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Ventriculoscopic Management of Lesions in The Vicinity of the Third Ventricle

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ABSTRACT

Background: Lesions of the third ventricle remain surgically challenging because traditional microsurgical approaches, such as the transcortical or transcallosal routes, are associated with significant morbidity. The development of neuroendoscopic techniques has provided a minimally invasive alternative that permits lesion management and simultaneous cerebrospinal fluid (CSF) diversion.

Objective: To evaluate the safety, efficacy, and short-term outcomes of ventriculoscopic management for lesions located in or adjacent to the third ventricle.

Patients and Methods: A prospective single-center clinical trial was conducted at Tanta University Hospitals including 20 patients older than six months with MRI-defined third-ventricular lesions. All patients underwent ventriculoscopic procedures tailored to lesion type, with or without endoscopic third ventriculostomy (ETV). Clinical and radiological parameters—including headache severity (VAS), papilledema grade, Evans index, and complication profile—were assessed at baseline and at 1, 3, and 6 months postoperatively.

Results: The mean preoperative headache score improved significantly from 7.1±1.5 to 0.5±1.0 postoperatively ($p<0.001$). Papilledema resolved or improved in 100% of cases, with complete resolution in 85%. The Evans index decreased from 0.44±0.08 to 0.24±0.07 ($p<0.001$). Overall clinical outcome was excellent in 15 patients (75%), good in 3 (15%), and fair in 2 (10%). Complications included transient fever (45%), transient memory loss (15%), intraventricular hemorrhage (10%), subgaleal collection (20%), and VP shunt requirement (25%). Favorable outcomes correlated with lower postoperative Evans index, papilledema resolution, and absence of gait disturbance.

Conclusions: Ventriculoscopy is a safe and effective minimally invasive approach for third-ventricular lesions. It achieves substantial symptom relief, radiological improvement, and high rates of excellent clinical outcomes, with an acceptable complication profile. Larger multicenter studies are warranted to validate prognostic factors such as Evans index reduction and papilledema improvement.

Keywords: Cranial endoscopy, Third ventricular lesions, Ventriculoscopy.

INTRODUCTION

Lesions involving the third ventricle are uncommon, accounting for approximately 0.6–0.9% of all intracranial space-occupying lesions. Despite their relative rarity, they pose a significant surgical challenge due to the deep midline location, the close proximity to critical neurovascular structures, and the potential for obstructive hydrocephalus[(1)].

Traditional microsurgical routes, such as the transcortical or transcallosal approaches, have been employed for decades with satisfactory lesion access, but they are associated with risks of cortical injury, seizures, memory disturbance, and disconnection syndromes[(2)].

Over the past three decades, neuroendoscopic techniques have emerged as a minimally invasive alternative, offering direct visualization of intraventricular lesions, the possibility of tumor biopsy or resection, and simultaneous cerebrospinal fluid (CSF) diversion when required[(3,4)].

Endoscopic third ventriculostomy (ETV) in particular has gained widespread acceptance as a treatment for obstructive hydrocephalus, while endoscopic cyst fenestration and colloid cyst excision have been shown to achieve outcomes comparable to microsurgery but with reduced morbidity[(5,6)].

Despite these advances, there remains a paucity of prospective clinical data that systematically evaluate both clinical and radiological outcomes following ventriculoscopic procedures, especially in Middle Eastern and African neurosurgical centers. Most available reports are retrospective, involve heterogeneous patient populations, and often lack standardized outcome measures or complication grading[(7,8)].

The present study was designed as a prospective clinical trial to assess the efficacy and safety of ventriculoscopic management of lesions in and around the third ventricle. Particular emphasis was placed on identifying radiological and clinical predictors of favorable outcomes, including changes in Evans index and papilledema, to provide guidance for surgical decision-making and patient selection.

PATIENTS AND METHODS

Study Design and Setting

This was a prospective, single-center clinical trial conducted at the Department of Neurosurgery, Tanta University Hospitals, Egypt, between.

Twenty consecutive patients older than six months, of both sexes, with MRI-confirmed lesions in or adjacent to the third ventricle were included. Exclusion criteria were: (1) refusal of participation, (2) isolated lesions confined to the lateral or fourth ventricles, (3) age below six months, and (4) uncorrectable coagulopathy or other contraindications to endoscopic surgery. The age cutoff

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was chosen because of anatomical and surgical considerations in infants.

All patients underwent detailed clinical and neurological assessment, including ophthalmological evaluation for papilledema and visual field testing. Endocrinological assessment was performed when suprasellar extension was suspected. Baseline imaging included MRI brain with gadolinium, high-resolution T2-weighted and CISS/FIESTA sequences, and cine phase-contrast MRI for cerebrospinal fluid (CSF) flow when ETV was planned. Non-contrast CT was performed 24 hours postoperatively to assess ventricular size, pneumocephalus, and hemorrhage.

All procedures were performed under general anesthesia using rigid endoscopes (Karl Storz GAAB® and Lotta® systems, Germany). A right frontal burr hole was fashioned approximately 2.5 cm lateral to the midline and 1 cm anterior to the coronal suture. The trajectory was planned to target the foramen of Monro and third ventricle.

Endoscopic interventions included:

-Endoscopic third ventriculostomy (ETV) for obstructive hydrocephalus.

-Cyst fenestration or excision for arachnoid and colloid cysts (Figure 1).

-Endoscopic biopsy or partial resection for neoplastic lesions (e.g., central neurocytoma, ependymoma).

Intraoperative neuronavigation was used selectively to optimize trajectory. Hemostasis was achieved with continuous irrigation and bipolar cautery when necessary. External ventricular drains (EVD) or Ommaya reservoirs were placed at the surgeon's discretion.

Patients were clinically assessed at 1 week, and at 1, 3, and 6 months postoperatively. Follow-up MRI was performed at 1 and 3 months, and included cine MRI to assess stoma patency after ETV. Clinical evaluation included headache severity (Visual Analogue Scale, VAS), presence of papilledema, gait disturbance, memory function, and urinary incontinence.

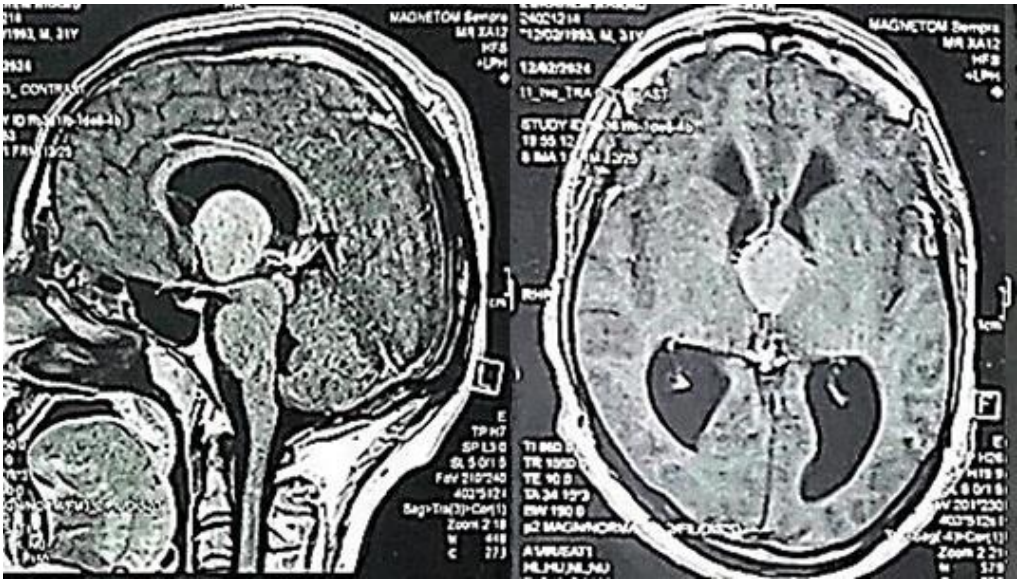

Figure (1 A): Preoperative MRI brain with contrast axial and sagittal showing a non-enhancing lesion at the third ventricle.

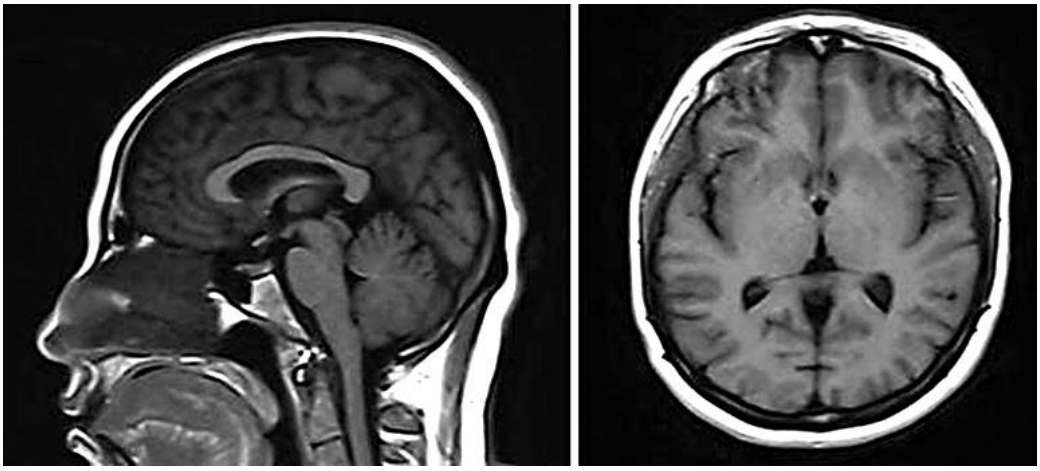

Figure (1 B): Postoperative axial and sagittal MRI brain.

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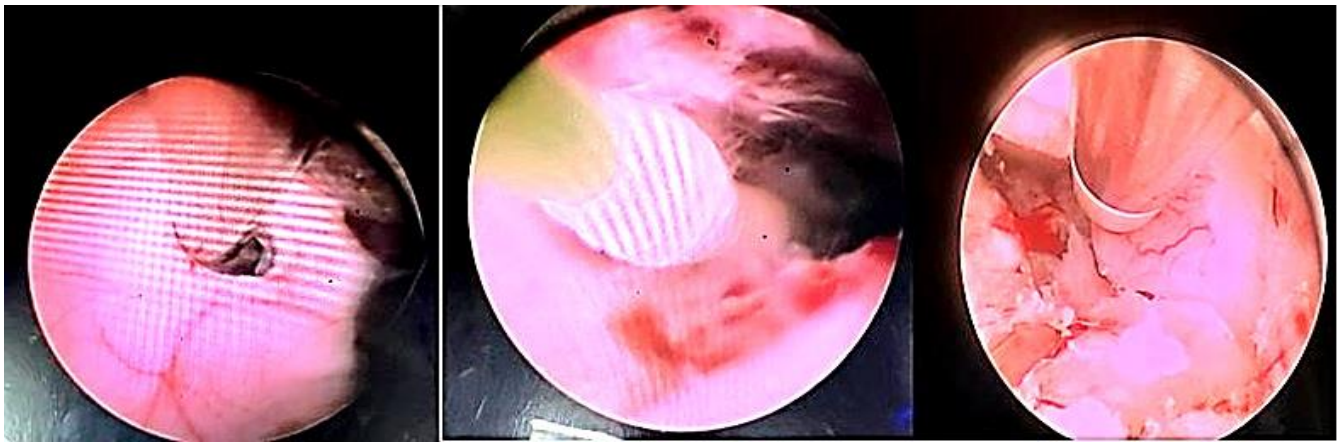

Figure (1 C): Intraoperative fenestration, aspiration of colloid content and excision.

Outcome measurement:

- Clinical improvement in presenting symptoms (headache VAS, papilledema, gait, memory).
- Radiological improvement measured by Evans index and ventricular size reduction.
- Avoidance of ventriculoperitoneal (VP) shunt.
- Procedure-related complications (graded using the Landriel-Ibañez classification) [9].
- Length of hospital stay and intensive care unit (ICU) stay.

Ethical approval:

The study was approved by the institutional Ethics Committee of Tanta University (approval number: 36264MS296/8/23) and registered at ClinicalTrials.gov (NCT06825286). Written informed consent was obtained from all adult participants or from parents/guardians in the case of pediatric patients. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation (SD) or median with range, and categorical variables as frequencies and percentages. Paired Student's t-test or Wilcoxon signed-rank test was used for pre- versus postoperative comparisons. Associations between categorical variables were tested with Chi-square or Fisher's exact test, as appropriate. Logistic regression was performed to identify predictors of favorable outcome. A p-value < 0.05 was considered statistically significant. Confidence intervals (95% CI) were reported for key outcomes. Effect sizes (Cohen's d for VAS change, odds ratios for predictors) were calculated to quantify clinical relevance.

RESULTS

A total of 20 patients were included, with a mean age of 16.8 ± 16.4 years. The cohort was evenly distributed by sex (10 males, 50%; 10 females, 50%). The most frequent presenting symptoms were headache (100%; mean preoperative VAS 7.1 ± 1.5), vomiting (70%), and papilledema (75%) (Table 1).

Table (1): Baseline Characteristics and Clinical Presentation

Variable	Category	n (%) or Mean ± SD
Age (years)	Mean ± SD (Median, Range)	16.8 ± 16.4 (11; 0.5–58)
Sex	Male / Female	10 (50%) / 10 (50%)
Headache (VAS)	Mean ± SD	7.1 ± 1.5
Vomiting	Yes	14 (70%)
Papilledema	G0 / G2 / G3	5 (25%) / 8 (40%) / 7 (35%)
Gait disturbance	Yes	6 (30%)
Memory disturbance	Yes	5 (25%)
Urinary incontinence	Yes	7 (35%)
Head enlargement	Yes	4 (20%)
Hormonal disturbances	Yes	2 (10%)

Preoperative imaging demonstrated CSF permeation in 85% and wide prepontine cisterns in 70% of cases. The mean Evans index was 0.45 ± 0.09, indicating marked ventricular enlargement. Lesion size exceeded 3 cm in more than half the patients (55%). Most common pathological diagnoses were suprasellar arachnoid cyst (30%), colloid cyst (25%), pineal cyst (10%), supracerebellar arachnoid cyst (10%) (Table 2).

Table (2): Radiological and Pathological Findings

Variable	Category	n (%) or Mean ± SD
CSF permeation	Yes	17 (85%)
Evans index	Pre-op Mean ± SD	0.45 ± 0.09
Wide prepontine cisterns	Yes	14 (70%)
Lesion size	≤1.5 cm / 1.5–3 cm / >3 cm	3 (15%) / 6 (30%) / 11 (55%)
Pathology	Suprasellar arachnoid cyst	6 (30%)
Pathology	Colloid cyst	5 (25%)
Pathology	Pineal cyst	2 (10%)
Pathology	Supracerebellar arachnoid cyst	2 (10%)
Pathology	Choroid plexus papilloma	1 (5%)
Pathology	Suprasellar craniopharyngioma	1 (5%)
Pathology	Tectal glioma	1 (5%)
Pathology	Thalamic glioma	1 (5%)
Pathology	Pineal germinoma	1 (5%)

Postoperatively, patients showed significant clinical and radiological improvement. Mean headache VAS decreased from 7.1 ± 1.5 to 0.5 ± 1.0, corresponding to a large effect size (Cohen's d ≈ 1.9). Papilledema resolved or improved in all patients, with complete resolution in 85%. The Evans index reduced from 0.44 ± 0.08 to 0.24 ± 0.07, a mean reduction of 0.20 (95% CI, 0.15–0.25). At 6 months, overall outcomes were mostly excellent in 15 patients (Table 3).

Table (3): Clinical and Radiological Outcomes

Parameter	Pre-op	Post-op	p-value
Headache (VAS)	7.1 ± 1.5	0.5 ± 1.0	<0.001
Papilledema	G2–G3 in 75%	Resolved/improved in 100%	<0.001
Evans index	0.44 ± 0.08	0.24 ± 0.07	<0.001
Overall outcome	—	Excellent 15 (75%), Good 3 (15%), Fair 2 (10%)	—

Complications were observed in a minority of patients and were generally transient. The most frequent was postoperative fever (45%), followed by subgaleal collection (20%), and memory loss (15%). A ventriculoperitoneal (VP) shunt was ultimately required in 5 patients (25%) (Table 4).

Statistical analysis revealed several factors associated with poorer outcomes. Fair outcomes were significantly associated with the occurrence of postoperative seizures, subgaleal collections, VP shunt dependence, and disturbance of consciousness. Preoperative symptoms, including gait disturbance, memory disturbance, and urinary incontinence, were also predictive of worse results. Radiologically, patients with excellent outcomes had significantly lower postoperative Evans indices (0.22 ± 0.06) compared to those with fair outcomes (0.34 ± 0.08). Papilledema improvement was a strong predictor of excellent outcome (Table 4).

Table (4): Postoperative Complications and Predictors of Outcome

Complication / Predictor	Incidence	Association with Outcome
Transient fever	9 (45%)	Not significant
Transient memory loss	3 (15%)	Not significant
Fits	1 (5%)	Higher in Fair outcome, p=0.009
Intraventricular hemorrhage	2 (10%)	Trend, NS
Subgaleal collection	4 (20%)	Higher in Fair outcome, p=0.010
VP shunt need	5 (25%)	Fair outcome, p=0.027
Disturbance of consciousness (DCL)	2 (10%)	Fair outcome, p<0.001
Papilledema improvement	85% resolved	Significant predictor of Excellent outcome, p=0.001
Gait disturbance	6 (30%)	Worse outcome, p=0.014
Memory disturbance	5 (25%)	Worse outcome, p=0.027
Urinary incontinence	7 (35%)	Worse outcome, p=0.038
Evans index post-op	0.22 ± 0.06 (Excellent) vs 0.34 ± 0.08 (Fair)	p<0.001

DISCUSSION

Multiple surgical routes have been described to access the third ventricle, including transcallosal, transcortical, and endoscopic techniques. Each has

distinct advantages and limitations, and the choice depends on lesion type, surgeon expertise, and patient characteristics[10]. Compared with microsurgical routes, ventriculoscopy offers a minimally invasive corridor, reducing the risks of cortical and callosal injury while allowing for simultaneous lesion management and cerebrospinal fluid (CSF) diversion[11].

In the current study, the mean age of patients was 17.7 years, with equal sex distribution. The most common symptoms were headache, vomiting, and papilledema, while gait, memory disturbance, and urinary incontinence were less frequent but clinically relevant. Radiologically, the majority showed CSF permeation, enlarged ventricles (mean Evans index 0.44), and lesions >3 cm. Pathologically, colloid cysts and suprasellar arachnoid cysts predominated, although rarer entities such as papilloma, glioma, and germinoma were also represented. Postoperatively, we observed significant improvement in headache VAS, papilledema, and Evans index. Overall, 87.5% of patients achieved good-to-excellent outcomes, consistent with previous reports[12,13].

Our findings are in agreement with **De Marco *et al.*** [12], who reported favorable outcomes after cyst removal or ETV in most patients, with low morbidity. Similarly, **Zhenye *et al.*** [13] demonstrated that ventriculoscopy for intraventricular neurocysticercosis was safe and effective, reinforcing the versatility of this approach. The low complication rates observed here align with studies comparing endoscopic and microsurgical approaches: **Grondin *et al.*** [5] found that microsurgical patients experienced higher morbidity than those treated endoscopically. **Sacko *et al.*** [8] confirmed the long-term safety and efficacy of ETV, particularly for hydrocephalus, supporting our results regarding CSF diversion. Together, these studies confirm that ventriculoscopy achieves outcomes comparable to or better than microsurgery, with fewer risks.

In our cohort, the most frequent complications were transient fever (43.8%), subgaleal collection (18.8%), and transient memory loss (18.8%). Intraventricular hemorrhage occurred in 12.5%, and seizures in 6.2%. VP shunt placement and disturbance of consciousness were each required in 25%. Importantly, most complications were minor and self-limiting. These findings mirror previous series, where intraoperative complication rates ranged from 9–15%[5,12], further validating the relative safety of endoscopic approaches.

Favorable outcomes in our study were strongly associated with papilledema improvement, lower postoperative Evans index, and absence of gait disturbance. Patients requiring VP shunts, or those who developed postoperative seizures or subgaleal collections, were more likely to experience poorer outcomes. These predictors are biologically plausible: papilledema resolution reflects effective CSF diversion, while persistent ventricular enlargement and shunt dependency indicate incomplete physiological restoration. **Sacko *et al.*** [8] similarly noted that age (very young children) and etiology (hemorrhage-related hydrocephalus) influenced prognosis after ETV, highlighting the multifactorial nature of outcomes.

Strengths of this study include its prospective design, uniform follow-up, and systematic use of clinical and radiological endpoints. Unlike retrospective reviews, we were able to directly correlate specific pre- and postoperative parameters with outcome. However, several limitations should be acknowledged. The sample size was small, limiting subgroup analyses. The follow-up duration, though adequate for early outcomes, does not address long-term recurrence or shunt independence. Finally, being a single-center study, generalizability may be limited.

Our results reinforce ventriculoscopy as an effective and safe modality for lesions in and around the third ventricle. The minimally invasive nature of the approach, coupled with the ability to simultaneously treat obstructive hydrocephalus, makes it an attractive first-line option. In clinical practice, Evans index reduction and papilledema improvement should be viewed as important predictors of outcome, guiding follow-up and postoperative monitoring. Integration of fast MRI protocols, routine neuro-ophthalmological evaluation, and shunt series imaging further enhance patient surveillance[14].

CONCLUSION

Ventriculoscopy represents a safe, minimally invasive, and effective approach for managing lesions in and around the third ventricle. In our prospective series, the majority of patients achieved excellent outcomes, with significant improvement in headache severity, papilledema, and ventricular size. The procedure was associated with an acceptable and largely transient complication profile.

Importantly, postoperative Evans index reduction, papilledema improvement, and absence of gait disturbance emerged as key predictors of favorable outcome. These parameters may serve as practical clinical and radiological markers to guide postoperative assessment and long-term surveillance.

While the results are encouraging, limitations such as the relatively small sample size and short follow-up underscore the need for larger multicenter trials. Future research should focus on validating predictive markers, refining patient selection, and integrating adjunctive technologies such as neuronavigation, intraoperative imaging, and advanced neurocognitive assessment.

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