ADDIS ABABA UNVERSITY COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICINE, DEPARTMENT OF SURGERY
NEUROSURGERY UNIT

OUTCOME OF ENDOSCOPIC THIRD VENTRICULOSTOMY IN OBSTRUCTIVE HYDROCEPHALUS

Investigator: Addu Sileshy (MD, Neurosurgical Resident (Year V))

Advisor: Abat Sahlu (MD, PGD.Assistant professor of Neurosurgery)

November, 2020

Addis Ababa, Ethiopia

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A thesis submitted to the department of surgery for the partial fulfilment of the requirements of specialty certificate in Neurosurgery.

November, 2020

Declaration

Name of investigator	Addu Sileshy, M. D
Full title of research project	Treatment outcome of endoscopic third ventriculostomy in obstructive hydrocephalus patients at Tikur Anbessa Specialized Hospital, and Myung sung Christian Medical Center from January 1 2016 to June 30 2020 G.C
Study area	Tikur Anbessa Specialized Hospital and Myung sung Christian Medical Center, Addis Ababa, Ethiopia.
Study Period	January 1 2016 to June 30 2020 G.C
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LIST OF ABBREVIATIONS/ACRONYMS

AAU -Addis Ababa University

AS-Aqueductal Stenos

CSF-Cerebrospinal Fluid

CT-Computerized Tomography

ETV-Endoscopic Third Ventriculostomy

ETVSS-Endoscopic Third Ventriculostomy Success Score

HCP-Hydrocephalus

ICH-Intracerebral Hemorrhage

ICP-Intracranial pressure

IVH-Intraventricular Haemorrhage

LOC-Level of Consciousness

MCM-Myung sung Christian Medical Hospital

MRI-Magnetic Resonance Image

PIH -Post Infectious Hydrocephalus

TASH-Tikur Anbessa Specialized Hospital

VPS-Ventriculo Peritoneal Shunt

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ABSTRACT

Objective: To analyse the overall outcome of ETV in obstructive hydrocephalus in relation to neurosurgery experiences on patient selection, intraoperative incidents, post-operative complications and follow up results. Predictors for post op complications, factors responsible for successful outcome and validation of ETVSS for adult patients were also taken into account.

Methodology: Institution based cross sectional retrospective study was conducted among 68 patients for whom ETV has been done at Tikur Anbessa Specialised Hospital and MCM hospital from January 1 2016 to June 30 2020 G.C. Data obtained for analysis included patient demographics, clinical manifestations, underlying etiology, ETVSS, peri operative incidents and follow up results. Collected data from patients' medical chart using data collection checklist was checked for completeness, coded and entered to SPSS version 25 for analysis. Descriptive statistics and Binary Logistic Regression were used for data analysis.

Results: Mean age at the time of procedure was 29.4yrs (Range from 2years to 68 years, SD=17.8). of which, patients aged ≥ 15 years constituted 76.5% of study population. Brain tumours (67.9%), Aqueductal Stenosis (14.7%), and PIH (11.8%) were causes of hydrocephalus in most study participants. Intraoperative uncontrolled haemorrhage (13.2%) and distorted 3rd ventricular floor anatomy (7.3%) has led to insertion of EVDs in 19.1% that subsequently led to ventriculitis in 11.8% (61.5% of all EVDs). Other encountered post op complications are IVH (14.7%), ICH (4.4%) and CSF leak (4.4%) with overall morbidity of 22%. With a mean follow up of 7.45 months, the total number of patients with shunt free survival up to their last follow up month becomes 59 with overall successful outcome of 86.7%. The mean duration of ETV failures were found to be on 20th post-operative day (range 5 to 52 days). Younger age (31.2%, PIH (50%), uncontrolled bleeding (44.4%), distorted ventricular anatomy (60%), EVD insertion (53.8%), ventriculitis (75%) and post op IVH (40%) were associated with failed outcome. Among the 68.7% of patients with a high probability of ETVSS 93.6% had a successful outcome.

Conclusions: Endoscopic third ventriculostomy is a safer and more effective treatment option for obstructive hydrocephalus. Factors indicating potential poor ETV outcome are distorted ventricular anatomy, post op IVH and ventriculitis

Keywords: ventriculostomy, hydrocephalus, outcome

1. INTRODUCTION

1.1 Background

Hydrocephalus carries a global health burden and remains one of the most frequent conditions seen and treated by neurosurgeons around the world. Among the numerous CSF diversion procedures for the treatment of hydrocephalus, shunting CSF to an extracranial location, commonly to the peritoneum, had been largely utilized and still effective in certain selective sets of patients (Omar, 2010).

However, shunt-related complications such as malfunction, infection, over drainage, shunt dependency and foreign body reaction in one hand and the development of neuroendoscopic methods, in the other led to the introduction and use of ETV for the treatment of obstructive hcp and to overcome shunt related complications (Foley, 2016).

Endoscopic third ventriculostomy is a surgical procedure that allows the CSF to flow directly from the third ventricle to the basal cistern and subarachnoid spaces thus bypassing the aqueduct of sylvus and the posterior fossa. this provides a more physiological and anatomical diversion pathway for CSF (Fokuhara,2000).

With the advancement of neuro-endoscopy a better intraoperative anatomic view and advanced tools have enabled a safer minimally invasive third ventriculostomy with low complication rates and mortality compared to VPS insertion.ETV has become the preferred treatment option for obstructive hydrocephalus patients by many experts, which currently makes it the gold standard for treatment (Hader et al., 2008; Foley, 2016).

1.2 Statement of the problem

Bulk of available literature on this subject is either from other countries experience with varying degrees of success for the procedure or focused primarily on paediatric populations. in addition, outcome of this treatment remained different with regard to age, cause, certain technical parameters and long-term follow-up results.

The need for clarification on success rate, associated potential complications, failure rate and overall outcome in all age groups. This will be paramount for patient selection criteria, especially considering the burdens of dealing with patients subjected to VPS insertion and having shunt related complications in resource limited and developing countries like Ethiopia. There is paucity of data in related matters in Ethiopia. Hence, this study is initiated to assesses the outcome and associated factors of ETV.

1.3 Significance of the study

The results acquired from this research aims to analyse and report our experience including adult population. Risk factors and possible predictors of failure will be analysed for improving outcomes and possibly avoiding complications. Based on setups to whom this research had been carried out validation of ETVSS for adult patients and experience other countries will be compared. This research will give a baseline data that helps to undertake further study to delineate the outcomes of hydrocephalus at national level.

2.LITREATURE REVIEW

Mumtaz.et.al (2006) analysed outcome of ETV in 155 patients with obstructive hydrocephalus due to aqueductal stenosis, posterior fossa tumour, brain stem and CP angle tumour and concluded ETV as an effective, safe and successful procedure in patients with obstructive hydrocephalus (Success rate was 71%.). It may be used as replacement procedure of ventriculo-peritoneal shunt as initial line of management in selected patients.

In study done by Feng.et.al (2010) on 58 patients with obstructive hydrocephalus between age of 5-67 years and follow up to 3 yrs. for whom ETV was done outcome was analysed and found out One month after ETV an overall clinical improvement was observed in 45 (77.6%) of 58 patients. The survival rate was 87% at the end of the 1st year and 84% at the end of the 2nd year post-ETV. The ETV was successful in 81% with intracranial tumors,82% with cystic lesions,88.9% with aqueductal stenosis, and 38% with intracranial haemorrhage or infection. ETV failed in eight patients (13.8%) and the time to failure after the procedure was a mean of 3.4 months. Major complications occurred in seven patients (12.1%), including intraoperative venous bleeding, arterial bleeding, and occlusion of the stoma. The overall mortality rate was 10.3% (six patients). The results indicate that ETV is a most effective treatment in cases of obstructive hydrocephalus that is caused by aqueductal stenosis and space-occupying lesions. Seventy-five percent of ETV failures occur within 6 months after surgery.

Oumar.et.al (2013) assessed outcome of ETV in 350 patients with obstructive hydrocephalus and the overall success rate was 68.5% (252 of the 368 procedures). Patients < 6 months of age had a 5-fold increased risk of ETV failure than older patients Haemorrhage-related and idiopathic chronic hydrocephalus had a higher risk of failure than other causes. Most failures (97%) occurred within 2 months of the initial procedure. The overall morbidity rate was 10%, Endoscopic third ventriculostomy is a safe procedure and an effective treatment option for hydrocephalus. Factors indicating potential poor ETV outcome seem to be very young children and haemorrhage-related and chronic hydrocephalus in adults.

Douglas Brookmeyer et.al (1998) done outcome analysis of ETV to determine which patient groups have the highest chance of successful ETV, a retrospective case review was performed.97patients underwent a total of 98 ETVs. There were 59 males and 38 females with a mean age of 8.1 years (range 1 day to 29.5 years). Twenty-six of 98 procedures (26%) were

abandoned due to either unfavourable anatomy, inability to perform a cistern ostomy, or haemorrhage. Follow-up data was available in 92 patients for a mean of 24.2 months. The rate of successful ETV in 71 patients, with either complete shunt avoidance or removal, varied widely by diagnosis and patient age. The highest success rates were achieved in patients with aqueductal stenosis, tectal plate tumour, myelomeningocele and posterior fossa tumour.

Complications included one transient herniation syndrome, one basilar artery perforation, 2 cases of ventriculitis, one transient decrease in level of consciousness, and one transient hemiparesis. These results support the continued use of ETV in only carefully selected patients with hydrocephalus. And demonstrated that ETV is a relatively safe and effective way of achieving long-term success in managing various forms of noncommunicating hydrocephalus. Additionally, the research demonstrated a relatively low threshold for abandoning the procedure, mainly due to safety concerns or the inability to identify favourable anatomy in the patient.

Joshua R. Duisk et.al (2007) studied 108 patients for success and complication rates of endoscopic third ventriculostomy for adult hydrocephalus. Long-term shunt independence was achieved in 77% of patients. Two additional patients, who initially failed, later achieved success after reoperation and remained shunt free for the duration of their follow-up. Therefore, after reoperation, shunt independence was achieved in 79% of patients. Of the patients who ultimately failed, 11 failed within 1 month. Therefore, 52% who ultimately failed had more than 1 month of shunt-free existence (mean, 10 months). There were 6 surgical complications, including 2 deaths related to intracranial haemorrhage from brain tumours (not directly related to ETV per se), and 10 medical complications. The median hospital length-of-stay was3 days. The median follow-up was 8 months (range, 0-95 months). Conclusions were Endoscopic third ventriculostomy for adult non communicating hydrocephalus is a well-tolerated procedure that has a high likelihood of achieving shunt-free existence.

In retrospective analysis done by Vulcuet.al for Long-term results of endoscopic third ventriculostomy, 113 patients (58 males, 55 females; mean age 35 years, age range 8 days to 77 years) who underwent 126 ETVs, and they highlight the initial postoperative outcome after 3 months and long-term follow-up with an average of 7 years. The initial clinical success rate was 82% and decreased slightly to 78% during long-term follow-up. Long-term success was analysed using Kaplan-Meier curves. Overall, ETV failed in 31 patients. These patients underwent a

second ETV or shunt treatment. A positive impact on long-term success was seen for age older than 6 months, and for obstruction due to cysts or benign aqueductal stenosis. The complication rate was 9% with 5 intraoperative and 5 postoperative events. The high clinical success rate in short-term and long-term follow-up confirms ETV's status as the gold standard for the treatment of obstructive hydrocephalus, especially for distinct pathologies. The patient's age and underlying pathology may influence the outcome. These factors should be considered carefully preoperatively by the surgeon (Vulcu et al., 2015).

Graeme.et.al (2012) retrospective analysis on Predictors of Surgery-Free Outcome in Adult Endoscopic Third Ventriculostomy based on patient, radiographic, and operative factors had assessed One hundred twenty-four consecutive adult patients (>18 years) treated with ETV at an academic institution were retrospectively reviewed according to demographic, clinical, operative, radiographic, and follow-up variables. After excluding patients with unclear aetiologies or complex previous CSF shunting regimens, there remained 103 patients undergoing ETV for obstructive hydrocephalus, either as initial intervention or in the setting of shunt failure.

The primary end point used to assess ETV failure was return to the operating room for CSF diversion. Return of radiographic findings consistent with uncompensated hydrocephalus was considered as a secondary end point. Associations with ETV failure were assessed via Cox proportionate-hazards regression analysis. Clinical improvement was seen in 76 (74%) patients within a median of one month after surgery. Radiographic improvement was seen in 59 (57%) patients within a median of two months after surgery. Fifty-seven (55%) of the patients remained symptom and surgery-free through last follow-up, a median of 5 [2-9] years after ETV. Lasting morbidity and mortality occurred in less than 1%.

Multivariate, independent associations with ETV failure included perioperative steroid use, intraoperative image guidance, and time to radiographic improvement. Patients who had image-guided surgery or perioperative steroid treatment were approximately 2.5 times less likely to experience ETV failure the study concluded Perioperative factors like infection and repeated shunting, intraoperative image guidance, and steroid treatment may lower ETV failure rates Graeme.et.al (2012).

Moujahed.et.als retrospective observational study on Predicting success of endoscopic third ventriculostomy: validation of the ETV Success Score in 168 mixed population of adult and

paediatric patients. Results show ETVSS did not show adequate discrimination but demonstrated excellent calibration in this population of patients 2 years and older. According to decision-curve analyses, the ETVSS is marginally useful in clinical scenarios in which 60% or 70% success rates are the thresholds for preferring ETV to CSF shunt. Previous history of CSF shunt and age were not associated with worse outcomes, whereas post haemorrhagic and postinfectious causes of the hydrocephalus were significantly associated with reduced success rates following ETV (Moujahed.et.al., 2014).

3. OBJECTIVES OF THE STUDY

3.1 GENERAL OBJECTIVE

- To determine outcome of ETV in Obstructive hydrocephalus patients.

3.2 SPECIFIC OBJECTIVES

- To determine predictors of success in ETV.
- To determine risk factors for ETV failure and complications of ETV.
- To compare and validate results based on ETVSS

4. METHODOLOGY

4.1. STUDY SETTING AND PERIOD

The study was conducted at Tikur Anbessa Specialized Hospital (TASH) and Myung sung Christian Medical (MCM) Hospital. TASH is a teaching and tertiary referral hospital located in Addis Ababa. MCM Hospital is a non-governmental hospital providing neurosurgical services with affiliation for neurosurgical training with AAU. The study was conducted from June 1 2020 to September 30 2020.

4.2 STUDY DESIGN

This study employed a hospital based retrospective cross-sectional study on treatment outcomes of ETV.

4.3. POPULATION

4.3.1 SOURCE POPULATION

Patients with obstructive HCP treated in either of the hospitals were source population of the current study.

4.3.2 STUDY POPULATION

Data was collected from medical records of patients with obstructive HCP and aged 2 years or more for whom ETV was done at TASH and MCM in Addis Ababa, Ethiopia from January 1 2016 to June 30 2020 G.C

4.3.3 INCLUSION CRITERIA:

All patients aged 2years or more and with obstructive HCP for whom ETV was done.

4.3.4 EXCLUSION CRITERIA:

- Patients with missing medical records
- Surgery for primary pathology is done within 3 months of ETV
- Follow-up for less than 3 months.

4.4. SAMPLING METHOD:

- Convenience sampling method was used.

4.5. STUDY VARIABLES

4.5.1. INDEPENDENT VARIABLES

- ✓ Age
- ✓ Causes of obstructive HCP
- ✓ Clinical presentation
- ✓ Imaging findings
- ✓ Intra operative incidents
- ✓ Post-operative complications
- ✓ Clinical improvements

4.5.2. DEPENDENT VARIABLES

- ✓ VPS free survival after 03 months of surgery

4.6. OPERATIONAL DEFINITIONS

Clinical Improvement -Partial or complete improvement of pre-operative sign and symptoms of acute or chronic obstructive hydrocephalus.

Criteria for Success-Avoidance of shunt insertion for recurrence or worsening of Signs and symptoms of acute or chronic obstructive hydrocephalus for at least 3 months post ETV

Meningitis or Ventriculitis- Patients that have an initial negative CSF analysis taken at the time of procedure and meets the CDC/NHSN criteria

Operative mortality-any death, regardless of the cause occurring within 30 days after surgery in or out of the hospital and after 30 days during the same hospitalization subsequent to the operation.

Endoscopic Technique: In our centre, we use a flexible neuroendoscope (Karl Storz GmbH & Co., Tuttlingen, Germany). Following induction of general anaesthesia and endotracheal intubation, the patient is positioned supine on the operative table with the head resting in a neutral. Through a right frontal pre coronal burr hole, the frontal horn is cannulated using the endoscopic trocar and the endoscope introduced into the lateral ventricle. The foramen of Monroe is identified at the intersection of the choroid plexus and the thalamo striate and septal veins; the third ventricle is then entered with the endoscope. The following structures are

identified in the third ventricular floor: the infundibular recess, the tuber cinereum, the mamillary bodies, and the basilar artery, which is usually visualized through the translucent floor. The floor was fenestrated with a Bugbee wire just behind the dorsum sellae by applying blunt penetration through the floor. The wire was used to gradually dilate the opening by gently stretching the tissues. The endoscope is then carefully guided into the prepontine cistern and any arachnoidal bands that seem to impede free flow of cerebrospinal fluid (CSF) are bluntly disrupted using the Bugbee wire. When bleeding is encountered, haemostasis is usually achieved using continuous irrigation with a lactated Ringer's solution. At the end of the procedure, CSF pulsations are usually observed through the newly created stoma, indicating adequate CSF flow between the ventricles and the subarachnoid space. The endoscope is removed. Finally, the skin is closed in a watertight fashion. Postoperatively, patients are transferred to the ward and are mobilized the next morning. The typical hospital length of stay following ETV is 2–4 days.

4.7. DATA COLLECTION AND ANALYSIS

Data was collected by the investigator using the data abstraction format attached at the end of the manuscript. Pre-test was done on 5 cards to assess the quality of the abstraction format and make the necessary modifications as well.

Statistical Package for Social Service Solution (SPSS), version 25 was used for data entry and analysis. Data was checked for completeness and entered in to SPSS manually. Categorical variables were summarized by using frequency and was presented with tables, graphs, or charts. Numerical variables were summarized by using mean, median, and standard deviation. Associations was determined by using Chi-square test for categorical variables and t-test for continuous variables. Associations was considered statistically significant when the p-value is less than 0.05, at 95% confidence interval and power of 80%. Outcome will be assessed by determining shunt free survival for at least 03 months.

4.8. ETHICAL CONSIDERATIONS

This study was conducted in accordance with the ethical principles stated in applicable guidelines on good clinical practice, whichever represents the greater protection of the individual. Patient's medical record numbers and codes given by data collector were used as identification and medical records are only handled by the principal investigator. Data was used only for this research purpose and will not be passed to any other third party. The research also has no intervention in any parts of patient management. The research proposal was passed through IRB of TASH and got clearance before commencement of the research.

5. RESULT

5.1. Socio-demographic Characteristics

A total of 121 ETV procedures were done in TASH and MCM Hospital ,79 patients were selected for initial analysis, from these ETV was abandoned in 8 and 3 patients died in hospital and finally 68 patients meet the inclusion criteria for analysis of the result. Mean age of patients was 29.4yrs (Range from 2years to 68 years, SD=17.8). There were 40 males and 28 females. Most of patients were operated in TASH (61, 89.7%). The details are described in Table 1.

Table 1: Socio-demographic characteristics of study patients (n=68)

Variable	Value	No of patients	Percentage
Age Group	2-14 years	16	23.5 %
	15-64 years	50	73.6%
	≥65 years	2	2.9 %
Sex	Males	40	59 %
	Females	28	41 %
Hospital	TASH	61	89.7 %
	MCM	7	10.3 %

5.2. Pre-operative Evaluation

From clinical evaluation, headache (59,86.8%), vomiting (50, 73.5%) blurring of vision (17,25%%) and altered mentation (16,23.5%) were the main manifestations at time of surgery. There were three groups of aetiologies for underlying cause of obstructive hydrocephalus; Tumours, congenital and post infectious. Overall, from individual variables, the aetiologies were mostly due to posterior fossa tumours (15,22.1%), Aqueduct Stenosis (10,14.7%), Pineal Region tumours (9,13%) and Post infection (8,11.8%). (Table 2)

No patients had a low ETVSS, with 21 (30.9%) patients having predicted probability of moderate (50-70) score and 47(69.1%) patients with high (≥80) probability score for success.

Table 2: Pre-operative Clinical manifestations and underlying cause of HCP (n=68)

	Variables	No of patients	Percentage
Clinical Manifestation	Headache	58	86.8 %
	Nausea and Vomiting	50	73.5 %
	Blurred Vision	17	25 %
	Double Vision	5	7.4 %
	Loss of Balance	15	22.1 %
	Seizure	12	17.6 %
	Urinary Incontinence	11	16.2 %
	Altered mentation	16	23.5 %
	Total	68	100%
Etiology	Posterior fossa tumor	15	22.1%
	AS	10	14.7%
	Pineal Region Tumor	9	13.2%
	Post Infection	8	11.8%
	Intraventricular Tumor	7	10.3%
	Tectal Mass	6	8.8%
	CPA Tumor	5	7.4%
	Brainstem Tumor	4	5.9%
	Chiari Malformation	4	5.9 %
	Total	68	100%

5.3. Intraoperative Findings and Incidents

From patient's intraoperative record, 55 (80.9%) had a clear CSF and procedure was uneventful, in the remaining 13 (19.1%) patients CSF was turbid in 3(4.4%), there were 3 (4.4%) findings of inter thalamic adhesion and 5(7.4%) cases of subependymal gliosis. Intraventricular septations inside third ventricular cavity were 5(7.3%) with additional 4(5.8%) patients having cysts inside third ventricle. There were 6(8.8%) patients with thick third ventricular floor that was difficult to fenestrate, but eventually demonstrated spontaneous CSF flow through the stoma.

EVD was inserted in all 13(19.1%) patients. The indications were uncontrolled bleeding from cortical veins in 8(61.5%) patients, third ventricular floor anatomy was found to be either thick or anatomy was distorted in 4 (30.7%) patients (fenestration was done with difficulty). Additionally, in one (7.8%) patient there was both uncontrolled bleeding and obscured ventricular anatomy (with sub-ependymal gliosis and inflammatory exudates).

Apart from the 68 patients analysed in this study there were 7 cases of abandoned ETV (8.9% of total 78 patients) reasons being uncontrolled haemorrhage in 3 (3.8%), anatomy was difficult to identify landmarks in another 4% (3.8%) and one patient has absent Foramen of Monroe (1.2%). Additional 3 patients developed ventriculitis in this group of which two ended up with VPS insertion and one patient died due to complications related to ventriculitis.

5.4. Post-operative course in the hospital

Among the entire participants, 55 (80.9%) of the patients with uneventful ETV and symptomatic improvement without any post-operative complications were discharged to follow up. On post op control CT/MRI intracranial hematoma was identified along the tracks of operative corridor in 3(4.4%) patients with additional 10(14.7%) cases of hematoma inside either lateral or third ventricular cavity and CSF leak seen in 3(4.4%) patients (Table 3).

Ventriculitis developed in 8 (61.5% of patients on EVD and 11.8% of all study population) out of 13 patients on EVD that had initial CSF sample analysis taken intra op with no suggestive feature of infection. Among these 6(75%) patients had no improvement despite successful treatment of ventriculitis and VPS was inserted eventually. Two (25%) patients showed improvement in preoperative clinical manifestations of hydrocephalus after ventriculitis has been medically treated and weaning from EVD has been done with discharge to follow up.

From the remaining 5 (38.5%) patients on EVD without evidence of ventriculitis 2 of them were weaned from EVD after hematoma cleared from CSF and discharged with improvement of clinical manifestations. Redo ETV was attempted in the rest of 3 patients, conversion to VPS insertion done in one patient after difficulty in demonstrating spontaneous flow through stoma and in 2 cases procedure was successful which resulted in improvement of symptoms and subsequent discharge. The overall morbidity seen in total 15 patients is 22%.

5.5. Death of Patients

Three patents died in the hospital after ventriculostomy was done, two were due to complications related to ventriculitis and one patient from complications related to IVH, DI and Hypothalamic Injury. Analysis was not done on these patients because they were considered as treatment failure.

5.6. Follow up

When possible, patients were followed at 1, 3, and 6 months postoperatively and every 6 months thereafter. All 68 patients had at least 3 months follow up. 5(7.35%) patients were lost after 6th post-operative month, of these 2 patients died at home from unknown cause. The mean duration of follow up was 7.45 months (Range 3 to 12 months, SD 3.52).

5.7. Redo ETV

Total of 6(8.8%) Redo ETVs done of which three were to patients before their discharge. Three patients presented with recurrence of preoperative symptoms on follow up, one patient was discharged improved after successful Redo ETV, in two patient's procedure was abandoned and VPS was inserted because of distorted 3rd ventricular floor anatomy. In the end from a total of 6 redo ETVs 3(50%) ended up requiring VPS insertion.

5.8. Overall outcome

From 68 patients with first ETV, 12 (17.6%) subsequently failed to show clinical improvement or developed worsening of symptoms. The mean duration of failure was 19.9days (range 5 to 52 days, SD 13.5). After analysing outcome of patients with redo ETV the total number of patients that required insertion of VPS were 9 (13.2%) and 59 (86.8%) patients had shown improvement of symptoms and haven't required VPS insertion for at least 6 months post ETV.

5.9. Predictive Factors for Post-operative Complication and successful ETV

After Bivariate correlational analysis of variables using Pearson correlation at a 5% level of significance, Intra operative finding of Distorted 3rd ventricular floor anatomy has a statistically significant association with the development of post-operative ICH,40% (2) Fisher's Exact Test 0. 013. Additionally, insertion of EVD has a statistically significant association for ventriculitis 61.5% (8), with Fisher's Exact Test of <.001

Independent sample T test was performed to analyses the difference in the mean age of patients between successful and failed ETV. patients with successful ETV were older (Mean=32, SE=2.27) compared to patients with failed ETV (Mean=12, SE=2.68.After bivariate correlational analysis assuming a normal distribution at a 5% level of significance variables with statistically significant association with the successful outcome of ETV using Pearson correlation are ethology, uncontrolled bleeding, distorted anatomy, EVD insertion, post op IVH, ventriculitis and using Spearman's rho test age group and ETVSS (Table 3).

Table 3. Bivariate analysis on the Predictors of successful ETV

Variables	Values	Successful ETV	Failed ETV	P-value
Age Group	≤14	11(68.8%)	5(31.2%)	0.044
	15-65	46(92%)	4(8%)	
	≥65	2(100%)	0	
Etiology	CPA tumour	4(80%)	1(20%)	0.035
	Brain stem tumour	4(100%)	0	
	Posterior fossa tumour	14(93.3%)	1(6.7%)	
	Intraventricular tumour	6(85.7%)	1(14.3%)	
	Post infectious	4(50%)	4(50%)	
	Pineal region tumour	9(100%)	0	
	Tectal mass	4(66.7%)	2(33.3%)	
	Aqueductal stenosis	10(100%)	0	
	Chiari Malformation	4(100%)	0	
ETVSS	50-70(Moderate)	15(71.4%)	6(28.6%)	0.021
	≥80(High)	44(93.6%)	3(6.4%)	
Uncontrolled Bleeding	Yes	5(55.6%)	4(44.4)	0.014
	No	54(91.5%)	5(8.5%)	
Distorted Ventricular Anatomy	Yes	2(40%)	3(60%)	0.015
	No	57(90.5%)	6(9.5%)	
EVD Insertion	Yes	6(46.2%)	7(53.8%)	<.001
	No	53(96.4%)	2(3.6%)	
Post op IVH	Yes	6(60%)	4(40%)	0.022
	No	53(91.4%)	5(8.6%)	
Ventriculitis	Yes	2(25%)	6(75%)	<.001
	No	57(95%)	3(5%)	

6.DISCUSSION

In the sociodemographic data of study patients at the time of operation, mean age of patients was 29.4 years,76.5% were 15 years and above. Regarding the underlying cause for hydrocephalus , 67.6% of the procedures were done for tumours(Posterior fossa tumour 22.1%, Pineal region tumour 13.2%, Intraventricular tumour 10.3%, Tectal tumour 8.8%,CPA tumour 7.4% and Brain stem tumour 5.9%), 14.7% for AS ,Post infectious 11.8% and Chiari malformation 5.9%.This predominance of tumours and AS for the indication of ETV and for patient selection criteria is in line with findings of many papers (Graeme.et.al,2012 ; Oumar.et.al,2013; Feng.et.al ,2010) as it has been shown successful outcome of ETV for these patients is among the highest.

The most common clinical manifestations at the time of Procedure was Headache 86.8% and vomiting 73.5% followed by visual blurring and/or double vision in 32.4%, altered mentation in 23.5%, balance difficulty 22.1%, seizure 17.6% and urinary incontinence in 16.2%. Considering majority of patients are adults and have similar group of underlying ethology to majority of studies, the proportion of signs and symptoms in lies in close proximity to most of the results.

Intraoperative uncontrolled haemorrhage (13.2%) and distorted 3rd ventricular floor anatomy(7.3%) has led to insertion of EVDs in 19.1%, it led to 11.8% of patients developing ventriculitis, as this study demonstrated the significant relation of EVD insertion to development of ventriculitis (61.5% of patients on EVD).In addition this study found that technical difficulties in identifying anatomic landmarks and attempting to create a stoma in the face of distorted 3rd ventricular floor anatomy(7.3%) led to a significant relation for development of post op ICH(4.4%).Other post op complications directly related to the procedure was IVH in 14.7% and CSF leak in 4.4%.The overall morbidity was 22% seen in 15 patients and surgical mortality (including the 7 patients with abandoned procedure) is 5.3%.

There have been several reports on ETV success rates of 70%–90% , these variations may be related to differences in the patient populations, underlying ethology for hydrocephalus, the follow-up periods, and the definitions of failure ETV.In this study ETV was considered successful when there is clinical improvement of signs and symptoms without the need for VPS insertion for a minimum of 3 months follow up. With a mean follow up of 7.45 months, during the first ETV,12 (17.6%) patients required either VPS insertion (6) or redo ETV (6).The initial success reached 82.36% after 3 months and was in agreement with current literature that reports

success rates of up to 90% (Graeme.et.al,2012 ; Mumtaz.et.al,2006 ; Duisk et.al,2007; Feng.et.al ,2010).The mean duration of ETV failures were found to be on 20th post-operative day ,considering the 3 cases(50% of Redo ETVs) which ended up with VPS insertion, the total number of patients with shunt free survival up to their last follow up month becomes 59 with overall successful outcome of 86.7%.

Significant predictors of successful outcome were found to be age with 92.3% of successful outcome in adult population compared to 68.8% in paediatrics patients, underlying ethology of hydrocephalus with low success rate seen in post infectious (50%) and tectal tumours(33.3%) in contrary to AS, Chiari Malformation, Tumours of Pineal region, Brain stem, Posterior fossa and CPA with intraventricular tumours which have comparable outcome from what's can be found in other series .(Oumar.et.al,2013;Graeme.et.al,2012 ; Mumtaz.et.al,2006 ; Duisk et.al,2007; Feng.et.al ,2010) Regarding ETVSS 93.6% of patients with high predictive probability score and 71.4% with moderate score had successful outcomes which is comparable to other studies including those done on paediatrics patients. Significant Predictors for unwanted outcome in which there is a high ETV failure include uncontrolled bleeding (44.4%), Distorted ventricular anatomy (60%), EVD insertion (53.8%), Ventriculitis (75%) and Post op IVH (40%).

7. STUDY LIMITATION

The study was done mostly on a single institution (TASH) patients and does not reflect experiences from other centres. Since it's a retrospective analysis and depend on availability and completeness of patient charts, limitations in both aspects led inferring of results for generalization difficult. Standard imaging modalities were not applied or routinely used in the management of these patients which makes analysis of objective measures for symptomatic improvements difficult. The minimum follows up period for these patients was 3 months and long difficult. The long-term outcome of these patients cannot be stated with confidence.

8. CONCLUSION

ETV is a safe and effective treatment modality for obstructive hydrocephalus patients especially for aetiologies of brain tumours and AS with 86.7% overall success. Among adult patients with high ETVSS 93.6% have successful outcome. Distorted ventricular anatomy, post op IVH and ventriculitis were the most ETV failures has been seen and most failures were seen with in the first month of surgery.

9. RECOMMENDATION

Larger sample sized and prospective analysis with longer follow up period will be required to answer limitations of this study. Considering the high rate of EVD contaminations avoiding low threshold for insertion can be suggested.

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APPENDIX I

Questionnaire

Social and demographic data

Age in years

Sex

MRN

Hospital

Telephone #

Etiology/Indication (Please tick boxes for any single or multiple options)

CPA tumor	Post traumatic	AS
Brain stem tumor	SAH	DWM
Posterior Fossa tumor	IVH	NTD
Intra Ventricular tumor	Redo ETV	Chiari Malformation
Pineal Tumors	VPS Failure	Tectal Mass
Other tumor locations	Post Infectious	Other causes

Clinical Manifestations (Please tick boxes for any single or multiple options)

Headache	Blindness	Urinary Incontinence
Nausea	Blurred Vision	Developmental Delay
Vomiting	Downward gaze/CN Palsy	Double Vision
Seizure	Memory Disturbance	Others, please specify

ETV success score

Category	Description	Value (%)	Score (%)
Age	<1month	0	
	1to<6months	10	
	6monthsto<1year	30	
	1to>10years	40	
	≥10years	50	
Etiology	post-infectious	0	
	Myelomeningocele, post IVH, non-tumor locations	20	
	Aqueductal stenosis, tectal tumor, other	30	
Shunt History	Previous shunt	0	
	No previous shunt	10	
		Total(range0–90%)	

Pre-operative MRI/CT Scan Result (Please tick boxes for any single or multiple options)

Clear pre mesencephalic cisternal anatomy	Yes	No
Intraventricular Cyst	Yes	No
Intraventricular septation	Yes	No
Isolated lateral ventricle	Yes	No

Intraoperative Findings/Incident (Please tick boxes for any single or multiple options)

Un eventful	Clear CSF	Cloudy/Turbid CSF
Absent septum pellucidum	absence of FoM	Traumatic BA aneurysm
Fused, thickened forniceal columns	intra-ventricular septations	Cardiac arrest
Intraventricular Cyst	Inter thalamic adhesions	Procedure abandoned (Reason)
Subependymal gliosis	Thickened 3rdventricular floor	EVD Inserted Reason
Un controlled Hemorrhage, origin if site identified	Inflammatory exudates	VPS insertion, Reason
Hypothalamic injury	Other findings	Death, Cause

Postoperative Course in Hospital (Please tick boxes for any single or multiple options)

Stable	Deterioration/Worsening
No improvement	3rd and/or 6th nerve palsies
Ventriculitis	Traumatic basilar artery aneurysm
Pneumocephalus	Motor Weakness
ICH	Control CT/ MRI finding
IVH	Redo ETV
Surgical site CSF leak.	VPS Insertion
Decreased LOC	Death (Cause)

Post OP follow Up

	<1month	3 months	6 months	1y	2yrs
No Improvement					
Worsening/Deterioration					
Partial/Complete Improvement					
Death Cause, if known					

Post OP imaging (if available)

APPENDIX II

ETV Success Score

Category	Description	Value (%)	Score (%)
Age	<1month	0	
	1to<6months	10	
	6monthsto<1year	30	
	1to>10years	40	
	≥10years	50	
Etiology	post-infectious	0	
	Myelomeningocele, post IVH, non-tumor locations	20	
	Aqueductal stenosis, tectal tumor, other	30	
Shunt History	Previous shunt	0	
	No previous shunt	10	
		Total(range0–90%)	

APPENDIX III

CDC/NHSN Criteria for Meningitis or ventriculitis

At least 1 of the following 1. Patient has organisms cultured from cerebrospinal fluid (CSF).

2. Patient has at least 1 of the following signs or symptoms with no other recognized cause: fever (>38^{C}), headache, stiff neck, meningeal signs, cranial nerve signs, or irritability AND at least 1 of the following: a. increased white cells, elevated protein, and/ or decreased glucose in CSF b. organisms seen on Gram's stain of CSF c. organisms cultured from blood