Endoscopic Third Ventriculostomy Instead of Shunt Revision in Children Younger Than 3 Years of Age

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■ OBJECTIVE: **Endoscopic third ventriculostomy (ETV) is a valuable option in the treatment of shunt failure, but no clinical data exist for young children. The aim of this study was to elucidate the role of ETV in patients younger than 3 years of age with shunt malfunction.**

■ METHODS: **A cohort of 37 patients younger than 3 years of age with shunt malfunction underwent ETV instead of shunt revision. Patients' preoperative condition and medical history were studied to determine the impact of a number of variables on outcome. The Fisher exact test was used to assess differences among groups.**

■ RESULTS: **Median age at ETV was 21.6 months (8—36 months). Diagnosis was obstructive hydrocephalus in 24 patients and communicating hydrocephalus in 13. Median age at initial shunt placement was 3.2 months (10 days to 30 months). The etiology of shunt malfunction was obstruction ($n = 27$) or infection ($n = 10$). Overall ETV failure rate was 40.5% (15/37). Patients whose age at initial shunt placement was <6 months and/or who had a preterm birth history had higher relative rates of ETV failure. Other variables, including type of hydrocephalus, interval between initial shunt placement and ETV, history of intraventricular bleeding and/or infection, and etiology of shunt malfunction, did not significantly affect the final outcome.**

■ CONCLUSIONS: **Patients younger than 3 years with obstructive or communicating hydrocephalus may benefit from ETV in the event of shunt malfunction and have about a 60% probability of becoming shunt free.**

INTRODUCTION

Shunt placement is the standard treatment for patients with hydrocephalus and is used widely as a first-line treatment. It is indicated broadly for both communicating and obstructive types of hydrocephalus and for various etiologies of hydrocephalus.[1] The risk of shunt malfunction (25%—40% in the first year after shunt placement and 4%—5% per year thereafter), however, is relatively high, with 81% of patients requiring shunt revision after 12 years. Therefore, shunt failure during a patient's life is almost inevitable.[2,3]

Endoscopic third ventriculostomy (ETV) for hydrocephalus was an important advance in the treatment of patients with hydrocephalus. The effectiveness of primary ETV in obstructive hydrocephalus has led to high rates of shunt independence, ranging from 79% to 87.1%.[4,5] ETV performed after shunt failure is termed secondary ETV. Previous studies on pediatric or mixed series showed only slight differences in the rates of success between primary (74%) and secondary (70%) ETV.[2,6-9] Recently, more and more surgeons have realized the benefits of ETV over shunt revision. Patient age and hydrocephalus etiology and type, however, have been reported to influence the effectiveness of ETV.[10] The use of ETV in the treatment of hydrocephalus in very young children, including those with communicating hydrocephalus, is

Key words
- Endoscopic third ventriculostomy
- Hydrocephalus
- Pediatric
- Ventriculoperitoneal shunt failure

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
CT: Computed tomography
ETV: Endoscopic third ventriculostomy
MRI: Magnetic resonance imaging
VP: Ventriculoperitoneal

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controversial.[11,12] As a result, many patients considered candidates for ETV may not be offered the procedure by a surgeon.

To our knowledge, there are no data on secondary ETV in children younger than 3 years of age, or on the effectiveness of secondary ETV in the treatment of communicating hydrocephalus in very young patients. We present the results of a retrospective study of secondary ETV to treat both obstructive and communicating hydrocephalus in patients younger than 3 years of age.

METHODS

Patients

Data on patients who underwent ETV instead of shunt revision for a malfunctioning ventriculoperitoneal (VP) cerebrospinal fluid (CSF) shunt between June 2005 through October 2014 ($n = 37$) were collected from our database. Except in a few emergency cases, in which the last available imaging was by computed tomography (CT), patients had undergone recent magnetic resonance imaging (MRI). The selection of patients for secondary ETV was based on specific characteristics observed on MRI sagittal images, i.e., the patency and morphology of the prepontine cisterns and, most important, the anatomic features of the floor of the third ventricle, to ensure that there was enough space to create the hole.

The diagnosis of shunt malfunction was made on the basis of clinical symptoms and radiologic signs, including ventricular dilatation on CT or MRI. Most CT scans showed only slight differences in ventricular dimensions compared with previous neuroradiologic studies performed when the shunts were functioning, reflecting the loss of brain compliance in these patients after long-term shunting. ETV was not performed in hydrocephalic patients younger than 6 months. This study was approved by the Research Ethics Committee of Fudan University. The parents of each patient provided consent for clinical data to be used in the present study.

SURGICAL TREATMENT

One surgeon performed all 37 ETVs using the same technique and equipment. All procedures were performed with patients under general anesthesia and in a supine position. After skin incision, an approach was made through a frontal burr hole (1–2 cm anterior to the coronal suture and 2.5 cm lateral to the midline) to ensure adequate trajectory. All intraventricular procedures were performed with a rigid endoscope (HOPKINS Forward-Oblique Telescope 30°; Karl Storz GmbH & Co. KG, Tuttlingen, Germany) with a high-definition camera via a freehand technique through a 5.6-mm working channel. Interpeduncular and prepontinne cisterns were inspected to cut and dissect any arachnoids for sufficient CSF flow. Removal of the previous shunt device was performed during the same surgery under ventricular-catheter monitoring. No external ventricular drain was inserted after ETV.

Postoperative Management

Patients were monitored closely for clinical signs and symptoms of intracranial hypertension. Effectiveness of the procedure was determined by relief of clinical symptoms with or without imaging improvements on CT or MRI. Three months after ETV, a CSF-flow MRI was performed to assess ventriculostomy patency and flow pulsatility. Success was defined by the following criteria: 1) no further intervention required to treat hydrocephalus and 2) the absence of signs or symptoms of increased intracranial pressure.

Statistical Analysis

All statistical analyses were performed using the Stata 12.0 package (Stata Corporation; College Station, Texas, USA). The Fisher exact test was used to compare differences between groups. A P value < 0.05 was considered statistically significant.

RESULTS

Clinical data are presented in Table 1. Mean age at operation was 21.6 months (range, 8–36 months). The majority of cases ($n = 24$) were obstructive hydrocephalus, including posterior fossa tumor or pineal region space-occupying lesions ($n = 9$) and idiopathic aqueduct stenosis ($n = 15$). Thirteen patients were diagnosed with communicating hydrocephalus. The primary causes of communicating hydrocephalus were postmeningitic in 8, post-hemorrhagic in 3, and unknown in 2. Median age at the time of placement of the first shunt was 3.2 months (range, 10 days to 30 months). Twelve patients had a preterm birth history. The causes of shunt malfunction were obstruction in 27 patients and shunt infection with under-drainage in the other 10.

Table 1. Preoperative Clinical Variables

Preoperative Clinical Variables of the Patients	*n*	% or range
Median age at ETV, months	21.6	8–36
Median age at the time of the first shunting, months	3.2	10 days to 30 months
Length of the time from the first shunting until ETV, months	16.3	1.5–29
Types of hydrocephalus		
Obstructive	24	64.9
Communicating	13	35.1
History of CNS infection before ETV		
No	29	78.4
Yes	8	21.6
History of intracranial hemorrhage before ETV		
No	31	83.8
Yes	6	16.2
Birth history		
Preterm	12	32.4
Full-term	25	67.6
The origin of shunt malfunction		
Obstruction	27	73.0
Infection	10	27.0

ETV, endoscopic third ventriculostomy; CNS, central nervous system.