

# Endoscopic Techniques for Re-establishing Cerebrospinal Fluid Circulation in Ventricular Tumors

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## ABSTRACT

**Background:** Ventricular tumors frequently obstruct cerebrospinal fluid (CSF) pathways, resulting in hydrocephalus and increased intracranial pressure. **Objective:** To evaluate the effectiveness and outcomes of endoscopic techniques for re-establishing cerebrospinal fluid circulation in patients with ventricular tumors. **Methods:** This retrospective observational study was conducted at Aria institute of medical sciences Quetta from march 2025 to march 2026 and included 190 patients with ventricular tumors associated with obstructive hydrocephalus who underwent endoscopic intervention. **Results:** The mean age of patients was  $24.8 \pm 15.6$  years, and 58.9% were male. The third ventricle was the most common tumor location (40.0%). Endoscopic third ventriculostomy was performed in 62.6% of patients, while endoscopic biopsy was performed in 44.2%. Successful restoration of CSF circulation was achieved in 163 (85.8%) patients, hydrocephalus improved in 158 (83.2%), and neurological improvement occurred in 149 (78.4%). Ventriculoperitoneal shunt placement was required in 22 (11.6%) patients. The mean hospital stay was  $4.6 \pm 2.3$  days, and mortality was 2.6%. Younger age, shorter symptom duration, third ventricular tumors, endoscopic third ventriculostomy, and combined procedures were significantly associated with successful outcomes ( $p < 0.05$ ). **Conclusion:** Endoscopic techniques provide high rates of successful CSF circulation restoration with favorable neurological outcomes and low shunt dependency in patients with ventricular tumors.

**Keywords:** Ventricular tumors; neuroendoscopy; cerebrospinal fluid circulation; hydrocephalus; endoscopic third ventriculostomy

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## INTRODUCTION

Ventricular tumours are an important subcategory of intracranial tumours as they are closely associated with pathways of CSF and are more likely to cause obstructive hydrocephalus [1]. They can develop in the lateral ventricle, third ventricle or fourth ventricle and include ependymoma, choroid plexus tumors, central neurocytoma, subependymal giant cell astrocytoma, colloid cysts, germ cell tumors, and metastatic deposits [3]. Intraventricular tumors, even if small, can block CSF flow at critical points like the foramen of Monro, aqueduct of Sylvius or at the fourth ventricular outlets, causing elevated ICP and neurological impairment [2]. Pediatric patients with hydrocephalus due to a ventricular tumour may have symptoms of headache, vomiting, papilledema, abnormal mental status, visual changes, gait ataxia, memory loss or developmental delay

[4]. Therefore, it is important to restore CSF circulation in time to avoid acute neurological impairment and to achieve better clinical stability prior to definitive treatment of the tumor [6]. The ventriculoperitoneal (VP) shunt has been the established surgical procedure for CSF diversion, and is associated with a variety of complications including infection, obstruction, overdrainage, dependency, and tumor seeding; however, endoscopic techniques offer a safer and more physiological means of CSF diversion and have gained traction in recent years [5]. The use of neuroendoscopy has revolutionized the treatment of ventricular tumors and enabled direct visualization of the anatomy of the ventricles, restoration of CSF pathways, to a certain degree, biopsy of the tumor, fenestration of the cysts, septostomy, and in selected cases, resection of the tumor through minimally invasive corridors [7]. One of the most common procedures for obstructive hydrocephalus

associated with tumors of the posterior third ventricle, pineal region, aqueduct or posterior fossa is called endoscopic third ventriculostomy (ETV) [9]. ETV creates an opening in the floor of the third ventricle, thus bypassing the obstructed pathway and draining the CSF directly into the basal cisterns and decreasing the need to rely on permanent CSF drainage shunts [8].

Depending on the location of the tumor and CSF pathway blockage, other endoscopic procedures such as septostomy, aqueductoplasty, cyst fenestration and endoscopic tumor biopsy can be performed. In tumors located in the ventricle, endoscopic biopsy is a very useful procedure in the presence of a deep tumor location where surgical access would have high morbidity, since the procedure will also allow CSF diversion during the same procedure [12]. Neuroendoscopy is particularly beneficial in patients who need to be treated for hydrocephalus immediately before oncological treatment is planned [11]. Endoscopic CSF diversion for a variety of ventricular tumors has been shown to provide good results such as decreasing shunt dependence, shortening hospital admission, minimizing infection rate and achieving an acceptable rate of procedural safety [13]. But location of the tumour, anatomy of the ventricles, the extent of the hydrocephalus, patient age, previous treatment and surgeon experience all play a role in determining the success of the surgery [15]. Even though there are no procedure-related complications, some complications can occur, such as bleeding, CSF leak, infection, failed ventriculostomy or the need for secondary shunt placement, which need to be carefully followed-up [14].

**Objective**

To evaluate the effectiveness and outcomes of endoscopic techniques for re-establishing cerebrospinal fluid circulation in patients with ventricular tumors.

**Methodology**

This was a retrospective observational study conducted at Aria institute of medical sciences Quetta from march 2025 to march 2026, including 190 patients with ventricular tumors who underwent endoscopic procedures for re-establishing cerebrospinal fluid (CSF) circulation and management of tumor-associated hydrocephalus. Patients of all age groups and both genders with radiologically confirmed ventricular tumors associated with obstructive hydrocephalus who underwent endoscopic intervention for CSF diversion, restoration of CSF pathways, tumor biopsy, or related neuroendoscopic procedures were included. Patients with complete preoperative imaging, operative records, and postoperative follow-up data were considered eligible. Patients with non-ventricular intracranial tumors, communicating hydrocephalus without evidence of ventricular obstruction, previous permanent CSF diversion procedures before presentation, incomplete medical records, inadequate postoperative follow-up, or patients managed exclusively with open surgery without endoscopic intervention were excluded.

**Data Collection**

After obtaining ethical approval, data were collected retrospectively from hospital records using a structured

proforma. Demographic variables included age, gender, and presenting symptoms. Clinical variables included duration of symptoms, neurological status at presentation, evidence of raised intracranial pressure, and radiological findings. Tumor-related characteristics included ventricular location, tumor size, histopathological diagnosis, degree of hydrocephalus, and site of CSF pathway obstruction. Operative variables included type of endoscopic procedure performed, such as endoscopic third ventriculostomy, endoscopic septostomy, aqueductoplasty, cyst fenestration, endoscopic biopsy, or combined procedures. Postoperative data included restoration of CSF circulation, improvement in hydrocephalus, neurological recovery, need for ventriculoperitoneal shunt placement, length of hospital stay, procedure-related complications, and mortality. Successful restoration of CSF circulation was defined as radiological and clinical improvement of hydrocephalus without the requirement for additional permanent CSF diversion during follow-up.

**Statistical Analysis**

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between patients with successful and unsuccessful endoscopic outcomes were performed using independent t-tests and chi-square tests where appropriate. Multivariable logistic regression analysis was used to identify factors associated with successful restoration of CSF circulation. A p-value ≤0.05 was considered statistically significant.

**Results**

The mean age of patients was 24.8 ± 15.6 years, with most patients aged 18–40 years (81, 42.6%). Males were more common (112, 58.9%) than females (78, 41.1%). The mean symptom duration was 3.8 ± 2.1 months. Headache was the most frequent symptom (156, 82.1%), followed by vomiting (131, 68.9%), visual disturbance (74, 38.9%), gait imbalance (48, 25.3%), and altered consciousness (29, 15.3%).

**Table 1: Baseline Demographic and Clinical Characteristics of Patients with Ventricular Tumors (N = 190)**

Variable	n (%) / Mean ± SD
Age (years)	24.8 ± 15.6
<18 years	72 (37.9)
18–40 years	81 (42.6)
>40 years	37 (19.5)
Male	112 (58.9)
Female	78 (41.1)
Duration of symptoms (months)	3.8 ± 2.1
Headache	156 (82.1)
Vomiting	131 (68.9)
Visual disturbance	74 (38.9)
Gait imbalance	48 (25.3)
Altered consciousness	29 (15.3)

The third ventricle was the most common tumor location (76, 40.0%), followed by lateral ventricle (49, 25.8%), pineal region (38, 20.0%), and fourth ventricle (27, 14.2%).

Colloid cyst was the most frequent diagnosis (41, 21.6%), followed by central neurocytoma (36, 18.9%), ependymoma (32, 16.8%), and germ cell tumor (28, 14.7%).

**Table 2: Tumor Characteristics and Endoscopic Procedures Performed (N = 190)**

Variable	n (%)
Tumor Location	
Third ventricle	76 (40.0)
Lateral ventricle	49 (25.8)
Pineal region	38 (20.0)
Fourth ventricle	27 (14.2)
Histopathological Diagnosis	
Colloid cyst	41 (21.6)
Central neurocytoma	36 (18.9)
Ependymoma	32 (16.8)
Germ cell tumor	28 (14.7)
Other tumors	53 (27.9)
Endoscopic third ventriculostomy (ETV)	119 (62.6)
Endoscopic biopsy	84 (44.2)
Septostomy	31 (16.3)
Cyst fenestration	24 (12.6)
Combined procedures	58 (30.5)

Successful restoration of CSF circulation was achieved in 163 (85.8%) patients, while hydrocephalus improved in 158 (83.2%). Neurological improvement occurred in 149 (78.4%) patients, whereas 28 (14.7%) showed no clinical improvement. VP shunt placement was required in 22 (11.6%), and procedure failure occurred in 27 (14.2%). The mean hospital stay was  $4.6 \pm 2.3$  days, and mortality was 5 (2.6%).

**Table 3: Clinical and Radiological Outcomes Following Endoscopic Intervention (N = 190)**

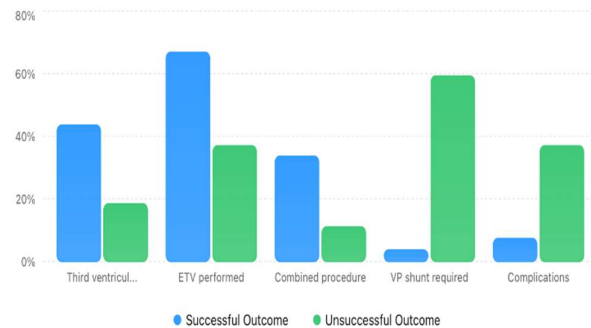
Variable	n (%)
Successful restoration of CSF circulation	163 (85.8)
Improvement in hydrocephalus	158 (83.2)
Neurological improvement	149 (78.4)
No clinical improvement	28 (14.7)
Need for VP shunt placement	22 (11.6)
Procedure failure	27 (14.2)
Mean hospital stay (days)	$4.6 \pm 2.3$
Mortality	5 (2.6)

Successful outcomes were associated with younger age ( $23.7 \pm 14.8$  vs.  $31.2 \pm 17.3$  years;  $p=0.02$ ) and shorter symptom duration ( $3.4 \pm 1.8$  vs.  $5.9 \pm 2.6$  months;  $p<0.001$ ). Third ventricular tumors (43.6% vs. 18.5%;  $p=0.01$ ), ETV use (66.9% vs. 37.0%;  $p=0.004$ ), and combined endoscopic procedures (33.7% vs. 11.1%;  $p=0.02$ ) were more common

in successful cases. VP shunt need and complications were significantly higher in unsuccessful outcomes.

**Table 4: Factors Associated with Successful Restoration of CSF Circulation**

Variable	Successful Outcome (n=163)	Unsuccessful Outcome (n=27)	p-value
Age (years), Mean $\pm$ SD	$23.7 \pm 14.8$	$31.2 \pm 17.3$	0.02
Symptom duration (months), Mean $\pm$ SD	$3.4 \pm 1.8$	$5.9 \pm 2.6$	<0.001
Third ventricular tumor, n (%)	71 (43.6)	5 (18.5)	0.01
Endoscopic third ventriculostomy, n (%)	109 (66.9)	10 (37.0)	0.004
Combined endoscopic procedure, n (%)	55 (33.7)	3 (11.1)	0.02
Need for VP shunt, n (%)	6 (3.7)	16 (59.3)	<0.001
Procedure-related complications, n (%)	12 (7.4)	10 (37.0)	<0.001



**Figure 1. Comparison of factors associated with successful and unsuccessful restoration of cerebrospinal fluid circulation following endoscopic management of ventricular tumors.**

**Discussion**

This study compares the methods of endoscopy to restore CSF circulation in 190 patients with ventricular tumors. 163 (85.8%) patients were successfully restored to CSF circulation, and 158 (83.2%) had an improvement in their hydrocephalus and 149 (78.4%) had neurological improvement. The results indicate that neuroendoscopic intervention is an effective minimally invasive procedure for the treatment of hydrocephalus caused by tumors. High success rates of EFD have also been reported for ventricular tumours with the success rate being around 75% to 90% in

most studies, particularly if the obstruction is at the aqueduct, third ventricle, or posterior ventricular pathways [15]. The average age of patients was  $24.8 \pm 15.6$  years with the majority of patients being between 18 and 40 years old. Males appeared to be more prevalent than females (58.9%). This demographic distribution is similar to that of prior studies; in some cohorts, patients were younger adults, in particular, and pediatric patients, with a slight male predominance, in whom tumor of the ventricles requiring endoscopic management occurred. This relatively young age distribution could result from the fact that tumors like central neurocytoma, germ cell tumors, ependymoma and colloid cysts are more likely to be found in the younger age groups [16]. The most common presenting symptom was headache (82.1%) followed by vomiting (68.9%) and visual disturbance (38.9). These symptoms are due to raised ICP as a result of obstructive hydrocephalus. Previous studies also have reported headache, vomiting, papilledema, visual blurring, gait disturbance and altered sensorium as the most common clinical features associated with CSF pathway obstruction in ventricular tumors. This reinforces the significance of early diagnosis of hydrocephalus signs/symptoms to avoid neurological deterioration [17]. In this series, the most common site of tumor was the third ventricle (40.0%), followed by the lateral ventricle (25.8%), pineal region (20.0%) and fourth ventricle (14.2%). Previous studies have also reported that hydrocephalus is a frequent occurrence with lesions of the third ventricular region and pineal region due to their close relationship with the foramina of Monro and aqueduct of Sylvius. Because of these anatomical relations, they show great promise for use in endoscopic CSF diversion procedures like endoscopic third ventriculostomy [18].

In this study, the most common procedure was endoscopic third ventriculostomy performed in 62.6% of patients, followed by endoscopic biopsy (44.2%) and combined (30.5%). This is the dual diagnostic and therapeutic use of neuroendoscopy in the case of tumors of the ventricles. The ability to perform CSF diversion and tissue diagnosis simultaneously with endoscopy has also been highlighted in previous studies and is a factor that decreases the need for staged procedures as well as dependence on permanent shunting. Although ventriculoperitoneal shunts were required in 11.6% of patients, most patients did not require permanent CSF diversion following endoscopic intervention. Similar shunt avoidance after ETV and related techniques has been previously reported, and lower shunt dependence rates in the long follow up compared to the conventional ventriculoperitoneal shunting. This is clinically relevant as infection, shunt obstruction, overdrainage of the shunts and repeated revisions have a significant impact on the long term outcome [19]. Youth, brief symptom history, third ventricular tumor localization, endoscopic third ventriculostomy (ETV) and combined endoscopic procedures were found to be significant factors associated with successful outcome. Patients who have a successful result are younger than those who have an unsuccessful result ( $23.7 \pm 14.8$  vs.  $31.2 \pm 17.3$  years) and had a shorter duration of symptoms ( $3.4 \pm 1.8$  vs.  $5.9 \pm 2.6$

months). The success of the endoscopies in the past have also been reported to be improved if the intervention is earlier, the child is younger and the period of hydrocephalus is shorter, presumably because of less chronic deformity of the ventricles and better absorptive capacity of CSF [20]. More favorable results were seen in third ventricular tumors, with 43.6% of the resected tumors being successful in comparison to 18.5% of the nonresected tumors. This may be because the anatomical features of the third ventricle are very favourable for ETV and the obstructed pathway can be bypassed. Earlier studies have also reported a much higher success rate for ETV in obstructive hydrocephalus due to aqueductal, pineal, and posterior third-ventricular lesions than in complex multiloculated or communicating hydrocephalus.

#### Limitations

This study has several limitations. As a retrospective observational study, it relied on the accuracy and completeness of medical records, making it susceptible to information and documentation bias. The study was conducted at a single center, which may limit the generalizability of the findings to other institutions and patient populations. Differences in tumor histology, tumor size, surgeon experience, and selection of endoscopic techniques may have influenced outcomes but could not be fully standardized. The duration of follow-up varied among patients, potentially affecting the assessment of long-term CSF circulation and delayed procedure failures. Additionally, detailed neurocognitive outcomes, quality-of-life assessments, and long-term tumor control data were not available for all patients. Prospective multicenter studies with standardized follow-up protocols are needed to validate these findings further.

#### Conclusion

Endoscopic techniques are effective and safe methods for re-establishing cerebrospinal fluid circulation in patients with ventricular tumors. In this study, successful restoration of CSF circulation was achieved in 85.8% of patients, with substantial improvement in hydrocephalus and neurological status while minimizing the need for permanent ventriculoperitoneal shunting. Younger age, shorter symptom duration, third ventricular tumor location, and use of endoscopic third ventriculostomy were associated with better outcomes.

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