Symptomatic Pineal Cysts: Clinical Manifestations and Management

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Summary

Between 1991 and 2000, seven patients presented with symptomatic pineal cysts at our hospital (6 females, 1 male). Average age was 22 years (range 4–33 years). Headache was present in 6 patients, who were subsequently operated on. A scotoma and a transient inferior visual field deficit were minor signs in two patients respectively. A Parinaud syndrome with vertical gaze paralysis was found in none. In one child, paroxysmal pupillary dilatations and contractions (Springer pupils) constituted the only signs and a conservative policy was adopted. Four patients presented with hydrocephalus and were treated by an endoscopic resection of their pineal cysts (one stereotactically, three free-hand). Two other patients presented with a prolonged history of symptoms and signs: headache alone in one, headache with discrete neurological deficits in the other. Ventricles in these two patients were not dilated and therefore an open cyst resection by infratentorial supracerebellar approach was performed. Average follow-up in the six “operated” patients was 29 months (range 12–108 months). All four patients treated by endoscopy, are symptom-free at follow-up, whereas the two who were approached by open surgery, are not. Clinical presentation, radiological evaluation and treatment modalities of pineal cysts are discussed and compared with experiences reported in the literature. It is concluded that pineal cysts in the presence of obstructive hydrocephalus are a clear indication for endoscopy with a rigid endoscope.

Keywords: Endoscopy; hydrocephalus; microsurgery; pineal cyst.

Introduction

Neoplasms in the pineal region account for approximately 1% of all brain tumours [62]. In children, however, pineal tumours are responsible for 3 to 11% of brain tumours [2, 19]. In adults 60% of pineal tumours are benign, whereas in children, 60% are malignant [29]. Glial pineal cysts constitute a separate entity and are common incidental findings on MRI: prospective analysis could yield an incidence of up to 4.3% of cysts larger than 5 mm [23, 36, 63]. Also in routine autopsies, a prevalence of 40% is reported, including all cysts more than 2 mm in diameter [27]. Pineal cysts rarely become symptomatic. Until 10 years ago, only 27 cases were described [42, 64]. Since then, several authors have reported their existence and described possible treatment modalities. The management of pineal cysts, as well as of pineal tumours in general [3, 10, 29, 33], has been subject of debate in the last decade. Regarding pineal cysts, some authors advocate an open surgery technique [13, 41, 44], while others recommend stereotactic aspiration [33, 42, 50, 56]. Recently, the use of endoscopy has been reported as a third option [22, 28, 59]. Neuro-endoscopy often has proved its merits in the management of intra- and para-ventricular cystic lesions [4, 5, 8, 17, 22, 30, 48]. However, experience in endoscopic treatment of symptomatic pineal cysts is limited: only four cases are reported in the literature to date [22, 28, 59]. Both Turtz and Hellwig, presenting one and two cases respectively, use a flexible endoscope, inserted stereotactically [28, 59]. Gaab, on the contrary, approached a pineal cyst with a rigid endoscope, guided by neuronavigation [22].

In 1986, our centre designed a multipurpose rigid endoscope, engineered by Richard Wolf®, Belgium, in association with R. W. Knittlingen®, Germany. Since then, we went through several prototypes and have gained experience in neurosurgical applications of endoscopy, on which we have reported repeatedly [1, 4–8].

Purpose of the present study is to demonstrate the usefulness and safety of rigid endoscopy in dealing with pineal cysts accompanied by obstructive hydrocephalus.
Patients and Operative Technique

Patients (Table 1)

Our series consists of 7 consecutively admitted patients, 6 females and 1 male, harbouring a pineal cyst with correlating symptoms and signs. Admissions occurred between 1991 and 2000. Five patients were young adults (aged 26, 26, 27, 30 and 33 years) and two were children (aged 4 and 5 years). All seven were referred from outside our centre. Nature and duration of symptoms were assessed. For radiological diagnosis, CT was performed in 6 patients and MRI in all seven. Five patients required each a single surgical procedure. One patient (case 1) was admitted to our department with a ventricular-peritoneal shunt, placed in emergency by a referring neurosurgeon. At referral, ligature of this shunt was performed one day before endoscopic treatment. Histopathological specimens were obtained in all "operated" patients. Following surgery, regular clinical visits on an outpatient basis were provided. This maintained a follow-up of 12 months in five patients, 19 months in one and even 9 years in another. The latter follow-up time enabled us to assess potential cyst recurrence in this patient, treated by endoscopy in 1991.

All “operated” patients underwent a postoperative neurological examination and a radiological evaluation by MRI. In one child who presented only with apringing pupils, a conservative policy of “wait and see” was adopted.

Operative Technique and Material

Open Microsurgery. Two patients were operated on using sub-occipital craniectomy, as first performed by Krause in 1913 [30] and adapted for microsurgery by Stein [53]. The patient is in a sitting position, with the head in flexion, attached in a head clamp. Under the external occipital protuberance, a single burr hole is made, which is gradually enlarged using a rongeur. The transverse sinuses are left intact and a midline infratentorial supracerebellar access to the pineal region is provided after Y-shaped incision of the dura. The tentorium and cerebellum are subsequently retracted. Once the quadrigeminal cistern, harbouring the pineal cyst, is reached, the deep cerebral veins may constitute a major obstacle for safe approach. The posterior cyst wall is dissected as extensively as possible and fenestrated centrally, followed by resection.

Endoscopic Technique and Patients (Figs. 1 and 2). Four patients underwent endoscopy, performed under general anaesthesia. The patient is in a supine position with the head slightly flexed, so that the burr hole becomes the highest point of the operating field. This burr hole is situated far frontally – at the level of the hairline or even more anteriorly – and 3 cm from the midline, traditionally on the non-dominant side. However, preoperative MRI may assist in planning the best entrance point for safe approach through the foramen of Monro towards the pineal cyst. The inner edges of the burr hole are conically removed to permit a somewhat wider action radius for the endoscope shaft. Bone filings and small bits of bone from the rongeur are saved for the closure at the end. After a cruciate incision is made in the coagulated dura, a small 6 mm linear cortical incision is made and a small cottonoid pledge is inserted a few millimetres to keep the incision open. The endoscope is now inserted and once it has entered the ventricle and before any irrigation, a sample of CSF for cytopathological and neurochemical analysis may be aspirated if a neoplastic lesion is in the differential diagnosis. This aspiration is possible through one of the side channels, after removal of their mandrins and before attachment of the outlet tubing.

Our rigid neuro-endoscope has a length of 305 mm and an outer diameter of 6 mm. Besides the two side channels (internal diameter each 1.67 mm), it consists of a working channel (internal diameter 2.5 mm) and a channel for the optical instrument (3 mm). The working channel is used for insertion of auxiliary instruments such as grasping forceps, biopsy forceps, scissors, tissue screw, aspirating catheter, balloon catheter, hook electrode and laser (Nd:YAG laser, using 200–220 V and 50–60 Hz with maximally 60 W power in continuous mode). The endoscope can rotate around its own axis and the telescope has a 5° angled lens, offering a 120° field of view.

The pineal region can be reached easily by penetration through the foramen of Monro. However, in manipulating the endoscope, one should take care not to injure the surrounding fornas. Once the third ventricle is reached, the pineal cyst becomes visible (Fig. 1). First the cyst and it surroundings are inspected. If tiny vessels on the surface are present, which is mostly not the case on the anterior wall of pineal cysts, these are first coagulated using a blunt laser fibre in the non-contact mode. Then a hole is made in the capsule by cutting laser in contact. A dense fluid escapes from the cyst may be noted. This is aspirated by a stiff aspiration catheter, which can repeatedly be inserted into the cyst and retracted. Gradually, the cyst become collapsed and additional shrinkage of the capsule is obtained by coagulation at regular distances. Fleeced parts can be removed using the grasping forceps. Occasionally, simultaneous use of grasping forceps and cutting laser (which is introduced through one of the side channels) is advisable for pieces that are too adherent. Small cephalic bleedings frequently occur and are usually halted by increasing the irrigation flow. If necessary, small vessels can be coagulated on the inflated balloon catheter can be temporarily held in place. The posterior cyst wall, which is often highly vascularised, is coagulated around and inspected for some minutes for residual haemorrhage. Finally a decompressed cerebral aqueduct is visualised as first indicator of a successful procedure (Fig. 2). The endoscope is sequentially retracted. Between the dura and skull, a small circu- piece of dura substitute is inserted, extending ~3 mm under the edges of the burr hole. The latter itself is stuffed with a moist static sheet is draped as covering, before the subcutaneous and ticular tissues are sutured.

The endoscope was inserted stereotactically in one patient. Therefore, co-ordinates of the cyst centre were determined using measurements. Accessory devices were used for frame insta-
Results

Symptoms and Radiological Evaluation (Tables 1 and 2)

Symptoms and clinical history are summarised in Table 1. The presence of hydrocephalus was concomitant with a short history of symptoms typical of intracranial hypertension, including lethargy and vomiting (cases 1-4). Parinaud syndrome was found in none. Minor visual deficits were found in two patients: in case 1 a transient inferior field defect, in case 6 a paracentral scotoma. Case 1 also showed papilledema. Case 7 presented with the unique findings of paroxysmal mydriasis and miosis, most frequently affecting the left pupil unilaterally, but sometimes bilaterally. Other neurological deficits were present in case 6 who featured imbalance, an ataxic gait and discrete pyramidal signs.

Different time courses of headache were noticed: in all non-obstructive patients (cases 5 and 6) and in one obstructive patient (case 2), headache was experienced at intervals, whereas in three other obstructive patients (cases 1, 3 and 4) a continuous headache was reported. Headache was notified to be holocranial in five patients, but was indicated unilaterally parietal and at the same time clearly position-linked in one (case 5).

A CT-scan was performed in all patients and showed supratentorial hydrocephalus in 4. In 3/4 (cases 1, 3 and 4) a space-occupying lesion at the outflow of the third ventricle was noticed, whereas in 1/4 (case 2) only suspicion of aqueductal stenosis was noticed on CT. In the two patients who lacked hydrocephalus (cases 5 and 6), CT clearly showed a pineal mass. The latter was noticed already five years (case 5) and one year (case 6) pre-operatively. MRI features are listed in Table 2 (see also Figs. 3, 4 and 5). Diameter of the cysts mostly varied between 10 and 20 mm, but one
Table 1. Clinical Data

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex/age</th>
<th>Symptoms and signs</th>
<th>Duration of symptoms</th>
<th>HC</th>
<th>Surgical technique</th>
<th>HAD</th>
<th>Duration of FU</th>
<th>FU events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/30</td>
<td>headache, vomiting, visual deficit, papilledema</td>
<td>3 weeks</td>
<td>+</td>
<td>stereotactic endoscopy</td>
<td>4</td>
<td>108 mths.</td>
<td>no</td>
</tr>
<tr>
<td>2</td>
<td>F/26</td>
<td>headache, lethargy, vomiting</td>
<td>3 months</td>
<td>+</td>
<td>free-hand endoscopy</td>
<td>3</td>
<td>12 mths.</td>
<td>no</td>
</tr>
<tr>
<td>3</td>
<td>F/4</td>
<td>headache, lethargy, vomiting</td>
<td>1 week</td>
<td>+</td>
<td>free-hand endoscopy</td>
<td>2</td>
<td>12 mths.</td>
<td>no</td>
</tr>
<tr>
<td>4</td>
<td>F/33</td>
<td>headache, lethargy, vomiting</td>
<td>1 week</td>
<td>+</td>
<td>free-hand endoscopy</td>
<td>3</td>
<td>12 mths.</td>
<td>no</td>
</tr>
<tr>
<td>5</td>
<td>F/27</td>
<td>headache</td>
<td>4 years</td>
<td></td>
<td>SO craniotomy</td>
<td>9</td>
<td>12 mths.</td>
<td>headache, cervicalgia, visual deficit, resolving Parinaud</td>
</tr>
<tr>
<td>6</td>
<td>F/26</td>
<td>headache, visual deficit, diplopia, gait disturbances, spastic paresis, anorexia, lethargy</td>
<td>6 years</td>
<td></td>
<td>SO craniotomy</td>
<td>29</td>
<td>19 mths.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>F/5</td>
<td>springing pupil</td>
<td>2 years</td>
<td></td>
<td></td>
<td></td>
<td>6 months</td>
<td>no</td>
</tr>
</tbody>
</table>

HC Hydrocephalus, HAD number of hospital admission days, FU follow-up, SO suboccipital, + present, – absent.

The duration of the two interventions by infratentorial, supracerebellar approach amounted to 4 hours (case 5) and 5.5 hours (case 6). In one patient (case 5), the procedure was confined to a subtotal cyst resection because of complicating venous bleedings. The latter were successfully managed by bipolar coagulation and chemical haemostasis (Gelfoam®). Postoperative MRI consequently showed a persisting cyst (Fig. 5). In the other patient, complete resection was accomplished and MRI showed an enlarged quadrigeminal cistern in the postoperative state (Fig. 5). Average hospital stay amounted to 19 days. Follow-up symptoms are listed in Table 1. Both patients maintained their headaches. Postoperatively, one (case 6) developed a Parinaud syndrome, which resolved during admission. The same patient was multidisciplinarily examined because of cervicalgia and a tubular visual field. The latter was considered to be non-organic attributable to hysterical personality traits. Other symptoms in this patient, indicated at the time of presentation, ceded after surgery (Table 1).

Four patients underwent endoscopy. The duration of the procedure from insertion until retraction of the endoscope, amounted maximally to 30 minutes. No complications occurred. Samples of the cyst wall for histopathological analysis were obtained in all. Conventionally, all four endoscopically treated patients postoperatively stayed one night in the intensive care unit, but consciousness was regained rapidly in all. On average, only 3 in-patient days followed the endoscopic procedure. All patients were symptom-free and no recurrences occurred on follow-up. Control MRI showed complete restoration of the third ventricle outflow (Figs. 3 and 4).

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Histopathological analysis was performed in all and showed variants of a typical pattern, which consists of an inner layer of glial tissue, surrounded by pial parenchyma. The former usually features Rosenthal fibres and granular bodies, and the latter may harbour depositions of haemosiderin, suggestive of previous haemorrhage. At the time of this study, results of fluid content analysis could be retrieved in two patients (cases 1 and 3). A high concentration of protein material and erythrocytes, was found in both.

Table 2. MRI Findings

<table>
<thead>
<tr>
<th>Case</th>
<th>Size (AP x LL x CC)</th>
<th>Gd enhancement</th>
<th>Fluid level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 x 15 x 14 mm³</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2</td>
<td>20 x 18 x 16 mm³</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>3</td>
<td>14 x 15 x 11 mm³</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>4</td>
<td>32 x 19 x 22 mm³</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>5</td>
<td>20 x 18 x 17 mm³</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6</td>
<td>18 x 18 x 10 mm³</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>7</td>
<td>17 x 15 x 10 mm³</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

Gd Gadolinium; AP anteroposterior, LL laterolateral, CC craniocaudal, diameters on MRI sections.

patient (case 4) presented with a cyst measuring up to 32 mm.

Surgery, Histology and Outcome

Four patients underwent endoscopy. The duration of the procedure from insertion until retraction of the endoscope, amounted maximally to 30 minutes. No complications occurred. Samples of the cyst wall for histopathological analysis were obtained in all. Conventionally, all four endoscopically treated patients postoperatively stayed one night in the intensive care unit, but consciousness was regained rapidly in all. On average, only 3 in-patient days followed the endoscopic procedure. All patients were symptom-free and no recurrences occurred on follow-up. Control MRI showed complete restoration of the third ventricle outflow (Figs. 3 and 4).
Fig. 3. Sagittal, axial and coronal sections of MRI, T1 (case 4). (a–c) At presentation. Signals of the cyst contents are greater than those of CSF. The posterior wall shows enhancement with Gadolinium (a, arrow). On axial image (b, arrow), the interthalamic adhesion is visualised (see also Fig. 1). (d–f) 1 month after endoscopy. Only a remnant of cyst is visualised, with opening into the third ventricle (d, white arrow). Hydrocephalus is relieved.

Discussion

Clinical Presentation

Similar to others' experiences [23, 36, 61], our series confirms the epidemiological preponderance of pineal cysts in young females in their third decade of life. However, we observed two cases in toddler-aged children (cases 3 and 7). In three patients (cases 1, 3 and 4) apoplectic pineal cysts could be assumed, based on a fluid level on MRI in 2 and on endoscopic fluid aspiration in 3. In such cases, endoscopic vision is temporarily blurred by reddish cyst contents. Relying on the analysis of cyst contents, previous haemorrhage in symptomatic cysts is often assumed, as well in reviewed [42, 64], as in recent reports [13, 42]. Therefore, such acute cystic haemorrhage may possibly be considered as the main reason for symptoms. However, full-blown apoplexy is rarely diagnosed pre-operatively on radiological studies. Some authors consider apoplectic conversion of pineal cysts only as a possible epiphenomenon [64]. To our knowledge, 4 cases of sudden unexpected death due to pineal apoplexy, are described in the literature [9, 39, 40, 52]. In pineal cysts, like in other pineal tumour lesions [57], acute hydrocephalus resulting from apoplexy may be one presenting sign. Other clusters of symptoms and signs are possible [61, 64]: firstly, paroxysmal headache with gaze paresis; and secondly, chronic headache, gaze paresis, papilledema, and hydrocephalus. We observed a variable occurrence of these. Only one patient harboured papilledema. Moreover, vertical gaze paresis, the Parinaud syndrome, was observed in none of our patients at the time of presentation. This entity, due to focal compression of the superior colliculus, is considered as a main feature of pineal tumours. Similar to
our experience, it is rarely encountered in the cyst series of Fain [13] and Ockler [44], but gaze paresis was present in all Wisoff’s reported cases [64]. Other ocular dysfunctions were manifest in two patients: case 6 presented with a central scotoma and case 1 mentioned a transient loss of the inferior visual field. The sign of ‘springing pupils’ was observed in one child, in which a conservative policy was followed. The latter has been described as an isolated phenomenon or as part of clinical syndromes [25, 26], but never in conjunction with pineal masses. Neurological deficits in the motor, sensory and cerebellar systems are possible and have been previously reported [13, 31, 44], although not readily explicable from an anatomical point of view. Indeed, one patient (case 6) presented with slight pyramidal signs and imbalance.

Regarding headache, three different patterns are distinguished in our small series: either a chronic history of intermittent headache (cases 5 and 6), or a short-term history of paroxysmal headache (case 2), or thirdly, an acute persisting headache (cases 1, 3 and 4). Intermittent obstruction of the cerebral aqueduct is assumed to cause headache presenting at intervals [64]. Aqueductal stenosis, whether intermittent or not, may obviously lead to obstructive hydrocephalus. However, other pathogenic mechanisms of headache may be involved, certainly if hydrocephalus is absent. Miyatake [41] notices the possible compression of veins in the pineal region, including the precentral cerebellar vein, internal cerebral veins and the great vein of Galen.

Contrary to general assumption, obstructive hydrocephalus is not an obligatory condition for pineal cysts to become symptomatic, nor in the review of the era before 1990 [64], nor in recent reports. In our study, hydrocephalus was found in four out of seven patients (57%). In other reports, this ranges between 17% and 43% [13, 44, 64].

Radiological Findings

Selecting pineal cysts with aqueductal stenosis as a proper indication for endoscopy, implies the need for correct diagnosis of this entity. CT-scan proves relevant in demonstrating hydrocephalus and may often raise suspicion of a third ventricle space-occupying lesion. However, MRI is always indispensable. The reported characteristics of pineal cysts on MRI [15, 34-36, 45] are confirmed in our seven cases. Their signals on T1-weighted images are slightly greater than CSF.
which is attributed to a high protein content. In one patient (case 4), this feature was so pronounced, that the differential diagnosis with a hemangioblastoma was considered (Fig. 3). On T1-weighted images, pineal cysts feature a hyper-intense signal, equal to or even more intense than CSF (Fig 4). Regarding enhancement with gadolinium, results are less unequivocal. This phenomenon is encountered by most authors [13, 15, 41], but not by all [64]. We observed it in five out of seven patients. It is present as a thin enhancement of the cystic wall. Gadolinium was never captured in a nodular form as reported in Fain’s series [13]. Generally, enhancement in our study was more prominent in the posterior wall (Figs. 3 and 5). This is compatible with the endoscopic finding of a strongly vascularised posterior wall and may be attributed to the afferent vascularisation of the pineal cyst. Furthermore, pineal parenchyma has no blood-brain barrier [37]. Radiological diagnosis of apoplexy is based on the intracystic fluid level, featured superiorly on T1-weighted images [45], as was observed in 2 patients (Fig. 4).

Although diagnostic interpretation of pineal cysts on MRI seems feasible, it may be controversial. In his retrospective analysis, Fleige notices a variable MR appearance of pineal cysts, possibly making them indistinguishable from other pineal-region tumours [16]. Neoplastic lesions, such as pineoblastomas, teratomas and low-grade astrocytomas, may also feature a cystic nature on MRI, but these lesions are mostly heterogeneous. Moreover, distinction is possible by their endoscopic appearance.

**Surgical Management**

Traditionally, symptomatic pineal cysts are managed by craniotomy for surgical excision. The infratentorial-supracerebellar approach is most commonly used [13, 41, 44, 55]: the occipital-transentorrtal method and the interhemispheric-transcallosal approach are variants, used for pineal cysts [64] or tumours [54]. Complications and morbidity of the infratentorial supracerebellar approach are reported, but these are rare and mostly temporary [13]. Despite advances in microsurgical techniques and assisting tools such as neuronavigation, surgery in the pineal region remains a complex venture. We proceeded to craniectomy in 2 cases in whom hydrocephalus was absent and thus endoscopy could not be performed. In one patient (case 5), this was complicated by venous bleedings, which could be managed intra-operatively, but restricted us to a subtotal resection. This illustrates the close proximity of the confluence of Rosenthal’s basal vein and the internal cerebral vein into Galen’s great vein. Furthermore, in the two patients approached by open microsurgery, complaints of headaches persisted. Precise cause of these symptoms is uncertain. We are aware that this may not be entirely due to surgery, because the two patients presented from the beginning with a chronic history and without hydrocephalus. Retrospectively, the question might be raised whether surgery was really indicated. Postoperative MRI-scans of the two craniotomy patients showed a totally resected cyst in one (case 6) and a subtotally resected, smaller persisting cyst in the other (case 5) (Fig. 5). The former postoperatively presented with neck pain and increasing visual disturbance. On the contrary, the same patient was relieved from pyramidal and ataxic symptoms. The latter also experienced a gradually resolving Parinaud syndrome, not present before surgery. This finding has been reported elsewhere [13].

As an alternative for microsurgery, blind stereotactic management of pineal cysts is proposed [42, 56, 60]. Stereotactic aspiration involves a minimally invasive procedure, but is disputed because of the possible cyst re-expansion and the uncertain histological specimen. In one of two stereotactically treated patients, Stern reported the need for re-aspiration 71 months after the initial aspiration [55]. Consequently, stereotactic treatment of pineal cysts requires long-term follow-up to prove its efficacy, similarly to endoscopy [22]. The extensive series of Kreth on stereotaxy in the pineal region contained 14 cases of pineal cysts. In 8 out of these 14 patients, symptoms did not resolve [33]. This may be attributed either to incorrect histological diagnosis, insufficient treatment or a false correlation between symptoms and radiological findings. In two other cases presented by Mussolino, stereotactic aspiration lacked clear histological samplings of the cyst wall, but only provided fluid cyst contents [42]. Nevertheless, specimens obtained by microsurgery may also result in improper diagnosis if communication between surgeon, radiologist and pathologist fails, as observed by Fain [13]. The cystic nature has often disappeared in surgical sections of cysts. This stresses the importance of direct visualisation of the pineal lesion, which is obtained by endoscopy more readily. The probability of haemorrhagic complications of stereotactic procedures, which was formerly noted in the pineal region [46, 47], is considered low in recent reports [51, 56]. Still, its blind
approach implies taking unnecessary risks, given the alternative of endoscopy.

In our four patients in whom endoscopy was performed, this technique proved relevant, both diagnostically and therapeutically. No surgical complications occurred. The duration, not only of the procedure itself, but also of the subsequent hospital admission is remarkably shorter as compared with open surgery. All patients are symptom-free at follow-up, including one patient, treated 9 years ago. These results confirm the sparse reports of endoscopic treatment of pineal cysts [22, 26, 57]. Regarding the completeness of resection, we remove the cyst wall as much as possible, using coagulation and grasping forceps. Even adherent parts are gently removed, but strongly vascularised parts are not retracted, but coagulated around. We believe that in the case of pineal cysts, unlike neoplastic tumours, total endoscopic removal is feasible and may be as efficient as microsurgical resection. Postoperative MRI may show remnants of the cyst with a normal flow through the cerebral aqueduct (Fig. 3 and 4). It should be noticed that longstanding aqueductal compression may result in persisting stenosis, refractory to resection of the mass by microsurgery or endoscopy. If this occurs, endoscopy offers the possibility of performing a third ventriculostomy. This was not necessary in our presented cases. As observed by Turtz, the mere endoscopic treatment of the cyst itself is mostly sufficient [57]. A simple third ventriculostomy without cyst management would not be advisable because a persistently expanding cyst may result in progressive gaze difficulties [64]. Furthermore, if pathological analysis reveals a neoplastic lesion, such ventriculostomy may favour spinal metastasis. Concerning endoscopic shunting procedures, the creation of an anastomosis between the third ventricle and the quadrigeminal cistern may seem advisable at first impression. However, this is obsolete as there is no communication between the quadrigeminal cistern and the subarachnoid space of the brain convexity.

Our first patient, like those of Hellwig and Turtz, was endoscopically approached using a stereotactic frame [28, 59]. However, as we have gained experience in endoscopy over the last decade, stereotactic insertion has not proved superior to free-hand insertion if hydrocephalus is sufficiently present. Unlike Hellwig [28] and Turtz [59], we use a rigid instead of a flexible endoscope, for reasons of visual quality. We also fear a higher probability of injuries in manipulating a flexible endoscope. Since the introduction of endoscopy in our department in 1986, we have always favoured rigid endoscopes [1, 4–8]. We consider our arguments confirmed by the widespread use of these endoscopes nowadays. Gaab used a rigid endoscope in treating a pineal cyst, guided by neuronavigation [22]. The latter indeed may assist in planning a straight access and choosing an ideal entry point. Once the ventricles are reached, we consider the direct view offered by the endoscope as most reliable. Additionally, cyst walls may be very compliant in contact with the penetrating endoscope tip, contrary to the static neuronavigation image. This means that such a wall may still cover the lens and obliterate the view, while on the navigation image the tip of the instrument protrudes already for more than one centimetre beyond the wall.

With regard to pineal tumours, we refer to the successful application of endoscopy, not only in the last decade [12, 14, 20, 53], but already in 1973 [21]. We are convinced that endoscopy is indicated for tissuesampling of true neoplastic lesions of the pineal gland, but not for total resection. We also note the recent application of endoscopy in order to assist in microsurgery [11, 30, 49]. Among other indications for such procedures, endoscopy-assisted microsurgery has already proved its merits for the treatment of pineal region tumours [38, 54]. Due to this technique, the endoscope could also be introduced in the management of non-obstructive, symptomatic pineal cysts. However, these should be treated with reserve, as was demonstrated in this report by the two cases of open surgery.

Finally, we wish to conclude with a warning: endoscopy remains a surgical act and over-enthusiasm is to be avoided. Its success and seemingly easy technique are no excuses for treatment of all pineal cysts. After all, most of these have a symptomless course. Hence, clinical experience is the major guide for correct application of neuro-endoscopy.

Conclusions

Pineal cysts are common incidental findings, but rarely become symptomatic. If so, a high degree of clinical suspicion is needed, because headache may be the only feature. Headache may have either a prolonged, intermittent or an acute course in time. Some patients may feature discrete ocular signs, such as springing pupils, which was uniquely observed in one of our patients. Radiological evaluation by means of MRI is very suggestive of the diagnosis. A pineal cyst
in the presence of hydrocephalus is an important indication for endoscopic treatment, since no complications or recurrences are encountered in our experience. In the absence of hydrocephalus, symptomatic pineal cysts can be approached by suboccipital craniectomy, but only with reserve. Since recently, the latter may be assisted by endoscopy.

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Comment

This is a well-written, carefully presented and well-illustrated manuscript covering an area of interest and some controversy. I think it is an excellent contribution to the management of pineal cysts.

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