# The role of endoscopic third ventriculostomy in the treatment of hydrocephalus

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## Abstract

Hydrocephalus (HCP) is the pathological accumulation of cerebro-spinal fluid (CSF). The conventional treatment has been extra cranial CSF shunting to another body cavity, peritoneum, cardiac atrium or pleura. Endoscopic third ventriculostomy (ETV) is an alternative for treatment of hydrocephalus that can eliminate the need for implantation of a lifelong ventricular shunt system. ETV is superior to shunt considering the economic costs of the procedure.

The aim of this study is to present the experience in the treatment of hydrocephalus by using ETV at the Neurosurgical Service of "Mother Theresa" Hospital in Tirana from the year 2008 to 2014. We report an overall mid-term success rate of 90% and support ETV as the first choice treatment of non-communicating hydrocephalus, or in shunt failure.

***Keywords***: hydrocephalus, neurosurgery, ventriculostomy.

## Introduction

Hydrocephalus (HCP) is the pathological accumulation of cerebro-spinal fluid (CSF). Usually, symptomatic hydrocephalus is caused by an obstruction in CSF circulation. When the obstruction is localized outside the ventricles the condition is called communicating hydrocephalus. When the obstruction occurs within the ventricular system, preventing the communication between ventricles and subarachnoid space, the condition is called non-communicating HCP (1).

Since the 1950s, the conventional treatment has been extra cranial CSF shunting to another body cavity, peritoneum, cardiac atrium or pleura. Despite the development of new shunt materials and techniques, the failure rate associated with a shunt within the 1st year has remained high ranging from 25.7% to 36.8% (1-4). Endoscopic third ventriculostomy (ETV) is an alternative for treatment of HCP that can eliminate the need for implantation of a lifelong ventricular shunt system. Due to the application of endoscopic technology to intraventricular surgery, we are now able to perform third ventriculostomies in a minimally invasive fashion.

## Methods

This was a consecutive case-series retrospective study. The data were collected from the patients' database at the University Hospital Centre "Mother Teresa" in Tirana for the period 2008-2014. All reports of patients operated on with the diagnosis of HCP were evaluated by collecting the indications for surgery, primary diagnosis, history, previous ETV, previous DVP, history of meningitis, and modality of treatment (VP shunt or ETV). If a VP shunt was performed after ETV, this was considered a "failed ETV procedure".

ETV procedure was performed in the same centre from the same surgeon (first author of this article). Briefly, our ETV technique is as follows: Under general anesthesia, the head in neutral position in a horseshoe headrest. Using a right frontal mediopupillary curved incision, a burr hole is performed just shy to the coronal suture. Dural opening, ventriculo-puncture using a 6mm trocar, than a 0 degree endoscope is introduced. Usually we do not use the holding device. After the identification of the Monroe foramen, the endoscope is advanced in the third ventricle; the mammillary bodies are identified, and with Fogarty catheter 4F a perforation in the third ventricle floor, in the midline, is performed.

## Results

From January 2008 to December 2014, 40 patients have been treated in our clinic (Table 1). The age range was from 0.9 to 69 years (median: 32 years); 14 (35%) patients were less than 20 years old. The follow-up period was 5 to 74 months (mean value: 57 months). Principal causes of hydrocephalus included HCP due to failed DVP (12 cases), tumoralaqueductal stenosis (11 cases) and persistent HCP after Chiari I malformation decompression or tumour removal (seven cases) (Table 2). Of note, in two cases the cause of hydrocephalus was cerebral tuberculosis during treatment or after. Transient complications were encountered in 1 (2,5%) case (left occulomotor palsy). There were no mortality events in our series. The overall success rate was 90%. In 4 cases (10%), ETV procedure has failed and a DVP was performed after 3-12 months (Table 3).

**Table 1. Patients' data**

| Case | Age | Etiology of HCP | Comments | Time of ETV failure (months) |
|---|---|---|---|---|
| 1 | 5 | Intraventricular haemorrhage | Operated 4 yrs after the haemorrhage | |
| 2 | 11 | Intracranial Germinoma | Multiple locations | |
| 3 | 1 | Shunt malfunction | | |
| 4 | 49 | Cranial trauma | Remote | |
| 5 | 18 | Persistant HCP | After posterior fossa ependymoma removal | |
| 6 | 1,25 | Neuroepitelial cyst | Intraventricular, causing acueductal stenosis | |
| 7 | 63 | iNPH(1) | | 12 |
| 8 | 43 | Shunt malfunction | | |
| 9 | 10 | Persistant HCP | postChiari I decompression | |
| 10 | 8 | Shunt malfunction | | |
| 11 | 46 | Persistant HCP | temporal cavernomatous malformation removal | |
| 12 | 33 | Persistant HCP | postChiari I decompression | |
| 13 | 19 | Acquired aquductal stenosis | history for tuberculosis | |
| 14 | 66 | Shunt malfunction | | |
| 15 | 4 | Shunt malfunction | | |
| 16 | 3 | Shunt malfunction | | |
| 17 | 27 | Shunt malfunction | | |
| 18 | 27 | Persistant HCP | postChiari I decompression | |
| 19 | 21 | Ventriculo-thalamo-pedunculare pendymoma | CHT+RT(2) as definitive treatment | |
| 20 | 36 | Persistant HCP | postChiari I decompression | |
| 21 | 67 | Shunt malfunction | VP shunt for NPH, SDH(3), shunt removal | 3 |
| 22 | 64 | Shunt malfunction | | |
| 23 | 55 | Shunt malfunction | | |
| 24 | 64 | NPH | after III ventricle CM(4) removal | |
| 25 | 47 | Shunt malfunction | Shunt for residual HCP after ventricular tumor removal | |
| 26 | 36 | Pineal region lesion | | |
| 27 | 45 | Pineal region lesion | | |
| 28 | 67 | Tentorial notch meningioma | | |
| 29 | 24 | Pineal region lesion | NF1(5), Intratumoral haemorrage at ETV failure | 9 |

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|---|---|---|---|---|
| 30 | 25 | Congenital aqueductal stenosis | Macrocrania, recently signs of increased ICP[6] | |
| 31 | 45 | Shunt malfunction | | |
| 32 | 0,9 | Tubercular meningitis | 2 months after beginning specific treatment | |
| 33 | 5 | Pineal region lesion | | |
| 34 | 50 | Posterior corpus callosum GBM[7] | | |
| 35 | 2 | Acuiredaqueductal stenosis | Periaqueductal hyperintensity in T2 and FLAIR MRI [8] sequences, extending to the right thalamus | |
| 36 | 18 | Pineal region lesion | NF1 | |
| 37 | 60 | NPH | 5 months before SAH[9] | 4 |
| 38 | 31 | Persistant HCP | postChiari I decompression | |
| 39 | 69 | Pineal region metastasis | | |
| 40 | 65 | LOVA[10] | | |

(1) iNPH – idiopatic normal pressure hydrocephalus; (2) CHT + RT – chemotherapy and radiotherapy; (3) SDH – subdural hematoma; (4) CM – cavernous malformation; (5) NF1 – neurofibromatosis type 1; (6) ICP – intracranial pressure; (7) GBM – glioblastomamultiforme; (8) FLAIR MRI – Fluid-attenuated inversion recovery magnetic resonance imaging; (9) SAH – subarachnoidal haemorrhage; (10) LOVA - Long-standing overt ventriculomegaly in adults.

**Table 2. Causes of hydrocephalus treated with ETV**

| Causes of hydrocephalus | Number |
|---|---|
| **Shunt malfunction** | 12 |
| **Tumours** | 11 |
| **Persistant HCP** | 7 |
| **NPH** | 2 |
| **TBC** | 2 |
| **Congenital aqueductal stenosis** | 1 |
| **Cranial trauma** | 1 |
| **iNPH** | 1 |
| **Intraventricular haemorrhage** | 1 |
| **LOVA** | 1 |
| **Intraventricular neuroepitelial cyst** | 1 |

**Table 3. Cases with ETV failure**

| Case | Age | Aetiology of hydrocephalus | Comments | Time of ETV Failure (months) |
|---|---|---|---|---|
| 7 | 63 | iNPH | | 12 |
| 37 | 60 | NPH | 5 months before SAH | 4 |
| 29 | 24 | Pineal region lesion | NF1, Intratumoral haemorrage at ETV failure | 9 |
| 21 | 67 | Shunt malfunction | VP shunt for NPH, SDH, shunt removal | 3 |

## Discussion

ETV was first performed in our institution in the year 2000 (M.P.) using a standard definition camera system. The new high definition 3 CCD system was acquired in 2008. This event was chosen to begin our study, because this system is the state-of-art in neuroendoscopy material, and coupled with eight years of learning curve, probably reflects the best results achievable by our team.

ETV success depends on patient's characteristics including age, origin of hydrocephalus, and history of shunt therapy. An Endoscopic Third Ventriculostomy Success Score (ETVSS) model has been constructed to predict success of therapy in childhood hydrocephalus. Several papers have shown that ETVSS closely may predict the actual success of ETV, serving as a useful tool to predict success of ETV (5-8). Previous CNS infection, intraventricular hemorrhage and previous history for myelomeningocele repair are considered risk factors for ETV success.

In our series, we did not have all the data to calculate the ETVSS, because this score was described in the year 2010, after the beginning of our study. Also this score is validated for childhood HCP.

In our series, the failures were seen in 4 (10%) patients. Three of them had normal pressure hydrocephalus, two idiopathic and one after subarachnoidal haemorrhage. Even though there are reports claiming the benefit of ETV in NPH (9) the selection of patients is the most critical variable in ETV success. Probably our patient selection has to be stricter in this setting. The other failure was probably due to tumoral hemorrhage closing the stoma.

Our success rate (90%) compares favourably with reported success rates of 79% (10).

The complication rate of ETV is 2.5% in our series, lower than the reported overall complication rate of usually between 5% and 15% (11,12). Permanent morbidity is reported lower than 3% (11,12); in our series it was 0. The reported mortality of ETV is lower than 1% (11,12); in our series it was 0. Reported complications may include: SAH, meningitis, confusion, oculomotor palsy, diabetes insipidus, cerebrospinal fluid leak, herniation syndrome, confusion, decrease of consciousness, and loss of thirst. The incidence of infective complications in ETV (0% in our series) versus shunting has been reported to be significantly lower 1-5% vs. 1-20%. Moreover, different from shunting procedures, infections in children with third ventriculostomy have a more benign course, being generally controlled by antibiotic treatment alone (13). Our results compare very favourably with that of the literature.

However, as a method it requires considerable experience, and several studies report a relation of experience not only with success rates but also with complication avoidance (10,11,13).

ETV should be considered even in hydrocephalus due to intracerebral hemorrhage. However, performing an ETV with a blurred field of vision and distorted ventricular anatomy is a challenge for any endoscopic neurosurgeon and should be reserved for experienced neuroendoscopists (14). Our case of intracerebral haemorrhage was operated several years after the event, thus, the field of vision was clear.

## Conclusions

Our results support the ETV as an established method for the treatment of non-communicating hydrocephalus in carefully selected patients. Our rates of success and complications compare very favourably with the literature. ETV has good results in selected cases of non-communicating HCP and of HCP previously shunted. Failure is seen within one year after the procedure, mostly in NPH.

**Conflicts of interest**: None declared.

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