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ORIGINAL ARTICLE

Neuroendoscopic management of posterior third ventricle and pineal region tumors: technique, limitation, and possible complication avoidance

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Abstract The endoscopic approach has gained an increased popularity in recent years for the biopsy and, in selected cases, the removal of tumors of the posterior third ventricle and pineal region. The authors report their experience on a series of 20 patients discussing also the technical limitations and complication avoidance. This is a prospective study of 20 patients with posterior third ventricle and pineal region tumors surgically managed by endoscopic biopsy and/or excision and simultaneous third ventriculostomy. The removal of the lesion could be achieved in 12 cases whereas in 8, only a biopsy could be performed. A histological diagnosis could be obtained in all cases. No delayed third ventricular stoma failures were recorded in any patient at the latest follow-up (mean follow-up, 39 months). Severe postoperative complications were recorded in 2 out of 12 cases of tumor removal attempt and in zero out of eight cases of biopsy. A delayed (3 weeks) postoperative mortality occurred in a patient harboring a GBM that developed an intratumoral hematoma 48 h postoperatively, one patient was in a vegetative state. Transient postoperative complications included: nausea and vomiting (five cases) and diplopia (two cases). One patient developed a bilateral ophthalmoplegia that recovered within 6 months due to residual tumor hemorrhage. Higher rate of complications was found in the case of vascularized and/or larger lesions. Endoscopic management of posterior third ventricle lesions may represent an effective option. However, though biopsies remain often a safe procedure, tumor excision should be limited to highly selected cases (cystic, poorly vascularized, and/or smaller than 2.5-cm lesions).

Keywords Posterior third ventricle tumor · Pineal tumor · Neuroendoscopy · Laser · Complications · Minimally invasive neurosurgery

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Introduction

Posterior third ventricle and pineal region tumors account for 0.6% to 0.9% of all brain tumors [2, 44, 63]. These lesions are characterized by their histological heterogeneity. Germ cell tumors represent 20% to 37% of cases; intrinsic pineal tumors, 22% to 27%; gliomas, 24% to 28%; and other lesions, 12% to 32% [2, 31, 32, 49, 50]. The management and related prognosis vary due to their histology, and by consequence, the pathological diagnosis is mandatory [2, 11, 13, 16, 18, 27, 28, 30, 32, 36, 37, 41, 43–45, 48–50, 52, 54, 55, 62, 68]. Traditionally, tissue samples of the

pineal and posterior third ventricle lesions are obtained by open surgery and/or stereotaxy [10, 14, 34, 38, 40, 47, 49, 50, 66]; more recently, the introduction of neuroendoscopy has given an effective adjunct of management. Neuroendoscopy can be performed either by rigid or flexible devices [69]. Its implementation using rigid devices has been reported by many authors [17, 18, 26, 39, 45, 52, 64, 70]. In the present paper, the authors present their experience in managing such lesions in a series of 20 patients describing technical details and limitations, outcome, and avoidance of possible complications.

Patients and methods

The present study was on a prospective series of 20 consecutive patients with pineal region and posterior third ventricle tumors managed endoscopically from January 2005 to December 2009 (endoscopic biopsy and/or excision and simultaneous third ventriculostomy) coupled with frameless stereotactic guidance (image-guided surgery, IGS) in two different centers using the same devices and treatment algorithms. All patients had pre- and postoperative MRIs at 6 weeks, 6 months, and every year thereafter when applicable.

Indications for neuroendoscopy biopsy/excision

Neuroendoscopy was considered the first choice treatment option in all patients with pineal region and/or posterior third ventricle lesions with dilated ventricles, as it is a minimally invasive procedure giving the possibility to achieve the histological diagnosis and in selected cases excision of the lesion. Inclusion criteria were the presence of a pineal/ posterior third ventricle mass associated to an obstructive hydrocephalus. A relative limitation could be the presence of very small ventricles although such a problem might be easily managed by using systematically the IGS guidance.

The decision to perform biopsy versus excision and vice versa was mainly made on a per-operative basis evaluating the tumor intrinsic characteristics (bleeding and consistency) as well as in the preoperative stage based on its contrast enhancement CT, MRI, and MRA scans. This subsequently leads to planning the best management strategy (either radio-surgery and/or chemotherapy) avoiding the open surgery if possible.

Surgical technique

All procedures were performed with the patient under general anesthesia and in a supine position. The head was lightly flexed. The operation was planned and completed with the aid of a rigid endoscope of 0° and 30°using a free hand technique.

We used the Hopkins II optical system (Endoscopy-America, Charlton, MA, USA), operative channel by Karl Storz (Tuttlingen, Germany), 30 cm long and 2.9 mm in diameter. IGS was also used (Stealth Station, Medtronic Surgical Navigation Technologies, Louisville, CO, USA). A single frontal right-sided burr hole was used. Its position was chosen and verified by the IGS. The operative approach consisted of a small (1.5–2 cm) right (linear) horizontal frontal incision placed very anteriorly, possibly on a frontal wrinkle, in order to easily direct the endoscope toward the posterior portion of the third ventricle (see also Figs. 1 and 2). Following placement of the burr hole, dural coagulation, and pial piercing, the endoscope was advanced toward the lateral ventricle, and CSF was taken for cytological and biochemical analyses. After entering the foramen of Monro, the endoscope direction was readjusted and, following the ventricular landmarks and the indications of the neuronavigation system, aimed toward the tumor. The tumor was then identified (see also Figs. 3a, b and 4a–c), and after visual inspection of the lesion, a careful coagulation of its surface was performed, followed by biopsy and/or removal with the aid of a biopsy rongeur and in 12 cases by a diode laser (maximum power, 30 W; Dornier MedTech Laser, Wessling, Germany) (see also Figs. 5a–d and 6a, b). Hemostasis was achieved by a combination of both gentle ringer irrigation and bipolar or diode laser coagulation. Following tumor biopsy and/or partial/gross total removal, a standard endoscopic third ventriculostomy was completed via a second standard frontal coronal burr hole (see also Fig. 2).

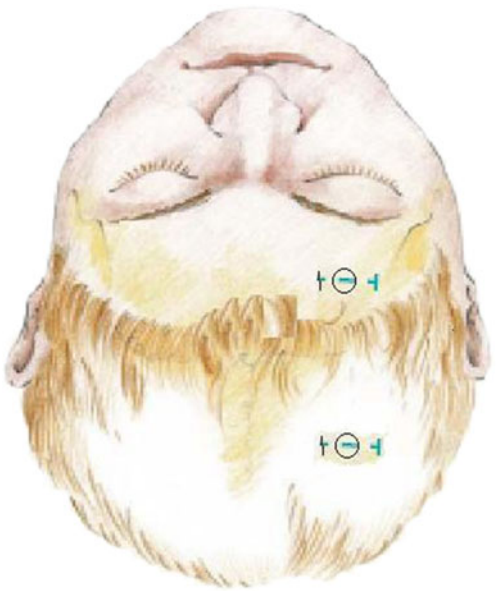

Fig. 1 Schematic drawing showing skin incision and burr hole position

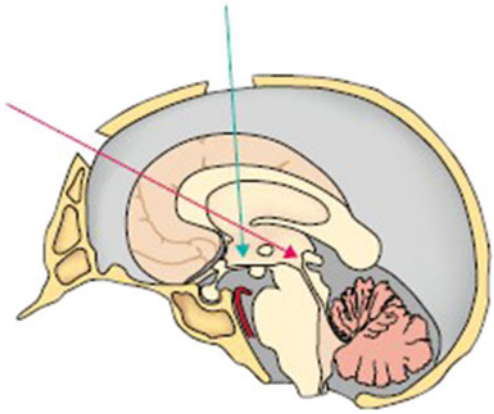

Fig. 2 Schematic drawing showing the different tumor excision and third ventriculostomy trajectories. The two burr holes allow the obtaining of two distinct trajectories aiming to the two distinct targets (III ventricle's floor and pineal region) without risk of damaging the fornix or choroid plexus at the foramen of Monro

Always a minimum of eight sample tissue (range, 8 to 12) has been provided for histopathology investigation with a systematic prior frozen section. No attempt to perform the ventriculostomy using the anterior frontal burr hole was done to avoid any fornix tension/disruption.

Results

Among the 20 patients managed, 8 were men and 12 were women with a median age of 31 years (range, 16 to 67 years). In all patients, the ventricles were large enough to ensure a straightforward procedure with the aid of IGS. Gross tumor removal was achieved in eight cases (40%), partial removal in four cases (20%). A biopsy was done in eight cases (40%) with a mean of ten tissue samples (range, 8 to 12). In all cases, the third ventriculostomy could be performed. All procedures were uneventful and had a mean duration of 128 min (range, 83 to 187 min). The blood loss was always negligible, and 17 of the 20 patients operated on could be discharged home between the first and seventh postoperative day.

A pathological diagnosis was achieved in all cases as follows: germinoma in eight cases, glioblastoma in one, epidermoid cyst in three, neurocytoma in two, pilocytic astrocytoma in two, ependymoma in one, pinecytoma in one, benign pineal cyst in one, and primitive neuroectodermal tumor (PNET) in one.

Complications were separated into transient and permanent. Ten patients (50%) had transient fever, which typically resolved within 1 to 2 days after surgery. No infectious complications were observed. In five patients (25%), nausea and vomiting were observed postoperatively resolving within 24 h. Two patients (10%) showed transient double vision immediately after surgery which resolved completely within 4 weeks. One patient having a large (4.5 cm in diameter) pineal pilocytic astrocytoma undergoing partial removal (about 30% of the lesion) developed a bilateral ophthalmoplegia due to a postoperative intratumoral apoplexy which recovered within 3 months. One delayed (3 weeks) postoperative mortality occurred in a patient harboring a GBM of 3.5 cm in diameter undergoing partial resection (about 40% of the tumor) and developing extensive intratumoral hemorrhage 48 h postoperatively. One patient harboring a large cystic pineocytoma developed a vegetative state, but a clear and understandable clinical/radiological cause was not detected.

At a mean follow-up of 39 months (range, 12 to 60 months), no infectious complications (0%) as well as no seeding tumor dissemination (0%) were recorded. Patients underwent additional treatment (radiotherapy and/or chemotherapy) according to the tumor histology. No additional open microsurgical tumor removal was

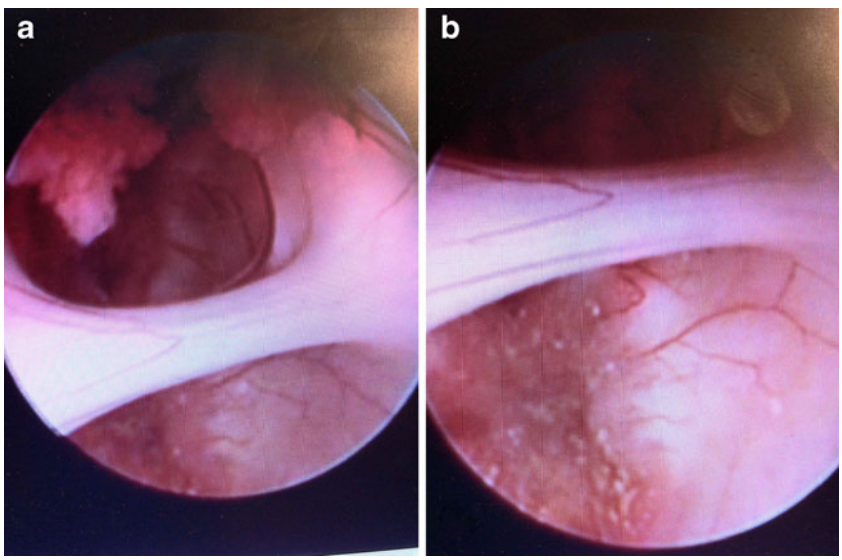

Fig. 3 Operative endoscopic view. **a** Close view of the tumor (PNET) underneath the interthalamic adhesion; also, the choroid plexus is identified on top of the foramen of Monro. **b** Closer view of the same case showing the tumor going further posteriorly into the third ventricle

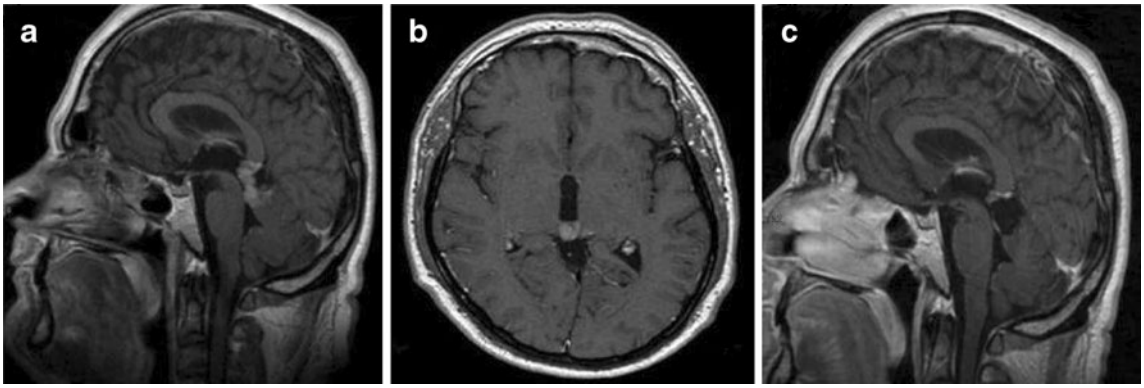

Fig. 4 Preoperative **a** sagittal and **b** axial T1-enhanced MRI showing a posterior third ventricle PNET; **c** postoperative 2-year F-U sagittal T1-enhanced MRI showing the PNET complete removal

performed in this series. Neither early nor delayed stoma failure was recorded, and no ventriculoperitoneal (VP) shunt conversion was needed in these patients at the latest clinical and radiological follow-up.

Discussion

Pineal region and posterior third ventricle tumors have always been of great interest for the neurosurgeon, constituting at the same time a real surgical challenge due to their deep-seated position, difficult approach, and high related mortality/morbidity rate [2, 4, 31, 33, 35] see also Table 1. Recently, the introduction of the neuroendoscopy has opened new horizons in the management of such neoplasm. Furthermore, the technique has greatly evolved from simply treating the associated hydrocephalus [3, 4, 6, 9, 12, 19, 20, 33, 42, 47, 57, 59, 65] to sampling tumor tissue, to tumor resection. The use of a rigid instrument offers more advantages such as superior optical and light quality thus giving the possibility to obtain larger quantities of pathological tissue in biopsies or even to perform various

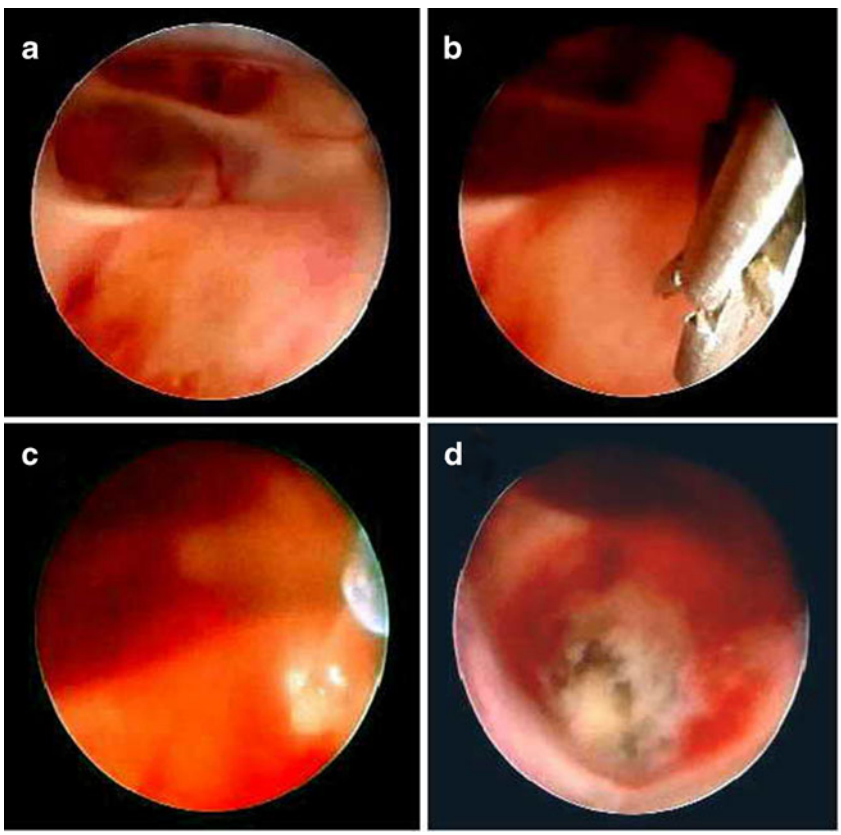

Fig. 5 Endoscopic operative view of a central neurocytoma excision. **a** Anterior view of the tumor underneath the interthalamic commisure. **b** View of the tumor biopsy by a rongeur. **c** View of tumor removal and hemostasis by a diode laser. **d** Final view after complete resection of the tumor

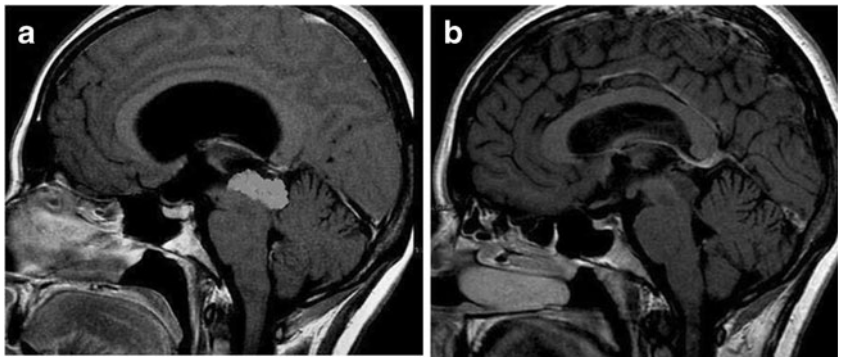

Fig. 6 Case of a posterior third ventricle neurocytoma. **a** Preoperative sagittal T1-enhanced MRI showing a posterior third ventricle neurocytoma. **b** Postoperative 2-year F-U sagittal T1-enhanced MRI showing a complete removal

degrees of tumor removal in selected cases, and to attain better hemostasis [7, 8, 51, 53].

The intrinsic advantage of this technique is its ability to better identify and visualize neurovascular structures within the posterior third ventricle and pineal recess providing better control, better manipulation, and by consequence preservation of neural structures. Some authors have described [7, 8, 25] the use of a biportal approach introducing two light sources through the right and left lateral ventricles. This technique could have some advantages in exceptional situations to control extensive bleeding. However, this creates the risk of a bilateral frontal lobe lesion, particularly in the dominant hemisphere; it also reduces the real essence of a minimally invasive procedure.

In all our cases, the lesion could be reached using the endoscope coupled to the IGS. A biopsy was performed in eight cases with mild and temporary complications whereas tumor removal was attempted in 12. The complication rates in the former group were higher (2 out of 12). The histological diagnosis could be achieved in all cases realizing systematically frozen sections and a mean of ten tissue samples. We do believe that this feature can increase the diagnostic rate explaining also as in our series a diagnostic rate of 100%.

The decision between biopsy and tumor removal was based per-operatively evaluating the tumor intrinsic characteristics as bleeding, consistency, adherence as well as in the preoperative stage based on its contrast enhancement CT, MRI, and MRA scans. In two cases, though a tumor removal had been planned, only an incomplete removal could be done because of hard consistency and annoying bleeding.

The main limitations of this approach are, in fact, related to the size, consistency, and vascularization of the tumor.

Table 1 Results of most relevant stereotactic, microsurgical, and endoscopic series for the management of posterior third ventricle and pineal region tumors

Authors	Year	No. of cases	Approach	Patient population	GTR (%)	Mortality (%)	Major morbidity (%)
Pecker et al. [47]	1979	25	Stereotactic	Adult	NA	0	NS
Apuzzo et al. [2]	1987	22	Stereotactic	Adult	NA	0	0
Lapras et al. [33]	1987	86	Microsurgical	Adult/pediatric	65	NS	NS
Luo SQ et al. [35]	1989	64	Microsurgical	Adult/pediatric	21	10	NS
Dempsey et al. [10]	1992	15	Stereotactic	Adult	NA	0	0
Bruce et al. [4]	1995	160	Microsurgical	Adult/pediatric	45	4	3
Sawin et al. [55]	1996	7	Stereotactic	Adult	NA	0	0
Regis et al. [50]	1996	370	Stereotactic	Adult	NA	NS	NS
Ferrer et al. [13]	1997	4	Endoscopic	Adult	NS	0	25
Oi et al. [44]	2000	6	Endoscopic	Pediatric	NS	0	0
Gangemi et al. [18]	2001	5	Endoscopic	Adult	NS	0	0
Field et al. [14]	2001	19	Stereotactic	Adult	NS	0	0
Pople et al. [48]	2001	34	Endoscopic	Adult	NA	0	NS
Konovalov et al. [31]	2003	201	Microsurgical	Adult/pediatric	NA	10	NS
Bruce et al. [5]	2004	81	Microsurgical	Adult/pediatric	47	1	2
Chernov et al. [7]	2006	23	Endoscopic	Adult	NA	0	0
Lefranc et al. [34]	2011	88	Stereotactic	Adult/pediatric	NA	0	0
Present series	2011	20	Endoscopic	Adult	40	5	5

NS not stated, *NA* not applicable, *GTR* gross total removal

Firm lesions impede safe endoscopic resection, whereas soft tumors and those removable by suction are most amenable for endoscopic removal. Ventricular tumors which are highly vascularized make endoscopic resection very difficult as vision is obscured. Preoperative evaluation of the tumor consistency and vasculature, based on its contrast enhancement CT, MRI, and MRA scans, is essential and crucial [24, 62]. Extensive coagulation of the tumor surface before any excision/tissue sampling seems to be the best way to remarkably reduce the bleeding risk [70]. However, it carries a potential risk of altering the tissue sample. However, in our experience, the histopathological analysis could be carried out in all cases.

As suggested by other authors [17, 60], tumor size might constitute the main limitation for such technique that could be not suitable for an intraventricular tumor larger than 2.5 cm. However, the development of an ultrasonic aspirator adapted to neuroendoscopy [46] and other devices with a non-heat-generating tissue removal system as Myriad™ [29] might open new possibilities to achieve a safe excision of larger tumors.

Many recent reports [10, 34, 61, 68] have illustrated a role for diode lasers in this type of surgery. In our experience, coupling neuroendoscopic procedures with a diode laser is a suitable strategy as it works both by coagulating without physical contact and by tissue vaporizing with direct contact. This specific feature allows for tumor resection with minimal or no risk to adjacent structures. However, in cases of infiltrating tumors, the risk of damaging adjacent structures remains high. Hemostasis should be checked carefully and often (at each step) with cauterization and/or continuous irrigation [17, 48, 52, 70]. In none of our cases was an open craniotomy necessary nor the endoscopic procedure abandoned for troublesome bleeding. Vascularized lesions carry also the risk of delayed tumoral bleeding from the residual lesion. In our series, one patient developed a bilateral ophthalmoplegia due to an intratumoral hematoma following a partial excision of a large pineal lesion, suggesting that endoscopic technique is not suitable for large and highly vascularized tumors unless a gross total removal can be achieved.

Conversely, a few authors have reported an intratumoral hemorrhage occurring either before endoscopic sampling [67] or after an endoscopic third ventriculostomy (ETV) without tumor sampling [5]. In these cases, hemorrhage probably occurred due to the sudden ICP reduction.

Besides the intraoperative bleeding and postoperative residual tumor apoplexy, the most frequent complications recorded in this type of surgery are: ventricular collapse, pneumocephalus, and tumor dissemination [29]. During endoscopic procedures, the excessive loss of CSF might also lead to a ventricular collapse that can be associated with a subdural hematoma [15, 56, 58], and pneumocephalus may be seen [21] causing postoperative headache and vomiting until its complete resolution. Copious irrigation with Ringer's lactate might reduce such complication.

The CSF dissemination rate of germ cell tumors and other malignant pineal lesions has been estimated to be between 5% and 57% [1, 2, 16, 22, 23, 36, 37, 39, 55]. In our experience, to avoid or reduce such a complication, we perform the tumor sampling before the ETV. The rationale is to keep the subarachnoid space isolated/ during biopsy, and as soon as the biopsy is completed, the ventricles are copiously rinsed. This technique seems sensible [44, 45, 70], and in our series, it has been successful in preventing tumor dissemination. However, the main risk of such strategy is that in the case of excessive bleeding from the tumor, the vision might get blurred and the third ventriculostomy not feasible safely. The problem of the hydrocephalus would thus not be addressed. For such a reason, in the case of acute hydrocephalus in which the main problem is represented by the raised ICP, it might be more suitable to start from the ETV followed by the tumor biopsy/removal.

Conclusion

Endoscopic management of posterior third ventricle and pineal region tumors represents a minimally invasive method of treatment which is associated to a high rate of complication (15% of the cases, 69) and thus should be performed by experienced surgeons. Whereas the biopsy is often a safe procedure, tumor excision should be attempted in selected cases such as poorly vascularized, soft and/or cystic and no bigger than 2.5 cm in diameter.

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Comments

Marc Sindou, Lyon, France

We do agree with the authors' conclusion that "endoscopic management of posterior third ventricle lesions may represent an effective option."

We, even more, estimate that with the exception of meningiomas and other similar tumors, endoscopic approach should be the first option, as it affords the possibility to get CSF sampling for cytologic and marker studies, as well as to harvest tumor tissue for histopathologic diagnosis. It also allows performing ventriculo-cisternostomy in the (frequent) eventuality of coexisting hydrocephalus.

As regards tumor removal, at least at the first stage, we think that indications should be very restricted, not only because of the risk of not being able to control hemostasis, but also because the histopathologic nature of the lesion has to be firmly ascertained before deciding resection. We all know that the number of tumors is well controllable with radio- and/or chemotherapies.

Restriction by the authors of attempts at endoscopic removal to only those tumors which are cystic or poorly vascularized and smaller than 2–5 cm in diameter seems wise.

For tumors posteriorly located in the pineal region, besides the endoscopic procedure through the transfrontal–interventricular foramen of Monro route, a trans-posterior fossa approach was recently developed, namely infratentorial–supracerebellar, that may be applied to the posteriormost pineal region tumors.

So, neurosurgeons are fortunate to have these endoscopic approaches that may be offered to the patients, besides the microsurgical open approaches, the later ones being either suboccipital (i.e., infratentorial–supracerebellar) or supraoccipital–transtentorial especially when the tentorium is stiff.

Dattatraya Muzumdar, Mumbai, India

Chibbaro et al report their experience in the neuroendoscopic management of pineal region tumors. They conclude that neuroendoscopy in pineal region tumors requires skill and expertise. They propose that tumor excision should be limited to highly selected cases (cystic, poorly vascularized, and/or smaller than 2.5-cm lesions).

Neuroendoscopy for pineal region tumors has been described during the last decade, and gradually, the procedure has been refined to make it more safe and smooth. In neurosurgical centers with expertise in neuroendoscopy, it has become a routine procedure in experienced hands. The decision to perform ETV is universal, but biopsy and/or tumor excision has been decided on individualized cases preoperatively. The extent of resection has to be judicious, philosophical, and patient centric. Pineal region tumors have diverse etiologies, and hence, there are likely to be large-scale variations in the consistency and vascularity of the tumors.

Although the sample size is small, the present study is prospective and well conducted. The high selection of cases for neuroendoscopy is self-explanatory. There is no statistical analysis performed. It is worthwhile to know that all patients had a patent stoma and there was no need for any conversion to VP shunt. The follow-up period is adequate.

The present study echoes the sentiments expressed in the previous case studies reported in literature. However, the present study may be considered as an adjunct to the existing information on the topic. A larger sample size or multiinstitutional study would be worthwhile.

Tamas Doczi, Pecs, Hungary

The authors present a series of 20 patients with third ventricle neoplasms and associated obstructive hydrocephalus. They introduce the two-burr hole approach by neuronavigation guidance of two separate endoscope routes for (1) performance of tumor removal or biopsy for histological confirmation and guidance of further therapy and (2) definitive management of hydrocephalus by third ventriculostomy with avoidance of a shunt. Their technique of a "minimally invasive approach" and its complication rate may be contrasted with open craniotomy for performance of excisional biopsy and with shunting for control of the associated hydrocephalus. The authors series argues the usefulness of the minimally invasive approach with an elegant solution of the clinical problems and an accurate diagnosis leading to further appropriate management. Performance of an endoscopic biopsy under direct visualization must improve sampling yield for accurate histological assessment, as well as diminishing the risks for bleeding by the avoidance of tumor-related vessels compared with blind stereotactic needle biopsy approaches. As shown, bleeding is the major obstacle of endoscopic radical tumor removal. Obstructive hydrocephalus can almost always be managed by this approach, without the significant long-term complications and difficulties of shunting. Two ports of cranial entry are required to provide a direct, linear approach to two separate targets within the third ventricle. This is necessary because the authors use rigid lens scopes. The low frontal approach through the foramen of Monro to the posterior third ventricle region could be more safely achieved with direct visualization with a separately passed, simultaneously imaging coronal endoscope at the foramen of Monro as we have shown earlier [9]. Although the approach below the hairline requires only a small incision and burr hole, it certainly demonstrates cosmetic impact in the visualized face of the patient. The "minimally invasive" philosophy would necessitate the use and development of tools that make this surgery achievable through a single burr hole. In contrast with thoraco-abdominal spinal endoscopic procedures, minimal invasiveness in intracranial neurosurgery is imperative: in the future, the right coronal burr hole approach may be used with a steerable fiberscope in the third ventricle for performing a safe biopsy. Angle-view rigid lens scopes of 30° and 70° already allow visualization of the suprapineal recess, posterior commissure, and aqueduct regions via the coronal approach toward the floor of the third ventricle. If the frontal below the hairline approach is necessary, another alternative to third ventriculostomy for management of hydrocephalus could be aquaductoplasty, i.e., reopening the aqueduct and placement of a third ventricle–fourth ventricle stent to circumvent the obstruction through the normal cerebrospinal fluid flow pathway. Endoscopy has undoubtedly become established in neurosurgery. The ascertaining of indications, however, is still a problem and, at times, controversial. Further technical improvements are needed to be able to perform a safe tumor removal.

Mikhail Chernov, Yoshihiro Muragaki, Hiroshi Iseki, Tokyo, Japan

Chibbaro et al. have reported their experience with neuroendoscopic management of pineal region and posterior third ventricle tumors. The results obtained in the series of 20 consecutive patients treated in two neurosurgical centers are definitely valuable because they reflect several very important issues.

First, it seems that nowadays neuroendoscopic biopsy has become the standard option for patients with intraventricular tumors, which can be successfully applied even in cases without accompanied hydrocephalus. While technical nuances and devices used for tissue sampling are varied from one center to another, the procedure typically provides a high level of safety and efficacy. The morbidity rate is not low, but the vast majority of complications are mild, temporary, and self-resolving. In the referenced series, no one severe side effect was encountered in eight patients who underwent pure biopsy of the neoplasm, and the diagnostic yield of the procedure was 100%. The latter definitely was reached due to a large quantity of obtained pathological material with at least eight tissue samples per case and because of constant use of the intraoperative histopathological investigation on the frozen sections. In the recently appeared national survey of the neuroendoscopic procedures for management of ventricular and paraventricular tumors in Japan, which had incorporated 714 patients operated on in 123 different centers, the diagnostic yield was slightly lower (92.8%), and the main reason for inability to establish the diagnosis was insufficient tumor sampling [1]. It should be mentioned, however, that high diagnostic yield does not necessarily reflect sufficient diagnostic accuracy, particularly in cases of histologically heterogeneous neoplasms, which are frequently encountered in the pineal region and posterior third ventricle. In fact, neuroendoscopic tissue sampling represents a modification of the open biopsy, which is accompanied by the highest rate of diagnostic errors [4]. Possible incorporation of the neurochemical navigation with 5-aminolevulinic acid may increase the diagnostic efficacy of the neuroendoscopic procedures [8].

Second, contrary to pure biopsy, the endoscopic resection of the pineal region and posterior third ventricle tumors in the presented series was associated with significant risk of major morbidity. Out of 12 patients, one died, another one has remained in the vegetative state, and the third one had prolonged bilateral ophthalmoplegia. It should be specifically emphasized, that two out of four patients who underwent partial tumor resection had experienced postoperative hemorrhage in the neoplastic remnants with very serious clinical consequences. Based on this limited experience, it can be concluded that partial endoscopic removal of the pineal and posterior third ventricle neoplasms should be definitely avoided. It necessitates careful selection of the surgical candidates. The authors critically analyzed their own results and suggested that endoscopic resection should be recommended only in cases of small (less than 2.5 cm in diameter), avascular, soft and/or cystic tumors, which generally corresponded to the opinion of others [6, 7]. Certainly, surgical experience, appropriate training, and advanced equipment are equally important for attainment of good outcome.

From the technical standpoint, the authors used the standard approach for rigid endoscope with the separate entries for tumor biopsy or removal and for third ventriculostomy (ETV). However, it does not seem absolutely necessary. Careful planning of the procedure can identify the optimal single trajectory, which can be effectively used for both manipulations [2, 3]. On the other hand, use of the rigid endoscope for tumor sampling and a flexible one inserted through the same shield for ETV (so-called "mother and daughter" technique) may also limit the procedure to the single entry. We agree that creation of the communication between basal cisterns and ventricular system not before, but after completion of the tumor sampling, may prevent possible subarachnoid seeding of the neoplasm. While the risk of this complication is rather low (6.8% [1]) and it was never met in the referenced series, every attempt should be done for its avoidance. Finally, it is important to mention that use of neuronavigation system based on the preoperative images for guidance of the endoscopic resection of the intraventricular tumors should be done with great caution due to high risk of mislocalization errors caused by the brain shift phenomenon [5].

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