Original Article

Assessing the Effectiveness of Neuro-Endoscopic Procedures in the Treatment of Hydrocephalus

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ABSTRACT

Objective: This study investigated the efficacy of neuro-endoscopic procedures as treatment modalities for this disorder, specifically endoscopic third ventriculostomy (ETV), endoscopic ventriculocisternostomy (EVC), and choroid plexus coagulation (CPC).

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Department of neurosurgery LRH Peshawar from January 2023 to June, 2023.

Materials and Methods: We retrospectively evaluated the long-term outcomes, patient selection criteria, post-operative complications, and integration of neuro-endoscopic procedures in 88 patients suffering from hydrocephalus presented during 05 study years.

Results: Demographic characteristics of patients indicated that majority of patients were under 10 years old, 29 (32.95%) out of 88 patients were male and 61 patients (69.31%) were already on chemotherapy ($p<0.05$). Mean pre-operative ventricular cyst volume was 1.30 ± 0.33 cm^3 while, post-operative was substantially reduced to 0.48 ± 0.10 cm^3 ($p<0.05$). Clinical outcomes for hydrocephalus patients revealed that 61 patients (69.31%), experienced successful symptom relief ($p<0.05$), 13 patients (14.77%) experienced partial relief while, and 11 patients (12.50%) experienced complications. Their average quality of life score was 82 ($p<0.05$) but 14.77% required some form of re-intervention and three patients passed away. Infection was the most common complication ($p<0.05$), affecting nine patients (10.22%).

Conclusion: Neuro-endoscopic is the minimally invasive, safe, effective and compatible procedure as treatment modality for hydrocephalus. It offered substantial benefits and favorable long term outcome compared to conventional shunt systems.

Key Words: Brain tumor; Intra-cranial pressure; Minimally invasive surgery; Shunt system; Ventriculocisternostomy.

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INTRODUCTION

Hydrocephalus is a neurological disorder characterized by an abnormal accumulation of cerebrospinal fluid (CSF) in the ventricular system or subarachnoid spaces of the brain. This complex disorder, which has been recognized for centuries, continues to be a subject of intensive research and development, posing a persistent challenge to neurology and neurosurgery.

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Hydrocephalus manifests across a broad age range, from newborns to the elderly, and its causes are diverse[1-2]. Although multifaceted, the pathophysiology of hydrocephalus is fundamentally based on the imbalance between CSF production and subsequent absorption[3]. CSF is typically absorbed into the bloodstream by arachnoid granulations after travelling through the ventricular system and being primarily produced by the choroid plexus residing within the brain's ventricles[5]. Any disruption to this balanced cycle can result in hydrocephalus. Numerous causes, such as congenital malformations, intracranial hemorrhages, meningitis, and tumors, can obstruct the normal flow or absorption of CSF, resulting in this condition.

By optimizing CSF circulation, the primary objective of hydrocephalus treatment is to reduce or normalize intracranial pressure[6]. Conventionally, shunt systems are used to divert excess CSF from the brain to another part of the body for absorption. These systems have limitations and potential complications, such as shunt malfunction and infection, despite their ubiquitous use[7-8]. In non-communicating hydrocephalus, surgical interventions such as endoscopic third ventriculostomy

(ETV), which creates an alternative pathway for CSF flow, are favored. In addition, pharmacological treatments that target CSF production are being evaluated, despite the fact that their efficacy has not been conclusively established[9-10].

The most common neuro-endoscopic hydrocephalus treatment is ETV, which opens the third ventricle floor to allow CSF to bypass an obstruction. Obstructive or "non-communicating" hydrocephalus is often treated first[11]. Growing research supports neuro-endoscopic hydrocephalus treatment[12]. ETV success rates range from 60% to 90%, depending on patient age, hydrocephalus aetiology, and shunt history, according to numerous research. Despite its potential, ETV has drawbacks. CSF leaks, infections, and hemorrhages are prominent[13-14].

Neuro-endoscopic treatments for hydrocephalus have been examined, but long-term outcomes, ideal patient selection criteria, and post-operative consequences are still unknown[15]. To fill these gaps, longitudinal, multicenter, well-structured research are needed. This study evaluated the long-term success rates and quality of life improvements of neuro-endoscopic procedures, assessed the spectrum of associated complications and developed guidelines for their prompt recognition and effective management, and investigated the efficacy of integrating neuro-endoscopic procedures with other treatment modalities, such as pharmacotherapy or simultaneous shunt placement, in specific patient populations.

MATERIALS AND METHODS

From January to June 2023, LRH Peshawar's neurosurgery department did this study. The study is retrospective. It comprises data collection and analysis from Mardan Medical Complex hydrocephalus patients who received neuro-endoscopic procedures. The data came from 88 hydrocephalus patients who received neuro-endoscopic procedures from July 2017 to November 2022. The hospital's ethics committee's confidentiality and privacy rules guided data collection.

The investigation included neuro-endoscopic hydrocephalus patients of any age or gender. Insufficient medical data, lost to follow-up, or simultaneous brain surgeries eliminated patients from the study.

Neuro-endoscopic operations address hydrocephalus and other neurological diseases. Invasive surgeries are reduced. The procedure varies on hydrocephalus' cause and patient. Endoscopic Third Ventriculostomy is the most frequent neuro-endoscopic hydrocephalus therapy. Preparations were careful before the surgery. CT and MRI images demonstrate hydrocephalus obstruction of the brain, ventricular system. Patients frequently had general anesthesia. The patient was supine or prone for a 3 cm scalp incision. A particular drill created a skull burr hole. This allowed narrow-diameter endoscopy. The burr hole puts the endoscope's camera and light into the brain's ventricular system.

The endoscope was carefully directed to the third ventricle floor to create a small CSF hole to lower intracranial pressure. After ventriculostomy success, the endoscope was gently removed. A small plate covered the cranial burr hole, and stitches closed the scalp incision. The patient was hospitalized for days after surgery. To verify surgery success, further imaging scans were routinely done. The patient was monitored for infection and other issues.

Patients received procedures to treat symptoms, remove lesions, and lower hydrocephalus-related intracranial pressure. Patients' medical histories, physical examinations, CT, MRI, surgery reports, pathological results, and follow-ups were utilized. Demographics, hydrocephalus type, neuro-endoscopic procedure, surgical problems, follow-up period, and clinical findings were obtained. The major goals were symptom alleviation and ventricular size reduction, whereas the secondary objectives were procedure-related issues and repeat procedures or shunt installation 20.

The data were input into Excel and analyzed using SPSS 26.0. Mean, standard deviation, and median described continuous numbers, whereas frequencies and percentages described categorical ones. ANOVA or Chi-square compared categorical and continuous variables. P-values ≤ 0.05 were significant.

The hospital's IRB authorized the experiment. This retrospective inquiry waived consent. To preserve anonymity, all identifying information was erased before data processing.

RESULTS

The research categorized patients by age: under 10 (48.86%), 11-30 (19.33%), and over 30 (31.81%), with significant age differences ($p<0.05$). Out of 88 patients, 29 (32.95%) were male and 59 (67.05%) were female ($p<0.05$). Prior to the trial, 61 patients (69.31%) had chemotherapy, whereas 27 patients (30.69%) did not get any treatment ($p<0.05$) (Table 1). Congenital abnormalities caused hydrocephalus in 14, intraventricular hemorrhage in 11, brain tumors in 8, traumatic brain injury in 18, meningitis in 17, subarachnoid hemorrhage in 7, and other unexplained causes in 13. Each disrupts cerebrospinal fluid flow, creating hydrocephalus (Figure 1). Cephalalgia was the most prevalent hydrocephalus symptom, affecting 78%. Hydrocephalus' high intracranial pressure likely caused this. 41% of patients had large heads, especially neonates and young toddlers with unjoined skull bones. 25% had urinary incontinence and 32% balanced gait difficulties. Additionally, 31% of patients experienced impaired vision, 25% cognitive impairments, and 39% vomiting, which may be related by excessive intracranial pressure (Figure 2).The group of hydrocephalus patients had pre- and post-operative ventricular cyst volumes measured. The pre-operative ventricular cyst volume was 1.30+0.33 cm3, whereas the post-operative volume was dramatically reduced to 0.48+0.10 cm3 (p<0.05). These patients had less ventricular lesions after the operation (Table 2).Hydrocephalus patients having ETV exhibited successful symptom therapy in 61 (69.31%), partial alleviation in 13 (14.77%), and no change in three (3.40%). Table 3 shows 11 (12.50%) individuals encountered issues. After receiving ETV for hydrocephalus, patients had an average quality of life score of 82, indicating a favorable post-operative status (p<0.05). Thirteen patients (14.77%) required re-intervention, and three died throughout the experiment. The slight life score increase to 85 improved patients' quality of life. Three fatalities caused a three-year mortality rate of 9.41% (Table 4). Nine patients (10.22%) had infection, the most common result (p<0.05). Four patients suffered hemorrhage, four CSF leakage, two brain structural damage, and 1.13% memory and paralysis (Table 5).

Table No.1: Demographic characteristics of patients

S. No	Demographic value	Number of patients n=88	Frequency (%)	p-value
1	Age (years) <10 11-30 >30	 43 (88) 17 (88) 28 (88)	 (48.86) (19.33) (31.81)	0.00001*
2	Gender (n) Male Female	 29 (88) 59 (88)	 (32.95) (67.05)	0.00001*
3	Previous treatments (n) Chemo-therapy None	61 (88) 27 (88)	(69.31) (30.69)	0.00001*

***indicated that the p-value was significant at p<0.05**

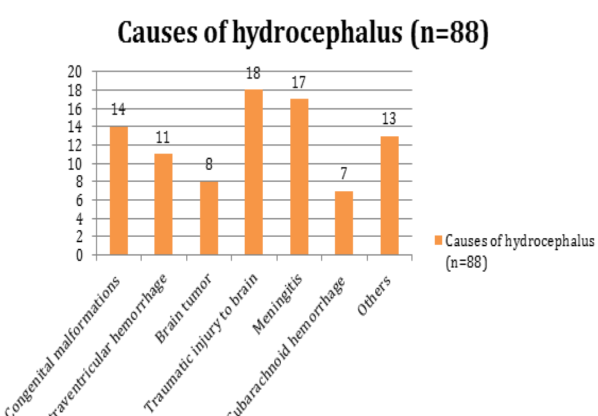

Figure No.1: Causes of hydrocephalus in study patients

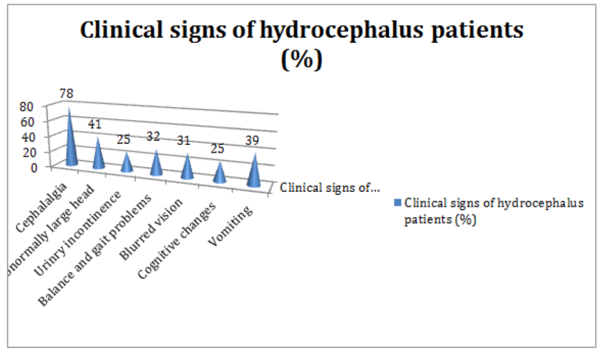

Figure No.2: Clinical manifestations of hydrocephalus in study group

Table No.2: Pre-operative and post-operative clinical and radiological outcomes

S. No	Mean pre-operative ventricular cyst volume (cm^3)	Mean post-operative ventricular cyst volume (cm^3)	F-value	p-value
1	1.30+0.33	0.48+0.10	5.1441	0.0530

Table No.3: Clinical outcomes of hydrocephalus patients subjected to ETV

S. No	Clinical outcome of ETV	No. of patients (n)	Frequency (%)	P-value
1	Successful alleviation of symptoms	61	69.31	0.00001*
2	Partial alleviation of symptoms	13	14.77	
3	No improvement	03	3.40	
4	Onset of complications	11	12.50	

***indicated that the p-value was significant at p<0.05**

Table No.4: Long term outcome and follow-up of the cases

S. No	No. of patients (n)	Follow-up periods (months)	Life score	Re-intervention n(%)	Mortality n(%)
1	88	12	82	13	3
2	85	24	85	08	2
3	83	36	90	03	3

Table No.5: Complications after ETV in hydrocephalus patients

S. No	Complications	No. of patients (n)	Frequency (%)	p-value
1	Infection	09	10.22	

2	Bleeding	04	4.54	0.00010*
3	Leakage of CSF	04	4.54	
4	Damage to brain structures	02	2.27	
5	Memory issues	01	1.13	
6	Paralysis	01	1.13	

***indicated that the p-value was significant at p<0.05**

DISCUSSION

Hydrocephalus patients' demographics, clinical features, and results were examined in this research. The age distribution of patients in the research showed that most were under 10. The majority of patients were women. Hydrocephalus is caused by congenital abnormalities, bleeding, tumors, and trauma. The patient group had cephalalgia, enlarged skull, urine incontinence, and poor eyesight. ETV therapy dramatically decreased ventricular cyst volume, suggesting success. Most patients had symptom alleviation, improving life quality. However, a tiny minority of individuals had problems, mostly infections. Understanding hydrocephalus' demographics, clinical features, and ETV intervention's effectiveness is stressed in the research. We concluded that neuroendoscopy treats hydrocephalus safely and effectively. The research found that neuroendoscopy improved outcomes over non-neuroendoscopy. Neuroendoscopy patients had less blood loss, operation time, symptom alleviation, and complete resection. The neuroendoscopy group had no cyst recurrence, whereas the non-neuroendoscopy group had 20.5%. During follow-up, neuroendoscopy patients' transitory fever and subdural fluid buildup were addressed. The clinical results of lateral ventricle arachnoid lesions treated with neuroendoscopic treatment were better than non-neuroendoscopic procedures[16]. Neuroendoscopy and microsurgical resection for intraventricular lesions are equally effective and safe, according to our study. Multiple studies suggest that neuroendoscopy reduces morbidity and shortens hospital stays for adult and pediatric patients, allowing them to return to work faster[17]. The conventionally-treated group experienced more surgical complications and worse results than the neuroendoscopic group[18]. Neuroendoscopy was comparable in pediatric and adult neurosurgical populations, with infection being the most common consequence, although it was deemed a substantial therapeutic option for adult patients who qualified[19]. Another research found that primary aqueductal stenosis patients benefited best from ETV treatment. Treatment effectiveness is not simply dependent by ventricular size. In shunting patients, ETV was effective, although the result was difficult to predict. ETV is a palliative treatment option for oncological patients with secondary hydrocephalus and a prelude to further treatment 24.Another retrospective study examined 90 endoscopically treated loculated hydrocephalus patients. 37 (41.1%) children with multiloculated hydrocephalus, 37 (41.1%) with isolated lateral ventricle, 13 (14.4%) with excluded temporal lobe, and 3 (3.3%) with isolated fourth ventricle were studied. The average number of endoscopic treatments per patient was 1.91, with 42.2% needing just one. Neuroendoscopy caused problems in 17 children (18.9%) and shunt operations in 52 (57.8%). At the last follow-up, 28.9% of children were shunt-free and 47.8% had one. Long-term loculated hydrocephalus therapy with neuroendoscopy proved successful. In situations of distorted anatomy, neuronavigation and intraoperative ultrasonography improved success[20,11].

CONCLUSION

Minimally invasive neurosurgery is the alternative method for treating various neurological conditions. It has been demonstrated to be an effective, minimally invasive and relatively safe treatment for patients with hydrocephalus. The study offered significant insights into the efficacy of neuro-endoscopic procedures as treatment modality for hydrocephalus. It offered substantial benefits, particularly in cases of non-communicating hydrocephalus. Compared to conventional shunt systems, these include higher success rates, improved long-term patient outcomes, enhanced quality of life, and fewer complications and surgical revisions. The importance of patient selection for the successful implementation of neuro-endoscopic procedures is a key finding of this study. However, additional research is required in this regard. Despite the promising outcomes of neuro-endoscopic procedures, it is important to note that they are associated with their own set of complications, which are typically less frequent and less severe than those associated with conventional shunt systems. Future research should focus on refining and standardizing identification and treatment protocols for these complications.

Author's Contribution:

Concept & Design of Study:	Haider Ali
Drafting:	Muhammad Mushtaq, Waheed Alam
Data Analysis:	Ali Haider
Revisiting Critically:	Haider Ali, Muhammad Mushtaq
Final Approval of version:	Haider Ali

Conflict of Interest: The study has no conflict of interest to declare by any author.

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