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Impact of previous abdominal surgery on shunt revision in pediatric ventriculoperitoneal shunt cases at a single center

Önceden geçirilmiş abdominal cerrahinin pediatrik ventrikülöperitoneal şant revizyonu üzerindeki etkisi: Tek merkezli bir çalışma

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ABSTRACT

BACKGROUND

The main problems encountered during postoperative follow-up after ventriculoperitoneal shunt surgeries are ventriculoperitoneal shunt malfunction and related complications. One of the reasons for malfunction is problems with the distal catheter. This study aimed to analyze pediatric cases and establish whether there is a link between a history of abdominal surgery and the need for shunt revision.

METHODS

We conducted a retrospective analysis of 138 pediatric patients who underwent surgery at our institution between 2010 and 2018.

RESULTS

In the first year postoperatively, 33.2% of the patients required shunt revision. Furthermore, we found a significant relationship between a history of abdominal surgery and the requirement for shunt revision ($p < 0.0001$). Additionally, the length of the proximal catheter inside the ventricles appeared to affect the need for shunt revision ($p < 0.001$).

CONCLUSION

Similar to other studies, we believe that our findings show that a history of abdominal surgery impacts the need for shunt revision. This contributes to existing literature on the topic.

KEYWORDS

Abdominal surgery, pediatric, shunt revision, ventriculoperitoneal shunt surgery

ÖZ

AMAÇ

Ventriküloperitoneal (VP) şant disfonksiyonu ve ilişkili komplikasyonlar, VP şant cerrahileri sonrası postoperatif takipte karşılaşılan başlıca sorunlardır. Şant disfonksiyonunun nedenlerinden biri distal katetere ilişkin sorunlardır. Bu çalışmada, çocuk hastalar retrospektif olarak analiz edilerek, önceden geçirilmiş abdominal cerrahinin şant revizyon ihtiyacıyla olası ilişkisi araştırılmıştır.

GEREÇ YÖNTEM

2010 ile 2018 yılları arasında kurumumuzda cerrahi müdahale geçirmiş 138 pediatrik hasta retrospektif olarak analiz edilmiştir.

BULGULAR

Ameliyat sonrası ilk yıl içinde hastaların %33,2'sinde şant revizyonu gerekmiştir. Önceden geçirilmiş abdominal cerrahi öyküsü ile şant revizyon gereksinimi arasında anlamlı bir ilişki bulunmuştur ($p < 0.0001$). Ayrıca, ventrikül içindeki proksimal kateter uzunluğunun da şant revizyonu üzerinde etkili olduğu saptanmıştır ($p < 0.001$).

SONUÇ

Bulgularımız, önceki çalışmalarla paralel olarak, abdominal cerrahi öyküsünün şant revizyon gereksinimi üzerinde etkisi olduğunu göstermektedir. Bu sonuç mevcut literatüre katkı sağlamaktadır.

ANAHTAR KELİMELER

Abdominal cerrahi, ventrikülperitoneal şant cerrahisi, pediatrik, şant revizyonu

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Despite its relatively high complication rate, ventriculoperitoneal (VP) shunt surgery is the gold standard for treating pediatric hydrocephalus (1-4). Mechanical and infectious complications persist despite advances in shunt material technology. The shunt malfunction rate in the pediatric population is 20–85% (5); this rate is lower in adults at 17–33% (6,7). The malfunction rate in the first year postoperatively is 30–50% (2, 8-11). The main causes of shunt malfunction are infection, overdrainage, and mechanical obstruction (disconnection, breakdown, or passage obstruction) (8,12).

Patients who have undergone VP shunt surgery may also experience gastrointestinal complications, including (i) abdominal pseudocyst formation, (ii) ascites, (iii) bladder perforation, and (iv) bowel-related complications (appendicitis, intestinal perforation, intestinal adhesions, anal extrusion of the peritoneal catheter, abdominal herniation, and migration of the distal end to the scrotal sac) (13,14).

However, no study has examined the impact of previous abdominal surgery on VP shunt revision rates. Intestinal adhesion after abdominal surgery is a natural process. However, its impact on the risk of shunt revision has not yet been clearly demonstrated. This retrospective study reviewed cases involving pediatric patients with VP shunts. Revisions made during follow-up and complications were analyzed in detail.

Materials and Methods

This study was approved by the ethics committee at our university. We examined all patients who underwent VP shunt placement between 2010 and 2018 and found 328 adult and pediatric patients. Patients >18 years old were excluded, and 138 pediatric cases were eventually included in this study. The demographics, type of hydrocephalus, history of abdominal surgery, duration of hospitalization and follow-up, location of the proximal catheter, complications, reasons for revision, number of shunt surgeries, and number of external ventricular drainage (EVD) surgeries were noted.

The senior neurosurgeon performed all pediatric procedures, and shunt placement was performed free hand, based on the bony landmarks and related measurements; no neuronavigation was used. Preferably, the parietal bone on the right side (if there was no previous surgical scar present) was used, and a burr hole was placed at a point 2–4 cm more cranially located than the Frazier point. The dura was opened cross-shaped, and epidural hemostasis was achieved. Then the proximal shunt catheter was sent as the length measured preoperatively by computed tomography (CT). A mini-laparotomy technique was used for the abdominal portion of the operation. All the patients received perioperative cefazolin as a prophylactic antibiotic.

The preoperative Evans ratio (ER) was calculated for all the patients (2). Postoperatively, we noted the placement of the proximal catheter and its length inside the ventricles. Intraoperative and postoperative complications were assessed, and the time to and reasons for revisions were noted. We then compared the revision rates between patients with and without previous abdominal surgery.

Statistical Package for Social Sciences version 22.0 (SPSS, Chicago, IL, USA) was used for statistical analysis. The mean and standard deviation (SD) were calculated, the t-test was used for group comparisons, and the Kaplan–Meier estimator was used to analyze the cumulative revision-free rates. The log-rank test was used to determine survival rates, and statistical significance was set at $p < 0.05$.

Results

All findings are summarized in Table 1. Of the 138 pediatric patients, 73 (52.9%) were female, and 65 (47.1%) were male. The mean age at diagnosis was 3.66±5.45 years. Additionly, the mean follow-up duration was 2.69±3.05 years. The mean time to revision surgery was 10.84±12.40 months, with 64 (46.4%) patients requiring this surgery.

During the first year postoperatively, 56 (33.2%) patients required shunt revision surgery. A statistically significant relationship was found between a history of abdominal surgery and the need for shunt revision ($p < 0.0001$) (Figure 1). Additionally, a proximal catheter length inside the ventricular system of <2 cm significantly impacted the requirement for shunt revision ($p < 0.001$). The calculated odds ratio values for a history of abdominal surgery and catheter length inside the ventricles were 3.36 (95% confidence interval (CI): 1.85–6.11) and 3.61 (95% CI: 1.75–7.44), respectively.

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Table 1. Patient demographics, postoperative CT findings and complications

	All patients	Patients with previous abdominal operation	Patients without previous abdominal operation
Gender			
Female	73(52.9%)	24(17.4%)	49(35.5%)
Male	65(47.1%)	19(13.8%)	46(33.3%)
Age of diagnosis (years)	3.66±5.45	3.74±5.44	3.63±5.49
Chiari Malformation	10(7.2%)	3(2.2%)	7(5.1%)
Previous operation for meningomyelocele	19(13.8%)	8(5.8%)	11(8%)
Previous operation for intracranial tumour	15(10.9%)	4(2.9%)	11(8%)
Hydrocephalus types			
Communicating	72(52.2%)	20(14.5%)	52(37.7%)
Idiopathic Normal Pressure	3(2.2%)	1(0.7%)	2(1.4%)
Posthemorrhagic	17(12.3%)	8(5.8%)	9(6.5%)
Obstructive	42(30.4%)	14(10.1%)	28(20.3%)
Benign Intracranial Hypertension	4(2.9%)	0	4(2.9%)
# of EVD surgeries (with revisions)	24(17.4%)	11	13
1	13(9.4%)	6(4.4%)	7(5.1%)
2	7(5.1%)	3(2.2%)	4(2.9%)
3	1(0.7%)	1(0.7%)	0(0.0%)
4	2(1.4%)	0(0.0%)	2(1.4%)
7	1(0.7%)	1(0.7%)	0(0.0%)
EVD duration (days)	16.04±19.17	19.81±25.81	12.84±11.76
# of VP shunt surgeries (with revisions)		43(31.2%)	95(68.8%)
1	71(51.4%)	2(1.4%)	69(50%)

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2	28(20.3%)	16(11.6)	12(8.7%)
3	20(14.5%)	14(10.1)	6(4.3%)
4	7(5.1%)	4(2.9%)	3(2.2%)
5	5(3.6%)	1(0.7%)	4(2.9%)
6	1(0.7%)	1(0.7%)	0(0.0%)
7	4(2.9%)	3(2.2%)	1(0.7%)
9	2(1.4%)	2(1.4%)	0(0.0%)
Duration of follow-up (years)	2.69±3.05	2.63±2.90	2.72±3.10
Exitus	10 (7.2%)	3(2.2%)	7(5.1%)
Preoperative Evans Ratio	0.46±0.13	0.44±0.11	0.46±0.14
Postoperative CT			
Optimal position (correct ventricle at foramen of Monroe level)	49(35.5%)	19(13.8%)	30(21.7%)
Tip crossed the midline towards the contralateral ventricle	50(36.2%)	14(10.1%)	36(26.1%)
Correct ventricle, tip not at foramen of Monroe level	34(24.6%)	8(5.2%)	26(18.8%)
Tip twisted	5(3.6%)	2(1.4%)	3(2.2%)
Proximal catheter, length inside the ventricle (cm)			
<1	10(7.2%)	2(1.4%)	8(5.8%)
1-<1.5	10(7.2%)	5(3.6%)	5(3.6%)
1.5-<2	13(9.4%)	4(2.9%)	9(6.5%)
>2	105(76.9%)	32(23.2%)	73(52.9%)
Complications			
Meningitis	7(5.1%)	5(3.6%)	2(1.4%)
Intraventricular hemorrhage	3(2.2%)	2(1.4%)	1(0.7%)
Subdural hematoma	2(1.4%)	1(0.7%)	1(0.7%)
Subdural hygroma	3(2.2%)	1(0.7%)	2(1.4%)

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Protrusion of the distal catheter from anus	2(1.4%)	2(1.4%)	0(0%)
Superior sagittal sinus injury	1(0.7%)	1(0.7%)	0(0%)
Peritonitis	3(2.2%)	1(0.7%)	2(1.4%)
Intraabdominal abscess	4(2.9%)	4(2.9%)	0(0%)
Mechanical complicaitons			
Proximal obstruction	15(10.9%)	5 (11.6%)	10(10.5%)
Distal obstruction	7(5.1%)	5(11.6%)	2(2.1%)
Proximal fracture	2(1.4%)	1(2.3%)	1(1.1%)
Distal fracture	2(1.4%)	2(4.7%)	0
Disconnection	19(13.8)	5(11.6%)	14(14.7%)
Intraperitoneal cyst	3(2.2)	2(4.7%)	1(1.1%)
Catheter migration	4(2.9%)	2(4.7%)	2(2.1%)
Lengtening required	2(1.4%)	2(4.7%)	0
No malfunction	5(3.6%)	4(9.3%)	1(1.1%)
Revision			
Yes	64(46.4%)	32(23.2%)	32(23.2%)
No	74(53.6%)	11(8%)	63(45.7%)
Time to revision (months)	10.84±12.40	11.41±13.08	10.29±11.88
< 1 month	10(7.2%)	6(9.2%)	4(6.2%)
1-6 months	26(18.8%)	12(18.5%)	14(21.5%)
6-12 months	10(7.2%)	3(4.6%)	7(10.8%)
12-24 months	6(4.3%)	5(7.7%)	1(1.5%)
> 24 months	13(9.4%)	6(9.2%)	7(10.8%)

Twenty-five patients experienced perioperative or postoperative complications. In one patient with Crouzon syndrome, the burr hole was unintentionally placed on the superior sagittal sinus. The resulting bleeding was controlled, and the surgery was completed using an alternative burr hole. However, the patient required 8 weeks of follow-up in the paediatric intensive care unit (pICU) after surgery. After this challenging and instructive complication, the use of intraoperative Doppler ultrasound in patients with cranial vault anomalies became standardpractice in our clinic. In two patients with a history of abdominal surgery, the distal catheter protruded through the anus. Mechanical complications were observed in 59 (42.8%) patients; the most common cause was disconnection (13.8%).

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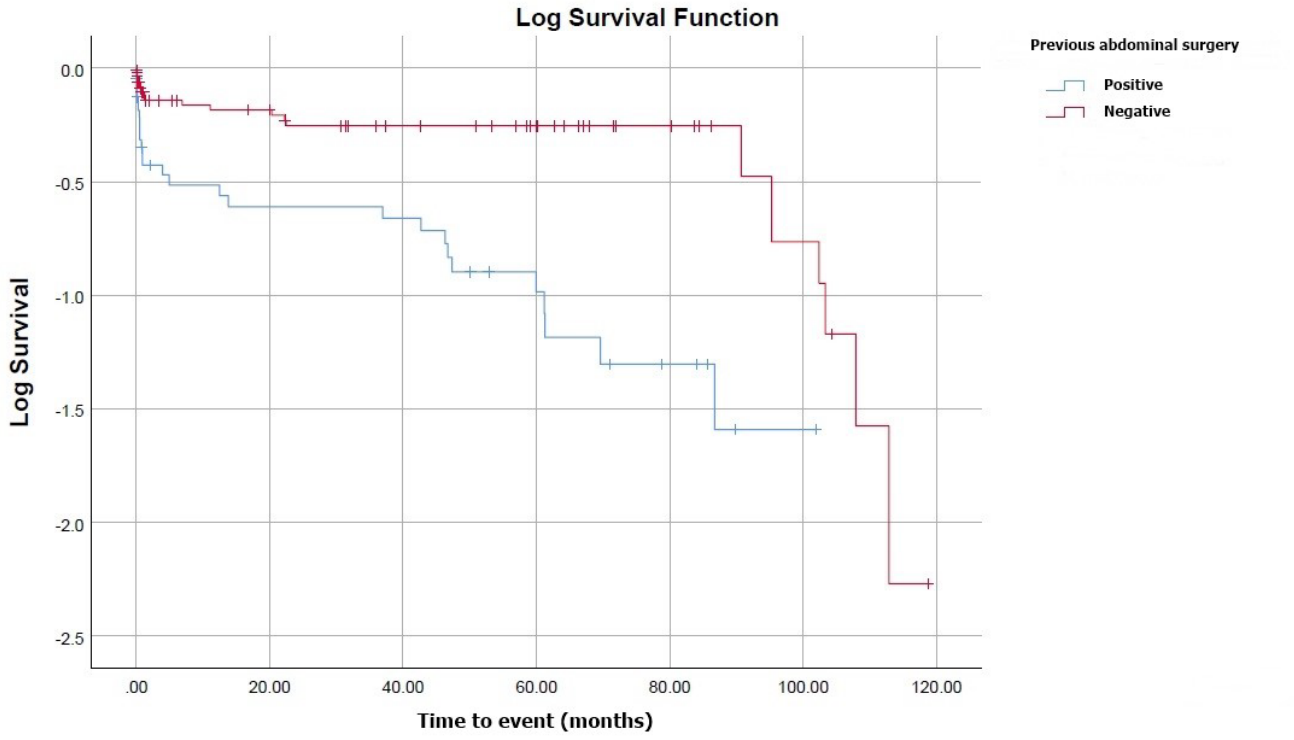


Figure 1. Kaplan-Meier estimator demonstrates time to event (shunt revision). Patients with a history of previous abdominal surgery are shown in blue, while those without are shown in red.

Discussion

Catheters placed during VP shunt surgery are intended to remain in place for the patient's lifetime. Thus, one of the main aims of the surgery is to prevent the need for any revision surgeries (2, 5, 12, 15). The factors affecting the need for revision surgeries have been widely studied. However, the impact of a history of previous abdominal surgery on revision rates has not been extensively investigated; this study retrospectively examined this topic. We also detail the reasons for the surgical revisions and complications.

The three main surgical options for distal catheter placement in VP shunt surgery are mini-laparotomy, laparoscopy, and percutaneous trocar-assisted techniques (16, 17). Possible technical complications include visceral perforation (within three months of surgery), extraperitoneal catheter positioning, distal obstruction, and pseudocyst formation (3). Risk factors for visceral perforation include younger age and the presence of meningomyelocele (18, 19).

Sefarinova et al. demonstrated that the percutaneous trocar-assisted technique carries a risk of abdominal visceral and vascular injury; however, they stated that there was no statistically significant difference between this technique and laparoscopy (3). Schucht et al. compared shunt malfunction rates in the laparoscopic and mini-laparotomy techniques. They found that the only difference was a higher rate of distal catheter malfunction in the mini-laparotomy group. The distal catheter malfunction rate in the mini-laparotomy group was 8%, whereas there were no cases of distal catheter malfunction in the laparoscopy group (1). No statistically significant difference was found when patients with a history of abdominal surgery were compared between the two groups

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(1). In our study, there was a statistically significant association between a history of abdominal surgery and the need for shunt revision ($p < 0.0001$). However, when focusing specifically on distal catheter malfunction as the cause of revision, this difference was not statistically significant. All patients who underwent revision surgery had laparotomy performed again; however, the placement was performed using a different muscular and fascial route within the same incision.

Correct placement of the ventricular catheter is the most important factor in achieving revision-free survival (20, 21). Wan et al. proposed a five-point grading system based on the length of the catheter inside the ventricle (2). A catheter with a length of >2 cm inside the ventricle was considered a perfectly placed. Ventricle size was the most important factor in ensuring the proximal catheter was perfectly placed in the ventricle (2). In our study, 76.9% of the proximal catheters were >2 cm inside the ventricles. Additionally, the calculated odds ratio for revision was 3.61 (95% CI: 1.75–7.44) if the catheter length inside the ventricle was <2 cm.

Stone et al. demonstrated no relationship between the etiology of hydrocephalus and shunt malfunction in their study of 64 pediatric patients and 234 procedures (22). Anderson et al. showed that 30-day shunt malfunction is related to the etiology of hydrocephalus in adult patients in a study of 321 pediatric and 362 adult patients. However, no significant relationship was found in the pediatric population, despite performing a multivariate analysis. A significant relationship was found between shunt malfunction and whether the surgery was primary or secondary, and whether it was performed by one or multiple surgeons (with secondary surgery and single surgeon being more likely to cause shunt malfunction) (23). Similarly, Rocque et al. found a relationship between the etiology of hydrocephalus and shunt malfunction in univariate analyses. However, they were unable to demonstrate this in multivariate analyses (24).

This study had some limitations. Due to the limited number of patients, the different types of surgeries that patients with a history of abdominal surgery had undergone could not be evaluated in detail. Additionally, it was unclear whether patients had experienced any postoperative surgical site infections.

Very few studies in the current literature have investigated the direct relationship between the length of the peritoneal (abdominal) end of the shunt and the risk of shunt dysfunction (25). Instead, most available reports focus on other factors associated with distal malfunction, such as catheter configuration, the position or patency of distal slit openings, peritoneal adaptation, the relative shortening of the distal catheter due to patient growth, and the formation of abdominal pseudocysts (26, 27, 28, 29).

However, based on the insights gained from the present study and the gaps identified in the existing literature, we plan to systematically record the length of the distal (abdominal) catheter in our future cases. We will also assess its potential influence on shunt function through a prospective study reflecting our own clinical experience. This approach could provide valuable data to clarify whether peritoneal catheter length has a measurable impact on distal complications and contribute to optimization of ventriculoperitoneal shunt placement techniques in the future.

Overall, VP shunt surgery is the first-line treatment for hydrocephalus. Although highly effective, it is associated with a variety of complications. Despite technological and patient care developments, the incidence rates of these complications are far from decreasing. Previous studies have described several of these complications (5, 8, 12). One of the predisposing factors for such complications is a history of abdominal surgery, which was studied in detail in this study. We found that a history of abdominal surgery and a catheter length of less than 2 cm inside the ventricle had the greatest impact on shunt revision rates. We conclude that a previous history of abdominal surgery in the pediatric population increases the risk of shunt failure and thus the need for shunt revisions.

Conclusion

Ventriculoperitoneal shunt malfunction is a common and challenging complication during the postoperative period. Among the various causes, problems related to the distal catheter play a significant role. Prompt recognition and resolution of these issues is essential for enhancing long-term outcomes and reducing the need for shunt revisions in pediatric patients.

Conflicts of interest and source of funding
None declared

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Ethical approval

This study was approved by the Ethics Committee of Dokuz Eylul University with the decision number 2018/21-04, dated August 9, 2018.

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