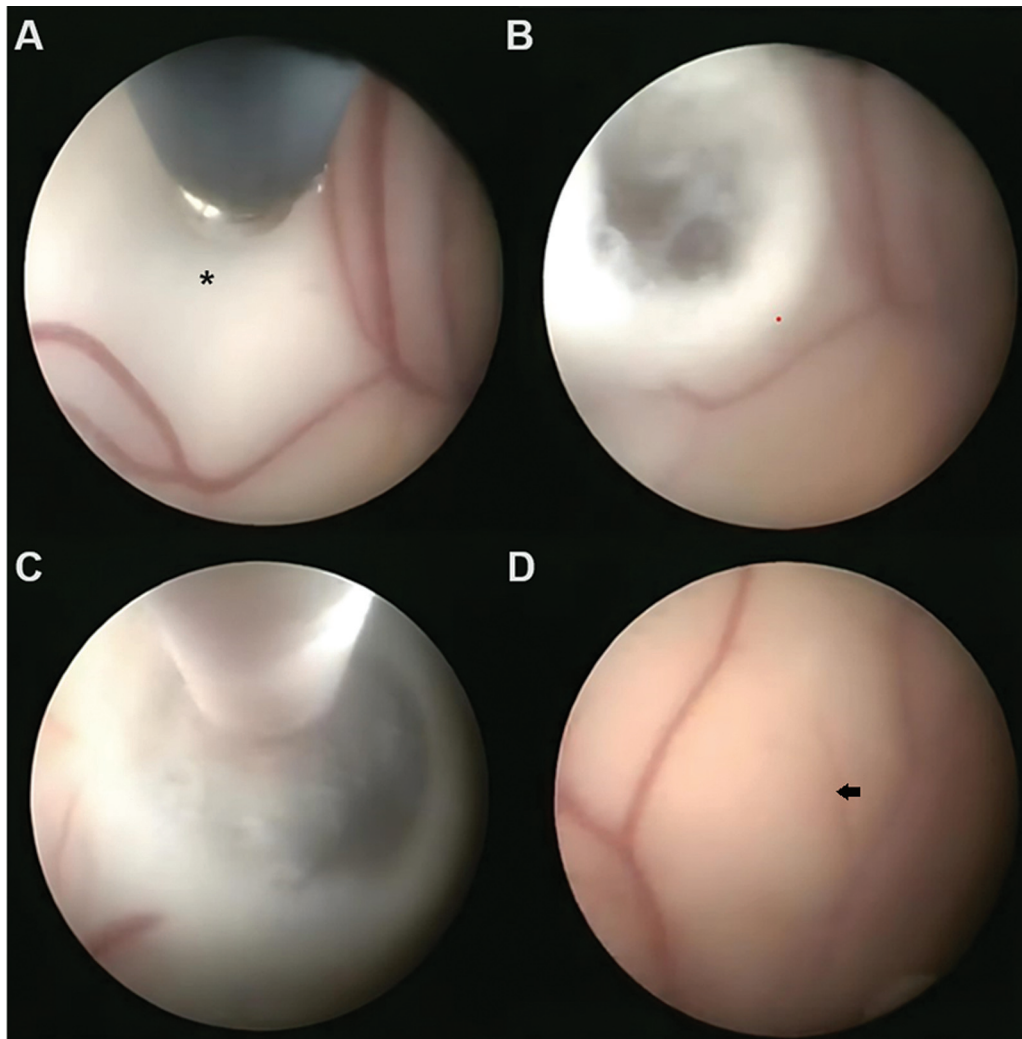


Fig. 2 Neuroendoscopic view of septostomy with anatomic landmarks. **A.** Septum pellucidum (black asterisk) **B.** Opening of the septum pellucidum **C.** Introduction of the Fogarty catheter and completion of the ostomy **D.** View of the lateral wall of the contralateral ventricle (black arrow).

Regarding the type of hydrocephalus, we found 8 patients (57%) with bilateral obstruction and 6 patients (43%) with unilateral obstruction (isolated ventricular hydrocephalus) (►Table 1).

The etiologies of hydrocephalus found were related to ventricular inflammatory conditions (7 cases), neoplasms (4 cases), neurocysticercosis (2 cases), and intraventricular cyst (1 case) (►Table 1) (►Figs. 3 and 4).

Altered consciousness (8 of 14 cases, 57%) was the most common symptom, ranging from confusion, drowsiness/lethargy, to coma, followed by headache found in 6 of 14 cases (42%) (►Table 2).

Surgical Results and Complications

Overall, right after septostomy, 9 patients (64%) exhibited patent septostomy with clinical and radiological improvements. One patient with unilateral hydrocephalus initially showed improvement after septostomy. However, after 6 months, they were readmitted with symptoms like those observed before the initial surgery. At that point, it was decided to implant a ventriculoperitoneal shunt.

Related to the previous history of CSF shunting, 3 patients had successful outcomes while 1 patient presented with technical failure.

Nine patients underwent 12 simultaneous procedures in addition to ESP: 4 foraminoplasties, 3 biopsies, 2 removals of ventricular catheters, one ETV, one cyst-ventriculostomy, and one cysticercal removal.

Regarding the type of hydrocephalus, postoperative septostomy patency was observed in 6 patients (42.8%) with bilateral hydrocephalus and 3 patients (21.4%) with unilateral hydrocephalus. In one patient with bilateral hydrocephalus secondary to a tumor, fenestration of the septum pellucidum combined with foraminoplasty allowed for the restoration of physiological CSF circulation, eliminating the need for shunt placement.

Regarding the etiology of hydrocephalus, septostomy patency was observed in 3 patients (42%) from the group of patients with hydrocephalus secondary to inflammatory causes, 4 patients (100%) with brain tumor, 1 patient (50%) with neurocysticercosis, and 1 patient (100%) with ventricular cyst. (Details in ►Table 1).

Table 1 Summary of patient's data and results

Patient	Age/Sex	Type of hydrocephalus	Etiology of hydrocephalus	Clinical improvement	Radiological improvement	Previous shunt	Concomitant endoscopic procedure	Complications	Subsequent surgery	Follow up
1	46/M	Unilateral	Post inflammatory	No	No	No	Foraminoplasty	No	No	2 months (death)
2	52/M	Bilateral	Tumor	Yes	Yes	No	Biopsy	No	No	3 months (death)
3	57/M	Bilateral	Tumor	Yes	Yes	No	Foraminoplasty and biopsy	No	No	1 month (death)
4	69/F	Bilateral	Tumor	Yes	Yes	No	Biopsy	No	VPS	3 years
5	71/M	Unilateral	Post inflammatory	Yes	Yes	Yes	No	Minor thalamic contusion	VPS (after 6 months)	2 years
6	13/M	Unilateral	Intraventricular cyst	Yes	Yes	No	Cyst fenestration	No	No	3 years
7	45/M	Bilateral	Post inflammatory	Yes	Yes	Yes	ETV/ventricular catheter removal	Intraventricular hemorrhage	VPS	4 years
8	49/M	Bilateral	Tumor	Yes	Yes	No	Biopsy	No	VPS	2 years (death)
9	42/M	Unilateral	Post inflammatory	No	No	No	Monroplasty	Insufficient septostomy	VPS	2 months (death)
10	2 months/M	Unilateral	Post inflammatory	No	No	No	No	No	No	6 months
11	44/M	Unilateral	Neurocysticercosis	Yes	Yes	No	No	No	No	3 years
12	21/F	Bilateral	Post inflammatory	No	No	Yes	Ventricular catheter removal	Intraventricular hemorrhage	VPS	6 months
13	42/M	Bilateral	Post inflammatory	Yes	Yes	Yes	No	No	VPS	3 years
14	35/F	Bilateral	Neurocysticercosis	No	No	No	Foraminoplasty/ cysticercal removal	No	VPS	6 years

Abbreviations: ETV, endoscopic third ventriculostomy; VPS, ventriculo-peritoneal shunt.

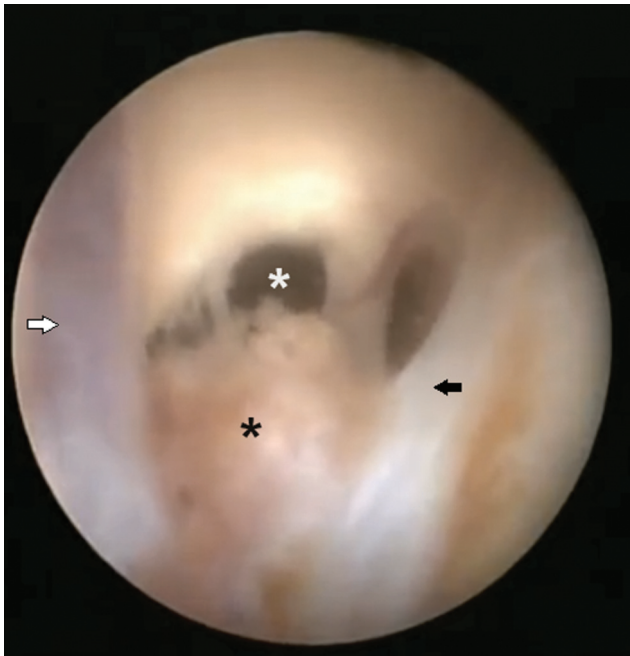


Fig. 3 Obstruction of the foramen of Monro due to inflammatory etiology. Foramen of Monro partially obstructed (white asterisk), choroid plexus (black asterisk), septal vein (white arrow), and thalamostriate vein (black arrow).

Out of 14 patients, 4 (29%) experienced complications. Two patients with post-inflammatory hydrocephalus and a history of previous shunt surgery presented with intraventricular hemorrhage during maneuvers to remove the previous ventricular catheter. In both cases, lavage was performed with saline solution, and an external ventricular shunt

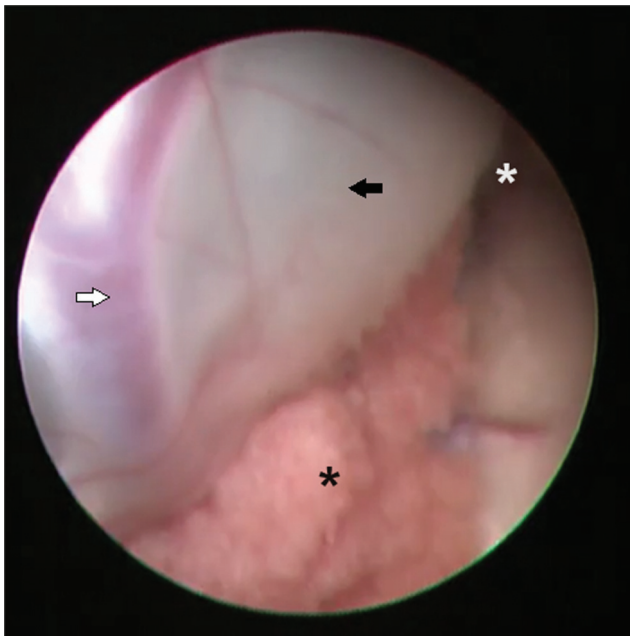


Fig. 4 Foramen of Monro (white asterisk), choroid plexus (black asterisk), septal vein (white arrow), septum pellucidum displaced by tumor (black arrow).

Table 2 Main preoperative symptoms

Symptom	Number of patients (%)
Mental confusion	4 (29)
Drowsiness/torpor	2 (14)
Coma	2 (14)
Headache	6 (43)
Total	14 (100)

catheter was utilized postoperatively. Both patients showed good outcomes and were promptly referred for placement of a ventriculoperitoneal shunt.

A third patient with post-inflammatory hydrocephalus exhibited severe ependymal scarring and thick septum pellucidum. The ostomy opening was insufficient, and the patient was referred early for placement of a ventriculoperitoneal shunt. Another patient suffered minor thalamic contusion presenting satisfactory neurological evolution during the follow-up period.

Four deaths were observed in the postoperative period (between 30 and 90 days). None of these deaths were directly related to the surgical procedure; all were associated with clinical complications or progression of the underlying disease.

The mean follow-up after septostomy was 23.7 months (range 1 month to 6 years).

Discussion

Endoscopic septostomy emerges as a promising alternative for treating hydrocephalus related to obstruction of one or both Monro foramen.¹⁴ The patency of this membrane opening facilitates the restoration of physiological cerebrospinal fluid circulation, potentially reducing the need for shunt placement^{13,14} or even obviating its necessity in cases of isolated lateral ventricle hydrocephalus.

In this small series, we present a sample of cases from our initial experience with this technique in a public hospital neurosurgery service. Our success rate achieved with the procedure (64%) is like previous described series.¹⁵

The etiology of hydrocephalus is described as the main factor related to the success of the procedure.²¹ We observed in our series that in the group of patients with brain tumors, the high success rate of septostomy is similar to previous descriptions.²² On the other hand, we observed a high rate of procedural failure (57%) in the group of patients with post-inflammatory hydrocephalus. According to Aldana et al, in these cases, anatomical distortion making it difficult to identify anatomical structures, as well as scar tissue from the ependyma, may even prevent the procedure from being carried out.¹⁵

A previous history of ventricular surgeries such as shunts is also described as a greater risk of the septostomy not being effective, though, in the present series, we did not observe this relationship.¹⁵

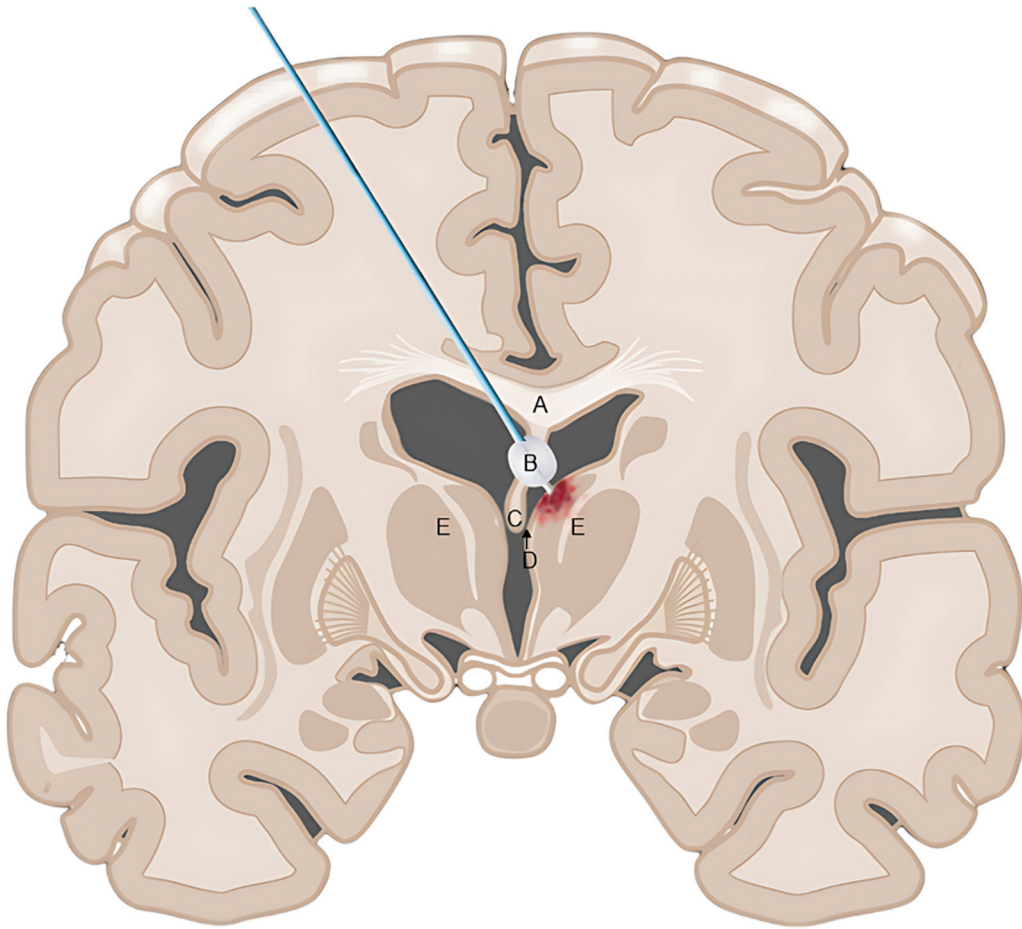


Fig. 5 Illustration of potential brain injury during endoscopic septostomy. When the tip of the fogarty catheter is larger than the distance between the septum pellucidum and the contralateral ventricle wall, it can cause trauma (indicated by the red-shaded area). Corpus callosum (A), fogarty catheter balloon crossing septum pellucidum (B), fornix (C), foramen of Monro (D), and thalamus (E). Image modified from "Slagter-Drawing Coronal section of the brain - no labels" by Ron Slagter, license: CC BY-NC-SA.²¹

Contemporary ventricular neuroendoscopy permits the performance of multiple additional procedures alongside septostomy. In our series, 9 patients (64%) underwent additional endoscopic procedures concomitant with septostomy. The relevance of neuroendoscopy in the current management of hydrocephalus of different etiologies is emphasized.²³ Although endoscopic septostomy is a simple and effective procedure, it is not without its share of complications.²⁰ Our complication rate (29%) is consistent with previous reports.²⁴

Neuroendoscopy allows the surgeon to safely remove previously implanted ventricular catheters that have been left in the ventricular system.²⁵

In two patients, during coagulation maneuvers of the choroid plexus, adhered to the tip of the ventricular catheter, a small intraventricular hemorrhage was observed and controlled after continuous irrigation and compression of saline solution for a few minutes. In the end, the removal of the catheter was successfully performed.

Performing a septostomy in patients with post-inflammatory complex hydrocephalus can also be a challenging procedure considering the thickness of the septum pellucidum and the possibility of multiple membranes or

layers adjacent to it.²⁶ In a patient with post-inflammatory hydrocephalus, we observed this condition. The poor outcome of the procedure in this case was related to this finding.

The prevention of complications necessitates a detailed preoperative analysis of imaging examinations. In a patient with unilateral hydrocephalus, we observed a small traumatic lesion in the contralateral thalamus related to the introduction of the fogarty catheter into the opening made in the septum pellucidum.

When using the large ventricle to perform ESP, we must evaluate in imaging tests whether the tip of the fogarty catheter is larger than the distance between the septum pellucidum and the wall of the contralateral ventricle. In our opinion when it happens the use of fogarty should be avoided, and the opening of the septum pellucidum should be widened with the monopolar coagulator in a safe way (→ Fig. 5).

Conclusion

Endoscopic septostomy is an effective and safe procedure in the treatment of complex hydrocephalus of different etiologies. Our surgical results are related to our learning curve

with neuroendoscopy. The benefit for patients is evident considering the possibility of carrying out endoscopic procedures simultaneously with septostomy in a safe and effective way.

Conflict of Interests

The authors have no conflict of interest to declare.

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