Endoscopic third ventriculostomy – effectiveness of the procedure for obstructive hydrocephalus with different etiology in adults

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Abstract

Introduction: *After a time of domination of shunt placement, endoscopic third ventriculostomy (ETV) has been increasingly applied in treatment of obstructive hydrocephalus.*
Aim: *To assess the effectiveness of ETV in treatment of adults with three-ventricle hydrocephalus of different etiology.*
Material and methods: *Ninety-six patients with obstructive hydrocephalus were studied: 24 with primary aqueductal stenosis, 61 with brain tumor, and 2 with basilar tip aneurysm. In 9 patients the etiology of hydrocephalus remained undetermined. The assessment of treatment results was based on clinical and radiological criteria.*
Results: *Clinical improvement was observed in 74 (77.1%) patients, and radiological improvement in 52 (54.2%). One patient died. Follow-up of 24 patients with primary aqueductal stenosis has shown that in 20 (83.3%) of them clinical improvement has been stable, and in 14 (58.3%) radiological improvement has been observed. Two patients required shunt placement due to hydrocephalus recurrence 12–24 months after the ETV procedure. Among 9 patients with undefined hydrocephalus, 3 required shunt placement within 6 months after ETV (2 shunted previously). Endoscopic third ventriculostomy treatment in a patient with hydrocephalus caused by basilar tip aneurysm succeeded. The assessment of ETV effectiveness in oncological patients has been indirect in view of the underlying disease.*
Conclusions: *The best results of ETV treatment have been demonstrated for patients with primary aqueductal stenosis. Ventricle size cannot determine the effectiveness of treatment as an individual requirement. Endoscopic third ventriculostomy is effective in previously shunted patients although the prediction of outcome should be cautious. Endoscopic third ventriculostomy enables preparation for further therapy and is palliative treatment in oncological patients with secondary hydrocephalus.*

Key words: *endoscopic third ventriculostomy, obstructive hydrocephalus, long-term outcome.*

Introduction

Obstructive hydrocephalus develops due to a blockage in circulation of the cerebrospinal fluid (CSF). From the clinical point of view, obstructive hydrocephalus results from diseases causing an occlusion in the ventricular system, and it is also termed non-communicating hydrocephalus [1]. The issue of treatment in obstructive hydrocephalus has been subject to evolution for years – from the first experience of Dandy and Mixter with an endoscopic approach, through shunt placement introduced by Nulsen and Spitz, to the increasingly appreciated endoscopic third ventriculostomy (ETV) nowadays [2]. Endoscopic third ventriculostomy is a well-established method of treatment in pediatric neurosurgery, allowing a reduction in the number of shunt

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placements, while there are fewer reports on this topic in adults [3, 4]. So far there is no effective, simple diagnostic method that allows for proper selection of patients for ETV. Theoretically, the greatest efficacy of ETV should be achieved in cases of non-communicating hydrocephalus with preserved patency of the subarachnoid space, up to the point of absorbing the CSF [4]. However, in practice, the qualification for ETV often is based on empirical grounds.

Aim

The aim of this study is to present short- and long-term results of ETV treatment in adults with three-ventricle hydrocephalus of different etiology.

Material and methods

Ninety-six patients with obstructive hydrocephalus undergoing operations over the past 10 years in our Neurosurgery Department were studied. The study group consisted of 41 women and 55 men aged 18–82 years (average age 47 years). In all patients the initial diagnosis was made based on head computed tomography (CT) or magnetic resonance imaging (MRI) scan or both, performed before or at the time of admission. A variety of findings presented in neurological examination were associated with hydrocephalus alone and in some cases with underlying disease causing hydrocephalus (Table I). In case of uncertainty about the final diagnosis, head MRI T2-weighted images were of critical importance. In 56 patients active hydrocephalus with periventricular lucency of the CSF and clamping of the cerebral sulci were found. In 3 cases, due to suspicion of vascular malformation (basilar tip aneurysm), diagnostic procedures were expanded by: digital subtraction angiography in 2 cases and angio-CT scan in 1 case. Etiology of obstructive hydrocephalus in the study group is presented in Table II. In 9 cases the cause of hydrocephalus remained undetermined with unequivocal radiological presentation of hydrocephalus. In 1 patient with primary aqueductal stenosis, the MRI scan revealed in the vicinity of the sylvian aqueduct a small hyperintense lesion of unknown etiology, observed in further scans. In patients with tumor of the posterior portion of the third ventricle, in 14 patients with cerebellopontine angle tumor and in 10 patients with cerebellar tumor the ETV procedure was preparation for the further stages of treatment. In 3 patients with cerebellopontine angle tumor and in 2 patients with cerebellar tumor (in all cases: large tumor size, poor general condition of patient, advanced age of patient) as well as in patients with multiple metastases and in patients with mesencephalic tumor ETV was a palliative procedure. Five patients with hydrocephalus of undetermined etiology had been previously shunted and were admitted with symptoms of shunt dysfunction. Studied patients have not received any particular pharmacological treatment. In case of coexisting brain edema, a standard approach was implemented.

The aim of ETV is to communicate the third ventricle with the interpeduncular cistern and create flow which bypasses an obstruction to the circulation of the CSF. The important step in preoperative planning is the assessment of conditions for fenes-

Table I. Clinical symptoms in 96 patients with obstructive hydrocephalus

Type of symptoms	Number of patients
Symptoms of intracranial hypertension	71
Cognitive disorders	51
Gait disturbance	45
Urine incontinence	33
Locomotor ataxia	25
Cranial nerve palsy	18
Hemiparesis	12
Parinaud’s symptom	10

Table II. Etiology of the obstructive hydrocephalus in studied patients

Cause of hydrocephalus	Number of patients
Primary aqueductal stenosis	24
Tumor of posterior portion of the third ventricle	19
Cerebellopontine angle tumor	17
Cerebellar tumor	12
Multiple metastases	8
Mesencephalic tumor	5
Basilar tip aneurysm	2
Undefined	9
Total	96

tration in the floor of the third ventricle. In all patients the final selection for the ETV procedure was based on neuroimaging analysis with at least axial and sagittal sections. In several cases initial diagnostics had to be supplemented to meet these requirements. The width of lateral ventricles, the width of the third ventricle and the distance between the clivus and basilar artery were analyzed. Their appropriate size allows handling of the endoscope without an increased risk to the surrounding structures and performing safe ventriculostomy. The optimal trajectory of the endoscopic approach to the floor of the third ventricle was obtained by a burr hole placed in the right frontal area 1 cm in front of the coronal suture and 2–3 cm from the midline (Kocher's point). In some patients placement of the entry point was modified based on planimetric measurements made on sagittal scans.

During the ETV procedure the patient was positioned supine with anteflexed head stabilized in a Mayfield head holder. The rigid Karl Storz GAAB model endoscope with Hopkins 0° optics having the outer diameter of 6.5 mm and 3 mm working channel diameter was the most commonly used. The intracranial approach was performed with the burr hole diameter of 10 mm. After dura incision and arachnoid coagulation, the lateral ventricle was punctured using a Cushing needle that was directed towards the base of the nose and external acoustic foramen. Manometric measurement of CSF pressure and estimation of the distance between the brain surface and ventricle were made. Using the same trajectory the endoscopic sheath was introduced with the aid of a trocar replaced in the next stage with the endoscope. Some of the procedures were performed free hand and most of them with the use of a frame fixing endoscope. After the lateral ventricle was reached, the foramen of Monro and situated laterally the head of the caudate nuclei and medially the pellucid septum were indentified. A great anatomical landmark was the choroid plexus passing through the foramen of Monro to the third ventricle, and visible in its lower margin the point where the thalamostriate vein unites with the septal vein. Then the endoscope was introduced into the third ventricle, keeping a safe distance from the structures mentioned above and from columns of fornix limiting the foramen of Monro from the anterior-medial side. In the third ventricle (moving the endoscope forward) the infundibular recess, mammillary bodies and if possible the dorsum sellae and basilar tip were indentified. The infundibular recess and mammillary bodies form a triangle, which is an anatomical equivalent of the tuber cinereum – a structure that, in the case of hydrocephalus, is usually thin. Ventriculostomy was performed in the anterior part of the described triangle by perforation of the floor of the third ventricle to the interpeduncular cistern. The technique of fenestration was dependent on the structure of the floor. If the floor was thin, use of a Fogarty balloon catheter no. 3 was sufficient. In case of increased vascularization of the floor, bipolar coagulation was used first and then a Fogarty catheter or forceps to enlarge the perforation. Occasionally occurring bleeding was brought under control by irrigation of the operative field with Ringer's solution at the temperature of 36–37°C. After withdrawal of the neuroendoscope, the hole in the dura was closed with TachoSil. The galea and the skin were tightly sutured (Photos 1 A–E).

To evaluate the treatment results, clinical and radiological criteria were used. Neurological examination was performed according to the generally applicable protocol. Neuroimaging studies including head CT or MRI were performed and evaluated by the same team of radiologists. The first follow-up scan was carried out within 48 h after surgery and then 1 month, 6 months and about a year after the operation. Further follow-up scans took place in most patients at annual intervals. In case of reasonable suspicion of ETV treatment failure or complications, the described schedule was modified. The criteria for clinical improvement were remission of symptoms of intracranial hypertension, cognitive and locomotor functions improvement, and sphincter control improvement. A partial remission of these symptoms was assessed as a slight clinical improvement. In this group of patients cases with a stable clinical course were also included. The criteria for radiological improvement were reduction in the width of the cerebral ventricles described by the Evans ratio and remission of active hydrocephalus features – the presence or widening of cerebral sulci and remission of periventricular lucency of CSF. Long-term outpatient observation lasted from 1 to 3 years (average 27 months).

Results

In 74 (77.1%) patients in the early period after ETV a clinical improvement was achieved, while in

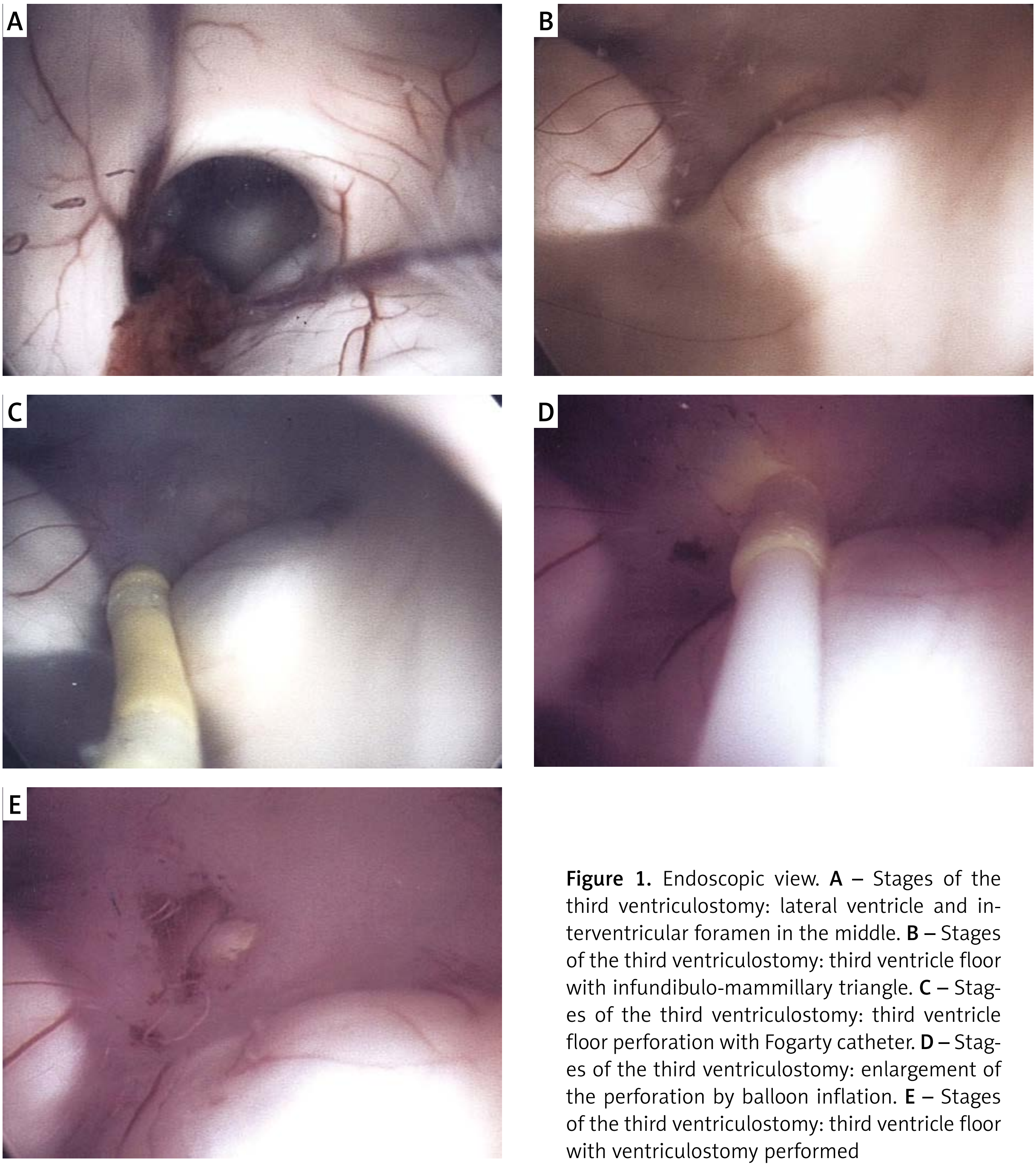

Figure 1. Endoscopic view. **A** – Stages of the third ventriculostomy: lateral ventricle and interventricular foramen in the middle. **B** – Stages of the third ventriculostomy: third ventricle floor with infundibulo-mammillary triangle. **C** – Stages of the third ventriculostomy: third ventricle floor perforation with Fogarty catheter. **D** – Stages of the third ventriculostomy: enlargement of the perforation by balloon inflation. **E** – Stages of the third ventriculostomy: third ventricle floor with ventriculostomy performed

52 (54.2%) cases it was associated with partial remission of radiological signs of hydrocephalus and a small reduction in the width of the cerebral ventricles (Tables III and IV). Symptoms of intracranial hypertension presented before subsided. Significant improvement of cognitive functions was observed. In the case of patients with primary aqueductal stenosis and patients with hydrocephalus of undetermined etiology, locomotor functions and sphincter control also improved. Ventriculostomy does not influence the other neurological symptoms related to oncological disease causing hydrocephalus. In 22 (22.9%) patients the ETV procedure resulted in slight improvement or remained insignificant for their neurological condition. These were cases without hypertension in the ventricular system. In such situ-

Table III. Effectiveness of endoscopic third ventriculostomy in obstructive hydrocephalus of different etiology. Early assessment – clinical presentation

Cause of hydrocephalus	Clinical improvement	Slight clinical improvement/no clinical improvement
Primary aqueductal stenosis	18	6
Tumor of posterior portion of the third ventricle	16	3
Cerebellopontine angle tumor	13	4
Cerebellar tumor	10	2
Multiple metastases	5	3
Mesencephalic tumor	4	1
Basilar tip aneurysm	2	–
Undefined	6	3
Total	74 (77.1%)	22 (22.9%)

Table IV. Effectiveness of endoscopic third ventriculostomy in obstructive hydrocephalus of different etiology. Early assessment – radiological presentation

Cause of hydrocephalus	Reduction of ventricle diameters	Ventricle diameters unchanged
Primary aqueductal stenosis	12	12
Tumor of posterior portion of the third ventricle	10	9
Cerebellopontine angle tumor	9	8
Cerebellar tumor	6	6
Multiple metastases	5	3
Mesencephalic tumor	3	2
Basilar tip aneurysm	2	–
Undefined	5	4
Total	52 (54.2%)	44 (45.8%)

ations no action against hydrocephalus beyond further observation and causal treatment was taken. In 1 patient with primary aqueductal stenosis, bleeding from the choroid plexus during the ETV procedure occurred. This made it difficult to continue ventriculostomy safely, and surgery was abandoned. After 2 weeks the ETV procedure was redone successfully. One patient presented memory disorders resulting from probable fornix injury for a few days after surgery. In 2 cases CSF leakage from the postoperative wound occurred, and it was secured with additional skin sutures. One patient with a tumor of the cerebellum, in whom surgery was complicated by persistent bleeding from the place where the ventriculostomy was made, despite external ventricular drainage placement, died on the fifth postoperative day.

In the assessment of the long-term effectiveness of ETV, oncological patients with obstructive hydrocephalus were excluded, since the final outcome in this group is conditioned by the undertaken causal treatment. Among 24 patients with primary aqueductal stenosis, during follow-up, in 2 of the cases the clinical condition improved and in another 2 the width of the cerebral ventricles decreased. After 6–12 months following surgery, in 20 (83.3%) patients in this subgroup the clinical improvement was maintained, of whom in 14 (58.3%) it was correlated with improvement of the radiological image. The remaining 2 patients required shunt placement. After 12–24 months following surgery in 2 cases symptoms of hydrocephalus recurred, in 1 case after craniocerebral injury and in another after viral infection of severe course. In both cases a ventriculoperitoneal shunt was placed finally. Among 9 patients with hydrocephalus of undetermined cause, 3 required shunt treatment within 6 months after the ETV procedure, including 1 patient with a shunt placed previously to ETV. Treatment in patients with obstructive hydrocephalus caused by basilar tip aneurysm succeeded, with a satisfactory long-term outcome.

The assessment of effectiveness of ventriculostomy in other patients is only indirect due to conditions mentioned above. In 3 patients with tumor of the posterior portion of the third ventricle who (after the ETV procedure) underwent radiotherapy, a ventriculoperitoneal shunt was placed because of recurrence of hydrocephalus features. Among 17 patients with cerebellopontine angle tumor, in 4 of them, directly after tumor resection, ventriculostomy failed to be sufficient and in the presence of emerging symptoms of hydrocephalus external ventricular drainage and then a shunt were placed. In cases of cerebellar tumor, after tumor resection no recurrence of the symptoms of hydrocephalus were observed. Patients with hydrocephalus caused by multiple metastases never showed up in our outpatient unit for long-term observation, and our efforts to obtain information about their outcome failed. Among 5 patients with a mesencephalic tumor, 2 died within 12 months after surgery, and the outcome of the other 3 has remained unknown.

Discussion

Endoscopic third ventriculostomy is the most commonly performed neuroendoscopic procedure nowadays. It enables one to restore conditions of CSF circulation close to physiological and to avoid complications associated with shunt treatment in many patients. Although the ETV procedure has been performed routinely for many years in many centers, still of interest remain issues related to: the appropriate selection of cases, the surgical technique and the assessment of the effectiveness of the treatment.

In our series, patients scheduled for ETV surgery suffered from three-ventricle hydrocephalus in most cases resulting from primary aqueductal stenosis or related to oncological disease. At the same time, clinical and radiological presentation likely allowed us to exclude impaired patency of the subarachnoid space and/or impaired CSF resorption. Such criteria were adopted in order to standardize the collected data following the other studies [5–14]. While the ETV treatment in patients with primary aqueductal stenosis does not raise a discussion, the cases in which the circulation of cerebrospinal fluid is secondarily blocked by a tumor may raise doubts [12]. The generally accepted rule of conduct in this situation is histopathological evaluation of the lesion in order to select the method of treatment or to remove the lesion. In 13 patients with tumor of the posterior portion of the third ventricle after ventriculostomy, endoscopic biopsy was performed to verify the lesion. In other cases, because of increased vascularization of the tumor and potential bleeding, biopsy was abandoned. In patients with cerebellopontine angle tumor and cerebellar tumor, excluding 5 cases, ventriculostomy was the temporary alternative for extraventricular drainage used previously. These were patients with large tumors, with emerging symptoms of intracranial hypertension resulting from hydrocephalus, and with multiple comorbidities requiring a long preparation for elective surgery. Yet another was the role of ventriculostomy as palliative treatment. Endoscopic third ventriculostomy has enabled us to avoid shunt treatment in patients in whom causal treatment was discontinued due to: location and clinical staging of neoplasm, high risk associated with the target surgery, or the ultimate lack of patient agreement on the target surgery. The selection for ventriculostomy in patients with three-ventricle hydrocephalus of undetermined etiology was based on empirical considerations. In patients treated previously with shunt placement, this method of treatment (ETV) is not always accepted, in line with the conviction "shunting once means always shunting" [15–18]. However, the lack of experience led us to undertake the surgery in these patients as well.

In addition to the clinical criteria, radiological evaluation of conditions to carry out the procedure plays a very important role in selection of patients for ETV. Use of head CT and/or MRI scans made with appropriate planes is sufficient for this purpose. The smallest width of the third ventricle allowing safe maneuvers of the endoscope is estimated to be

0.8–1.0 cm [9]. Hayashi *et al.* based on MRI scans in the sagittal plane determined the average distance between the infundibular recess and basilar tip. In patients with hydrocephalus it is 12 ±3.7 mm, while in the elderly due to displacement of the basilar artery to the front in relation to the mammillary bodies it may be reduced up to 6 mm [18]. Morota *et al.* made a certain observation. In hydrocephalus with increased intracranial pressure, in case of empty sella, MRI usually reveals herniation of the anterior part of the third ventricle floor to the sella that changes the anatomical relations [19].

Endoscopic third ventriculostomy is considered a technically uncomplicated procedure. Using a rigid neuroendoscope guarantees holding the chosen trajectory of access to the floor of the third ventricle. Although most ventriculostomies are performed using a rigid neuroendoscope, there are also supporters of the use of a flexible version [9]. It has a smaller diameter and allows the penetration of recesses of the ventricular system. Direct vision inspection provides proper anatomical and space orientation in the operative field, and it minimizes the risk of injury to important vascular and nervous structures. However, the procedure can also be performed stereotaxically under fluoroscopic, CT or MRI control [20–22]. Supporting ETV with various frameworks and frameless neuronavigation systems has also been reported [11, 23]. The crucial step in the ETV procedure is the perforation of the floor of the third ventricle leading to the interpeduncular cistern. The perforation in patients with a thin, bluish, translucent floor allowing the identification of the basilar artery position should not cause major problems. Difficulties may occur if the floor of the third ventricle is thick, not transparent, rigid, with illegible anatomical structures. Sometimes, in such cases, discontinuation of the ETV procedure and subsequent shunt placement is advised [24–27]. In the presented series we did not have any situation as described above. A trick that allows for verification of the basilar artery position and choice of a safe perforation place is use of a Doppler microprobe [28]. The best way to perform ventriculostomy is using a Fogarty catheter, but it is not always possible. Sharp instruments and coagulation must be used with extreme caution. Enlargement of the fenestration using a balloon catheter should be performed at the level of the floor of the third ventricle, not otherwise. Effective perforation must include all of the layers forming the floor of the third ventricle – the ependymal layer of the ventricle, pia mater and arachnoid mater of the interpeduncular cistern. It is assumed that the width of the fenestration cannot be less than 3–5 mm [27, 29]. Wood has presented ventriculostomy performed using a laser beam [30]. Other techniques have also been described, but generally they do not affect the final result of treatment [9, 31].

The obtained effectiveness of ETV in adults is difficult to compare to similar studies, since they are mostly related to mixed age groups of patients. Teo, based on a review of different series of patients treated with ETV, assumes effectiveness of the treatment in 50% to 90% in selected cases of aqueductal stenosis in adults. According to him, patients with primary or secondary aqueductal stenosis, with three-ventricle hydrocephalus, with an oval-shape third ventricle, over 2 years of age, previously shunted, who have never been a subject to radiotherapy, with a thin translucent floor of the third ventricle have a good prognosis. Patients who do not meet these criteria become shunt-dependent in 50% of cases [27]. Gangemi *et al.* evaluated the effectiveness of ventriculostomy in treatment of obstructive hydrocephalus twice, based on multicenter studies in Italy [9, 10]. In this study involving 140 patients of mixed age, under observation for 6–12 years, a good outcome was reported in 87.1% of cases regardless of patients' age and etiology of hydrocephalus.

It is believed that the clinical response of adult patients to ventriculostomy differs from the pediatric population, because of the duration of hydrocephalus, the differences in CSF circulatory dynamics and reduced elasticity of the brain [7]. In 74 (77.1%) patients of our series in the early period after ETV a clinical improvement was achieved, while in 52 (54.2%) cases it was associated with partial remission of radiological symptoms of hydrocephalus. The first major series of adult patients treated with ETV was presented by Dusick *et al.* It included 108 patients, of whom 52 were diagnosed from idiopathic aqueductal stenosis, 47 from brain tumor resulting in non-communicative hydrocephalus, and 9 from other pathologies causing the obstruction in CSF flow. After a mean follow-up of 8 months, shunt independence in 79% of patients was reported, and there were 2 deaths [7]. In the more recent study of Woodworth *et al.*, 124 patients were analyzed. Seventy-four percent of them achieved shunt independence, and an improvement of clinical condition was observed an average of 1 month after surgery, while a radiological improvement was reported in 57% of cases and occurred at a median of 2 months after surgery [32]. The data describing the effectiveness of ventriculostomy in adults in other studies only slightly differ from those listed above, which mostly results from the adopted end points [6, 11, 33]. In the only existing Polish study, involving 20 patients over the age of 18 years, observed for an average of 12 months, clinical improvement was reported in 90% of cases, and radiological improvement in 88%. The success rate was dependent on the etiology of hydrocephalus [12]. Our own observations have shown over 83% long-term effectiveness of ETV in patients with hydrocephalus due to aqueductal stenosis, in 58.3% of cases confirmed radiographically. It was also found that the clear effect of the treatment is not noticeable until a few weeks to several months after surgery. This is explained by the need to adapt the subarachnoid space to the new conditions of CSF circulation [27]. The effectiveness of ventriculostomy in the primary aqueductal stenosis, if disease was diagnosed in adulthood, is assessed as 66–85% [5, 11, 12, 34]. Tisell *et al.* reported only 50% long-term effectiveness of this treatment. The condition of one-third of patients, after clinical improvement lasting 1–12 months, deteriorated for unclear reasons, in spite of patent ventriculostomy. The worst prognosis applied to patients over 60 years of age [14]. The results of ETV in treatment of three-ventricle hydrocephalus of undetermined etiology are always difficult to predict, but even in such cases, treatment should be undertaken [35]. Grunert *et al.* achieved a 50% success rate in the group of patients defined as above [11]. In the case of previously shunted patients, in mixed age groups, the effectiveness of ventriculostomy is in the range 57–82% [5, 15]. Woodworth *et al.* postulate less importance of the ETV procedure as an independent method of treatment, while they see ETV as a good complement to shunt treatment in cases of complications and necessary revision [17]. It is difficult to discuss the long-term effectiveness of ventriculostomy in patients with hydrocephalus of an oncological cause in the same way as before, since ventriculostomy in these cases was a solution to conduct further planned stages of treatment or was a palliative procedure. In 7 cases ETV did not meet our expectations, which resulted in shunt placement. The effectiveness of ventriculostomy in patients with lesions that cause blockage of the CSF circulation pathways from outside, with a wide diversity of cases, ranges in the literature between 58% and 92% [5, 6, 11, 12, 36]. It seems that it is also recommendable treatment in patients with advanced oncological disease who do not have any metastases to the meninges and did not undergo prior radiotherapy of the brain. Nguyen *et al.*, in a series of 7 patients with diagnosed metastases in the posterior fossa of the cranium and in the thalamus, in 5 cases reported improvement of outcome expressed as a life extension from a few to several weeks [37].

Postoperative radiographic evaluation of the ventricular system may not always give the expected image of effectiveness of ETV. This is confirmed by the obtained results. Buxton *et al.* and Melot *et al.* demonstrated that the radiological presentation itself might be confusing and should not be the only reference to the effectiveness of ETV treatment [38, 39]. Moreover, as Schwartz *et al.* observed, for reliable assessment of the effectiveness of ventriculostomy, measurement of the width of the third ventricle than lateral ventricles is more important. In patients over 70 years of age, shunted previously or after meningitis, reduction of the size of the ventricular system should not be expected [40, 41]. More reliable information on the patency of the ventriculostomy may be provided by phase-contrast cine MRI or isotope cisternography [42, 43].

In the studied group of patients, 4 developed transient complications, not affecting the final outcome, and 1 death occurred. Among the most commonly reported complications of ETV, the following have been mentioned: intraoperative arterial or venous bleeding, subdural hematoma, subdural hygroma, qualitative and quantitative disturbances of consciousness, oculomotor or abducent nerve palsy, hemiparesis, diabetes insipidus, loss of appetite, menstrual cycle disorders, CSF leakage from the wound, and infections. Overall, the number of complications does not exceed 5–15%; these are transient disorders described in 6–8%, and stable observed in 0–2% of cases. The perioperative mortality rate is 0–1.5% [19, 25, 26, 42, 44–51]. It supports the recognition of ventriculostomy as a safe procedure.

Conclusions

The best results of ETV treatment were demonstrated for patients with hydrocephalus caused by primary aqueductal stenosis. Clinical improvement did not correspond with reduction of cerebral ventricle diameters; therefore ventricle size cannot be an independent criterion in the assessment of the effectiveness of ETV treatment. Endoscopic third ventriculostomy procedure is effective in patients treated previously with shunt placement, although the prediction of outcome should be cautious for this group. Endoscopic third ventriculostomy enables one to prepare patients with hydrocephalus for the causal treatment. It is used also as a method of palliative treatment.

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