ORIGINAL PAPER

Endoscopic third ventriculostomy and choroid plexus cauterization in childhood hydrocephalus in Zambia

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ABSTRACT

Background: Endoscopic third ventriculostomy (ETV) and Choroid Plexus Cauterization (CPC) have been recommended as reliable surgical options in developing countries for childhood hydrocephalus owing to reported shunt failures in shunt dependency.

Objective: To evaluate outcomes of the ETV and ETV-CPC procedures as surgical options for selected forms of hydrocephalus in Zambia.

Methods: Between 2007 and 2010, 131 children with hydrocephalus underwent the ETV or ETV-CPC procedures at Beit Cure Hospital (BCH) and were eligible for the analysis. Failed ETV was defined as cases that needed subsequent surgical procedures within 6 months of operation.

Results: A total number of 110 (84%) children underwent ETV-CPC and 21 (16%) had ETV alone. The overall success rate was 74%, whereas ETV-CPC was 76% and ETV alone was 62% ($p < 0.0001$). ETV success rate was more likely with children aged one year and above ($p < 0.06$) and with non-post infectious hydrocephalus ($p < 0.29$). Age and etiology were not significantly associated with the outcomes.

Conclusions: Endoscopic third ventriculostomy is a safe, reliable and effective option for selected forms of hydrocephalus in Zambia. The combination of ETV and CPC was more effective than ETV alone. It is highly recommended that such services be extended to other referral hospitals as options to shunt placement, especially in cases where access for treatment failure is likely to be delayed.

INTRODUCTION

Managing childhood hydrocephalus in sub-Saharan Africa can be potentially overwhelming due to several socioeconomic and factors related to health care[1-4]. It has been reported that resultant consequential disabilities from hydrocephalus can be reduced by, specialized surgical and other forms of management but neither has been readily available for most African countries due to several factors[5]. The placement of a Ventriculo-Peritoneal Shunt (VPS) is the most common treatment for hydrocephalus, though it has been associated with shunt obstruction, infection, and over-drainage of

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cerebrospinal fluid (CSF)[1]. Endoscopic third ventriculostomy (ETV) has been widely and successfully used for more than 80 years as an alternative to shunt procedures in many lesions leading to obstructive hydrocephalus[6,7]. It has been reported that combining ETV with choroid plexus cauterization (CPC) has been shown to treat hydrocephalus more effectively than ETV alone[3].

Endocscopic third ventriculostomy and CPC have been shown to decrease the number of hospital days and emergency visits for shunt failure hence are recommended as the current surgical options for selected forms of hydrocephalus in developing countries[8,9]. Six months success of ETV has been associated with a 3-year success rate of 95%, from the results shown in a large prospective Ugandan study edifying the efficacy of ETV[2]. Success in the ETV-CPC procedure has been reported in West Africa in Lagos, Nigeria[10] and East Africa in Mbale, Uganda where children treated came from Kenya, Tanzania, Malawi, Somalia, Rwanda, Congo and Mauritius[1]. Although ETV success has been reported in a good number of studies, controversies exists whether age of patient and etiology of hydrocephalus influence the outcomes[7].

In 2007, the Beit Cure Hospital (BCH) in Zambia introduced ETV and CPC as primary management for selected cases of childhood hydrocephalus owing to the observed increase in shunt failure rates in the country. These surgical procedures are relatively new for hydrocephalus management in the country, hence the outcomes are not well known. In the light of this development, we sought to determine the outcomes of ETV, alone and in combination with CPC as primary treatment of childhood hydrocephalus.

METHODOLOGY

A descriptive retrospective cohort research design with quantitative methods was utilised. Ethical approval was obtained from the Biomedical Research Ethics Committee of the University of Zambia. This article is part of the first author's PhD study in the Department of Physiotherapy, at the School of Medicine, University of Zambia.

The research study was conducted under the auspices of the BCH in Lusaka. The BCH is one of the two centres providing specialized care to children with spina bifida (SB) and hydrocephalus in Zambia. It **is a** private hospital that provides surgical facilities to children with physical disabilities.

Identification and recruitment of participants

The inclusion criteria used for recruitment in the study was: the child should have been diagnosed with hydrocephalus, underwent ETV or ETV-CPC, and had a follow-up record of six months post surgery.

A total of 179 files of children with hydrocephalus who underwent the ETV and ETV-CPC procedures were identified from those who were managed from June 2007 to January 2010. A convenient sample of 131 files (n=131) were eligible for analysis, while 48 were eliminated due to either follow-up of duration less than six months or lost to follow-up, giving a cohort follow-up rate of 75%.

Data capturing

Demographic and patient characteristics of the children including gender, age and etiology were investigated using a data capturing sheet. Age range was categorized into three groups: 0-5 months, 6-11 months and one year and above. Etiology was classified under three groups: post infectious hydrocephalus (PIHC), non- post infectious hydrocephalus (NPIHC-without myelomenigocele) and non-post infectious hydrocephalus (NPIHCM-with myelomeningocele). Hydrocephalus of a post infectious origin specified post meningitis and other infections while NPIHC comprised of patients with aqueduct stenosis, tumors, Neural Tube Defects (NTDs) and other congenital abnormalities from unknown cause. The presence or absence of a shunt before surgery was taken into account and surgical interventions given were reported as ETV alone and a combination of ETV-CPC.

Successful ETV was defined as cases free from subsequent surgical procedure for definitive CSF diversion or death related to hydrocephalus management within six months of operation. Failure of ETV was defined as cases requiring any subsequent surgical procedure for cerebrospinal fluid diversion after the primary management or case mortality below six months post surgery.

Data analysis

Descriptive statistics was used to analyze the data using SPSS version 17. Categorical variables were compared using either the Fishers' Exact test or Chi-square test. Multivariate logistic regression analysis and Univariate Analysis of Variance were done to test subject effects. Cumulative survival rates were estimated using Kaplan-Meier methods.

RESULTS

Demographic and clinical characteristics

The demographic and clinical characteristics of the 131 patients are summarized in table 1. The results of the study showed that there were more males (61%) than females (39%) ($p = 0.006$). The majority (63%) of the children were aged between 0-5 months, followed by those between 6-11 months with 24% and lastly by those with one year and above with 13% ($p < 0.0001$). The most common (73%) cause of hydrocephalus was PIHC secondary to meningitis and other infections followed by NPIHC with 19% and NPIHCM, 8% ($p < 0.0001$). From the 131 children, 121 (92%) had no history of shunt placement prior to surgery while 10 (8%) had a history of shunt failure ($p < 0.0001$).

Characteristic	Number (N=131)	Percentage %
Sex		
Female	51	39%
Male	80	61%
Age		
0-5 months	83	63%
6-11 months	31	24%
12 months and above	17	13%
Etiology		
PIHC	95	73%
NPIHC	25	19%
NPIHCM	11	08%
Presence of failed VPS at surgery time	10	08%
Yes	121	92%
No		

Outcomes of ETV

The summary showing the flow of all patients recruited during the study and results of the ETV and ETV-CPC are presented in figure 1. The results of the outcomes of the ETV and ETV-CPC showed that there were 2 mortalities and 8 failures in the first month. The second month had 10 failures, the third had 5, fourth had 8, fifth 1 and the sixth month had no failures giving a total number of 34 failed cases and 97 successful cases. The graph of survival analysis has been presented in figure 2 to show the rate of failed cases.

Figure 1: *Diagram showing the flow of all patients recruited during the study. N = number of patients.*

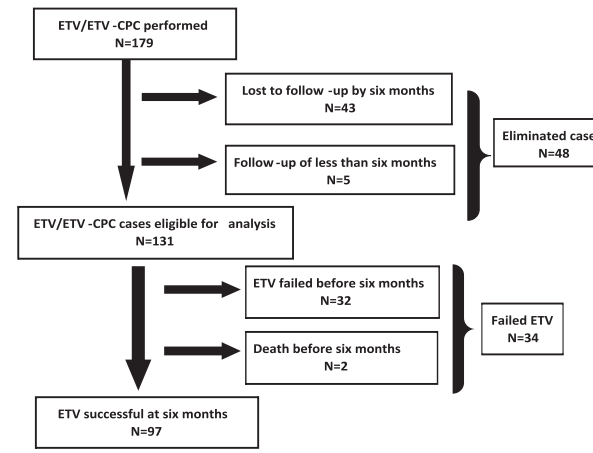
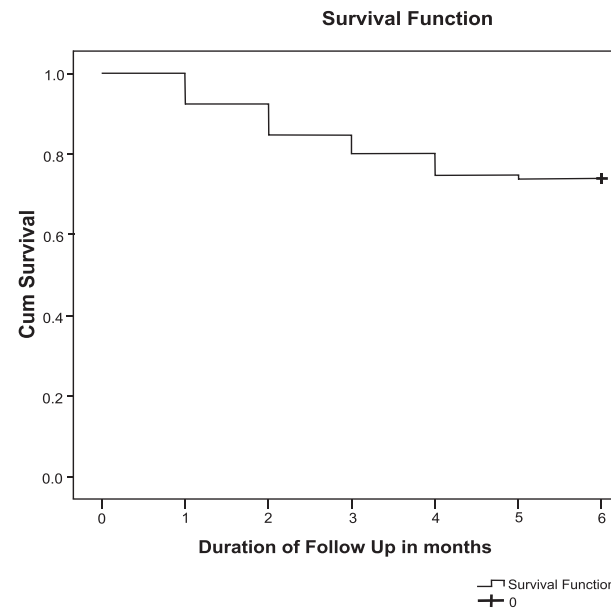


Figure 2: *The graph of survival analysis showing the 34 failed cases*



The overall success rate was 74% (97 out of the 131 children). The success rate in children who underwent ETV-CPC was 76%, while ETV alone was 62% ($p < 0.0001$). When data was exposed to univariate analysis of variance, age, etiology and shunt placement were not significantly associated with the outcomes.

Outcomes of ETV in relation to the demographic and clinical characteristics

The ETV outcomes in relation to the demographic and clinical characteristics are summarised in table 2. Children who were aged one year old and above (94%) were more likely to have a successful outcome followed by those aged between 0-5 months (73%) and lastly those aged between 6-11 months (64%), though not significant ($p = 0.06$). There was more ETV success rate in children with NPIHC ($p = 0.29$).

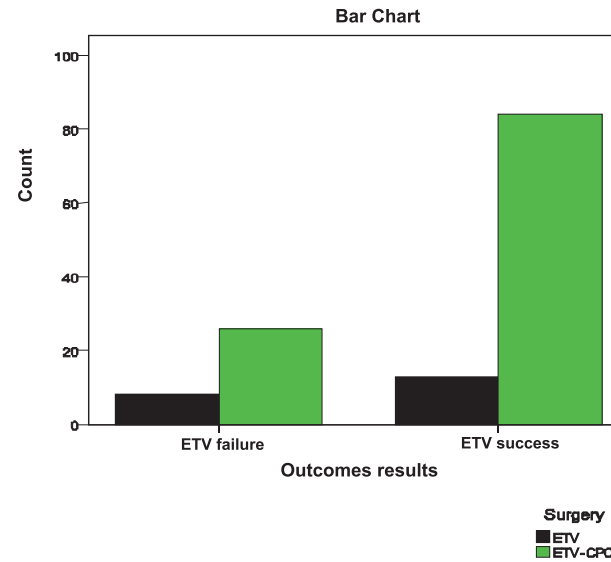
TABLE 2: *Outcome after ETV in relation to demographic and clinical characteristics of patients*

Characteristic	Success rate	Failure rate	*P value*
Age			*0.06*
0-5 months	61 (73%)	22(27 %)	
6-11 months	20 (65%)	11 (35%)	
12 months and above	16 (94%)	01(6%)	
Etiology			*0.29*
PIH C	69 (73%)	26 (27%)	
NPIHC	20 (83%)	05 (17%)	
NPIHCM	08 (73%)	03 (27%)	
Presence of failed VPS at surgery time			*0.71*
Yes	07 (70%)	03 (30 %)	
No	90 (74%)	31 (26%)	

Outcomes of ETV in relation to the surgical interventions

A total of 110 (84%) children underwent a combination of ETV and CPC procedures, while 21 (16%) were exposed to ETV alone ($p < 0.0001$). There was more success (76%) in children who underwent ETV-CPC than those exposed (62%) to ETV alone but the difference was not significant ($p = 0.30$) (figure 3). Complete or bilateral CPC was done in 51 (39%), 59 (45%) underwent partial or unilateral CPC and 21 (16%) had no cauterization due to fibrosis of the choroid plexus ($p < 0.0001$). Additionally, the results showed that ETV was more likely to be successful in children who underwen partial/unilateral CPC even though the difference was non-significant ($p = 0.08$).

Figure 3: *The graph showing outcomes of ETV in relation to the surgical interventions*



DISCUSSION

Success of a combination of ETV and CPC has been reported in West and East Africa. The two procedures have been recommended as reliable, safe and effective options in sub-Saharan Africa. Much more importantly, the procedure has shown to reduce hospitalization days, hence cutting off the costs of transport and medicine. In spite of the benefits of the use of the procedure, controversies exist whether age or etiology has an impact on the treatment outcomes.

As noted in results of this study, the introduction of ETV and ETV-CPC can contribute greatly to decrease the hospital days and emergency visits for shunt failure which is an important factor in the rehabilitation of children with hydrocephalus in Zambia given the size of the country. This in the long run contributes to serving government revenue that goes into the cost of hospitalization. It has also been observed that the stability acquired can help bring about meaningful physiotherapy results in

children with delayed milestones and physical disabilities.

Outcomes of ETV in relation to demographic and clinical characteristics

Fundamentally, ETV success is believed to be dependent on a number of factors like the age of a patient, etiology of hydrocephalus and many other findings of intra-operative assessments during surgery. There has been a debate whether patient age, cause of hydrocephalus, or both influence the outcome. Some authors postulate that only age influences outcome[11,12], others only origin, and still others both factors[7]. Age has been associated with the long-term reliability of ETV. For instance, some authors have postulated that patients less than six months old have poor reliability and that the probability of ETV success gradually increases during the first few months of life[7, 11,12,13,14,15,16,17]. Despite such overwhelming inferences that the younger age has poor reliability of ETV, some authors have favored its application in the younger age[3, 4, 15, 16,17,18,19,20,]. Our results showed that there was more ETV success rate in children aged one year old and above, though not significant ($p = 0.06$). Regarding our results, we agree with authors that postulate that the younger age has poor reliability of ETV outcome.

Although the exact incidence of hydrocephalus in Zambia is not well known, it has previously been reported by some investigators that the most common cause is congenital associated with NTDs and aqueductal stenosis[21]. In contrast, our results showed that hydrocephalus secondary to meningitis and other infections was the common cause accounting for 73% of cases. Our results are supported by a study that was done in Zambia that showed that bacterial infections presenting with bacterial meningitis was the common cause of hydrocephalus[22]. Our results are also in line with the findings of East Africa in Uganda that showed 61% and 60% of the cases reported CNS infection as actually the single most common cause of hydrocephalus respectively[4, 23]. Neonatal meningitis has been previously associated with ventriculitis, aqueductal obstruction, ventricular loculations, and cerebral infarction[4].

Endoscopic third ventriculostomy has been reported to have a high success rate in patients with an existing shunt which have failed[7, 24, 25]. It is believed that patients with shunts may lose the ability to absorb CSF through the subarachnoid space, but this may be reversible even after relatively longer periods of VPS use. Our results showed that 70% of the children admitted for shunt failure, were shunt free after ETV. This is similar to the findings of a study done in France, which showed ETV success in 63% of the patients that were admitted for shunt failure[7]. The possibility of having shunt malfunctioning in the first year after placement and subsequently overtime is universally recognized[4]. The use of ETV has been advocated for in cases of shunt failure even in patients in whom a shunt has been in place for many years[7]. However, in the event of ETV failure, a shunt may be an optimal choice.

Outcomes of ETV in relation to surgical interventions

Endoscopic third ventriculostomy has been used widely and successfully for more than 80 years as an alternative to shunt procedures in many lesions leading to obstructive hydrocephalus[6,7]. The successful procedure of ETV-CPC has been reported in West and East Africa[1, 8]. The overall ETV success rate of the current study was 74%. Hopf and others, reported[7] a 79% success rate, 68.5% in a study done in France[7] and 59% in a Ugandan study[4]. The ETV success rate of the current study compares favourably with other reported experiences.

The success rate of the ETV-CPC was 76% while ETV alone was 62%. This is supported by the Ugandan study[3] that showed that the ETV-CPC (75%) procedure has been shown to be more successful than ETV (67%) alone. A probable explanation for the added benefit of CPC is that it reduces CSF production sufficiently to compensate for a "communicating" component of the hydrocephalus that may exist in infants who do not have sufficiently developed CSF circulation and absorption capacity to accommodate the new efflux of CSF through the ETV stoma[3].

Endoscopic third ventriculostomy has been found to have failure rate of between 20-50% in various series[26] and another study[16] estimated the failure rate between 0 - 36%. The failure rate of this current study was 26% hence fits in the ranges of the 0-36%. The most failures of the ETV procedure occurred

within 2 months of the procedure. This is comparable with the findings of studies done in France[7] and Uganda[2] where most failures were reported to have occurred within 2 months of the initial procedure.

Limitations of the study

A high number of children were lost (25%) to follow-up. Lack of active follow-up might have affected the results because some children could have had ETV failure or died in the community hence not included in the analysis, leading to possibility of exaggerated success of the procedures.

CONCLUSIONS

Endoscopic third ventriculostomy is a safe and reliable procedure for selected children with hydrocephalus in Zambia. It reduces the number of days for hospitalization and visits for shunt failures hence possesses great benefits for both the nation and caregiving families. Children with ETV-CPC failure do not present in acute conditions as failed VPS. These results can be considered encouraging as they compare favourably with studies done elsewhere. Post meningitis and other infections were the most common cause of hydrocephalus. It can be concluded that the procedures have better results in children aged one year and above and those with non-post infectious hydrocephalus.

With such overwhelming results, it is highly recommended that such services be extended to other referral hospital as an option to shunt placement, especially in cases where access to care for treatment failure is likely to be delayed. However, a longer follow-up period and more widespread experience are warranted.

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