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Research Article

Short-Term Outcomes and Associated Factors of Endoscopic Third Ventriculostomy among Patients with Hydrocephalus at Bugando Medical Centre Mwanza, Tanzania

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Abstract

Background: Hydrocephalus is a disturbance of Cerebral Spinal Fluid (CSF) formation, flow, or absorption, leading to an increase in volume occupied by this fluid in the central nervous system. Until recently, hydrocephalus could only be treated by insertion of a Cerebro Spinal Fluid (CSF) shunt. The use of endoscopy to create an internal CSF diversion through the floor of the third ventricle an Endoscopic Third Ventriculostomy (ETV) has become an important alternative to CSF shunting for children with hydrocephalus, since the incidence of complications mortality and cost is higher in with the ventriculoperitoneal shunt procedure and hence greater benefit can be achieved using ETV.

Although varying degree of success for the procedure has been reported depending on the type and etiology of hydrocephalus, age of the patient and certain technical parameters.

Objective: To determine short-term outcomes and associated factors of endoscopic third ventriculostomy among patients with hydrocephalus at Bugando medical centre, Tanzania.

Methods: It was a four-month longitudinal retrospective and prospective study conducted at Bugando Medical Centre, patients below five years old were enrolled with non-communicating hydrocephalus at SOPD, Neurological and Pediatric ward and Intensive care unit from March to June 2022. Data were entered in excel and analysed using STATA version 15.

Results: Ninety one patients were enrolled in the study, 54 males (59.3%) with median age 7 (IQR: 5- 14) months at surgery. Most of patients had single symptoms at the time of presentation. However, 52 (57.1%) had increase in head circumference with median duration of symptom 3 (IQR: 1-3) months, and most of participants were from rural areas 76 (83.5%).

In our study success of ETV was 83.5 % (76), mortality 4.4% (4), post-operative complication was 11% (10) and length of hospital stay was 19.3% (18). Success of ETV were significantly associated with presenting symptom of one (P=0.019) and intraoperative findings (clear CSF) (P=0.05), post-operative complications were associated with presenting symptoms of more than one (P=0.017) and increased length of hospital stay was associated with coexists co-morbid (P=0.000) and duration of operation more 52 minutes (P=0.028).

Conclusion: Although ETV is less cost-effective compare to ventriculoperitoneal shunt procedure and offer a low risk and can be considered as effective treatment of obstructive hydrocephalus in children. ETV is still facing some of the challenges such as post-operative complications, increase in length of hospital stay and failure which are attributed more with anatomy of the ventricular system.

Keywords: Endoscopic third ventriculostomy; Outcomes; Associated factors

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Background

Hydrocephalus, characterized by a disturbance in Cerebral Spinal Fluid (CSF) formation, flow, or absorption, results in an increased volume of fluid within the Central Nervous System (CNS) [1]. Left untreated, hydrocephalus can rapidly lead to brain damage, severe neurological and developmental disorders, and even death [2-4]. Clinical presentations vary with age, and prenatal ultrasound can detect fetal ventriculomegaly, sometimes as early as 18-20 weeks' gestation [5-8].

While the global burden of infant hydrocephalus affects both rich and poor countries, it is notably pronounced in sub-Saharan Africa

(SSA), with approximately 180,000 new cases emerging annually [5,9-11]. Regardless of the etiology, timely surgical intervention is crucial for preventing dire outcomes and achieving more favorable results for these children [5,9,11].

However, managing hydrocephalus in developing nations is impeded by significant economic constraints, resulting in delayed treatment, with most patients not seeking medical attention until at least seven months after the onset of symptoms [3,9,10]. The management of hydrocephalus and its associated complications necessitates surgical expertise and a lifelong approach to patient follow-up [3,8,9].

Managing childhood hydrocephalus in sub-Saharan Africa is particularly challenging due to various socioeconomic and healthcare-related factors [8-10]. Specialized surgical and other forms of management that could reduce consequential disabilities are not readily available in many African countries due to several factors [10-12].

Traditionally, hydrocephalus in our setup has been treated by the insertion of a Cerebrospinal Fluid (CSF) shunt. However, this method is associated with long-term complications, including infection, obstruction, and over-drainage of CSF, each requiring additional surgery [13-16]. The introduction of endoscopy for creating an internal CSF diversion, known as Endoscopic Third Ventriculostomy (ETV), has become a crucial alternative to CSF shunting for children with hydrocephalus [12,17-19]. ETV allows ventricular CSF to bypass anatomic obstructions, entering and being absorbed through the subarachnoid space *via* a hole created in the floor of the third ventricle, without the need for an implanted foreign device [8,20,21]. This marks a significant advancement in hydrocephalus treatment, the first major revolution since the invention of the CSF shunt over 50 years ago [8,11,15].

When successful, ETV provides a simple and permanent treatment that avoids many long-term complications associated with CSF shunting [11,12,22]. This is particularly appealing in developing countries, where the economic cost of a CSF shunt can be burdensome for many families, and complications, such as shunt infection, are less likely to be promptly managed [13,18,23,24]. However, a challenge persists as more than 30% of children do not respond to ETV and subsequently require a CSF shunt [25-28].

The incidence of hydrocephalus in East Africa is notably high, and using shunts in developing countries, even if cost and availability challenges are overcome, presents unique issues [29-31]. The complications of shunt malfunction and infection are manageable with competent neurosurgical care, but access to such care is often hindered by financial and logistical barriers for most patients [27,31,32].

Methodology

Study design and population

The study was longitudinal retrospective and prospective study involving children, undergoing endoscopic third ventriculostomy with non-communicating hydrocephalus admitted at Bugando Medical Centre from early March to June 2022. Bugando Medical Centre offers specialized and super-specialized medical care for all specialties and receives referrals from public and private hospitals from Lake Zone.

We consecutively enrolled consenting participants below five years of age who were admitted at BMC with obstructed hydrocephalus after meeting inclusion criteria, parent/relative were required to provide written informed consent prior to enrolment. Study participants were retrospectively and prospectively enrolled between March to June 2022 and each participant was followed up for outcomes for 30 days post-operative.

Data collection

- Data was collected by using structured questionnaire and data collection check list. This included, social demographic characteristics (E.g., age, sex), Clinical presentation, Duration of illness, preoperative diagnosis, Intraoperative findings, post-operative complications.
- Patients were captured in SOPD, Neonatal and Pediatric ICU, Neurosurgical and Pediatric ward. Concept of the study will be introduced to Parent or caregiver, informed consent to conduct the study was obtained.
- It started with filling of the social demographic data, any visible associated anomaly, findings of physical examination of patient pre, intra and post-operative, laboratory results and radiological results of brain, chest and abdomen on questionnaire and data collection check-list.
- The principal investigator had a room to participate in some surgeries without affecting the treatment or breaching the confidentiality and this helped to minimize loss of follow-up and it helped in parents or guardians on outcomes.
- Post-operative patients were followed in the ward and after discharge at SOPD and being tracked at home through the mobile phone from parents or caregivers.

Data analysis

Data were transferred from questionnaires and data collection sheet in full and entered into excel and STATA version 15 for analysis. Continuous variables were summarized and presented as means and standard deviation (SD) or medians with Interquartile Range (IQR). The association between various patient variables with post-operative complications, length of hospital stay and success of ETV, variables with P value of <0.05 in the univariate analysis were included in the multivariate analysis and significance level was set as a P value of <0.05.

Results

A total of ninety-one patients participated in the study, comprising 54 males (59.3%) with a median age of 7 months (IQR: 5-14) at the time of surgery. Most patients presented with one symptom; specifically, 52 individuals (57.1%) exhibited an increase in head circumference, with a median duration of symptoms recorded at 3 months (IQR: 1-3). A significant portion of the participants, accounting for 76 individuals (83.5%), hailed from rural areas.

In our study, the ETV success rate stood at 83.5% (76 cases), with a mortality rate of 4.4% (4 cases). Post-operative complications were observed in 11% of instances (10 cases), and the average length of hospital stay was 19.3 days (18 cases) [33-35].

The factors associated to post-operative complications, duration of hospitalization, and the success of ETV are detailed in Tables 1-3, respectively. Notably, post-operative complications demonstrated an association with the presence of multiple presenting symptoms (P=0.017), while the length of hospital stay was correlated with the

coexistence of comorbidities (P=0.000) and operations lasting more than 52 minutes (P=0.028). Additionally, the success of ETV exhibited a significant association with the presence of a single presenting symptom (P=0.019) [35-40].

Discussion

Endoscopic Third Ventriculostomy (ETV) has gained widespread acceptance as a viable treatment for hydrocephalus in children. Current global experiences indicate that ETV serves as a valuable alternative to shunt placement, particularly in cases of obstructive hydrocephalus. Notably, ETV is recognized for its simplicity, speed, and safety in pediatric patients [5,21,41-49]. In our study, the overall success rate of ETV was 83.5%, with a complication rate of 11%, aligning with similar findings in the existing literature [15,21,27,36,38,41,49-51].

However, these complications pose a significant burden on healthcare systems and can have a negative impact on a child's quality of life. Identifying which children are more likely to benefit from ETV, as opposed to experiencing treatment failure and necessitating subsequent shunt insertion, remains challenging [50,51]. Previous literature on ETV has provided limited guidance in accurately predicting outcomes. While some studies assert that patient age is the sole predictor of ETV success, others propose that the underlying cause of hydrocephalus, particularly in infants, plays a pivotal role. Various researchers have explored both preoperative and intraoperative factors to ascertain ETV success. Notably, previous analyses have often been confined to single-center studies with restricted sample sizes [50-55].

Conclusion

Despite being less cost-effective than the ventriculoperitoneal shunt procedure, Endoscopic Third Ventriculostomy (ETV) presents a low-risk and effective treatment option for obstructive hydrocephalus in children. However, ETV encounters challenges such as post-operative complications, prolonged hospital stays, and failure, which are primarily associated with the anatomical characteristics of the ventricular system.

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Table 1: Factors associated with post-operative complications.

Characteristic	Number (%)	Univariate		Multivariate	
		OR[95%CI]	P 0.05	OR[95%CI]	P 0.05
Presented symptoms					
≤ 1	52(57.1)				
>1	39(42.9)	6.13[1.22-30.71]	0.028	7.7[1.4-40.8]	0.017
Duration of symptoms					
≤ 3month	50(55)	3.71[0.74-18.57]	0.11		
>3month	41(41)				
Duration of operation					
≤ 52minute	49(53.85)	2.17[0.52-8.97]	0.286		
>52minute	42(46.15)				
Duration of anaesthesia					
≤ 74minute	51(56)				
>74minute	40(44)	0.51[0.12-2.11]	0.353		
Intraoperative findings					
Scattered CP	29(31.87)				
Clear CSF Fibrotic	48(52.75)	4.95[1.36-18]	0.015	1.2[0.2-5.8]	0.89
Unclear CSF	4(4.4)	1.35[0.12-14.82]	0.81	0.7[0.4-7]	0.912
	10(10.99)	4.05[0.44-36.94]	0.215	0.8[0.6-10.1]	0.868

Table 2: Factors associated with length of hospital.

Characteristic	Number (%)	Univariate		Multivariate	
		OR[95%CI]	P 0.05	OR[95%CI]	P 0.05
Presented symptoms					
≤ 1	52(57.1)	1			
>1	39(42.9)	0.57[0.19-1.69]	0.314		
Duration of symptoms					
≤ 3month	50(55)	1			
>3month	41(41)	3.03[1.02-8.99]	0.045	2.5[0.7-8.9]	0.17
Coexist comorbid					
No	78(85.71)	1			
Yes	13(14.29)	2.4[1.9-3.1]	0	14.9[3.4-66.1]	0
Duration of operation					
≤ 52minute	49(53.85)	1			
>52minute	42(46.15)	1.7[1.68-3.1]	0.005	4.7[1.2-18.3]	0.028
Duration of anaesthesia					
≤ 74minute	51(56)	1			
>74minute	40(44)	2.17[0.52-8.97]	0.286		
Intraoperative findings					
Scattered CP	29(31.87)	1			
Clear CSF	48(52.75)	1.64[0.46-5.83]	0.441		
Fibrotic	4(4.4)	2.08[0.17-25.31]	0.565		
Unclear CSF	10(10.99)	2.68[0.48-14.89]	0.26		

Table 3: Factors associated with success of ETV.

Patient characteristic	Number (%)	Univariate		Multivariate	
		OR[95%CI]	P 0.05	OR[95%CI]	P 0.05
Age					
≤ 6month	44(48.4)	1			
>6month	47(51.6)	1.76[0.57-5.42]	0.327		
Presenting symptoms					
≤ 1	52(57.1)	4.5[1.3-15.3]	0.018	4.7[1.3-17.4]	0.019
>1	39(42.9)	1			
Duration of symptoms					
≤ 3month	50(55)	1			
>3month	41(45)	1.28[0.41-3.95]	0.667		
Co-exist co-morbid					
Yes	13(14.3)	1			
No	78(85.7)	2.84[0.31-2.96]	0.965		
Duration of operation					
≤ 52minute	49(53.9)	1			
>52minute	42(46.1)	0.98[0.32-2.96]	0.965		
Duration of anaesthesia					
≤ 74minute	51(56)	1			
>74minute	40(44)	1.21[0.39-3.75]	0.736		
Intraoperative findings					
Scattered CSF	29(31.87)	1			
Clear CSF	48(52.75)	4.95[1.36-18]	0.015	3.8[1.0-14.5]	0.051
Fibrotic	4(4.4)	1.35[0.12-14.8]	0.806	1.46[0.11-19.7]	0.773
Unclear CSF	10(10.99)	4.05[0.44-36.9]	0.215	3.57[0.26-49.31]	0.343

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