Long-Term Outcomes of Endoscopic Third Ventriculostomy in Adults

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■ OBJECTIVE: **To describe long-term outcomes of endoscopic third ventriculostomy (ETV) in adults with hydrocephalus.**

■ METHODS: **Single-institution retrospective review of adults treated with ETV between 1998 and 2006. Patient demographic, treatment, and follow-up data were collected. The patients were divided into 2 groups: primary ETV for patients with previously untreated or newly diagnosed hydrocephalus and secondary ETV for patients with a previous shunt presenting with shunt malfunction. ETV outcome was deemed successful if the patient remained shunt-free after ETV. Multivariate analysis was performed using Cox regression.**

■ RESULTS: **The study population comprised 190 patients, with a median age of 43 years (range, 16—79 years). The median duration of follow-up was 112 months (range, 1—190 months). The primary ETV group contained 129 patients; the secondary ETV group, 61 patients. Operative complications occurred in 11 patients (6%). A successful outcome was obtained in 139 patients (73%). ETV failure occurred in 51 patients, with a median time to failure of 2 months (range, 0—124 months). Although the majority (86%) of ETV failures occurred within 2 years postoperatively, failure was noted in 3 cases between 5 and 10 years after intervention, including in 1 patient at a 124-month follow-up. In multivariate analysis, only previous shunt was found to influence outcomes ($P = 0.021$), with shorter ETV survival noted in patients with a previous shunt. Age, indication, and ETV success did not influence outcome.**

■ CONCLUSIONS: **ETV is a safe procedure with excellent rates of long-term efficacy; however, late failure can occur, and patients should be instructed to seek medical advice if symptoms recur. A previous shunt is associated with a higher ETV failure rate.**

Endoscopic third ventriculostomy (ETV), first performed by Mixter in 1923, is an established treatment modality for obstructive hydrocephalus in children.[1] Its efficacy depends on several factors, however, including indication, presence of a previous shunt, and patient age. Age is a particularly important factor, with rates of cerebrospinal fluid (CSF) reabsorption appearing to decrease with increasing age, such that the efficacy of ventriculostomy, which diverts CSF to the subarachnoid space through a fistula in the third ventricle floor, may decrease with age.[2-4] Studies reporting long-term efficacy in adults are sparse and limited by sample size, however. We have previously reported our institutional experience with ETV in adults[5]; here we report our updated experience with longer-term outcomes.

METHODS

Study Population

The Institutional Review Board of The Walton Centre Foundation Trust approved this study. Adult patients (age ≥16 years) who underwent an ETV at the institution between April 1998 and August 2007 were included in a case notes review. Data were collected on patient demographics, cause of hydrocephalus, indication for ETV, operative complications, and follow-up treatment. The etiology of hydrocephalus was classified as aqueduct

Key words
- Endoscopic third ventriculostomy
- Hydrocephalus
- Long-term outcomes
- Shunt

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
ETV: Endoscopic third ventriculostomy
LOVA: Long-standing overt ventriculomegaly in adults
NPH: normal-pressure hydrocephalus

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stenosis, long-standing overt ventriculomegaly in adults (LOVA), tumor, Chiari malformation, and others. The ETV success score was also calculated for each patient as described previously.[6] Patients were divided into 2 ETV groups: primary ETV, comprising patients with previously untreated or newly diagnosed hydrocephalus, and secondary ETV, comprising patients with a previous shunt presenting with shunt malfunction.

Procedure

The operative technique has been described previously.[5,7] In brief, patients were placed supine, with head flexed 10 degrees. A right precoronal burr hole was created 3 cm from the midline. An introducing catheter was inserted into the right lateral ventricle to a depth of 4–5 cm, and the inner sleeve was withdrawn. Various endoscopes were used, including flexible and rigid instruments. The endoscope was inserted and guided through the foramen of Monro into the third ventricle. A light-touch balloon (NMT Neurosciences Innovasive Systems Inc., Boston, MA, USA) was used to fenestrate the floor midway between the infundibulum and mammillary bodies. Images of the third ventricle are shown in Figure 1. The fenestration was entered to inspect the prepontine space, to confirm a clear path to the subarachnoid space. If multiple membranes were encountered, these were fenestrated as well. The cortical hole left by the endoscope was plugged with thick Spongostan (Johnson & Johnson, New Brunswick, New Jersey, USA) to avoid CSF leakage into the subdural space, and the wound was closed. In cases of shunt malfunction, the shunt was removed in its entirety unless it was deemed so old or embedded that it was dangerous to do so. Other ventricular access devices (e.g., EVD or CSF reservoirs) were not routinely inserted at the time of ETV.

Statistics and Outcomes

Statistical analyses were performed using SPSS version 21 (IBM, Armonk, New York, USA). ETV outcome was deemed as successful if the patient remained shunt-independent after ETV placement. ETV survival was calculated in months from the date of surgery to the date of shunt placement, or censored at the date of last follow-up if the patient remained shunt-independent. Survival analysis was used to determine the effect of the following on ETV success: age (less than or equal to median age vs. greater than median age), presence of previous shunt, indication, and ETV success score ($\geq$80 vs. <80). Univariate analysis was performed using Kaplan Meier survival curves and the log-rank test. Multivariate analysis was performed using a forward stepwise Cox regression model, including variables with $P < 0.10$ in univariate analysis.

RESULTS

Patient Characteristics

A total of 190 patients underwent an ETV procedure during the study period. The median patient age was 43 years (range, 16–79 years) years, and the median duration of follow-up was 112 months (range, 1–190 months). The primary ETV group contained 129 patients, and the secondary ETV group contained 61 patients. The primary ETV group was older on average (mean age, 45 years vs. 36 years; $t = 3.692$; $P < 0.001$, independent t test). Patients in the secondary group had failure of a ventriculoperitoneal ($n = 56$; 92%) or ventriculoatrial ($n = 5$; 8%) shunt.

Complications and Mortality

Operative complications occurred in 11 patients (6%), including 3 cases of procedure abandonment due to abnormal anatomy ($n = 2$) or profuse bleeding ($n = 1$). Other complications included minor intraoperative hemorrhage ($n = 2$), CSF leak ($n = 2$), asymptomatic subdural haematomas ($n = 2$), and transient abducens palsy ($n = 2$). None of these 11 patients had early (<1 month) postoperative mortality. There were 42 deaths during the follow-up period, the majority in the primary ETV group ($n = 34$; 81%). Data on causes of death could not be obtained. Overall mortality was 26% in the primary ETV group and 13% in the secondary ETV group.

Repeat ETV Procedures

Fifteen patients required 1 or more repeat ETV procedures. All patients had evidence of complete or partial closure of the

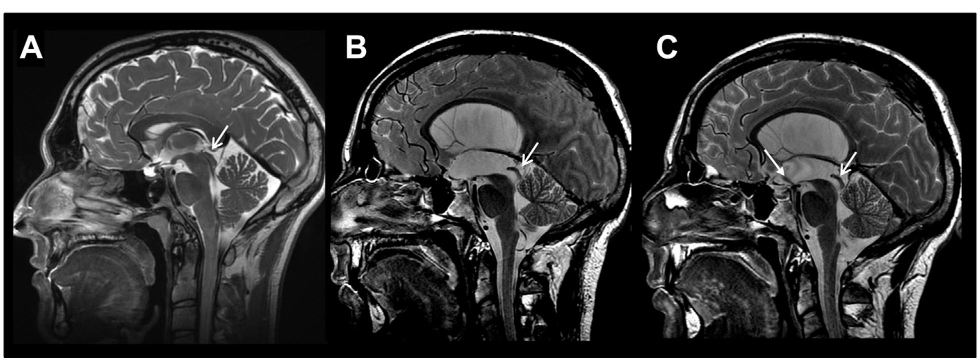

Figure 1. T2-weighted sagittal magnetic resonance imaging showing third ventricle anatomy in (**A**) normal, (**B**) hydrocephalus presurgery, and (**C**) hydrocephalus post-ETV. *Open arrowheads* indicate the tectal plate and aqueduct below. Note that in (**B**), the aqueduct is expanded indicating high pressure and in (**C**) the aqueduct is smaller after ETV. The *closed arrowhead* indicates flow (low signal intensity) through the ventriculostomy in the third ventricle floor.