The Egyptian Journal of Hospital Medicine (October 2024) Vol. 97, Page 4588-4592

Relation between Resection Extent and Intraoperative Hemorrhage and External Ventricular Drain Insertion in Lateral Ventricular Tumors

Moataz Abdel Wahab Sayed Mohammed[1]*, Esam Abdel Rahman Elkhatib[2], Khaled Elsayed Mohamed[2], Sherif H Ali[2], Ahmed Mohammed Abdelmonem[2]

[1]Neurosurgery Department, Nasser Institute Hospital for Research and Treatment, Cairo, Egypt

[2]Neurosurgery Department, Faculty of Medicine, Suez Canal University, Egypt

***Corresponding author:** Moataz Abdel Wahab Mohammed, **Email:** Mo3taz_abdelwahab@hotmail.com, **Phone:** +201098291239

ABSTRACT

Background: Lateral ventricular tumors are rare, deep-seated lesions often surrounded by vital neurovascular structures, making surgical resection challenging. The extent of resection significantly impacts intraoperative events such as hemorrhage and the need for external ventricular drain (EVD) placement. **Objective:** To evaluate the relation between the extent of tumor resection and intraoperative hemorrhage and EVD insertion in lateral ventricular tumors.

Patients and Methods: This retrospective study was conducted on 45 patients with lateral ventricular tumors treated surgically at Suez Canal University Hospitals and Nasser Institute Hospital. Resection extent (total, sub-total, or biopsy) was related with intraoperative hemorrhage and EVD placement.

Results: Total resection was achieved in 48.9%, sub-total resection in 31.1%, and biopsy in 20% of cases. Intraoperative hemorrhage occurred significantly more in total resections (36.4%) compared to sub-total resections and biopsies (0%, p=0.006). EVD insertion was significantly higher in total (72.7%) and sub-total resections (78.6%) compared to biopsies (22.2%, p=0.012). At surgery, Karnofsky Performance Scale (KPS) scores were significantly higher in total and sub-total resections (median 90, p=0.008) but showed no significant difference postoperatively (p=0.218).

Conclusion: The extent of tumor resection relates with increased intraoperative hemorrhage and EVD insertion, highlighting the importance of careful surgical planning to balance resection extent and complication risks.

Keywords: Lateral Ventricular Tumors, Tumor Resection, Intraoperative Hemorrhage, External Ventricular Drain, Neurosurgical Outcomes.

INTRODUCTION

The lateral ventricle (LV) system is a complex anatomical structure divided into the body, atrium, and horns (frontal, temporal, and occipital). Tumors of the LV, comprising both primary and secondary types, represent between 0.8% and 1.6% of all brain tumors. Primary tumors originate within the ventricle, while secondary tumors extend into the ventricular cavity from surrounding structures. Due to their deep-seated location, these tumors often grow significantly before causing symptoms such as headaches, visual disturbances, or signs of obstructive hydrocephalus. This delay in symptomatology is commonly due to the benign and slow-growing nature of many ventricular tumors [1, 2]. Please divide the paragraph into 2 paragraphs with one reference for each of them.

The surgical management of lateral ventricular tumors remains challenging because of their deep location and the frequent involvement of vital neurovascular structures. The primary aim of surgery is complete tumor resection, while minimizing complications such as intraoperative hemorrhage or cerebrospinal fluid (CSF) obstruction, which often necessitates the insertion of an external ventricular drain (EVD). Achieving this balance requires careful preoperative planning, informed by the tumor's size, location, histopathology, and the patient's overall condition [3, 4]. Among the available surgical approaches, the choice of transcortical or transcallosal techniques depends on the tumor's location and the surgeon's preference. The extent of tumor resection, whether total, sub-total, or biopsy, significantly impacts intraoperative events like hemorrhage and postoperative needs such as EVD placement. Understanding these correlations can aid in optimizing surgical planning and improving patient outcomes [5-7].

AIMS OF THE STUDY

This study aims to evaluate the relation between the extent of tumor resection and the occurrence of intraoperative hemorrhage and EVD insertion in patients undergoing surgical management of lateral ventricular tumors.

PATIENTS AND METHODS

Study Design and Participants:

This retrospective study reviewed prospectively collected data of 45 patients with lateral ventricular tumors who underwent surgical treatment at the Neurosurgery Departments of Suez Canal University Hospitals and Nasser Institute Hospital.

Inclusion and Exclusion Criteria:

Inclusion criteria were patients with lateral ventricular tumors who underwent surgical resection and medically competent patients. While patients with general contraindications for surgery and refused to participate were excluded.

METHODS

Preoperative Assessment:

This included a detailed history, general and neurological examinations, and radiological imaging. Neurological assessment focused on cranial nerves, motor power using the Frankel grading system and reflexes. Imaging studies included pre- and post-contrast

Received: 24/07/2024
Accepted: 24/09/2024

brain magnetic resonance imaging (MRI) and computed tomography (CT).

Surgical Procedure:

Surgical resections were performed via either the transcortical or transcallosal approaches. Standard microneurosurgical techniques were employed, with tumors resected in bloc or piecemeal. External ventricular drains (EVDs) were inserted intraoperatively when required, particularly in cases of significant intraoperative hemorrhage or CSF obstruction.

1. Anterior (Frontal) Transcortical Approach

The anterior transcortical approach targets lesions in the frontal horn, lateral ventricle, and third ventricle, using patient positioning and cranial entry techniques tailored to minimize brain tissue disruption and optimize surgical access. Variations include unifrontal or bifrontal incisions and careful management of the dura and cerebrospinal fluid to facilitate safe access. The posterior transcortical approach, employed for regions behind the postcentral gyrus, necessitates patient positioning that protects critical speech and visual areas, with surgical entry above the ventricular junctions guided by landmarks like the choroid plexus. The intraparietal sulcus approach leverages specific positioning and incisions to navigate the atrium through this sulcus, while temporal approaches (transcortical and trans-sulcal) involve strategic navigation through or between temporal gyri to reach the ventricular system, focusing on preserving vital vascular structures. Each technique is adapted based on the lesion location and involves meticulous planning to avoid critical structures and optimize surgical outcomes.

2. Anterior Interhemispheric Transcallosal Approach

Surgical approach for resecting brain tumors involves two main patient positions: supine with the head vertical and semi-lateral with the head horizontal, enhancing visibility along the corpus callosum. Various techniques were used, including curved or horseshoe-shaped scalp incisions, and sometimes lumbar drains to facilitate access by causing cortical collapse. Craniotomy was tailored around the coronal suture to protect motor areas, and durotomy aimed to preserve vascular integrity. Cotton balls were used in place of retractors to minimize brain compression, supporting brain structures during surgery. Dissection proceeded along the falx cerebri, navigating around critical arteries and the corpus callosum, with incisions carefully placed to avoid functional areas and facilitate access to the ventricles. Various methods were employed to access the third ventricle when necessary, emphasizing minimal disruption to surrounding structures.

Intraoperative Monitoring and Management:

General anaesthesia with balanced anaesthetic techniques was used. Also, prophylactic antibiotics, corticosteroids, and anticonvulsants were administered. Intracranial pressure was managed with mild hyperventilation and intravenous mannitol.

Outcomes and Assessments:

The primary outcomes included the relation between the extent of tumor resection (total, sub-total, or biopsy) and occurrence of intraoperative haemorrhage and also between the extent of tumor resection and intraoperative placement and duration of EVD usage. Postoperative evaluation involved CT or MR imaging to monitor for tumor recurrence and assess brain condition. Patients' Karnofsky Performance Scale[(Ref)] (KPS) scores were evaluated 30 days post-surgery and compared with preoperative scores.

Ethical considerations:

The study was done after being accepted by the Research Ethics Committee, Suez Canal University. All patients provided written informed consents prior to their enrolment. The consent form explicitly outlined their agreement to participate in the study and for the publication of data, ensuring protection of their confidentiality and privacy. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Data Management:

Data management and statistical analysis were done using SPSS version 26 (IBM, Armonk, New York, United States). Categorical variables were compared using chi-square test, and continuous variables were analysed using t-tests or nonparametric; equivalents nonparametric equivalents (Kruskal-Willis test). A p-value of <0.05 was considered statistically significant.

RESULTS

This study provides the frequency distribution of clinical and neuroimaging characteristics for 45 patients who underwent surgical operations for resection of lateral ventricle tumors. The study included 23 males (51.1%) and 22 females (48.9%), with a mean age of 34.62±14.25years (range from 2 to 68 years). Many patients showed some symptoms where headache was evident in 84.4% of patients, visual disturbance in 35.6%, fits in 28.9%, motor weakness in 11.1%, and urinary incontinence in 2.2% of patients. At the time of diagnosis, 93.3% of the patients were fully conscious, whereas 6.7% had altered mental status. Besides, the median preoperative Karnofsky scale[(Ref)] (KPS) score was 90 with range of 70-90. Concerning the description of resection extent in the studied patients, it was total resection in 22 (48.9%) patients, sub-total resection in 14 (31.1%) patients, and biopsy in 9 (20%) patients (Table **1** and Figure **1**).

Table (1): Distribution of resection extent in all studied patients

		Studied patients (n=45)	
Resection extent	**Total**	22	48.9%
	Sub-total	14	31.1%
	Biopsy	9	20%

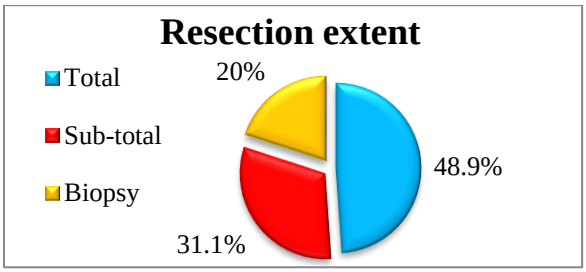

Figure (1): Distribution of resection extent in all studied patients.

There was a statistically significant increased percentage of intraoperative hemorrhage in patients with total resection (8 patients, 36.4%) when compared with patients with sub-total resection (0 patients, 0%), and patients with biopsy (0 patients, 0%) (p-value=0.006). Also, there was a statistically significant increased percentage of EVD in patients with total resection (16 patients, 72.7%) and patients with sub-total resection (11 patients, 78.6%) when compared with patients of biopsy (2 patients, 22.2%) (p-value=0.012) (Table **2** and Figure **2**).

Table (2): Relation between resection extent and intraoperative hemorrhage and external ventricular drain (EVD) in studied patients

		Resection extent						X^2	P-value
		Total (n=22)		Sub-total (n=14)		Biopsy (n=9)			
Intraoperative Hemorrhage	**No**	14	63.6%	14	100%	9	100%	**10.2**	**0.006***
	Yes	8	36.4%	0	0%	0	0%		
EVD	**No**	6	27.3%	3	21.4%	7	77.8%	**8.88**	**0.012***
	Yes	16	72.7%	11	78.6%	2	22.2%		

X^2: Chi-square test, *: Significant (p-value < 0.05).

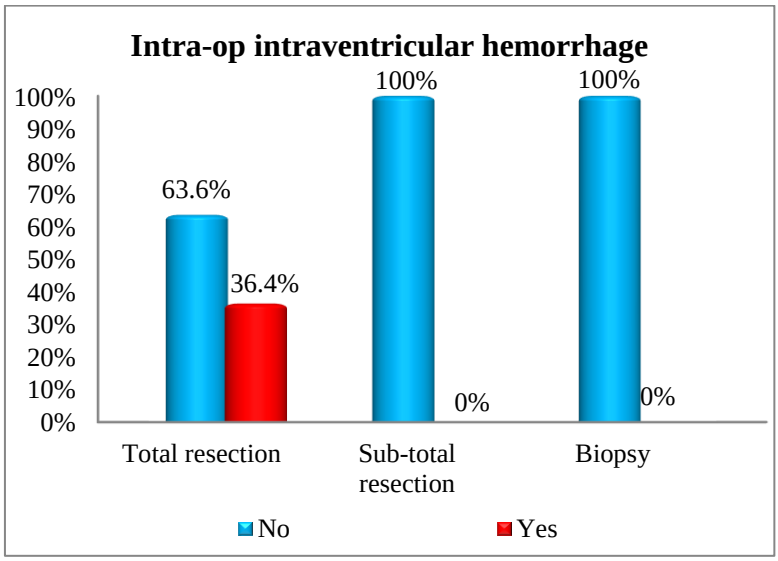

Figure (2): relation between resection extent and intraoperative hemorrhage in studied patients.

There was a statistically significant difference of KPS at surgery as regard resection extent. In patients with total resection, median KPS was 90 with IQR of 80 -90, in patients with sub-resection, median KPS was 90 with IQR of 80 -90 while in patients with biopsy, median KPS was 80 with IQR of 75 -80 (p-value=0.008). While, no statistically significant relation was found between resection extent and post-operative KPS (p-value=0.218) (Table **3**).

Table 3: Relation between resection extent and KPS in studied patients

		Resection extent			Stat. test	P-value
		Total (n=22)	Sub-total (n=14)	Biopsy (n=9)		
KPS (at surgery)	**Median**	90	90	80	**KW=9.7**	**0.008***
	IQR	80 – 90	80 - 90	75 – 80		
KPS (post-op)	**Median**	90	80	80	KW=3.04	0.218**
	IQR	80 – 90	77.5 - 90	80 – 85		

*: Significant (p-value < 0.05), **: Insignificant (p-value < 0.05), **KW:** Kruskal Willis test.

DISCUSSION

Lateral ventricular tumors pose unique surgical challenges due to their deep-seated location and proximity to critical neurovascular structures. Achieving optimal outcomes requires balancing maximal tumor resection with minimal complications, such as intraoperative hemorrhage and cerebrospinal fluid obstruction. The choice of surgical approach and resection extent is pivotal in determining intraoperative events and postoperative recovery, making it essential to explore these correlations to guide surgical strategies and improve patient outcomes [(8)]. So, we aim to evaluate the correlation between the extent of tumor resection and the occurrence of intraoperative hemorrhage and EVD insertion in patients undergoing surgical management of lateral ventricular tumors.

In our study, total resection was 22 (48.9%) patients, sub-total resection 14 (31.1%) patients, and biopsy 9 (20%) patients. While, **Elkallaf *et al.*** [(7)] found that excisions were gross-total (n=19) and near-total (n=1). In the study of **Aftahy *et al.*** [(9)], gross-total resection was achieved in 93.3% (42/45). Also, **D'Angelo *et al.*** [(10)] study revealed that total-resection was performed in 82% of patients. Clinically, complete tumor resection is our surgical goal. However, some tumors are difficult to completely resect because of their rich blood supply, non-clearly distinct boundaries, or tightly adhesive with normal brain tissue. To protect normal brain tissue and blood vessels, and to prevent severe postoperative intracranial edema and intracranial hypertension [(Ref)].

In the current study, we detected that there was statistically significant (p-value =0.006) increased percentage of intraoperative hemorrhage in patients with total resection when compared with patients with sub-total resection and patients with biopsy. This could be explained by that gross-total resection is considered dangerous and has been associated with high mortality and morbidity in many cases, especially when the lesion is related to critical and vital neurovascular structures [(9)]. In addition, there was a statistically significant (p-value=0.012) increased percentage of EVD in patients with total resection and patients with sub-total resection when compared with patients of biopsy. This was similar to the study of **Zhang *et al.*** [(11)] who included 97 patients who underwent resection of LV tumors, detected that univariate analysis showed that total and sub-total resection (p=0.003 for both) were predictive factors for EVD. Regarding relation between resection extent and complications, there was no statistically significant relation between resection extent and complications. Similarly, **Stendel** [(12)] reported no significant differences between complete and incomplete resection as regard postoperative complications.

Regarding relation between resection extent and KPS**,** we detected statistically significant difference (p-value=0.008) of KPS at surgery as regard resection extent. In patients with total resection, median KPS was 90 with IQR of 80-90, in patients with sub-resection, median KPS was 90 with IQR of 80-90, while in patients with biopsy, median KPS was 80 with IQR of 75-80. However, post-operative KPS showed no statistically significant relation with resection extent. While, the study done by **Stendel** [(12)] on two hundred forty-three patients with glioblastoma multiforme. Patients with complete and incomplete resections as revealed by early MRI scans were compared. In this study, KPS at surgery showed no significant difference between patient with complete resection and patients with incomplete resection. These differences could be explained by different sample size and different type of tumors included as they include glioblastoma only, while we included many types of tumors (benign and malignant).

The study limitations include the relatively small sample size, in addition to the relatively short follow-up period. The absolute number of cases does not allow for proper statistical analysis. Unlike the transcortical approach, the patients who underwent the transcallosal approach were few and therefore making a direct comparison between these 2 approaches in regard to the outcome problematic.

CONCLUSION

The extent of resection in lateral ventricular tumors significantly influences intraoperative outcomes. Total resection is associated with a higher risk of intraoperative hemorrhage and a greater need for EVD insertion, reflecting the complexity of achieving complete tumor removal in these anatomically challenging lesions. These findings emphasize the necessity of meticulous preoperative planning and intraoperative management to optimize surgical outcomes while minimizing complications.

- **Financial support and sponsorship: Nil**.
- **Conflict of Interest: Nil**.
- **Competing interests: Nil**.

REFERENCES

1. **Seçer H, Düz B, Izci Y *et al.* (2008)**: Tumors of the lateral ventricle: the factors that affected the preference of the surgical approach in 46 patiens. Turk Neurosurg., s18:345-55.
2. **Cikla U, Swanson K, Tumturk A *et al.* (2016)**: Microsurgical resection of tumors of the lateral and third ventricles: operative corridors for difficult-to-reach lesions. J Neurooncol., 130:331-40.
3. **Elwatidy S, Albakr A, Al Towim A *et al.* (2017)**: Tumors of the lateral and third ventricle: surgical management and outcome analysis in 42 cases. Neurosciences (Riyadh), 22:274-81.
4. **Deopujari C, Karmarkar V, Shaikh S *et al.* (2021)**: Neuroendoscopy in the Surgical Management of Lateral and Third Ventricular Tumors: Looking Beyond Microneurosurgery. Neurol India, 69:1571-8.
5. **Ellenbogen R (2001)**: Transcortical surgery for lateral ventricular tumors. Neurosurg Focus, 10:E2.

6. **Hoz S, Ismail M, Palmisciano P *et al.* (2024)**: Cortical incisions and transcortical approaches for intra-axial and intraventricular lesions: A scoping review. Surg Neurol Int., 15:82.
7. **Elkallaf M, Elsaadany W, Moussa W *et al.* (2021)**: Transcortical approaches to large intraventricular tumors: a prospective case series of 20 patients. Egypt J Neurosurg., 36:1-11.
8. **Ahmed M, Nadeem M, Shahzad U *et al.* (2024)**: A comprehensive approach to lateral ventricular tumor resection: techniques, technologies, and outcomes. Neurosurg Rev., 47:489.
9. **Aftahy A, Barz M, Krauss P *et al.* (2020)**: Intraventricular neuroepithelial tumors: surgical outcome, technical considerations and review of literature. BMC cancer, 20:1-14.
10. **D'Angelo V, Galarza M, Catapano D *et al.* (2008)**: Lateral ventricle tumors: surgical strategies according to tumor origin and development—a series of 72 cases. Neurosurgery, 62:SHC1066-SHC75.
11. **Zhang C, Ge L, Li Z *et al.* (2022)**: Single-center retrospective analysis of risk factors for hydrocephalus after lateral ventricular tumor resection. Front Surg., 9:886472.
12. **Stendel R (2009)**: Extent of resection and survival in glioblastoma multiforme: identification of and adjustment for bias. Neurosurgery, 64:E1206.