Open Journal of Modern Neurosurgery, 2020, 10, 325-333
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

The Outcome of Endoscopic Third Ventriculostomy in a Mixed Population of Adult and Pediatric Patients

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How to cite this paper: Mbaye, M., Gahito, L., Thiam, A.B., Thioub, M., Sy, E.N., Faye, M., Diop, S., Ndongo, M., Ndoye, N., Ba, M.C. and Badiane, S.B. (2020) The Outcome of Endoscopic Third Ventriculostomy in a Mixed Population of Adult and Pediatric Patients. *Open Journal of Modern Neurosurgery*, **10**, 325-333.
https://doi.org/10.4236/ojmn.2020.103035

Received: March 25, 2020
Accepted: May 22, 2020
Published: June 1, 2020

Abstract

Background: Endoscopic third ventriculocisternostomy (ETV) is the most common neuroendoscopic technique in the treatment of noncommunicating hydrocephalus. Since its introduction, ETV has been a safe alternative to ventriculoperitoneal shunt (VP shunt), which has a high complication rate with significant socio-economic consequences. The authors report the results of ETV performed in the neurosurgical department of FANN teaching hospital in Dakar. **Methods:** This retrospective study presents the results of ETV performed in 513 patients with hydrocephalus of various etiologies, ranging from February 2010 to February 2018. We have included in our series from 2010 to 2016, all patients with clinically revealed non-communicating hydrocephalus followed by a brain computed tomography (CT) scan or brain magnetic resonance imaging (MRI) and who have benefited from an ETV, in which the ETV Success Score was evaluated. **Results:** The mean age of our patients was 14.10 years, with 298 (58%) males. The clinical symptomatology varied in both children and adults and manifested in children as macrocrania in 67.8% of the patients, while in adults, it manifested as raised intracranial pressure (ICP) in 87.5% of patients. A brain CT scan was performed in 461 (89.86%) of patients. The causes of hydrocephalus were dominated in 49% of patients by malformative pathologies, followed by tumors in 41% of patients, infections in 2.33% of patients, and normal-pressure hydrocephalus in 3.8% of patients. During the postoperative period, we found 21.41% of various complications. **Conclusions:** The findings in our series were compared to those in the literature and were satisfactory, thus proving the effectiveness and safety of ventriculocisternostomy in our department. In resource-limited countries, ETV can be performed with good results and less mortality and morbidity.

Keywords

Endoscopic Third Ventriculostomy, Hydrocephalus, Minimally Invasive Neurosurgery

1. Introduction

Endoscopic ventriculocisternostomy (ETV) is now considered to be the standard approach for noncommunicating hydrocephalus, whether congenital or secondary to an obstructive lesion.

The influence of age, etiology, and previous shunting has been frequently reported and predictive scores and guidelines have been described by authors who have identified risk factors and developed various methods that predict the success of ETV and have been validated by many centers worldwide [1]. In our context, this retrospective study presents the results at the Neurosurgery Department of FANN Hospital in Dakar, SENEGAL.

2. Materials and Methods

From February 2010 to February 2018 we collected epidemiological, clinical, radiological, and evolutionary data of 513 patients that helped assess the success of ETV. We have included in our series from 2010 to 2016, all patients with clinically revealed non-communicating hydrocephalus followed by a CT scan or brain MRI and who have benefited from an ETV, in which the ETV Success Score was evaluated. Patients with incomplete records were excluded from the study. We performed the classic surgical technique (the perforation of the third ventricle floor and communication with the subarachnoid spaces at the interpeduncular cistern). The main criteria of success were mainly the absence of surgical re-operation and the absence of death due to hydrocephalus within the 6-month postoperative period. The most commonly used tool to predict the chances of successful ETV is the endoscopic third ventriculostomy success score (ETVSS) developed by Kulkarni *et al.* [2] based on logistic regression techniques according to the patient's age, the etiology of hydrocephalus and the history of shunting. The final ETVSS is the addition of the age score, etiology score, and shunt score. The resulting ETVSS has a range from 0 (very poor success) to 90 (very high success). The method of calculation is shown in **Table 1**. The score was ranked according to the following intervals: score ≤ at 40 points is low ETVSS score, between 50 and 70 points is moderate ETVSS score, and if the score ≥ at 80 points is high ETVSS score. The data were analyzed with SPSS 20.0 statistical software.

3. Results

During the study period, 628 ETV was performed but only 513 procedures were selected. The pediatric population concerned 334 cases and 179 were the adult

Table 1. Calculation of the ETV success score according to Kulkarni *et al.* [2].

Variables	Age	Etiologies	Previous shunt
0 point	<1 month	Post infectious	Yes
10 points	1 month to <6 months		No
20 points		• Myelomeningocele • Intraventricular hemorrhage • Non-tectal brain tumors	
30 points	6 months to <1 year	• Aqueduct stenosis • Tectal brain tumor • Other etiologies	
40 points	1 year to <10 years		
50 points	≥10 years		

population. The mean age was 14.10 years, with extremes ranging from 5 months to 73 years. The sex ratio was 1.38. We found 67.8% macrocrania in the pediatric population and 87, 5% of raised intracranial pressure (ICP) in the adult population. Twelve patients had a history of a ventricul operitoneal shunt (VP shunt). A brain CT scan was performed in 461 (89.86%) of patients and MRI in 108 cases. The causes of hydrocephalus were dominated in 49% of patients by malformative pathologies, followed by tumors in 41% of patients, infections in 2.33% of patients, and normal-pressure hydrocephalus in 3.8% of patients. The patient's characteristics are detailed in **Table 2**.

- The calculation of ETVSS success score according to Kulkarni *et al.* showed in our study 74, 7% of high success; 20, 3% of moderate success, and 5% of low success. Nine cases of moderate intraoperative bleeding were found and controlled by flushing. The complications after ETV involved 110 (21, 41%) patients and were summarized in **Table 3**. The median follow-up time was 8 months with extremes between 5 and 3 years. The evolution at 6 months was sustainable for 340 patients, transient for 143 cases (redo ETV in 81 cases, VP shunt in 56 cases), and 30 cases of failure.

4. Discussion

With the advent of ETV in the management of noncommunicating hydrocephalus, these indications have diversified in our service with an acceptable ratio of ETV frequency/study period compared to the reports of Sacko [3] and Joachim [4].

The mean age observed in our series, due to the high number of pediatric cases recorded, tended towards an adult population, as outlined by most authors. In contrast to Furlanetti *et al.* [1], most of the authors found a clear male predominance, which may be linked to the demographics of the different study areas. The clinical presentations reported in the different series varied according to the age groups and the diagnostic time limits. Other signs were in the foreground and led to the diagnosis, as in the series reported by Gangemi *et al.* [5] and Tazi

Table 2. Characteristics of patients.

Variable		Total
Number of patients		513
Age		
• <1 month		0 (0)
• 1 - 6 months		36 (7%)
• 6 months - 1 year		64 (12, 5%)
• 1 - 10 years		170 (33, 14%)
• ≥10 years		243 (47, 36%)
Sex		
Male		298 (58%)
Female		215 (42%)
Etiology		
Malformative pathologies	Aqueduct stenosis Dandy-Walker	251 (49%)
Tumors	Posterior fossa tumor Pineal region tumor Third ventricle tumor	210 (41%)
Normal-pressure hydrocephalus		20 (3, 8%)
Post meningitis hydrocephalus		12 (2, 3%)
Others	Arachnoid cyst, posthemorrhagic hydrocephalus	20 (3, 9%)
VP shunt first		
• +		12 (2, 3%)
• –		501 (97, 7%)

Table 3. Complications following ETV.

Postoperative complications	Number of cases	%
CSF leakage	58	11.30
Meningitis	27	5.26
Stomal obstruction	4	0.78
Suppuration of surgical wound	3	0.58
Aseptic hyperthermia	10	1.95
Diabetes insipidus	1	0.19
Pneumocephaly	1	0.19
Ventriculoatrial shunt	6	1.16
Total	110	21.41

et al. [6]. Ideally, before each ETV procedure, cerebral should be performed [6]. This situation disobeys the obstacles linked to the availability of the examination but, above all, to the economic constraints in our countries.

A cerebral CT scan has been indicated to be sufficient in this series with its availability in our regions. In our series, malformative pathologies were predominant, with aqueduct stenosis being the main and most common indication encountered. Sacko [3] found a high frequency of tumor causes.

The main intraoperative adverse effects were represented in 9 patients by low-abundance bleeding related to damage to the cortico-dural veins or the choroid plexus. This complication has been outlined by some authors [7], in the study reported by Ersahin and Arslan [8], and then in the study performed by Koch and Wagner [9]. It accounted for 0.53% in the Schroeder [10] study and 2.9% in the Sokal *et al.* [11] study. Intraventricular hemorrhage emanating from small subependymal vessels due to the impact of endoscopic instruments is the most frequently reported [12] [13]. Hemostasis was obtained as suggested by Walker [14]: Ringer's lactate irrigation. Cinalli *et al.* [12] reported the occurrence of a case of intraventricular hemorrhage (1.49%), intraoperatively requiring the procedure to be stopped.

Some authors [10] [12] report major bleeding due to the involvement of thalamo-striated veins, septal veins, the choroid plexus, or one of the arteries located under the floor in 10% of cases. The basilar artery or the P1 segment of the posterior cerebral artery is usually involved. ETV is then immediately abandoned, and an external CSF shunt is placed [13] [14] [15].

According to most authors, damage to the large vessels is rare and accounts for approximately 1% of the complications of ETV [10] [13] [15].

Among the postoperative complications, CSF leakage was the main and most frequent complication found in our study, as is the case in several other studies, [3] [10] [16] [17] and it can lead to ventriculitis or meningitis [18] [19] [20]. An increase in intracranial pressure resulting in CSF leakage may occur in the early postoperative period because the restoration of the arachnoid granulation resorption mechanism is not immediate and will require time to adjust [21] [22]. Lumbar punctures are required during this interval. Kombogiorgas and Sgouros [23] suggest that CSF leakage in the immediate postoperative period is instead associated with successful ventriculocisternostomy. The management of our patients was dominated by second-hand suturing of the surgical wound associated with depletive lumbar punctures.

Infections account for the majority of nonspecific complications of ETV [24]. The rate varies from 1% to 5% and includes infections of the operative scar, ventriculitis, and meningitis. The rate observed in our study was consistent with the assessment in the literature.

The transient hyperthermia observed in our series may be related to hypothalamic dysfunction or aseptic inflammation of the epidermis and persisted 48 hours after ETV. It should also be noted that it could be related to the resorption of hemorrhage. Postoperative hyperthermia without clinical or bacteriological signs of meningitis is still not considered a complication [25].

One case of transient diabetes insipidus resulting in polyuria was detected in our series. It may have been related to hypothalamic trauma during ETV.

Pneumocephaly is an exceptional complication reported in some studies [26] [27]. It was found in our study in a 38-year-old patient in immediate postoperative care. This could be explained in our patient by a significant loss of CSF, especially at the beginning of the procedure, and possibly insufficient irrigation causing a subdural detachment.

Other complications have been described but were not found in our series, such as transient memory impairment, heart rhythm disorders, secondary compartmentalization, a syndrome of anterograde amnesia associated with bulimia, personality disorder, frontal infarction, and acute subdural hematoma [8]. Schroeder *et al.* [10] recommend that to minimize complications, the stoma should be made midway between infundibular resections and midline mammary bodies.

The Endoscopic Third Ventriculocisternostomy Success Score (ETVSS) developed by the Toronto group Kulkarni *et al.* [2], despite controversies, provides a simplified means of predicting the success rate at 6 months post-ETV for patients with hydrocephalus initially in children based on age, the etiology of hydrocephalus and the presence of a previous shunt and then can be extended to adults.

Various studies have validated this scoring system to predict the success of the procedure following the example of Durnford *et al.* [28], Breimer *et al.* [29] and Foley *et al.* [30], who consider the ETVSS to be an adequate tool for the individual assessment of patients and to establish their prospective course of response to ETV.

In our cohort of a mixed population of children and adults, we found a high success rate of 74.7% in the majority of cases, consistent with most published series, with the predominant indications being Sylvius aqueduct stenosis followed by tumoral hydrocephalus.

Sacko *et al.* [3], in their cohort-based on 636 procedures, established an overall success rate of 73% in a postoperative follow-up period equivalent to 35 months.

Warf *et al.* [31], in their practice in Uganda, following their series of ETV involving 153 patients aged less than one year, reported a success rate in this population of 53%. The success rate of surgery in patients with myelomeningocele is 40% versus 70% for those with obstructive hydrocephalus [5].

In the cohort described by Furlanetti *et al.* [1] of 114 consecutive patients under 18 years of age who underwent ETV from January 2000 to January 2010, ETV was shown to be safe and effective in children with an accurate ETVSS to predict outcomes closely related to the patient's age and the etiology of hydrocephalus.

It should be remembered, however, that as a first-choice surgical alternative to shunt placement in patients with hydrocephalus, ETV treatment fails in some patients, although they are the best theoretical candidates for the procedure. This is particularly highlighted by Gianaris *et al.* [32] in their retrospective study of ETV failure in patients with the highest ETV success scores, suggesting that the best candidates for ETV are those with a relatively acute increased intracranial pressure. This may explain the failure rate also recorded in our series. The limitations of the study are the low numbers and the mixing of age groups. We intend to continue this study by studying the specificities of the pediatric population. The limits of the technical platform also constitute a weakness.

5. Conclusion

ETV is a safe and minimally invasive surgical technique due to its high success rate in obstructive hydrocephalus and its low complication rate. A good selection of patients considering the ETV success score can provide good results, the outcome is also strongly related to the etiology of hydrocephalus. The ETV success score is a simplified and accurate method for estimating the success of the procedure during a 6-month follow-up after ETV.

Conflicts of Interest

No conflict of interest.

Ethical Approval

OK.

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