**UNIVERSITY OF MEDICINE AND PHARMACY**

**“CAROL DAVILA”, BUCHAREST**

**DOCTORAL SCHOOL**

**MEDICINE DOMAIN**

# DOCTORAL THESIS

**PhD Supervisor:**

**PROF. UNIV. DR. MIRCEA RADU GORGAN**

**PhD Student:**

**ADRIAN MIRCEA FÜRTÖS**

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# *Supratentorial ventricular system tumors – anatomo-clinical considerations, prognostic data and impact upon adult population*

# SUMMARY OF THE DOCTORAL THESIS

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# Annex

Introduction
I. General part – Current state of knowledge ..... 5
1. General data – History and anatomy of the ventricular system ..... 5
2. Supratentorial intraventricular tumors – diagnosis and treatment ..... 5
II. Original part – Personal contributions ..... 7
3. Work hypothesis and general objectives ..... 7
4. General methodology of the research ..... 7
5. Study 1 – Anatomo-clinical considerations in supratentorial ventricular system tumors ..... 7
5.1. Introduction (specific work hypothesis and objectives) ..... 7
5.2. Material and method ..... 7
5.3. Results ..... 8
5.4. Discutions ..... 9
5.5. Conclusions ..... 11
6. Study 2 – Surgical considerations in supratentorial ventricular system tumors ..... 12
6.1. Introduction (specific work hypothesis and objectives) ..... 12
6.2. Material and method ..... 12
6.3. Results ..... 12
6.4. Discutions ..... 14
6.5. Conclusions ..... 16
7. Study 3 – Prognostic data and impact upon adults in supratentorial ventricular system tumors ..... 17
7.1. Introduction (specific work hypothesis and objectives) ..... 17
7.2. Material and method ..... 18
7.3. Results ..... 18
7.4. Discutions ..... 20
7.5. Conclusions ..... 23
8. Conclusions and personal contributions ..... 24
Bibliography

# List of published scientific papers

1. **Adrian Mircea Fürtös**, Aurelia Mihaela Sandu, Ciubotaru Vasile Gheorghe, Gorgan Radu Mircea, Ligia Gabriela Tătăranu, *Unusual locations of gangliogliomas: intraventricular and posterior fossa*, Turkish Neurosurgery, 2023, volume 33(5), 887-897, ISI Web of Science (SCIE), FI 0,8, Q3
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2. **Adrian Mircea Fürtös**, Aurelia Mihaela Sandu, Vasile Gheorghe Ciubotaru, Radu Mircea Gorgan, Ligia Gabriela Tătăranu, *Skull base chordomas - emphasis on surgical strategy and recurrence-free survival*, Medicine and Pharmacy Reports, 2025, volume 98(2), 210-216
   https://medpharmareports.com/index.php/mpr/article/view/2797
   PubMed indexed journal
   (chapter 5, p. 7-11)

3. **Adrian Mircea Fürtös**, Aurelia Mihaela Sandu, Radu Mircea Gorgan, Ligia Gabriela Tătăranu, *Navigating life following surgery - Quality of life in patients with supratentorial intraventricular brain tumors*, Balneo and PRM Research Journal, 2025, volume 16(2), 809, ISI Web of Science (ESCI), IF 1,1, Q3
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## INTRODUCTION

Tumors of the supratentorial ventricular system represent a unique category in neurosurgical pathology, characterized by histological heterogeneity, anatomical complexity and major surgical challenges. Deep localization and intimate vecinity with critical structures imply a high surgical risk.

Although relatively rare, these lesions have a significant impact on functional and vital prognosis of the adult patient, justifying the need for an integrated analysis of clinical, imaging and histological factors.

## I. GENERAL PART – CURRENT STATE OF KNOWLEDGE

### 1. General data – History and anatomy of the ventricular system

Understanding the ventricular system evolved from the ancient conceptions of Aristotle and Galen to modern anatomical descriptions.[1-3]

The supratentorial ventricular system consists of two lateral ventricles and single third ventricle. The lateral ventricles have a complex structure, being divided into frontal horn, body, atrium, occipital horn and temporal horn, each having anatomical relationships with critical structures such as the thalamus, fornix and hippocampus.[4, 5]

Third ventricle is a median cavity located between thalamus and hypothalamus[4], its vecinity explaining the particular clinical pattern of tumors located at this level.

### 2. Supratentorial intraventricular tumors – diagnosis and treatment

Supratentorial intraventricular tumors are a heterogeneous group of lesions from the histological point of view, characterized by structural variability, different biological behavior and anatomical peculiarities that influence both the clinical status and the therapery strategy. In adults, low-grade lesions prevail, but the tumor spectrum is wide, including ependymomas, subependymomas, gliomas, central neurocytomas, meningiomas, choroid plexus tumors, colloid cysts, germ cell tumors, pineal region tumors, craniopharyngiomas or metastases.[6]

Distribution of tumor types is closely related to location. Tumors of the lateral ventricles are the most common and include mainly central neurocytomas, meningiomas and subependymomas, while tumors of the third ventricle have more frequently neuroepithelial origin and are associated with damage to hypothalamic structures. Choroid plexus tumors are

characterized by a rich vascular supply, and ependymomas often present a heterogeneous structure, with infiltrative potential and associated necrosis or calcifications. Central neurocytomas are typical found in young adults and are frequently located near the foramen of Monro, causing symptoms due to obstruction of cerebrospinal fluid flow.[6]

Positive diagnosis of these lesions is mainly based on magnetic resonance imaging, which allows detailed topographical and structural characterization of tumors. The imaging assessment includes tumor size and volume analysis, vecinity and delimitation with neighboring structures, pattern of contrast enhancement, as well as identification of elements suggestive for biological aggressiveness, such as peritumoral edema, necrosis or signal heterogeneity semnal.[7, 8] Presence of calcifications or cysts can orientate differential diagnosis towards certain histological types. Imaging also plays an essential role in surgical planning, by defining the optimal approach trajectory and assessing relationships with critical structures such as the thalamus, fornix or deep veins.

Treatment of supratentorial intraventricular tumors is predominantly surgical, the main objective being to achieve a maximum safe resection. Choosing surgical approach is determined by tumor location, size and anatomical relationships.[7, 9-15] Transcortical approaches are frequently used for tumors of the lateral ventricles, especially for bulky lesions, providing direct access and adequate exposure, while transcallosal approaches are preferred for median lesions or for those located in the third ventricle, allowing access without crossing cerebral cortex. In selected cases, especially for small lesions or for diagnostic purposes, endoscopic techniques can be used.

## II. ORIGINAL PART – PERSONAL CONTRIBUTIONS

### 3. General work hypothesis and objectives

General work hypothesis is represented by the assumption that clinical, imaging, histological and intraoperative issues of patients harboring supratentorial intraventricular tumors affects postoperative outcome, which allows building a predictive model applicable in neurosurgical practice.

Study objectives included analysis of anatomical and clinical issues of supratentorial intraventricular tumors, assessment of results following surgery and identifying prognostic factors involved in patients' outcome.

### 4. General methodology of the research

We performed a retrospective study, which included patients operated between 2009 and 2024. Clinical, imaging, histological, intraoperative and postoperative data were analyzed using acknowledged univariate and multivariate statistical methods.

### 5. Study 1 – Anatomoclinical considerations in supratentorial ventricular system tumors

#### 5.1. Introduction (specific work hypothesis and objectives)

The aim of this study was to assess relationship between tumor location, histological type and clinics, in order to identify relevant correlations for preoperative diagnosis. Thus, the analysis sought to highlight specific anatomo-clinical patterns, suitable for prooper differential diagnosis making and assessment of tumor biological behavior, starting from the preoperative stage.

#### 5.2. Material and method

A total number of 217 patients with positive histological supratentorial intraventricular tumors were included. Clinical, imaging and histological variables were analyzed. Linkage between tumor location, imaging features and histological type were assessed, using descriptive and analytical statistical methods, with the aim of identifying significant correlations.

### 5.3. Results

Between 1st of January 2009 and 31st of December 2024, 380 cases of supratentorial intraventricular lesions were identified, of which only 217 cases met the inclusion criteria, representing histological positive intraventricular tumors. These accounted for 57.1% of the total intraventricular lesions, the remaining being paraventricular tumors with secondary extension, non-tumoral cystic lesions and isolated cases of vascular or infectious pathology.

The study group included 217 patients with supratentorial intraventricular tumors. Sex distribution was relatively even, with a slight male predominance (118 cases, 54.4%).

Histology analysis revealed predominance of low-grade tumors. Grade I tumors accounted for 56.2% (n=122), followed by grade II (19.8%, n=43), grade IV (17.5%, n=38), and grade III (6.5%, n=14). According to tumor histology, the most common entities were colloid cyst (n=52, 24%), central neurocytoma (n=28, 12.9%), meningioma (n=23, 10.6%), subependymoma (n=17, 7.8%) and metastases (n=16, 7.4%). Other tumor included ependymomas grade II and III, adult-type diffuse gliomas, choroid plexus tumors, germ cell tumors, craniopharyngiomas, and lymphomas.

Patinets' age varied according to histology. Germ cell tumors were diagnosed at younger ages (germinoma: mean age 21.55 years), while non-meningothelial mesenchymal tumors (mean age 60.33 years), metastases (mean age 57.50 years) and subependymomas (mean age 52.94 years) predominantly occurred in elderly patients. Common tumors such as central neurocytoma (36.93 years), meningioma (53.43 years) and ependymoma (46.77 years) showed intermediate distributions.

Anatomical distribution showed predominance of tumors located within the lateral ventricles, especially in the body (n=52), frontal horn (n=51) and atrium (n=46), compared to the occipital horn (n=8) and temporal horn (n=4). Tumors of the third ventricle were also common, with 93 cases in the anterior part and 40 in the posterior part.

Distribution of tumor types according to location revealed specific patterns. Central neurocytomas were predominantly located within the lateral ventricles (frontal horn and body), while colloid cysts showed a typical location at the level of the anterior third ventricle. Meningiomas were frequently found in the atrium and ventricular body, while ependymomas and subependymomas showed a more heterogeneous distribution. The germ cell tumors were predominantly located in the posterior third ventricle.

From de clinical point of view, symptoms were dominated by intracranial hypertension, present in more than half of the patients (n=111, 52.1%). Headache was the most common symptom (about 80%), followed by nausea and vomiting (49.3%), dizziness and vertigo (30.7%) and balance disorders (23.5%). Cognitive impairment (18.4%) and decreased visual acuity (13.4%) were also common. Other symptoms included motor deficit (11.5%), memory disorders (10.3%), epileptic seizures and hemiparesis in lower percentages. The sudden onset of symptoms was found in 7.8% of patients.

Tumor volume showed an uneven distribution, varying from 0.094 $cm^3$ to 44.745 $cm^3$, reflecting the heterogeneity of tumor sizes. Imaging features analysis revealed hydrocephalus in 63.6% of patients (n=138), contrast enhancement in 67.3% (n=146), and perilesional edema in 44.2% (n=96). Intratumoral cysts were present in 43.3% of cases (n=94), calcifications in 23.5% (n=51), and intratumoral necrosis in 23% (n=50). Tumor margins were well defined in 68.2% of cases and infiltrative in 31.8%.

Vascular supply according to location revealed significant variations, with tumors of the III ventricle being fed predominantly by perforating and choroidal arteries, while tumors of the lateral ventricles presented a mixed vasculature, arrising from the ACA, ACM and ACP. The most common sources were the posteromedial (41.3%) and anterior (36.2%) choroidal arteries, followed by the medial (37.2%) and lateral (22%) lenticulostriate arteries. Other sources included the subcallosal artery (12.4%), thalamoperforating arteries (12.4%), and hypothalamic-pituitary arteries (6.9%). Venous drainage was deep in all cases. Overall analysis of vascular supply according to tumor type revealed statistically significant association between histology and tumor feeding arteries ($p < 0.001$).

### 5.4. Discuţii

Results highlight the heterogeneous nature of supratentorial intraventricular tumors, both from the histological, clinical and imaging point of view. The histological distribution of intraventricular tumors in this series is comparable to the international literature.[16, 17] The predominance of low-grade tumors, especially colloid cyst, central neurocytoma, meningioma, and subependymoma, confirms that this pathology is dominated by lesions with relatively favorable biological behavior, despite deep localization.[18, 19] Also, the significant amount

of high-grade tumors and metastases emphasizes the need for a rigorous differential evaluation.

Age distribution revealed important variations according to the histological type, suggesting a specific biological tropism. Germ cell tumors occur predominantly in young patients[20], while mesenchymal lesions, metastases and subependymomas are more common in older age.[21, 22] These differences support the role of age as a guiding element in preoperative diagnosis, although it does not represent an independent determining factor.

Anatomically, the predominance of tumors within the lateral ventricles, especially at the level of body and frontal horn, reflects both the larger volume of these compartments and the diversity of structures of cellular origin. The frequent localization of tumors at the level of the third ventricle, especially in the anterior part, is correlated with the histological peculiarities, the colloid cyst being the most representative lesion in this region[23]. Tumor extension in several ventricular compartments highlights the expansive character of some lesions.

Correlations between histology and location highlight the existence of relatively constant patterns. Central neurocytomas are characteristically located at the level of the lateral ventricles[19, 24], while colloid cysts present a typical location in the anterior part of the third ventricle[23, 25]. Meningiomas prevail in the atrium atriumului[26, 27] and germ cell tumors are more frequently associated with posterior part of the third ventricle.[20, 28] These findings in the orientation of the preoperative diagnosis. These findings have practical relevance in guiding preoperative diagnosis.

From a clinical point of view, symptoms are dominated by intracranial hypertension, present in more than half of the patients. The increased frequency of headache, nausea, vomiting, and balance disturbances reflects the impact of mass effect and obstruction of cerebrospinal fluid flow. Cognitive and visual disturbances suggest involvement of adjacent structures. Acute onset, although less common, indicates life-threatening situations, frequently associated with obstructive hydrocephalus.

The high frequency of hydrocephalus and contrast enhancement highlights the obstructive and vascular mechanism of intraventricular tumors. Presence of perilesional edema and intratumoral necrosis reflects the variability of biological aggressiveness, while calcifications and cystic components are suggestive help guide the differential diagnosis.

Well-defined tumor margins, predominant in most cases, suggest an expansive rather than infiltrative character for most lesions.

The important variability of the tumor volume indicates that these lesions can evolve asymptomatically to reach large sizes, especially when they are located in non-eloquent brain regions. Conversely, tumors located in strategic areas, such as third ventricle, may become symptomatic early through obstruction of cerebrospinal fluid flow.

Analysis of tumor vascular supply highlights the anatomical complexity of these lesions. Predominance of arterial supply from the choroidal system and deep perforating branches reflects the deep location and close vecinity with critical structures. Vascularization differences according to location and histology suggest the existence of specific patterns, with relevance in surgery planning. Overall, the results support the importance of integrating clinical, imaging, anatomical and histological data in the assessement of intraventricular supratentorial tumors, providing a useful framework for guiding diagnosis and tailored treatment.

### 5.5. Conclusions

Histology of intraventricular tumors in this series is similar to relevant international literature. The predominance of benign lesions (WHO grade I-II), especially colloid cyst, ependymal and glioneuronal tumors is confirmed. The low frequency of primary malignant tumors and paucity of metastases reflect the particularities of this tumor group, characterized by favorable biological behavior. Age has great variability, depending on the histological subtype of tumor. Germ cell tumors and low-grade glial tumors occur more frequently at young age, while meningeal neoplasms, metastatic or high-grade gliomas predominate at older age. Intraventricular tumors' location, dominated by lesions originating in the anterior part of the third ventricle, reflects the specific histogenetic tropism. Symptoms of supratentorial intraventricular tumors are polymorphic, being dominated by signs of intracranial hypertension. Tumor growth near narrow ventricular corridors causes obstruction of CSF flow and early diagnosis, while growth in clinically silent areas allows a large tumor volume. Intraventricular tumors are large, deep and well vascularized. Vascularization of intraventricular tumors strictly depends on the anatomical location within the ventricular system.

## 6. Study 2 – Surgical considerations in supratentorial ventricular system tumors

### 6.1. Introduction (specific work hypothesis and objectives)

The aim of this study was to evaluate surgical aspects of ventricular tumors resection. In this context, the analysis focused on correlation of surgical approaches with anatomic and biologic particularities of tumors, as well as their impact upon grade of resection. Nevertheless, identifying optimal surgical strategies in order to maximize safety and efficiency of the operation was considered.

### 6.2. Material and method

Surgical approaches, grade of tumor resection and the intraoperative technical details were analyzed. Variables related to the type of surgery, laterality of approach, magnification techniques and intraoperative characteristics of the tumor were included. Statistical analysis aimed to assess the associations between these variables and surgical outcomes, particularly the grade of resection.

### 6.3. Results

The group of study included 217 patients with supratentorial intraventricular tumors, who underwent surgery 222 times. Most patients benefited from a single surgery (n = 212, 97.7%), while 5 patients (2.3%) required reoperations.

According to types of surgery microsurgical techniques prevailed (73%), followed by endoscopic procedures (17.6%) and combined approaches (under 5%). Stereotactic biopsy was used in 4.1% of cases. Analysis of surgery extension showed that minimally invasive operations were performed in 51 cases (23%), while open surgery was used in 171 cases (77%). Overall, the data show a clear predominance of open surgery and microsurgical techniques in treatment of supratentorial intraventricular tumors, with selective use of minimally invasive and stereotactic approaches. Regarding laterality of the approach, the majority of interventions were performed through a right approach (n = 143, 64.4%) compared to a left approach (n = 55, 24.8%). Median approaches were used in 22 cases (9.9%), and bilateral combined approaches were rare (n = 1, 0.5%).

From an anesthetic point of view, almost all interventions were performed under general anesthesia with orotracheal intubation (n = 218, 98.2%), the use of combined anesthesia being

rare (n = 4, 1.8%). Surgical instruments used were predominantly microsurgical (n = 171, 77%), followed by endoscopic tools (n = 44, 19.8%). The Leksell stereotactic frame was used in 5 cases (2.3%), and the biopsy needle in 9 cases (4.1%). Analysis of distribution of magnification techniques revealed the predominant use of the operating microscope, concordant with high share of open surgery, while the endoscope was used in cases selected for the minimally invasive approach.

Distribution of surgical approaches revealed the predominance of the frontal transcortical approach, used in 39.6% of cases (88/222). Other transcortical approaches were less frequently performed: parietal transcortical in 9% (20/222), occipital transcortical in 2.7% (6/222), and temporal transcortical in 1.8% (4/222). Transcortical transsulcal approach through TP/TPO/PO junction was performed in 5% of cases (11/222). The transcallosal approach was used in 5.4% of cases (12/222), while translamina terminalis subfrontal and transtentorial occipital approaches were each used in 1.8% of surgeries (4/222). The infratentorial supracerebellar approach accounted for 9.9% of surgeries (22/222). Endoscopy was performed in 18.9% of cases, and stereotactic biopsy in 4.1%.

Distribution of surgical approaches according to tumor location revealed the predominant use of frontal transcortical approach for lesions within the frontal horn (n = 45), ventricular body (n = 41), and anterior third ventricle (n = 37). Lesions located at the level of the ventricular atrium were frequently approached frantal transcortical (n = 15) and through transcortical parietal approaches or through TP/TPO/PO junction (n = 17 and n = 9). For lesions of the posterior third ventricle, the infratentorial supracerebellar approach was predominant (n = 21), followed by the frontal transcortical (n = 5) and endoscopic (n = 4) approaches.

Distribution of surgical approaches according to histology revealed important variability. Central neurocytomas (n = 28) were predominantly approached frontal transcortical (n = 21), whereas subependymomas (n = 17) and ependymomas (n = 14) showed a more heterogeneous distribution of approaches. Meningiomas (n = 23) were frequently approached by transcortical approaches and, in some cases, by infratentorial approaches. Colloid cysts (n = 52) were treated predominantly using endoscopy (n = 34), the latter being the main indication for this type of approach. Metastases (n = 16) and craniopharyngiomas (n = 9) showed a variable distribution of approaches, adapted to anatomical peculiarities.

Analysis of distribution of surgical approaches according to tumor vascular supply revealed predominant use of microsurgical approaches in well-vascularized tumors, especially through transcortical and transcallosal approaches. Endoscopy was more commonly used in lesions with low or moderate vascular supply, whereas hypervascular tumors predominantly required open approaches.

Gross total resection was achieved in 72.1% of cases (n = 160). Subtotal resection was performed in 18.5% (n = 41), while biopsy was performed in 8.6% of cases (n = 19). Near-total resection and exploratory surgery were rare (0.5% each). Analysis of tumor volume distribution by grade of resection revealed variability between groups, with a greater dispersion of volumes in subtotal resections compared with gross total resections. Extreme values of tumor volume were observed in all resection categories, including the biopsy group. Tumor volume does not predict the probability of obtaining a more extensive grade of resection ($p$ = 0.693). Surgical strategy must be adapted to the tumor's biological features, well-vascularized tumors or with complex vascular supply frequently requiring classic microsurgical approaches or staged surgery.

Tumor consistency was predominantly soft in 53% of cases (n = 102), while 47% of tumors showed firm consistency (n = 115). The intraoperative appearance was homogeneous in 60.4% of cases (n = 131) and inhomogeneous in 39.6% (n = 86). In terms of vascularity, 31.3% of the tumors were well vascularized (n = 68), 19.4% moderately vascularized (n = 42), and 49.3% poorly vascularized (n = 107). Intratumoral hemorrhage was present in 14.28% of cases (n = 31).

### 6.4. Discusions

Integrated data analysis confirms that, although surgical approach and technique are essential in the management of these lesions, the final outcome is determined mainly by tumor features and grade of resection.

The final results proved that surgery of the 217 patients was dominated by microsurgery (73%) and open surgery (77%), with the selective use of minimally invasive techniques, especially endoscopy (17.6%). This distribution reflects the anatomical complexity of intraventricular tumors and the need for superior visual and technical control in deep, frequently well-vascularized lesions. Transcortical approaches, especially the frontal one

(39.6%), represented the main access route, being preferred due to the direct trajectory and adequate exposure, while transcallosal or infratentorial approaches were reserved for tumors without hydrocephalus or posterior locations.

Although there are significant changes in distribution of surgical approaches according to location, histology and vascular supply, these differences reflect technical adjustment to tumor particularities and do not represent independent prognostic factors. In other words, surgical approach must be seen an adaptive tool, whose role is to facilitate achievement of the main objective, namely, maximum safe resection.

The importance of extension of resection is strongly supported by the data from study 2, where complete resection was achieved in 72.1% of cases, subtotal resection in 18.5%, and biopsy in 8.6% of cases. This parameter is the major determinant of postoperative outcome. Correlation between gross total resection and favorable outcome is explained by the tumor reduction, removal of mass effect and limitation of risk of recurrence, especially in the case of low-grade tumors, which predominate in this pathology.

At the same time, variability of tumor volume observed according to grade of resection highlights technical difficulty of surgery in case of high-volume lesions or located in the vicinity of eloquent areas. Although gross total resections were also achieved in large tumors, the increased dispersion of volumes in the subtotal resection group suggests that size and anatomic features sometimes limit safe surgical resection. This observation correlates with the results from the first study, where tumor volume was identified as a factor associated with clinical signs, highlighting the continuity between preoperative features and surgical outcome.

Tumor peculiarities found intraoperatively play an important role in surgical strategy. Tumor consistency (soft in 53% of cases), vascular supply (31.3% well-vascularized tumors) and homogeneous or inhomogeneous appearance influence difficulty of resection and operative risk. However, these characteristics have an essential role in surgical planning and choosing the propper surgical technique, indirectly contributing to an optimal resection.

Also, distribution of surgical approaches according to histology highlights the adaptability of surgical strategies. For example, the predominant use of endoscopy in the treatment of colloid cysts reflects the favorable characteristics of these lesions (small size, limited vascularity), while solid, well-vascularized tumors required microsurgery. This

differentiation supports the idea that there is no universally superior technique, only individualized strategies.

These results support the need for personalized surgical planning, based on integration of clinical, imaging, and anatomical data, with the goal of achieving maximal safe resection. At the same time, they confirm the logical continuity between preoperative tumor features and postoperative results, highlighting the central role of biological factors in the outcome of these patients.

### 6.5. Conclusions

Surgery of supratentorial intraventricular tumors remains predominantly microsurgical, with open surgery accounting for 77% of all procedures, while minimally invasive techniques were used in 23% of cases. This fact reflects the need for direct control of deep neurovascular structures and limitations of exclusively endoscopic approaches in certain tumor types. Surgical approach was mainly influenced by tumor location and histology, confirming the work hypothesis of the study. The different ventricular compartments required distinct surgical corridors, with the transcortical and transcallosal approaches most commonly used for the lateral ventricles and the anterior part of the third ventricle. The right-sided approach was preferred (64.4%), to avoid damaging the cerebral structures of the dominant hemisphere and reduce the risk of postoperative neurological deficits. Gross total resection was achieved in a percentage (72.1%), demonstrating the effectiveness of the microsurgical strategies used and the appropriate selection of the operative approach. Subtotal resections accounted for 18.5% and biopsies for 8.6% of procedures. Tumor volume was associated with grade of resection ($p = 0.693$), the extent of resection depending more on the anatomical features, vascular supply and histology, rather than tumor size. Endoscopy had well-selected indications, being predominantly used for cystic lesions or tumors of the anterior third ventricle. Repetitive surgery demonstrated the role of staged therapy, especially in tumors with high vascular supply or initial limited access, where conversion to microsurgery allowed gross total resection. Overall, results of this study support the fact that the optimal surgical strategy in supratentorial intraventricular tumors is determined by the interaction between location, histology and peculiarities of the tumor vascul supply, and not exclusively by the size of the lesion.

## 7. Study 3 – Prognostic data and impact upon adults in supratentorial ventricular system tumors

### 7.1. Introduction (specific work hypothesis and objectives)

The aim of the study was to identify prognostic factors and assess survival in supratentorial intraventricular tumors. In this context, the study aimed not only to describe survival, but also to identify the relations between clinical, imaging and therapeutic factors involved in the outcome of patients, in order to define an integrated prognostic model applicable in current practice.

### 7.2. Material and method

The analysis included assessment of survival by Kaplan-Meier methods and identifying prognostic factors using logistic regression. Demographic, clinical, imaging, histological and intraoperative variables were included, statistical analysis aimed both at identifying factors associated with the outcome, and at assessing their predictive capacity through multivariate models and ROC curves.

### 7.3. Rezults

The group of 217 patients was analyzed. According to the Glasgow Outcome Scale (GOS), the postoperative outcome was favorable in most patients, 173 cases (79.7%) being classified in GOS 5, while 18 patients (8.3%) presented moderate deficit (GOS 4), 12 patients (5.5%) severe deficit (GOS 3), and 14 patients (6.5%) died (GOS 1). Postoperative complications were recorded in 64 patients (29.5%). The average hospital stay was 16.42±14.285 days, ranging from 3 to 151 days.

The analysis of outcome using functional scores revealed a significant postoperative improvement for the modified Rankin score (mRS) ($Z = -7.383$, $p < 0.001$) and for the Karnofsky Performance Status (KPS) score ($Z = -6.901$, $p < 0.001$), while changes in the Glasgow Coma Scale (GCS) score did not reach the threshold of statistical significance ($Z = -1.784$, $p = 0.074$).

Regarding seizure control, assessed according to the Engel scale, complete absence of postoperative seizures (class I) was achieved in 23 patients (57.5%). Rare seizures (class II) were recorded in 1 patient (2.5%), significant improvement (class III) in 3 patients (7.5%), and

insignificant improvement or worsening (class IV) in 12 patients (30%), including 3 cases (7.5%) with increased seizure frequency.

Analysis of postoperative complications according to the Clavien-Dindo classification showed a predominance of grade II (8.3%) and III (7.9%) complications, while severe complications included grade IV (3.7%) and death (grade V) in 6.5% of patients. The most common complications were hydrocephalus (10.1%), hemorrhage (about 10%), respiratory failure (7.4%), cardio-circulatory disorders (6.5%), motor deficit (6%), altered state of consciousness (6.9%), and septic complications (3.7%).

Analysis of demographic factors did not reveal significant associations between gender or age and the occurrence of postoperative complications ($p > 0.05$). In contrast, length of hospital stay was a significantly associated factor in both univariate (OR = 1.196; 95% CI: 1.131-1.266; $p < 0.001$) and multivariate analysis (OR = 1.205; 95% CI: 1.137-1.278; $p < 0.001$).

Analysis of tumor features revealed that, in multivariate model, peritumoral edema (OR = 3.378; 95%CI: 1.285–8.953; $p = 0.014$) and hydrocephalus (OR = 2.707; 95%CI: 1.255–5.839; $p = 0.011$) were independent factors associated with the occurrence of postoperative complications. In univariate analysis, poor vascularization ($p = 0.005$), necrosis ($p = 0.011$), contrast enhancement ($p = 0.007$) and irregular tumor margins ($p = 0.015$) were also identified as significant factors, but these did not maintain their significance in the multivariate analysis.

Regarding preoperative clinical factors, intracranial hypertension was significantly associated with complications occurrence in univariate analysis (OR = 5.819; 95%CI: 2.915–11.618; $p < 0.001$) and remained significant in multivariate analysis (OR = 4.286; 95%CI: 0.393–13.183; $p = 0.011$). Acute onset was also associated with the occurrence of complications in multivariate analysis (OR = 0.222; 95%CI: 0.050–0.993; $p = 0.049$).

Intraoperative factors analysis revealed that laterality of approach (OR = 2.230; 95%CI: 1.030–4.827; $p = 0.042$), extent of resection (OR = 1.654; 95%CI: 1.086–2.518; $p = 0.019$), patient positioning (OR = 0.447; 95%CI: 0.215–0.929; $p = 0.031$), length of corticotomy (OR = 3.106; 95%CI: 1.399–6.898; $p = 0.005$) and dural plasty (OR = 7.323; 95%CI: 3.010–17.817; $p < 0.001$) were independent factors associated with the occurrence of postoperative complications.

Postoperative outcome analysis revealed, in the multivariate model, that preoperative mRS score (OR = 1.086; 95%CI: 1.01–1.16; $p$ = 0.022) and presence of intracranial hypertension (OR = 0.133; 95%CI: 0.04–0.44; $p$ = 0.001) were independent factors associated with clinical outcome. Also, presence of postoperative complications was strongly associated with an unfavorable outcome (OR = 0.009; 95%CI: 0.00–0.08; $p < 0.001$).

The mean overall survival was 125.066 months (95%CI: 114.728–135.404), and median survival was 180 months. Survival was significantly influenced by age, with patients ≤ 50 years presenting a median survival of 143.971 months compared to 91.684 months in those > 50 years (Log-rank $\chi^2 = 24.473$; $p < 0.001$).

Histological grade had a significant impact on survival ($\chi^2 = 84.427$; $p < 0.001$), with median survival decreasing progressively from 160.409 months for grade I to 62.062 months for grade IV. Histological grade also significantly influenced recurrence-free survival ($\chi^2 = 11.378$; $p = 0.010$).

Type of surgery significantly influenced overall survival, with minimally invasive surgery being associated with a higher median survival compared to open surgery (169.252 vs. 112.775 months; $\chi^2 = 18.341$; $p < 0.001$). In contrast, recurrence-free survival was shorter with the minimally invasive approach (27.429 months vs. 70.571 months; $\chi^2 = 4.690$; $p = 0.030$).

The grade of resection did not significantly influence overall survival ($\chi^2 = 2.415$; $p = 0.491$), but was associated with recurrence-free survival ($\chi^2 = 8.993$; $p = 0.011$).

Presence of postoperative complications was associated with a significant reduction in survival (141.406 months in the absence of complications vs. 84.628 months in the presence of them; $\chi^2 = 27.655$; $p < 0.001$).

Survival analysis in the studied group revealed a median survival duration of 125 months (95% CI: 114.7–135), without reaching the median during the follow-up period. The distribution of survival curves indicated a prolonged maintenance of the survival probability in most cases.

Stratification of patients according to histology demonstrated statistically significant differences between groups. High-grade tumors were associated with a significant decrease in survival compared with low-grade lesions ($p$ = 0.001). Kaplan–Meier survival curves revealed a clear separation between these categories, confirmed by the log-rank test.

Analysis of imaging parameters identified peritumoral edema and intratumoral necrosis as significant factors for survival. The presence of peritumoral edema was associated with a significant reduction in survival ($p < 0.001$). Similarly, intratumoral necrosis demonstrated a significant negative impact on survival ($p < 0.001$).

In contrast, hydrocephalus and tumor calcifications did not show a statistically significant association with survival ($p > 0.05$). Although frequently encountered, hydrocephalus did not independently influence the probability of survival in the performed analysis. Calcifications did not reveal significant differences between groups in terms of survival.

Multivariate analysis confirmed the independent role of some prognostic variables. Histological grade remained the predominant factor, and the analyzed imaging markers additionally contributed to differentiation of risk between patients.

Based on these variables, a prognostic score was developed, statistically evaluated for its predictive capacity. The model demonstrated a significant association between the increase in score and the risk of event, with an Exp(B) = 1.571 (95% CI: 1.282–1.924; $p = 0.000$). ROC curve analysis revealed an area under the curve (AUC) of 0.748, indicating a good discrimination capacity of the model in differentiating patients with a favorable prognosis from those with a poor prognosis. Distribution of survival probabilities according to the risk categories defined by the prognostic score revealed differences between groups, with higher survival values in low-score categories and lower values in the high-score categories. The integration of clinical, imaging and histological variables within the prognostic model allowed a combined risk assessment, highlighting differences between subgroups according to the distribution of the factors analyzed.

### 7.4. Discutions

The first major aspect highlighted is the overall favorable postoperative outcome of patients. The high proportion of patients with maximum score on the GOS scale (GOS 5 79.7%) indicates the effectiveness of surgical treatment in this pathology, despite the anatomical complexity and associated risks. However, the existence of a non-negligible percentage of patients with moderate or severe deficit, as well as the mortality rate of 6.5%, underlines the heterogeneity of outcome and the need to identify risk factors. These data

confirm that, although the majority of patients benefit from a good functional outcome, there are high-risk subgroups, for whom the prognosis is significantly more reserved.

The significant improvement in postoperative functional scores (mRS and KPS) highlights the positive impact of surgery on neurological and functional status. The absence of significant change in the GCS score suggests, however, that the level of consciousness is not the main sensitive indicator for evaluating the outcome in this category of patients, compared to scores reflecting global functionality. This aspect supports the idea that the prognostic assessment must be multidimensional and include complex functional indicators.

Seizure control is another important element of postoperative outcome. Obtaining complete absence of seizures in over half of patients demonstrates the effectiveness of surgical treatment not only in controlling tumor mass, but also in improving associated symptoms. However, existence of a percentage of patients with unfavorable outcome (Engel class IV) indicates that epilepsy associated with these tumors may have complex mechanisms, not always completely reversible by surgery.[29]

Postoperative complications, present in approximately 30% of patients, constitute a central element in the prognostic analysis. Their distribution, with the predominance of grade II and III complications, suggests a significant, but generally controllable, morbidity. However, the presence of severe complications (grade IV and V) and their impact on mortality highlight the importance of identifying predictive factors. Among these, hospital stay appears as a robust marker, independently associated with complication occurrence, probably reflecting the severity of cases and the complexity of the postoperative outcome.

Analysis of tumor factors highlights the essential role of imaging features. Peritumoral edema and hydrocephalus were identified as independent factors for complications occurrence, which underlines their importance as markers of biological severity and impact upon brain structures. Although other imaging parameters (necrosis, contrast enhancement, irregular margins) were significant in the univariate analysis, loss of significance in the multivariate model suggests their interdependence and the predominant role of some key variables.

Clinically, intracranial hypertension stands out as a major factor, both in complications occurrence and impacting prognosis. Its independent association with unfavorable outcome confirms the role of mass effect and cerebrospinal fluid flow dynamics disorders in

determining postoperative outcomes. Acute onset also appears as an associated factor, suggesting that the initial clinical presentation reflects the severity of the disease and influences subsequent outcome.

Intraoperative factors have a significant contribution on the risk of complications. Laterality of the approach, grade of resection, patient positioning, length of corticotomy and the need for duraplasty are all independent factors, which underlines the importance of surgical technique and intraoperative decisions. These results highlight that, in addition to tumor feature, surgical strategy and technical execution directly influence patient outcome.

Regarding survival, Kaplan-Meier analysis reveals a high median duration (approximately 125 months), suggesting a favorable overall prognosis for most patients. However, this median value masks significant differences between subgroups. Age is an important factor, with younger patients showing significantly longer survival, reflecting both biological reserve and the distribution of histological types.

Histology stands out as the main determinant of survival, with a progressive decrease in life expectancy with increasing tumor grade. The marked differences between low-grade and high-grade tumors confirm the central role of biological aggressiveness in the outcome of the disease. This result is also supported by the analysis of recurrence-free survival, where histological grade remains a significant factor.

Imaging parameters, especially peritumoral edema and intratumoral necrosis, demonstrated a negative impact on survival, reinforcing their role as markers of aggressiveness. In contrast, hydrocephalus and calcifications did not significantly influence survival, suggesting that they reflect mechanical or structural aspects rather than the biological behavior of the tumor.

An interesting result is the influence of the type of surgery on survival. Minimally invasive surgery was associated with a higher overall survival, but with a lower recurrence-free survival compared to open surgery. This apparent contradiction may be explained by case selection, with minimally invasive techniques probably being used in less aggressive or more biologically favorable lesions.

Grade of resection did not significantly influence overall survival, but had impact on recurrence-free survival, suggesting that the extent of resection contributes mainly to local

control of the disease, without decisively modifying the overall outcome, which is dominated by tumor biological characteristics.

An essential element highlighted is the major impact of postoperative complications on survival. The significant reduction in life expectancy in patients with complications confirms that these are not just transient events, but determinants of long-term prognosis.

Finally, the multivariate analysis and the development of the prognostic score represent a synthesis of all these variables. The model obtained, with a good discrimination capacity (AUC = 0.748), demonstrates the usefulness of integrating clinical, imaging and histological data into a practical risk stratification tool. Association between higher score and risk of event confirms its validity and its potential for clinical application.

Prognosis of supratentorial intraventricular tumors is determined by complex interaction of biological, clinical, and therapeutic factors. Histological grade remains the central element, but imaging markers and clinical-surgical variables contribute significantly to defining individual risk. Integrating these parameters into a prognostic model allows for a more precise assessment and individualization of therapeutic management. Results provide a solid framework for understanding the links between clinical, imaging, histological, and surgical variables, integrating them into a coherent pognostic model.

### 7.5. Conclusions

Surgery for supratentorial intraventricular brain tumors remains a complex, but functional results of this study show that most patients (79.7%) can achieve good neurological recovery. Morbidity and mortality are in ranges comparable to those reported in reference centers, which confirms the effectiveness of the therapeutic protocol used. Complications were present in almost one third of patients, highlighting the need for continuous improvement of surgical techniques, minimally invasive approaches and strict perioperative monitoring. Histological grade is the main prognostic factor, significantly influencing both overall survival and recurrence-free survival. Peritumoral edema and intratumoral necrosis are imaging markers of aggressiveness, associated with both complications' occurrence and decreased survival. Intracranial hypertension and preoperative functional status (mRS, KPS) are independent clinical factors associated with postoperative outcome. Postoperative complications significantly influence prognosis, being associated with reduced survival and

unfavorable outcome. Certain intraoperative factors (extent of resection, laterality of approach, surgical technique) contribute to the risk of complications and indirectly influence the outcome. Extent of resection influences recurrence-free survival, without significant impact on overall survival. The type of surgery is associated with differences in survival, reflecting case selection and tumor features. The own prognostic score, based on integration of clinical, imaging and histological variables, has a good predictive capacity and allows efficient stratification of patients into risk categories. Integration of clinical, imaging and histological variables allows for a more precise assessment of prognosis and optimization of therapeutic management.

## 8. Conclusions and personal contributions

Original contributions in studying supratentorial intraventricular tumors in adults include analysis of a large group of patients in order to identify independent prognostic factors, allowing the outline of a unitary perspective on this pathology, characterized by histological heterogeneity, anatomical complexity and evolutionary variability. The thesis highlights the determining role of histological, imaging and surgical factors in the outcome of supratentorial intraventricular tumors.

Personal contributions also include development of a statistically validated prognostic score, with applicability in risk stratification and optimization of therapeutic management.

In conclusion, correlation of clinical, imaging, histological and surgical data allows a more precise assessment of prognosis and contributes to optimization of treatment, with a direct impact on patients' outcome.

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