Original article

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Diagnosis and endoscopic treatment of suprasellar arachnoid cysts in pediatric patients: A case series and analysis of clinical observations

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Suprasellar arachnoid cysts are rare entities, accounting for approximately 20% of all intracranial arachnoid cysts.

Objective: To evaluate the efficacy of endoscopic ventriculocystostomy and endoscopic ventriculocystocisternostomy in the treatmentof children with suprasellar arachnoid cysts.

Materials and Methods: Between 2016 and 2023, 29 children with suprasellar arachnoid cysts were treated at the Romodanov Institute of Neurosurgery, National Academy of Medical Sciences of Ukraine. The cohort included 18 boys (62%) and 11 girls (38%), with ages ranging from 4 months to 17 years (mean age – 2.8 years). Depending on the surgical technique used, patients were divided into two groups: Group 1 (n=19) underwent endoscopic ventriculocystostomy, and Group 2 (n=10) underwent endoscopic ventriculocystocisternostomy.

Results: The effectiveness of both procedures was confirmed by clinical and radiological assessments. Postoperative hospital stay ranged from 6 to 18 days in Group 1 (mean – 10.2±3.1 days) and from 7 to 17 days in Group 2 (mean – 11.3±3.8 days; p=0.411). The duration of surgery ranged from 25 to 70 minutes (mean – 48.4±13.0 min) in Group 1 and from 45 to 70 minutes (mean – 52.5±8.2 min) in Group 2 (p=0.378). In the early postoperative period, full recovery was observed in 6 patients (33%) in Group 1 and in 2 patients (20%) in Group 2. In the long-term follow-up period, recovery rates were 63% and 70%, respectively. No mortality or disease progression was reported, and no patient required permanent shunt placement. Recurrence occurred in one patient from Group 1.

Conclusions: The analysis of clinical and radiological data demonstrates the effectiveness of both ventriculocystostomy and ventriculocystocisternostomy. Both methods may be recommended for the treatment of suprasellar arachnoid cysts in children due to their minimally invasive nature, low postoperative complication rates, and absence of mortality.

Keywords: *arachnoid cyst; endoscopy; shunting; children*

The first reports of suprasellar arachnoid cysts (ACs) date back to 1935 and are associated with the name of A. Barlow [1]. He was the first to attempt surgical removal of such a cyst, although the patient died on the second postoperative day. In 1960, V. Cassinari reported eight cases of cysts located in the chiasmal-sellar region [2]. In 1965, R. Bernard described a suprasellar AC in a pediatric patient [3].

In adults, suprasellar cysts account for only 9% of all ACs, while in pediatric populations, their prevalence reaches 21% [10, 11]. The most common location of ACs is within the lateral fissure of the brain, where they partially or completely fill the middle cranial fossa (MCF), constituting the majority of intracranial ACs [5]. A less frequent subtype is the suprasellar AC, situated within the suprasellar cistern, projecting into the third ventricle [4, 6]. Suprasellar AC is non-neoplastic, congenital cavity filled with cerebrospinal fluid (CSF) and lined by arachnoid membrane. They are thought to arise due to an anomaly of the Liliequist membrane or cystic dilatation of the interpeduncular cistern [22]. The precise etiology of suprasellar ACs remains uncertain; however, recent data suggest that they may result from a valvular mechanism at the site where the basilar artery penetrates the prepontine arachnoid membrane [7, 8].

The clinical presentation of ACs is highly variable and may be asymptomatic. Most cysts remain stable over time, but a subset may gradually enlarge and provoke clinical symptoms [9]. Current evidence indicates that in children under the age of 4, ACs are frequently asymptomatic, necessitating careful monitoring for potential growth [12].

As cysts enlarge, patients may develop neurological symptoms due to compression of adjacent structures and/or the onset of hydrocephalus. This may manifest clinically as vomiting, seizures, headaches, macrocrania, endocrine disturbances, ataxia, developmental delay, visual deficits, or oculomotor dysfunctions [13, 14].

Obstructive hydrocephalus may occur as a result of cyst-induced compression of the foramen of Monro or

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the cerebral aqueduct, thereby impairing CSF outflow. Endocrine dysfunction may arise from compression of the pituitary stalk, and visual disturbances may be caused by pressure on the optic nerve and surrounding structures. Among clinical manifestations, headache is the most prevalent symptom, occurring in 66% of patients [15]. Studies have shown that signs of elevated intracranial pressure are the most common symptoms in adults, whereas pediatric cases are more frequently characterized by delayed psychomotor development and macrocephaly [17]. Due to the potential emergence of these clinical symptoms in larger cysts, surgical treatment is considered a preferable approach over observation. Several surgical techniques are available for the treatment of such cysts: microsurgical fenestration via open craniotomy, cystoperitoneal shunting, and endoscopic treatment through ventriculocystostomy (VCS) or ventriculocystocisterno- stomy (VCCS) [18]. In VCS, an endoscope and instruments are used to fenestrate only the apical membrane of the cyst, whereas in VCCS, the same endoscopic approach is applied: the apical membrane is fenestrated, and the endoscope is advanced into the cyst cavity to penetrate through the cyst to the inferior membrane located in the interpeduncular and prepontine cisterns, where additional fenestration is performed to enable communication between the cyst and the basal cisterns [4].

There are no standardized preoperative criteria for selecting each surgical method, which likely explains the variability in technique preference among institutions and surgeons. Given the rarity of these cysts, no single center has accumulated a sufficiently large number of cases to conduct a thorough evaluation of surgical outcomes. Furthermore, despite the increasing rate of diagnosis of suprasellar arachnoid cysts in the pediatric population, only a limited number of studies have examined the differences in surgical outcomes across various approaches.

Objective: To evaluate the effectiveness of endoscopic ventriculocystostomyc and endoscopic ventriculocystocisternosto-my in the treatment of pediatric patients with suprasellar arachnoid cysts.

Materials and methods

Inclusion criteria:

Patients under 18 years of age;

Presence of symptoms associated with suprasellar arachnoid cysts AC;

Availability of informed consent from the patient's parents to participate in the study;

Use of endoscopic surgical techniques for the treatment of suprasellar AC (endoscopic ventriculocystostomy VCS or ventriculocystocisternostomy VCCS).

Study Participants

All children under the age of 18 who underwent endoscopic surgical treatment for suprasellar AC were identified through a systematic review of case histories at the Romodanov Institute of Neurosurgery of the National Academy of Medical Sciences of Ukraine. For the purposes of this study, patient inpatient and outpatient records were reviewed, including operative reports, preoperative and postoperative assessments based on instrumental diagnostic methods, surgical technique employed, postoperative course, and clinical follow-up data.

All pediatric patients underwent preoperative magnetic resonance imaging (MRI) of the brain, including thin-slice sequences (sT2W_TSE, T2W_TSE, CSF-drive). Special attention was paid to cyst size, presence of hydrocephalus, upward displacement of the floor of the third ventricle, posterior displacement of the brainstem, and vertical displacement of the optic chiasm and mammillary bodies ***(Fig. 1)***.

Neurosonography was performed at different stages of treatment in children under the age of one year. In urgent cases and during the postoperative period, spiral computed tomography of the brain was conducted.

Ventricular system enlargement was observed in all examined cases. The diagnosis of "obstructive hydrocephalus" was confirmed in all 29 (100%) patients. The presence of hydrocephalus enabled the use of endoscopic surgical techniques. For diagnosis, determination of indications, planning of the type/ course of intervention, and postoperative monitoring, neurosonography was performed in 18 cases (62%), spiral CT of the brain in 17 (41%), including 5 for diagnostic verification and 12 within the first 24 hours after surgery, and brain MRI in all 29 patients (100%).

Between 2016 and 2023, twenty-nine children were surgically treated at the Romodanov Institute of Neurosurgery of the National Academy of Medical Sciences of Ukraine. Among them, 18 (62%) were boys and 11 (38%) were girls. The age at the time of the first operation ranged from 4 months to 17 years (mean age – 2.8 years).

The most common symptoms included macrocephaly (in 55% of patients) and signs of intracranial hypertension (in 41%). Developmental delay was observed in 7 patients (24%). Oculomotor disorders were noted in 5 cases (17%), and decreased visual acuity in 3 (24%).

All patients underwent surgery under general anesthesia using an exclusively endoscopic approach. Patients were positioned supine. The burr hole was made 1 cm anterior to the coronal suture and 3 cm lateral to the midline. A rigid endoscope (Lotta series, Karl Storz, Germany) with three access ports was used for the operations ***(Fig. 2)***.

A dural incision was performed. The endoscopic trocar was introduced perpendicularly to the skull surface, which facilitated access to the right lateral ventricle. The apical surface of the cyst wall, which was obstructing the foramen of Monro, was visualized. The surgeon used clearly identifiable anatomical landmarks for orientation. With the aid of bipolar electrocoagulation, ventriculostomy forceps, and micro-scissors, a stoma was created between the lateral ventricle and the cyst cavity (endoscopic cystocisternostomy – group 1). After the initial opening of the proximal cyst wall in group 2, the endoscope was advanced toward the distal (inferior) aspect of the cyst wall to perform fenestration (stoma formation). This technique allows communication between the cyst and the CSF pathways, as well as connection between the lateral ventricle and the interpeduncular cistern, thereby facilitating effective treatment.

This article contains some figures that are displayed in color online but in black and white in the print edition.

The endoscopic anatomy and procedural steps of the endoscopic intervention are illustrated in ***Fig. 3***.

All surgeries were primary interventions, i.e., performed without prior use of microsurgical techniques for treating suprasellar cysts. One patient had a history of ventriculoperitoneal shunt placement performed at another medical facility.

According to the method of endoscopic surgical treatment, patients were divided into two groups: Group 1 (n = 19) underwent endoscopic VCS, Group 2 (n = 10) – endoscopic VCCS.

The diagnosis of AC in all patients was established based on clinical and instrumental diagnostic findings.

Clinical outcomes assessed included symptoms present at the time of initial diagnosis, during postoperative follow-up, or prior to repeat surgery. These were categorized as resolved, improved, unchanged, or worsened (according to the description of the patient or their parents).

Changes in cyst size were analyzed based on MRI data obtained preoperatively and postoperatively (on the 90th day after surgery). Three dimensions (length, height, width) were measured and converted into a calculated volume (cm^3).

Follow-up duration ranged from 12 to 48 months, with a mean of 22 months.

Quality of life in the preoperative, early postoperative, and late postoperative periods was assessed using the Lansky Performance Scale ***(Table 1)***.

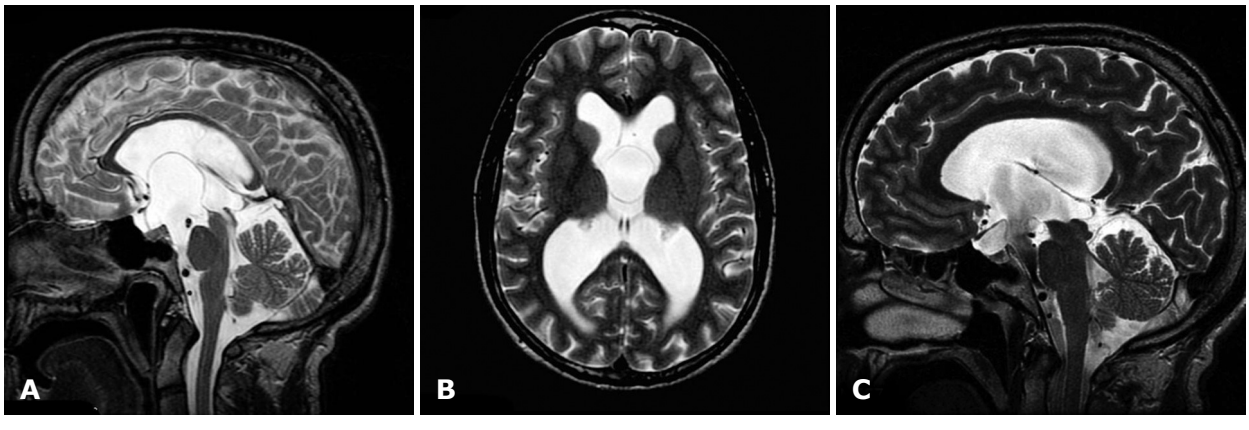

Fig. 1. MRI of the иrain. Signs of a suprasellar arachnoid cyst: A – T2-weighted sagittal images; B – T2-weighted axial images; C – postoperative condition after endoscopic VCS in CSF-drive mode

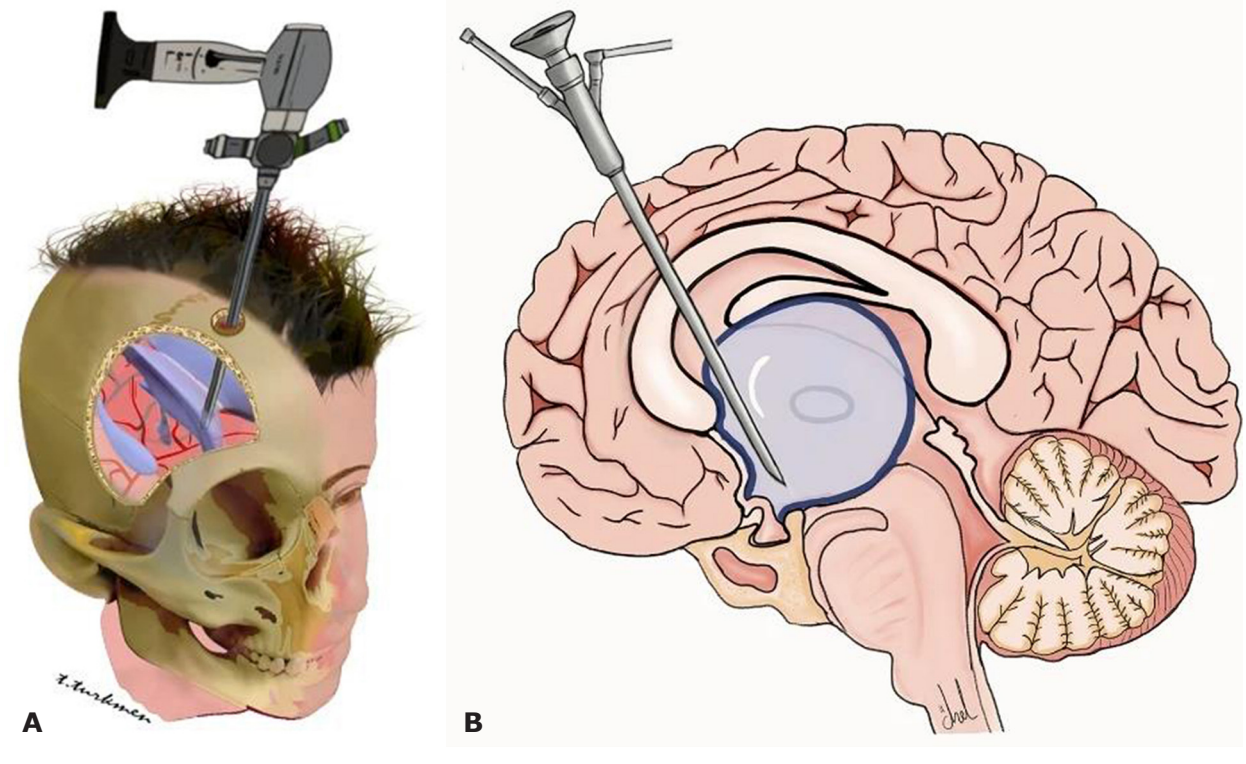

Fig. 2. Illustrative depiction of neuroendoscopic surgical technique: A – schematic representation of the trephination point; B – endoscopic view of a ventriculocystocisternostomy in a patient with a giant suprasellar arachnoid cyst [19]

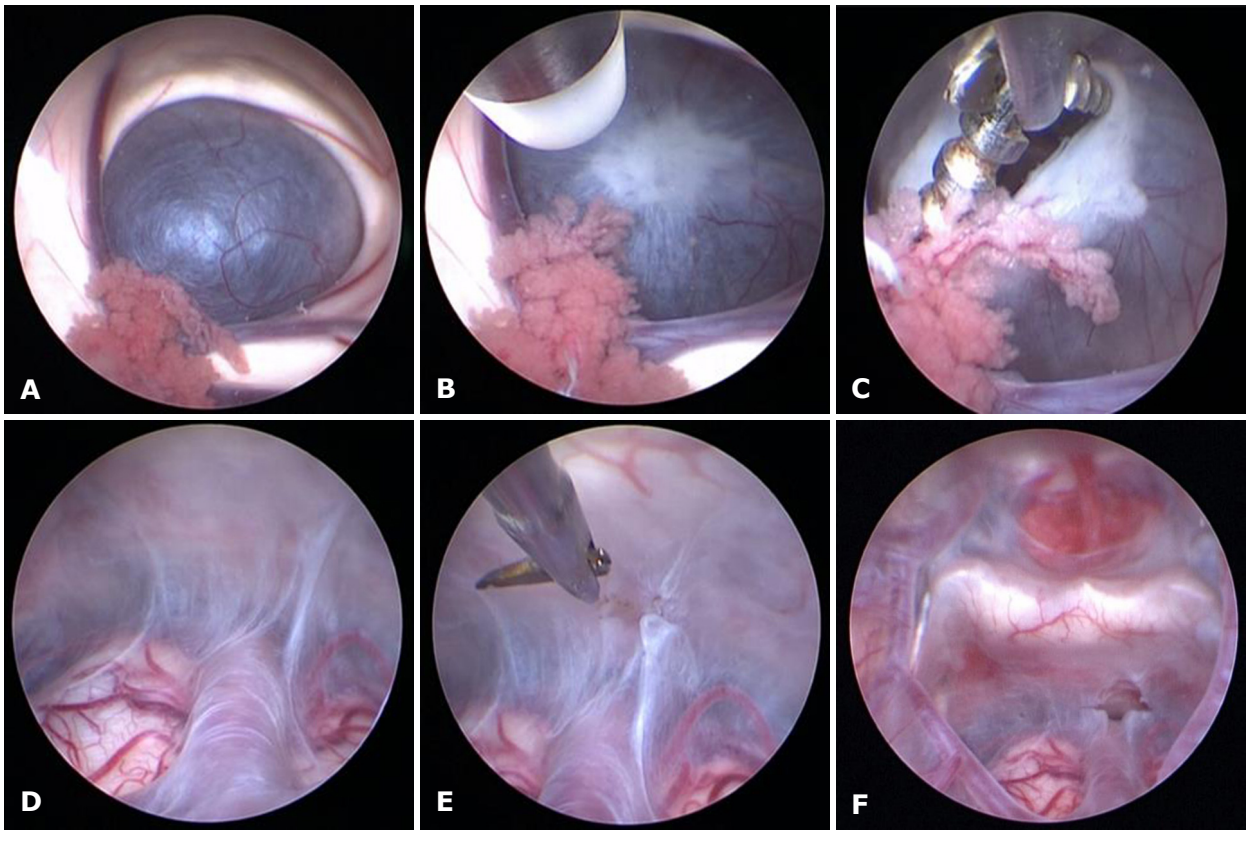

Fig. 3. Intraoperative anatomy during endoscopic VCS and endoscopic VCCS:
A – intraoperative endoscopic view of the cyst;
B, C – operative stages of stoma formation between the ventricular system of the brain and the suprasellar cyst (endoscopic VCS);
D – intraoperative endoscopic view of the internal surface of the cyst wall, basilar artery, and brainstem;
E – stage of stoma formation between the cyst cavity and the interpeduncular cistern (endoscopic VCCS);
F – view of the completed stoma, pituitary gland and infundibulum, basilar artery, cranial nerves, and dorsum sellae

Table 1. Lansky scale (for patients under 16 years of age)

Description	Condition assessment, score
Fully active, normal	100
Minor limitations in physical activity	90
Active, but tires quickly	80
Noticeable limitations in activity, spends less time on play	70
Minimal participation in active play, engaged in quiet activities	60
Gets dressed, but spends most of the time lying down; does not engage in active play, can participate in quiet activities	50
Spends most of the time in bed, but can participate in quiet activities	40
Sleeps most of the time, requires assistance even with the calmest activities	30
Sleeps most of the time, capable only of passive engagement	20
Confined to bed	10
Moribund (near death)	0

Study design

This study was conducted as a retrospective analysis.

Statistical analysis

Data processing and analysis were performed using descriptive statistics, univariate and multivariate analyses, as well as survival estimation methods. The statistical software used was Statistica v.10 (StatSoft® Inc., USA, license No. STA862D175437Q). The Shapiro–Wilk test was applied to assess the normality of quantitative variable distributions. Parametric statistics were used for normally distributed data. The mean (*M*), standard error of the mean (*m*), and standard deviation (*SD*) were calculated. Comparisons were made using Student's t-test for independent samples. For ordinal data (e.g., Lansky scale), the median (*Me*) and interquartile range (25;75%) were calculated.

Statistical significance of differences in categorical data was assessed using the χ^2 test (Fisher's exact test) and the Mann–Whitney U test for ordinal data. Differences between groups were considered statistically significant at P<0.05 (error risk <5%).

Results and discussion

The duration of postoperative hospital stay was comparable between the two groups: in Group 1, it ranged from 6 to 18 days (mean (10.2±3.1) days); in Group 2, from 7 to 17 days (mean (11.3±3.8) days, P=0.411).

No complications were observed in Group 1. In contrast, two (6%) surgical complications occurred in Group 2. One (3%) case of intraoperative arterial bleeding during VCCS was reported. The bleeding was minor, did not require interruption of the procedure, and resolved spontaneously within a few minutes after irrigation, with no postoperative consequences. In the postoperative period, one (3%) case of wound cerebrospinal fluid (CSF) leakage was recorded following VCCS.

Post-treatment outcomes indicated a reduction in cyst size ***(Table 2)***.

In Group 1, during the early postoperative period, cyst size showed no significant change (10–30% reduction compared to preoperative measurements) in 5 cases (26.3%). A mild reduction was observed in another 5 cases (26.3%), while a marked reduction (51–100%) was noted in 9 cases (47.4%). In Group 2, cyst size remained unchanged in 1 case (10%), decreased by 31–50% in 4 cases (40%), and by 51–100% in 5 cases (50%).

A recurrence was documented in one case in Group 1. During reoperation, intraoperative endoscopic evaluation revealed closure of the stoma. The child underwent repeat endoscopic VCS twice due to cyst recurrence in the postoperative period. A decision was made to perform endoscopic VCCS as a subsequent intervention. No disease progression was observed during the follow-up period.

The duration of surgical intervention ranged from 25 to 70 minutes, averaging (48.4±13.0) minutes in Group 1 and from 45 to 70 minutes in Group 2, with a mean duration of (52.5±8.2) minutes (p=0.378).

No deterioration in condition or emergence of new neurological deficits was observed in either group during the early or late postoperative periods.

The general preoperative condition of the children in both groups, as assessed by the Lansky scale, averaged 80 (70; 90) points (p=0.924).

In the early postoperative period, quality of life improved: in Group 1, the median score was 90 (80;100), and in Group 2, it was 90 (80;90) (p=0.848). In the late postoperative period, both groups reported a median score of 100 (90;100) (p=0.659), indicating comparable outcomes between the groups.

Complete recovery (absence of complaints and regression of preoperative symptoms) in the early postoperative period was achieved in 6 (33%) patients in Group 1 and in 2 (20%) patients in Group 2 (p=0.507). In the late postoperative period, full recovery was observed in 12 (63%) and 7 (70%) patients, respectively (p=0.712). The improvement in quality of life over time was statistically significant in both groups (p=0.001).

Effective treatment of suprasellar ACs in pediatric patients remains a topic of ongoing discussion among pediatric neurosurgeons. Notably, compared to adults, children are twice as likely to present with such cysts, necessitating research to determine the most appropriate surgical approach. As pediatric neurosurgery has advanced over the past decade, there has been a growing preference for endoscopic treatment over traditional microsurgical fenestration via craniotomy and/or shunting. Despite the evolution of this technique, few studies have been conducted, and most have involved small sample sizes, likely due to single-center limitations and the rarity of such cases. Consequently, only a limited number of institutions have had the capacity to compare all surgical approaches comprehensively and draw definitive conclusions.

Since suprasellar ACs are typically asymptomatic, the majority of patients opt against surgery in favor of conservative management and observation. However, surgical intervention has been justified in patients presenting with pronounced clinical symptoms and a high risk of complications, necessitating operative treatment.

Table 2. Tomographic results of surgical treatment of suprasellar arachnoid cysts in the early postoperative period

Group	No Change	No Significant Change	Slight Reduction in Cyst Size	Significant Reduction in Cyst Siz	Total
1-st (n=19)	0	5 (26,3%)	5 (26,3%)	9 (47,4%)	19 (100,0%)
2-nd (n=10)	0	1 (10,0%)	4 (40,0%)	5 (50,0%)	10 (100,0%)
Total		6 (20,7%)	9 (31,0%)	14 (48,3%)	29 (100,0%)

Note: no change refers to a cyst size reduction of 0–10%; insignificant change denotes a reduction of 11–30%; mild reduction implies a decrease of 31–50%; marked reduction indicates a size decrease of 51–100%. The difference between the groups was statistically insignificant ($p(\chi^2)=0.536$).

Long-term outcomes are typically evaluated based on symptom resolution, instrumental confirmation of cyst size reduction, and the need for additional surgical interventions (including repeated endoscopic procedures or shunt system revisions). Each of the three primary treatment approaches—fenestration via open craniotomy, cystoperitoneal shunting, and endoscopic fenestration—has distinct advantages and disadvantages. According to current scientific literature, endoscopic fenestration is considered the most effective treatment for arachnoid cysts.

Open cyst fenestration is generally not recommended as the optimal treatment for ACs due to the risks and complications associated with craniotomy. Nevertheless, one of its advantages lies in the potential to achieve shunt independence [17, 20]. However, this approach is often viewed as overly aggressive for treating symptomatic ACs [20,21]. Furthermore, open surgical procedures are frequently associated with high recurrence rates and limited effectiveness [17, 20, 21]. Complications following open fenestration may include meningitis, subdural hematoma, seizures, hemiparesis, and oculomotor nerve palsy [20, 21].

Given the relative risks, complications, and outcomes of microsurgical cyst wall fenestration, this method is generally recommended less frequently than alternative treatment options. Cystoperitoneal or ventriculoperitoneal shunting serves as an alternative to microsurgical fenestration. Shunting is often more effective than craniotomy-based fenestration [17, 20, 22]; however, it may lead to lifelong shunt dependency [17, 20] and frequently necessitates revision surgeries [22, 23].

The complication rate associated with shunting is lower than that of open fenestration [17, 23], which is why it is often preferred over craniotomy [20, 23].

Given the potential complications related to both microsurgical fenestration via craniotomy and shunting, in comparison to endoscopic treatment, most studies conclude that endoscopic surgery (either VCS or VCCS) is the superior method for treating sellar ACs in pediatric patients. Although endoscopic surgical management of this condition was previously considered limited, such procedures are now increasingly performed.

Among endoscopic approaches, most studies favor VCCS over VCS due to better clinical outcomes. This preference is attributed to the lower failure rate of VCCS compared to VCS. Patients undergoing VCCS are less likely to require reoperation, thus facing a reduced risk of infection and other postoperative complications associated with repeated neurosurgical interventions. Additionally, VCCS offers the highest probability of complete symptom resolution in affected patients [23].

However, numerous studies report an increased risk of anatomical damage during VCCS due to the close proximity of cranial nerves and the basilar artery. This is because the surgical approach requires navigating through the cyst into the interpeduncular and prepontine cisterns, whereas VCS only involves opening the apical membrane and entering the cyst cavity.

Conclusions

The endoscopic technique can be recommended for the treatment of suprasellar arachnoid cysts in pediatric patients, as it is effective, minimally invasive, and associated with low postoperative complication and mortality rates. According to our data, both procedures—ventriculocystostomy and ventriculocystocisternostomy—demonstrated nearly equivalent clinical and radiological outcomes.

The detection of stomal reocclusion following VCS in cases of cyst recurrence highlights the importance of performing VCCS during the initial surgery to prevent recurrence.

Endoscopic methods for treating symptomatic suprasellar arachnoid cysts enable sustained regression of clinical symptoms with minimal risk of reoperation.

In our view, the observed complications are more closely related to anatomical variations rather than the choice of surgical method. However, considering both current literature and our findings, there is a significant difference in the long-term recurrence rates between VCS and VCCS. We conclude that VCCS should be considered the procedure of choice in the treatment of these cases.

Disclosure

Conflict of interest

The authors declare no conflict of interest.

Ethical standards

All procedures performed on patients in this study were in accordance with the ethical standards of the institutional and national research ethics committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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