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RETROSPECTIVE ANALYSIS OF PEDIATRIC HYDROCEPHALUS PATIENTS TREATED WITH ENDOSCOPIC THIRD VENTRICULOSTOMY

PEDİATRİK YAŞ GRUBUNDA ENDOSKOPİK ÜÇÜNCÜ VENTRİKÜLOSTOMİ YAPILAN HASTALARIN RETROSPEKTİF ANALİZİ

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ABSTRACT

Objective: Ventriculoperitoneal (VP) shunt and endoscopic third ventriculostomy (ETV) are commonly utilized surgical interventions for managing hydrocephalus. This study aimed to analyze ETV procedures performed on patients under 17 years of age, focusing on demographic factors such as age and gender, etiological considerations, surgical complications, and the necessity for VP shunt placement.

Material and Method: A retrospective study was conducted on pediatric patients who underwent ETV for hydrocephalus at the Department of Neurosurgery, Istanbul Faculty of Medicine, Istanbul University, spanning from January 2015 to June 2022. The study encompassed 44 patients aged 17 years or younger, with assessments made retrospectively based on clinical and radiological outcomes.

Result: Among the 44 patients subjected to ETV for hydrocephalus, 24 were female (54.5%) and 20 were male (45.4%), with a mean age of 7.3 years. The most prevalent presenting symptom was headache, reported by 11 patients (25%), followed by increased head circumference in 10 patients (22.7%). The primary etiology of hydrocephalus was intracranial tumors (34%). In five patients (11.3%), ETV was performed to address shunt malfunction following a prior VP shunt procedure. Regression of hydrocephalus occurred in 30 patients (68.1%), while 14 patients (31.8%) necessitated a subsequent VP shunt placement. Postoperative wound complications were documented in five patients (11.3%).

ÖZET

Amaç: Hidrosefali ameliyatlarında ventrikülo-peritoneal (V/P) şant ve endoskopik üçüncü ventrikülostomi (EÜV) sıklıkla tercih edilen cerrahilerdir. Çalışmamızda 17 yaş altında EÜV yapılan hastaların yaş ve cinsiyete göre dağılımlarını, cerrahi komplikasyonlarını ve V/P şant ihtiyaçlarının incelenmesi amaçlanmıştır.

Gereç ve Yöntem: Ocak 2015-Haziran 2022 tarihleri arasında İstanbul Üniversitesi İstanbul Tıp Fakültesi, Beyin ve Sinir Cerrahisi Anabilim Dalı'nda 17 yaş altında EÜV ameliyatı yapılan 44 hasta çalışmaya dahil edilmiştir. Hastaların klinik ve radyolojik sonuçları retrospektif olarak değerlendirilmiştir.

Bulgular: Endoskopik üçüncü ventrikülostomi yapılan hastaların 24'ü kadın (%54,5), 20'si erkekti (%45,4). Hastaların ortalama yaşları 7,3 idi. En sık hastaneye başvuru şikâyetleri 11 hastada saptanan (%25) baş ağrısı ve 10 hastada saptanan(%22,7) baş çevresinde artıştı. İncelenen hastalar arasında hidrosefalinin en yaygın nedeni intrakraniyal tümördü (%34). Daha önce V/P şant operasyonu yapılan ve takiplerinde şant disfonksiyonu gelişen beş (%11,3) hastaya EÜV yapıldı. EÜV yapılmış 44 hastanın 30'unda (%68,1) hidrosefalinin gerilediği görülürken, 14 hasta (%31,8) ikinci kez opere edilerek V/P şant takıldı. EÜV sonrası ikinci kez opere edilerek V/P şant takılan 14 hastanın 7'sine (%50) ilk ayda, 4'üne (%28,5) ise EÜV sonrası 1-3 aylık süreçte V/P şant takıldı. EÜV yapılan hastaların beşinde (%11,3) postoperatif yara yeri problemi geliştiği görüldü.

Sonuç: Geleneksel şant cerrahisine kıyasla EÜV komplikasyon riskinin daha düşük olması ve operasyon sonrası yaşam kalitesini

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Conclusion: ETV offers distinct advantages over traditional shunt surgery, including reduced complication risks and enhanced quality of life. Although the success of ETV in children can be affected by various factors, the procedure was demonstrated as safe and effective in many pediatric patients.

Keywords: Hydrocephalus, endoscopic third ventriculostomy, ventriculoperitoneal shunt

arttırması gibi birçok avantaj sunar. Çocuklarda ETV'nin başarısı çeşitli faktörlerden etkilenebilmesine rağmen prosedürün birçok pediatrik hastada güvenli ve etkili olduğu gösterilmiştir.

Anahtar Kelimeler: Hidrosefali, endoskopik üçüncü ventrikülostomi, ventriküloperitoneal şant

INTRODUCTION

Pediatric hydrocephalus can arise from various causes such as congenital defects, infections, tumors, or brain injuries. If left untreated, hydrocephalus can lead to developmental delays, impaired cognitive function, and potentially fatal outcomes (1). Therefore, it is essential to promptly diagnose and manage this condition to prevent long-term complications (2-4). Endoscopic third ventriculostomy (ETV) is a minimally invasive surgical technique wherein an endoscope is allowed to visualize the third ventricle and create an opening in its floor, facilitating the unrestricted flow of cerebrospinal fluid (CSF) and bypassing any obstructions (5). ETV is increasingly favored over traditional ventriculoperitoneal (VP) shunt procedures due to its lower risk profile. While shunts have historically been utilized, they pose risks of complications such as infections, disconnections, and malfunctions (6). In contrast, ETV is a one-time intervention that does not involve the insertion of foreign materials into the body (7). In this study, we present a series of pediatric hydrocephalus cases treated with ETV at a single center.

MATERIALS and METHODS

Patient population

We conducted a retrospective analysis involving pediatric patients who received treatment with ETV for hydrocephalus at the Department of Neurosurgery, Istanbul Faculty of Medicine, Istanbul University, spanning from January 2015 to June 2022. A study comprised a total of 44 patients aged 17 years or younger. Data for the analysis were sourced from hospital records, encompassing details such as age, gender, family medical history, presenting symptoms, neurological examination results, preoperative and postoperative radiological findings, postoperative complications, and follow-up outcomes. Patients who underwent ETV and those lacking adequate follow-up at our institution were excluded from the study. Approval for this research was obtained from the ethics committee of İstanbul University, İstanbul Faculty of Medicine (Date: 11.05.2023, No: 1755581), ensuring the confidentiality of patient identities.

Surgical technique

The ETV procedure is conducted under general anesthesia on a patient positioned supine, without requiring head fixation. The procedure commences with planning a U-shaped incision centered at Kocher's point, located 3 cm laterally from the midline and 1–2 cm anterior to the coronal suture. Sterile precautions are observed during preparation and draping of the surgical site. A burr hole is then created slightly lateral to the designated Kocher's point, with the careful removal of the medial part of the burr hole in a semicircular manner to access to an ultrasound-guided working channel. Intraoperative ultrasound is utilized to visualize the lateral ventricles, third ventricle, and third ventricular floor. A trajectory starting from the foramen of Monro and extending toward the third ventricular floor is chosen. The puncture adapter is connected to the working channel and adjusted accordingly. Visualization of the ventricular entry is confirmed, often accompanied by a distinct popping sensation (8). Identification of the foramen of Monro is facilitated by the convergence of the thalamostriate vein, anterior septal vein, caudate vein, and choroid plexuses. Once the endoscope is advanced through the foramen of Monro, the third ventricular floor is punctured at a site between the infundibular recess and mammillary bodies, where the floor is the thinnest. Care is taken to identify and avoid the basilar artery to prevent bleeding and injury. Blunt penetration of the third ventricular floor is achieved using a monopolar coagulator tip to minimize vascular risk. Subsequently, a specialized NeuroBalloon catheter with two balloon compartments or a Fogarty two-French balloon catheter is inserted through the initial fenestration. The balloon is gradually inflated within the fenestration to enlarge the opening, then deflated and withdrawn. Finally, the fenestration allows visualization of structures in the prepontine cistern (Figure 1) (9).

Postoperative criteria for determining success

Clinical success is defined as the resolution of preoperative signs indicating elevated intracranial pressure, including improved levels of consciousness, relief from headaches, stabilization or reduction in head circumference, and cessation of seizures.

Radiological success is determined by observing either a decrease or stabilization in ventricular size during follow-up evaluations, as assessed by the Evans ratio index (9).

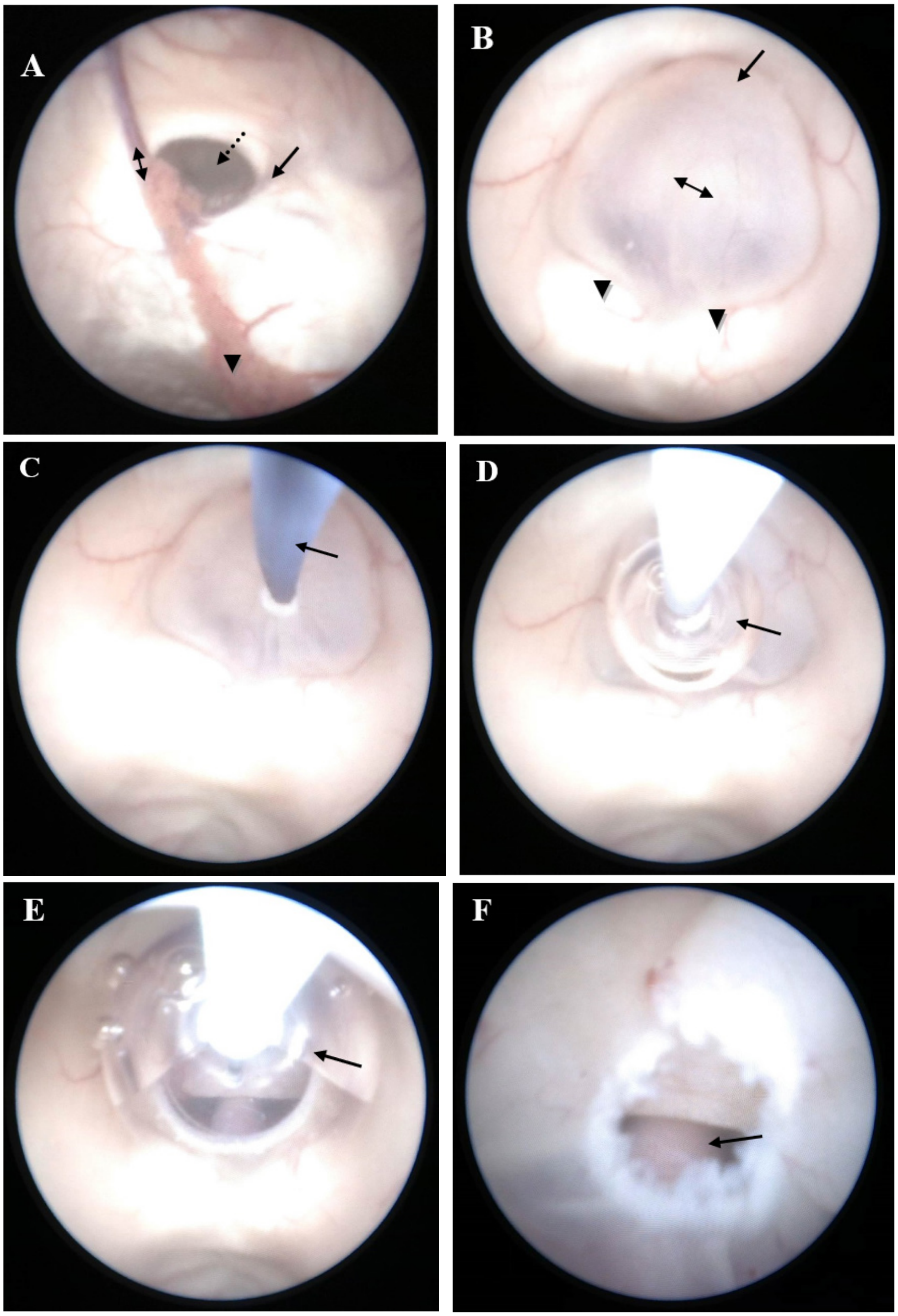

Figure 1: Intraoperative images during ETV
(A) Visualization of the right foramen of Monro (indicated by dashed arrow) featuring the thalamostriate vein (arrow), septal vein (double arrow), and choroid plexus (arrowhead).
(B) Observation of the floor of the third ventricle displaying the intermammillary membrane (double arrow), bilateral mammillary bodies (arrowheads), and anterior infundibular recess (arrow).
(C) Puncture of the floor of the third ventricle using a Fogarty balloon catheter (arrow).
(D, E) Image showing the inflated Fogarty balloon catheter (arrow).
(F) Final depiction of the third ventriculostomy with the prepontine cistern, alongside the basilar artery (arrow)

RESULTS

Among the cohort of 44 patients, 24 (54.5%) were female and 20 (45.4%) were male, with a mean age of 7.3 years. Males had a mean age of eight years, while females had a mean age of 6.8 years. The average duration of operations was 64 min, and patients were followed up for an average of 12 months (Table 1). The most frequently reported symptoms included headache (11 patients, 25%), increased head circumference (10 patients, 22.7%), nausea and vomiting (nine patients, 20.4%), dizziness (five patients, 11.3%), and seizures (four patients, 9%), and somnolence (four patients, 9%).

The study identified that 15 patients (34% of the total) developed hydrocephalus due to intracranial tumors, with 11 tumors situated infratentorially and four supratentorially. Biopsy via ETV was performed in two patients. Additionally, five patients (11.3%) had hydrocephalus associated with myelomeningocele, three (6.8%) had meningitis, and three (6.8%) had arachnoid cysts. Moreover, five patients (11.3% of the total) had a history of premature birth and germinal matrix bleeding (Table 1).

Among the 44 patients who underwent ETV, 30 (68.1%) experienced regression of clinical symptoms. In 11 of these patients, no radiological changes in ventricular size were observed, despite symptomatic improvement. The overall success rate of ETV in our study was 68.1%.

However, 14 patients (31.8%) still had persistent hydrocephalus after ETV and required VP shunt insertion. Among these, seven (50%) had the shunt inserted within the first month after ETV, while four (28.5%) had it inserted within 1–3 months post-ETV. Furthermore, five patients (11.3%) who underwent ETV for hydrocephalus had previously undergone VP shunt placement and required ETV due to shunt dysfunction. Additionally, five patients (11.3%) experienced postoperative wound complications.

Table 1: Patient demographics

Age		
Number of patients	44	
Average age	7.36 (min 1-max 17)	
Gender	**n (%)**	
Male	20 (45)	
Female	24 (55)	
Presenting complaints	**n (%)**	
Headache	11 (25)	
Head circumference growth	10 (22.7)	
Nausea–vomiting	9 (20.4)	
Dizziness	5 (11.3)	
Seizure	4 (9)	
Somnolence	4 (9)	
Incidental	3 (6.8)	
Cause of hydrocephalus	**Total n (%)**	**Success rate n (%)**
Intracranial tumor	15 (34)	12 (80)
Infratentorial	11 (25)	9 (81.8)
Supratentorial	4 (9)	3 (75)
Myelomeningocele	5 (11.3)	2 (40)
Germinal matrix bleeding	5 (11.3)	3 (60)
Meningitis	3 (6.8)	1 (33.3)
Arachnoid cyst	3 (6.8)	2 (66.6)

DISCUSSION

Numerous studies have established that ETV is an effective and safe treatment option for pediatric hydrocephalus (10). The success rate of ETV in children varies from 58% to 90%, depending on factors such as the underlying cause of hydrocephalus, the child's age, and the surgical technique employed (10-13). Moreover, ETV has been linked to a lower incidence of complications and a shorter hospital stay compared to traditional shunt surgery (14). However, ETV may not always be suitable for every pediatric patient with hydrocephalus, and careful patient selection and preoperative planning are essential for optimal outcomes. Overall, ETV can serve as a valuable treatment choice for pediatric hydrocephalus, but the decision to proceed with this surgery should be based on individual patient consideration (15). In our study, the overall success rate of ETV, encompassing both radiological and clinical outcomes, was 68.1%. In 11 out of 30 patients, there were no radiological changes observed in ventricular size; nonetheless, clinically, the patients experienced symptom improvement. Emphasizing clinical correlation over radiological findings is prioritized in determining successful outcomes. While imaging can provide valuable insights into the patient's condition, solely relying on it may be insufficient (15).

ETV offers several advantages over traditional VP shunt surgery, including a decreased risk of infection, a reduced need for revision surgery, and an enhanced quality of life (16). Notably, one of the primary benefits of ETV in children is its capacity to circumvent the potential complications associated with long-term shunt dependency. Shunts can malfunction, become infected, or obstruct, necessitating additional surgeries for replacement or revision (17). In contrast, ETV establishes a new pathway for CSF circulation, eliminating the requirement for an implanted device (18). This can significantly mitigate the risk of complications linked to shunt surgery and enhance overall outcomes for children with hydrocephalus (19). Generally, the procedure is well-tolerated in pediatric patients, with few serious complications reported. Among the individuals in our study, five (11.3%) who underwent ETV for hydrocephalus had previously undergone VP shunt placement. Subsequently, there was no indication of shunt dependency among these patients during the follow-up period.

Shunt dependency can arise after ETV if the procedure fails to provide sustained alleviation of hydrocephalus symptoms (20). Several factors may increase the likelihood of shunt dependency following ETV, including younger age and the presence of concurrent comorbidities like spina bifida or aqueductal stenosis (21). The effectiveness of ETV may also be influenced by the underlying cause of hydrocephalus, with superior outcomes documented in cases of obstructive pathologies such as aqueductal stenosis compared to other etiologies (22). While the risk of shunt dependency following ETV exists, it is important to underscore that ETV can still serve as an effective treatment option for many hydrocephalus patients. Despite the potential for shunt dependency post-ETV, patients should not be discouraged from considering ETV as a viable treatment option (23). Our analysis revealed that patients undergoing surgery for intracranial tumors achieved a success rate of 80%, surpassing that of other pathologies.

Similar to any medical procedure, ETV carries potential risks and complications. Despite being deemed minimally invasive, complications of ETV can range from minor to life-threatening (24). Common complications include CSF leakage, bleeding, infection, and postoperative headache. CSF leakage, occurring in approximately 5%–10% of ETV cases, is a relatively frequent complication (24-26). Conservative measures like bed rest and antibiotics are typically employed to manage this complication, although surgical repair may be warranted in some instances (27). While bleeding is rare, infection rates range from 0.5% to 4% (28). Postoperative headache, though common, usually resolves within a few days. More severe complications, such as the development of a subdural hematoma, are extremely rare, occurring in less than 1% of cases (29). Nonetheless, they can lead to significant consequences like permanent brain damage or death. Despite these potential risks and complications, ETV remains a valuable treatment option for many hydrocephalus patients (30). In our study, postoperative wound problems were observed in five out of 44 patients (11.3%).

CONCLUSION

In summary, ETV stands as a beneficial treatment choice for pediatric hydrocephalus. It presents numerous advantages over traditional shunt surgery, notably a reduced risk of complications and enhanced quality of life. Although the success of ETV in children may be impacted by various factors, it has demonstrated safety and efficacy in a substantial proportion of pediatric cases.

Ethics Committee Approval: The study has ethical approval from the İstanbul University, İstanbul Faculty of Medicine (Date: 11.05.2023, No: 1755581).

Informed Consent: All patients signed the informed consent form.

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Conflict of Interest: The authors have no conflict of interest to declare.

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