



Individualized Management of Subdural Effusion-Hematoma in Pediatric Shunt Patients

Pediatric Şant Hastalarında Subdural Efüzyon-Hematoma'nın Bireyselleştirilmiş Yönetimi

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ABSTRACT

Aim: This study examines the challenges of managing subdural effusion-hematoma (SEH) following shunt procedures for treating hydrocephalus in a pediatric population. It raises questions about the effectiveness of fixed-pressure versus adjustable shunts, particularly in the management of SEH complications. While adjustable shunts have been lauded for their flexibility, neither option has fully eradicated the risk of SEH. The study aims to share clinical insights into managing these complications, given the lack of a one-size-fits-all solution.

Material And Method: This study retrospectively analyzes data from 2011 to 2022 on 496 pediatric patients who underwent ventriculoperitoneal (VP) shunt surgery for hydrocephalus at the same hospital. The study focuses on 11 patients with shunt-related subdural effusion-hematoma (SEH).

Results: This detailed study on 11 pediatric patients who developed subdural effusion-hematoma (SEH) after shunt placement reveals a diverse range of symptoms and treatments. Asymptomatic patients were closely monitored, while those with shunt infections had their shunts removed and underwent extra-ventricular drainage (EVD). In more severe cases, such as reduced consciousness, emergency interventions like shunt removal and hematoma surgery were performed. The outcomes varied, but many patients showed improvements and some were even able to continue without a shunt, based on individualized assessments and treatments.

Conclusion: The study concludes that managing SEH in pediatric patients post-shunt placement is complex and individualized, emphasizing that treatment should be symptom-based rather than solely relying on radiological findings, thereby filling a gap in the literature that mostly focuses on adults.

Keywords: Hydrocephalus, shunt, adjustable shunt, subdural effusion, subdural hematoma

ÖZ

Amaç: Bu çalışma, pediatrik bir popülasyonda hidrosefali tedavisi için şant prosedürleri sonrası subdural efüzyon-hematoma (SEH) yönetiminin zorluklarını incelemektedir. Sabit basınçlı ve ayarlanabilir şantlar arasındaki etkinliği, özellikle SEH komplikasyonlarının yönetimi açısından sorgulamaktadır. Ayarlanabilir şantlar esneklikleri için övülse de, hiçbir seçenek SEH riskini tamamen ortadan kaldırmamıştır. Çalışma, bu komplikasyonların yönetimine dair klinik içgörüler paylaşmayı amaçlamaktadır, çünkü tek tip bir çözüm yoktur.

Gereç ve Yöntem: Bu çalışma, 2011'den 2022'ye kadar aynı hastanede hidrosefali için ventriküloperitoneal (VP) şant ameliyatı geçirmiş 496 pediatrik hastanın verilerini retrospektif olarak analiz etmektedir. Çalışma, şantla ilgili subdural efüzyon-hematoma (SEH) gelişen 11 hastaya odaklanmaktadır.

Bulgular: Şant yerleştirilmesi sonrası subdural efüzyon-hematoma (SEH) gelişen 11 pediatrik hastayı detaylı olarak inceleyen bu çalışma, çeşitli belirtiler ve tedaviler ortaya koymaktadır. Asemptomatik hastalar yakından izlenmiş, şant enfeksiyonları olanlarda ise şantlar çıkarılmış ve ekstra-ventriküler drenaj (EVD) yapılmıştır. Daha ciddi vakalarda, gibi bilincin azalması gibi durumlarda, şant çıkarılması ve hematoma ameliyatı gibi acil müdahaleler yapılmıştır. Sonuçlar farklılık gösterse de, birçok hasta iyileşme göstermiş ve bazıları bile bireyselleştirilmiş değerlendirmeler ve tedaviler temelinde şantsız devam edebilmiştir.

Sonuç: Çalışma, şant yerleştirilmesi sonrası pediatrik hastalarda SEH yönetiminin karmaşık ve bireyselleştirilmiş olduğu sonucuna varmaktadır. Tedavinin belirti temelli olması gerektiğini vurgulamakta ve bu konuda çoğunlukla yetişkinlere odaklanan literatüre bir katkı sağlamaktadır.

Anahtar Kelimeler: Hidrosefali, şant, ayarlanabilir şant, subdural efüzyon, subdural hematoma

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INTRODUCTION

Shunt placement procedures for the treatment of hydrocephalus have a broad global application and continue to be a commonly utilized treatment method in today's technology (1,2). However, complications such as subdural effusion-hematoma (SEH) may occur following this type of surgical intervention. The clinical course of these complications can vary from individual to individual, ranging from mild, asymptomatic cases to states of paralysis and coma (1,2). In the literature, considerable emphasis has been placed on the positive prognostic effects of using adjustable (programmable) shunts for SEH (1-6). The inability to adjust pressure settings after the implantation of fixed-pressure shunts, coupled with the idea that cerebrospinal fluid (CSF) regulation could be influenced by individual differences, suggests that using the same shunt settings for all patients might lead to complications in some cases. On the other hand, adjustable-pressure shunts offer the flexibility to modify pressure settings post-implantation, providing particularly more controlled management in cases of SEH. It is commonly recommended in the literature that, in the presence of SEH, adjustable shunts should start at higher pressure settings and be gradually reduced (4,5). However, the course of action to be followed when SEH occurs in a patient with a fixed-pressure shunt is not clearly defined.

Our clinical experience shows that not only the application of shunts but also patients' responses to shunt complications are highly individualistic. Therefore, applying a standardized approach to every patient is not very likely, both in the treatment of hydrocephalus and in the management of shunt complications. When evaluating different types of shunts, although the most advantageous seems to be the adjustable shunt, even its use has not completely eliminated the risk of SEH. It has merely facilitated the management of complications (4-6).

In our study, we aim to discuss the characteristics of pediatric patients who developed SEH following shunt application, our follow-up and treatment approaches, and our outcomes. While we may not have the chance to prepare a one-size-fits-all guideline for these situations, we would like to share our experiences in the management of post-shunt SEH cases based on our clinical observations.

MATERIAL AND METHOD

The study was carried out with the permission of Selçuk University Local Ethics Committee (Date: 26.09.2023, Decision No: 2023/436). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Data from our hospital's information system was retrospectively analyzed, covering the period from 2011 to 2022 and involving 496 patients under the age of 18 who had undergone ventriculoperitoneal (VP) shunt surgery and were still under our follow-up. Of these patients, 11 who had shunt-related SEH and whose diagnosis, radiological imaging and treatment were entirely carried out at our hospital were included in the study.

Inclusion criteria for the study were as follows:

- Patients being under the age of 18 at the time of the operation
- Having been diagnosed with hydrocephalus via brain computed tomography (CT) or magnetic resonance imaging (MRI) prior to the first shunt operation
- All surgical procedures, treatments, and follow-ups related to the patient's shunt having been carried out by departments at our hospital, and data being accessible within our hospital's information system
- Complete post-operative radiological imaging having been conducted and this data being accessible within the system
- Patients having at least a 6-month period of stable well-being following the diagnosis and treatment of SEH.

Patients who had a history of head trauma or anticoagulant medication use—factors that could potentially cause SEH—were excluded from the study. This exclusion was implemented to ensure a more predictable assessment of SEH solely related to shunt placement, eliminating the influence of other contributing factors like head trauma or anticoagulant use.

RESULTS

Of the 11 patients included in the study, 63.6% (n: 7) were male. The average age was 72.3 months (min. 12 - max. 132), and the average follow-up period was 72.9 months (8-120). The etiology of the shunts in these patients were as follows: congenital hydrocephalus accounted for 54.5% (n: 6), post-meningitis hydrocephalus was 18.2% (n: 2), and hydrocephalus developing after premature birth-intraventricular hemorrhage was 27.3% (n: 3). All the initial shunt types applied upon diagnosing hydrocephalus were of fixed pressure. Of these, 54.5% (n: 6) were medium-pressure burr-hole type shunts, 36.6% (n: 4) were medium-pressure flat abdomen type shunts, and 9% (n: 1) was a medium-pressure mini burr-hole type shunt.

The presenting complaints of the patients when SEH was initially diagnosed through imaging were as follows: 36.3% (n: 4) were asymptomatic, 36.3% (n: 4) were preliminarily diagnosed with shunt infection (nausea, vomiting, and restlessness (n: 2), nuchal rigidity (n:1), and fever of unknown origin (n: 1)), 9% (n: 1) presented with



altered consciousness and a drop in the Glasgow Coma Scale (GCS: 8), 9% (n: 1) exhibited reduced cooperation with his mother and a tendency to sleep, and 9% (n: 1) oral feeding was reduced.

In the initial stage of treatment management for patients diagnosed with SEH, either asymptotically or symptomatically, decisions were made based on their neurological examinations and symptoms;

The average follow-up duration for the 36.3% (n: 4) of patients in the asymptomatic group was 78 months (range 12-120). The cortical pressures of their SEH were minimal. The initial approach for these patients involved close neurological examination and follow-up of radiological images. Despite an increase in SEH volume in two patients during follow-up, monitoring continued because they remained asymptomatic. At the end of the 12th month, routine follow-up was resumed in the asymptomatic patient group, which included one patient whose SEH had stabilized since diagnosis (n: 1), one whose SEH had ceased to progress in the images (n: 1), and two whose SEH had regressed (n: 2).

In the 36.3% (n: 4) of patients preliminarily diagnosed with shunt infection (experiencing symptoms such as nausea, vomiting, restlessness [n: 2], neck stiffness [n: 1], and unlocalized fever [n: 1]), all had their shunts removed, sent for culture, and had an extra-ventricular drainage (EVD) system installed. Normally, cerebrospinal fluid (CSF) is drained from the EVD at rates of 3-5-7 cc/hour based on CSF pressure conditions; however, in these patients, CSF was drained at 1 cc/hour, and their tolerance was evaluated. In patients with no regression upon neurological examination, EVD was kept closed for monitoring. If their well-being continued, the EVD was removed (75%, n: 3). Patients who completed their infection treatments continued their follow-ups without a shunt. Control brain CT scans showed that the brain parenchyma had expanded, and the subdural hygroma (SEH) had either regressed or completely disappeared. For one patient who could not tolerate the closed monitoring of the EVD, an adjustable (programmable) shunt was implanted after the infection treatment was completed.

One patient (9%, n: 1) presented to the hospital with altered consciousness and a moderate-to-low Glasgow Coma Scale (GCS) score of 8. Due to the patient's decreased neurological exam, emergency shunt removal and bilateral subdural hematoma surgery were performed. In the immediate postoperative period, the patient's GCS improved to 13-14. Follow-up examinations showed that the brain parenchyma had expanded, there was some ventricular enlargement, but there was no extraventricular cerebrospinal fluid (CSF) passage. The patient has been followed up for 52 months without a shunt and with a GCS of 15.

In patients with decreased cooperation with their mother and increased sleepiness (9%, n: 1) (Image 1), as well as in patients with reduced oral intake (9%, n: 1), the shunt was ligated at the neck. This procedure is done under local anesthesia and involves making a 1 cm incision perpendicularly over the palpable shunt tract in the neck area, after which the shunt is located, looped, and tied off with a free silk suture. The aim of the procedure is to intentionally disrupt the continuity of the shunt tract and render the shunt nonfunctional. This allowed for controlled monitoring without the shunt. Early follow-up without the shunt was tolerated and improvements in symptoms were observed, leading to the removal of the shunts and the discharge of the patients. Patients were then closely monitored in outpatient clinics. Despite the expansion of the brain parenchyma seen in brain CT scans, the absence of periventricular CSF passage led to the continuation of shunt-free follow-up for the patients (**Figure 1**).

DISCUSSION

Shunt-related Subdural Effusion/Hematoma (SEH) is a frequently encountered complication following hydrocephalus surgery, although there is insufficient information in the literature regarding its management (7-9). It is generally believed that the primary cause is the tearing of the cortical bridging veins due to the altered fluid dynamics following the placement of a ventricular shunt (4). In the literature, most cases of SEH are likely interpreted as a postoperative complication related to the shunt and have been noted to occur within the first 6 months following the initial shunt operation (10-12). In our series, this time span is 66 months (min.3 - max.100 months). The values that led us to find an average time above that reported in the literature are generally attributable to groups that were diagnosed as asymptomatic and/or due to shunt infection. Nevertheless, it is evident that SEH complications can also develop years after the initial shunt surgery (**Figure 1**). Can this etiology be entirely explained by CSF (Cerebrospinal Fluid) balance, or are there other overlooked factors at play? This could be the subject of another study.

In the literature, the almost singular recommendation for preventing SEH is the installation of an adjustable shunt in each patient, starting with the drainage of cerebrospinal fluid (CSF) at high pressure (7-9). Due to our healthcare policy, an adjustable shunt system is obtained for specific cases only when the patient's unique situation is indicated. Indeed, in a 10-year follow-up, only 11 out of 496 pediatric shunt patients were identified as candidates for an adjustable shunt, and of those, only two had the system implemented. While there have certainly been other indications for which we have applied adjustable shunts, considering that only 0.4% of adjustable shunt usage is attributed to SEH pathology, it is clear that it is not an absolute necessity for all patients.

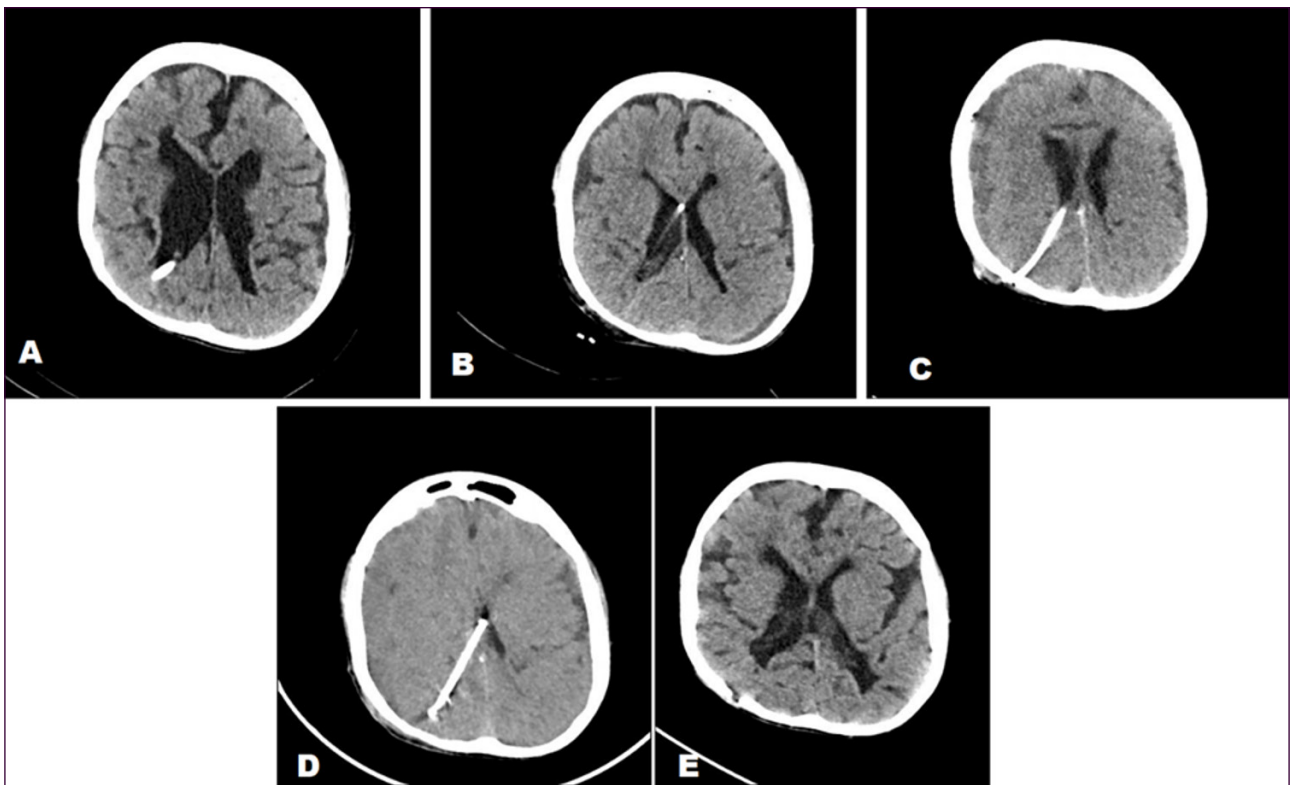


Figure 1- Six-year-old patient, diagnosed with congenital hydrocephalus during the newborn period, has been followed up at our hospital after the implementation of a 'Burr Hole Type Medium Pressure, Fixed Pressure Setting' shunt.

1A - During the two-year follow-ups of the patient, brain computed tomography (CT) scans appeared normal.

1B - In the third year following shunt placement, control brain CT scans revealed the presence of bilateral subdural effusion/hematoma (SEH). The patient, whose neurological examination was stable, was closely monitored.

1C - During the patient's outpatient check-up three months later, it was observed that the effusion had increased and the ventricles were becoming less distinct. The patient was in good general condition and had no active complaints. It was decided to continue monitoring as long as the neurological examination remained stable. The family was informed about the situation and follow-up outpatient examinations continued.

1D - The patient presented with symptoms of reduced cooperation with his mother and increased sleepiness at the sixth month of SEH detection. Brain CT scans showed an increase in the size of the SEH and less distinct ventricles. The neurological examination revealed a Glasgow Coma Scale (GCS) score of 14. The patient's shunt was ligated at the neck, disabling it, and the patient was admitted for general condition monitoring. During the 4 days of hospital stay, it was observed that the patient's general condition improved and complaints regressed. A shunt removal operation was performed.

1E - An average of 2 years of shunt-free follow-ups revealed a GCS of 15 for the patient, and he had no active complaints. Control brain CT scans showed the ventricular structure was similar to the period when the patient was followed up with a shunt (Figure 1A), there was no extraventricular cerebrospinal fluid (CSF) passage, and the sulci appeared relaxed

Indeed, there are multiple publications emphasizing that the development of SEH can still occur despite the presence of an adjustable shunt, underscoring that it is not an unequivocal solution (3-5, 12-14).

The clinical manifestation of SEH is highly variable and individualized, often not aligning with radiological findings (10,11). In addition to 36.3% of the patients being asymptomatic, another 36.3% were diagnosed while being investigated for shunt infection. Even for those with shunt infections, their presentation involved symptoms like general malaise, fever, and neck stiffness rather than noticeable changes in neurological examinations. After treatment for the shunt infection, these patients reverted to their previous general state. All of these patients underwent shunt removal therapy, and only one could not tolerate follow-up without a shunt, leading to the implementation of an adjustable shunt. None underwent "burr hole surgery

for hematoma drainage" specifically for SEH. From this perspective, one might speculate that if the patients diagnosed with SEH while being investigated for suspected shunt infection had not exhibited symptoms due to the infection, perhaps they would also have fallen into the asymptomatic group. However, this remains an unprovable hypothesis.

In the literature, cases of SEH that are noted to require emergency surgery are usually those with severe clinical symptoms, significant blood accumulation, and serious intracranial pressure (10-12). In our series, we have had only one such case, who underwent both shunt removal and bilateral burr hole drainage of the subdural hematoma in the same session. This patient showed marked improvement in neurological examination during the early postoperative period. Although closely monitored for potential shunt requirement, subsequent follow-ups revealed no such need.



In the literature, the incidence of shunt-related SEH in patients is reported to range from 5% to 35%. None of these rates are specifically pediatric-focused (6-8,12,13). In our study, the incidence of SEH among the included patients is 2.2%. One of our inclusion criteria, which likely contributed to this lower incidence rate, was that all follow-up and treatments related to the shunt must have been conducted at our hospital. Given that shunt patients require long-term follow-up, fulfilling this criterion of receiving treatment and follow-up at a single center is a challenging requirement.

At the time of initial shunt implantation in our hospital, if the patient has no specific individual conditions, whichever type of shunt is available is used. Should specific conditions arise for the patient (such as the occurrence of SEH, presence of slit ventricles, skin issues, etc.), the most suitable alternative shunt type is determined, and it is procured by our hospital, indicating the patient's special condition. Therefore, our initial choice of shunt type is solely determined by what is available at our hospital at the time of the procedure. While there are publications stating that adjustable shunts may be preventative for SEH but are not a definitive solution, none of these literature findings are specific to the pediatric age group. In fact, much of the data comes from studies that focus on adult populations dealing with conditions like normal-pressure hydrocephalus (6,8,12-14). For pediatric patients who continue to fare well during a shunt-free period, especially prior to the trial of an adjustable shunt, complete shunt removal should also be considered as a viable option. In our study, only 2 patients who could not tolerate being shunt-free received an adjustable shunt, and their average follow-up duration after this operation has been 28 months. During this period, imaging and neurological examinations for these patients remained stable. Additionally, in our study, 45.4% (n: 5) of patients benefited from the removal of the shunt, and the average follow-up duration for these patients has been 69.6 months.

Limitations

Due to the small sample size, statistical evaluations are not meaningful. Therefore, we have shared our clinical experiences with the patients, but no statistical assessments have been made. Future studies may be planned with larger patient populations, and perhaps including adult populations for a more comprehensive analysis.

CONCLUSION

Managing the follow-up and treatment of patients with SEH due to shunt placement presents a perplexing and challenging task, given the inherent variability in clinical courses and radiological images across individual cases.

Our study findings underscore that, despite not performing any surgical interventions on asymptomatic patients, their SEH remained stable or even regressed. This emphasizes that treatment planning should always be tailored to the patient's symptoms, rather than focusing solely on correcting radiological findings.

While most existing data on SEH are related to adult populations, our study contributes to the literature by specifically examining the pediatric period.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Selçuk University Local Ethics Committee (Date: 26.09.2023, Decision No: 2023/436).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients for the study.

Referee Evaluation Process: Externally peer-reviewed.

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