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Effectiveness of endoscopic third ventriculostomy in a resource-constrained setting

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ABSTRACT

Background. Hydrocephalus is a serious condition that, if left untreated, can lead to significant morbidity. While it can affect individuals of all ages, congenital hydrocephalus is more common in children under two years of age. Endoscopic third ventriculostomy (ETV) has gained renewed popularity in recent years, following earlier concerns over complications associated with shunting procedures.

Methods. This prospective cohort study was conducted over an 18-month period in a hospital setting and included children under two years of age diagnosed with hydrocephalus. Of the 75 patients initially enrolled, 68 completed the study and were followed for six months post-intervention. Demographic data, including age and sex distribution, were collected. The primary outcome was the success or failure of ETV, assessed at six months following the procedure.

Results. Males comprised twice the number of females in the cohort. Most patients were between one and six months of age. The success rate of ETV at six months post-procedure was 73.5%.

Conclusion. ETV is an effective treatment for hydrocephalus in children under two years of age, with a promising success rate and potential to reduce dependency on shunting in resource-constrained settings.

Keywords: effectiveness, endoscopic third ventriculostomy, hydrocephalus, resource-constrained

Abbreviations (in alphabetical order):

CSF – cerebrospinal fluid
CT – computed tomography
ETV – endoscopic third ventriculostomy
LUTH – Lagos University Teaching Hospital
VPS – ventriculoperitoneal shunting

INTRODUCTION

Hydrocephalus is a relatively uncommon neurological condition that can lead to cosmetic disfigurement, cognitive impairment in most affected children, and ultimately death if left untreated. Early intervention significantly reduces both morbidity and mortality [1,2].

Traditional shunting procedures have long been the mainstay of treatment, but they are associated with numerous drawbacks [3]. In recent years, the resurgence of endoscopic third ventriculostomy (ETV) has addressed many of the concerns related to shunt hardware complications [4]. ETV was first attempted by Dandy and his team but initially met with limited success. Over time, advancements in both technology and surgical techniques have led to improved outcomes. ETV is now increasingly utilized in the treatment of hydrocephalus and is associated with fewer complications than shunt procedures [5,6].

While varying success rates have been reported in the literature, they are generally encouraging. Some predictive tools for ETV outcomes have been proposed, although few are widely adopted [7,8]. Success following ETV is typically defined as the absence of the need for additional surgery, accompanied by

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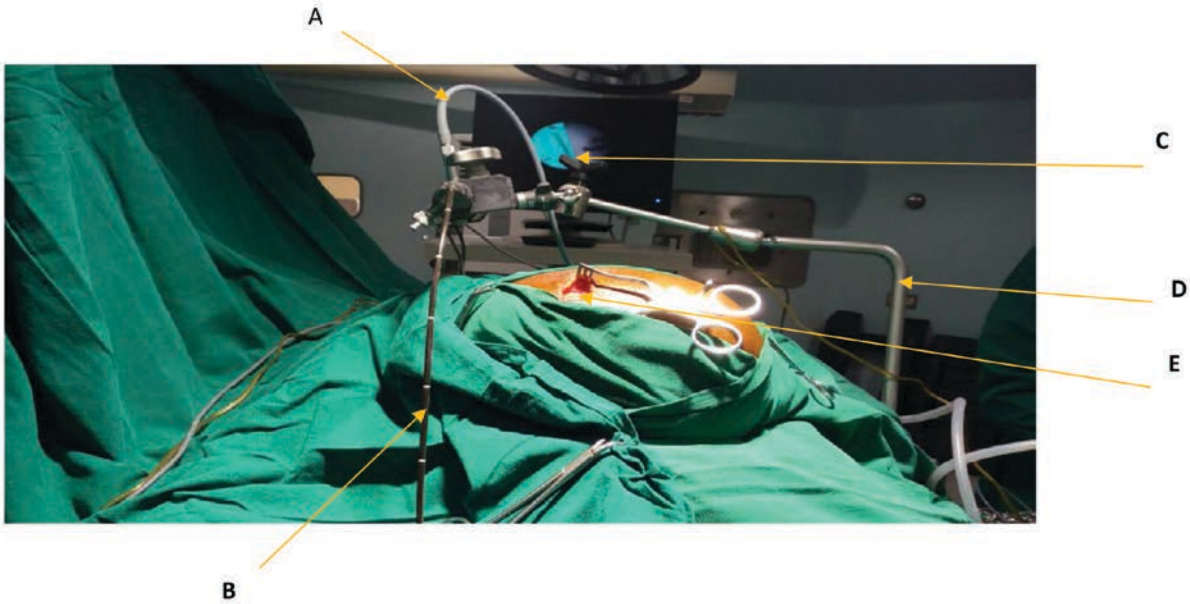

FIGURE 1. ETV setup at Lagos University Teaching Hospital
A – Light source, B – Flexible endoscope, C – Monitor, D – Scope holder, E – Kocher's point

clinical and/or radiological resolution of hydrocephalus. ETV may serve as a safe and effective alternative to shunting in selected infants under two years of age. This study focuses on children within the first two years of life who underwent ETV as a treatment for hydrocephalus.

METHODOLOGY

This was a hospital-based prospective cohort study involving children diagnosed with hydrocephalus who underwent endoscopic third ventriculostomy (ETV) at the Lagos University Teaching Hospital (LUTH), Lagos, Nigeria. The study spanned 18 months, from November 2015 to April 2016.

Inclusion and exclusion criteria

Children under two years of age who presented with clinical features of hydrocephalus and had confirmatory brain CT scans were included, provided they met the criteria for ETV. Exclusion criteria included children older than two years, those who were unconscious, comatose, or brain-dead, and patients treated with methods other than ETV or those lacking preoperative brain CT scans.

Sample size

A total of 75 children underwent ETV. The sample size was calculated using Fischer's statistical formula [9], based on a reported prevalence of 4.65% from a multicenter European study [10], as local prevalence data in Nigeria were unavailable. The confidence level and margin of error were set at 95% and 5%, respectively.

Preoperative evaluation

Eligible patients were recruited after obtaining informed consent from parents or guardians. Data collected included age at birth, suspected cause of hydrocephalus, previous shunt history, and age at surgery. A brain CT scan was used to confirm diagnosis and etiology.

Head circumference was measured using a non-elastic tape from the glabella to the occiput. Developmental progress was assessed based on milestones such as social smiling and neck control.

Intraoperative procedure

ETV was performed under general anesthesia with the patient in a supine position, head turned to the left and elevated 15–30 degrees using a doughnut headrest. After shaving and preparing the surgical field with 10% povidone-iodine, prophylactic ceftriaxone (100 mg/kg) was administered at induction.

The right Kocher's point – defined as 2.5–3 cm lateral to the midline and just anterior to the coronal suture – was used as the entry point. A U-shaped skin flap was raised pedicled on the superficial temporal artery. Burr holes were made in 10 patients with a closed anterior fontanelle, followed by durotomy and minimal cortisectomy.

A flexible endoscope was introduced through the right lateral ventricle, and cerebrospinal fluid (CSF) flow was confirmed. The endoscope was navigated through the foramen of Monro to the floor of the third ventricle. Key anatomical landmarks, including the mammillary bodies, infundibular recess, clivus, and the basilar artery complex, guided the fenestration. A ventriculostomy was created using

TABLE 1. Age distribution at the time of surgery among 68 pediatric patients with hydrocephalus who underwent endoscopic third ventriculostomy (ETV)

Age (months)	Frequency (%)
< 1	5 (7.4)
1- <6	39 (57.4)
6 - <12	14 (20.6)
12-24	10 (14.7)
Total	68 (100.0)

TABLE 2. Etiology of hydrocephalus in 68 pediatric patients who underwent endoscopic third ventriculostomy (ETV)

Etiology	Frequency (%)
Aqueductal stenosis	42 (61.8)
Myelomeningocele	14 (20.6)
Infections	10 (14.7)
Dandy–Walker malformation	2 (2.9%)
Total	68 (100.0)

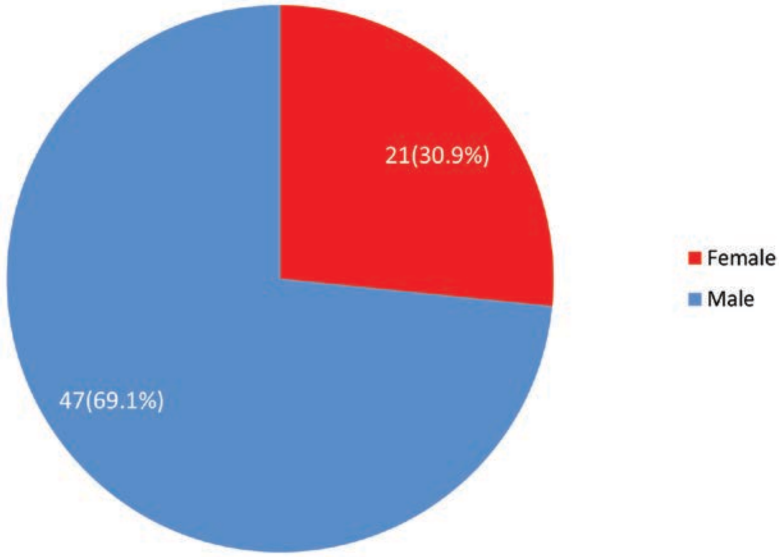

FIGURE 2. Sex distribution of 68 pediatric patients with hydrocephalus who underwent endoscopic third ventriculostomy (ETV)

TABLE 3. Association between age at surgery and outcome of endoscopic third ventriculostomy (ETV)

Age at surgery (months)	Outcome of ETV		Total n (%)	p-value
	Failed ETV (%)	Successful ETV (%)		
<1	4 (80.0)	1(20.0)	5 (100.0)	0.097
1-<6	12 (30.8)	27(69.2)	39 (100.0)	0.073
6- <12	0 (0.0)	14(100.0)	14 (100.0)	0.001
12-24	2 (20.0)	8(80.0)	10 (100.0)	0.05
Total	18 (26.5)	50 (73.5)	68 (100.0)	0.05

electrocautery and blunt dissection. Successful CSF flow through the stoma confirmed patency.

The scalp was closed in two layers under sterile conditions. Intraoperative observations and any conversions to ventriculoperitoneal shunting (VPS) or repeat ETV within six months were documented. Postoperative care followed the standard neurosurgical protocol.

Follow-up

Follow-up assessments were conducted at 1 week, 1 month, 3 months, and 6 months postoperatively. Occipitofrontal circumference (OFC) was measured during each visit. Developmental milestones, including social smiling and neck control, were evaluated. Indicators of ETV success or failure included changes in head circumference, vomiting, developmental delay or arrest, and CT evidence of ventricular dilation.

Data collection and analysis

A structured pro forma was used to collect data, including demographics, birth history, presumed etiology of hydrocephalus, prior interventions, clinical presentation, imaging findings, treatment, and outcomes. Each participant was assigned a unique identification number to ensure confidentiality. Brain CT images were stored digitally in the radiology department.

Data analysis was performed using IBM SPSS version 22. Descriptive and inferential statistics were used, with a p-value <0.05 considered statistically significant. Results were presented in tables, charts, and diagrams.

Ethical approval and parental consent

The study protocol was reviewed and approved by the Lagos University Teaching Hospital Institutional Review Board. Written informed consent was obtained from the parents or guardians of all participating children prior to enrollment.

RESULTS

A total of 75 patients who met the inclusion criteria were enrolled in the study. Three patients who initially consented later withdrew, and four were excluded due to incomplete data following loss to follow-up. Therefore, 68 patients were included in the final analysis.

The ages of the 68 patients ranged from birth to 24 months, with a mean age of 5.45 ± 5.41 months. The majority of patients (57.4%) were between 1 and less than 6 months old, followed by 20.6% aged 6 to less than 12 months. Infants younger than 1 month represented the least common group (7.4%) (Table 1).

Of the 68 patients, 47 (69.1%) were male and 21 (30.9%) were female, yielding a male-to-female ratio of 2.2:1 (Figure 2).

Prior to undergoing endoscopic third ventriculostomy (ETV), 53 patients (77.9%) had no history of previous shunt procedures, whereas 15 patients (22.1%) had undergone ventriculoperitoneal (VP) shunting.

The most common causes of hydrocephalus identified in this cohort were aqueductal stenosis (61.8%), myelomeningocele (20.6%), and infection (14.7%). Only two cases were attributed to Dandy–Walker malformation (Table 2).

At the six-month follow-up, ETV success was highest in children aged 6 to less than 12 months (100%, p = 0.001), followed by those aged 12 to 24 months (80%, p = 0.05), and children aged 1 to less than 6 months (69.2%). In contrast, ETV failed in 80% of infants younger than one month (Table 3).

DISCUSSION

Hydrocephalus is a relatively common neurological condition. When untreated, it can lead to cognitive decline, developmental delays, psychosocial impairment, and other potentially life-threatening complications. These consequences impose a significant burden on both patients and their caregivers.

Surgical intervention remains the cornerstone of treatment for pediatric hydrocephalus. However, choosing the most appropriate surgical option can be challenging. This decision often depends on available treatment modalities, the surgeon's expertise, the effectiveness of each option, and the preferences of the patient's family or guardian. Endoscopic third ventriculostomy (ETV) is one such treatment option, offering the advantage of fewer long-term complications compared to ventriculoperitoneal (VP) shunting. Nonetheless, the success of ETV depends heavily on appropriate patient selection and well-defined eligibility criteria that can predict surgical outcomes.

In resource-limited settings such as ours, ETV setup is capital-intensive, and there is limited expertise in ETV procedures and personnel training compared to shunting procedures. However, the long-term benefits of ETV may outweigh the initial challenges by reducing shunt-related complications.

In this study, 68 patients were evaluated. The age distribution showed that the majority – 39 patients (57.4%) – were between 1 and less than 6 months old. Fourteen patients (20.6%) were between 6 and less than 12 months, while five patients (7.4%) were younger than 1 month. These findings are similar to those reported by Fani et al. [11], who studied 59 children under 2 years and found that 55.95% were younger than 6 months. Our study also aligns with their findings regarding gender distribution, with males comprising the majority of patients. Moreover, both studies support the observation that ETV success rates tend to improve with increasing patient age (Table 3).

Regarding etiology, presumed aqueductal stenosis was the most common cause of hydrocephalus in our study, accounting for 61.8% of cases (Table 2). This pattern is consistent with findings from other studies. For instance, Breimer et al. [12] reported aqueductal stenosis in 26.9% of 104 pediatric patients. While this percentage is lower, the larger sample size may account for the difference. Similarly, Fani et al. [11], in a study with a comparable number of patients, also identified aqueductal stenosis as the leading cause of hydrocephalus in children under two years of age.

The effectiveness of ETV has been well-documented in the literature. Fani et al. [11] and Breimer et al. [12] reported ETV success rates of 76% and 68%, respectively. In our study, ETV was successful in 73.5% of patients (Table 3), a result identical to that reported by Ojo et al. [13], who found a 73.5% success rate in their series of 34 patients. These consistent findings reinforce the reliability of ETV as an effective treatment for selected cases of pediatric hydrocephalus. Similar outcomes were also observed by other authors [14–17].

Limitations

- The relatively high cost of brain CT scans may have excluded some eligible children due to financial constraints.
- Some long-term complications of ETV may have been missed due to the short follow-up period.
- The six-month duration of outcome assessment may not fully capture long-term efficacy or complications.
- The sample size calculation relied on prevalence data from a European study due to a lack of local data, which could affect generalizability.

CONCLUSION

Endoscopic third ventriculostomy (ETV) is an effective and reliable method for managing hydrocephalus in children under two years of age, provided that clear and appropriate selection criteria are applied. This study demonstrated a success rate of 73.5% at six months post-procedure, consistent with previous research, highlighting ETV as a viable alternative to ventriculoperitoneal shunting. Given the fewer long-term complications associated with ETV and its potential benefits in resource-limited settings, it should be considered a first-line treatment option for carefully selected pediatric patients. Further research with longer follow-up periods is recommended to assess long-term outcomes and optimize patient selection for this procedure.

Authors' contributions:

E. Morgan: Conceptualization, manuscript writing, data generation and analysis, discussion.

Bankole O.B.: Manuscript editing, proofreading, discussion.

Kanu O.O.: Conceptualization, manuscript proofreading.

Conflict of interest:

The authors declare no conflict of interest.

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