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Research article

Navigating life following surgery - Quality of life in patients with supratentorial intraventricular brain tumors

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Abstract: Intraventricular tumors are rare lesions growing inside brain ventricles. The aim of this study was to assess the quality of life of patients operated for supratentorial intraventricular tumors and identify prognostic factors for postoperative outcome. We performed an observational retrospective study, including consecutive patients operated for supratentorial intraventricular tumors, from 2009 to 2024. We found 217 patients; there were 118 (54.4%) males and 99 (45.6%) females, with mean age 44 years. We achived gross total resectionin 73.7% of cases.Favorable postoperative outcome was seen in 79.7%.Morbidity was 29.5%, and mortality was 6.5%. Endoscopy had similar results compare to open surgery. Quality of life was influenced, in bivariate analysis, by preoperative mRS, intracranial hypertension, hydrocephalus, minimally invasive surgery, histological grade, and postoperative complications, but in multivariate logistic regression, only preoperative mRS (p=0.022), intracranial hypertension (p=0.001) and postoperative complications (p=0.000) remained independent predictors. Surgery is the treatment of choice in supratentorial intraventricular brain tumors. Endoscopy is a feasible alternative to open surgery, with similar postoperative results. Outcome is favorable in most patients and quality of life is significantly influenced by preoperative mRS, presence of intracranial hypertension and postoperative complications.

Keywords: brain ventricles; endoscopy; microsurgery; quality of life

1. Introduction

Intraventricular tumors represent a rare and diverse group of central nervous system neoplasms growing inside brain ventricles. Tumors can be either primary or secondary and may include a wide spectrum of histological types. Due to their deep-seated location and proximity to critical neuroanatomical structures, these tumors often present unique diagnostic and therapeutic challenges. Common symptoms include headache, nausea, visual disturbances, and cognitive decline, usually resulting from obstruction of cerebrospinal fluid (CSF) flow and increased intracranial hypertension (ICH).

Over the past decades, advances in neurosurgical techniques and neuro-oncology have improved patients' survival. However, survival statistics alone do not fully capture patient's experience. The impact of both tumor and its treatment on cognitive function, emotional well-being, and daily functioning can be profound—making quality of life (QoL) a critical component of patient care.[1, 2] QoL reflects more than just absence of disease; it encompasses a patient's physical comfort, mental health, ability to perform routine tasks, and maintain social connections.[2-4] For patients with intraventricular tumors, these aspects are often affected both before and after surgery, especially given the risk of complications, like memory loss, hydrocephalus, or neurological deficits.

Despite its importance, QoL in patients with supratentorial intraventricular brain tumors remains understudied. Most existing research focuses on high-grade gliomas[5-9] or more common brain tumor types[10, 11], leaving a gap in understanding the lived experiences of those with intraventricular tumors. More attention to this area could guide clinicians toward more patient-centered care strategies, tailored rehabilitation, and better long-term support.

Over the time many scoring systems tried to comprehend the complex concept of QoL. Functional scorings, such as Glasgow Outcome Scale (GOS), on one hand, and holis-tic systems, on the other hand, we used. GOS and holistic QoL measures are both valua-ble, but they serve different purposes, GOS assess better objective clinical outcome, count-ing whether patients can function independently, while holistic QoL measurements are essential for understanding the subjective experience of health and life satisfaction.

The aim of this study was to assess the quality of life of patients operated for supratentorial intraventricular tumors and identify prognostic factors for postoperative outcome.

2. Materials and Methods

We performed an observational retrospective study, including consecutive patients admitted and operated for supratentorial intraventricular tumors, over a period of time of 16 years, from January 2009 to December 2024. We excluded patients with intraventricular cysts, paraventricular tumors extending into the ventricular system, fourth ventricle tumors and patients who did not undergo surgery.

The study was approved by the hospital's ethic board. Statistical analysis was done using IBM SPSS®, version 20.0. Statistical significance was set to $p < 0.05$. All patients included in the study gave their informed consent to be part of medical research activity and the study was approved by the hospital ethic committee.

We reviewed medical records and collected data regarding demography, clinics, imaging, surgical technique, histology, and postoperative outcome. QoL was estimated using GOS. We favor GOS usage over other dedicated instruments be-cause is familiar to neurosurgeons, is simple and objective, focuses on functional status, is widely accepted and validated, correlates with broader QoL measures and is practical for longitudinal follow-up. Complications were defined as any adverse medical event, medi-cal or surgical, occurring in the first 30 days following surgery. Patients were followed, clinic and imaging, at 2, 6, 12 months, and after that annually.

3. Results

We found 217 consecutive patients with supratentorial intraventricular tumors operated in a single clinic, two departments. Patients' data are summarized in table 1. Tumor growth within the ventricular system is highlighted in figures 1 and 2.

Table 1. Univariate analysis of patients with supratentorial intraventricular tumors.

Parameter	No.	%
Sex		
M	118	54.4
F	99	45.6
Sudden onset	17	7.8
ICH	111	52.1
Hydrocephalus	138	63.6

Type of surgery				
Minimally invasive	49		22.6	
Open surgery	168		77.4	
Approach location				
Left-side approach	56		25.8	
Right-side approach	138		63.6	
Median approach	22		10.1	
Combined (left + right-side) approach	1		0.5	
Grade of resection				
GTR	160		73.7	
NTR	1		0.5	
STR	37		17.1	
Biopsy	19		8.8	
GOS				
5 GR	173		79.7	
4 MD	18		8.3	
3 SD	12		5.5	
1 D	14		6.5	
Histology WHO grade				
1	122		56.2	
2	43		19.8	
3	14		6.5	
4	38		17.5	
Complications	64		29.5	
	Median	**Stddeviation**	**Minimum**	**Maximum**
Age	44.09	15.711	13	74
Tumor volume	491.116	3414.504	0.0942	44745
Hospital stay	16.42	14.285	3	151

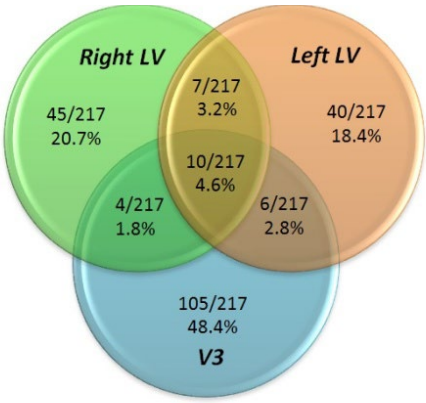
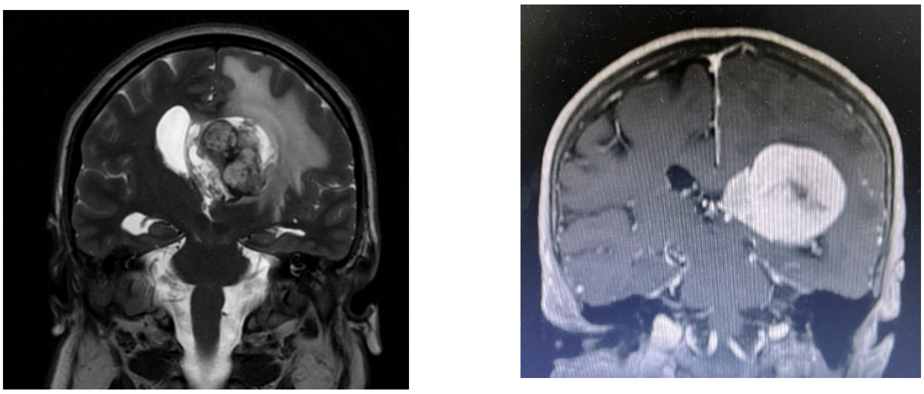


Figure 1. Tumor location within ventricular system.



(**a**) (**b**)

Figure 2. MRI images of supratentorial intraventricular tumors.(**a**) T2-weighted MRI, coronal section. Inhomogeneous tumor, located in the body of the left lateral ventricle, causing ventricular enlargement, midline shift and periventricular surrounding edema. (**b**) T1-weighted MRI, coronal section. Well defined tumor located in the atrium of the left ventricle, contrast enhancing, without mass effect.

Giving the fact that we considered an anatomical region as inclusion criteria, histology was complex, as shown in table 2. Histology was established according to 2021 WHO Classification of Tumors of the Central Nervous System.[12]

Table 2. Tumor histology.

Histology		**Grade**	**No.**	**%**
Circumscribed astrocytic gliomas	Pilocytic astrocytoma	1	5	2.3%
	SEGA	1	6	2.8%
Adult-type diffuse gliomas	Grade II astrocytoma	2	3	1.4%
	Anaplastic astrocytoma	3	2	0.9%
	Oligodendroglioma	2	1	0.5%
	Glioblastoma	4	1	0.5%
Ependymal tumors	Supratentorial grade II ependymoma	2	8	3.7%
	Supratentorial anaplastic ependymoma	3	6	2.8%
	Subependymoma	1	17	7.8%
Glioneuronal and neuronal tumors	Central neurocytoma	2	28	12.9%
	Anaplastic ganglioglioma	3	1	0.5%
Choroid plexus tumors	Choroid plexus papilloma	1	9	4.1%
Meningiomas	Meningioma	1	23	10.6%
Mesenchymal non-meningothelial tumors	Epitheliod hemagioendothelioma	3	1	0.5%
	Hemangiopericytoma	3	1	0.5%
	High grade sarcoma	4	1	0.5%
Germ cell tumors	Germinoma	4	11	5.1%
	Mixed cell tumor	4	1	0.5%
	Mature teratoma	1	1	0.5%
	Immature teratoma	3	1	0.5%
	Choriocarcinoma	4	1	0.5%
Pineal tumors	Pineocytoma	1	1	0.5%
CNS lymphomas	Lymphoma	4	7	3.2%
Tumors of the sellar region	Craniopharyngioma	1	9	4.1%
Metastases	Metastases	4	16	7.4%
Otherlow-grade tumors	Colloid cyst	1	52	24%
	Epidermoid cyst	1	1	0.5%
	Neurenteric cyst	1	1	0.5%
	Hamartoma	1	1	0.5%
	Xantogranuloma	1	6	1.4%

Ventricles can be accessed either minimally invasive endoscopically or transcranial. In 73.7% (160/217) of cases we were able to achieve complete resection. Grade of resection was defined as gross total resection (GTR) complete resection of the entire tumor as detected on postoperative contrast MRI, near total resection (NTR) resection of >90% of the tumor, subtotal resection (STR) and biopsy.

Outcome was evaluated using modified Rankin score (mRS), Karnofsky Performance Scale (KPS) and Glasgow Coma Scale (GCS) before and after surgery. We applied Wilcoxon signed-rank tests and we found that patients improved after surgery when considering mRS (Z= -7.383, p=0.000)and KPS (Z= -6.901, p=0.000), but we found no statistical difference when it came to GCS (Z= -1.784, p= 0.074).

Postoperative outcome was also evaluated using GOS. Postoperative outcome was favorable in most cases, 79.7% (173/217) patients having good recovery and 8.3% (18/217) moderate disability. Poor outcome was found in rest, 5.5% (12/217) being severely disabled and 6.5% (14/217) perished. Morbidity rate was 29.5%.We found that GOS was influenced by preoperative mRS, ICH, hydrocephalus, minimally invasive surgery, histopathological grade, postoperative complications in bivariate analysis. After logistic regression only preoperative mRS, ICH and postoperative complications statistically influenced outcome (table 3). Follow-up period varied from 3 to 192 months.

Table 3. Statistical analysis of patients with supratentorial intraventricular tumors.

Factors	**Bivariate analysis**		**Multivariate analysis**[§]		
	Test value	***p* value**	***OR Exp(B)***	***95% CI***	***p* value**
Age	ϱ = -0.048*	0.478	1.003	[0.97-1.04]	0.841
Sex	Z = -0.326†	0.744	0.945	[0.31-2.82]	0.919
mRS preop.	X^2 = 19.296‡	0.002	1.086	[1.01-1.16]	0.022
ICH	Z = -3,215†	0.001	0.133	[0.04-0.44]	0.001
Sudden onset	Z = 0,787†	0.431	1.800	[0.346-9.35]	0.485
Hydrocephalus	Z = -2,538†	0.011	0.407	[0.09-1.70]	0.218
Tumor volume	ϱ = -0.403*	0.000	1.000	[0.99-1.00]	0.213
Minimally invasive vs. open surgery	Z = -3.284†	0,001	4.004	[0-inf]	0.998
Surgical approach	X^2 = 7.552‡	0.056	6.435	[0.69-59.84]	0.089
Grade of resection	X^2 = 2.718‡	0.437	0.934	[0.09-8.88]	0.953
Histology	ϱ = -0,171*	0.012	0.951	[0.55-1.64]	0.858
Complications	Z = -10.356†	0,000	0.009	[0.00-0.08]	0.000

Tests used to perform statistical analysis: * Spearman correlation, ϱ = Spearman's correlation coefficient; † Mann-Whitney U test, ‡ Kruskal-Wallis test, § Multinominal logistic regression

4. Discussion

Ventricular tumors may arise from the septum pellucidum, ventricle walls, choroid plexus, arachnoid cells and periventricular structures. Giving the fact that we took into account a brain region, histology is complex.[13] In our study, colloid cysts were the most common tumors, being found in 24% of patients, followed by central neurocytomas 12.9%, meningiomas in 10.6%, subependymomas 7,8% and metastases 7,4%. Elwatidy et al. also found colloid cysts as most common intraventricular tumor, followed by pineal tumors, central neurocytoma and pilocytic astrocytoma.[14] High frequency of colloid cysts was also reported by Milligan et al., followed by pilocytic astrocytomasandmeningiomas.[15]

Also, histology varies with age. Pineal region tumors, ependymomas, pilocytic astrocytomas, choroid plexus tumors are found in pediatric patients, whereas colloid cysts, meningiomas, central neurocytomas, high grade gliomas and metastases are seen in adults.[14, 16, 17] We only studied adults with a median age 44 years. In our study sex distribution was even, fact also confirmed by literature[16].

Symptoms are caused by ICH and tumor location. Symptoms secondary to ICH usually occur early and are very prominent. Classic clinical presentation of ICH is headache, vomiting and papilledema. We found ICH in 52.1% of patients. Arseni et al. reported presence of ICH in 60-80% of cases.[18, 19] Headache is a prodromal symptom in both children and adults.[14] It is nonspecific, diffuse, and slowly progressive with intermittent sudden worsening. These episodes are caused by blockage of CSF flow by tumor, progressive upstream CSF accumulation and ventricle expansion. Due to change in ventricle shape and upstream CSF high pressure, new pathways around the tumors occur, with ventricle emptying and headache relief. Vomiting is concordant with headache. Bilateral papilledema or optic atrophy is found in 66-80% of cases.[18, 19] The pathophysiological mechanisms incriminated in its occurrence are either disruption of the axoplasmic flow by transmission of increased intracranial pressure to the optic papilla/discus through the subarachnoid space along the optic nerve, or equalization of the pressure from the central vein of retina and intracranial pressure at the point of passage of the vein into the subarachnoid space, located 1 cm posterior to the eyeball.[20] Once optic atrophy arises, headache vanishes. We found secondary hydrocephalus in 63.6% of patients. Sudden onset was seen in 7.8%. Sudden onset was caused by acute hydrocephalus or intratumoral bleeding. Sudden death was also reported in the literature.[21]

Tumor volume was connected with location inside the ventricular system. Tumors located near narrow CSF pathways became symptomatic at smaller volumes. Tumors growing inside body, atrium or horns of the lateral ventricles have larger volumes, than tumors arising from the third ventricle or foramen of Monro, because they have space to expand. Median tumor volume in our group of patients was 491.116cm^3, but we encountered a wide range of sizes, from very small to giant tumors.

Surgery is treatment of choice, most patients in our study having good recovery and moderate disability after surgery. We used scales like, mRS[22-24] and KPS[25] to forecast outcome. We found high statistical significance of preop/postop comparison of mRS and KPS. Lack of statistical significance for preop/postop GCS may occur because this scale has low specificity for brain tumors, being a scale dedicated to traumatic brain injury. Morbidity and mortality are high, in our study they were 29.5% and 6.5% respectively. Similar fatalities and complications rates were reported by other authors.[26]

Accessing the ventricular system is a demanding, high risks surgery and carries many technical challenges. Brain ventricles have deep location and are surrounded by vital structures. The goal of surgery is tumor resections without or with minimal complications. There is no consensus regarding the best approach, each approach must be tailored according to radiological appearance, tumor location, presence of hydrocephalus, histology, age, comorbidities. We excluded patients with fourth ventricle tumors from our study, because posterior fossa pathology requires completely different approaches, compared with supratentorial ventricles lesions.

Microsurgical approaches can be divided into lateral or midline approaches. Tumors originating in the frontal horn and body of the lateral ventricle can be accessed frontal transcortical (transgiral through F2 girus or transsucal through superior frontal sulcus) or interhemispheric anterior transcallosal. Numerous approaches were reported for tumors growing from the atrium.[16, 27] Surgery of ventricular carrefour is demanding, because of vicinity of optic radiations, which run from on the lateral walls of the temporal horn, trigone, and occipital horn. Parietal transcortical routes (transgiral through P1, transsulcal through interparietal sulcus or through parieto-occipital sulcus) may injure optic radiations. On the contrary, medial wall of the atrium is entirely free of the optic radiations[28], so midline interhemispheric approaches, such as posterior transcallosal, ipsilateral transprecuneus[27], transfalcine transcuneus[27], interhemispheric parieto-occipital through gyrus cinguli[29], contralateral interhemispheric trans falcinetranscingular infra-precuneus[30] seem more logic. Other approaches reported suitable to reach the trigone are transsylvian, posterior transtemporal, subtemporal[29]. Transcortical temporal approaches (through T2 or T1) to the temporal horn, even if direct and easy, have the huge disadvantage that they cross the optic radiations. So, in order to avoid Mayer loop, transsylvian[31] and trans fusiform gyrus[32] approaches were described.

Although small, third ventricle surgery is tailored differently according to tumor location in the anterior or posterior part. Surgical approaches to the anterior part of the third ventricle aresubfrontal trans lamina terminalis, pterional transsylvian, anterior interhemispheric transcallosal (interforniceal of transventricular transforaminal, transventricular transchoroidal) and transcortical transventricular transforaminal. Posterior part can be reached posterior interhemispheric transcallosal (trans velum interpositum or transventricular transchoroidal), occipital transtentorial, and infratentorial supracerebellar.[17, 27]

Each and every type of surgery carries technical challenges and possible complications. In our institution, we preferred transcortical approaches, mostly due to surgeons' preferences. Main advantages of transcortical approaches are represented by direct route to the lateral ventricle and short and wide surgical corridor. But transcortical approaches are also associated with higher risks of developing postoperative seizures, porencephalic cysts, damage of optic radiations leading to homonymous hemianopsia, hemiparesis, or speech disturbances. Transcallosal approaches are more demanding when it comes to dissection, provide a long and narrow surgical corridor, but can be used even in people without hydrocephalus. Complications can be devastating. Accidental intraoperative injury of pericallosal arteries leads to secondary ischemia, bridging veins rupture may cause edema or venous hemorrhagic stroke, division of both fornicesis followed by severe memory loss and akinetic mutism. Following posterior callosotomy, patients may develop disconnection syndrome, characterized by left-hand tactile anomia, left side apraxia mimicking left hemiparesis, pseudohemianopsia, right side anosmia for smell, impaired spatial syntheses of the right hand with inability to copy complex drawings, low spontaneity of speech and incontinence.[33]

In the past years, endoscopy has emerged as an alternative to open surgery. Particular anatomy of the ventricular system makes it proper candidate for endoscopy. Today's endoscopes are versatile; there are rigid, flexible and angled endoscopes, which helps see around the corner and provide increased maneuverability. Although some studies advocate that minimally invasive surgery has better outcome[34-36], we found no difference between endoscopic and open surgery. Endoscopy is minimally invasive procedure that allows access to deep brain structures. Advantages of endoscopy are limited invasivity, single burr hole approach, limited damage to brain tissue, thus lowering hospital stay and fasten recovery. Disadvantages are limited working space, small instruments, longer operation time, limited use of coagulation, poor visualization in case of bleeding, impossibility of control heavy bleeding. Heavy bleeding may require conversion to open surgery. But although recovery is faster, grade of resection is lower compare with microsurgery.[37-39]

In our study we had more patients who underwent microsurgery and they were equally distributed across the whole period of time. Endoscopy was used mostly in the last period of the study. Microsurgery was preferred because it is familiar to all neurosurgeons, provides better visualization and larger surgical field. Choosing the best approach must be tailored according to tumor location, size, consistency, and surgeon's preference.

While treatment options such as surgical resection, endoscopic approaches, radiotherapy, or chemotherapy have advanced in recent years, the potential risks associated with these interventions, including neurological deficits, memory disturbances, and endocrine dysfunction, highlight the importance of evaluating outcomes beyond survival. In this context, assessing QoL has become increasingly relevant in both clinical practice and research. QoL is an indicator of patients' well-being and an important predictor of rehabilitation. In the last decades many clinical studies and researches focus on assessment of QoL. We quantified QoL using GOS. GOS assesses functional outcome and focuses on survival, independence and recovery level, opposite to holistic QoL measures, which focuses on overall well-being, life satisfac-tion and emotional health. GOS is practical, and is more appropriate in a neurosurgical department where patients have a limited hospital stay. We preferred GOS, instead of simple dichotomic variable (favorable versus unfavorable), because GOS stratifies patients in more categories.

QoL following surgery for supratentorial intraventricular brain tumors may be influenced by several factors such as: histology, tumor location, extent of surgery, age, comorbidities. As a first step we took several parameters, in order to see how they influenced postoperative results in a bivariate analysis. In such manner, we found preoperative mRS, ICH, hydrocephalus, type of surgery (minimally invasive surgery vs. open surgery), histopathological grade, postoperative complications being associated with poor outcome. But, in the second step, we went further to verify the statistical significance in a more complex model, using logistic regression. This narrowed the possibilities, and only preoperative mRS, ICH and postoperative complications remained prognostic factors for outcome. Parameters like age, sex, onset of symptoms, tumor volume, surgical approach and grade of resection have no impact on postoperative course.

Preoperative mRS is a strong predictor of outcome following surgery, so it is warrant to operate patients in good shape. Taking into account patients from the last two categories of GOS, 6 patients out of 12 with postoperative severe disability have preoperative mRS 3 and 4 and 12 patients out of 14 who died following surgery, had preoperative mRS3 and 4. ICH occurs in late stages of the disease and worsens prognosis. Complications are significantly associated with bad outcome and poor QoL. All efforts must be made in order to minimize complications.

Although histology, on bivariate analysis, seems to influence the QoL, multivariate analysis failed to find any correlation between them. Significance loss was caused by confounding and mediation of other variables included in the model.. Histology, though, has impact on survival, so prognosis is better in patients with lower grade tumors. Tumor volume alone was not associated with low GOS score, because surgical challenges are complex, and depend upon multiple tumor characteristics (location, consistency, vascularization, etc.).

Regarding type of surgery (minimally invasive vs. open surgery) we found that patients belonging to the first category have significant higher GOS scores compare with open surgery, in a bivariate analysis, but not in a multivariate one. Endoscopy offers a faster recovery and a short hospital stay, but in order to verify whether it is associated with better prognosis as an independent prognostic factor, more cases operated minimally invasive must be included. The two cohorts in our study differed substantially in size (49 vs. 168 patients), which introduces a risk of selection bias and limits the comparability of outcomes. This disparity may reflect differences in patient referral patterns, data availability, or selection criteria. Although descriptive statistics were used to compare baseline characteristics, the smaller sample size in one group may reduce statistical power and increase susceptibility to variability. As such, results should be interpreted with caution, and future studies with more balanced groups are needed to validate these findings.

Left side approaches were used when tumors were located in the left lateral ventricle or in left-handed patients with third ventricle tumors. We preferred right side approaches in people with midline tumors, in order to avoid the dominant hemisphere. Achieving GTR did not ensure a good outcome, because in many situations complete resections carries more surgical risks, STR being milder and with less complications. We consider that if you are not able to perform GTR safely it is best to leave some tumor in place thus lowering morbidity.

Measuring QoL provides a more holistic understanding of the impact of the disease and interventions, guiding shared decision-making and personalized care plans. To the best of our knowledge, this is the largest study regarding QoL in patients operated for supratentoral intraventricular tumors.

Strengths of this study are large cohort over a long period of time and long follow-up. Limits of this study are retrospective analysis and usage of a functional, non-dedicated scale. Future research on prospective trails using dedicated instruments are needed to bet-ter understand the impact of QoL following surgery for intraventricular tumors.

5. Conclusions

Histology of ventricular tumors is complex, but grade I WHO lesions are predominant. Surgery is the treatment of choice in supratentorial intraventricular brain tumors. Surgery is challenging and risky, with high rates of morbidity and mortality. Endoscopy is a feasible alternative to open surgery, with similar postoperative results. Choosing the best approach must be tailored according to tumor location, size, consistency, and surgeon's preference. Gross total resection can be achieved in most cases. Outcome after surgery is favorable in the majority of patients and quality of life is significantly influenced by preoperative mRS, presence of intracranial hyperpressure and postoperative complications. Quality of life is an important parameter for assessment of postoperative outcome of patients with intraventricular tumors. In spite of its limitations, retrospective design and usage of a Glasgow Outcome Scale, the present study comes to fill the gap in the literature regarding quality of life in patients with supratentorial brain tumors. In spite of its limitations, retrospective design and usage of a Glasgow Outcome Scale, the present study comes to fill the gap in the literature regarding quality of life in patients with supratentorial brain tumors. Further research, prospective trails, using dedicated quality of life instruments are needed..

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