

Evaluation of Shunt Revisions in Pediatric Hydrocephalus Cases

Pediatric Hidrosefali Olgularında Şant Revizyonlarının Değerlendirilmesi

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ABSTRACT

Introduction: Ventriculoperitoneal shunt surgery is one of the most commonly used methods in patients with hydrocephalus. This study aims to reveal the causes of complications and revision after shunt surgery and discuss measures that can be taken against these situations.

Methods: We retrospectively reviewed the shunt revisions of 248 pediatric age groups who underwent ventriculoperitoneal shunt surgery due to hydrocephalus between 2000 and 2016.

Results: Of the 248 patients, 127 (51.2%) were female and 121 (48.8%) were male. The mean age was 12 months. The most common etiologic cause was congenital hydrocephalus. 71 of 248 patients (28.6%) underwent revision surgery. More than one revision surgery was performed in 23 (% 32.4) of 71 patients who underwent revision surgery. Infection (21.7%) and ventricular catheter occlusion (17.1%) were the most frequent causes of revision surgery.

Conclusion: The rate of revision surgery due to ventriculoperitoneal shunt surgery in pediatric patients is still high despite the development of diagnosis and treatment methods and many researches about it. Investigating preventable causes of revision surgeons may help to reduce high revision rates.

Key words: Hydrocephalus, Complications, Meningomyelocele, Ventriculoperitoneal Shunt

ÖZET

Giriş: Ventriküloperitoneal şant uygulaması hidrosefali hastalarda en sık kullanılan yöntemlerden biridir. Bu çalışmanın amacı şant cerrahisi sonrası gelişen komplikasyon ve revizyon nedenlerini ortaya koymak ve bu durumlara karşı alınabilecek önlemleri tartışmaktır.

Yöntemler: 2000 - 2016 yılları arasında hidrosefali nedeniyle ventriküloperitoneal şant cerrahisi uygulanan pediatrik yaş grubundaki 248 hastanın retrospektif olarak şant revizyonları incelenmiştir.

Bulgular: Opere edilen 248 hastanın 127 tanesi (%51,2) kız, 121 tanesi (%48,8) erkekti. Ortalama yaş 12 ay bulundu. En sık görülen etyolojik neden konjenital hidrosefaliydi. 248 hastanın 71 tanesine (%28,6) revizyon cerrahisi uygulandı. Revizyon cerrahisi yapılan 71 hastanın 23 tanesine (%32,4) birden fazla sayıda revizyon cerrahisi uygulandı. Revizyon cerrahisinin kendi içinde oranlarına baktığımızda enfeksiyon (%21,7) ve ventriküler kateter tıkanıklığı (%17,1) en sık nedenler idi.

Sonuç: Pediatrik hastalarda ventriküloperitoneal şant cerrahisine bağlı revizyon cerrahisi oranları, tanı ve tedavi yöntemlerinin gelişmesine ve hakkında bir çok araştırma yapılmasına rağmen halen yüksek seyretmektedir. Revizyon cerrahisinin önenebilir nedenlerinin araştırılıp incelenmesi yüksek olan revizyon oranlarını düşürmeye yardımcı olabilir.

Anahtar Kelimeler: Hidrosefali, Komplikasyon, Meningomyelozel, Ventriküloperitoneal Şant

INTRODUCTION

Hydrocephalus is one of the important diseases of the past and present with high mortality and morbidity, all over the world and in our country. Despite its early diagnosis and treatment methods, it still maintains its importance.

Today, the most effective and widely used treatment modalities in the treatment of hydrocephalus are operations shunt and endoscopic surgeries (1). Shunt operations are the process of draining the cerebrospinal fluid (CSF) into another cavity with high CSF absorption capacity, simply using a tube. The main

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purpose of surgical treatment in patients with hydrocephalus is to reduce intracranial pressure and return it to normal. Although there are many studies on ventriculoperitoneal (V/P) shunts, there are still large gaps in the literature and there is no serious evidence-based guideline for hydrocephalus.

There is no general consensus on the follow-up and treatment of V/P shunt complications, and there are many different diagnoses and treatment methods for the management of complications (2,3).

In general neurosurgery practice, V/P shunt operations are accepted as surgeries with high complication rates (4). The morbidity and mortality of hydrocephalus have decreased significantly over time, but hydrocephalus still causes potential complications that may require surgical treatment (5).

METHODS

This study includes 248 cases operated on with the diagnosis of hydrocephalus between 2000-2016. Open and endoscopic third ventriculostomy operations and ventriculoatrial, ventriculopleural shunt operations were not included in the study. 248 operated cases were reviewed retrospectively. Computed tomography examination was performed in all 248 cases (CT). CSF examination was performed in all patients. The diagnosis was made by examining the ratio of Evan's with CT in patients with routine clinical findings. Intracranial pressure monitoring was not performed. All of the cases were operated under general anesthesia. A medium pressure adjustable shunt was used first for all patients. Programmable shunts were routinely used in patients who underwent revision surgery. Patients with intracranial hemorrhage and meningitis were taken to shunt operation after the acute phase passed. Broad-spectrum antibiotics were used for 3 days in the post-operative period. V/P shunt functionality was decided according to neurological examination and CT findings. V/P shunt was not applied if the white blood cell count

was 60 mm³ and the protein content was more than 1000.

Ethics committee approval for our study was received on 01.08.2018 from Health Sciences University Ankara Health Practice and Research Center with decision number 533.

The data of the study were analyzed with the Statistical Package for the Social Sciences (SPSS) version 20.0. Number, percentage, mean, standard deviation, median, minimum and maximum values were used in the presentation of the data. According to the results of the normal distribution test, Kruskal Wallis Analysis of Variance Test was used as a nonparametric test. Chi-square test was used in the analysis of categorical data. P<0.05 was accepted for statistical significance.

RESULTS

Of the 248 patients operated on, 127 (51.2%) were female and 121 (48.8%) were male. There were 87 patients younger than 1 month, 72 patients between 1 month and 3 months, 55 patients between 3 months and 12 months, 23 patients between 1 year and 6 years, and 11 patients between 6 years and 16 years (Table 1).

Table 1. Distribution of cases by age and gender

Age	Female	Male	Total number of cases
<1 month	45	42	87
1 month - 6 month	37	35	72
6 month - 24 month	26	29	55
2 years - 6 years	14	9	23
6 years - 16 years	5	6	11
TOTAL	127	121	248

The average age was 12 months. Of the 248 cases treated, 110 (44.4%) congenital hydrocephalus with meningocele, 69 (27.8%) congenital hydrocephalus not associated with meningocele, 37 (14.9%) hydrocephalus due to perinatal hemorrhage, 15 (6%) due to intracranial mass. hydrocephalus, 12 (4.9%) hydrocephalus due to infection and 5 (2.0%) hydrocephalus due to traumatic hemorrhage (Table 2).

Table 2. Number of cases by etiology

Etiology	Number of cases
Congenital Hydrocephalus (including Mmc)	110
Congenital Hydrocephalus (Excluding Mmc)	69
Perinatal Hemorrhage	37
Intracranial mass	15
Infection	12
Traumatic hemorrhage	5
Total	248

Abb. Mmc: Meningocele

The mean follow-up period of 248 patients who were operated was 22 months. During the follow-up period, 71 patients (28.6%) underwent revision surgery due to complications and shunt dysfunction. When we look at our revision rates during the 1-year follow-up, the result was 17.7%. Two or more revision surgeries were performed in 23 patients (9.3%). Shunt dysfunction due to infection was the most common cause of revision with 21.4% (n = 15). The second and third most common causes were ventricular catheter occlusion with 17.1% (n = 12), and distal catheter occlusion with 12.9% (n = 9). Other reasons are as follows; 10% subdural collection, 10% shunt rupture, separation and migration, 8.6% wound problems, 5.7%

ventricular catheter misplacement, 5.7% abdominal tip shortness, 4.3% isolated ventricle due to development, % 2.9 abdominal pseudocyst formation, 1.4% shunt dysfunction due to shunt valve occlusion.

When classified according to the etiology of 71 revised patients, 31 (43.6%) Congenital Hydrocephalus (including MMC), 21 (29.6%) Congenital Hydrocephalus (excluding MMC), 12 (16.9%) Perinatal Hemorrhage, 6 (8.5%) Infection, 1 of them (1.4%) was observed to be in the intracranial mass class. No revision was performed in 3 patients with shunts due to traumatic hemorrhage.

Revision surgery rates according to etiologic reasons were 28.2% for congenital hydrocephalus (including MMC), 30.4% for congenital hydrocephalus (excluding MMC), 32.4% for hydrocephalus due to perinatal hemorrhage, 6.7% for hydrocephalus due to intracranial mass and 50% for infection-related hydrocephalus. When we examined the rate of revision surgery with the age at which V/P shunt surgery was performed, revision surgery was performed on 55 (34.6%) of 159 patients up to the age of 3 months, and 16 (18%) of 89 patients older than 3 months. The low rate of revision surgery in patients older than 3 months was found to be statistically significant (p=0.009).

23 (32.4%) of 71 patients who underwent revision surgery required 2 or more revision surgeries. The rate of undergoing 2 or more revision surgeries in patients who underwent shunt revision due to infection was 40%. This rate was 44.4% in distal catheter occlusion, 42.9% in subdural collection, 14.3% in shunt rupture, separation, migration, 66.7% in wound site problems, 75% in ventricular catheter misplacement, 33% in isolated ventricle formation, and 50% in abdominal pseudocyst. A second revision was not required in patients who underwent revision surgery due to ventricular catheter occlusion, short abdominal tip, and occlusion of the shunt valve (Table 3).

Table 3. Comparison of the first revision surgery and the need for additional revision

Causes of revisions	Number of revisions	2 or more revisions
Infection	15	6
Ventricular catheter occlusion	12	0
Distal catheter occlusion	9	3
Subdural collection	7	3
Shunt rupture, separation, migration	7	1
Wound problems	6	4
Misplacement of the ventricular catheter	4	3
Short abdominal tip	4	0
Isolated ventricles	3	1
Abdominal pseudocyst	2	1
Occlusion of the shunt valve	1	0

DISCUSSION

In studies conducted in various centers, revision rates range from 16% to 50% (5,6). In our study, our overall revision rate was found to be 28.6%, consistent with the literature (7). Shunt obstruction is among the most common causes of shunt dysfunction. There may be occlusion of the ventricular end, more often the abdominal end, and less frequently the valve. In our study, the most common cause was infection 21.4%, ventricular catheter occlusion the second most common cause 17.1%, and respectively distal catheter occlusion 12.9%, subdural collection (shunt over drainage) 10%, shunt rupture, separation, migration 10%, wound location problems were found 8.6%, ventricular catheter misplacement 5.7%, short abdominal tip 5.7%, isolated ventricles development 4.3%, abdominal pseudocyst

formation 2.9%, shunt valve obstruction 1.4%. When the literature is examined, there is no certain consensus on the reasons for revision. Sometimes the same situations can be expressed in different terms.

When we look at the rates of revision surgery with the age at which V/P shunt surgery was performed, 55 (34.6%) of 159 patients aged up to 3 months and 16 (18%) of 89 patients older than 3 months underwent revision surgery in our study. The low rate of revision surgery in patients older than 3 months was found to be statistically significant ($p=0.009$). These results were similar to Tervonen et al.'s study of 80 pediatric patients (8).

Prematurity and being underweight at the time of shunt placement are among the risk factors for shunt revision. It has been reported in various publications that being underweight increases the revision rate as the week of delivery decreases and shunt surgery is performed (9,10). In our study, children born prematurely and with low birth weight were compared with children born at term and with normal weight, and no significant results could be obtained. Patients who had a shunt within 3 months of birth were included in the group. We attribute the reason why this comparison is not similar to the literature because we used birth weight instead of the patient's weight during shunt surgery. Because in the study group, there are samples with low birth weight and normal weight at the time of surgery.

Shunt infection rates vary, but generally range from 4% to 17% (11,12). In our study, this rate was 6%; however, it was the most common reason for revision (21.4%). In the studies conducted, infection rates were found to be higher in the neonatal period. The reasons for this are that their immune systems are not sufficiently developed, their skin is thin, they have additional congenital malformations, their hospital stay is long, and their shunt dysfunction rates are high (13). In our study, when patients aged 3 months and younger are compared with those older than 3 months, the rate

of shunt infection is higher in patients younger than 3 months.

When we compared the rate of going to two or more revisions due to the first revision surgery, it was observed that the revision rates (66.7% and 75%, respectively) due to wound problems and incorrect placement of the ventricular catheter were higher than the other rates. In congenital hydrocephalus is a chronic disease and usually accompanied by additional diseases, it was thought that wound healing was impaired and therefore recurred. Since a hydrocephalic brain does not always have an anatomical appearance and may have an asymmetrical ventricular structure, revisions due to incorrect placement of the ventricular tip have been thought to have a high rate of revision.

There are various opinions regarding the timing of shunt surgery in patients with hydrocephalus associated with MMC. While MMC surgery and shunt surgery are said to be in the same session, as it shortens the hospital stay, it is said to reduce infection rates, while the other opinion is that a long-lasting surgery increases the risk of infection. It has been reported that infective pathology rates such as meningitis, ventriculitis and wound site problems will be less in V/P shunt surgeries performed in different sessions (14). In our study, the rate of revision in hydrocephalic patients who underwent V/P shunt due to MMC was compared with the shunt placed in the same session and the revision rates of the patients who needed shunt in later times. No significant difference was found in revision and infection rates when shunted patients were compared with the others in the same session.

When we examine the relationship between the first shunt surgery and revision surgery according to the reasons for the first revision surgery, it is observed that there is not much data in the literature in this sense. In our study, the mean time between subdural collection and ventricular catheter misplacement and revision

surgery was found to be 23.7 – 8.2 days, respectively. They are detected quite early compared to other revision causes. We attribute this to the fact that these complications can be revealed by CT seen in the post-operative period.

CONCLUSION

Hydrocephalus is an important health problem in terms of mortality and morbidity all over the world and in our country. Despite the increase in prenatal examination methods, it is still encountered at a significant rate in the newborn and pediatric age group.

The rates of revision surgery due to V/P shunt surgery in pediatric patients are still high, despite the development of diagnostic and treatment methods and many studies on it.

When the causes of revision surgery are examined, reasons such as infection, ventricular and distal catheter occlusion, subdural collection, mechanical problems of the shunt, wound site problems, and incorrect placement of the ventricular catheter is seen. Infection and ventricular catheter occlusion are among these causes. Remarkably, some of these causes are among preventable causes rather than the natural course of the disease.

Complication rates were found to be higher in patients younger than 3 months compared to other age groups. Although most V/P shunt surgeries are planned as an emergency, the timing of surgery is very important.

A significant portion of patients who underwent V/P shunt surgery due to hydrocephalus undergoes revision surgery of 2 or more. The most common causes of this condition include wound problems and incorrect placement of the ventricular catheter.

The fact that shunt surgery complications can be prevented keeps this issue up to date. Scientific studies on the causes of V/P shunt revision will be effective in preventing complications.

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