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A cross-Sectional Study of Iraqi Patients to find out The Role of Endoscopic Third Ventriculostomy in the Treatment of Hydrocephalus

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Abstract: **Background:** The endoscopic third ventriculostomy (EVT) is widely regarded as the optimal surgical technique for treating hydrocephalus, regardless of its underlying cause. **Objective:** This study aims to evaluate the effectiveness of endoscopic third ventriculostomy in the treatment of hydrocephalus patients. **Patients and Methods:** Clinical data was collected from patients aged between 20 and 60 who underwent the endoscopic third ventriculostomy procedure at different hospitals in Iraq between July 15th, 2022, and August 18th, 2023. The study assessed the success and failure rates of the procedure, as well as the 24-month survival outcomes, using the Kaplan-Meier method. **Results:** Among all patients, there were 20 cases of infection, with the highest rate observed in patients aged between 50 and 60. Males accounted for 35 cases, surpassing females who had 20 cases. The follow-up period for surgical results was five years, with an average hospital stay of 7 days. Three patients exhibited high heart rate, while four patients had high blood pressure. Out of the total 55 patients, 51 experienced successful ETV surgical outcomes, while four were unsuccessful. Postoperative complications were recorded in eight patients. **Conclusion:** The endoscopic third ventriculostomy (EVT) technique is the preferred alternative to ventriculoperitoneal shunt for the treatment of hydrocephalus patients.

Keywords: Hydrocephalus; Endoscopic third ventriculostomy (ETV); Kaplan-Meier.

INTRODUCTION

During the 20th century, ventriculoperitoneal bypass surgery (HSV) was the primary classical method for treating hydrocephalus [Algin, O. *et al*., 2015]. The introduction of HPV significantly improved the prognosis for these patients, shifting from a life-threatening condition to a relatively favorable outcome post-surgery [Borcek, A. O. *et al*., 2017]. The advantages of using shunts in neurosurgery were evident, surpassing any drawbacks, as they allowed for a relatively simple surgical technique that greatly enhanced the quality of life for hydrocephalus patients [Hellwig, D. *et al*., 2005]. However, it became apparent over time that patients who underwent these operations became shunt-dependent and required lifelong supervision from various specialists, including neurosurgeons. Furthermore, the use of shunts often led to multiple complications that necessitated additional surgical interventions [Drake, J. M. *et al*., 2009]. Consequently, the introduction of neuroendoscopy was met with great enthusiasm among surgeons, as it offered patients the opportunity to avoid reliance on ventricular bypass systems and the associated complications. [Breimer, G. E. *et al*., 2013]

Ventriculocisternostomy has regained significant recognition in hydrocephalus treatment. The high frequency of malfunctions in cerebrospinal fluid bypass valves, which had been the almost exclusive treatment for hydrocephalus for many years, compelled many surgeons to master the ventriculocisternostomy technique. [Simon, T. D. *et al*., 2008; Feng, H. *et al*., 2004]

Although the success rate published varies between 50% and 80%, with a higher percentage in patients under one year if choroidal plexus coagulation is performed [Bouras, T. *et al*., 2013], the failure of endoscopic ventriculostomy and its treatment remains a subject of controversy [Lee, S. H. *et al*., 2011]. The incidence and risk factors associated with the closure of the ostomy are still unknown, as it can occur early or late and varies with the patient's age [Gangemi, M. *et al*., 2007]. Current evidence suggests that in patients under two years of age, endoscopy failure is linked to poor cerebrospinal fluid (CSF) absorption due to

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the underdevelopment of Paccioni granulations, while in older patients, it is due to ostomy closure. [Foley, R. W. *et al*., 2016; Schroeder, H. W. *et al*., 2002]

Neuroendoscopy emerged as a potential solution for hydrocephalus without the use of shunts and was initially hailed as a groundbreaking technique in neurosurgery and a cure for hydrocephalus [Brohi, S. R. *et al*., 2010; Bouras, T. *et al*., 2012]. Endoscopic ventriculostomy of the third ventricle's bottom, often referred to as "endoscopic triventriculostomy," was primarily developed for treating occlusive hydrocephalus with blockage at the level of the brain's plumbing. [Chowdhry, S. A. *et al*., 2012]

Studies on endoscopic triventriculostomy (ETVS) in pediatric patients began surfacing in the literature during the 80s and 90s [Dinçer, A. *et al*., 2011]. However, extracting meaningful data and establishing fundamental principles of endoscopy in the younger age group proved challenging at that time despite numerous publications [Dlouhy, B. J. *et al*., 2012]. The success rate of endoscopic interventions during that period ranged from 35% to 89% [Oi, S. *et al*., 2011]. Since the 90s, ETVS has been recognized as an alternative to bypass surgery, particularly for patients with obstructions in the cerebral plumbing [Paidakakos, N. *et al*., 2012]. Additionally, it has gradually become the primary surgical method for treating hydrocephalus in pediatric neurosurgery. [Sacko, O. *et al*., 2010]

PATIENTS AND METHODS

In this observational, cross-sectional study, a total of 55 hydrocephalus patients who had undergone endoscopic third ventriculostomy were selected for participation. The demographic information was solicited from individuals aged from 20 to 60 years, who were admitted to different hospitals in Iraq. The timeframe for the data collection spanned from July 15th, 2022, to August 18th, 2023.

The pathological data were systematically collected and encompassed all patients who had been subjected to the endoscopic third ventriculostomy. The parameters included age, gender, symptoms presented, concomitant health conditions, and a previous medical history of hydrocephalus. The study further delved into the surgical procedure details for individuals who had undergone endoscopic third ventriculostomy, including aspects such as right and left biopsy, cyst fenestration, septostomy, and size.

The study also incorporated comprehensive clinical data during the perioperative and postoperative periods. This included the duration of the surgical procedure, the length of hospital stays, and results from biochemical tests, which notably revealed elevated heart rates and high blood pressure. The study scrutinized the success and failure outcomes of endoscopic third ventriculostomy surgery.

Comparative data was assembled, contrasting postoperative findings following the endoscopic third ventriculostomy technique with the preoperative criteria. This included the success and failure indices for the technique when used for treating hydrocephalus patients. The study also recorded the incidence rate of patients who experienced postoperative complications during a 5-year follow-up period.

The Kaplan-Meier method was employed to calculate the survival rate of patients post-endoscopic third ventriculostomy. The study further identified multivariate logistic regression of risk factors for long-term postoperative hydrocephalus patients. The study's exclusion criteria encompassed pediatric patients with hydrocephalus, individuals with a previous history of surgical interventions, and those with morbid obesity. For statistical data analysis, all patient outcomes' characteristics were cohesively compiled and analyzed using SPSS version 22.0.

RESULTS

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Table 1: Baseline demographic characteristics of patients in the study

Characteristics	**Number of patients [55]**	**[%]**
Age [years]		
20 - 30	8	14.55%
31 – 40	12	21.82%
41 - 50	15	27.27%
51 - 60	20	36.36%
Sex [M/F]		
Males	35	63.64%
Females	20	36.36%
Symptoms		
Headaches	24	43.64%
Papilledema	15	27.27%
Problems with balance	8	14.55%
Changes in visual acuity	4	7.27%
Nausea and vomiting	2	3.64%
Altered mental status	2	3.64%
Comorbidities		
Developmental delays	18	32.73%
Learning disabilities	15	27.27%
Epilepsy	8	14.55%
Motor impairments	8	14.55%
Mental health disorders	6	10.91%
Origin of hydrocephalus		
Aqueductal stenosis	19	34.55%
Nontectal brain tumor	14	25.45%
Tectal tumor	9	16.36%
Cysts	9	16.36%
Myelomeningocele	4	7.27%

Table 2: ETV procedure outcomes

Characteristics	**Number of patients [55]**	**[%]**
ETV Procedure		
Left	45	81.82%
Right	10	18.18%
ETV & others		
Biopsy	20	36.36%
Cyst fenestration	6	10.91%
Septostomy	3	5.45%
Techniques		
Fogarty balloon catheter		
size 4	47	85.45%
size 3	8	14.55%
Others		
YAG laser	4	7.27%
bipolar cautery	3	5.45%
Clinical outcomes		
Follow-up [years], (mean ± SD)	3.7 ± 1.3	-------
Length of stay in hospital [Days], (mean ± SD)	6.2 ± 1.3	
Operation time [hours]	1.8 ± 1.2	
Intraoperative biochemical examination		
High heart rate	3	5.45%
Hypertension	4	7.27%

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ETV surgical outcomes		
Successful	51	92.73%
Failed	4	7.27%

Table 3: Comparison between prior and post-ETV success.

	Prior		**Post**	
Etiology	Successful ETV	Faild ETV	Successful ETV	Faild ETV
Origin of hydrocephalus				
Aqueductal stenosis	30%	70%	92.6%	7.4%
Nontectal brain tumor	30%	70%	90%	10%
Cysts	42%	58%	64%	36%
Tectal tumor	39%	61%	72%	28%
Myelomeningocele				
ETVSS				
≥80	10%	90%	80%	20%
50-70	20%	80%	90%	10%
< 40	15	85%	85%	15%
Third ventricle bowing	30%	70%	70%	30%

Table 4: Post-operative complications outcomes

Complications	**Number of patients [55]**	**[%]**
CSF leak	3	5.45%
Bleeding	2	3.64%
Bacterial meningitis	1	1.82%
infection	1	1.82%
Subdural hematoma	1	1.82%

Table 5: Multivariate logistic regression of risk factors associated with hydrocephalus

Variables	**OR (95% CI)**	**P-value**
Age	0.93 [0.89-1.012]	0.23
Sex	0.90 [0.87-1.1]	0.21
CSF leak	1.1 [0.4-2.1]	0.65
Intra-operative bleeding	3.51 [2.9-6.5]	0.25
Headaches	2.81 [2.2-6.53]	0.031
Developmental delays	2.69 [1.6 -3.3]	0.22

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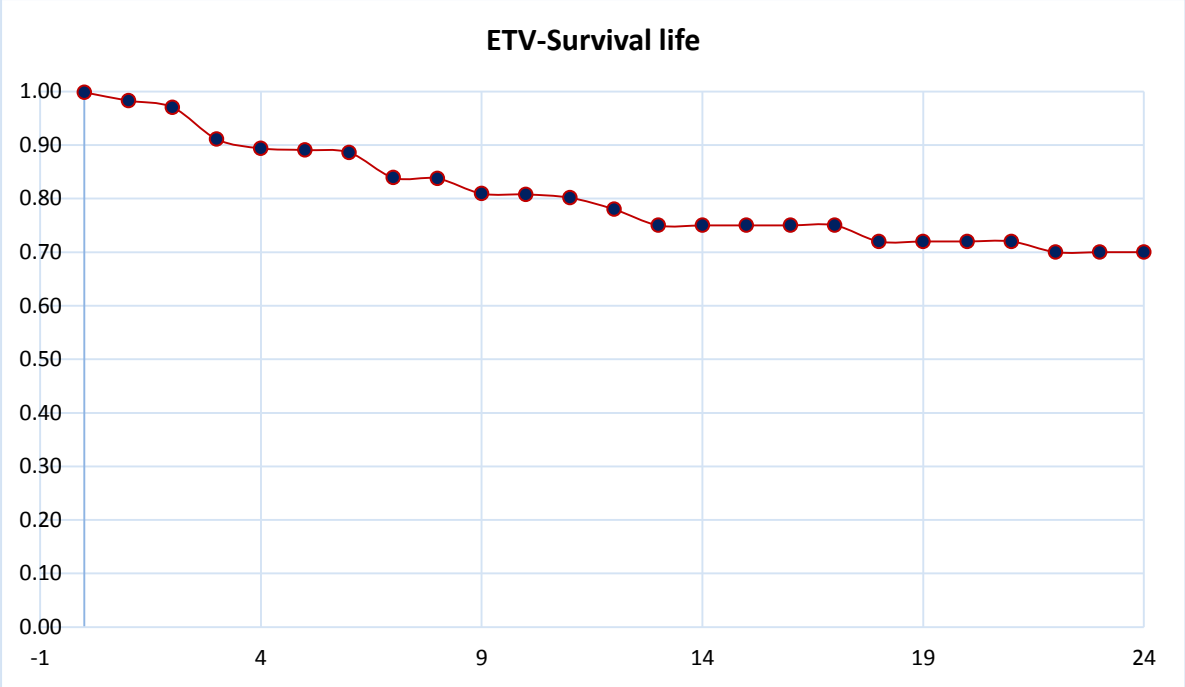

Figure 1: Postoperative outcomes associated with survival-life of patients after endoscopic third ventriculostomy by Kaplan-Meier.

DISCUSSION

This study presents the findings of a comprehensive analysis of surgical data, specifically focusing on patients aged 50-60 years. The results indicate that this age group has the highest infection rate, with 20 patients affected out of the entire sample. Additionally, the study reveals that males (35 cases) have a higher infection rate than females (20 cases), accounting for 43.64% of all patients. Headache emerges as the most common symptom among patients, with 32.73% experiencing this condition. Moreover, developmental delays are identified as the most prevalent comorbidity, affecting 32.73% of patients.

Furthermore, the study investigates the origins of hydrocephalus and identifies Aqueductal stenosis (19 cases) and Nontectal brain tumor (14 cases) as the most common underlying diseases in hydrocephalus patients.

In terms of the surgical procedure for laparoscopic third ventriculostomy, the study examines the outcomes of 55 patients, with 10 undergoing the procedure on the right side and 45 on the left side. The study also explores the outcomes of patients who underwent Biopsy (20 cases), Cyst fenestration (6 cases), and Septostomy (3 cases). The patients were followed up for a period of 5 years, with an average hospital stay of 7 days. A total of 3 cases experienced high heart rates, while 4 cases had high blood pressure.

The study reports a success rate of 92.85% for the ETV surgical procedure, with 51 patients experiencing successful outcomes and 4 cases resulting in failure. Postoperative complications were recorded in 8 patients, with CSF leak (3 cases) and bleeding (2 cases) being the most common complications observed. The study also reveals a decrease in the survival rate to 70% at the 24th month.

Based on previous research, laparoscopic third ventriculostomy is a specialized surgical procedure designed to treat hydrocephalus, a condition characterized by abnormal accumulation of cerebrospinal fluid in the brain, leading to increased intracranial pressure [Sandberg, D. I. *et al*., 2008]. The endoscopic third ventriculostomy technique has proven to be highly effective in draining excess cerebral fluid and alleviating hydrocephalus symptoms [Shannon, C. N. *et al*., 2011]. However, the success of this surgical procedure depends on the surgeon's expertise and the individual patient's characteristics. While the procedure can be performed on patients of all ages, including children and adults, success rates may vary significantly. It is important to note that this technique is not without drawbacks, as it is associated with common complications such as

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intraoperative bleeding, infection, and cerebrospinal fluid leakage. [Shimizu, T. *et al*., 2012]

A study conducted in Spain suggests that the endoscopic third ventriculostomy technique may not be effective for all hydrocephalus patients, particularly those with anatomical deformities. In contrast, a French study indicates that this technique demonstrates high success rates in maintaining stable survival rates for patients both during and after surgery. [Sodhiya, P. *et al*., 2019]

CONCLUSION

The endoscopic third ventriculostomy (EVT) technique is a preferred alternative to ventriculoperitoneal shunt and is considered highly effective in the treatment of hydrocephalus patients. According to this study, the success rate of the EVT technique of 92.73% and the low postoperative complication rate of less than 8% establish its status as the currently favoured method for treating hydrocephalus.

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