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Risk Factors and the Management of Entrapped Temporal Horn following Lateral Ventricular Tumor Surgery

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ABSTRACT

AIM: To investigate the risk factors and optimize the management of entrapped temporal horn (ETH) following lateral ventricular tumor surgery.

MATERIAL and METHODS: We reviewed 41 cases of lateral ventricular tumors treated at the department of neurosurgery of our institution between January 2012 and September 2020. We summarized and analyzed the preoperative symptoms, intraoperative conditions, postoperative complications of the entrapped temporal horn, treatment measures, and recovery.

RESULTS: Of the 41 patients, 14 (34.1%) had ETH complications. A univariate analysis revealed that the tumor location, tumor diameter, the intraoperative use of hemostatic materials, no extraventricular drainage (EVD) was placed at the end of the operation, tumor stroke, the exposure mode of the tumor boundary, and postoperative meningitis were potential risk factors for the development of ETH. A multivariate binary logistic stepwise regression analysis revealed that tumor diameter ≥3.2 cm (OR=14.808, p=0.037), tumor stroke (OR=50.793, p=0.015), non-EVD (OR=0.023, p=0.033), and the mechanical separation of the tumor boundary (OR=30.617, p=0.045) were risk factors for ETH.

CONCLUSION: ETH often occurs following the surgery of lateral ventricle tumors. Large tumor diameter, tumor stroke, non-EVD at the end of operation, and the mechanical separation of the tumor boundary are the risk factors of ETH. The natural exposure of the tumor boundary during surgery, avoiding the use of hemostatic materials, placing an EVD tube at the end of operation, and postoperative infection control can effectively reduce the occurrence of ETH. It is essential to select the appropriate treatment method for patients with postoperative ETH.

KEYWORDS: Lateral ventricle tumor, Entrapped temporal horn, Extraventricular drainage, Tumor stroke, Ventricular wall adhesion

ABBREVIATIONS: ETH: Entrapped temporal horn, **EVD:** Extraventricular drainage, **OR:** Odds ratio, **CI:** Confidence interval, **CT:** Computed tomography, **MRI:** Magnetic resonance imaging, **CSF:** Cerebrospinal fluid, **VPS:** Ventriculoperitoneal shunt

INTRODUCTION

Lateral ventricular tumors account for approximately 0.75% to 1.6% of intracranial tumors (2). Approximately 19.0% of the patients develop lateral ventricular temporal horn outflow tract obstruction following tumor resection, concomitant with continuous cerebrospinal fluid (CSF) secretion from the temporal horn choroid plexus (29). This eventually results in localized obstructive hydrocephalus in the temporal horn with one or several symptoms, such as intracranial hypertension, hemianopia, hemiparesis, speech disorders, confusion, and gait and consciousness disorders, termed en-

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trapped temporal horn (ETH) (17,29,31). ETH can cause intracranial hypertension or exert an occupying effect to compress the surrounding brain tissue, which can cause uncal herniation and be life-threatening. The failure to carefully conduct clinical observation or an improper treatment adversely affects the prognosis. It is challenging to deal with ETH, and there is no standard treatment at present (20). Therefore, a careful analysis of several factors in the pre-, intra-, and postoperative periods of lateral ventricular tumors is clinically important for preventing ETH as well as guiding its subsequent treatment. In this research, we aimed to review 41 patients with lateral ventricular tumor treated at the department of neurosurgery between January 2012 and September 2020. Moreover we intended to analyze the process of diagnosis and treatment, explore the risk factors of postoperative ETH, and propose optimized treatment strategies.

MATERIAL and METHODS

This study has been approved by the Ethics Committee of Affiliated Hospital of Nantong University, the number is 2022-K004-01.

Patient Data

Between January 2012 and September 2020, 41 patients (19 men and 22 women) with lateral ventricular tumor were treated at our department. The median age was 56 years (range, 14 years to 73 years), and their clinical history ranged from 2 days to 4 years (median, 1 month). Twenty-two and 19 tumors were located in the trigone and other locations, respectively. Nine patients demonstrated hydrocephalus of the ventricle and temporal horn dilatation before operation, and preoperative tumor stroke resulted in intraventricular hemorrhage in seven patients. Experienced neurosurgeons performed all operations, including total and partial resection in 40 and one case, respectively. Postoperative pathological examination revealed 20, two, nine, and 10 cases of meningioma, choroid plexus papilloma, ependymoma, and other types (eight cases of glioma and two cases of lymphoma), respectively. The follow-up ranged from 2 months to 7 years, and computed tomography (CT) or magnetic resonance imaging (MRI) was used during the follow-up.

Hemostatic Materials

We used intraoperative hemostatic materials in the following 23 patients: i) six patients with obvious bleeding during intratumoral resection and temporary hemostasis with fluid gelatin (SURGIFLO Haemostatic Matrix) in the tumor cavity and ii) 17 patients with gelatin sponge (Absorbable Gelatin Sponge) dressing to prevent damage to the ventricular wall from electrocoagulation cautery while separating the tumor from ventricular wall adhesions. In all patients, we removed the gelatin sponges before the end of operation, and the excess fluid gelatin was carefully rinsed with warm saline.

Definition of Entrapped Temporal Horn

ETH refers to a localized obstructive hydrocephalus in the temporal horn owing to the obstruction of the temporal horn outflow tract of the lateral ventricle and the persistent CSF secretion from the temporal horn choroid plexus. It is characterized by one or several symptoms of intracranial hypertension, hemianopia, hemiparesis, speech disorders, confusion, and gait and consciousness disturbances. These symptoms are commonly observed following lateral ventricular tumor resection (17,29,31).

Definition of Tumor Stroke

Tumor stroke can be caused by an immature vascular structure, a weak vascular wall, and high brittleness during tumor growth. Under certain conditions, rupture leads to bleeding, followed by brain tumor stroke. Herein, tumor stroke specifically refers to ventricular tumor stroke, where the bleeding breaks into the lateral ventricles.

Definition of Meningitis

A case was defined as meningitis on meeting at least one of the following criteria: i) organisms cultured from the CSF or ii) one of the signs or symptoms without other recognized causes, namely fever (>38°C), headache, meningeal signs, and at least one of the following: a) increased white cell count, elevated protein, and/or decreased glucose level in CSF, b) organisms observed on Gram staining of the CSF, c) positive antigen test of the CSF, d) organisms cultured from blood, and e) diagnostic single antibody titer (Immunoglobulin M) or a four-fold increase in paired sera (Immunoglobulin G) for pathogens (6,22).

Evaluation of Postoperative Neurological Deficits

We evaluated the neurological function with reference to the National Institutes of Health Stroke Scale. The assessed components included the level of consciousness, visual field, gaze, upper limb movement, facial palsy, lower limb movement, sensory, ataxia, and dysarthria (15).

Exposure Mode of the Tumor Boundary

During natural exposure, intratumoral resection reduces the volume, collapses the tumor envelope, naturally reveals the gap between the tumor and the ventricular wall, and avoids the direct harassment of the ventricular wall. By contrast, during mechanical separation the tumor is mechanically separated from the surrounding ventricular wall by the padded septa of cotton or gelatin sponge.

Statistical Analysis

The data were analyzed by the statistical software SPSS 22.0, and the adoption rate of counting index (%) was expressed. We performed the χ^2 test and binary logistics stepwise regression in the univariate and multivariate analyses, respectively.

RESULTS

The Incidence and Management of Postoperative Entrapped Temporal Horn

Of the 41 patients, there were 20 patients with extraventricular drainage (EVD) remaining in the temporal horn at the end of operation, 21 without EVD, 23 with intraoperative hemostatic materials, seven with tumor stroke breaking into the ventricle, and six with postoperative meningitis, including three, 11, 10, six, and five cases of postoperative ETH complications, respectively. Moreover, 14 cases demonstrated ETH complications, where as six cases achieved a steady state during follow-up. We identified ETH-mediated acute intracranial hypertension in other eight cases, including two, five, and one case dehydrated by hyperosmolarity, with EVD, and decompressed with a bone flap as well as an EVD, respectively. All patients had a resolution of intracranial hypertension and the stabilization of the dilated temporal horn.

Statistical Results

Analysis of Differences Between Groups

Results of the univariate analysis suggested (Table I) that the tumor location, tumor diameter, the intraoperative use of hemostatic materials, no EVD was placed at the end of the operation, tumor stroke, the exposure mode of the tumor boundary, and postoperative meningitis were potential risk factors for the development of ETH ($p<0.05$). There was no significant difference in the age at diagnosis, sex,

Table I: Analysis of the Difference of Counting Indexes Between the ETH Group and Then on-ETH Group

Variable		Patients (%)	Postoperative ETH (%)	χ^2	p-value
Age at diagnosis (years)					
Median (range)	56 (14-73)				
	≥56	21 (51.2)	7 (33.3)	0.013	0.910
	<56	20 (48.8)	7 (35.0)		
Sex					
	Male	19 (46.3)	7 (36.8)	0.114	0.735
	Female	22 (53.7)	7 (31.8)		
Clinical history					
Median (range)	1 month (2 days-48 months)				
	≥1 month	25 (61.0)	8 (32.0)	0.131	0.717
	<1month	16 (39.0)	6 (37.5)		
Preoperative KPS score					
Median (range)	90 (60-90)				
	≥90	25 (61.0)	10 (40.0)	0.976	0.323
	<90	16 (39.1)	4 (25.0)		
Tumor location	Trigone	22 (53.7)	11 (50.0)	5.306	**0.021**
	Others	19 (46.3)	3 (15.8)		
Tumor diameter (cm)					
Median (range)	3.2 (1.2-6.0)				
	≥3.2	15 (36.6)	10 (66.7)	11.125	**0.001**
	<3.2	26 (63.4)	4 (15.4)		
Extent of resection	Total resection	40 (97.6)	14 (35.0)	0.531	0.466
	Subtotal resection	1 (2.4)	0 (0)		
Use hemostatic materials	Yes	23 (56.1)	10 (43.5)	6.54	**0.011**
	No	18 (43.9)	4 (22.2)		
Extraventricular drainage placed at the end of the operation	Yes	20 (48.8)	3 (15.0)	6.366	**0.012**

Table I: Cont.

Variable		Patients (%)	Postoperative ETH (%)	χ^2	p-value
	No	21 (51.2)	11 (52.4)		
Preoperative hydrocephalus	Yes	9 (22.0)	4 (44.4)	0.544	0.461
	No	32 (78.0)	10 (31.25)		
Tumor stroke	Yes	7 (17.1)	6 (85.7)	9.982	**0.002**
	No	34 (82.9)	8 (23.5)		
Postoperative neurologic deficits	Yes	8 (19.5)	5 (62.5)	3.553	0.059
	No	33 (80.5)	9 (27.3)		
Tumor type	Meningioma	20 (48.8)	6 (30.0)	5.090	0.278
	Ependymoma	9 (22.0)	3 (33.3)		
	Choroid plexus papilloma	2 (4.9)	2 (100)		
	Glioma	8 (19.5)	3 (37.5)		
	Lymphoma	2 (4.9)	0 (0)		
Exposure mode of the tumor boundary	Natural exposure	27 (65.9)	6 (22.2)	5	**0.039**
	Mechanical separation	14 (34.1)	8 (57.1)		
postoperative meningitis	Yes	6 (14.6)	5 (83.3)	7.562	**0.006**
	No	35 (85.4)	9 (25.7)		

Table II: The Results of Logistics Regression Analysis of Multiple Factors Affecting ETH

Variable	Regression coefficient	Standard error	Wald statistics	p-value	OR	95%CI of OR	
						Lower limit	Upper limit
Tumor diameter	2.695	1.294	4.336	**0.037**	14.808	1.172	187.179
Tumor stroke	3.928	1.619	5.888	**0.015**	50.793	2.128	1212.324
Extraventricular drainage placed at the end of the operation	-3.77	1.764	4.567	**0.033**	0.023	0.001	0.732
Exposure mode of the tumor boundary	3.422	1.705	4.029	**0.045**	30.617	1.084	864.991

OR: *Odds ratio;* ***CI:*** *Confidence interval.*

clinical history, preoperative Karnofsky Performance Status (KPS) score, the degree of tumor resection, preoperative hydrocephalus, tumor type, and postoperative neurologic deficits between the groups (p>0.05).

Logistic Regression Analysis of Multiple Factors Affecting ETH

We considered the occurrence of ETH as a dependent variable Y (Y=0, non-ETH group; Y=1, ETH group). The age at diagnosis, sex, clinical history, preoperative KPS score, the degree of tumor resection, preoperative hydrocephalus, postoperative neurological deficits, tumor location, tumor diameter, the intraoperative use of hemostatic materials, whether to place EVD at the end of the operation, tumor stroke, tumor type, the exposure mode of the tumor boundary, and postoperative meningitis were regarded as X1–X15. The multivariate binary logistics stepwise regression analysis (Table II) revealed that tumor diameter ≥3.2cm (OR=14.808, p=0.037), tumor stroke (OR=50.793, p=0.015), non-EVD(OR=0.023, p=0.033), and the mechanical separation of the tumor boundary (OR=30.617, p=0.045) were the risk factors for ETH.

■ TYPICAL CASES

Case 1

A 64-year-old woman was admitted because of "headache and dizziness for more than 2 months." Preoperative cranial MRI displayed an occupied trigone of the left lateral ventricle (Figure 1A). The tumor was completely resected during the operation, and was easy to bleed. Moreover, we used liquid gelatin for repeated rinsing, and the EVD tube was not placed at the end of the operation. Postoperative pathological examinations revealed meningioma. We did not identify temporal horn dilatation in CT on that day post-surgery (Figure 1B). CT revealed left temporal horn dilatation on day 7 (Figure 1C). Following the treatment of hyperosmotic dehydration and lowering intracranial pressure, the patient's general condition gradually improved. CT before discharge revealed that the temporal horn was no longer enlarged (Figure 1D), and the patient was generally in a good condition. Therefore, she was discharged and regularly re-examined.

Case 2

A 48-year-old woman was admitted because of "dizziness and headache for more than 3 days". MRI examination in other hospitals revealed space occupation in the left ventricular trigone. Thus, we considered the possibility of meningioma. Preoperative CT examination in our hospital revealed an occupied left ventricular trigone (Figure 2A), accompanied by dilated hydrocephalus in the temporal horn of the left ventricle (Figure 2B). We considered the intraoperative natural exposure of the tumor border owing to the large size of the tumor. The tumor was completely excised, and no extraventricular drain remained post-surgery. Postoperative pathological examinations displayed meningioma. On postoperative review, CT did not reveal a dilatation of the temporal horn of the left ventricle. On postoperative day 5, MRI demonstrated an enlarged temporal horn of the left ventricle (Figure 2C). However, she exhibited stable vital signs and normal general condition. There was no obvious discomfort, following which she was discharged. One year later, MRI displayed an enlarged trigone and the temporal horn of the left ventricle (Figure 2D); nonetheless, the enlargement was significantly smaller than that before.

Case 3

A 48-year-old woman was admitted because of "dizziness for 10 days." Before operation, MRI revealed space occupation in the trigone of the right ventricle (Figure 3A), and ependymoma was considered. We performed a total resection of the tumor,

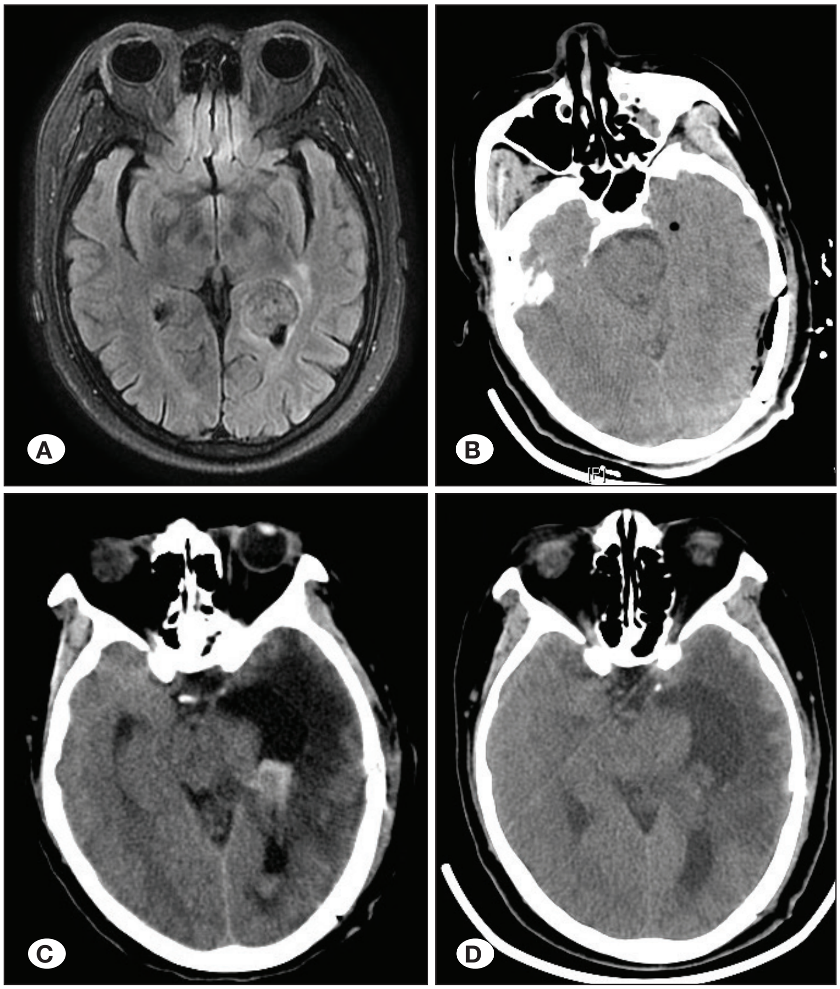

Figure 1: A) Preoperative axial MRI. **B)** CT re-examination on the day following operation. **C)** CT re-examination of CT postoperative day 7. **D)** CT re-examination before discharge on postoperative day 20.

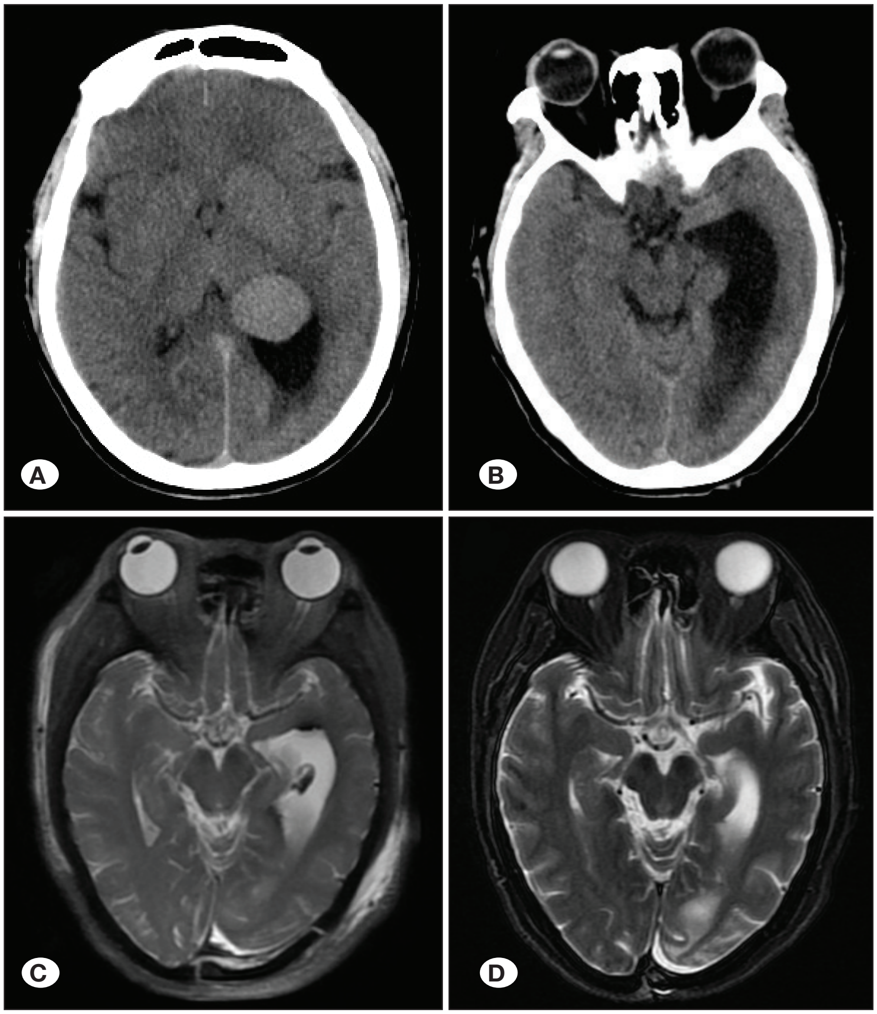

Figure 2: A, B) Preoperative CT. **C)** MRI re-examination before discharge on postoperative day 5. **D)** MRI re-examination 1 year post-surgery.

which was easy to bleed following removal. In addition, we used liquid gelatin for repeated rinsing. No ventricular drainage tube was placed. Postoperative pathological examinations revealed meningioma. CT displayed minor hemorrhage in the operative area on that day post-surgery (Figure 3B). Following treatment, such as hyperosmotic dehydration, MRI revealed an asymmetry of the ventricular system, compression displacement of the right lateral ventricle, and the dilatation of the temporal horn (Figure 3C). On postoperative day 6, the patient exhibited a progressive decrease in consciousness and was unable to respond. The muscle strength of her left limb was significantly worse than that before the operation. Moreover, she displayed positive pathological signs. CT revealed increased effusion in the temporal horn of the right ventricle, and the midline moved to the left (Figure 3D). We performed right ventricular Ommaya drainage and right temporal occipital bone flap decompression during the emergency surgery. Postoperative CT demonstrated that the effusion in the right temporal horn subsided, in addition to an alleviated midline displacement (Figure 3E). Later, although the temporal horn was still hydrocephalus, it shrunk and tended to be stable (Figure 3F). Simultaneously, the patient was discharged because of her general condition is good. CT demonstrated the hydrocephalus dilatation of the temporal horn ½ year later; however, there was no significant progression (Figure 3G). MRI revealed dilated hydrocephalus of the temporal horn 1 ½ year later without substantial progression, compared with findings from the previous follow-up (Figure 3H).

Case 4

A 53-year-oldman was admitted because of “headache and dizziness for more than 4 years, which suddenly aggravated for half a month.” Before the operation, CT revealed space occupation in the trigone of the left ventricle, and the hematoma of the left temporal lobe ruptured into the left ventricle with space occupying effects (Figure 4A). We completely resected the tumor and removed the intracranial hematoma. Moreover, we placed the EVD tube. Postoperative pathological examination revealed meningioma. CT demonstrated that the hemorrhage in the ventricular system was obviously absorbed on that day post-surgery, besides the EVD tube remaining in place (Figure 4B). Furthermore, it revealed greater absorption of the intraventricular hemorrhage than that before on postoperative day 3 (Figure 4C). Therefore, we removed the EVD tube and administered continued treatment. The patient recovered gradually. MRI displayed that the intraventricular

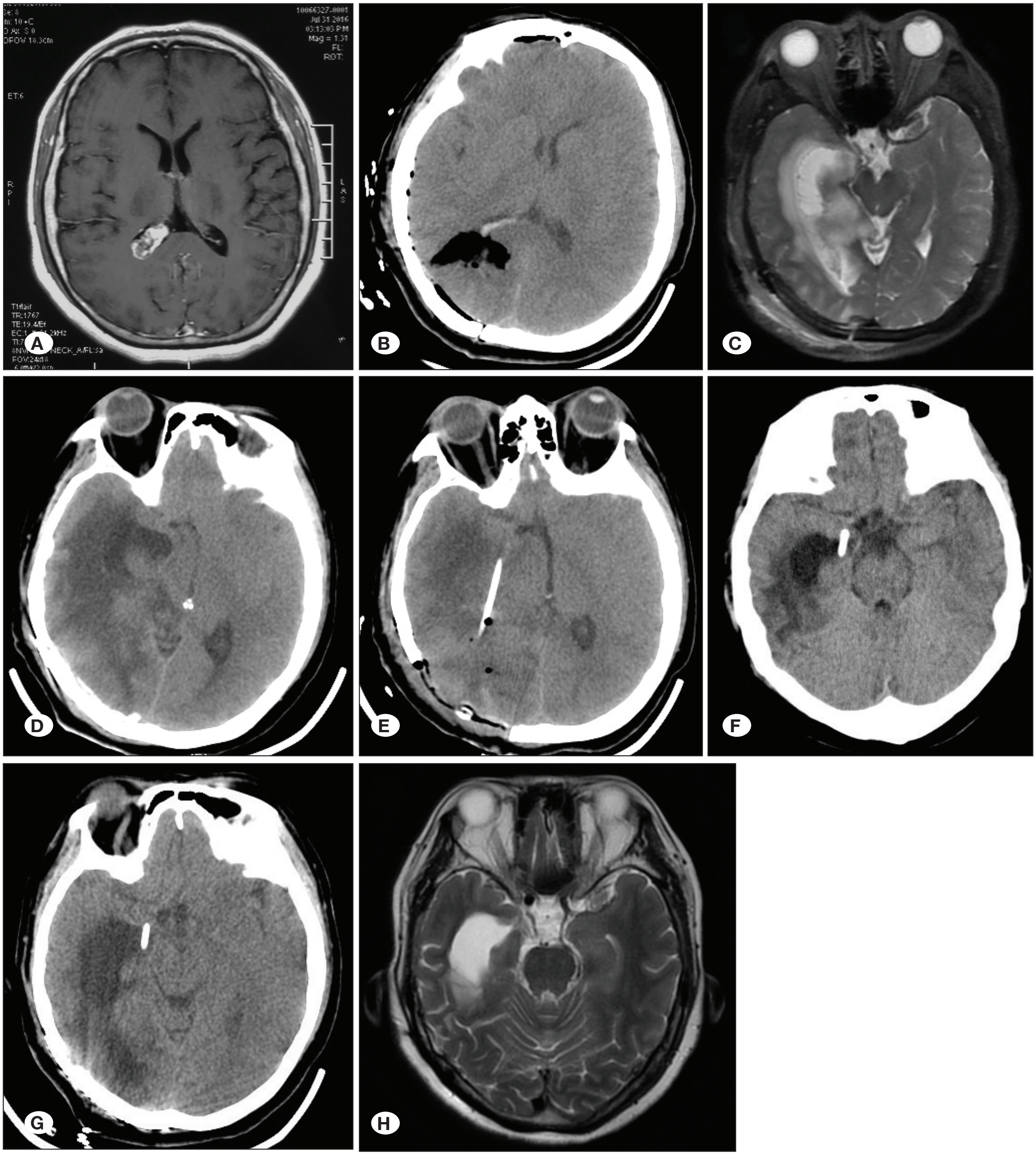

Figure 3: A) Preoperative MRI. **B)** CT re-examination on the day following operation. **C)** MRI re-examination on postoperative day 3. **D)** CT re-examination on postoperative day 6. **E)** CT re-examination on the similar day following intraventricular drainage. **F)** The dynamic reexamination of CT following drainage tube implantation. **G)** CT re-examination 6 months following discharge. **H)** MRI re-examination 1 ½ years following discharge.

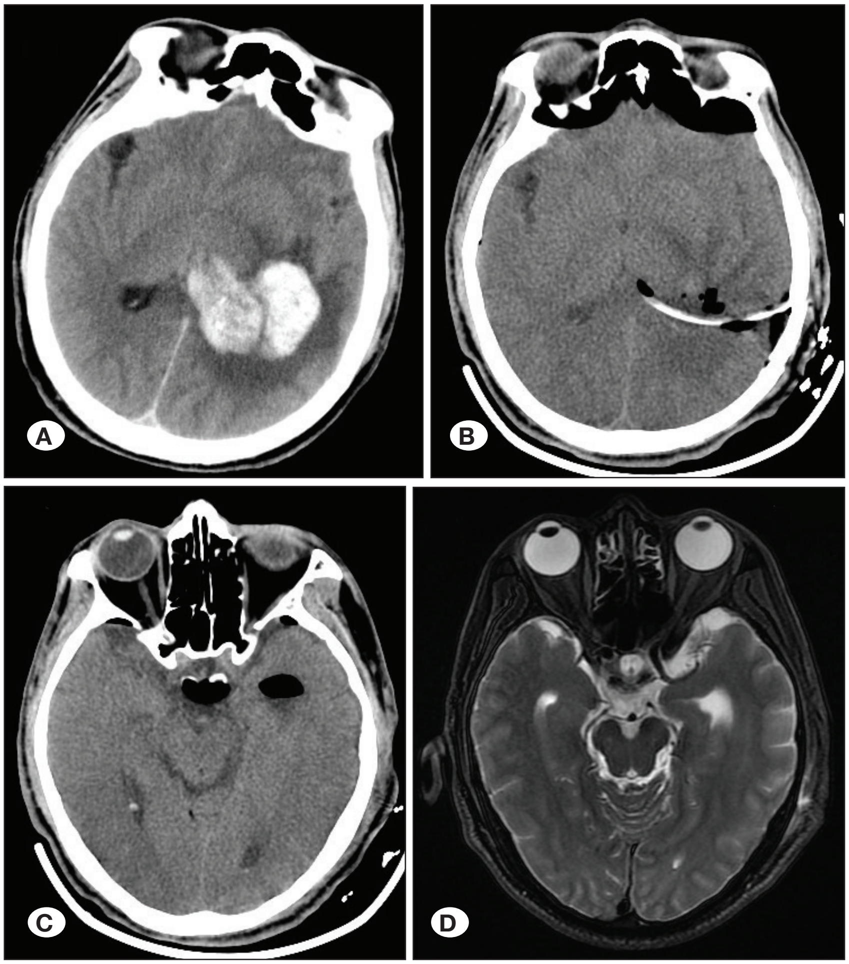

Figure 4: A) Preoperative CT. **B)** CT re-examination on the day following operation. **C)** CT re-examination on postoperative day 3. **D)** MRI re-examination before discharge.

hemorrhage and hydrops had been basically absorbed (Figure 4D), following which he was discharged.

DISCUSSION

ETH, a special form of hydrocephalus, was first proposed by Cairns and Daniel (4) in 1947. It principally occurs following tumor resection in the lateral ventricle, particularly in the trigone. The tumor originates from structures, such as the lateral ventricular wall and choroid plexus (9); thus, it is closely associated with the ventricular wall, which inevitably damages the wall during the operation. This eventually results in local adhesion, an obstruction of the outflow tract of CSF in the temporal horn, and acute dilatation. Despite improvements in neurosurgical techniques, ETH is still unavoidable. In this study, the incidence of postoperative ETH was 34.1%. The univariate analysis revealed that the tumor location, tumor diameter, the intraoperative use of hemostatic materials, no EVD was placed at the end of the operation, tumor stroke, the exposure mode of the tumor boundary, and postoperative meningitis were potential risk factors for ETH development. Moreover, the multivariate binary logistic stepwise regression analysis revealed that tumor diameter ≥3.2cm, tumor stroke, non-EVD, and the mechanical separation of tumor boundary were the risk factors for ETH.

The clinical symptoms and signs of lateral ventricular tumors appear relatively late owing to sufficient ventricular space and slow tumor growth. Moreover, the tumor often becomes large before the patients visit a doctor (28). The long-term compression of the ventricular wall by large tumors and its invasion causes local structural changes, thereby making surgical resection more difficult. In this study, 15 patients had large tumors, which were ≥3.2cm in diameter. The tumors obstructed the ventricular channels and affected CSF circulation, thus resulting in preoperative ventricular fluid accumulation and the dilatation of the temporal horn. Concurrently, the hollow collapse of brain tissue following tumor resection affected postoperative CSF circulation and predisposed it to ETH development (18).

While removing bulky lateral ventricular tumors, some surgeons may apply high pull on the tumor and even involve the ventricular wall. Wang et al. (29) suggested that excessive intraoperative pull on brain tissue can lead to postoperative symptoms of neurological deficits, which indirectly reflect the trauma to brain tissues caused by surgery. In addition, it increases the risk of scar formation and ETH complications in the operative area post-surgery. Our findings suggested identified the mechanical separation of the tumor border as a risk factor for ETH. For lateral ventricular tumors, we do not recommend the intraoperative mechanical separation of the tumor envelope border and surrounding lateral ventricular wall regardless of the tumor size. Instead, intratumoral resection collapses the tumor envelope, which naturally exposes the tumor and lateral ventricular border and reduces the excessive harassment of the ventricular wall, thus lowering the risk of postoperative ETH. In addition, some operators may select an electrocoagulation cautery of the choroid plexus to treat hydrocephalus. This is because choroid plexus cautery presumably exerts a positive effect on the treatment of hydrocephalus (1,14,23,30). However, extensive cautery of the choroid plexus during the resection of lateral ventricular tumors can damage the integrity of the ventricular wall and increase the risk of postoperative ventricular channel adhesion obstruction. In addition, the choroid plexusis supposedly involved in the repair of the ependyma and ventricular wall injury, particularly during hydrocephalus. The surviving choroidal cells can secrete beneficial neurotrophic molecules (10,24,25). Therefore, we recommend reducing the excessive electrocoagulation harassment of the ventricular choroid plexus during lateral ventricular tumor surgery. However, the electrocoagulation cautery of the choroid plexus is occasionally unavoidable in actual surgery owing to the need for tumor resection. Low intensity electrocoagulation with spot cautery during the operation can reduce additional damage to the choroid plexus (5,8,34).

We recommend placing an EVD tube during the operation to prevent the occurrence and development of ETH for patients with preoperative tumor stroke or abundant tumor blood supply leading to substantial bleeding during the operation. Multiple blood clots formed during the intraventricular hemorrhage can block the small vascular pathway of arachnoid villi into venous sinus and ependymal cells. Moreover, they can attach to the arachnoid granules to obstruct CSF circulation (3,32). Lateral ventricular tumors with rich blood supply often bleed during resection, blood breaks into the ventricle may increase the risk of ETH. Moreover, surgeons often use hemostatic materials for difficult hemostasis. Our findings demonstrated that the incidence of ETH significantly increased following the application of hemostatic materials. This is because the contact between these materials and the ventricles results in mild rejection, which gradually accumulates and forms an obstruction in the ventricle (26). In addition, repeated washing or washing aggressively while flushing liquid gelatin will damage the microstructure of the fragile ventricular wall. Intraoperative gelatin sponges tend to detach from the bleeding surface and form debris, thus leading to a new obstruction. Moreover, gelatin sponges that are not absorbed in the short term post-surgery can accumulate for a long duration, thus blocking CSF passage. The univariate analysis indicated that the intraoperative use of hemostatic materials was associated with ETH. Furthermore, hemostatic materials, such as fluid gelatin and gelatin sponges, should be avoided to the maximum possible extent.

Our findings demonstrated an association between the presence of postoperative meningitis and ETH. Ventricular inflammation can form adhesions in the ventricular wall, thus narrowing the CSF circulation pathways and causing occlusion. The causative mechanism may be that inflammation destroys the ventricular canal membrane in the ventricular wall, thus triggering the gradual accumulation of local ventricular exudates as well as inflammatory debris tissue in the ventricles. This eventually forms an obstruction (26). This warrants attention to postoperative infection control. Due to preoperative tumor stroke, intraoperative tumor resection, and the risk of bleeding, placement of hemostatic materials may lead to intraventricular debris and bloody and inflammatory components that are difficult to drain, resulting in ventricular wall adhesions and obstruction. We identified non-extraventricular drain at the end of the operation as a risk factor for ETH. The EVD tube is convenient for the drainage of intraventricular residue and bloody and inflammatory components, thereby reducing the risk of ventricular wall adhesion. Maintaining homeostasis of the temporal horn of the lateral ventricle can effectively prevent ETH (16,27). However, the duration of retention should be short. This is because Ohwaki et al. and Kasuya et al. demonstrated that a longer duration of EVD tube placement and excessive drainage can lead to the development of hydrocephalus, besides inducing meningitis and ventriculitis. We recommended accurately registering the daily CSF drainage and the height of the drainage tube, and the decision for its removal can be made in approximately 3 days to 5 days (12,29).

Different clinicians have dissimilar opinions about patients with ETH (7,11,27,33). In patients with ETH not causing intracranial hypertension, increased hydrostatic pressure in the dilated temporal horn inhibits CSF secretion. The hydrostatic pressure is higher than that in the rest of the ventricles, in addition to tiny CSF outflow tracts in the temporal horn. Moreover, CSF can partially flow out and its formation and reflux in the temporal horn are relatively stable under the effect of greater hydrostatic pressure. In addition, it can reach a steady state. Treatment modalities for the acute phase of intracranial hypertension caused by ETH are principally classified into the following three types: hypertonic drug dehydration treatment, EVD surgery, and internal drainage, such as ventriculoperitoneal shunt (VPS) and endoscopic fenestration techniques. The aforementioned methods are used to relieve ETH-mediated intracranial hypertension in the acute phase. However, we initially consider hypertonic drug dehydration treatment, which is not for ETH itself rather ETH-mediated intracranial hypertension upon observing significant acute cranial hypertension. By contrast, we consider surgery following an ineffective conservative drug treatment. Endoscopic fenestration techniques can avoid shunt placement or the implantation of extraneous matter; however, the anatomical structure of the temporal horn is usually changed by dilatation, and it is easy to damage neurovascular and other structures. Simultaneously, the postoperative stoma is at a risk of stenosis relapse and occlusion (13,21). Furthermore, we do not recommend placing a permanent implant during the acute phase of intracranial hypertension in ETH. This can be partially attributed to VPS contraindication in patients with combined meningitis and the distant spread of tumor cells with the shunt in patients with lateral ventricular malignancy.

Our study had a few limitations. First, the overall sample size was relatively small. Second, the results obtained from statistical analyses may be limited. This warrants confirming the identified risk factors based on additional data. We intend to focus on the comparison of EVD, VPS, and endoscopic fenestration techniques in the treatment of postoperative ETH in the future.

CONCLUSION

ETH usually occurs following the operation of lateral ventricular tumors. A tumor diameter ≥3.2 cm, tumor stroke, non-EVD, and the mechanical separation of tumor boundary were the risk factors for ETH. We recommend natural exposure for lateral ventricular tumors and reducing the use of hemostatic materials during operation. For patients with the aforementioned risk factors, we recommend placing an EVD tube in the temporal horn at the end of the operation. Surgeons should initially consider follow-up observation for patients with postoperative ETH. Hypertonic drug dehydration can be initially performed for ETH-mediated acute intracranial hypertension. However, surgeons can consider surgical treatment, such as EVD or endoscopic fenestration techniques, following ineffective drug treatment.

Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: Authors declare no conflict of interest.

AUTHORSHIP CONTRIBUTION

Study conception and design: GS, QY

Data collection: GS, JY, ZZ, GN

Analysis and interpretation of results: GS, JS

Draft manuscript preparation: GS, JY

Critical revision of the article: GS, JY, QY

All authors (GS, JY, JS, ZZ, GN, QY) reviewed the results and approved the final version of the manuscript.

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