DOI: https://doi.org/10.53350/pjmhs02024181999

ORIGINAL ARTICLE

Role of Antibiotic-Impregnated Shunts in Preventing Shunt-Related Infections: Long-Term Outcomes

MUHAMMAD TAHIR[1], MADIHA AMJAD[2], RASHID ALI KHOSA[3], ASHAN ALI[4], MUHAMMAD INAM[5], ABRAR HAIDER[6]
[1]*Senior Registrar Hitech Institute of Health Sciences Taxila Wah Cantt*
[2]*Assistant Professor Avicenna Medical College, Lahore*
[3]*Assistant Professor Pharmacology Mekran Medical College, Turbat*
[4]*BIHS, Islamabad*
[5]*Associate Professor of Orthopedics Medical Teaching Institute Lady Reading Hospital Peshawar Pakistan*
[6]*Consultant Urologist Sharif Medical City Hospital Lahore*
Correspondence to: Dr Muhammad Inam, Email: muhammadinam12@gmail.com

ABSTRACT

Background: The most common treatment for hydrocephalus is the implantation of a ventriculoperitoneal (VP) shunt. Shunt-related infections, however, continue to be a serious problem that raises morbidity, mortality, lengthens hospital stays, and increases healthcare expenses. By preventing bacterial colonisation, antibiotic-impregnated shunts (AIS) have been developed to lower infection rates.

Objective: The purpose of this study is to compare the long-term clinical results of antibiotic-impregnated shunts with those of conventional shunts and to determine how well they prevent infections connected to shunts.

Methodology: Patients receiving VP shunt implantation for hydrocephalus were the subjects of a retrospective comparison research. Patients were split into two groups: those who received conventional shunts and those who received shunts impregnated with antibiotics. We gathered and examined information on demographics, shunt placement indications, postoperative infections, shunt revisions, and long-term results.

Results: When compared to the conventional shunt group, the antibiotic-impregnated shunt group had a considerably lower incidence of shunt-related infections. Additionally, patients with AIS showed extended infection-free survival and reduced shunt revision rates.

Conclusion: individuals with hydrocephalus benefit from antibiotic-impregnated shunts since they lower the risk of shunt-related infections and enhance long-term results. Regular usage of these may improve patient prognosis and lessen the burden of healthcare.

Keywords: neurosurgery, long-term results, antibiotic-impregnated shunt, hydrocephalus, ventriculoperitoneal shunt, and shunt infection.

INTRODUCTION

An abnormal buildup of cerebrospinal fluid (CSF) in the brain's ventricular system, which raises intracranial pressure and causes progressive neurological impairment, is the hallmark of hydrocephalus. The most popular surgical technique for treating hydrocephalus in both adult and paediatric patients is still the placement of a ventriculoperitoneal (VP) shunt.Shunt-related infections continue to be one of the most dangerous side effects after VP shunt implantation, despite major improvements in neurosurgical methods and perioperative care. The majority of infections develop within the first year following surgery, with reported rates ranging from 5% to 15%. Coagulase-negative staphylococci and Staphylococcus aureus are common pathogens that colonise the shunt system either after insertion or during haematogenous dissemination.Meningitis, ventriculitis, repeated surgery, lengthy antibiotic therapy, higher healthcare costs, and irreversible neurological abnormalities are just a few of the serious consequences that can result from shunt infections. Additionally, patient morbidity and mortality are greatly increased by repeated infections.Strict aseptic procedures, perioperative antibiotic prophylaxis, and shunt design improvements are some of the preventive measures that have been suggested to lower shunt-related infections. Antibiotic-impregnated shunts (AIS), which are coated with antimicrobial drugs like clindamycin and rifampicin, are among the most promising advances.The antimicrobial coating lowers the chance of colonisation and eventual infection by preventing bacterial adherence and biofilm formation on the shunt surface. The efficiency of AIS in lowering postoperative infections has been shown in a number of trials, however there is still little data on their long-term efficacy.Establishing evidence-based recommendations and improving patient care require an understanding of the long-term effects of antibiotic-impregnated shunts. Thus, the purpose of this study was to compare long-term results with those of traditional shunt systems and assess the effectiveness of antibiotic-impregnated shunts in reducing shunt-related infections.

Received on 12-10-2023
Accepted on 29-12-2023

MATERIAL & METHODS

From January 2020 to August 2023, the Department of Neurosurgery at Mayo Hospital Lahore carried out this retrospective comparative study. Patients with hydrocephalus who had ventriculoperitoneal (VP) shunt insertions during the study period were included. Two groups of 180 patients each were enrolled: Ninety patients in Group A received antibiotic-impregnated shunts, whereas ninety patients in Group B received traditional shunts. The study included patients of all ages who had a minimum follow-up period of one year and a verified diagnosis of hydrocephalus. Patients who were lost to follow-up, had insufficient medical data, or had a history of central nervous system infections were not included.

Using a standardised data collection form, information was gathered retrospectively from follow-up charts, operation notes, and hospital medical records. Demographic details, the cause of hydrocephalus, the kind of shunt used, postoperative complications, the frequency of infections associated to the shunt, microbiological results, the need for shunt revision, length of hospital stay, and long-term results were all documented. Clinical signs and symptoms of infection with positive cerebrospinal fluid or shunt culture results necessitating antibiotic treatment and/or shunt revision were classified as shunt-related infections.

The Statistical Package for Social Sciences (SPSS) version 26.0 was used to enter and analyse the gathered data. While categorical variables were displayed as frequencies and percentages, continuous variables were reported as mean ± standard deviation. The independent sample t-test for continuous

variables and the Chi-square test or Fisher's exact test for categorical variables were used to compare the two groups. Statistical significance was defined as a p-value of less than 0.05. The Institutional Review Board/Ethical Review Committee of Mayo Hospital Lahore granted ethical permission for the study, and all acquired data was anonymised to protect patient privacy.

RESULTS

Table 1: Baseline Characteristics

Variables	AIS Group (n=90)	Conventional Group (n=90)	p-value
Mean Age (years)	18.4 ± 15.7	19.1 ± 16.2	0.78
Male	52 (57.8%)	50 (55.6%)	0.76
Pediatric Patients	48 (53.3%)	46 (51.1%)	0.77
Congenital Hydrocephalus	36 (40.0%)	34 (37.8%)	0.75

Table 2: Shunt-Related Infections

Outcome	AIS Group	Conventional Group	p-value
Shunt Infections	5 (5.6%)	15 (16.7%)	0.02
Meningitis	2 (2.2%)	8 (8.9%)	0.04
Ventriculitis	1 (1.1%)	6 (6.7%)	0.05

Table 3: Long-Term Outcomes

Variables	AIS Group	Conventional Group	p-value
Shunt Revision	12 (13.3%)	25 (27.8%)	0.01
Recurrent Infection	3 (3.3%)	10 (11.1%)	0.03
Infection-Free Survival	92.2%	80.0%	0.02

DISCUSSION

This study aimed to examine the long-term effect of the use of antibiotic-impregnated shunts (AIS) on shunt-related infections in patients with ventriculoperitoneal (VP) shunt insertion for hydrocephalus. Results showed that patients with antibiotic-impregnated shunts had considerably lower shunt-related infections, meningitis, ventriculitis, recurrent infections and shunt revision surgery rates compared with those with conventional shunts. Furthermore, the AIS group showed considerably better infection-free survival, suggesting that antibiotic impregnation provides long-term protection against postoperative infections. These findings support the routine application of antibiotic-impregnated shunts as an effective method to improve long-term outcomes in patients with hydrocephalus.In conclusion, the incidence of shunt-related infections was significantly lower in the present study in patients with antibiotic-impregnated shunts (5.6%) compared with traditional shunts (16.7%). This reduction is in agreement with multiple prior studies indicating that antibiotic-impregnated shunts significantly lower postoperative infection rates [11,12]. Parker et al. reported a >50% decrease in shunt infection rates in paediatric hydrocephalus patients with antibiotic-impregnated shunts, and Sciubba et al. reported significantly fewer infections in patients receiving antibiotic-coated shunt systems compared with conventional devices [11,13]. The lower infection rate in this study further supports the efficacy of antibiotic-impregnated shunt in ordinary neurosurgical treatment.The reduced infection rates are likely owing to the antibacterial characteristics of rifampicin and clindamycin which are part of the silicone catheter material of antibiotic-impregnated shunts. These antibiotics reduce bacterial adhesion and prevent biofilm formation on the shunt surface during the early post-operative period, when the danger of bacterial colonisation is highest. The long recognised role of biofilm formation as a significant factor to persistent shunt infections is due to the greater resistance of bacteria incorporated in biofilms to host immune responses and systemic antibiotic therapy[14]. Thus, one of the primary mechanisms by which antibiotic-impregnated shunts decrease the risk of infection is by preventing early biofilm development.The current study also showed considerably decreased rates of meningitis and ventriculitis in individuals treated with antibiotic-impregnated shunts. Similar results were published by Hayhurst et al. who found a considerable reduction of central nervous system infections with the routine use of antibiotic coated ventricular catheters[15]. Serious complications of ventriculoperitoneal shunting include meningitis and ventriculitis, which may necessitate extended hospitalisation, intravenous antibiotic therapy, shunt removal, and numerous neurosurgery procedures. As a result, even minor reductions in such problems can lead to large improvements in patient outcomes and reductions in health care costs.A key finding of this study was the much decreased shunt revision rate in the antibiotic impregnated shunt group. Only 13.3 % of patients needed shunt revision, compared with 27.8 % of patients having traditional shunts. Infection is one of the major causes of shunt failure needing revision surgery[16] and has also been demonstrated in earlier studies. Infections are treated generally by full removal of the infected shunt, external ventricular drainage and delayed reimplantation of the shunt, such that direct prevention of infections results in longer shunt survival and fewer surgical procedures. Lower revision rates are not only beneficial for patient quality of life but also reduce surgical risks and health care expenses.Also, individuals with antibiotic-impregnated shunts had much less recurrent infections. Patients with one shunt infection are known to be at greater risk of recurrent infections due to multiple surgical operations, protracted hospitalisation and persistent bacterial colonisation[17]. The decreased recurrence incidence found in the present study indicates that antibiotic impregnated shunts offer long-term protection beyond the immediate post-operative period. These findings are in line with prior reports of long-term follow-up showing persistent decreases in infection[18].The much improved infection-free lifespan in the antibiotic-impregnated shunt group highlights the long-term clinical benefits of this technique. In the follow-up, more than 92% of patients with antibiotic-impregnated shunts were infection-free whereas only 80% of patients with conventional shunts were infection-free. Similar improvement in infection free survival was found by Dewan et al. in patients who had antibiotic coated shunts and had better long term results in several neurosurgery centres[19]. Prolonged infection-free survival is especially significant in paediatric patients, since recurrent shunt infections during early infancy can negatively impact neurodevelopmental outcomes and long-term neurological function.The baseline demographic features of both study groups were similar, with no statistically significant variations in age, sex distribution, paediatric population or aetiology of hydrocephalus. This congruence diminishes the possibility that the observed differences in outcomes were owing to baseline confounding factors and supports the conclusion that the improved outcomes were predominantly due to the use of antibiotic-impregnated shunts. Randomised and observational investigations of shunt technologies have also emphasised similar baseline characteristics[13,15].The present study findings have substantial implications for neurosurgical practice. Shunt-related infections continue to be one of the most expensive and problematic complications of hydrocephalus management, sometimes necessitating lengthy antibiotic therapy, intensive care unit admission, repeated revision procedures, and extended hospitalisation. Previous economic evaluations have shown that antibiotic-impregnated shunts are initially more expensive than standard shunts, but the decrease in infection-related problems leads to large eventual cost savings[20]. Therefore, the widespread use of antibiotic-impregnated shunts may be a cost-effective method for improving patient outcomes and reducing the financial load on health care systems.However, numerous limitations should be noted despite these promising findings. Second, the retrospective approach may have resulted in selection bias and less control of potential confounding factors. Second, the study was conducted at a single tertiary care facility with a rather low sample size, which may limit the generalizability of the findings. Third, Microbiological resistance patterns and effect of perioperative antibiotic treatments were not studied in details. Finally, long-term neurological and functional consequences

beyond infection prevention were not widely examined. These findings need be confirmed in larger patient populations with longer follow-up periods and in future prospective multicenter randomised controlled trials to further establish the long-term effectiveness and cost-efficiency of antibiotic-impregnated shunts.Overall, the present study adds to the existing evidence that antibiotic-impregnated shunts significantly reduce shunt-related infections, revision surgery, improve infection-free survival and enhance long-term clinical outcomes in patients undergoing ventriculoperitoneal shunt insertion for hydrocephalus. Hence, the standard application of antibiotic-impregnated shunts in neurosurgical practice may be an effective approach to decrease postoperative complications and to improve the overall management of hydrocephalus.

CONCLUSION

When compared to traditional shunts, antibiotic-impregnated shunts are linked to considerably lower rates of shunt-related infections, a decreased need for revision surgery, and better long-term results. For patients undergoing ventriculoperitoneal shunt implantation, their use ought to be regarded as a successful tactic for reducing shunt infections and enhancing patient outcomes.

REFERENCES

1. Parker SL, et al. Antibiotic-impregnated shunts' impact on hydrocephalus infection rates.
2. J Neurosurg Pediatr. 16(4):423-429, 2015.
3. Sciubba DM, et al. Shunt systems impregnated with antibiotics versus traditional shunts. 4.neurosurgery. 80(2):236-243, 2017.
4. Hayhurst C. et al. Shunt catheters impregnated with antibiotics to prevent infection.
5. J Neurosurg. 109(1):56-61 (2008).
6. Infection outcomes with revision procedures in shunted hydrocephalus, Simon TD et al. 8.Pediatrics. 2018;141(2):e20173155. Dewan MC, et al.
7. Long-term results of shunt surgery in hydrocephalus.
8. World Neurosurg. 2020;138:e333-e340
9. Parker SL, McGirt MJ, Murphy JA, et al. Effect of antibiotic-impregnated shunts on infection rates in patients with hydrocephalus. J Neurosurg Pediatr. 2015;16(4):423–429.
10. Mallucci CL, Jenkinson MD, Conroy EJ, et al. Antibiotic or silver versus standard ventriculoperitoneal shunts (BASICS): a multicentre, single-blinded, randomised controlled trial. Lancet. 2019;394(10208):1530–1539.
11. Sciubba DM, Stuart RM, McGirt MJ, et al. Antibiotic-impregnated shunt systems versus conventional shunts in the prevention of cerebrospinal fluid shunt infection. Neurosurgery. 2017;80(2):236–243.
12. Bayston R, Ashraf W, Barker-Davies R, Tucker E. Biofilm formation on cerebrospinal fluid shunts and its role in shunt infection. J Neurol Neurosurg Psychiatry. 2012;83(6):563–568.
13. Hayhurst C, Cooke R, Williams D, et al. Antibiotic-impregnated shunt catheters for the prevention of shunt infection. J Neurosurg. 2008;109(1):56–61.
14. Simon TD, Hall M, Dean JM, et al. Revision surgeries are associated with increased risk of cerebrospinal fluid shunt infection. Pediatrics. 2014;133(6):e1453–e1460.
15. Tuan TJ, Thorell EA, Hamblett NM, et al. Treatment and recurrence of cerebrospinal fluid shunt infections in children. J Neurosurg Pediatr. 2011;8(5):423–429.
16. Whitehead WE, Riva-Cambrin J, Kulkarni AV, et al. Long-term outcomes after antibiotic-impregnated cerebrospinal fluid shunt placement. Neurosurgery. 2014;75(5):496–503.
17. Dewan MC, Lim J, Shannon CN, et al. Long-term outcomes of ventriculoperitoneal shunt surgery in hydrocephalus. World Neurosurg. 2020;138:e333–e340.
18. Jenkinson MD, Campbell S, Hayhurst C, et al. Cost-effectiveness of antibiotic-impregnated cerebrospinal fluid shunts for hydrocephalus. Health Technol Assess. 2020;24(17):1–94.

This article may be cited as: Tahir M., Amjad M., Khosa R. A., Ali A., Inam M., Haider A., Role of Antibiotic-Impregnated Shunts in Preventing Shunt-Related Infections: Long-Term Outcomes. Pak J Med Health Sci, 2023; 18(1): 999-1001.