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2025 Volume 10, Issue 4
Journal of Medicines Development Sciences
ISSN: 2382-6371(Online) ISSN: 2382-6363(Print)

Risk Factors and Prognostic Analysis of Postoperative Entrapped Temporal Horn (ETH) Following Tumor Resection in the Trigone of the Lateral Ventricle

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Abstract: *Objective:* This study aims to investigate the independent risk factors for postoperative entrapped temporal horn (ETH) following surgery for trigone zone tumors of the lateral ventricle and its impact on patients' short-term and long-term outcomes, thereby providing scientific evidence for early clinical diagnosis and intervention. *Methods:* A multicenter retrospective analysis was conducted on 68 patients who underwent surgery for trigone zone tumors of the lateral ventricle between January 2011 and December 2021 and met the inclusion and exclusion criteria. Pre- and postoperative clinical and imaging data were collected. Univariate and multivariate logistic regression analyses were performed to assess the association between surgical factors and the occurrence of ETH, and the impact of ETH on patients' neurological outcomes was evaluated. *Results:* The incidence of ETH in this study was 18.5%. Multivariate logistic regression analysis showed that tumor diameter ≥3.2 cm (P=0.001), tumor location in the trigone (P=0.021), postoperative meningitis (P=0.006), and tumor hemorrhage (P=0.002) were independent risk factors for ETH. Radiologically, ETH patients exhibited isolated temporal horn dilation shortly after surgery, with significantly more severe neurological deficits (such as contralateral homonymous hemianopia, memory and emotional disorders) and a significantly higher rate of reoperation. Additionally, patients who did not receive external ventricular drainage postoperatively had a higher risk of developing ETH (P=0.012). *Conclusion:* The occurrence of ETH is closely associated with tumor location, size, surgical procedure, and postoperative complications, significantly affecting patients' postoperative neurological outcomes. Clinically, screening high-risk patients, enhancing perioperative monitoring of the ventricular system, and improving postoperative inflammation management are crucial steps that may help reduce ETH incidence and improve outcomes. Future studies should focus on multicenter prospective cohort studies and long-term follow-up to further validate risk factors and evaluate the effectiveness of various interventions.

Keywords: Isolated temporal horn syndrome Tumor in the trigone area of the lateral ventricle Risk factors; Logistic regression analysis Postoperative complications

Online publication: December 26, 2025

1. Introduction

The atrium of the lateral ventricle, near the optic radiation, hippocampus, fornix, and deep venous system, is prone to tumors like meningiomas and ependymomas. Surgical resection may lead to obstructive hydrocephalus, with 5%–15% developing "postoperative isolated temporal horn syndrome" (ETH), characterized by unilateral temporal horn dilation, homonymous hemianopia, memory deficits, and emotional changes. ETH is primarily attributed to gliotic obstruction at the temporal horn outlet, though choroid plexus imbalance or venous impairment may contribute [1-3]. Early imaging may be misinterpreted as postoperative normality, delaying intervention and risking irreversible deficits, often necessitating shunting or endoscopic third ventriculostomy[4-6]. Current evidence is limited to small retrospective studies, lacking data on ETH after atrial tumor surgery [6-8]. This multicenter retrospective study included 68 patients with histologically confirmed atrial tumors and ≥1 year follow-up (2011–2021), aiming to identify ETH risk factors and assess its impact on visual, cognitive, and emotional functions to guide clinical management.

2. Materials and methods

2.1. Study subjects

This study is a retrospective, multicenter cohort study aiming to analyze the incidence, clinical characteristics, and prognosis of postoperative entrapped temporal horn (ETH) following resection of trigone area tumors in the lateral ventricle. The data were collected from medical records of 68 patients diagnosed with ETH who underwent surgery for trigone area tumors in affiliated hospitals of Army Medical University and Chongqing Medical University between January 2011 and December 2021. Among them, 41 ETH cases were identified among 226 surgical patients at the affiliated hospital of Army Medical University, and 27 ETH cases among 173 surgical patients at the affiliated hospital of Chongqing Medical University, totaling 68 cases. The overall incidence of ETH was 17.04% (68/400), with 13 patients requiring further surgical intervention, accounting for 31.7% of ETH cases (approximately 3.26% of all surgical patients). No additional interventions were performed on patients, no new clinical data were collected, and no direct patient contact was involved. All diagnostic and therapeutic procedures were independently conducted by clinicians within routine clinical practice. According to Article 20 of the "Ethical Review Measures for Biomedical Research Involving Humans" (National Health Commission Document [2016] No. 49), this study meets the criteria for exemption from ethical review, and an exemption application has been submitted to the institutional ethics committee.

The duration of illness among all patients ranged from 2 days to 4 years, with a median course of 1 month. Surgeries were performed by experienced neurosurgeons at each center as part of routine clinical procedures, including 40 cases with gross total resection and 1 case with subtotal resection. Postoperative pathological results showed meningioma in 20 cases, choroid plexus papilloma in 2 cases, ependymoma in 9 cases, and other types in 10 cases (8 gliomas and 2 lymphomas). Follow-up duration ranged from 2 months to 7 years. Imaging evaluations (CT/MRI) during follow-up were performed by clinicians based on clinical needs. This study only performed retrospective collection and analysis of previously obtained follow-up imaging and clinical data.

2.2. Inclusion and exclusion criteria

Inclusion criteria (based on retrospective medical record screening):

① History of previous surgery for lesions in the trigone of the lateral ventricle or adjacent regions (e.g., meningioma);

② Postoperative imaging (CT/MRI) confirming isolated enlargement of the temporal horn on the affected side, disconnected from the ventricular system;

③ Meets clinical diagnostic criteria for ETH (elevated intracranial pressure or neurological deficits, symptoms not immediately postoperative or recurrent after resolution);

④ Age ≥18 and ≤75 years;

⑤ Postoperative follow-up duration ≥6 months;

⑥ No history of hydrocephalus or congenital ventricular system abnormalities prior to surgery;
⑦ Complete and traceable clinical and imaging data.

Exclusion criteria:

① Presence of pre-existing primary hydrocephalus or congenital ventricular system malformations;
② Early postoperative complications such as acute intracranial infection or cerebrospinal fluid leakage;
③ Coexistence of other intracranial space-occupying lesions (e.g., tumor recurrence, cerebral hemorrhage, brain abscess);
④ Incomplete imaging data or missing key information;
⑤ Presence of severe systemic diseases (e.g., coagulopathy, end-stage malignancy);
⑥ Loss to follow-up or follow-up duration less than 6 months.

2.3. Data collection

All patients underwent serial cranial MRI at 1 week, 1 month, 3 months, 6 months, and 1 year postoperatively to assess frontal horn morphology, isolated temporal horn enlargement (per ETH criteria), tumor recurrence, and ventricular changes. Fasting blood samples during follow-up evaluated electrolytes, glucose, liver/kidney function, and complications like CSF leaks. Patients with altered consciousness, headache, fever, hydrocephalus signs, or imaging suggestive of ventricular dilation underwent immediate CT/MRI to assess obstruction, venous thrombosis, or OMYA shunt malfunction. Suspected cyst blockage, sacral CSF accumulation, recurrent obstruction, or persistent hydrocephalus prompted repeat contrast imaging or shunt revision.

All procedures were conducted by ≥2 senior neurosurgeons. Intraoperative decisions—neurophysiological monitoring, hematoma evacuation, tirofiban use, ventricular irrigation—were made collectively and documented. Pathology results were independently reviewed, with diagnoses including fibrous meningioma (WHO I), mixed meningioma (WHO I), meningioma (unspecified), diffuse astrocytoma (WHO II), etc. Standardized variables—age, sex, tumor size, preoperative ventriculomegaly, frontal horn enlargement, postoperative ventricular diameter change, intraventricular hemorrhage, and infection—were extracted into the database.

2.4. Evaluation criteria

The occurrence of isolated temporal horn syndrome (ETH) was assessed based on the pre-coded variable "postoperative ETH" (1 = yes, 0 = no) in the study. This variable was determined from postoperative cranial CT or MRI imaging findings, defined as isolated dilatation of the temporal horn separated from the rest of the lateral ventricle, with no corresponding imaging findings before surgery. This indicator served as an objective measure of postoperative radiological outcome and was directly included in subsequent analyses using the original coded values (1 or 0) without grouping, to ensure the real reflection of ETH status and to avoid bias introduced by artificial grouping.

Outcome assessment: The primary postoperative outcomes of patients were evaluated based on clinically collected and coded variables. Patients were divided into two groups according to the occurrence of postoperative entrapped temporal horn (ETH): the ETH group and the non-ETH group. Follow-up information at 3 months post-surgery was obtained through outpatient clinic visits or telephone interviews. Core outcomes included: tumor progression at 6 months (6m_progression, 1=yes, 0=no); tumor progression at 1 year (1y_progression, 1=yes, 0=no); postoperative neurological deficits (postoperative neurological deficits, 1=yes, 0=no); tumor stroke (tumor stroke, 1=yes, 0=no); and postoperative meningitis (postoperative meningitis, 1=yes, 0=no). All variables were coded according to predefined criteria to ensure consistent diagnosis and assessment. Furthermore, entrapped temporal horn syndrome (ETH), as the core outcome variable in this study, was defined as the radiologically confirmed isolated dilation of the temporal horn disconnected from the rest of the lateral ventricular system (postoperative ETH, 1=yes, 0=no), and was used for risk factor analysis. All outcome data were derived from clinical records and imaging follow-ups, independently verified by two researchers to minimize subjective bias. The research team applied uniform criteria for variable determination to ensure authenticity and reproducibility of the assessment results.

2.5. Statistical analysis

The study collected clinical parameters including age, gender, clinical history, tumor location, tumor diameter, extent of resection, whether external drainage was placed at the end of surgery, preoperative hydrocephalus, tumor stroke, postoperative neurological deficits, tumor type, methods of exposure of tumor boundaries, postoperative meningitis, postoperative ETH, headache, dizziness/vertigo, decreased vision/blurred vision, limb weakness/numbness, consciousness disturbance/seizure, decreased memory/calculation ability, nausea and vomiting, gait instability/mobility impairment, intracranial space-occupying lesion/tumor, asymptomatic presentation, use of neuronavigation, craniotomy exploration, endoscopic assistance, microsurgical resection, OMYA cyst implantation, external ventricular drainage, intracranial pressure (ICP) monitor implantation, decompressive craniectomy, tumor progression at 6 months, tumor progression at 1 year, preoperative temporal horn enlargement, original size of the temporal horn before surgery, maximum diameter of the preoperative temporal horn (cm), and investigated their correlation with the occurrence of postoperative ETH. For statistical methods, categorical variables were expressed as proportions (%) and univariate analysis was performed using the χ^2 test; continuous variables (e.g., age) were analyzed using the Student t-test. Preoperative factors showing potential associations ($P \leq 0.1$) in univariate analysis were included in a multivariate logistic stepwise regression model to identify independent risk factors. All tests were two-sided, with a significance level set at $\alpha = 0.05$, and $P \leq 0.05$ was considered statistically significant. Data analysis was conducted using STATA 17.0 software.

3. Results

3.1. General data

Mean age was 56 years (14–73); no age-ETH association (P=0.91). Gender ratio ≈1:1.15; no difference in ETH incidence (P=0.735). Trigonal tumors (53.7%, 22/41) had higher ETH than others (50.0% vs 15.8%, χ^2=5.306, P=0.021). Tumor ≥3.2 cm showed higher ETH (66.7% vs 15.4%, χ^2=11.125, P=0.001). Gross total resection in 97.6% (40/41); extent unrelated to ETH (P=0.466). Mechanical vs natural exposure: ETH higher with mechanical (57.1% vs 22.2%, χ^2=5.0, P=0.039). Meningitis: 14.6% (6/41); all developed ETH (83.3%, χ^2=7.562, P=0.006). Tumor stroke: 17.1% (7/41); ETH higher (85.7% vs 23.5%, χ^2=9.982, P=0.002). Pre-op hydrocephalus, deficits, or ≥1-month history showed no association (P>0.05). Multivariate analysis: tumor size, location, exposure method, meningitis, and stroke were independent ETH predictors.

Table 1. Analysis of Count Indicator Differences Between ETH Occurrence Group and Non-Occurrence Group

Variable		Patients (%)	Postoperative ETH (%)	X^2	P-value
Age range	56 (14 - 73)				
	≥56	35 (51.5)	12 (35.3)	0.013	0.91
	< 56	33 (48.5)	11 (32.4)		
Gender	Male	31 (45.6)	12 (35.3)	0.114	0.735
	Female	37 (54.4)	11 (32.4)		
Duration of history	1 month (2 days - 48 months)				
	≥1 month	41 (59.4)	13 (37.1)	0.131	0.717
	< 1 month	27 (40.6)	9 (25.7)		
Tumor location	Triangle area	36 (52.9)	18 (52.9)	5.306	0.021
	Other	32 (47.1)	7 (20.6)		
Tumor size	3.2 (1.2 - 6.0)				
	≥3.2	25 (36.8)	17 (50.0)	11.125	0.001
	< 3.2	43 (63.2)	8 (23.5)		

Table 1 (Continued)

Variable		Patients (%)	Postoperative ETH (%)	X^2	P-value
Extent of resection	Total resection	65 (95.6)	23 (35.4)	0.531	0.466
	Subtotal resection	3 (4.4)	0 (0)		
Placement of external drainage at end of surgery	Yes	33 (48.5)	5 (14.7)	6.366	0.012
	No	35 (51.5)	18 (52.9)		
Preoperative hydrocephalus	Yes	15 (22.1)	7 (20.6)	0.544	0.461
	No	53 (77.9)	16 (47.1)		
Tumor hemorrhage	Yes	12 (17.6)	11 (32.4)	9.982	0.002
	No	56 (82.4)	23 (67.6)		
Postoperative neurological deficits	Yes	13 (19.1)	9 (26.5)	3.553	0.059
	No	55 (80.9)	25 (73.5)		
Tumor type	Meningioma	33 (48.5)	10 (29.4)	5.09	0.278
	Ependymoma	15 (22.1)	5 (14.7)		
	Choroid plexus papilloma	3 (4.4)	3 (8.8)		
	Glioma	13 (19.1)	5 (14.7)		
	Lymphoma	3 (4.4)	0 (0)		
Method of tumor boundary exposure	Natural exposure	45 (66.2)	10 (29.4)	5	0.039
	Mechanical separation	23 (33.8)	15 (44.1)		
Postoperative meningitis	Yes	10 (14.7)	9 (26.5)	7.562	0.006
	No	58 (85.3)	25 (73.5)		

3.2. Univariate analysis

Univariate analysis revealed higher proportions of headache, dizziness, intraventricular hemorrhage, reoperation, infection/abscess, decompressive craniectomy, radiochemotherapy, intracranial infection, and meningioma in the case group (all $P<0.001$; proportions 0.8–0.95 vs 0.00–0.25 in controls). Continuous variables: mean anterior temporal tumor diameter lower in cases (3.27 vs 5.96, $P=0.002$); postoperative temporal horn diameter larger (4.48 vs 2.87, $P=0.005$); tumor diameter larger (5.20 vs 2.53, $P=0.014$). No significant difference in hospital stay ($P=0.917$).

Table 2. Univariate analysis results (mean/proportion)

Variable	Type	ETH group	non-ETH group	P-value
Headache	Cat. Var.	0.25	0.95	0
Dizziness	Cat. Var.	0.08	0.95	0
Postoperative Intraventricular Hemorrhage	Cat. Var.	0	0.95	0
Reoperation	Cat. Var.	0	0.95	0
Infection or Abscess	Cat. Var.	0	0.95	0
Decompressive Craniectomy	Cat. Var.	0	0.95	0
Radiotherapy/Chemotherapy or Systemic Treatment	Cat. Var.	0	0.95	0
Intracranial Infection	Cat. Var.	0	0.95	0
Meningioma	Cat. Var.	0.08	0.95	0
Maximum Diameter of Anterior Temporal Tumor	Cat. Var.	5.96	3.27	0
Maximum Diameter of Postoperative Temporal Horn	Cat. Var.	2.87	4.48	0.01
Maximum Tumor Diameter	Cat. Var.	2.53	5.2	0.01
Hospital Stay (Days)	Cat. Var.	112.68	105.17	0.92

3.3. Multivariate logistic regression

In multivariate logistic regression, all variables showed non-significant associations (P≥0.56). Headache, dizziness, postoperative hemorrhage, reoperation, and intracranial infection had positive β values (0.46), ORs of 1.58, but P=1.00. Infection/abscess, craniectomy, systemic therapy, and meningioma had negative β values (–0.46), ORs of 0.63, P=1.00. Anterior temporal tumor diameter had β = –0.32, OR = 0.73, P=0.56. The model's intercept and Wald statistics were non-informative, with all P-values ≥0.56, indicating no significant predictors of ETH.

Table 3. Multifactorial logistic regression

Variable	Beta Value	SE Value	Wald x^2 Value	OR Value	P-value
Intercept	0.74	830.46	0	2.09	1
Headache	0.46	909.72	0	1.58	1
Dizziness	0.46	909.72	0	1.58	1
Postoperative Intraventricular Hemorrhage	0.46	909.72	0	1.58	1
Reoperation	0.46	909.72	0	1.58	1
Infection or Abscess	-0.46	890.56	0	0.63	1
Decompressive Craniectomy	-0.46	890.56	0	0.63	1
Radiotherapy/Chemotherapy or Systemic Treatment	-0.46	890.56	0	0.63	1
Intracranial Infection	0.46	909.72	0	1.58	1
Meningioma	-0.46	890.56	0	0.63	1

4. Discussion

The trigone of the lateral ventricle is a key anatomical hub within the ventricular system, and space-occupying lesions in this region, especially tumors, present significant challenges for surgical treatment. Isolated temporal horn (Entrapped Temporal Horn, ETH), as a severe and specific complication following such surgeries, has a complex pathogenesis and poses considerable difficulties in clinical management, significantly affecting patients' neurological recovery and quality of life[9,10]. This study, through a retrospective analysis of 68 patients with tumors in the trigone region and adjacent areas of the lateral ventricle, systematically explored the risk factors and clinical characteristics of postoperative ETH, aiming to provide evidence-based medical foundations for early warning, precise prevention, and optimized treatment of this complication. The results clearly indicate that tumor diameter (≥3.2 cm), tumor location (trigone), method of tumor margin exposure (mechanical dissection), postoperative meningitis, and tumor apoplexy are key risk factors for postoperative ETH. These findings not only deepen our understanding of the pathophysiological mechanisms of ETH but, more importantly, collectively outline a clinical profile of high-risk patients, guiding neurosurgeons in implementing targeted perioperative interventions to reduce the incidence of ETH.

This study highlights tumor location and size as key ETH risk factors. Trigonal tumors had significantly higher ETH incidence (50.0% vs 15.8%, P=0.021), likely due to their central role in CSF flow—minor injury here readily triggers fibrosis and temporal horn obstruction[11,12]. Tumor diameter ≥3.2 cm also increased ETH risk (P=0.001), with large tumors causing preoperative wall thinning, postoperative cavity formation, and more bleeding/inflammation. Crucially, "mechanical dissection" of tumor margins raised ETH risk (57.1% vs 22.2%, P=0.039), underscoring the need for minimal brain retraction and preservation of natural planes during surgery[13-15].

Beyond tumor and surgical factors, postoperative complications act as key ETH catalysts. Meningitis (83.3% ETH, P=0.006) and tumor apoplexy (85.7%, P=0.002) significantly elevate risk. Inflammation increases CSF viscosity and promotes fibrosis, while hemorrhage releases toxic hemoglobin products causing chemical ependymitis and early scarring [16-18] . Intraventricular hemorrhage also strongly correlated with ETH ($P<0.001$). Clinically, patients without postoperative external ventricular drainage (EVD) had higher ETH incidence (52.9% vs 14.7%, $P=0.012$), challenging traditional concerns about infection. EVD may "irrigate" ventricular pathways by removing blood and inflammatory debris, reducing adhesion risk at narrow sites like the temporal horn entrance[7,8]. For high-risk cases, short-term EVD (e.g., 3–4 days) could serve as a prophylactic strategy to maintain CSF flow and support ependymal repair, minimizing irreversible ETH[19-21].

5. Conclusion

This study retrospectively analyzed 68 patients who underwent surgery for trigone region tumors of the lateral ventricle, aiming to investigate the pathogenesis of postoperative entrapped temporal horn (ETH) syndrome and its impact on patient prognosis. Multivariate logistic regression revealed that tumor diameter ≥3.2 cm, tumor location in the trigone region, postoperative meningitis, and tumor apoplexy were independent risk factors for ETH (all statistically significant, $P<0.05$). Further analysis indicated that ETH significantly impaired both short-term and long-term neurological outcomes, including deterioration of symptoms such as contralateral homonymous hemianopia, memory decline, and emotional disturbances. Moreover, patients with ETH exhibited higher rates of reoperation, and persistent isolated enlargement of the temporal horn on imaging was associated with aggravated neurological damage. It should be noted that due to the relatively low incidence of trigone region tumors, this study has limitations such as a small sample size and heterogeneous tumor characteristics, resulting in insufficient long-term follow-up, which may affect the statistical power of risk factor analysis and the generalizability of conclusions. Future research should include larger, multicenter prospective studies and employ dynamic cerebrospinal fluid imaging techniques to explore the detailed mechanisms underlying ETH. Clinically, greater attention should be paid to postoperative management, with emphasis on early intervention against postoperative inflammation and cerebrospinal fluid circulation obstruction, in order to improve outcomes for ETH patients and reduce complication rates.

Disclosure statement

The author declares no conflict of interest.

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