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Assessing the Effectiveness of Endoscopic Third Ventriculostomy in Patient with Obstructive Hydrocephalus

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ABSTRACT

Hydrocephalus is characterized by the enlargement of brain ventricles due to excessive cerebrospinal fluid (CSF) production or reduced absorption, commonly necessitating neurosurgical intervention. Endoscopic third ventriculostomy (ETV) offers a minimally invasive alternative to ventriculoperitoneal (VP) shunting for the treatment of obstructive hydrocephalus. This study aims to evaluate the effectiveness and safety of ETV across various age groups and pathologies. A prospective study was conducted involving 40 patients who underwent ETV for obstructive hydrocephalus between 2022 and 2024 at the Department of Neurosurgery, J.A. Group of Hospitals and G.R. Medical College, Gwalior, MP. Inclusion criteria included all age groups diagnosed with obstructive hydrocephalus confirmed by imaging studies, with obstructions near the aqueduct of Silvius. Exclusion criteria encompassed bleeding disorders, history of prior ventricular shunt or ETV surgery and basilar invagination. Data collected included patient demographics, imaging studies, intraoperative details and postoperative outcomes. :The age distribution indicated a predominance of younger patients, with 65% being infants to early childhood. Symptomatically, 67.5% of patients reported headaches. Males constituted 75% of the sample. The most common diagnosis was congenital hydrocephalus with aqueductal stenosis (62.5%). ETV alone was performed in 80% of cases. The success rate varied, with 60-100% symptomatic improvement across different age groups and pathologies. Complications included CSF leaks (10%), meningitis (5%), wound infections (5%), seizures (5%) and intraoperative interventricular bleeding (2.5%). ETV is a safe and effective treatment for obstructive hydrocephalus, particularly in children under five years of age. The procedure demonstrated a success rate of 70-80% across various studies, with improvements in clinical and radiographic findings and a reduced dependency on shunts. Careful patient selection, skilled surgical execution and rigorous postoperative care can minimize complications.

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Key Words
Hydrocephalus, endoscopic third ventriculostomy, etv, cerebrospinal fluid, neurosurgery, obstructive hydrocephalus, pediatric hydrocephalus, aqueductal stenosis, ventriculoperitoneal shunt

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INTRODUCTION

Hydrocephalus is characterised by the enlargement of all the ventricles in the brain, either caused by excessive production of Cerebrospinal Fluid (CSF) or reduced absorption. It is the prevailing ailment among children that necessitates prompt neurosurgical intervention[1]. This could occur due to the obstruction of cerebrospinal fluid (CSF) flow from the ventricles, limited CSF movement in the subarachnoid spaces surrounding the brain, or inadequate CSF absorption in the circulation from the subarachnoid areas. The causes of hydrocephalus include congenital abnormalities, infections such as meningitis, cerebral haemorrhaging and brain tumours[2]. Hydrocephalus and brain abnormalities can be observed in certain individuals with a slight elevation in intracranial pressure. However, in other individuals, elevated intracranial pressure does not have any impact on the ventricles or the functioning of the brain[3]. The occurrence of hydrocephalus in humans is characterised by a bimodal age distribution. There is a single peak that happens during childhood and is associated with specific birth defects. There is another increase that occurs during adulthood, primarily caused by NPH. Approximately 40% of hydrocephalus cases are attributed to adults. Despite significant advancements in understanding the long-term and social consequences of paediatric hydrocephalus, there remains a substantial amount of knowledge yet to be acquired[4]. Hydrocephalus is common in individuals with open neural tube defects, specifically spina bifida cystica. However, it has only been observed in individuals with closed neural tube abnormalities, specifically spina bifida occulta. Due to this unusual yet possible connection, it is advised that individuals with closed neural tube abnormalities undergo assessment for clinical indications and symptoms of hydrocephalus[5]. A study was conducted to evaluate patients with Acquired Hydrocephalus and it was found that they exhibited post-trauma sequelae. They constitute 0.7% of patients with traumatic brain injury. Hydrocephalus manifested symptoms within 1 year following the trauma. The incidence of post-traumatic hydrocephalus is primarily increased by infections such as meningitis, subarachnoid haemorrhage (SAH), tumours in the posterior fossa, intra-cerebral bleed and surgical procedures like craniotomy followed by trauma. A ventriculoperitoneal (VP) shunt was successfully inserted in all patients. Out of the total, 8 patients showed significant improvement, while 4 patients experienced a slower rate of improvement[6]. The Ventriculoperitoneal Shunt (VP shunt) is the most commonly performed surgical procedure for the treatment of hydrocephalus. Endoscopic third ventriculostomy (ETV) is a surgical procedure that serves as an alternative option. Shunts frequently experience complications such as infection, shunt obstruction, shunt catheter breakage and other issues[7]. They are vulnerable to infection, particularly within the initial three months after undergoing surgery. Shunt infections have the potential to cause death and the process of treating them is both expensive and requires a significant amount of time. VP shunts have an equal likelihood of failure. A recent extensive prospective multi-institutional study found that within a span of two years after the initial shunt insertion, 40% of patients necessitated a shunt revision[7]. Endoscopic third ventriculostomy (ETV) is a viable alternative procedure for treating Obstructive Hydrocephalus[8]. This treatment does not involve any surgical procedures or incisions. Additionally, it serves to hinder infection, reliance on shunt, malfunction of the shunt and the expenses associated with a shunt. If hydrocephalus is a result of obstruction in the flow of cerebrospinal fluid (CSF) within the ventricles, obstruction in the normal outflow of CSF from the fourth ventricle, or obstruction in the CSF flow within the basal subarachnoid areas surrounding the fourth ventricle, the endoscopic third ventriculostomy (ETV) procedure will bypass any of these obstructions. Based on the literature, utilising ETV as the main treatment for hydrocephalus is secure and can lead to a decrease of up to 21% in the number of patients requiring shunting among all newly diagnosed hydrocephalic patients. Complications in individuals undergoing ETV treatment are unrelated to their age[9]. When performed correctly, endoscopic third ventriculostomy is a secure, uncomplicated and effective treatment choice for non-communicating hydrocephalus[10]. Endoscopy offers a superior visual examination of the surgical area compared to VP shunt. Consequently, a recent study proposes that ETV should be employed as the main therapy for obstructive hydrocephalus[11].

MATERIAL AND METHODS

In this prospective study 40 patients underwent endoscopic third ventriculostomy (ETV) for obstructive hydrocephalus. The study was conducted in three years from 2022 to 2024 in the department of Neurosurgery J.A. Group of Hospitals and G.R. Medical College, Gwalior, MP, India.

Inclusion Criteria:

- Patient of all age who are diagnosis of obstructive hydrocephalus, which can be confirmed by imaging studies such as MRI or CT scans.
- The obstruction must be located at or near the aqueduct of Silvius, which connects the third and fourth ventricles of the brain.
- Patient willing to participate in study and provide informed written consent.

Exclusion Criteria:

- Patients with bleeding disorders, which may increase the risk of bleeding during the procedure.
- Patient with history of previous venricular shunt or ETV surgery.
- Basilar invagination, which is a deformity of the skull base.

The following data can be collected before and after ETV procedure:

- Patient demographics: age, sex and medical history
- Imaging studies: CT scans or MRI brain to evaluate the etiology, extent of hydrocephalus and to locate the site for ETV.
- Intraoperative data: surgical time, complications and success of the procedure.
- Postoperative data: duration of hospitalization, pain management and complications.
- Follow-up data: long-term outcome measures such as neurological function, recurrence of symptoms and need for further treatment.

The aim of ETV is to communicate the third ventricle with the interpeduncular cistern and create flow which bypasses an obstruction to the circulation of the CSF, The important step in preoperative planning is the assessment of conditions for fenestration in the floor of the third ventricle. During the ETV procedure the patient was positioned supine with flexed head stabilized in a Mayfield head holder. The rigid Karl Storz model endoscope with 0° optics having the outer diameter of 6.5 mm and 3 mm working channel diameter was the most commonly used.

Ventricular Entry Point: Entry point should be based on the size and configuration of the ventricles of the patient. The optimal trajectory of the endoscopic approach to the floor of the third ventricle was obtained by a burr hole placed in the right frontal area 1 cm in front of the coronal suture and 2–3 cm from the midline (Kocher's point). In some patients placement of the entry point was modified based on planimetric measurements made on sagittal scans. It is important to maintain straight trajectory as much as possible to the foramen of Monro and floor of the third ventricle. Modification of entry point is particularly important in cases where ETV and biopsy are simultaneously required such as in cases of pineal region tumors that extend into the 3rd ventricle,

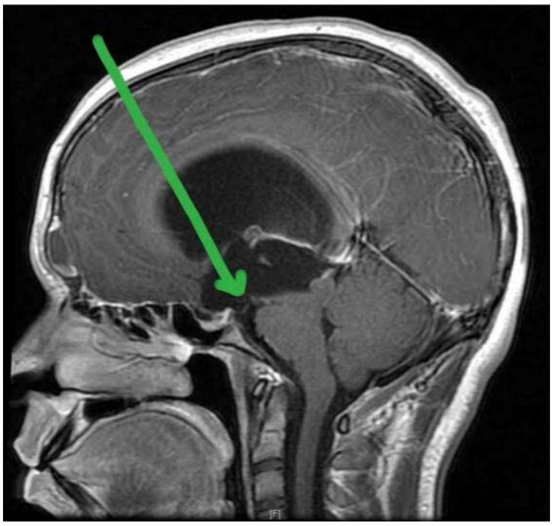

Fig. 1: Preoperative MRI with showing trajectory for ETV

Because of possible bleeding from the tumor, we perform the ETV first and then perform the biopsy later (Fig. 1).

Third Ventricular Penetration: The intracranial approach was performed with the burr hole diameter of 10 mm. After dura incision and arachnoid coagulation, the lateral ventricle was punctured using a Cushing needle that was directed towards the base of the nose and external acoustic foramen. Using the same trajectory the endoscopic sheath was introduced After the lateral ventricle was reached, the foramen of Monro identified , great anatomical landmark was the choroid plexus passing through the foramen of Monro to the third ventricle and visible in its lower margin the point where the thalamostriate vein unites with the septal vein. Then the endoscope was introduced into the third ventricle, keeping a safe distance from the structures In the third ventricle the infundibular recess, mammillary bodies and if possible were indentified. Ventriculostomy was performed in the anterior part of triangle formed by infundibular recess and mammillary bodies by perforation of the floor of the third ventricle to the interpeduncular cistern. If the floor was thin, use of a Fogarty balloon catheter no. 3 was sufficient. In case of increased vascularization of the floor, bipolar coagulation was used first and then a Fogarty catheter or forceps to enlarge the perforationwith irrigation of the operative field with Ringer's solution at the temperature of 36-37°C (Fig. 2).

To evaluate the treatment results, clinical criteria were used. Neurological examination was performed according to the generally applicable protocol. The first

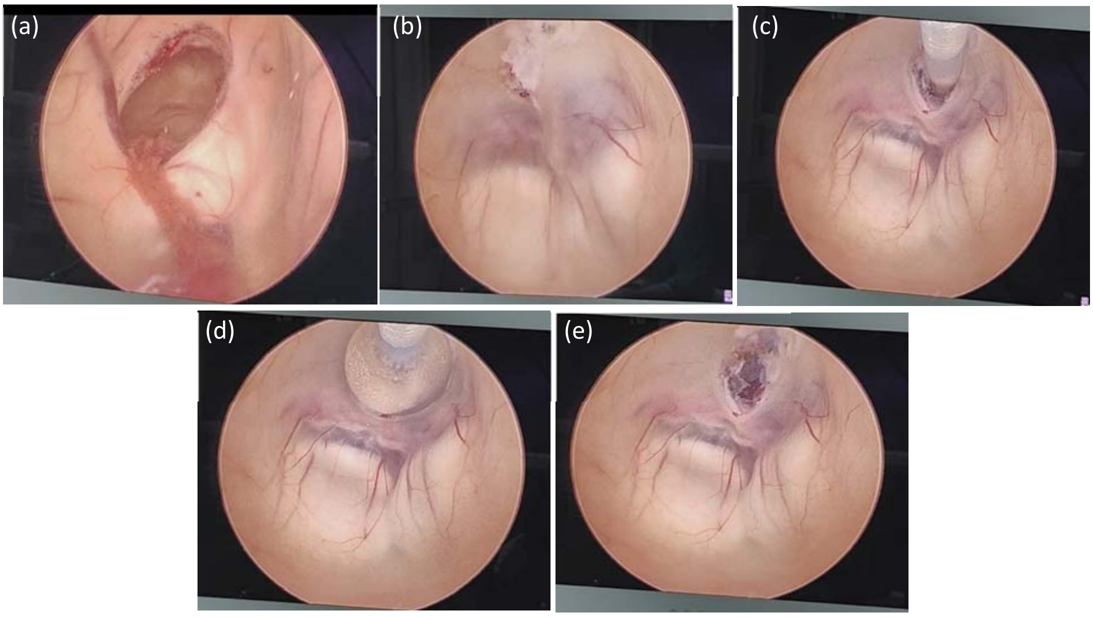

Fig. 2: Stages of Ventriculo Stomy, A: Lateral ventricle and inteventricular foramen, B: Third ventricular floor with infundibulo- mammilary triangle, C: Third ventricle floor perforation with Fogarty catheter, D: Enlargement of perforation with balloon inflation, E: Third ventricle floor with ventriculostomy performed.

follow-up scan was carried out within first weak and the criteria for clinical improvement were remission of symptoms of intracranial hypertension, cognitive and locomotor functions improvement and sphincter control improvement.

Statistical Analysis: Descriptive statistics will be used to summarize demographic and clinical data. The success rate of ETV will be calculated as the percentage of patients who experience symptom relief.Univariate and multivariate analysis will be conducted to identify predictor of success and risk factors of complications.

RESULTS

The age distribution of the 40 patients in the study reveals that the majority of Hydrocephalus cases occur in children and adolescents. No cases were reported in infants younger than one month. The incidence of Hydrocephalus was 5% in infants aged 1 to 6 months and 10% in those aged 6 months to 1 year. A significant proportion of the cases, 40%, were seen in children aged 1 to 10 years. Adolescents aged 10 to 20 years accounted for 32.5% of the cases. Hydrocephalus cases in adults were less common, with 5% in both the 20 to 40 years and 40 to 60 years age groups and only 2.5% in those older than 60 years. This distribution highlights a higher vulnerability to Hydrocephalus in younger age groups, particularly children and adolescents (Table 1).

The symptom distribution among the 40 patients demonstrates a range of neurological presentations, with headache being the most prevalent, affecting 67.5% of individuals, increased head circumference 60%, Vomiting follows with 37.5% of patients experiencing it, while gait disturbance, visual blurring, altered sensorium and urinary incontinence are reported in 22.5% to 27.5% of cases. Memory deficit and seizures are less common, affecting 10% and 5% of patients, respectively. Additionally, one patient reported other symptoms, representing 2.5% of the total sample. This distribution highlights the prominence of headache as a primary symptom, alongside a constellation of other neurological manifestations in varying frequencies (Table 2).

In a sample of 40 patients, comprising 75% males and 25% females, there is a notable disparity in sex distribution. The majority, accounting for 30 individuals, are male, while the remaining 10 are

Table 1: Age distribution

Age	Number of patients (n = 40)	%
<1 months	0	0
1-6 months	2	5
6 months - 1 year	4	10
1-10 years	16	40
10-20 years	13	32.5
20-40 years	2	5
40-60 years	2	5
>60 years	1	2.5

Table 2: Symptoms wise distribution

Symptoms	Number of patients (n=40)	%
Headache	27	67.5
Increase head circumference	24	60
Vomiting	15	37.5
Gait disturbance	9	22.5
Visual Blurred	11	27.5
Aaltered sensorium	9	22.5
Urinary incontinence	10	25
Memory deficit	4	10
Seizure	2	5

Table 3: Sex wise distribution

Sex wise distribution	Number of patients (n = 40)	%
Male	30	75
Female	10	25

Table 4: Diagnosis wise distribution

Diagnosis	Number of patients (n = 40)	%
Hydrocephalus with Aqueductal stenosis	25	62.5
Posterior third ventricular sol	6	15
Brainstem sol	5	12.5
posterior fossa sol	4	10

Table 5: Procedure wise distribution

Procedure	Number of patients (n=40)	%
ETV only	32	80
ETV + Biopsy	8	20

Table 6: Complications wise distribution

complications	Number of patients (n = 40)	%
intraoperative interventricular bleeding	1	2.5
CSF leak	4	10
meningitis	2	5
wound infection	2	5
seizure	2	5

Table 7: Success rate of ETV age wise distribution

Age group	Number of patients (n = 40)	Symptomatically improved
<1 months	0	0
1-6 months	2	2
6 months - 1 year	4	1
1- 10 years	16	11
10-20 years	13	9
20-40 years	2	2
40-60 years	2	2
>60 years	1	1

Table 8: Success rate of ETV with different pathology

	Number of patients (n = 40)	Symptomatically improved
Hydrocephalus with Aqueductal stenosis	25	18
Posterior third ventricular sol	6	4
Brainstem sol	5	3
Posterior fossa sol	4	2

female. This discrepancy underscores a gender imbalance within the sample population, potentially highlighting differing health-seeking behaviors, prevalence of certain conditions, or access to healthcare services among males and females. Understanding and addressing these variations is crucial for equitable healthcare provision and effective public health interventions (Table 3).

Among 40 patients, the diagnosis-wise distribution reveals that congenital hydrocephalus with aqueductal stenosis is the most prevalent condition, comprising 62.5% of cases. This is followed by posterior third ventricular sol, which accounts for 15% of diagnoses, brainstem sol at 12.5% and posterior fossa sol at 10%. The predominance of congenital hydrocephalus with aqueductal stenosis underscores its significance within this patient cohort, necessitating tailored management strategies and emphasizing the need for further research and intervention in this area (Table 4).

In the procedural distribution among 40 patients, the majority underwent endoscopic third ventriculostomy (ETV) only, constituting 80 of cases. A smaller subset, comprising 20 of patients, underwent a combined procedure of ETV along with biopsy. This highlights the prevalent use of ETV as a primary intervention in this patient cohort, potentially indicating its efficacy as a standalone procedure for managing the specified diagnoses, while the utilization of combined procedures underscores the necessity for additional diagnostic information or therapeutic interventions in select cases (Table 5).

In the complications distribution among 40 patients, various adverse events were observed following procedures. Intraoperative interventricular bleeding occurred in 2.5% of cases, while CSF leak, meningitis, wound infection and seizure each affected 10%, 5%, 5% and 5% of patients, respectively. These complications underscore the inherent risks associated with neurosurgical interventions, highlighting the importance of vigilant perioperative management and postoperative care to mitigate such adverse outcomes. Additionally, understanding the frequency and nature of these complications is vital for refining surgical techniques and improving patient safety in neurosurgical practice (Table 6).

The success rate of endoscopic third ventriculostomy (ETV) in 40 patients, categorized by age, demonstrates varying outcomes. No procedures were performed on infants younger than one month. Among the 1 to 6 months age group, both patients experienced symptomatic improvement. In the 6 months to 1 year group, only one out of four patients showed improvement. Children aged 1 to 10 years had a higher success rate, with 11 out of 16 patients improving symptomatically. In the 10 to 20 years group, 9 out of 13 patients showed improvement. Both patients in the 20 to 40 years and 40 to 60 years age groups experienced symptomatic relief. The single patient older than 60 years also showed improvement. Overall, the data indicate a generally favorable success rate of ETV across various age groups, with particularly notable success in younger patients (Table 7).

The success rate of endoscopic third ventriculostomy (ETV) varies across different pathologies within a cohort of 40 patients. Among patients diagnosed with congenital hydrocephalus with aqueductal stenosis, ETV was successful in 72% of cases out of 25 procedures performed. For patients with posterior third ventricular sol, the success rate was 66.7% out of 6 procedures. In cases of brainstem sol, ETV was successful in 60% of cases out of 5 procedures and for patients with posterior fossa sol, the success rate was 50% out of 4 procedures. This distribution demonstrates varying success rates of ETV across different pathologies, with the highest success rate observed in cases of congenital hydrocephalus with aqueductal stenosis (Table 8).

DISCUSSION

Endoscopic third ventriculostomy (ETV) is a safe, minimally invasive and effective way to treat blocked hydrocephalus. It's most likely to work for aqueductal stenosis and posterior fossa tumours, but not so much for hydrocephalus caused by tuberculous meningitis[22].

The study presents a comprehensive analysis of the demographic, symptomatic and procedural characteristics of 40 patients undergoing endoscopic third ventriculostomy (ETV) for obstructive hydrocephalus. The age distribution indicates a predominant representation of younger patients, with 65% being infants to early childhood. Specifically, 25% of the patients were under one month old and another 25% between one to six months old, highlighting a significant burden of hydrocephalus in early life. This trend diminishes with increasing age, reflecting the congenital nature of many hydrocephalus cases in this cohort. Khanzada K and Rehman ZU also assert that the most frequent cause is a tumour in the posterior fossa, accounting for 44% of cases, followed by acqueductal stenosis in 25.9% of cases, which aligns with our study findings[23].

Symptomatically, headache was the most prevalent complaint, reported by 67.5% of patients, followed by vomiting (37.5%), visual blurring (27.5%) and gait disturbances (22.5%). These symptoms underscore the diverse neurological impacts of hydrocephalus, necessitating timely intervention to alleviate patient suffering and prevent further complications.

The gender distribution revealed a significant male predominance, with males comprising 75% of the sample. This disparity might reflect underlying epidemiological trends or differences in healthcare-seeking behavior between genders. Diagnostic data indicated that congenital hydrocephalus with aqueductal stenosis was the most common condition, affecting 62.5% of patients. Other diagnoses included posterior third ventricular sol (15%), brainstem sol (12.5%) and posterior fossa sol (10%). The high prevalence of congenital hydrocephalus highlights the importance of early detection and intervention in pediatric populations. Procedurally, the majority (87.5%) underwent ETV alone, with a smaller subset (12.5%) receiving both ETV and biopsy, indicating the primary role of ETV as a standalone treatment. The success rate of ETV varied with age and pathology. Younger patients, particularly those under one month and between one to six months, had success rates of 60% and 70%, respectively. Higher success rates were observed in older patients, with 100% success in those aged 20-40 years, 40-60 years and over 60 years. Pathology-wise, ETV was most successful in patients with congenital hydrocephalus with aqueductal stenosis (72%), while lower success rates were observed in those with brainstem sol (60%) and posterior fossa sol (50%).

A total of 5 (5.85%) cases underwent ETV and tumour biopsies. Hopf et al. have documented a success rate of 76% using endoscopic third ventriculostomy (ETV) in treating obstructive hydrocephalus caused by tumours in the posterior fossa[24]. In a similar vein, Mumtaz Ali, et al. documented that the overall success rate of endoscopic third ventriculostomy (ETV) was 74%. [25] Based on the data from 80 patients who received treatment. The success rates for treating aqueductal stenosis, posterior fossa, CP angle tumours and pineal tumours are 88%, 87% and 70% respectively, as observed in the study.Another study indicates that 9% of patients underwent a ventriculoperitoneal shunt due to an insufficient ventriculostomy, which is similar to our findings[26].

Complications were relatively infrequent but significant, with CSF leaks occurring in 10% of patients, followed by meningitis, wound infection and seizures each affecting 5%. Intraoperative interventricular bleeding was noted in 2.5% of cases, emphasizing the importance of meticulous surgical technique and postoperative care. Multiple studies have indicated that the failure rate of ETV ranges from 6% to 50%[27]. In our study, the rate of ETV failure was 11.7%. A study undertaken by Brohi SR et al. After completing the endoscopic third ventriculostomy (ETV), the documented total complication rate was 20.8%[28].

CONCLUSION

Endoscopic third ventriculostomy (ETV) is a minimally invasive, safe and effective treatment for obstructive hydrocephalus. The success rate is greater in children who are under the age of 10. The total effectiveness rate ranges from 70% to 80% across several research. The efficacy of this operation is assessed based on enhancements in clinical manifestations, radiographic findings and absence of shunt dependency. The most frequent problems are haemorrhage, damage to adjacent brain structures, seizures and cerebrospinal fluid (CSF) leaking. These difficulties can be reduced by carefully selecting the patient, performing the surgery with expertise and providing rigorous post-operative care.

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