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ORIGINAL ARTICLE

Management of pediatric Sylvian arachnoid cysts. A retrospective study

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Background and purpose – Neurosurgical approaches in Sylvian arachnoid cysts include microsurgery, endoscopy, and shunting. Yet, their relative safety and efficacy is still under debate. This retrospective study evaluated 36 pediatric patients with Sylvian arachnoid cysts and treated with different surgical types to contribute to global data.
Methods – The study included 24, 8, and 4 patients receiving endoscopic, microsurgical, and shunt surgeries, respectively. Preoperative and postoperative assessments included the patients' demographics and symptoms, cyst size and type, psychomotor status, length of hospital stay, and complications with a mean follow-up of 37.3 months.
Results – All types of surgeries alleviated headaches and seizures in most of the patients. Shunt operations led to the highest reduction in cyst size in the early postoperative period and relieved cranial palsy in all patients. Microsurgery achieved greater healing regarding hemiparesis and seizures, and reduced cyst size more effectively in the early postoperative period than endoscopy. Complication rates were similar between the endoscopy and microsurgery groups.
Conclusion – Arachnoid cyst surgery is efficient and relatively safe. The higher efficacy of microsurgery may be associated with the lesser chronic presence of cysts in this group rather than its technical superiority. Endoscopic surgery is challenging, yet it may be advocated to avoid craniotomy and shunt complications. Surgical-type decisions for

Arachnoid cysták kezelése a gyermekgyógyászatban. Retrospektív tanulmány

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Bevezetés – A Sylvianus arachnoidacysták idegsebészeti megközelítései közé tartozik a mikrosebészet, az endoszkópia és a söntölés. Ezek viszonylagos biztonságossága és hatékonysága még mindig vita tárgyát képezi. Ez a retrospektív vizsgálat 36, Sylvianus arachnoidacystában szenvedő, különböző műtéti típusokkal kezelt gyermekbeteget értékelt, hogy hozzájáruljon a globális adatokhoz.
Módszerek – A vizsgálatba 24, 8, illetve 4 beteg került bevonásra, akik endoszkópos, mikrosebészeti, illetve söntműtétben részesültek. A műtét előtti és utáni felmérések a betegek demográfiai adatait és tüneteit, pszichomotoros állapotát, a cysta méretét és típusát, a kórházi tartózkodás hosszát és a szövődményeket foglalták magukba, átlagosan 37,3 hónapos követési idővel.
Eredmények – A műtétek minden típusa enyhítette a legtöbb betegnél a fejfájást és a rohamokat. A söntműtétek eredményezték a cysta méretének legnagyobb mértékű csökkenését a korai posztoperatív időszakban, és minden betegnél enyhítették a cranialis idegek bénulását. A mikrosebészet nagyobb gyógyulást ért el a hemiparesis és a rohamok tekintetében, és hatékonyabban csökkentette a cysta méretét a korai posztoperatív időszakban, mint az endoszkópia. A szövődmények aránya hasonló volt az endoszkópos és a mikrosebészeti csoportokban.
Következtetés – Az arachnoidacysta műtéti kezelése hatékony és viszonylag biztonságos. A mikrosebészet nagyobb hatékonysága

arachnoid cysts should be patient-tailored based on careful preoperative clinical and radiological examinations.

nem a módszer technikai fölényével, hanem inkább azzal hozható összefüggésbe, hogy ebben a csoportban a cysták kevésbé régóta álltak fenn. Az endoszkópos műtét kihívást jelent, mégis javasolható a craniotomia és a söntkomplikációk elkerülése érdekében. Az arachnoidacysták kezelésének műtéti típusára vonatkozó döntéseket a betegre szabottan kell meghozni a gondos preoperatív klinikai és radiológiai vizsgálatok alapján.

Keywords: Sylvian arachnoid cyst, endoscopy, microsurgery, cystoperitoneal shunt

Kulcsszavak: Sylvianus arachnoideacysta, endoszkópia, mikrosebészet, cystoperitonealis sönt

Intracranial arachnoid cysts are benign lesions containing cerebrospinal fluid residing within the cerebral convexity or cisternal arachnoid[1–4]. The most common location in both adults and children is the temporal fossa associated with the Sylvian fissure[2, 4–8]. There is a consensus for surgery for severe symptoms and risks of neurovascular compression and neurological deficits. Surgical approaches to treat Sylvian arachnoid cysts involve microsurgical fenestration or removal of the cyst, endoscopic fenestration, and cystoperitoneal shunts[3, 7–13]. Nonetheless, the efficacy and safety of different approaches are still debated. Hence, the present study aims to provide a single-center experience to contribute to global data and evaluate the outcomes of different approaches.

Patients and methods

Study ethics and cohort

This retrospective study complies with the ethical rules of the Declaration of Helsinki and its latest amendments. The ethics committee of Ankara University formally approved the study (Approval Number: I0-149-24). The parents of all patients gave signed informed consent forms after obtaining information from the primary physicians regarding the risks of each surgical type. The study included 36 patients (23 male and 13 female) receiving surgical treatment for Sylvian arachnoid cysts between February 2017 and August 2023 in the neurosurgery department of Ankara University. The mean follow-up period of the whole group was 37.3 months.

Preoperative assessment

The analyzed data comprised symptoms, cyst side, volume, and classes as evaluated with magnetic resonance imaging (MRI) and computed tomography (CT). Two observers calculated preoperative and postoperative cyst volumes using the free version of Horos v.4.0.0 software. Pediatric neurologists and psychiatrists examined and recorded patient data with psychomotor retardation to compare preoperative and postoperative status.

Decisioning for surgical indication and approach

The indication for surgery and selection of the surgical type were decided upon by consensus of the neurosurgical team. Surgeries were performed for large Sylvian cysts when symptomatic in children aged <2 years with progressive macrocrania, causing shift and compression of the brain parenchyma on MRI and seizures with lateralizing signs confirmed by electroencephalography. Surgeries were made only for Type II and III Sylvian arachnoid cysts. Microsurgical fenestration was used in the presence of intracystic bleeding or complex vascularity in the cyst wall. Endoscopic fenestration was performed in patients whose symptoms were proven to be related to Sylvian arachnoid cysts but did not have acute clinical worsening. Cystoperitoneal shunts were performed alone or with additional fenestration.

Surgical techniques

Endoscopy

Figure 1 demonstrates an intraoperative view of a right-sided type III Sylvian arachnoid cyst treated with endoscopic surgery. The head was tilted contralaterally and fixed on the silicone cap. After opening the dura mater, a 0° or 30° free-hand rigid scope (Storz®, Tuttlingen, Germany) was inserted within the cyst. The orientation

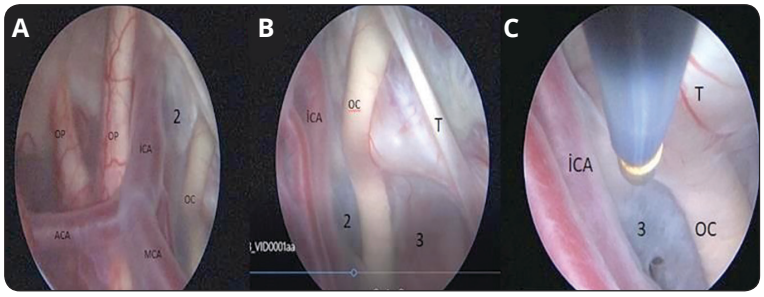

Figure 1. A *and* **B** *Intraoperative endoscopic view of a right-sided type III Sylvian cyst. Optic nerve (OP), internal carotid artery (ICA), oculomotor nerve (OC), anterior cerebral artery (ACA), middle cerebral artery (MCA), and the tentorium (T) free edge. The cyst membrane at the carotico-oculomotor triangle (2) and at the oculomotor-tentorial triangle (3).* **C** *The membrane at the carotico-oculomotor triangle (3) was perforated using the monopolar probe*

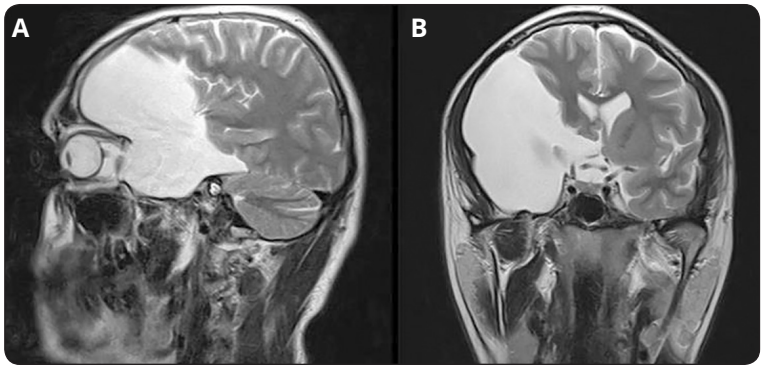

Figure 2. *Preoperative coronal and sagittal MRI of a Type III Sylvian arachnoid cyst treated by microsurgery*

landmarks were the free edge of the tentorium and the Sylvian fissure with the arterial trunks, veins, and cranial nerves. Cystocisternostomy was performed between the opticocarotid triangle or carotico-oculomotor triangle, or oculomotor-tentorial-triangle by creating a combination of these. Forceps and/or endoscopic scissors were used to make holes in the membranes. The holes were enlarged using the double-balloon catheter (neuroballoon catheter from Integra Neurosciences®, Antipolis, France).

Microsurgery

Figure 2 shows preoperative coronal and sagittal MR images of a large Type III Sylvian arachnoid cyst treated by microsurgical fenestration, and **Figure 3** depicts an intraoperative view of a Sylvian arachnoid cyst treated with microsurgery. The head was tilted contralaterally and fixed on a three-pin skull fixation device at an angle of 30°–45°. A 3- to 4-cm-diameter pterional craniotomy was performed to view the frontal lobe, temporal lobe, and the Sylvian fissure. The arachnoid cyst wall was perforated using an operating microscope and microsurgical techniques. After aspirating the cyst content, cystocisternostomy was obtained between the opticocarotid triangle and carotico-oculomotor or oculomotor-tentorial triangle.

Cystoperitoneal shunts

Figure 4 demonstrates CT images of a large Type III Sylvian arachnoid cyst treated by cystoperitoneal shunt and the postoperative reduction in cyst size. The head was tilted contralaterally and fixed on the silicone cap. A linear skin incision was made to fit the largest area of the cyst. Simultaneously, abdominal incision and peritoneal opening were started. The maximum possible portion of the cyst outer membrane was removed because a collapsed outer membrane may cause shunt tube occlusion. After intracranial placement of the shunt tube, the shunt's distal end was tunneled to the abdomen.

Postoperative evaluation and follow-up

Cranial CT was obtained in all patients in the early postoperative period. Depending on the clinical situation, CT was repeated in some patients before discharge. An outpatient clinic check was performed at the 2, 6 and 12 months. Afterward, follow-ups continued annually. Symptom resolution, clinical and radiological findings, the progress of macrocrania, late complications, and psychomotor status were evaluated during follow-ups.

Results

Demographic and clinical features

Table 1 summarizes the demographic features, lesion characteristics, length of hospital stay, and follow-up periods of patients classified according to the employed surgeries. The mean follow-up was 37.3 months (range: 12 – 109). There were 24 patients (66.7%) treated with endoscopy, including 17 males and 7 females, with an average age of 5.2 years (6 months – 16 years). All of the patients treated with cystoperitoneal shunts had a history of previous endoscopic or microscopic fenestration and had Galassi Type III cysts. In all surgical treatment groups, arachnoid cysts localized more on the left side. Other details regarding the patients' sex, age, and follow-up periods are presented in **Table 1**.

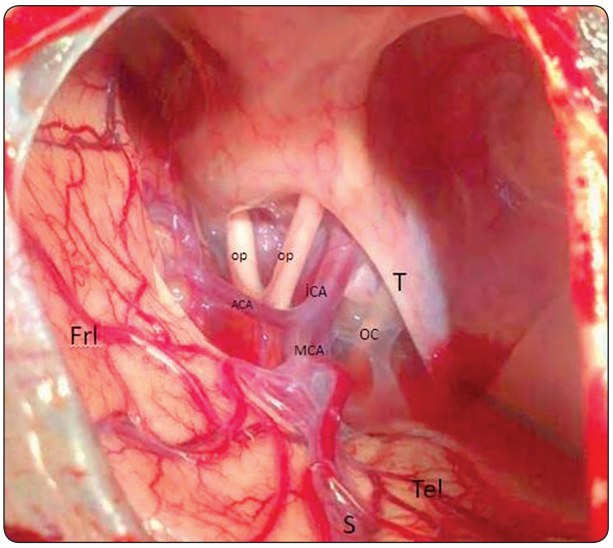

Figure 3. *Intraoperative microsurgical view of a right Sylvian cyst after perforating the cyst wall's outer membrane and fenestration communicating the cyst and cisterns. Frontal lobe (Frl), internal carotid artery (ICA), oculomotor nerve (OC), optic nerve (OP), internal carotid artery (ICA), anterior cerebral artery (ACA), middle cerebral artery (MCA), free edge of the tentorium (T), superficial Sylvian vein (S), temporal lobe (Tel)*

Outcomes

Outcomes of endoscopic surgery

Table 2 summarizes preoperative symptoms, cyst types and volumes, and postoperative outcomes in patients treated with endoscopic surgery. Endoscopic surgery relieved headaches in 17 of 19 patients having this condition. Among five patients admitted with hemiparesis, one benefitted with complete resolution and another with partial improvement. Among 8 patients who had seizures, seizures completely resolved in 2 allowing for withdrawal of antiepileptic drugs. In three patients, the seizure frequencies declined, achieving dose reduction of antiepileptics. One patient among 4 having psychomotor retardation showed improvement who had a Galassi Type III cyst and whose cyst volume decreased by about 50% postoperatively. This patient had a preoperative diagnosis of attention deficit hyperactivity disorder (ADHD) and had remarkably benefited, rated with an ADHD Rating Scale-IV score showing a significant decline. Other details shown in **Table 2** are not detailed to avoid giving repeated information.

Outcomes of microsurgery

Table 3 summarizes preoperative symptoms, cyst types and volumes, and postoperative results in patients treated with microneurosurgery. **Figure 5** demonstrates CT and MR images of an example case with this condition and a successful postoperative outcome. Three patients in this group had recently developed neurological symptoms. The seizures in 3 patients occurred for the first time after intracystic hemorrhage, and microsurgical treatment achieved complete seizure resolution. Abducens palsy in 1 patient continued postoperatively, and there was no improvement during the follow-up. While the skull growth rate of a 16-month-old patient with macrocrania returned to normal, there was no change in the skull growth rate of a 6-year-old patient. There was no postoperative psychomotor improvement in this group. Cyst volume decreased by at least 75% in the early postoperative period in all patients. Cyst sizes increased in 2 patients after 3 and 4 years of microsurgery; one was conservatively followed up due to lack of symptoms, and a cystoperitoneal shunt was applied to the other one due to the development of headache and hemiparesis, which improved these symptoms. The reader can refer to **Table 3** for other details regarding microsurgical outcomes.

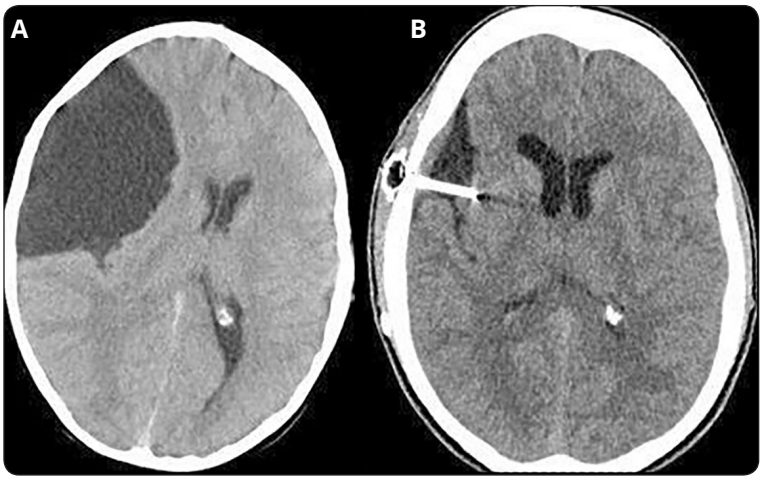

Figure 4. A *CT scan of a Type III Sylvian cyst treated by cystoperitoneal shunt.* **B** *Postoperative CT showing cyst size reduction*

Outcomes of shunting

Table 4 summarizes preoperative symptoms, cyst types and volumes, and postoperative results in patients treated with cystoperitoneal shunts. Among 4 patients suffering from headaches, 3 enjoyed pain relief. All patients in this group benefited from shunt surgery regarding seizures. Seizures significantly improved in 2 patients, allowing reductions in antiepileptic medication doses. In 1 patient, seizures completely resolved, resulting in complete cessation of antiepileptics. Cyst

Table 1. *Demographics and clinical features*

Type of surgical treatment			
	Endoscopy	Microsurgery	Cystoperitoneal shunt
Number of patients	24	8	4
Sex	16 male, 8 female	5 male, 3 female	2 male, 2 female
Mean age Range	5.2 6 months – 16 years	6.7 16 months – 17 years	5.5 20 months – 11 years
Galassi type II III	 7 17	 0 8	 0 4
Side	16 left, 8 right	5 left, 3 right	2 left, 2 right
Mean follow-up Range	31.3 months 12–60	44.8 months 14–109	43.4 months 16–71
Hospital stay Range	5.2 days 4–13	9.2 days 6–21	5.5 days 4–9

Table 2. *Preoperative features and postoperative results in the endoscopy group*

Symptoms and clinical presentation	Number of patients with preoperative symptoms (percentage)	Number of patients with postoperative symptom relief (percentage)
Headache	19 (79.2)	17 (89.5)
Hemiparesis	5 (20.8)	2* (40)
Seizures	8 (33.3)	5 (62.5)
Loss of consciousness	3 (12.5)	3 (100.0)
Cranial nerve palsy	3† (12.5)	2‡ (66.7)
Macrocrania	8 (33.3)	5 (62.5)
Psychomotor retardation	4 (16.7)	1 (25.0)
Temporal bulging	4 (16.7)	3 (75.0)

Cyst volumes			
Galassi type (patient number)	*Preoperative*	*Early postoperative* (percentage reduction)	*Last follow-up* (percentage reduction)
Type II (4)	45.6 ml	32.5 ml (28.7)	21.5 ml (52.9)
Type III (20)	79.9 ml	54.02 (32.4)	48.02 (39.9)

Patient numbers with postsurgical complications (percentage)	
Subdural hygroma	3 (12.5)
CSF leak (needing transient shunt)	2 (8.3)
Subdural hematoma	1 (4.2)
Epidural hematoma	1 (4.2)
Wound problem	1 (4.2)

*One complete resolution, one improvement. †Two oculomotor and one abducens palsy. ‡No change in abducens palsy. CSF: cerebrospinal fluid

volumes decreased by 75% or more in all patients. Shunt dysfunction occurred in 2 patients who developed headaches, one in the 14th month and the other in the 3rd year of follow-up. Headaches regressed after shunt revision in both. **Table 4** provides further data on the outcomes of shunt operations.

Table 3. *Preoperative features and postoperative results in the microsurgery group*

Symptoms and clinical presentation	Number of patients with preoperative symptoms (percentage)	Number of patients with postoperative symptom relief (percentage)
Headache	6 (75.0)	5 (83.3)
Hemiparesis	4 (50.0)	4 (100.0)
Seizures	3 (37.5)	3 (100.0)
Loss of consciousness	3 (37.5)	3 (100.0)
Cranial nerve palsy	3 (37.5)	2 (66.7)
Macrocrania	2 (25.0)	1 (50.0)
Psychomotor retardation	1 (12.5)	0 (0.0)

Cyst volumes			
Galassi type (patient number)	*Preoperative* (average)	*Early postoperative* (percentage reduction)	*Last follow-up* (percentage reduction)
Type III (8)	88.4 ml	12.02 ml (86.4)	19.02 ml (78.5)

Patient numbers with postsurgical complications (percentage)	
Subdural hygroma	2 (25.0)
Wound problem	1 (12.5)

Discussion

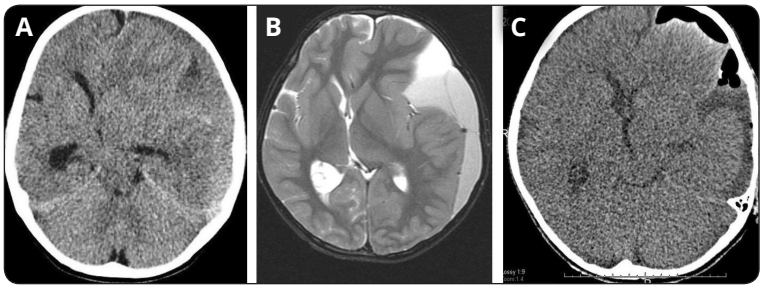

Figure 5. A *CT scan shows subdural hemorrhage in the left frontotemporal region.* **B** *MRI shows left chronic subdural hematoma and intracystic hematoma.* **C** *Postoperative CT scan shows the vanishing of the subdural and intracystic hematoma*

Several hypotheses were put forward to explain arachnoid cyst development, and more than one mechanisms may contribute to their formation. These include defective separation of the endomeninx during embryogenesis, arachnoid membrane duplication or splitting due to abnormal subarachnoid cistern growth, temporal lobe underdevelopment, arachnoiditis, and head traumas in infancy[2, 7, 9, 14–18]. Cyst symptoms develop mainly due to cerebrospinal circulation blockage and increased intracranial pressure, including headache, vomiting, drowsiness, bulging fontanels, hydrocephalus, macrocephaly, and visual disturbance[2, 4]. Intracystic bleeding, subdural hygroma, or hematoma may also occur[4, 8, 9, 18–20]. Preventive surgery may be employed even for asymptomatic patients vindicated by bleeding risks and to avoid cerebral blood flow reduction in the developing brain[4, 21]. In this case, intracranial pressure monitoring may guide surgical indication.[5] In this cohort, arachnoid cysts localized mainly on the left side, which is in line with previous observations[2]. Both endoscopy and microsurgery provided the same rate of symptom relief regarding nerve palsies, yet the resolution rate of hemiparesis was higher in the microsurgery group than in the endoscopy group. The greatest cyst size reductions and relief of all cranial palsies occurred in the shunt group, which may be ascribed to faster fluid drainage. Nonetheless, postsurgical symptom improvement is related more to the intracranial pressure reduction than to the cyst size[13].

Cystoperitoneal shunts could provide better outcomes for Type III cysts, yet fenestrations achieve better long-term results and lower complications in Type I and II cysts since brain re-expansion after shunting could obstruct the shunt pipe head[17]. A study reported the complete vanishing of cysts and no cyst regrowth in 92 children after a mean follow-up of 8.5 years who received cystoperitoneal shunt or solely ventricular drainage with successful treatment ratios of 72.8% and 15.2%, respectively[3]. The authors claimed that shunt operations are highly efficient and safe. Yet, other clinicians raise concerns regarding shunt dependency, high rates of revisions, infections, over-drainage,

Table 4. *Preoperative features and postoperative results in the shunt group*

Symptoms and clinical presentation	Number of patients with preoperative symptoms (percentage)	Number of patients with postoperative symptom relief (percentage)
Headache	4 (100.0)	3 (75.0)
Seizures	3 (75.0)	3 (100.0)
Cranial nerve palsy	2* (50.0)	2 (100.0)
Psychomotor retardation	2 (50.0)	0 (0.0%)
Temporal bulging	1 (25.0)	1 (100.0)

Cyst volumes			
Galassi type (patient number)	*Preoperative* (average)	*Early postoperative* (percentage reduction)	*Last follow-up* (percentage reduction)
Type III (4)	102.6 ml	16.2 ml (84.2)	13.3 ml (87.0)
Patient numbers with postsurgical complications			
Shunt dysfunction		2	

*Oculomotor palsy

and cerebellar tonsillar herniation[2, 3, 13, 22]. In parallel, in the present cohort 2 of the 4 patients treated with shunts required revisions.

This investigation observed that all kind of surgical treatments alleviated headaches in most patients, while hemiparesis was relieved in 40% and 100% of patients treated with endoscopy and microsurgery, respectively. Seizures were completely or partially reduced in 62.5% of patients treated with endoscopy and in all patients with shunts. In all patients in the microsurgery group, seizures completely vanished, allowing the withdrawal of antiepileptic medication. There were no patients in the microsurgery group with Type III cysts. The rates of cyst size reductions were higher in the microsurgery group than in the endoscopy group. Higher symptom relief and cyst size reductions achieved by microsurgery may be associated with both surgical efficacy and different patient features. Cyst fenestration in craniotomy allows more efficient cyst wall exploration, coagulation of risky vessels, and avoiding bleeding[3]. On the other hand, lower symptom reductions and cyst size in the endoscopy group may also be attributed to the patient's chronic disease. Indeed, patients in the endoscopy group were admitted with lower rates of hemiparesis and loss of consciousness, which are symptoms of sudden onset. Although in low rates, cognitive improvement after arachnoid cyst surgery may occur[4]. One patient with ADHD showed significant cognitive improvement with endoscopic surgery accompanied by a 50% reduction in the cyst volume. The cessation of the pressure on the temporal lobe and re-equilibration of the temporal blood circulation may have caused this improvement. As mentioned, the debate regarding the risks and benefits of different surgical approaches is continuing. One research comparing microsurgery, endoscopy, cystoperitoneal or subdural shunts showed no difference in immediate postoperative symptoms, yet endoscopies caused lesser event-free survivals and higher subdural hematoma rates[12]. Yet, microsurgery harbors risks as postsurgical scarring may occlude fenestrations, leading to nonnegligible rates of morbidity and mortality[3]. Further, other studies declared high treatment success with endoscopy. In 36 arachnoid cyst patients, 29 cases were treated only with endoscopy and 7 with additional shunts, which achieved cyst obliteration in 28 (77.8%) patients after a mean follow-up of 4.2 years[9].

The endoscopic approach is considered more advantageous for intraventricular cysts due to easier access.[13] Middle fossa cysts have restricted or absent connection with the ventricles, commonly hindering their access with ventriculocystostomy[10]. Therefore, the use of endoscopy for middle fossa cysts seems controversial. However, an endoscopic approach may still be preferred over shunts to avoid hazardous excessive fluid drainage and revisions[7, 10, 13]. In 17 children having Sylvian cysts treated with endoscopy, alleviation of mass effect symptoms were achievable in all patients, including 13 receiving several stomas[10]. Yet, 2 patients developed symptom recurrence at 12 and 20 months due to closed stomas, which resolved after redo-endoscopies[10]. In 20 children having type II (n=5) or III (n=15) Sylvian arachnoid cysts, endoscopic cystocisternostomies were achievable in all patients with several stomas leading successful outcomes in 18 and cyst size reductions in 10 patients[7]. Nonetheless, 3 and 2 patients required surgical repetition or shunt implantations, respectively. The authors advised a minimum of two fenestrations for efficient cyst marsupialization[7]. In 24 patients with Sylvian arachnoid cysts receiving endoscopy (n=20) or microsurgery (n=4), cyst volume reductions of more

than 10% were achieved in 83.3% of patients, and headaches vanished or relieved in 75%[8]. The authors preferred endoscopy if the MRI suggested the likelihood of fenestration towards the temporal horn of the ventricles or the basal cisterns and chose microsurgery if the fenestration of the medial cyst membrane wass only possible along the middle cerebral artery branches[8]. In 61 patients with arachnoid cysts, 33, 18, and 10 patients were treated with microsurgery, endoscopy, and cystoperitoneal shunts, respectively[13]. Postoperative events occurred in 20 patients with hygromas, higher in the microsurgery group, parallel to the current results, and explicable with the invasive nature of open surgeries. The mechanism of hygroma development is not entirely understood;some suggest remnant cyst wall secretions may exceed the cerebrospinal fluid absorption capacity[17]. This proposal also aligns with the fact that endoscopy could allow complete cyst removal at lower rates than microsurgery. Some groups suggest that multiple fenestrations during endoscopy achieve more successful results to reduce further surgeries[20]. A study evaluating 20 patients with arachnoid cysts reported surgical complications such as subdural hygroma, hydrocephalus, cerebrospinal fluid leak, hemiparesis, and spasticity[18]. No patients in the endoscopy group required surgical repetition or permanent shunts. Among those treated with endoscopic surgery, about 16.7% of patients suffered from complications, including cerebrospinal fluid leak and subdural or epidural hematoma. Some reports indicate higher hematoma development with endoscopy, which parallels the current results[11, 12].

Limitations

The major limitations of this study include its retrospective nature and the small number of patients, which hinders statistical comparisons. On the other hand, the management and long-term follow-up of patients were performed by the same team and in the same center, avoiding bias. Further, current observations provide additional information to global data, as few centers worldwide publish on this issue.

Conclusion

The "one size fits all" approach shall be avoided when deciding on the surgical type of arachnoid cyst treatment. Detailed and careful evaluations are necessary regarding the risks and benefits of each approach by preoperative clinical and radiological examinations.

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