Journal of Health and Rehabilitation Research 2791-156X JHRR

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Original Article

Pre-Operative CSF Analysis as a Prognostic Factor for Shunt Infection in Children

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Conflict of Interest: None.

Farooqi YH., et al. (2024). 4(1): DOI: https://doi.org/10.61919/jhrr.v4i1.324

ABSTRACT

Background: Ventriculoperitoneal (VP) shunting is a common surgical intervention for pediatric hydrocephalus, yet it is frequently complicated by shunt infections, leading to significant morbidity and mortality. The role of intraoperative cerebrospinal fluid (CSF) sampling in predicting these infections remains unclear, with limited evidence available, particularly in the pediatric population.

Objective: To evaluate the efficacy of intraoperative CSF sampling as a prognostic tool for shunt infections in pediatric patients undergoing VP shunt procedures.

Methods: This prospective study was conducted at Jinnah Post Graduate Medical Centre and included 100 pediatric patients (60% female, 40% male) who underwent VP shunt placement from June to December 2022. Patients with previous cranial surgeries were excluded. Intraoperative CSF samples were analyzed for microbial presence. We assessed patient demographics, clinical conditions necessitating VP shunt, shunt type, and follow-up data, including shunt infection or malfunction incidents. The main outcome measured was the correlation between intraoperative CSF sampling results and subsequent shunt infections, defined as positive culture from CSF or hardware.

Results: During the 6-month follow-up, 20% of the patients required shunt revision, with 5% (5 patients) developing shunt infections. All intraoperative CSF samples were sterile. Infections were predominantly caused by coagulase-negative staphylococcus and occurred despite negative intraoperative CSF results. The infection rate among those who underwent revision was 25%.

Conclusion: The study indicates a lack of correlation between sterile intraoperative CSF samples and the subsequent development of shunt infections in pediatric patients. This finding challenges the necessity of routine intraoperative CSF sampling during VP shunt insertion in the pediatric population.

Keywords: Ventriculoperitoneal shunt, Pediatric hydrocephalus, Shunt infection, Intraoperative CSF sampling, Neurosurgery.

INTRODUCTION

Ventriculoperitoneal (VP) shunting, the principal surgical strategy for pediatric hydrocephalus, despite advancements in surgical technologies, continues to be fraught with complications such as obstruction, infection, mechanical failure, over drainage, and distal catheter site failures (1). Shunt infections in children are particularly alarming, linked to increased mortality and morbidity, reduced intellectual performance, and seizure occurrences, with reported incidences varying between 5% and 15% across different institutions. These infections are typically associated with the shunt insertion process, often due to colonization (2).

Intraoperative cerebrospinal fluid (CSF) sampling, commonly executed during VP shunt placement, has not been extensively studied, especially in the pediatric demographic, for its predictive value regarding future shunt infections or its efficacy in guiding antibiotic therapy. Despite numerous protocols in scientific literature targeting the reduction of shunt infections during insertion, most overlook the incorporation of intraoperative CSF sampling (3). An exception is the protocol by Sweeney et al., which included intraoperative CSF sampling to verify the absence of intraoperative inoculation and to confirm sterile techniques (4). However, even they acknowledged the unreliability of this method in forecasting future shunt infections. Interestingly, adult studies have found no correlation between intraoperative CSF sampling and postoperative CSF status in infection cases, casting further doubt on the utility of this practice in pediatric patients (3, 5).

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This study, therefore, aims to rigorously assess whether routine intraoperative CSF sampling plays a significant role in managing future shunt infections in children at our institution. This inquiry is particularly crucial as it addresses a gap in existing literature, providing insights into whether this common intraoperative practice effectively contributes to the prognosis and management of one of the most serious complications associated with VP shunting in the pediatric population. The findings of this study could potentially reshape current protocols and influence clinical decisions, enhancing patient outcomes in a vulnerable demographic (5, 6).

MATERIAL AND METHODS

In this study, we conducted a prospective analysis of 100 pediatric patients, all below the age of 16, who underwent ventriculoperitoneal (VP) shunt placement at Jinnah Post Graduate Medical Centre between June and December 2022. The cohort was carefully selected to include only those who had not undergone previous cranial surgeries, such as external ventricular drain placement or Ommaya reservoir insertion, ensuring a more homogenous study group and minimizing confounding factors (7, 8).

Patient demographics, the clinical condition necessitating the VP shunt procedure, shunt type, and the dates of VP shunt insertion and any subsequent infection or malfunction were meticulously recorded. In addition to these parameters, comprehensive laboratory data was gathered, and patients were followed up rigorously to track their postoperative progress (9).

The cornerstone of this study was the examination of intraoperative cerebrospinal fluid (CSF) sampling results and their potential correlation with subsequent diagnoses of shunt infections. For the purposes of this research, a shunt infection was stringently defined as a positive culture obtained from either the CSF, the hardware, or both. The patient diagnoses that led to the requirement for VP shunt insertion were methodically categorized into distinct groups: tumors, myelomeningocele (MMC), meningitis, intraventricular hemorrhage (IVH), congenital conditions, trauma, and aqueduct stenosis (9, 10).

Data collection was systematic and comprehensive, ensuring the inclusion of all relevant variables. The assessment of the data was carried out with meticulous attention to detail. For the statistical analysis, the data were analyzed using the SPSS software, version 25. This choice of software facilitated a robust and sophisticated analysis, allowing for a thorough exploration of the relationships between intraoperative CSF sampling results and shunt infections. The analysis was conducted in the past tense and in the third person to maintain objectivity and adhere to the standards of medical research reporting.

RESULTS

In the study, a total of 100 pediatric patients who underwent ventriculoperitoneal (VP) shunt placement were analyzed. The gender distribution within this cohort revealed a higher proportion of female patients, accounting for 60%, compared to 40% male patients. This gender distribution is reflective of the patient demographics presenting for VP shunt procedures in the observed period.

The underlying causes of hydrocephalus, necessitating the VP shunt placement, varied across the patient group. The most prevalent cause was tumors, which were responsible for hydrocephalus in 40% of the cases. This significant representation indicates the critical role of tumor-related hydrocephalus in pediatric neurosurgical practice. The second most common cause was myelomeningocele (MMC), accounting for 20% of the cases. This condition underscores the importance of neural tube defects as a contributing factor to hydrocephalus in children.

Meningitis was identified as the cause in 15% of the patients, highlighting infectious diseases as a notable contributor to hydrocephalus development. Intraventricular hemorrhage (IVH) and congenital conditions each were responsible for 10% of the cases. These causes point towards the varied etiologies, including both acquired and congenital factors, leading to the need for VP shunt insertion. Trauma was the least common cause, accounting for 5% of the cases, suggesting its relatively lower but still significant role in the development of hydrocephalus that requires surgical intervention.

Overall, these findings provide a comprehensive overview of the patient demographics and the diverse etiologies of hydrocephalus in the pediatric population undergoing VP shunt procedures. This diversity underscores the complex nature of pediatric hydrocephalus and the need for tailored approaches in its management.

Table 1 Demographics and Etiology of Hydrocephalus in Patients Undergoing VP Shunt Procedures

Demographics	Patient Number (n=100)
Gender	
Male	40
Female	60
Etiology of Hydrocephalus	

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Demographics	Patient Number (n=100)
Tumors	40
Myelomeningocele (MMC)	20
Meningitis	15
Intraventricular Hemorrhage (IVH)	10
Congenital Conditions	10
Trauma	5

DISCUSSION

In our study, we scrutinized the effectiveness of intraoperative cerebrospinal fluid (CSF) sampling during ventriculoperitoneal (VP) shunt insertion as a predictive tool for shunt infections in pediatric patients. The importance of early detection of shunt infections is well acknowledged in clinical practice, given its significant influence on neurological outcomes, patient survival, hospital stay duration, and associated healthcare costs (11, 12). Shunt infection is a prominent cause of shunt failure and contributes considerably to morbidity and mortality in these patients. The development of these infections is thought to be influenced by various factors, including patient demographics, etiology of hydrocephalus, shunt type, and the duration of the surgical procedure (13, 14).

Our analysis of 100 pediatric VP shunt procedures over a six-month follow-up period revealed a 5% infection rate. Interestingly, all CSF samples taken during surgery showed no signs of infection, which suggests a lack of correlation between intraoperative CSF sampling and subsequent shunt infections. This observation is in line with previous research conducted in adults, which also found no significant relationship between intraoperative CSF sampling and the development of shunt infections. Our findings challenge the current practice of routine CSF sampling during VP shunt insertion, raising questions about its necessity, especially considering the costs involved in CSF analysis and associated healthcare expenses (4, 15).

The study, conducted at a single institution, does have its limitations, notably the potential variability in patient selection due to the discretion of individual surgeons in performing intraoperative CSF sampling. Furthermore, a six-month follow-up, while substantial, may not be long enough to fully capture the incidence and timing of shunt infections. A more extended follow-up period could provide a deeper understanding of the relationship between intraoperative CSF sampling and shunt infections (16, 17).

Our research primarily focused on CSF culture results and white cell counts. Expanding the analysis to include other CSF parameters such as protein levels, glucose, or specific biomarkers could enhance the predictive value of intraoperative CSF sampling. This broader approach might provide more comprehensive insights into the early detection of potential infections.

In conclusion, our findings underscore the need for a more thorough investigation into the effectiveness of intraoperative CSF sampling as a predictive tool for shunt infections (18). While there are reservations about its reliability and cost-effectiveness, it is recommended to continue this practice until more conclusive evidence emerges (19, 20). This conservative approach aligns with current surgical protocols, ensuring patient safety while the medical community awaits further research (21). Such studies should aim to encompass a larger, more diverse cohort and potentially extend the follow-up period to definitively ascertain the utility of intraoperative CSF sampling in pediatric neurosurgery (2, 4, 5, 8, 11, 13, 21, 22).

CONCLUSION

In conclusion, our study highlights the questionable efficacy of intraoperative cerebrospinal fluid (CSF) sampling as a predictive tool for shunt infections in pediatric ventriculoperitoneal (VP) shunt procedures. Despite the established importance of early shunt infection detection, our findings indicate no significant correlation between sterile intraoperative CSF samples and the subsequent development of infections. These results challenge the routine practice of CSF sampling during VP shunt insertion, considering its associated healthcare costs and implications. However, given the limitations of our single-institution study and the variability in surgical practices, it remains prudent to uphold current protocols until more comprehensive research provides definitive guidance. This study underscores the need for further large-scale, prospective research to thoroughly assess the predictive value of intraoperative CSF sampling, with potential implications for revising surgical protocols to enhance patient outcomes and optimize healthcare resources in pediatric neurosurgery.

REFERENCES

1. Afshari FT, Elawadly A, Thompson DN, Jeelani OUN, Aquilina K. Transcallosal approach and post-operative subdural collections: 12-year paediatric neurosurgery tertiary centre experience. Child's Nervous System. 2023:1-6.

2. Campbell D, Sinclair S, Cooke D, Webster D, Reid M. The incidence of VP shunt infection in a middle-income nation: a retrospective analysis of a pediatric population. Frontiers in Surgery. 2023;10.
3. Chia WL, Zaben M, Leach P. Is cerebrospinal fluid sampling necessary at the time of first ventriculo-peritoneal shunt insertion in paediatric patients? Clinical Neurology and Neurosurgery. 2021;204:106608.
4. Sweeney J, Zyck S, Tovar-Spinoza Z, Krishnamurthy S, Chin L, Bodman A. Evidence-based perioperative protocol for ventriculoperitoneal shunt infection reduction at a single institution. World neurosurgery. 2019;128:e814-e22.
5. Dhaliwal J, Ruiz-Perez M, Mihaela-Vasilica A, Chari A, Hill CS, Thorne L. Survival and quality of life after CSF diversion in adult patients with leptomeningeal metastasis–associated hydrocephalus: a systematic review and meta-analysis. Neurosurgical Focus. 2023;55(2):E16.
6. Elmaghrabi MM, Arab AA, Samih TA, Elawady MA, Wahdan MM. Predictors of Endoscopy Success in Treatment of Pediatric Idiopathic Obstructive Hydrocephalus. The Egyptian Journal of Hospital Medicine. 2022;89(1):5123-8.
7. Enayet AE, Nabil M, Rady MR, Yousef Y, Badawy E, El Beltagy MA. Surgical outcome of children with medulloblastoma: a retrospective study of a 405-patient series from Children's Cancer Hospital Egypt (CCHE-57357). Child's Nervous System. 2021;37:1931-40.
8. Ganau M, Magdum SA, Calisto A. Pre-operative imaging and post-operative appearance of standard paediatric neurosurgical approaches: a training guide for neuroradiologists. Translational Pediatrics. 2021;10(4):1231.
9. Hale AT, Riva-Cambrin J, Wellons JC, Jackson EM, Kestle JR, Naftel RP, et al. Machine learning predicts risk of cerebrospinal fluid shunt failure in children: a study from the hydrocephalus clinical research network. Child's Nervous System. 2021;37:1485-94.
10. Hani U, Kamran Bakhshi S, Shamim MS. Permanent pre-operative cerebrospinal fluid diversion in paediatric patients with posterior fossa tumours. JPMA The Journal of the Pakistan Medical Association. 2020;70(6):1101.
11. Kalangu KK, Esene IN, Dzowa M, Musara A, Ntalaja J, Badra AK. Towards zero infection for ventriculoperitoneal shunt insertion in resource-limited settings: a multicenter prospective cohort study. Child's Nervous System. 2020;36:401-9.
12. McAlpine A, Sauve L, Collet J, Goldfarb D, Guest E, McDonald P, et al. Risk factors for cerebrospinal fluid shunt infections during an outbreak: a case–control study. Journal of Hospital Infection. 2020;105(1):78-82.
13. Pilotto C, Liguoro I, Scaravetti S, Passone E, D'Agostini S, Tuniz F, et al. Risk factors of persistent hydrocephalus in children with brain tumor: a retrospective analysis. Pediatric neurosurgery. 2021;56(3):205-12.
14. Rahman MM, Khan SKN, Khan RA, Islam R, Sarker MH. Endoscopic third ventriculostomy in children: problems and surgical outcome: analysis of 34 cases. Chinese Neurosurgical Journal. 2021;7(02):137-42.
15. Sáenz A, Badaloni E, Grijalba M, Villalonga JF, Argañaraz R, Mantese B. Risk factors for surgical site infection in pediatric posterior fossa tumors. Child's Nervous System. 2021;37(10):3049-56.
16. Verhey LH, Maharaj A, Patel N, Manoranjan B, Ajani O, Fleming A, et al. External ventricular drainage in the management of pediatric patients with posterior fossa tumors and hydrocephalus: a retrospective cohort study. Child's Nervous System. 2023:1-8.
17. Youssef EM, Rashed ME, Elsayed BM, El Sheikh MO. Management and Outcome Predictors of Pediatric Cerebrospinal Fluid Shunt Infections. The Egyptian Journal of Hospital Medicine. 2022;89(2):7363-71.
18. Jakimovski D, Bonci G, Attia M, Shao H, Hofstetter C, Tsiouris AJ, et al. Incidence and significance of intraoperative cerebrospinal fluid leak in endoscopic pituitary surgery using intrathecal fluorescein. World neurosurgery. 2014;82(3-4):e513-e23.
19. Zhou Q, Yang Z, Wang X, Wang Z, Zhao C, Zhang S, et al. Risk factors and management of intraoperative cerebrospinal fluid leaks in endoscopic treatment of pituitary adenoma: analysis of 492 patients. World neurosurgery. 2017;101:390-5.
20. Kaptain GJ, Kanter AS, Hamilton DK, Laws ER. Management and implications of intraoperative cerebrospinal fluid leak in transnasoseptal transsphenoidal microsurgery. Operative Neurosurgery. 2011;68:ons144-ons51.
21. Strickland BA, Lucas J, Harris B, Kulubya E, Bakhsheshian J, Liu C, et al. Identification and repair of intraoperative cerebrospinal fluid leaks in endonasal transsphenoidal pituitary surgery: surgical experience in a series of 1002 patients. Journal of Neurosurgery. 2017;129(2):425-9.
22. Lobo BC, Baumanis MM, Nelson RF. Surgical repair of spontaneous cerebrospinal fluid (CSF) leaks: a systematic review. Laryngoscope investigative otolaryngology. 2017;2(5):215-24.