Original Research Article

International Journal of Neurology and Neurosurgery
Volume 10 Number 2, April - June 2018
DOI: http://dx.doi.org/10.21088/ijnns.0975.0223.10218.2

A Prospective Study of Endoscopic Third Ventriculostomy in Pediatric Andadult Hydrocephalus

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Abstract

Introduction: Endoscopic techniques are being increasingly used in the management of various neurosurgical pathologies, in recent times. Endoscopic third ventriculostomy (ETV) is a well accepted mode of treatment for obstructive hydrocephalus of various etiologies. Success rate of endoscopic third ventriculostomy is poor in post- hemorrhagic, post-infective hydrocephalus. It is safe in correctly selected cases. Good pre-operative planning, appropriate imaging, surgeons experience and good post-operative care help in successful results. The purpose of this study was to define the success rate of endoscopic third ventriculostomy in the treatment of obstructive hydrocephalus.

Aim of the Study: The purpose of this study is to determine the success rate of endoscopic third ventriculostomy (ETV) in the treatment of obstructive hydrocephalus in our Institution.

Materials and Methods: Patients with triventricular hydrocephalus secondary to posterior fossa lesions, brain stem gliomas, CP angle tumours, pineal tumours, aqueductal stenosis and patients with blocked shunts inserted for triventricular hydrocephalus were included. Patients with normal pressure hydrocephalus, post-subarachnoid haemorrhage hydrocephalus and age less than 2 years were excluded.

Results: A total of 52 patients with hydrocephalus were treated by the Endoscopic third ventriculostomy (ETV) procedure. There were 26 males and 26 females with age ranging from 2 years to 69 years and with a mean age of 30 years. Successful outcome was seen in almost 75% of patients (39 cases), while 13.5% of patients (7 cases) required VP shunt. Clinical and radiological improvement was observed in 2 patients (5.1%) and clinical improvement was observed in alone in 37 patients (94.9%) in final follow-up review of endoscopic third ventriculostomy functioning cases.

Conculsion: From this study, it can be concluded that endoscopic third ventriculostomy is the first line surgical procedure which is safe, fast and effective for treating obstructive hydrocephalus.The procedure is successful in 75% of cases. The success rate is highly dependent on the underlying pathology regardless of Endoscopic Third Ventriculostomy (ETV), Obstructive Hydrocephalus, Posterior fossa tumour, Aqueductal stenosis the age of patients.

Keywords: Endoscopic Third Ventriculostomy (ETV).

Introduction

Ventriculoscopy was introduced in the early 1900s. Walter E. Dandy used a primitive endoscope to perform choroid plexectomy in communicating hydrocephalus. He later introduced the sub-frontal approach for an open third ventriculostomy [1].

The high mortality rate of this approach prompted Dandy to accept a different treatment. Endoscopic management of hydrocephalus was tried in 1910 when VL L2 Espinasse, an urologist, used the cystoscope to cauterize the choroid plexus [2]. The first ETV was performed by William Mixter, an urologist, in 1923. He used an urethroscope to perform the third ventriculostomy in a child with obstructive hydrocephalus. Tracy J. Putnam made the necessary modifications in this urethroscope for cauterization of the choroid plexus [3]. The advent of valve-regulated

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Received on 07.04.2018, **Accepted on** 23.04.2018

shunt systems and the simplicity of the shunt technique resulted in minimal advances in third ventriculostomies for next 30 years. In 1947, H.F. McNickle introduced a percutaneous method of performing third ventriculostomy that decreased the complication rate andimproved the success rate. In the early 1970s, the leukotome was introduced to enlarge the perforation in third ventricle floor without injury to the surrounding vascular structures. This percutaneous technique was further modified after the advent of stereotactic frames. This resulted in renewed interest in the use of ETV for the treatment of obstructive hydrocephalus [4].

This was further supported by the advent of advanced fiber optic and lens technology. We now have small neuroendoscopes with deflectable tips, working ports, and good optic resolution, in addition to the rigid endoscopes with their excellent optic resolution. High definition camera has further improved visualization and recording [5].

An improvement in the success rate of third ventriculostomy in recent times could be due to better patient selection, improvements in endoscope, better imaging, advanced surgical technique and instruments. The incidence of congenital hydrocephalus is about 0.2–0.5/1,000 live births. A greater incidence has been reported in elderly primiparus mothers [6].

It can be related with a variety of physiological and pathological conditions. An obstruction at any point in the cerebrospinal fluid pathway may result in hydrocephalus. By tradition, obstruction within the ventricular system is called noncommunicating hydrocephalus and when the impairment is in the circulation through the subarachnoid space or absorption to the venous system, it is called communicating hydrocephalus. If the aetiology is known, it is further divided into congenital and acquired forms [7]. The aetiology of congenital hydrocephalus remains uncertain. An inheritable form of aqueductal stenosis has been described in males (X-linked hydrocephalus). The other mechanism of hydrocephalus is excess of CSF formation, seen in papilloma of the choroid plexus.

Rekate has classified hydrocephalus based on cerebrospinal fluid flow obstruction [8]. Impaired absorption is an alternative mechanism where venous sinus occlusions, vein of Galen malformations and developmental anomalies like craniostenosis with malformations of the skull base can leadto the development of hydrocephalus. Absence or disease of the arachnoidal villi, causing a disturbance of absorption can also result in hydrocephalus [9].

Materials and Methods

The study was conducted at the Institute of Neurosurgery, Madras Medical College from January 2015 to January 2016 on patients who underwent endoscopic third ventriculostomy (ETV) for obstructive hydrocephalus. Patients with triventricular hydrocephalus secondary to posterior fossa lesions, brain stem gliomas, CP angle tumours, pineal tumours, aqueductal stenosis and patients with blocked shunts inserted for triventricular hydrocephalus were included. Patients with normal pressure hydrocephalus, post-subarachnoid haemorrhage hydrocephalus and age less than 2 years were excluded. CT and /or MRI brain was performed in all the cases.

An informed consent was taken pre-operatively, explaining the prognosis. The ethical committee approval was taken from the hospital ethical committee. The GAAB Endoscopic system by Karl Storz GmbH & Co (Tuttlingen, Germany) was used which included rigid rod lens optics 0-degree. We kept our patients overnight in the neurosurgical intensive care unit for observation, and most patients could be discharged home the following first week if they did not require further definitive surgery for tumor.

We did postoperative imaging with computerized tomography imaging studies at 1week, 1month, 3months and 6 months to rule out postoperative complications and to follow up the ventricle size.

The success rate and complications in relation to the underlying pathology and age of the patients were analyzed. Endoscopic third ventriculostomy was considered successful in clinically improved patients with and without radiological improvement. Endoscopic third ventriculostomy was considered failed in patients who did not improve clinically. Ventriculoperitoneal shunt was considered in failed cases and no repeat endoscopic third ventriculostomy was attempted.

Data variables included age, gender, number, clinical variables included headache, nausea or vomiting, gait changes, 6th CN palsy, papilledema, and seizure. The Radiological variables included width of the third ventricle size, Evans ratio, FH/ID ratio, temporal Horns size, periventricular low density. These variables were recorded at admission and during the follow up period. Nature of complications after surgery were also recorded. Data was analyzed by descriptive statistics using Statistical Package for Social Sciences (SPSS) software version 20.0.

Result

A total of 52 patients with hydrocephalus were treated by the Endoscopic third ventriculostomy (ETV) procedure. There were 26 males and 26 females with age ranging from 2 years to 69 years and with a mean age of 30 years. The causes of hydrocephalus were Aqueductal stenosis six patients, Aqueductal stenosis with Shunt failure seven patients, Aqueductal stenosis with Shunt Extrusion two patients, Post Meningitis sequelae two patients, Meningitis with shunt failure one patient, Cerebellopontine angle tumor nine patients, Cerebellar tumor seven patients, Cerebellar tumor with Shunt failure three patients, Tentorial Meningioma one patient, Posterior Fossa Secondaires four patients, Brainstem Glioma three patients, Suprasellar epidermoid one patient, Dandy Walker syndrome with hydrocephalus one patient, Congenital hydrocephalus shunt failure one patient, cerebro vascular accident with hydrocephalus one patient, Posttraumatic hydrocephalus one patient, Posterior Fossa intra cerebellar hemorrhage with hydrocephalus one patient and pineal cyst Hydrocephalus one patient.

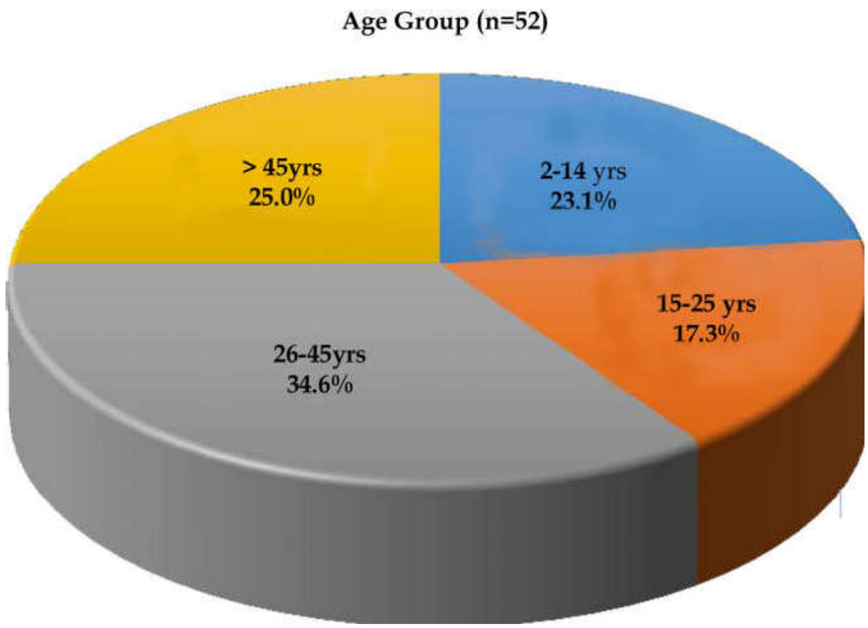

Chart 1: Group A- 2 to 14 years, Group B- 15 to 25 years, Group C- 26to 45 years, Group D- > 45 years

Table 1: Radiological Parameters of Hydrocephalus

Radiological parameters of Hydrocephalus	At Admission	1st week	1st Month	3rd Month	6th Month	Final FollowUp
Average Width of the third ventricle>2mm	11.44	9.33	7.46	6.47	6.54	6.05
Average Evans ratio (FH/BPD) = > 0.3	0.39	0.36	0.33	0.32	0.32	0.31
Average FH/ID =>0.5	0.49	0.46	0.42	0.41	0.43	0.42
Average Temporal Horns >2mm	10.54	7.92	5.69	4.79	5.29	5.12
Periventricular low density (present)	48	5	0	0	0	0

According to the age group underwent endoscopic third ventriculostomy 2 to 14 years 23% (12 patients), 15 to 25 years 17% (9 patients), 26 to 45 years 34% (18 patients) and more than 45 years 25 (13 patients). According to the age minimum age was 2 years to maximum age was 69, mean age 30.23 years and standard deviation 17.506. The follow up period after ETV ranged from 1 week to 41 weeks and a standard deviation of 11.190. The mean follow up period in the ETV functioning group was 25.85 weeks with standard deviation 9.258. In thegroup in whom ETV failed and VP shunt was done, the mean follow up period was 19.14 weeks with a standard deviation 11.408.

For the statistical analysis causes of hydrocephalus patients were grouped as Posterior fossa tumour in14 patients (26.9%), Aqueductal stenosis in 6 patients (11.5%), Already shunted in 12 patients (23.1), CP angle tumour in 7 patients (13.5%), Meningitis in 4 patients (7.7%) and Others in 9 patients (17.3%).

At the time of admission, the radiological parameters of patients were as followed. Average Width of the third ventricle size -11.44mm. Average Evans ratio (FH/BPD) -0.39.Average FH/ID -0.49. Average Temporal Horns size - 10.54mmThe presences of periventricular low density - 92% ofpatients.

In patients with Posterior fossa tumours endoscopic third ventriculostomy functioned in 42.9% of patients (6 cases).Conversion to VP shunt was required in 28.6% of patients (4 cases) and 28.6% of patients (4 cases) died. Aqueductal stenosis patients ETV functioning 100% of patients (6 cases) Already shunted patients endoscopic third ventriculostomy functioning 75% of patients (9 cases) converted into VP shunt 25% of patients (3 cases).

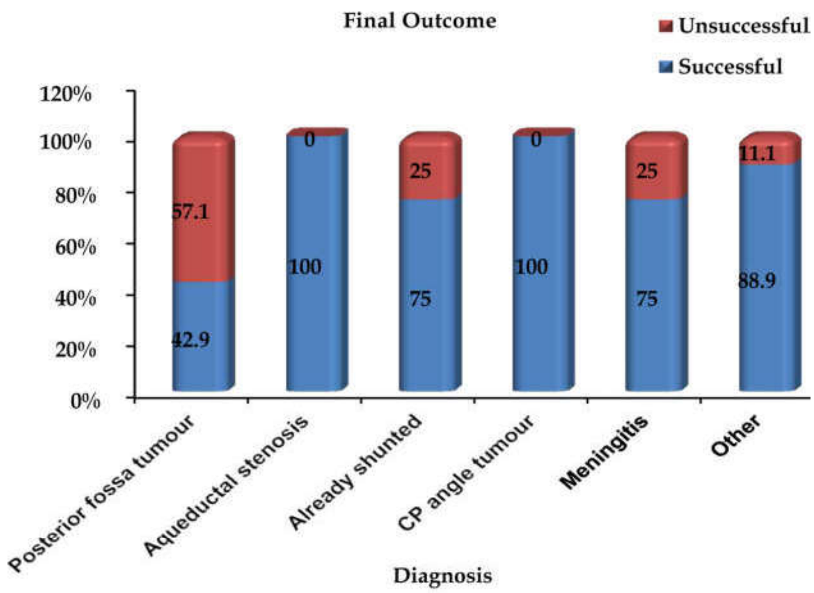

Chart 2: Final outcome of ETV patients

Table 2: Final Outcome in ETV patients

Diagnosis P-Value (0.027)	**Final Outcome n = 52** **Success(EV T Functioning) N=39 (%)**	**Unsuccessf ul (VP Shunt, Death-ETV, Death other) N=13 (%)**
Posterior fossa tumour	6 (42.9)	8 (57.1)
Aqueductal stenosis	6 (100)	0 (0)
Already shunted	9 (75)	3 (25)
CP angle tumour	7 (100)	0 (0)
Meningitis	3 (75)	1 (25)
Other	8 (88.9)	1 (11.1)
Total	39 (75)	13 (25)

CP angle tumour patients endoscopic third ventriculostomy functioning 100% of patients (7 cases) of Meningitis patients endoscopic third ventriculostomy functioning 75% of patients (3 cases), died 25 (1 case) and other patients endoscopic third ventriculostomy functioning 88.9% of patients (8 cases), converted into VP shunt 11.1% of patient (1 case).

Table 3: Clinical / Radiological outcome in ETV Functioning patients

Clinical / Radiological outcome in ETV Functioning cases n=39	**Number of patients**	**Percentage**
Clinical + radiological improvement	2	5.1
Clinical improvement only	37	94.9

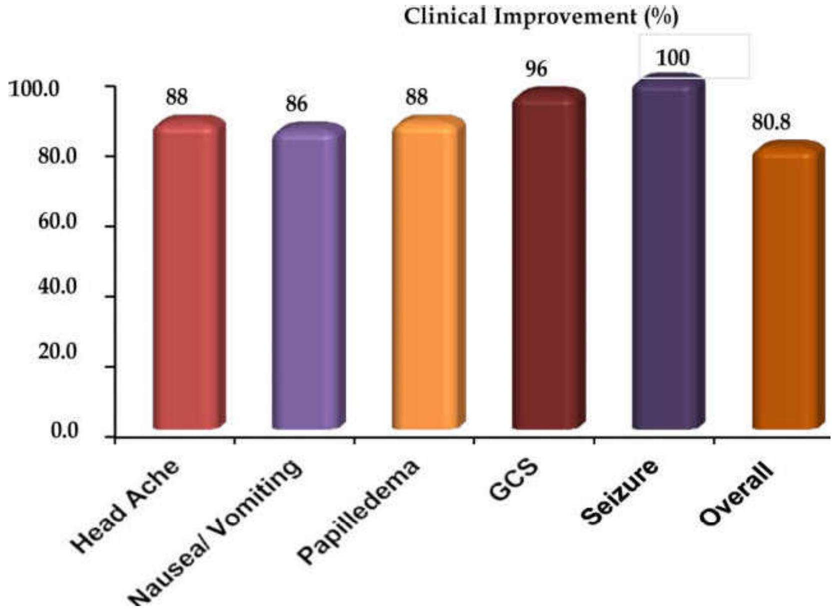

Chart 2: Clinical Improvements in ETV patients

Clinical improvement was observed in most patients in whom endoscopic third ventriculostomy continued functions. 6th cranial nerve palsy did not improved in one patient and on reappearance of the clinical symptoms. Resulted in conversion to VP shunt.

Radiological improvement was observed the in final follow-up with the width of the third ventricle decreasing to less than 2mm in 6% of patients, Evans ratio improving in all patients, FH/ID ratio improving in 90% of patients, temporal horns size decreasing to less than 2mm in 18% of patients and periventricular low density resolving in 90% of patients.

Reappearance of periventricular low density occurred in 10% of patients; these patients were considered as endoscopic third ventriculostomy failure Clinical and radiological improvement was observed in 2 patients (5.1%) and clinical improvement was observed in alone in 37 patients (94.9%) in final follow-up review of endoscopic third ventriculostomy functioning cases.Complications were seen in 5 (9.6%) patients. These included CSF leak in 2 cases (3.8%) and pneumocephalus in 3(5.8%) cases. These complications were managed conservatively.

Complications were seen in 5 (9.6%) patients. These included CSF leak in 2 cases (3.8%) and pneumocephalus in 3 (5.8%) cases.

These complications were managed conservatively. Successful outcome was seen in almost 75% of patients (39 cases), while 13.5% of patients (7 cases) required VP shunt.

Discussion

Endoscopic third ventriculostomy is good alternative treatment to cerebrospinal fluid shunt therapy in patients with obstructive hydrocephalus due to its improved long-term benefits and occasional complications as compared to ventriculoperitoneal shunt insertion. Endoscopic third ventriculostomy is considered to be highly safe and fast in skilled hands.The success of the procedure is based on different variables [10]. These variables can be independent; at are not related with the procedure or its complications procedure like age, sex, cause and type of hydrocephalus. History of previous surgery and procedure performed or they can be dependent variables including endoscopic third ventriculostomy failure and its complications, needs further treatment protocols to treat hydrocephalus. Success rate of endoscopic third ventriculostomy varies with the cause of hydrocephalus [11]. In our study the effectiveness were more in benign lesions of the brain which is comparable with Jinkenson MD [12]. It shows that endoscopic third ventriculostomy even though has different effectiveness in different diseases but overall success rate in obstructive hydrocephalus due to any cause [13]. Among the space occupying lesion the best effectiveness were observed in patients with cerebellopontine angle lesion (100%) followed by brain stem lesion (66.6%). The lowest success rate observed in our study was for posterior fossa lesion (42.9%). This is in contrast with the 85% success rate in the series of Sacko O. The difference in results depend on difference in patient age, cause of hydrocephalus, previous shunt status or other confounders [14]. Intra-operativevariations like thickness of the floor of the third ventricle and mean stoma size during surgical procedure, and postoperative complications like cerebrospinal fluid leak, infection, vascular and neuronal injury, seizure and abandoned procedure can contribute in the form of dependent variables for its failure [15]. In this study series of 52 patients, however, we found that variations in the relationship of the basilar artery complex to the third ventricular floor can occur, and anomalies of Basilar artery complex were noted in 8 of patients (15%) of our patients [16]. These anomalies included anterior translocation of the Basilar artery complex in 11.5% (6 cases) so that it lies underneath the midportion of the third ventricular floor, and ectatic anterior and upward bowing of an enlarged Basilar artery trunk in 3.8% (2 cases) seen, in which the vessels lie at risk underneath the midportion of the third ventricular floor [17]. If the floor of the ventricle is translucent, these vascular anomalies can be readily detected and a safe entry site determined. In this study, however, we found, translucent third ventricular floors in 47patients (90.4%), and thickened and opaque third ventricular floors in 5 patients (9.6%) which rendered the underlying vascular anatomy optically invisible [18]. The combination of an aberrantly located basilar artery complex and an opaque third ventricular floor occurred in 9.6% of the patients, placing them at increased risk for vascular injury [19]. Change in the ventricular size is not believed to be abrupt and of radiological follow-up at is needed at least 3 months post-op to observe in the change in the ventricular size. In this study radiological parameters of hydrocephalus such as average width of the third ventricle size, average Evans ratio and average temporal horns size showed reduction in most of the cases, but they do not return to normal size [20]. Periventricular low density resolved in the first week follow-up imaging and cases in whom it reappeared need VP shunt. The improvement in the clinical status of the patient has a greater value rather than the change in ventricle size. Radiological improvement in the ventricle size may be correlated correctly with endoscopic third ventriculostomy success [21]. Expected postoperative complications also involved abandoned procedure. Haemorrhage has both clinical significant and clinically non- significant, cerebrospinal fluid leakage, vascular and neuronal injury, infection and seizures, rare complications like sub-dural hygroma/ hematoma may contribute to fall in success rate. The success rate of endoscopic third ventriculostomy, therefore, needs proper clinical and radiological diagnosis and proper selection of patient before including to surgical indication for better outcome [22]. Age greater than 2 years, aqueductal stenosis and obstructive hydrocephalus due to tectal and nontectal tumours, (like brain stem, pineal, posterior fossa and CP angle tumour) were associated with excellent results. Successful results were seen in 39 cases out of 52, with a success rate of 75%. In those with previous shunt therapy, only 6 had a shunt free life [23]. The success rate in aqueductal stenosis with hydrocephalus with previous shunt showed success in 10 cases only. Successful results were obtained in the causes of hydrocephalus due to aqueductal stenosis six patients, aqueductal stenosis with shunt failure seven patients, aqueductal stenosis with Shunt extrusion two patients, post meningitis sequelae two patients, cerebellopontine angle tumor nine patients, cerebellar tumor seven patients, cerebellar tumor with shunt failure three patients, tentorial meningioma one patient, posterior fossa secondaires four patients, brainstem glioma three patients, suprasellar epidermoid one patient, Dandy Walker syndrome with hydrocephalus one patient, congenital hydrocephalus shunt failure one patient, CVA hydrocephalus one patient, posttraumatic hydrocephalus one patient, posterior fossa ICH hydrocephalus one patient and pineal cyst hydrocephalus one patient and meningitis with shunt failure one patient [24]. Clinical failure was noted in two patients due to poor initial GCS before surgery. Mortality occurred in 6 cases. Two (3.8%) patients died within one week of postoperatively, one dies due to low initial GCS and aspiration and another case died due two brainstem glioma. Other four (7.7%) patients died due to different reasons related to cerebellar tumour resection and posterior fossa secondaires [25]. Deaths were not due to endoscopic third ventriculostomy procedure per se and these factors were not related to surgical technique. CSF leakage was noted in 2 cases; none of these patients developed meningitis and the cases responded to conservative management. The complications in this study are comparable with the results of two international researchers [26].

Conculsion

From this study, it can be concluded that endoscopic third ventriculostomy is the first line surgical procedure which is safe, fast and effective for treating obstructive hydrocephalus. The procedure is successful in 75% of cases. The success rate is highly dependent on the underlying pathology regardless of the age of patients. Postoperative complications can be minimized in experienced hands by careful consideration of both dependent and independent variables during the procedure.Endoscopic third ventriculostomy is the first line treatment for patients with obstructive hydrocephalus.

Source of Suppourt: Nil

Conflict of Interest: None

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