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Endoscopic third ventriculostomy in the management of hydrocephalus: Outcome analysis of 168 consecutive procedures

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ABSTRACT

Background: Endoscopic third ventriculostomy (ETV) is the treatment of choice for obstructive hydrocephalus, but the outcome is still controversial in terms of age and aetiology.
Methods: Between 1998 and 2011, 168 consecutive procedures were performed in 164 patients, primarily children (56% < 18 years of age and 35% < 2 years of age). The causes of obstructive hydrocephalus included tumoural pathology, Chiari malformation, congenital obstruction of the aqueduct, post-infectious and post-haemorrhagic membranes, and ventriculo-peritoneal shunt (VPS) malfunctions. Successful ETV was defined by the resolution of symptoms and the avoidance of a shunt.
Results: ETV was successful in 75.6% of patients, but 19% of the patients required VPS in the first month after ETV, and 5.4% required a VPS more than one month after ETV. Four patients were ultimately submitted for second ETVs. In this series, no major permanent morbidity or mortality was observed.
Conclusions: ETV is a safe procedure and an effective treatment for obstructive hydrocephalus even following the dysfunction of previous VPSs and in children younger than two years.

1. Background

The incidence of congenital hydrocephalus is estimated to be 0.7 cases per 1000 live births in developed countries [1], and the incidence of neonatal hydrocephalus is estimated to be 3–5 per 1000 live births and predominantly occurs in males [2,3].

Hydrocephalus is one of the most common developmental disorders in children; it is more common than Down syndrome and congenital deafness [4] and is the leading indication for brain surgery in children [5].

Currently, many patients with hydrocephalus are considered candidates for endoscopic third ventriculostomy (ETV). The idea of an intracranial non-prosthetic "internal shunt" to overcome the obstruction site to achieve cerebro-spinal fluid (CSF) circulation and avoid the use of ventricular-peritoneal or auricular prostheses has gained wider increasing acceptance in the last 20 years [6]. The endoscopic fenestration of the third ventricle floor has been used with increasing frequently since the early 1990s primarily because of technical improvements (e.g., lighting sources, magnification and image resolution) [7,8]. The surgical indications for this procedure include the following: stenosis of the aqueduct, idiopathic stenosis of the Magendie and Luschka foramina, some cases of Dandy–Walker malformations, and post-haemorrhagic hydrocephalus [9–17]. ETV may also be performed in selected cases of hydrocephalus that are caused by mass effect of tumours of the pineal gland; tectal plate or posterior fossa; some suprasellar, quadrigeminal cistern, or arachnoidal extra ventricular cysts; or even midline intra-ventricular cysts [9,10,18–25].

Higher success rates have been reported for patients with stenosis of the aqueduct [11,26–30]. Lower success rates have been

Abbreviations: CSF, cerebrospinal fluid; CT, computed tomography; ETV, endoscopic third ventriculostomy; MRI, magnetic resonance image; VPS, ventriculo peritoneal shunt.

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reported for patients with post-infectious hydrocephalus and for post-haemorrhagic patients with prior ventriculo-peritoneal shunt (VPS) failures [28,29,31–33]. This procedure is considered less effective in paediatric populations, although the minimum age for the procedure remains controversial [9,26,28,29,34–36].

In this retrospective study, the surgical indications, surgical techniques, nosocomial outcomes and results of 168 consecutive ETVs that were performed in 164 patients at the Centro Hospitalar de São João do Porto (CHSJ) over a period of 13 years beginning with the introduction of the technique (performed between December 1998 to December 31 2011) were reviewed.

2. Methods

2.1. Patient population

Between December 1998 and December 2011, 168 consecutive ETVs (77.1% of the neuroendoscopic procedures) were performed at the Centro Hospitalar de São João do Porto (CHSJ) in 164 patients with obstructive hydrocephalus who were followed until December 31, 2012. The patients were predominantly male (the male:female ratio was approximately 3:2). The average age was 22.1 years at the time of surgery (56% of the patients were paediatric and 20.8% were infants), and the age of the male group was slightly younger (19.6 vs. 25.7 years in the males and females, respectively). The average follow-up was 77.6 months (13–168 months). Magnetic resonance imaging (MRI) diagnostic considerations included T1 with thin reconstruction in three planes, T2, CISS, flair and cine-phase contrasts.

The proportion of paediatric patients (i.e., those below the age of 18 years) was 56%, 31.6% were younger than two years (mean 6.7 months), and the youngest patient was 6 days old. Among our patients, 19.0% were 2–10 years old (mean 5.8 years), 5.4% were between 10 and 18 years (mean 13.9 years) and 44% were adults (mean 45.6 years).

The selection of the 168 cases of ETV (of the total of 817 surgeries for hydrocephalus thus excluding 649 VPSs) was based on clinical and imaging (i.e., computed tomography (CT) and MRI) evidence for obstructive hydrocephalus. The group included 34 patients with previous VPSs.

Procedural success was defined by clinical improvements and VPS independence, and failures were divided in two groups, early failure (within one month of the procedure) and late failure (after one month).

2.2. Surgical technique

All patients were operated on under general anaesthesia, in the dorsal decubitus position, with their heads stabilised. In the introduction of the rigid endoscope (MINOP®; Aesculap, Tuttlingen, Germany) transcortically towards the Monro cavity, 0–30° optics were used, and the working channel length was 18 cm. We also used two cannulae; one had an external diameter of 4.6 mm (13 F) and its own channels for the optic and for irrigation and drainage, and another 6 mm (18 F) cannula with another channel (2.2-mm diameter) for the introduction of micro-endoscopy instruments. The most frequently used optic was the 0° viewing angle.

After identifying the thalamo-striate vein, the septal vein, and the choroid plexus at the level of the Monro foramen and avoiding the fornix, the endoscope was advanced to the third ventricle as identified by the thin membrane that forms its floor. This membrane is bluish in colour and is located before the mammillary bodies and posterior to the tuber cinereum. For the cannulation of this structure, a Fogarthy type balloon-tip catheter with a blunt tip was used (4 French) to achieve an opening diameter on the floor of the third ventricle of at least 5 mm. None of the cases had histories of prior coagulation of the third ventricle floor. The endoscope was then inserted through the cisternostomy to the pre-pontine cistern to allow for the identification of the basilar artery and confirmation of the existence of a flawless communication.

Table 1
ETV failure adjusted for aetiology, gender, and age. The Aetiology distribution and logistic regression were used to compute odds ratios (ORs) and 95% confidence intervals (95% CIs).

	Adjusted OR (95% CI)
Aetiology	
Aqueductal stenosis	1
Chiari	3.26 (0.96–11.1)
Tumour	0.46 (0.14–1.48)
Others[a]	0.92 (0.33–2.57)
Age	0.97 (0.95–0.99)
Gender	
Female	2.00 (0.90–4.45)
Male	1

[a] Cysts (19), post-infectious (12), post-haemorrhage (12), Dandy–Walker malformation (4), occlusion of the basal cistern (4).

After removing the endoscope, duraplasty and biologic glue were used. The mean operative time was 75 min.

During the surgical procedure, continuous irrigation with Ringer's lactate (at 37 °C) was utilised to prevent ventricular collapse. Cisternostomies were achieved in all cases without resorting to stereotactic techniques, radiology or computerised neuronavigation (using the hands-free method).

3. Results

ETV was effective in 75.6% of cases, 19.0% required the insertion of a VPS system in the first month post-ETV, and 5.4% required a later intervention (VPS or re-ETV). In all ineffective ETV cases, the patency of the stoma was verified before placing the VPS.

As shown in Table 1, the incidence of ETV failure varied significantly across the different age groups (Chi square test–$p = 0.012$); the ETV incidence decreased with age (p for the trend = 0.00) and was significantly greater when the aetiology was a Chiari malformation (OR = 3.4).

Among the ETV failure cases, 23.2% of the patients who underwent ETV required an additional procedure, and 1.2% required more than two procedures (due to clinical and radiological findings related to complex hydrocephalus).

The procedure had to be repeated in four patients, including two failures (10 months and 9 years after the first procedures) and two obstructions by fibrin (two months and four years after the first procedure). Three of these patients were children older than two years.

No deaths were directly related to the surgical procedures. One of the cases (with an underlying pathology of a Chiari malformation) experienced subsequent ETV failure (13 months after the procedure) and developed acute and fatal intracranial hypertension.

In 78 patients, post-procedure, nonspecific, self-limited fevers (38 °C) were diagnosed, and 80% of these patients were below the age of 18. In these cases, no microbial agents were isolated from blood or CSF samples.

One patient exhibited self-limited bleeding of the pontic artery during the stoma balloon dilatation and required and external ventricular drain (EVD) and posterior VPS.

The success of the procedure appeared to increase with age. Although the adults exhibited a higher ETV success rate, there difference between the adults and children did not reach significance ($p = 0.14$). The primary diagnosis in this series was congenital