

ORIGINAL ARTICLE

Efficacy of Prophylactic Use of Ceftriaxone and Flucloxacillin Combination Therapy to Prevent Early Infection in Ventriculoperitoneal Shunt Surgery: A Randomized Controlled Trial

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ABSTRACT

Shunt infection is a dangerous complication of ventriculoperitoneal (VP) shunt surgery. Many factors have been identified, which causes shunt infection. Prophylactic antibiotics have been used for prevention of early shunt infection. A prospective, randomized controlled trial (RCT) was conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), between July 2008 and May 2010, to compare the efficacy of the combination of ceftriaxone and gentamicin with the combination of ceftriaxone and flucloxacillin in prevention of early infection in ventriculoperitoneal shunt surgery. A total of 30 patients were selected. Patients with preoperative fever or any other focus of infection, other medical problems e.g., diabetes mellitus, valvular heart disease, renal impairment and ruptured meningocele were excluded from the study. Patients who had previous cerebrospinal fluid (CSF) diversion surgery, e.g., endoscopic third ventriculostomy (ETV), external-ventricular drains (EVD), were also excluded from the study. They were further divided into two groups having 15 patients in each group. Control group (group A) received the combination of ceftriaxone and gentamicin. Case group (group B) received the combination of ceftriaxone and flucloxacillin. Indications of surgery were same for the both groups. In all patients, we used Chhabra slit n spring VP (Ventricular Peritoneal) shunt system (medium pressure) (made by the G. Surgiwear Ltd., Uttar Pradesh, India). All patients were given injectable (intravenous) antibiotics from the same manufacturer. Then they were followed up daily for infection for two weeks after the surgery. The patients aged between 2 months and 65 years, with a mean age of 19.9 years. Male-female ratio was 2:1. Out of the 30 patients, 7(23.3%) patients developed VP shunt infections. Out of them, 6 patients (in group A) received the combination of injection ceftriaxone and gentamicin, while only 1 received (in group B) the combination of injection ceftriaxone and flucloxacillin. The combination of ceftriaxone and flucloxacillin showed better prophylaxis in comparison to the combination of ceftriaxone and gentamicin ($p < 0.05$).

Keywords: Antibiotics, combination therapy, hydrocephalus, prophylaxis, ventriculoperitoneal shunt, shunt infection

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INTRODUCTION

Hydrocephalus is defined as an abnormal enlargement of the ventricles due to an excessive accumulation of CSF from a disturbance of its flow, absorption or, uncommonly, secretion^{1,2}. Hydrocephalus is one of the most common clinical conditions affecting the central nervous system, with an incidence of three to four per 1000 births for congenital hydrocephalus.

However, with the advent of shunt surgery these children can be assured of a near normal neurological development³. Ventriculoperitoneal (VP) shunt is a procedure of transporting the excess cerebrospinal fluid (CSF) from the ventricular system to the peritoneal cavity by placing a tube in the lateral ventricle and the other end at the peritoneal cavity⁴. This procedure has dramatically reduced the morbidity and mortality

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rates associated with hydrocephalus.

However, shunt infection is the common cause of failure of ventriculoperitoneal shunt surgery, with a reported incidence of 5%-15%^{3,5-8}. In Tanzania, the shunt infection rate is reported to be about 24.6%⁹. Shunt infection is associated with increased risk of seizure disorder, decreased intellectual performance, and a 2 fold increase in the long term mortality rate⁵. The organisms commonly causes shunt infections are *staphylococcus aureus*, coagulase negative *staphylococcus species*, Gram negative rods, and *enterococcus faecalis*^{5,6,10}. However, little is known regarding the optimal treatment of ventriculoperitoneal (VP) shunt infections in our country. Hence, this clinical study aims to compare the efficacy of the combination of ceftriaxone and flucloxacillin with the combination of ceftriaxone and gentamicin as prophylactic antibiotics in prevention of early shunt infection.

METHODS

This prospective, randomized controlled trial (RCT) was conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), between July 2008 and May 2010. Patient of any age requiring ventriculoperitoneal shunt surgery were included in the study. All patients with ventriculomegaly in imaging and signs of hydrocephalus undergoing ventriculoperitoneal shunt surgery were included in the study. Patients with preoperative fever or any other focus of infection, other medical problems e.g., diabetes mellitus, valvular heart disease, renal impairment and ruptured meningocele were excluded from the study. Patients who had previous cerebrospinal fluid (CSF) diversion surgery, e.g., endoscopic third ventriculostomy (ETV), external-ventricular drains (EVD), were also excluded from the study. Finally, a total of 30 patients were selected for the study aged between 2 months and 65 years. They were randomly divided into two groups; 15 patients were in each group. The control group (group A) received combination of injectable ceftriaxone and gentamicin, while the case group (group B) received the combination of injectable ceftriaxone and flucloxacillin. Every alternate patient was selected for either control or case group, and given antibiotic regimen accordingly and followed up for a period of two weeks after VP shunt surgery had done.

In all patients, we used Chhabra slit n spring ventricular peritoneal (VP) shunt system (medium pressure) (made by the G. Surgiwear Ltd., Uttar Pradesh, India). All patients were given injectable (intravenous) antibiotics from the same manufacturer. The prophylactic antibiotics were administered during the induction of general anaesthesia and continue up to 72 hours following surgery and until switching to suitable oral antibiotics. All antibiotics were given in adequate doses.

Shunt infection was defined, if at least one of the following criteria was present:

- 1) Presence of non-remitting fever in the absence of other causes;
- 2) Indication of infection along the shunt tract or incision site; and
- 3) Signs of meningeal irritation or peritonitis.

For data collection, a structured questionnaire and patient record forms were used. Detailed history of the condition was taken. General and neurological examination and imaging studies were done. Daily clinical notes were kept and analyzed to find out infection. Temperature chart was maintained every day. Complete blood count was done, if temperature was high.

After collection, data was checked for omission, inadequacy and inconsistency. Omission was corrected by re-taking history or re-examining the patient. Irrelevant and inconsistent data was discarded. Then data was analyzed using SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, IL, USA). Data was expressed as frequency and percentage. Pearson's Chi-square test was used for comparison. Statistical significance was set at $p < 0.05$.

RESULTS

The minimum age of shunt insertion was 2 months and the maximum age was 65 years, with a mean age of 19.90 years. The number of patients from 0–2 years were 8 patients (3 in control group A and 5 in case group B). In the 2–12 years age group, the total was 6 (4 in group A and 2 in group B). In the 12–30 years age group, the total patients were 4 (1 in group A and 3 in group B). 5 patents were in the 30–50 years age group (3 in group A and 2 in group B). In the >50 years age group, the total was 7 (4 in group A and 3 in group B). Regarding

gender, 20 patients were male and 10 patients were female; male-female ratio was 2:1. Of them, in the group A, 11 patients were male and 4 were female, while in the group B, 9 patients were male and 6 patients were female (Table 1). A total of 7 patients had shunt infections, along with persisting fever (6 were in group A and 1 in group B). Of them, 5 had surgical site infections (4 were in group A and 1 in group B). Shunt tract infections were observed in 3 patients in group A and only 1 patient in group B. Skin necrosis occurred in 1 patient of group B. Neck rigidity was found in 1 patient of group A. Peritonitis developed in 2 patients (1 patient in each group) (Figure 1). Regarding VP shunt infections, the total number of patients in 0–2 years age group was 2 (in group A), and in the 2–12 years age group also 2 (in group A). In the 12–30 years age group, the total patients were 2 (1 in each group). 1 patient was in the 30–50 years age group (in group A). However, in the >50 years age group, no patient had shunt infection (Table 2). A total of 6 patients in group A and only 1 patient in group B had VP shunt infection; the difference between two groups was statistically significant ($p < 0.05$) (Table 3).

Table 1: Demographic distribution of the patients (N=30)

Variables	Frequency		Total
	Group A Control (n=15)	Group B Case (n=15)	
Age group (in years)			
0–2	3	5	8
2–12	4	2	6
12–30	1	3	4
30–50	3	2	5
>50	4	3	7
Gender			
Male	11	9	20
Female	4	6	10

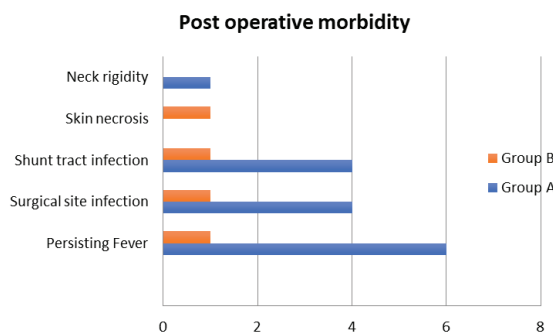


Figure 1: Distribution of the patients by postoperative morbidities (N=30)

Table 2: Age distribution of the patients with shunt infections (N=7)

Age group (in years)	Frequency	
	Group A Control (n=6)	Group B Case (n=1)
0–2	2	0
2–12	2	0
12–30	1	1
30–50	1	0
>50	0	0

Table 3: Comparison of the patients with and without shunt infections (N=30)

Groups	Frequency	
	Present	Absent
Group A Control (n=15)	6 (40.0%)	9 (60.0%)
Group B Case (n=15)	1 (6.67%)	14 (93.3%)
Total	7 (23.3%)	23 (76.7%)

$\chi^2=4.845, df=1; p < 0.05.$

DISCUSSION

In our study, most of the patients of shunt infection were less than two years old with a slight male dominance. This is also congruent with other studies^{11,12}. The following are most important clinical features of shunt infection: general malaise, pyrexia, headaches, vomiting, neck stiffness, abdominal tenderness or distension, recurrent lower end shunt obstruction, occasionally pain and erythema around the shunt¹³. In our study most common symptom was fever. In the present study, the rate of shunt infection is about 23.33%. In our center the shunt surgery was done as emergency procedure in 83.33% cases. The infection rate is little higher than other studies¹⁴⁻¹⁶.

There is no consensus about using prophylactic antibiotics. Different authors used different antibiotics. These were IV Penicillin and flucloxacillin¹¹, intravenous methicillin or penicillin¹², IV nafcillin or vancomycin⁵, IV ceftriaxone and ceftazidime¹⁵, IV cloxacillin or oxacillin¹⁴, gentamicin intraventricularly at surgery thereafter IV vancomycin¹⁷. Vancomycin is also recommended as prophylactic by many authors^{18,19}. prophylactic antibiotics reduce shunt infection²⁰⁻²². Shunt infection is caused by staphylococcal species especially *Staphylococcus epidermidis*, followed by *Staphylococcus aureus*, and it is responsible for two thirds of the infection^{23,24}. Shunt infection is very much troublesome for the patient. This results in fever, headache, vomiting, increased hospital stays, CSF leak and partial or complete removal of shunt²⁵⁻²⁷. Therefore, combination of antibiotics remains a good choice^{15,18,28}. Hence, evidence showed that the choice of prophylactic antibiotic is very much debatable. The route as well as the control group also differs among different investigators. We had selected injection ceftriaxone i.v. in both groups, but added injection gentamicin i.v. in control group and injection flucloxacillin i.v. in case group.

In this study, 6 patients in control group had shunt infection, which was 40% for the group. In the total sample, this was about 20% of overall shunt infection. On the other hand, in the case

group, only 1 patient had shunt infection. This was 6.7% of the case group and only 3.3% of the total sample. The difference between the groups was statistically significant ($p < 0.05$). The overall shunt infection was 23.3% in this study.

Our study has limitations. A small sample from a single centre in a specific region may not be able to represent the true picture of the whole country. Therefore, further studies with larger samples selected from different regions of the country are warranted.

CONCLUSION

Empiric antibiotic regimen leads to quality, standardized care for common infectious diseases by helping physicians select an initial therapy for a variety of infections. However, the prophylactic antibiotics are one of the mainstays in the prevention of infection in ventriculoperitoneal shunt surgery. Therefore, from the results of this study, we may conclude that using the combination of ceftriaxone and flucloxacillin (as i.v. injection) as prophylactic antibiotics may prevent the early shunt infection following ventriculoperitoneal shunt surgery. In Bangladesh, using an effective but relatively cheap antibiotic regimen can help the patients and their family as well as the healthcare system.

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Ethical approval: The study was approved by the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. Written informed consent was obtained from each adult patient and from the legal guardians/caregivers for minor patients. Assents were also sought from the minor patients, where applicable.

Authors' contribution: Conceptualization and design of the study: K Haroon, KK Barua; patient selection, data collection, compilation and analysis; K Haroon, T Taher, MS Alam; supervision of the study: KK Barua; manuscript preparation, editing and final submission: K Haroon, KK Barua, T Taher, MS Alam.

REFERENCES

- Kaye AH. Raised intracranial pressure and hydrocephalus. In: *Essential Neurosurgery*. 3rd ed. Malden, MA USA: Blackwell Publishing Ltd.; 2005. p.27-39.
- Lindsay KW, Bone I. Hydrocephalus. In: Lindsay KW, Bone I, Fuller G. eds. *Neurology and Neurosurgery Illustrated*. 5th ed. Edinburgh, UK: Churchill Livingstone; 2010. p.374-7.
- Ahmed A, Sandlas G, Kothari P, Sarda D, Gupta A, Karkera P, et al. Outcome analysis of shunt surgery in hydrocephalus. *J Ind Assoc Pediatr Surg*. 2009;14(3):98-101.
- Guevara J, Zijccaro G, Trevisan A, Denoya C. Bacterial adhesion to cerebrospinal fluid shunts. *J Neurosurg*. 1987;67:438-45.
- McGirt MJ, Zaas A, Fuchs HE, George TM, Kaye K, Sexton DJ. Risk Factors for pediatric ventriculoperitoneal shunt infection and predictors of infectious pathogens. *Clin Infect Dis*. 2003;36(7):858-62.
- Drake JM, Iantosca MR. Cerebrospinal fluid shunting and management of paediatric hydrocephalus. In: Schmidek HH, Roberts DW. eds. *Schmidek and Sweet Operative Neurosurgical Techniques: Indications, Methods, and Results*. 5th ed. Philadelphia, PA, USA: Saunders Elsevier; 2006. p.488-99.
- Bokhary MA, Kamal H. Ventriculo-peritoneal shunt infections in infants and children. *Libyan J Med*. 2008;3(1):20-2.
- Simon TD, Hall M, Riva-Cambrin J, Albert JE, Jeffries HE, Lafleur B, et al. Infection rates following initial cerebrospinal fluid shunt placement across pediatric hospitals in the United States. Clinical article. *J Neurosurg Pediatr*. 2009;4(2):156-65.
- Kinasha A, Kahamba J, Semali I. Complications of ventriculoperitoneal shunts in children in Dar es Salaam. *East Central Afr J Surg*. 2005;10(2):55-9.
- Conen A, Walti LN, Merlo A, Fluckiger U, Battagay M, Trampuz A. Characteristics and treatment outcome of cerebrospinal fluid shunt-associated infections in adults: a retrospective analysis over an 11-year period. *Clin Infect Dis*. 2008;47(1):73-82.
- Choksey MS, Malik IA. Zero tolerance to shunt infections: can it be achieved? *J Neurol Neurosurg Psychiatr*. 2004;75(1):87-91.
- George R, Leibrock L, Epstein M. Long-term analysis of cerebrospinal fluid shunt infections: a 25-year experience. *J Neurosurg*. 1979;51(6):804-11.
- Pople IK. Hydrocephalus and shunts: what the neurologist should know. *J Neurol Neurosurg Psychiatr*. 2002;73(suppl 1):i17-i22.
- Choux M, Genitori L, Lang D, Lena G. Shunt implantation: reducing the incidence of shunt infection. *J Neurosurg*. 1992;77(6):875-80.
- Malomo A, Adeolu A, Odebo T, Komolafe E, Shokunbi M. Prospective comparative trial of ceftriaxone versus ceftazidime as prophylactic perioperative antimicrobials in neurosurgery. *East Central Afr J Surg*. 2007;12(1):89-92.
- Kulkarni AV, Drake JM, Lamberti-Pasculli M. Cerebrospinal fluid shunt infection: a prospective study of risk factors. *J Neurosurg*. 2001;94(2):195-201.
- Ragel BT, Browd SR, Schmidt RH. Surgical shunt infection: significant reduction when using intraventricular and systemic antibiotic agents. *J Neurosurg*. 2006;105(2):242-7.
- Dawod J, Tager A, Darouiche RO, Al Mohajer M. Prevention and management of internal cerebrospinal fluid shunt infections. *J Hosp Infect*. 2016;93(4):323-8.
- Alnaami I, Aldehri M, Bahatheq A. Antibiotic prophylaxis and infection risk in pediatric ventriculoperitoneal shunt surgery: a systematic review and meta-analysis. *Eur J Pediatr*. 2026;185(3):153.
- Arts SH, Boogaarts HD, van Lindert EJ. Route of antibiotic prophylaxis for prevention of cerebrospinal fluid-shunt infection. *Cochrane Database Syst Rev*. 2019;6(6):CD012902.
- Ganesh VL, Garg K, Tandon V, Borkar SA, Satyarthi GD, Singh M, et al. Effect of topical and intraventricular antibiotics used during ventriculoperitoneal shunt insertion on the rate of shunt infection-a meta-analysis. *Acta Neurochir (Wien)*. 2022;164(7):1793-1803.
- Akbaş RA, Gündeşlioğlu ÖÖ, Ünal A, Oktay K, Akbaba M, Özlü F. Evaluation of ventriculoperitoneal shunt infections and risk factors in children. *Childs Nerv Syst*. 2024;40(12):4145-52.
- Simon TD, Schaffzin JK, Podkovik S, Hodor P. Cerebrospinal fluid shunt infections. *Infect Dis Clin North Am*. 2024;38(4):757-75.
- Moussa WM, Mohamed MA. Efficacy of postoperative antibiotic injection in and around ventriculoperitoneal shunt in reduction of shunt infection: a randomized controlled trial. *Clin Neurol Neurosurg*. 2016;143:144-9.
- Shah AS, Singh D, Singh H, Loomba P. Analyzing ventriculoperitoneal shunt infections: insights from institutional data. *Egypt J Neurosurg*. 2025;40(1):158.
- de Souza DN, Palla A, Yan RE, Grin EA, Farid M, Eremiev A, et al. Factors affecting infection risk and revision rates in shunted pediatric hydrocephalus: 10 years of data from a single academic center. *Childs Nerv Syst*. 2025;41(1):1-3.
- Tamber MS, Klimo P, Mazzola CA, Flannery AM. Pediatric hydrocephalus: systematic literature review and evidence-based guidelines. Part 8: management of cerebrospinal fluid shunt infection. *J Neurosurg Pediatr*. 2014;14(Suppl 1):60-71.
- Akram Asif A, Mahmood K, Riaz S, McHugh T, Sultan S. Bacterial ventriculoperitoneal shunt infections: changing trends in antimicrobial susceptibility, a 7-year retrospective study from Pakistan. *Antimicrob Resist Infect Control*. 2023;12(1):75.