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Surgery of Tumors of the Third Ventricle Region

L. Danaila, M. Radoi

Neurosurgical Department, National Institute of Neurology and Neurovascular Diseases, Bucharest, Romania

Rezumat

Tratamentul chirurgical al tumorilor de regiune de ventricul III

Introducere: Ventriculul III este o structură anatomică cerebrală, situată practic în centrul creierului și care este înconjurată de structuri cu rol vital. Autorii articolului prezintă experiența lor în tratamentul tumorilor cerebrale, care își au originea sau expansionează în ventriculul III, analizând reultatele post-operatorii și evoluția pacienților.
Material și metodă: Am realizat un studiu retrospectiv pe 120 pacienți, care au fost operați în clinica noastră pentru tumori situate la nivelul sau în regiunile adiacente ventriculului III. După locul de origine, aceste tumori au fost împărțite în: tumori primare de ventriculul III (69 cazuri) sau tumori dezvoltate din structurile anatomice adiacente (51 cazuri). Excizia chirurgicală a leziunii s-a realizat prin abord transcalos-transventricular (58,34%), transcortical parieto-occipital (26,67%) și subfrontal (15%). În toate cazurile rezecția tumorii s-a realizat sub microscopul operator. La 20 de pacienți (16,67%) a fost necesară montarea preoperatorie a unui drenaj ventricular. Nu s-au utilizat proceduri stereotactice.
Rezultate: Mortalitatea totală înregistrată a fost de 11,67% (14/120 decese). Decesul a fost determinat de cauze chirurgicale la 8 pacienți, complicații generale la 3 pacienți, recidiva tumorii la 2 pacienți și complicații ale drenajului ventriculo-peritoneal la un pacient. Evoluție bună peri-operatorie (GOS 5) a fost înregistrată la 54 de pacienți (45%), dar la un an de la operație, evoluție neurologică bună, a fost înregistrată la 72 de pacienți (60%). Monitorizarea neurologică pe termen lung a evidențiat deficite neurologice la 21,42% din pacienți, diabet insipid permanent la 5,1% și persistența unor semne neuropsihice la 28,57% din pacienți. Recidiva tumorii a fost întâlnită la 16 pacienții.
Concluzii: Abordul transcalos ramâne varianta neurochirurgicală de elecție pentru tumorile de ventricul III, deoarece permite vizualizarea bună a întregii cavități ventriculare prin diferite coridoare anatomice, iar deficitele neurologice și neuropsihice sunt rare.

Cuvinte cheie: tumori de ventricul III, aborduri chirurgicale, rezultate postoperatorii, prognostic

Abstract

Background: The third ventricle is located in the center of the brain, surrounded by critical structures. The authors reported their experience in the surgical treatment of tumors originated from or expanding within the third ventricle, analysing the postoperative results and patients' outcome.
Material and methods: We performed a retrospective study on 120 patients, who had been operated in our neurosurgical department for tumors of the third ventricle and adjacent region over the last 21 years. According to their place of origin, these tumors were divided into primary tumors of the

Corresponding author: Mugurel Petrinel Radoi MD, PhD
UMF "Carol Davila", Bucharest
National Institute of Neurology and Neurovascular Diseases, Bucharest
Neurosurgical Department
10-12 Berceni Street, 041902 Bucharest
Romania
Tel.: 021/3343004 int.2008
E-mail: muguradoi@yahoo.com

third ventricle (69 cases) and tumors developed from the surrounding structures (51 cases). The patients were operated on via a transcallosal-transventricular approach (58.34%), transcorticalparieto-occipital approach (26.67%) or subfrontal approach (15%). Microsurgery has been used in all cases. In 20 patients (16.67%), preoperative ventricular drainage was performed. Stereotactic procedures were not used in this study.
Results: The overall mortality in this series was 11.67% (14/120 died). The death was directly correlated to the surgery in 8 cases, to general complications in 3 cases, to recurrence of the tumor in 2 cases, and to shunt malfunction in one case. Perioperative good evolution (GOS 5) was noted in 54 patients (45%), but at one-year follow-up, good neurological evolution was recorded in 72 patients (60%). The long-term neurological outcome recorded neurological impairments in 21.42% of patients, a permanent diabetes insipidus in 5.1% of patients and the persistence of neuropsychological deficits in 28.57%. The recurrence of the tumor has been encountered in 16 patients (13.34%).
Conclusions: Transcallosal approach remains the best method for the microneurosurgical treatment of third ventricle tumors. This route provides the capability for a superior visualization of the entire cavity of the third ventricle through different corridors, and permanent neurological and neuropsychological deficits are not frequent.

Key words: third ventricle tumors, surgical approaches, postoperative results, outcome

Introduction

Operations in and around the third ventricle continue to pose significant technical challenges. Advanced microsurgical techniques combined with improved neuroanesthetic and postoperative critical care have made aggressive surgical resection a mainstay in the management of third ventricular tumors (1,2). Good understanding of third ventricular anatomic substrates optimizes patient selection and surgical outcome (3,4,5,6).

Third ventricular lesions encompass a wide spectrum of neoplastic and inflammatory processes. Neuroepithelial tumors are the most common primary neoplasms in the area adjacent to the third ventricle, and, of these, gliomas are preponderant. They include such lesions as juvenile pilocytic astrocytoma, fibrillary astrocytoma, protoplasmic astrocytoma, subependymal giant cell astrocytoma, glioblastoma multiforme and ependymoma. Metastatic tumors, the most common cerebral neoplasms in adults, may invade the third ventricle through its floor or lateral walls (7). Suprasellar germinomas and craniopharyngiomas can invade the third ventricle through its floor (8). Suprasellar extension of pituitary macroadenomas can also occur and are often accompanied by declining visual acuity or visual field disruption (8). Some cystic lesions may afflict the anterior third ventricular region and these include colloid cysts, epidermoid and dermoid tumors, and neurocysticercosis. Meningiomas arising from the velum interpositum (9), large falcotentorial meningiomas that extend anteroventrally and impinge on the third ventricle (10), arachnoid cysts (11), arteriovenous malformations (12), vein of Galen malformations (13), and cavernous malformations (14) may also be found in the region.

The choice of surgical approach depends on the goals of surgery in specific cases (biopsy, aspiration and decompression of a cystic lesion or complete surgical excision). The most frequently used is transcallosal approach, which allows the surgeon access to the third ventricle by three different surgical corridors. The transcortical approach permits access to lesions that arise from or extend into the third or lateral ventricles. The subfrontal anterior approach relies on a trajectory passing through the lamina terminalis in order to access the intraventricular component.

In this study, we collected data from 120 cases of tumors that arose or extended into the third ventricle. It reflects the surgical experience on treating third ventricular tumors of the senior author of the article, prof. dr. Danaila Leon, along with the presentation of the postoperative results and outcomes of this large series of patients.

Material and Methods

This is a retrospective study, over a period of 21 years (1990-2011), on a series of 120 patients who were operated on for a tumor located in or extending into the third ventricle. We re-examined and analysed the patient files, pre- and postoperative images, surgical protocols and histologic results. Clinical information was collected retrospectively, from inpatient and outpatient profiles, in a dedicated database. The files were analysed with focus on: (a) initial signs and symptoms, (b) grade of tumor resection, (c) histologic type of tumor, (d) postoperative neurological status, (e) postoperative complications, (f) perioperative morbidity/mortality, (g) outcome and clinical/imagistic follow-up, (h) recurrences.

Patients and clinic

One hundred and twenty patients with third ventricle tumors were operated on in the Neurosurgical Department of the National Institute of Neurology and Neurovascular Diseases – Bucharest between 1991 and 2011, and were included in this study. The male/female ratio was approximately 1 (M=63, F=57). The median age of patients at the moment of surgery was 42 years (range, 23-67).

The clinical presentation varied with tumor location in and around the third ventricle. Onset symptoms were dominated by intracranial hypertension caused by the obstruction of the CSF drainage pathways, which was noted in 84 patients (68.34%), and mental changes (59.16%, representing 71 patients). Diabetes insipidus (17.5%) and visual field impairments (35.83%) were present in patients with the tumor located in the anterior portion of the third ventricle. In patients with the tumor arising from the thalamus and

extending into the third ventricle, motor deficits (32 out of 120 patients) and sensory deficits (24 out of 120 patients) were dominant. Seizures were noted at onset in only 10% (12 patients), and were probably related to obstructed hydrocephalus. Change in the state of consciousness (somnolence, obnubilation or coma) at the moment of diagnosis, was present in 10 patients (8.34%), and 4 of them were in coma, with signs of acute hydrocephaly that had needed emergency external ventricular drainage at admission (*Table 1*).

Table 1. Most frequently encountered signs and symptoms

Signs and symptoms	No. of patients	Percentage (%)
Obstructive hydrocephalus	82	68.34%
Mental changes	71	59.16%
Impairment of vision (visual field changes)	43	35.83%
Endocrine disorders (diabetes insipidus)	21	17.5%
Motor deficits	32	26.67%
Sensory deficits	24	20%
Seizures	12	10%
Coma	4	3.34%

Treatment

All patients in the present series underwent surgical treatment. The goals of surgery varied widely depending on the clinical and imagistic aspects of an individual situation. Our main concern was to perform an extensive resection, rather than a simple biopsy, in order to provide immediate relief of the mass effect exerted by the tumor. Gross total resection was feasible in patients with benign or encapsulated tumors (e.g. colloid cysts, meningioma, craniopharyngioma).

Surgical approach depended on the location and size of the tumor. An operating microscope was used in all cases. No stereotactic procedure was performed. In our series, we used the following approaches for resection of tumors of the third ventricle:

a) interhemispherictranscallosal-transventricular approach – patients with primary tumors of the third ventricle (70 patients – 58.34%);
b) transcortical approach – mainly for lateral ventricle tumors expanding into the third ventricle (32 patients – 26.66%);
c) unilateralsubfrontal approach – mainly for resection of craniopharyngioma expanding into the third ventricle (18 patients – 15%).

Histology

Histology of the lesion affecting the third ventricle encompassed a wide range of neoplastic processes. Histologic result was available in 111 out of 120 patients, who underwent surgery (*Table 2*). According to their origin, we divided tumors of the third ventricle into: intra-axial tumors – 72 cases (65%), and extra-axial tumors – 39 cases (35%).

Follow-up

All patients were observed at a median of 2.5 years (0.2-8 years) after surgery. The first clinical follow-up, as a routine postoperative examination, was performed at a median of 3 months after surgery. Further follow-up was provided mostly by readmission of the patient for scheduled controls. One-year follow-up was provided only in 98 patients. General postoperative outcome was assessed using the Glasgow Outcome Scale (G.O.S), which described the neurological status of a patient as: good recovery (GR), moderate disability (MD), severe disability (SD), persistent vegetative state (PVS) and dead (D).

Results

Operative treatment

We chose the surgical approach depending on the exact location of the tumor, the differential diagnosis, tumor's size,

Table 2. Tumor histology in 111 out of 120 patients

	Histology		No. of patients
Intra-axial tumors 72 patients (65%)	Astrocytoma	Pilocytic astrocytoma	8 (7.2%)
		Low grade glioma	32 (28.82%)
		Anaplastic astrocytoma	2 (1.8%)
		Glioblastoma	2 (1.8%)
		Giant cell astrocytoma	2 (1.8%)
	Ependymoma		16 (14.4%)
	Subependymoma		7 (6.3%)
	Neurocytoma		3 (2.7%)
Extra-axial tumors 39 patients (35%)	Colloid cysts		16 (14.4%)
	Craniopharyngioma		12 (10.81%)
	Pituitary macroadenoma		2 (1.8%)
	Metastasis		3 (2.7%)
	Meningioma		3 (2.7%)
	Choroid plexus tumors		3 (2.7%)

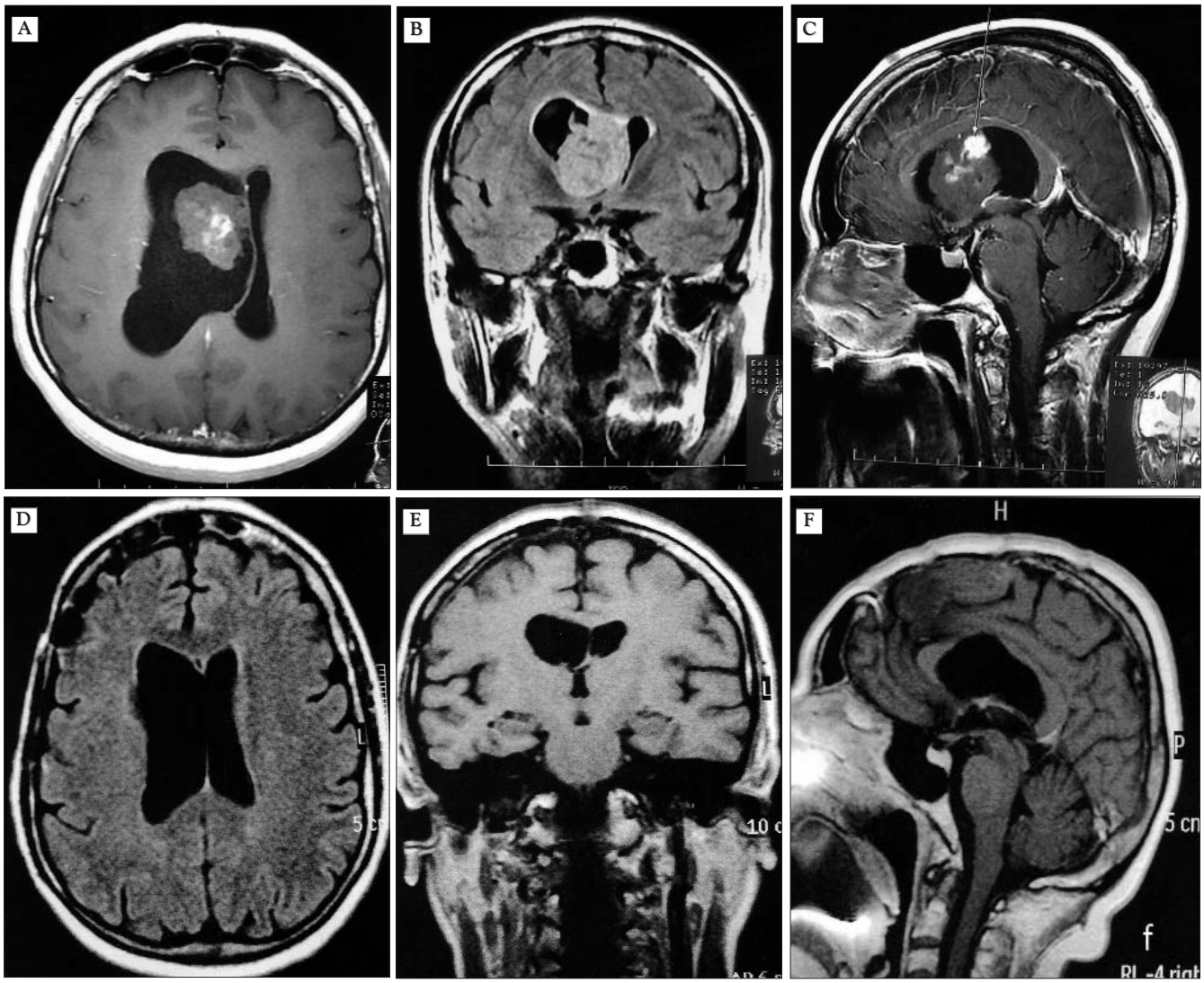

Figure 1. *47-year old woman presenting a tumor arising from the third ventricle and extending into the right lateral ventricle; (**A,B,C**) – preoperative cerebral MRI with gadolinium enhancement in axial, coronal and sagittal view; (**D,E,F**) – postoperative cerebral MRI with gadolinium enhancement showing the complete removal of the tumor. The tumor was resected using a transcallosal-transventricular approach, and the histologic exam revealed a subependymoma*

patient's clinical status and anatomical knowledge. Tumor excision was performed using standard microsurgical techniques, by three major approaches: transcallosal - transventricular approach (58.34% - 70 patients) (*Fig. 1*), transcorticalparieto-occipital approach (26.66% - 32 patients) and, less used, subfrontal approach, via lamina terminalis, (15% - 18 patients) (*Fig. 2*). Removal of the tumor, totally or partially, was considered depending on its size and anatomic location.

In 20 patients (20%), onset clinical symptoms were dominated by signs of internal hydrocephalus. In all these cases, ventricular drainage was performed prior to surgery. In 8 patients we performed a preoperative external ventricular drainage which was removed at the time of surgery. For the remaining of 12 patients, we performed a ventriculo-peritoneal drainage in 10 patients and a ventriculo-atrial drainage in 2 patients. The early postoperative course was complicated with an acute internal hydrocephalus in 9 patients. Six of them had had a ventricular drainage prior to surgery, and half of them developed shunt malfunction caused by postoperative debris. At one-year follow-up, 22 out of 120 patients of the whole series (18.34%) required a permanent CSF shunt.

Complications

The most significant immediate problems after surgery included: bleeding within the tumor bed, acute hydrocephalus, subdural hematoma. Tumor bed hemorrhage was noted in 14 patients (11.67%), but only 8 required evacuation due to acute neurological deterioration. Nine patients developed postoperative acute internal hydrocephalus and needed emergency placement/revision of a ventriculo-peritoneal drainage. Three patients had a postoperative subdural hematoma needing evacuation, but recovered well. Postoperative meningitis

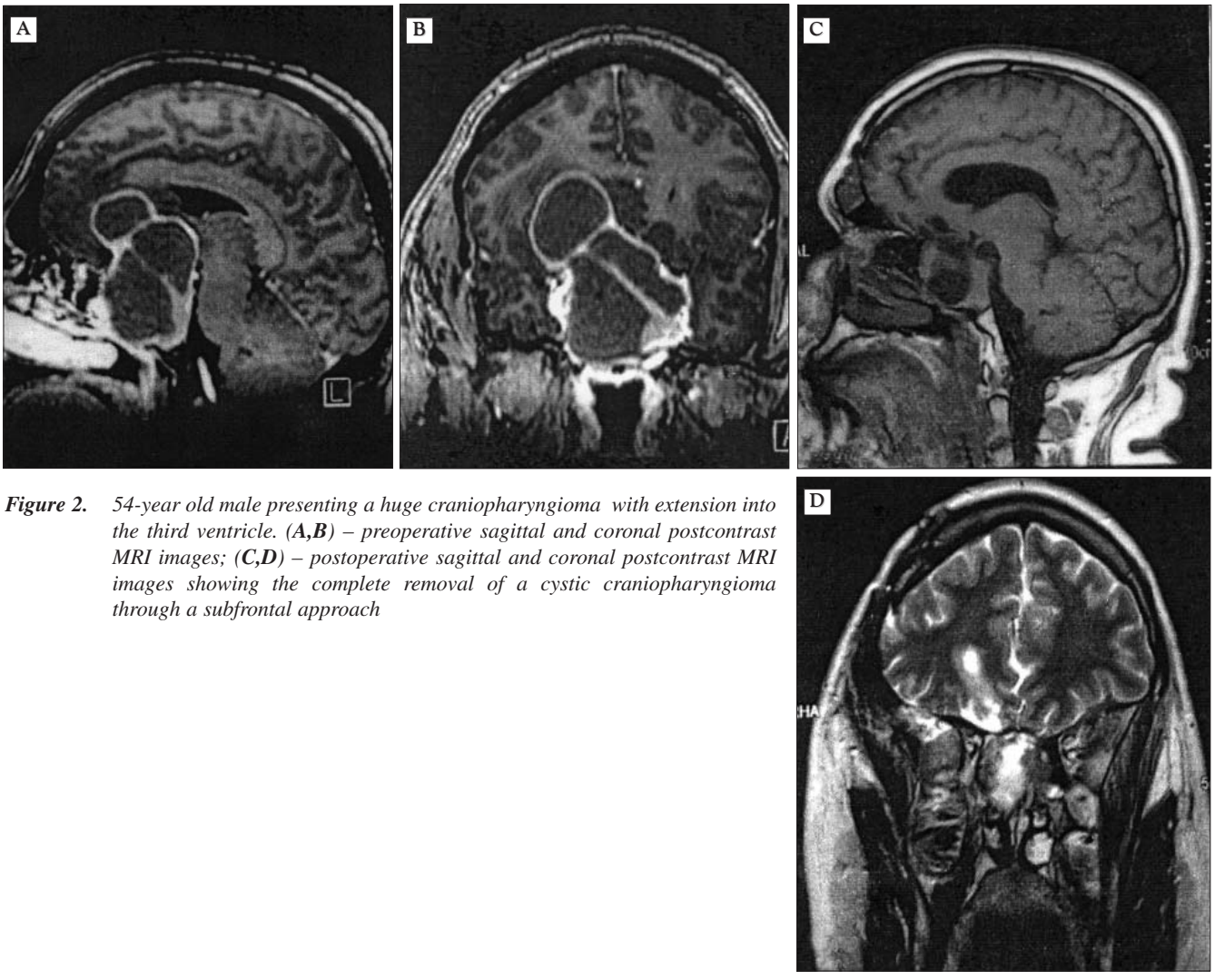

Figure 2. *54-year old male presenting a huge craniopharyngioma with extension into the third ventricle. (**A,B**) – preoperative sagittal and coronal postcontrast MRI images; (**C,D**) – postoperative sagittal and coronal postcontrast MRI images showing the complete removal of a cystic craniopharyngioma through a subfrontal approach*

developed in 2 patients, and in one of the cases caused the death of the patient. Neurological (hemiparesis, sensory deficits, speech disorders, visual field deficits and memory deficits) and endocrine impairments were the most frequently encountered perioperative complications in the surgery of third ventricular tumors (*Table 3*).

General outcome

Favorable outcome (GOS 5 and 4) at discharge was seen in 88 out of 120 patients (73.34%). Twelve patients had severe disability (GOS 3), especially because of worsened motor and memory deficits, and 3 patients were in a persistent vegetative state. Postoperative mortality was 9.16% (11 patients). In 8 patients the cause of death was related to surgery, and 3 patients died due to general complications (pulmonary embolism - 2 patients, and meningitis – 1 patient).

One-year follow-up was possible in 98 patients. Outcome analysis at that time of follow-up recorded neurological impairments (hemiparesis, aphasia, visual field deficits, sensory deficits) in 21 patients (21.42%), residual memory deficits and coordination problems in 28 patients (28.57%),

Table 3. *Postoperative course of patients with tumors of the third ventricle*

Characteristics	At discharge (no. of patients)	At follow-up (no. of patients)
No complications	72	78
Tumor bed hemorrhage	14	-
Acute subdural hematoma	3	-
Acute internal hydrocephalus	9	-
Meningitis	2	-
New/worsened hemiparesis	28	10
Visual field deficits	6	2
Speech disorders	12	4
New/worsened memory deficits	25	19
Residual endocrine disorders	10	5
Wound infection	3	-
Recurrences	-	16
Overall mortality	11	14

Table 4. General outcome at discharge and at one-year follow-up

Outcome	At discharge	At one year
GOS 5 (good recovery)	54 (45%)	72 (60%)[1]
GOS 4 (moderate disability)	34 (28.34%)	18 (15%)[1]
GOS 3 (severe disability)	18 (15%)	5 (4.16%)[1]
GOS 2 (vegetative state)	3 (2.5%)	0
GOS 1 (death)	11 (9.16%)	14 (11.6%)[1]
Total of patients	120 patients	109 patients[2]

[1]The percentage is calculated reporting to the 120 patients from the whole series

[2]The number of 109 patients consisted of the 98 patients for whom follow-up was possible at one year after surgery and the initial 11 deaths recorded at discharge

and residual endocrine disorders, represented by permanent diabetes insipidus in 5 patients (5.1%) (*Table 4*). At one-year follow-up three new deaths were recorded. Two cases were related to tumor re-growth and one to complication related to shunt malfunction. Overall recorded mortality, for the whole series of 120 patients, was 11.66% (14 patients). At one-year follow-up there were 90 patients with good neurological evolution or mild neurological deficits. They represented 75% of the whole series, and were considered to be regaining their social independence.

Recurrences

One-year follow-up was possible in 98 patients. Recurrence of the tumor was recorded in 16 patients (13.34%) who survived more than a year from the first surgery. Imagistic (CT or MRI) follow-up performed at discharge, demonstrated partial resection of the tumor in 22 patients (18.34%), out of which 12 were operated through transcallosal-transventricular approach, 8 by transcortical approach and 2 by subfrontal approach. Except for the two patients with craniopharyngioma operated through subfrontal approach, the rest of the other 20 patients with subtotal resection had intra-axial tumors.

In all patients with recurrences, partial resection of the tumor was performed. Ten of them underwent re-operation, with good neurological evolution in 80% (8 patients out of 10 patients).

Discussion

The third ventricle is the deepest midline cavity, and there are different types of tumors that can be located here. The choice of the third ventricular approach basically depends on the exact location of the lesion, the differential diagnosis, lesion size, patient's clinical status and anatomical knowledge. In our series, we did not consider access to the posterior portion of the third ventricle, such as infratentorialsupracerebellar. Basically there are three major approaches to the third ventricle: transcallosal, transcortical and endoscopic approaches (3). Less used is the subfrontal via lamina terminalis access. We did not use endoscopic approach in our series, which in our opinion is addressed only to particular lesions of the third ventricle, as colloid cysts (15,16).

As many other authors (3,5,6), for tumors which seems to arise primarily from the third ventricle we used the interhemispherictranscallosal approach, which allowed us direct access to the tumor's origin. After entering the lateral ventricle, there are three options for accessing the third ventricle: transforaminal, transcoroideotransveluminterpositum and interforniceal approach. When the tumor is extending into the third ventricle from the surrounding anatomical structures (as glial tumors), transcortical approach may prove very useful, especially when there is ventricular dilatation (17). The risks of postoperative epilepsy and unnecessary neural injury avert some neurosurgeons from this technique (18). Endoscopic approach remains very used for the treatment of colloid cysts because it is safe and it is associated with with shorter operative time, shorter hospital stay and lower infection rate compared to the transcallosal approach. However, more patients treated endoscopically needed a reoperation for residual cysts (19). Saphiro et al (20) said that despite the fact that endoscopic surgery has been reported to be more cost-effective and safer than open craniotomy for the resection of colloid cysts, it has a 5%-10% conversion rate to craniotomy, a 5% recurrence rate, a 5%-10% ventricular shunting rate, and a 5%-10% epilepsy rate.

Intraoperative tumor dissection may proceed towards a goal of total resection as long as the surgeon can identify a plane between the tumor and the surrounding normal structures. The adequacy of a subtotal resection is a matter of judgment and experience. Possible goals of subtotal resection beyond diagnosis include cytoreduction, in preparation for adjuvant therapy, relief of mass effect, and re-establishment of the CSF circulation (21). For invasive tumors, such as glioma of the thalamus or brain stem, debulking should proceed cautiously, because a gross total resection may be associated with a high likelihood of incurring a neurologic deficit; re-establishment of CSF circulation is a reasonable goal (17,21). With benign tumors (e.g, meningioma, teratoma, pilocytic astrocytoma, dermoid, well-differentiated pineocytoma), the surgeon must strive for a gross total resection in either piecemeal or en bloc fashion; if a total resection is achieved, the third ventricle should be inspected to ensure that there is no obstruction of the CSF circulation.

It should be underlined that, although several corridors to the third ventricle exist, they all ultimately demand the incision of the neural tissue which may be relatively free of the underlying diseases of this approach. Dissection of a tumor within the third ventricle could lead to hemiparesis, memory loss, increased endocrinopathy, visual loss and other signs of diencephalic injury (22). Transcallosal approach remains the best microsurgical method of all third ventricle tumors approaches. This route provides the capability for a superior visualization of the entire cavity of the third ventricle through different corridors. It was the most frequently used approach in our series, in over 58% of cases. Using this approach, with care during midline entry in relation to the cortical venous anatomy, and minimal midline retraction, permanent

neuropsychological and neurological deficits are not frequent (23). Transcortical-transventricular approaches to the third ventricle risk injury on the site of corticotomy or topectomy, and postoperative seizures could develop in up to 27% of patients (24).

Conclusions

The main objectives in the surgical treatment of tumors originated from or expanding within the third ventricle include finding the histology of the underlying lesion, achieving maximum lesion excision and normalizing CSF dynamics. It is important to achieve these tasks with minimum of physiologic perturbation and iatrogenic injury to the cortex. The death or permanent neurologic deficit rates in our series are similar with other studies published in the literature. We conclude that transcallosal approach remains the best surgical approach for the third ventricle, but other factors, including the tumor's origin, surrounding neural and vascular anatomy, patient's medical condition and surgeon's familiarity with the various techniques must be taken into consideration.

References

1. Kawashima M, Rhoton AL Jr, Matsushima T. Comparison of posterior approaches to the incisural space: microsurgical anatomy and proposal of a new method, the occipital bi-transtentorial / falcine approach. Neurosurgery. 2002;51(5):1208-20; discussion 1220-1.
2. Sekhar LN, Goel A. Combined supratentorial and infratentorial approach to large pineal-region meningioma. Surg Neurol. 1992;37(3):197-201.
3. Amar AP, Albuquerque FC, Apuzzo MJL. Anterior third ventricle lesion (including colloid cysts). In: Black P, Kaye A, eds. Operative Neurosurgery. New York:Churchill Livingstone; 2000. p. 753-768.
4. Yamamoto I, Rhoton AL Jr, Peace DA. Microsurgery of the third ventricle: Part I. Microsurgical anatomy. Neurosurgery. 1981;8(3):334-56.
5. Fonseca RB, Black PMcL, Filho HA. Approaches to the third ventricle. Arq Bras Neurocir. 2012;31(1):3-9.
6. Lozier AP, Bruce JN. Surgical approaches to posterior third ventricular tumors. Neurosurg Clin N Am. 2003;14(4):527-45.
7. Dănăilă L, Radoi M, Ciocan L, Stefănescu F. Surgical treatment of single brain metastases. Chirurgia (Bucur). 2012;107(3):366-72. Romanian
8. Tătăranu L, Gorgan M, Ciubotaru V, Dricu A. Endoscopia intracraniană. Aplicații. Bucureşti: Ed. Didactică şi Pedagogică R.A.; 2009.
9. Konovalov AN, Spallone A, Pitzkhleauri DI. Meningioma of the pineal region: a surgical series of 10 cases. J Neurosurg. 1996;85(4):586-90.
10. Papacocea T, Roşca T, Bădărău A, Papacocea R, Ciornei C, Ion AD. Cystic meningioma Chirurgia (Bucur). 2009;104(1): 99-103. Romanian
11. Engel U, Gottschalk S, Niehaus L, Lehmann R, May C, Vogel S, et al. Cystic lesions of the pineal region - MRI and pathology. Neuroradiology. 2000;42(6):399-402.
12. Dănăilă L. Microsurgical treatment of the interhemispheric arteriovenous malformations. Chirurgia (Bucur). 2012;107(6):701-14.
13. Konovalov AN, Pitskhelauri DI, Arutiounov NV. Surgical treatment of the thrombosed vein of Galen aneurysm. Acta Neurochir (Wien). 2002;144(9):909-15; discussion 915.
14. Vhora S, Kobayashi S, Okudera H. Pineal cavernous angioma presenting with Parkinsonism. J Clin Neurosci. 2001;8(3):263-6.
15. Pollock BE, Huston J 3rd. Natural history of asymptomatic colloid cysts of the third ventricle. J Neurosurg. 1999; 91(3):364-9.
16. De Witt Hamer PC, Verstegen MJ, De Haan RJ, Vandertop WP, Thomeer RT, Mooij JJ, et al. High risk of acute deterioration in patients harboring symptomatic colloid cysts of the third ventricle. J Neurosurg. 2002;96(6):1041-5.
17. Shizuo O, Samii A, Samii M. Operative techniques for tumors in the third ventricle. Op TechnNeurosurg. 2003;6(4):205-14.
18. Yasargil MG, Abdulrauf SI. Surgery of intraventricular tumors. Neurosurgery. 2008;62(6 Suppl 3):1029-40.
19. Horn EM, Feiz-Erfan I, Bristol RE, Lekovic GP, Goslar PW, Smith KA, et al. Treatment options for third ventricular colloid cysts: comparison of open microsurgical versus endoscopic resection. Neurosurgery. 2007;60(4):613-8.
20. Saphiro S, Rodgers R, Shah M, Fulkerson D, Campbell RL. Interhemispherictranscallosalsubchoroidal fornix-sparing craniotomy for total resection of colloid cysts of the third ventricle. J Neurosurg. 2009;110(1):112-5.
21. Amar AP, Albuquerque FC, Apuzzo MJL. Ventricular tumors. In: Youmans ed. Neurological Surgery. New York:Churchill Livingstone; 2004. p. 1237-63.
22. Apuzzo ML, Chikovani OK, Gott PS, Teng EL, Zee CS, Giannotta SL, et al. Transcallosal, interforniceal approaches for lesions affecting the third ventricle: surgical considerations and consequences. Neurosurgery. 1982;10(5):547-54.
23. Bellotti C, Pappada G, Sani R, Oliveri G, Stangalino C. The transcallosal approach for lesions affecting the lateral and third ventricles: surgical considerations and results in a series of 42 cases. Acta Neurochir (Wien). 1991;111(3-4):103-7.
24. Apuzzo MLJ, Litofsky NS. Surgery in and around the anterior third ventricle. In: Apuzzo MLJ ed. Brain surgery: complication avoidance and management. New York:Churchill Livingstone; 1993. p. 541-579.