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Endoscopic treatment of suprasellar and third ventricle-related arachnoid cysts

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Abstract *Objective:* To evaluate the role of neuroendoscopy in the treatment of rare suprasellar and other third ventricle-related arachnoid cysts. *Methods:* A review of supratentorial midline arachnoid cysts treated by endoscopic fenestration. *Results:* Ten cases were identified. The median age of these ten patients was 7.5 years. In three a cysto- or ventriculoperitoneal shunt had previously been inserted. Six cysts were located in the suprasellar/prepontine area, one was a combined suprasellar/middle fossa cyst, and three were complex cysts arising mainly in the quadrigeminal cistern and extending into the third ventricle. Successful endoscopic fenestration to both the ventricular system and the basal cisterns ("bipolar" fenestration) was achieved in all cases. In seven cases a cystoventriculostomy and cystocisternostomy was performed, while in three a cystoventriculostomy was combined with a third ventriculostomy, achieving additional communication to the subarachnoid space. The previously inserted shunts were removed at the end of the procedure. The median follow-up period was 17 (range 1–30) months. The clinical outcome was excellent in all cases, despite only marginal reduction in the cyst size and persistence of ventriculomegaly in some cases. No further treatment to the cyst was required during the period of follow-up. *Conclusion:* Third ventricle-related arachnoid cysts can be satisfactorily and safely treated by endoscopy. This approach leaves the patient shunt independent.

Keywords Neuroendoscopy · Arachnoid cysts · Suprasellar cysts

Introduction

Arachnoid cysts are often quoted as representing 1% of intracranial masses. Suprasellar arachnoid cysts are rare. They represent 6–20% of intracranial arachnoid cysts [1, 2, 8, 9, 11]. Arachnoid cysts in rare locations such as the quadrigeminal and ambient cisterns may extend into the third ventricle.

There is some controversy over the best operative treatment of arachnoid cysts [4, 11]. Arachnoid cysts are most commonly treated by craniotomy and cyst fenestration or resection, or by cysto-peritoneal shunting. Deep-seated arachnoid cysts are more difficult to approach surgically. Recently endoscopy has come to be regarded by many as the treatment of choice for arachnoid cysts, as it maintains the basic surgical strategy of cyst marsupialisation without the invasiveness of open craniotomy, while avoiding the complications caused by shunting [3, 5, 12, 13].

This review deals exclusively with a series of patients with suprasellar and other third ventricle-related arachnoid cysts treated via endoscopy.

Patients and methods

Patient population

From April 1998 to October 2000, ten patients with suprasellar and third ventricular arachnoid cysts were treated endoscopically

Table 1 Clinical presentation of ten cases with suprasellar/third ventricle-related arachnoid cysts (*M* male, *F* female, ↑*ICP* elevated intracranial pressure, ↓*VA* reduced visual acuity, *CLS* Coffin-Lowry syndrome, *Dev. delay* developmental delay, *Prec. puberty* precocious puberty)

Case	Age/sex	Previous treatment	Age at first diagnosis	Clinical features						
				↑ICP	Macro-cephaly	Ataxia	↓VA	Seizures	Dev. delay	Prec. puberty
1	4 years/F	Cystoperitoneal shunt	2 years		Yes	Yes				
2	1 month/F	–	Antenatal (20 weeks)	Yes	Yes					
3	8 years/M	–	5 years		Yes	Yes		Yes	Yes (CLS)	
4	4 years/M	Craniotomy and microsurgical fenestration of suprasellar arachnoid cyst	1 year	Yes	Yes	Yes	Yes		Yes	
5	9 years/F	Ventriculoperitoneal shunt	1 month	Yes	Yes		Yes		Yes (slight)	
6	7 years/F	–	7 years		Yes	Yes				Yes
7	44 years/M	Cystoperitoneal shunt	33 years	Yes		Yes		Yes		
8	16 years/M	–	16 years	Yes		Yes				
9	10 years/F	–	10 years	Yes				Yes		
10	6 years/F	–	6 years		Yes					Yes

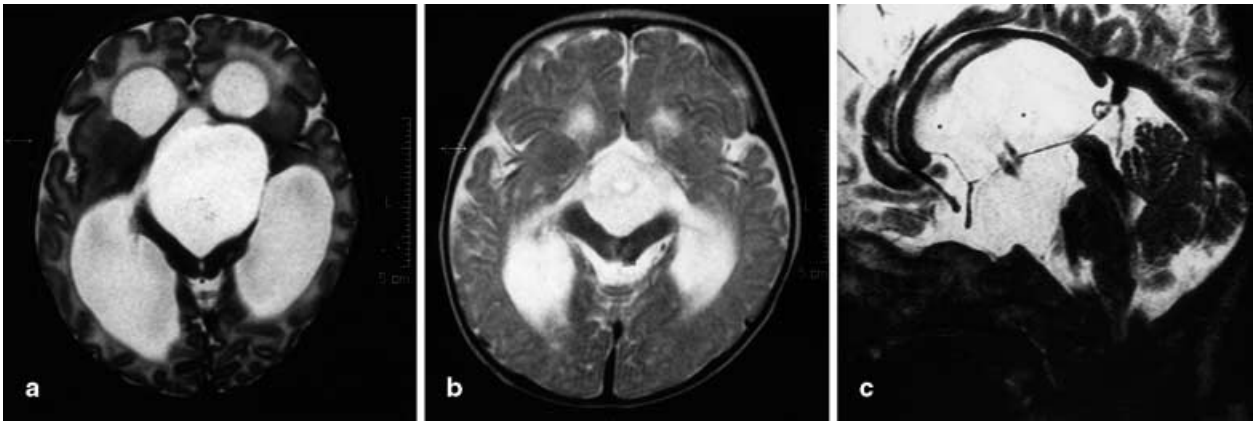

Fig. 1 a Preoperative T2-weighted axial MR scan of case 2, showing a large suprasellar prepontine cyst causing obstructive hydrocephalus. **b** Postoperative T2-weighted axial MR scan of case 2, showing significant reduction in the size of the prepontine cyst and the lateral ventricles. **c** Postoperative turbo spin echo T2-weighted MR scan of case 2, demonstrating CSF flow void at the ventriculocystostomy and the cystocisternostomy

by the same neurosurgeon (C.M.). There were four male and six female patients. At the time of surgery their ages ranged from 1 month to 44 years (median 7.5 years). Nine patients were under the age of 16 years. There was no history of birth trauma, intraventricular haemorrhage, or meningitis in any of the patients. One patient had sustained a previous head injury and a skull fracture (case 1). The clinical presentation of each patient is summarised in Table 1.

Previous surgical procedures included insertion of a cystoperitoneal shunt in two patients, insertion of a ventriculoperitoneal shunt in one patient, and craniotomy and microsurgical fenestration of a suprasellar arachnoid cyst in one patient. All these patients re-presented with recurrent symptoms and cyst expansion. The patient treated with craniotomy suffered from postoperative seizures and subdural hygroma, which required a subdural–peritoneal shunt. Those treated by shunting required shunt revisions in seven instances; two developed subdural hygromas; and one, shunt infection.

Preoperative MRI was performed in all patients, demonstrating the typical appearance of an arachnoid cyst in the suprasellar region in seven (Fig. 1a) and in the quadrigeminal cistern and extending to the third ventricle in three cases (Fig. 2a). In one patient the suprasellar cyst extended to the right temporal fossa. In all cases there was associated hydrocephalus. Five patients underwent serial yearly imaging over periods varying between 3 and 11 years prior to endoscopic treatment, and at some stage the arachnoid cyst was clearly shown to have expanded in size. One patient (case 2) had an antenatal diagnosis of suprasellar arachnoid cyst on the basis of an ultrasound performed at 20 weeks of gestation. This was confirmed by a fetal in utero MRI.

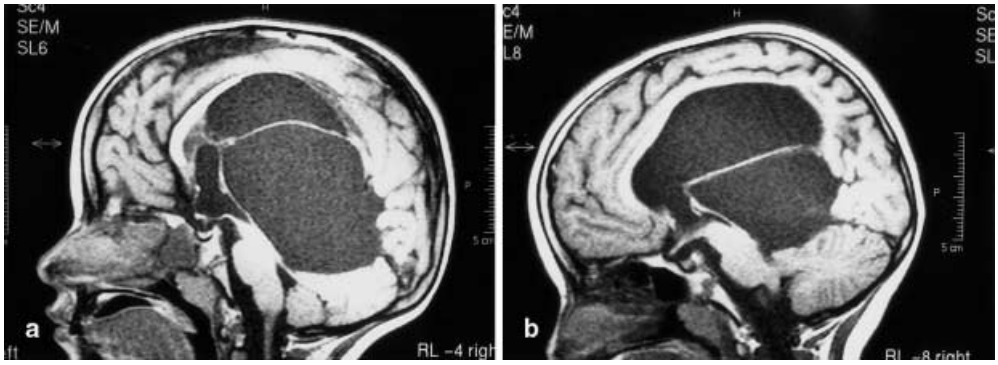

Fig. 2 **a** Preoperative midline sagittal T1-weighted MR scan of case 1, demonstrating a very large cyst in the quadrigeminal cistern extending superiorly and causing obstructive hydrocephalus. **b** Postoperative midline sagittal T1-weighted MR scan of case 1, showing reduction in cyst size following endoscopic cystoventriculostomy and third ventriculostomy

Table 2 Details of the operative procedures

Case	Anatomical description of cyst	Endoscopic procedure
1	Cyst in quadrigeminal cistern extending superiorly interhemispheric	Cystoventriculostomy + third ventriculostomy
2	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
3	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
4	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
5	Cyst in quadrigeminal cistern occupying tentorial incisura, extending to left middle cranial fossa	Cystoventriculostomy + third ventriculostomy
6	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
7	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
8	Cyst in quadrigeminal cistern at pineal region, compressing the tectum, extending into third ventricle	Cystoventriculostomy + third ventriculostomy
9	Suprasellar, prepontine arachnoid cyst	Cystoventriculostomy + cystocisternostomy
10	Suprasellar, prepontine arachnoid cyst with extension into the right middle fossa	Cystoventriculostomy + cystocisternostomy

Operative technique

Under general anaesthesia a right frontal burr hole was drilled 3–4 cm from the midline and on the coronal suture. In children under the age of 1 year an incision for the entry point of the endoscope was made at the lateral margin of the open anterior fontanel. A flexible neuroendoscope (Codman) was used in 9 of the 10 endoscopic procedures. The outer diameter of the endoscope sheath is 4.5 mm. The best trajectory was selected on the basis of preoperative MR imaging. The right lateral ventricle was tapped, and the endoscope was directed along the same trajectory and advanced to the foramen of Monro, where the dome of the cyst protruding into the third ventricle came into view. A fenestration was made between the cyst and the ventricle usually using an electrode (ME2 Codman) with a low current, and this was widened using a 3-F Fogarty balloon. The cyst was then entered with the endoscope. The electrode was used as a probe without the application of any current to create an opening into the basal prepontine cistern, which was also widened using a 3-F Fogarty balloon. The endoscope was then advanced through the fenestration to visualise the neurovascular structures in the basal cisterns and to ensure the creation of adequate communication between the cyst and the subarachnoid space. For the cysts arising from the quadrigeminal cistern and protruding through the posterior wall of the third ventricle, fenestration into the ventricle was performed using the flexible endoscope, and additional third ventriculostomy was then completed to relieve the associated obstructive hydrocephalus and to achieve indirect communication with the basal cisterns.

Results

In all cases with suprasellar cysts, the endoscopic creation of cystocisternostomy and cystoventriculostomy was successful. An additional third ventriculostomy was performed in the three cases in which the cyst was seen at the posterior aspect of the third ventricle during the procedure (Table 2). In all cases the pre-existing shunt was removed at the end of the operation.

The follow-up period ranged from 1 to 30 months (median 17, mean 18 months). There was no mortality and no major postoperative complications in our series. One patient suffered from transient postoperative sterile meningitis and another from mild hyponatraemia. The mean hospital stay was 7 days (range 2–15 days).

Table 3 demonstrates the clinical and radiological outcome of endoscopic treatment and the length of follow-up in each case. All patients with preoperative symptoms and signs of raised intracranial pressure (n=7) experienced complete resolution of these symptoms following the procedure. Macrocephaly was long standing in most patients, but in the patient who was treated during infancy (case 2) there was a slow decline in OFC on the centile chart. Of the six patients with ataxia, in two the gait

Table 3 Results of endoscopic treatment (↑ *ICP* symptoms and signs of raised intracranial pressure, *VA* visual acuity, *OFC* occipito-frontal circumference)

Case	Length of follow up	Clinical outcome	Post-endoscopy MR imaging		
			Cyst size	CSF flow void	Ventricular size
1	30 months	↑ ICP and ataxia resolved	Reduced	Absent	Same
2	25 months	↑ ICP resolved, OFC stabilised	Reduced	Present	Reduced
3	25 months	Gait improved	Slight reduction	Absent	Same
4	17 months	↑ ICP resolved, gait and VA improved, good progress in mainstream school	Same	Present	Reduced
5	29 months	↑ ICP resolved, VA improved, normal development	Reduced	Present	Same
6	17 months	Gait improved	Slight reduction	Present	Reduced
7	16 months	↑ ICP resolved, gait improved	Same	Present	Same
8	15 months	↑ ICP and ataxia resolved	Same	Present	Same
9	7 months	↑ ICP resolved	Reduced	Present	Same
10	1 month	Longer follow-up required to assess endocrinological outcome	Reduced	Present	Reduced

returned to normal and in four it improved. In both patients with reduced visual acuity this partially improved during the follow-up period. Our follow-up is too short to allow any comment on the effect of the endoscopic procedure on epilepsy, developmental delay, and endocrine disturbances such as precocious puberty. However, of the three patients with developmental delay two have shown improvement during the follow-up period (cases 4 and 5, Tables 1 and 3), while one patient with Coffin-Lowry syndrome (case 3) remains the same.

Follow-up MR imaging was done in all cases. This showed that in seven patients the arachnoid cyst was reduced in size after the endoscopic procedure, while ventricular size was reduced in only four cases (Figs. 1b and 2b). Postoperative midsagittal turbo spin echo T2-weighted MR images were obtained in all cases. CSF flow void was demonstrated in eight cases (Fig. 1c). During the period of follow-up no patient suffered from recurrent symptoms and none required the insertion of a ventricular shunt.

Discussion

Not all arachnoid cysts require surgical intervention. Arachnoid cysts may be discovered incidentally in 5–54% of unselected patients undergoing MRI scans [9]. Most arachnoid cysts are of developmental origin [8]. Choi and Kim postulate that head trauma in infancy or perinatal trauma may contribute to the pathogenesis of arachnoid cysts, including those of the suprasellar region, in some cases [2].

The majority of arachnoid cysts become symptomatic in early childhood; 60–90% of the reported patients are children [7, 8]. Head bobbing in children is a rare feature that suggests the diagnosis of suprasellar arachnoid cyst; it occurs in about 10% [10]. This feature was not noted in any of our patients. Visual field defects or impaired visual acuity has been reported to occur in about 30% of suprasellar arachnoid cysts [7].

On CT scan arachnoid cysts appear as nonenhancing extra-axial hypodense lesions with sharp borders. Suprasellar arachnoid cysts associated with hydrocephalus may be mistaken for an enlarged third ventricle on plain CT scans. In these cases ventricular shunting often leads to a paradoxical increase in the size of these cysts [10]. A ventriculogram performed by injecting contrast material through the existing shunt would confirm the diagnosis in these cases [7]. MRI scans show the cyst as hypointense on T1-weighted sequences and hyper-intense on T2-weighted images, with the cyst fluid producing signal characteristics of CSF. There is no enhancement of any part of the lesion after intravenous gadolinium administration.

The indications for operative management are variable and should take account of the patient's age. Symptomatic cysts should be treated especially when refractory symptoms are referable to a cyst in that location. Cysts resulting in hydrocephalus or recurrent seizures should be treated. Demonstration of cyst growth or the presence of neural compression, especially in children, even if asymptomatic, should be an indication for consideration of surgical treatment to allow the potentially normal development and function of the adjacent brain in the paediatric age group [11]. Incidental cysts should be periodically assessed with CT or MR imaging especially in children, as they may enlarge and compromise the full development of the surrounding brain [4].

Craniotomy for cyst fenestration or resection carries potential complications, such as postoperative neurological deficits, meningitis, subdural hygromas, and seizures [11]. The location of the cyst can aid in determining the

operative approach that offers the least morbidity [8]. For suprasellar arachnoid cysts with associated hydrocephalus, Hoffman et al. recommended a transcallosal approach to achieve communication between the cyst and the ventricular system, while in the absence of hydrocephalus a subfrontal approach and communication to the basal cisterns has been advised [7]. In some cases failure occurs and subsequent shunting would be needed. In one series 67% of patients with intracranial arachnoid cysts treated initially with craniotomy and cyst fenestration subsequently required cyst shunting for failure of symptomatic improvement [4]. However, in other series 76% of patients treated by craniotomy and fenestration remained shunt independent [11].

Shunting is accompanied by a higher incidence of additional surgical procedures and the disadvantages of life-long shunt dependence. Shunting of suprasellar and deep-seated cysts may be technically difficult [1]. Cystoperitoneal shunts have required revisions in 30–42% of reported cases because of cyst recurrence [4, 8, 10, 11]. In patients in our series who were initially treated by cystoperitoneal or ventriculoperitoneal shunting the cyst continued to increase in size. Two patients required shunt revisions on several occasions owing to blockage; two patients developed subdural hygromas; and one had a shunt infection.

Percutaneous ventriculocystostomy of suprasellar arachnoid cysts under radiological guidance following visualisation of the ventricles by metrizamide and the use of a long leukotome via a frontal burr hole has been successfully performed by Pierre-Kahn et al. [10].

Our series comprised of central supratentorial arachnoid cysts related to the third ventricle, for which microsurgical fenestration carries potential morbidity and shunt placement could be technically difficult. All were approached endoscopically via the third ventricle. Endoscopic fenestration has been used for arachnoid cysts in most intracranial locations, including the suprasellar region [3, 5, 13]. Endoscopic fenestration reduces complications involving shifts of the intracranial structures attributable to rapid decompression, as in other treatments [12]. The presence of associated hydrocephalus precludes leaving some patients shunt independent in those cases treated with craniotomy and cyst fenestration, as additional ventriculoperitoneal shunting may still be required. Endoscopic treatment offers the advantage of an additional third ventriculostomy or communication of the ventricular system through the cyst to the basal cisterns for the relief of associated hydrocephalus. In three of our patients who previously required shunt insertion, the shunts were removed following successful endoscopic treatment of the suprasellar arachnoid cyst, and they remained shunt independent during the follow-up period.

We used a flexible neuroendoscope in most cases because of the complex anatomical configuration of some of these cysts. A rigid endoscope is preferred by many on the grounds of its high resolution [5, 12, 13]. It is emphasised that wide fenestrations should be performed during endoscopic cystocisternostomies or ventriculocystostomies, with widening of the opening using a Fogarty catheter. Some advocate the placement of a fimbrial catheter through the fenestration into the adjacent basal cisterns or ventricles to prevent occlusion of the opening by collapse of the cyst and later scarring [13]. Decq et al. demonstrated by MR-imaged CSF flow dynamics the importance of fenestrating suprasellar cysts endoscopically to the basal cisterns and not just to the ventricles to prevent secondary closure of the opening and recurrence of symptoms [5]. The passage of CSF pulse waves in the cyst's cavity through sufficiently large windows in a "bipolar" fashion lowers the risk of re-formation of the cyst's membrane [8]. Previous experience with microsurgical treatment of arachnoid cysts suggests that multiple fenestrations into all arachnoid cisterns that are accessible leads to a lower rate of recurrence at long-term follow-up than do less aggressive methods, such as single fenestration [8, 11]. Based on these microsurgical reports and our own results with endoscopic surgery we recommend endoscopic "bipolar" fenestration of suprasellar cysts whenever possible both into the basal cisterns and into the ventricles. In the complex cysts arising from the quadrigeminal cistern in our series, fenestration into the ventricle only was feasible. Additional third ventriculostomy in the presence of associated hydrocephalus achieved communication to the basal cisterns indirectly.

The reduction in arachnoid cyst size following operative treatment by the different techniques is variable [1, 4, 6, 10, 11, 14]. The indications for further intervention depend on the persistence of the patient's symptoms and not upon the appearance of the cyst on postoperative imaging. In none of our patients did the cyst collapse totally following treatment. Permanent and satisfactory clinical improvement has been reported to occur despite only moderate or slight reduction of cyst volumes [2, 14]. Endocrinological disorders, which are reported to be associated in up to 60% of cases of suprasellar arachnoid cysts, usually persist following treatment despite the satisfactory decrease in volume of the cyst [10].

Our results compare favourably with those reported in other series of endoscopically treated intracranial arachnoid cysts [2, 5, 12, 13]. As symptoms may occur many years after fenestration [4], for endoscopically treated cases prolonged follow-up is required. For those patients who have been treated previously by shunting and in whom recurrent symptoms develop as a result of shunt malfunction, we recommend removal of the shunt system at the time of endoscopic treatment.

References

1. Basauri L, Selman JM (1992) Intracranial arachnoidal cysts. Child's Nerv Syst 8:101–104
2. Choi J-U, Kim D-S (1998) Pathogenesis of arachnoid cyst: congenital or traumatic? Pediatr Neurosurg 29:260–266
3. Choi J-U, Kim D-S, Huh R (1999) Endoscopic approach to arachnoid cyst. Child's Nerv Syst 15:285–291
4. Ciricillo SF, Cogen PH, Harsh GR, Edwards MSB (1991) Intracranial arachnoid cysts in children. A comparison of the effects of fenestration and shunting. J Neurosurg 74:230–235
5. Decq P, Brugieres P, Le Guerinel C, Djindjian M, Keravel Y, Nguyen J-P (1996) Percutaneous endoscopic treatment of suprasellar arachnoid cysts: ventriculocystostomy or ventriculocystocisternostomy? J Neurosurg 84:696–701
6. Galassi E, Tognetti F, Gaist G, Fagioli L, Frank F, Frank G (1982) CT scan and metrizamide CT cisternography in arachnoid cysts of the middle cranial fossa: classification and pathophysiological aspects. Surg Neurol 17:363–369
7. Hoffman HJ, Hendrick EB, Humphreys RP, Armstrong EA (1982) Investigation and management of suprasellar arachnoid cysts. J Neurosurg 57:597–602
8. Oberbauer RW, Haase J, Pucher R (1992) Arachnoid cysts in children: a European co-operative study. Child's Nerv Syst 8:281–286
9. Parch CS, Krauβ J, Hofmann E, Meixensberger J, Roosen K (1997) Arachnoid cysts associated with subdural hematomas and hygromas: analysis of 16 cases, long-term follow-up, and review of the literature. Neurosurgery 40:483–490
10. Pierre-Kahn A, Capelle L, Bruner R, Sainte-Rose C, Renier D, Rappaport R, Hirsch J-F (1990) Presentation and management of suprasellar arachnoid cysts. Review of 20 cases. J Neurosurg 73:355–359
11. Raffel C, McComb JG (1988) To shunt or to fenestrate: which is the best surgical treatment for arachnoid cysts in pediatric patients? Neurosurgery 23:338–342
12. Rampini P, Egidi M, Zavanone M, Orsi M, Alimehmeti R (1998) Stereotactically guided endoscopy for the treatment of arachnoid cysts. Pediatr Neurosurg 29:102–104
13. Schroeder HWS, Gaab MR, Niendorf W-R (1996) Neuroendoscopic approach to arachnoid cysts. J Neurosurg 85:293–298
14. Wester K (1996) Arachnoid cysts in adults: experience with internal shunts to the subdural compartment. Surg Neurol 45:15–24