Pediatr Pract Res 2023; 11(3): 97-100
DOI: 10.21765/pprjournal.1326593

ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Effect of Ventricular Catheter Entry Point and Tip Location on Proximal End Occlusion: A Multicenter Study in Pediatric Patients

Ventriküler Kateter Giriş Noktasının ve Uç Konumunun Proksimal Uç Tıkanıklığı Üzerindeki Etkisi: Pediatrik Hastalarda Çok Merkezli Bir Çalışma

Burak Gezer[1], Mevlut Ozgur Taskapilioglu[2], Murat Zaimoglu[3], Tuba Moralı Guler[4], Gokmen Kahilogullari[3], Hakan Karabagli[1]

[1] Department of Neurosurgery, Faculty of Medicine, Selcuk University, Konya, Turkey
[2] Department of Neurosurgery, Faculty of Medicine, Bursa Uludag University, Bursa, Turkey
[3] Department of Neurosurgery, Faculty of Medicine, Ankara University, Ankara, Turkey
[4] Department of Neurosurgery, Faculty of Medicine, Karabuk University, Karabuk, Turkey

ABSTRACT

Aim: This multicenter study investigates the effect of entry point and shunt tip location on proximal Ventriculoperitoneal (VP) shunt dysfunctions.

Material and Method: The medical records of 51 pediatric patients who were hospitalized for proximal shunt dysfunction between 2010 and 2021 were retrospectively reviewed.

Results: The study did not find statistically significant importance in terms of proximal shunt occlusion regarding the entry site of the shunt and the location of the shunt tip. There were no significant differences in the entry sites of the proximal end based on age distribution. Gender distribution did not vary significantly according to the insertion site of the proximal end.

Conclusion: It is believed that factors such as the choroid plexus and ependymal reaction play a more significant role in proximal shunt occlusion. Our findings are consistent with previous studies and emphasize the importance of the choroid plexus and ependymal reaction in shunt dysfunction. The study did not observe significant associations between the entry site of the shunt, etiology of shunt dysfunction, location of the proximal end on CT scans, and the risk of shunt failure. However, the study has limitations, including its retrospective design and limited sample size. Future prospective studies with larger sample sizes are needed. This study provides a foundation for future research aimed at improving the long-term effectiveness of VP shunt treatment and reducing complications in pediatric patients.

Keywords: Proximal shunt dysfunctions, ventricular shunting, entry site

ÖZ

Amaç: Bu çok merkezli çalışma, giriş noktasının ve şant ucu konumunun proksimal ventriküloperitoneal (VP) şant disfonksiyonları üzerindeki etkisini araştırmaktadır.

Gereç ve Yöntem: 2010 ile 2021 yılları arasında şant disfonksiyonu nedeniyle hastaneye yatırılan 51 pediatrik hastanın tıbbi kayıtları geriye dönük olarak incelendi.

Bulgular: Çalışmamızda, ventriküloperitoneal şantın giriş noktası ve şant ucu konumunun, proksimal uç tıkanıklığı açısından istatistiksel olarak anlamlı bir önemi yoktu. Yaş dağılımına göre proksimal ucun giriş yerlerinde anlamlı fark yoktu. Proksimal ucun giriş yerine göre cinsiyet dağılımı anlamlı farklılık göstermedi.

Sonuç: Proksimal şant tıkanıklığında koroid pleksus ve ependimal reaksiyon gibi faktörlerin daha önemli bir rol oynadığı düşünülmektedir. Bulgularımız, önceki çalışmalarla uyumludur ve şant disfonksiyonunda koroid pleksus ve ependimal reaksiyonun önemini vurgulamaktadır. Çalışmamız şantın giriş noktası, şant disfonksiyonunun etiyolojisi, proksimal uçların BT taramalarındaki konumu ve şant başarısızlığı riski arasında anlamlı ilişkileri gözlemlemedi. Ancak, çalışmanın geriye dönük tasarımı ve sınırlı örneklem büyüklüğü gibi sınırlamaları bulunmaktadır. Gelecekte daha büyük örneklem büyüklüğüne sahip prospektif çalışmalara ihtiyaç duyulmaktadır. Bu çalışma, pediatrik hastalarda VP şant tedavisinin uzun vadeli etkinliğini artırmayı ve komplikasyonları azaltmayı amaçlayan gelecekteki araştırmalar için temel oluşturmaktadır.

Anahtar Kelimeler: Proksimal şant disfonksiyonu, Ventriküler şant, Giriş noktası

Corresponding Author: Burak GEZER
Address: Hospital of Selcuk University Medical Faculty, Department of Neurosurgery, E Block, 0. Floor, Selcuklu, KONYA, TURKEY
E-mail: dr.burakgezer@gmail.com

Başvuru Tarihi/Received: 18.07.2023
Kabul Tarihi/Accepted: 08.09.2023

INTRODUCTION

Ventriculoperitoneal (VP) shunt is a commonly utilized neurosurgical treatment method. Approximately 30,000 shunt surgeries are performed annually in the United States (1). It has been reported that VP shunt failure rates range from 10% to 50% within the first year after surgery (2-4). Numerous studies have indicated that complications are more prevalent in pediatric cases compared to adults (5, 6).

Proximal end occlusion stands as one of the most frequent complications associated with VP shunts (7, 8). Factors contributing to this complication include the type of shunt material, shunt placement and surgical techniques, as well as variables like infections and prolonged shunt use. A study exploring the theory that the proximal catheter might become occluded by brain parenchyma during insertion from the cortex to the ventricle found that protecting the catheter with a removable sheath did not reduce shunt occlusion rates(9). Another theory suggests that the proximal catheter might experience occlusion due to fragments of the choroid plexus when placed near the foramen of Monroe (10). The relationship between the location of the proximal catheter and shunt dysfunction has not been clearly established (10, 11).

The objective of this study is to investigate proximal end dysfunctions in VP shunts. The study examines the causes, symptoms, diagnosis, and treatment of proximal end occlusion. Additionally, our research assesses the potential relationship between the entry point of the shunt and the proximal catheter tip with proximal end occlusion.

MATERIAL AND METHODS

The study was carried out with the permission of Selçuk University Local Ethics Committee (Date: 01.08.2023, Decision No: 2023/374). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The medical records of pediatric patients who were hospitalized for shunt dysfunction between the years 2010 and 2021 at three medical centers, namely the Neurosurgery Departments of Bursa Uludag University, Ankara University, and Selcuk University, were reviewed. A total of 1387 pediatric patients who underwent shunt surgery were included in our study. Patients who required shunt revision due to proximal tip occlusion were included in the study, while those who underwent early surgery due to malposition or developed shunt occlusion related to slit ventricles were excluded. Demographic characteristics of the patients, etiology of the initial shunt placement, shunt type, concomitant diseases, time between the first surgery and revision, location of the proximal end observed in CT scans, detectable cause of dysfunction, and follow-up time were recorded. Patients with missing data in their medical files were excluded from the study. Informed consent forms were obtained from the parents or legal guardians of the patients.

Statistical analysis

The conformity of continuous variables to the normal distribution was examined using the Shapiro-Wilk test. Continuous variables using median (minimum: maximum) values; categorical variables were expressed as n(%). Kruskal Wallis and Mann-Whitney U tests were used for comparisons of continuous variables between study groups, in case the normal distribution was not observed according to the results of the normality test. Categorical variables were compared between groups using the Fisher Freeman Halton Test. SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.) program was used for statistical analysis, and type I error level was accepted as 5% in statistical analysis.

RESULTS

There were no significant differences in the entry sites of the proximal end based on age distribution (p=0.267). The median age at the time of surgery was 16.50 months for patients with proximal left occipital insertion, 8.50 months for those with proximal right occipital insertion, and 12 months for those with frontal insertion. Gender distribution did not vary significantly according to the insertion site of the proximal end (p=0.379) (**Table 1**).

Table 1: Comparison of proximal end entry site by demographic characteristics

	Entry point of proximal catheter			p value
	Left Occipital (n=10)	Right Occipital (n=36)	Frontal (n=5)	
Age at the time of surgery (months)	16,50 (0,10:175)	8,50 (0,40:112)	12 (4:14)	0,267[a]
Gender				
Female	5 (50%)	12 (33,30%)	3 (60%)	0,379[b]
Male	5 (50%)	24 (66,70%)	2 (40%)	

Data are expressed as median (minimum:maximum) and n(%). a: Kruskal-Wallis Test, b: Fisher Freeman Halton Test.

No significant differences were observed in the entry sites of the proximal end based on the etiology and distribution of myelomeningocele (p=0.691, p=0.347, respectively) (**Table 2**). Additionally, there were no significant differences between the groups in terms of the time to proximal end obstruction and its location on CT scans (p=0.785, p=0.673). The distribution of occlusion etiology also showed no significant differences between the entry sites of the proximal end (p=0.295). Similarly, no significant differences were found in the distribution of follow-up time based on the entry sites of the proximal end (p=0.641) (**Table 2**).

Table 2: Comparison of the proximal end's entry site and its location in the brain, and the variables indicating the non-operational status

	Entry point of proximal tip						p value
	n	Left Occipital	n	Right Occipital	n	Frontal	
Etiology							
Congenital Hydrocephalus	10	7 (70%)	35	22 (62.90%)	5	2 (40%)	0.691[b]
Meningitis, Trauma, Intracerebral Hemorrhage, MMC, Posterior Fossa Mass		2 (20%)		6 (17.10%)		2 (40%)	
Intraventicular Hematoma, Intraventricular Cystic Lesion		1 (10%)		7 (20%)		1 (20%)	
Myelomeningocele							
Yes	10	5 (50%)	36	9 (25%)	5	1 (20%)	0.347[b]
No		5 (50%)		27 (75%)		4 (80%)	
Time to proximal end obstruction (months)	10	8.50 (1:16)	36	8 (1:17)	5	9 (2:17)	0.785[a]
Location of the proximal end in CT							
Frontal	10	3 (30%)	35	6 (17.10%)	5	2 (40%)	0.673[b]
Monreo		4 (40%)		20 (57.10%)		2 (40%)	
Occipital		3 (30%)		9 (25.70%)		1 (20%)	
Obstruction Etiology							
Meningitis	10	7 (70%)	35	22 (62.90%)	5	3 (60%)	0.295[b]
Choroid Plexus		3 (30%)		8 (22.90%)		0	
Ventricular Hematoma, Malposition, Shunt Pump Failure		0		5 (14.30%)		2 (40%)	
Follow-up (months)	10	12.50 (5:16)	33	12 (3:18)	3	10 (2:13)*	0.641[c]

Data are expressed as median (minimum:maximum) and n(%). a:Kruskal-Wallis Test, b:Fisher Freeman Halton Test, c: Mann-Whitney U Test, *: In the group with frontal proximal insertion site, it was not included in the analysis due to insufficient number of data pertaining to the follow-up period (n=3)

DISCUSSION

We present the findings of a multicenter study that investigated proximal shunt malfunctions with the goal of identifying potential associations with shunt failure that could be addressed. The medical records of 51 pediatric patients who were hospitalized for shunt dysfunction between 2010 and 2021 were reviewed at three centers: Bursa Uludag University, Ankara University, and Selcuk University.

In our study, we did not observe any misplaced proximal catheters, although it is possible that some data were missing in this retrospective analysis. This finding is in line with the study by Jeremiah et al., who reported that the accuracy of ventricular catheter placement is a crucial factor in shunt failure (12).

Similarly, Dickerman et al. found no significant association between the placement of the proximal catheter away from the choroid plexus and a lower rate of shunt failure at six months in their study involving 117 shunt revisions (11). This study also did not reveal a relationship between the placement of the ventricular tip and shunt failure, in agreement with Dickerman et al. We attribute the significance of our study's findings to the importance of the choroid plexus in proximal shunt occlusion, as well as the significance of ependymal reaction. Therefore, there was no statistically significant importance in terms of proximal shunt occlusion regarding the entry site of the shunt and the location of the shunt tip.

In contrast, Farahmand et al. reported that right frontal placement of the ventricular catheter was associated with a significantly reduced risk of shunt occlusion within six months compared to occipital placement in their study involving 411 adult hydrocephalus cases (11). However, we did not find a relationship between the entry point of the shunt and the failure rate in our study.

Furthermore, Sampath et al. reported that stereotactic placement of the ventricular catheter was associated with decreased proximal malfunction rates (13). In our series, all shunts were placed using the freehand technique without the aid of ultrasound or navigation.

One of the main limitations of our study was the small sample size and retrospective design. Additionally, the evaluation of shunt valve types was not included. At times, it was not possible to determine the surgeons who performed the shunt insertions in these university clinics. Some studies have reported higher risks of shunt complications when operated on by inexperienced surgeons.

This study demonstrates that there is no relationship between etiology, the location of the proximal end in CT scans, the etiology of obstruction, and shunt failure. More detailed prospective studies with larger sample sizes are needed to further investigate and prevent shunt failure.

CONCLUSION

This multicenter study examined the proximal end dysfunctions of VP shunts in pediatric patients. We found that there was no statistically significant relationship between the entry site of the shunt and the location of the shunt tip in terms of proximal shunt occlusion. This suggests that factors such as the choroid plexus and ependymal reaction may play a more significant role in proximal shunt occlusion than the specific

placement of the shunt components. Our findings align with previous studies that have highlighted the importance of the choroid plexus and ependymal reaction in shunt malfunction. We did not observe any significant associations between the entry site of the shunt, etiology of shunt dysfunction, location of the proximal end in CT, and the risk of shunt failure. However, it is important to note that our study had limitations, including its retrospective nature and small sample size. Future prospective studies with larger sample sizes are needed to further investigate the factors influencing shunt failure.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Selçuk University Local Ethics Committee (Date: 01.08.2023, Decision No: 2023/374).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

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

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Bondurant CP, Jimenez DF. Epidemiology of cerebrospinal fluid shunting. Pediatr Neurosurg 1995;23(5):254-9.
2. Khan F, Rehman A, Shamim MS, Bari ME. Factors affecting ventriculoperitoneal shunt survival in adult patients. Surg Neurol Int 2015;6.
3. Wu Y, Green NL, Wrensch MR, Zhao S, Gupta N. Ventriculoperitoneal shunt complications in California: 1990 to 2000. Neurosurgery. 2007;61(3):557-63.
4. Stein SC, Guo W. Have we made progress in preventing shunt failure? A critical analysis. J Neurosurg Pediat 2008;1(1):40-7.
5. Reddy GK, Bollam P, Caldito G. Long-term outcomes of ventriculoperitoneal shunt surgery in patients with hydrocephalus. World neurosurgery. 2014;81(2):404-10.
6. Paff M, Alexandru-Abrams D, Muhonen M, Loudon W. Ventriculoperitoneal shunt complications: a review. Interdisciplinary Neurosurgery. 2018;13:66-70.
7. Mcclinton D, Carraccio C, Englander R. Predictors of ventriculoperitoneal shunt pathology. Pediatr Infect Dis J. 2001;20(6):593-7.
8. McGirt MJ, Buck DW, Sciubba D, et al. Adjustable vs set-pressure valves decrease the risk of proximal shunt obstruction in the treatment of pediatric hydrocephalus. Child's Nervous Syst 2007;23:289-95.
9. Kehler U, Langer N, Gliemroth J, et al. Reduction of shunt obstructions by using a peel-away sheath technique? A multicenter prospective randomized trial. Clin Neurol Neurosurg 2012;114(4):381-4.
10. Dickerman R, McConathy W, Morgan J, et al. Failure rate of frontal versus parietal approaches for proximal catheter placement in ventriculoperitoneal shunts: revisited. J Clin Neurosci 2005;12(7):781-3.
11. Farahmand D, Hilmarsson H, Högfeldt M, Tisell M. Perioperative risk factors for short term shunt revisions in adult hydrocephalus patients. J Neurol Neurosurg Psychiatry. 2009;80(11):1248-53.
12. Jeremiah KJ, Cherry CL, Wan KR, Toy JA, Wolfe R, Danks RA. Choice of valve type and poor ventricular catheter placement: Modifiable factors associated with ventriculoperitoneal shunt failure. J Clin Neurosci 2016;27:95-8.
13. Sampath R, Wadhwa R, Tawfik T, Nanda A, Guthikonda B. Stereotactic placement of ventricular catheters: does it affect proximal malfunction rates? Stereotact Funct Neurosurg 2012;90(2):97-103.