(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 6, Issue 6 , Page No: 565-569
November-December 2023

IJMSCR

Evaluation Of Risk Factors Associated with Central Nervous System Shunt Infections

[1]Lilani Sunil P, [2]Shirpurkar Ritesh A *, [3]Bhilkar Kavita A, [4]Bade Jyoti B, [5]Chande Chhaya A

[1,2]Associate Professor, [3,4]Assistant Professor, [5]Professor

[1]MD Microbiology, Department of Microbiology, Shri Bhausaheb Hire Govt. Medical College, Dhule

[2]MD Microbiology, Department of Microbiology, Dr. Kiran C Patel Medical College & Research Institute, Bharuch

[3,4,5]MD Microbiology, Department of Microbiology ,Grant Government Medical College, Mumbai

***Corresponding Author:**
Dr Ritesh Shirpurkar*

MD Microbiology, Associate Professor, Department of Microbiology, Dr. Kiran C Patel Medical College & Research Institute, Bharuch

Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Introduction - Central Nervous System (CNS) shunts used for treating hydrocephalus are associated with infection. Various risk factors such as age, preterm delivery, revision of shunts for various reasons are among the risk factors that contribute to shunt infection. The present study was undertaken to evaluate various risk factors associated with CNS shunt infections.

Materials and Methods - A total of 86 patients admitted in Neurosurgery and Paediatric Surgery units over a period of 19 months were evaluated for development of shunt infections. Demographic details such as age and gender, along with other variables such as preterm delivery, clinical condition requiring CNS shunt surgery, previous CNS shunt surgery and prophylactic antibiotic coverage, if any, was recorded. A total of 176 CSF samples and 44 shunt tips from 86 patients were processed for culture and sensitivity.

Results – Overall infection rate was 23%, with highest in paediatric age group (75%). Infection rate was highest in the subgroup who underwent multiple shunt revisions (60%) followed by those with a single shunt revision (48%). Gram positive cocci were the predominant isolates. Methicillin resistance was recorded in 90% of Coagulase Negative Staphylococci and 73% of Staphylococcus aureus strains. Mortality rate was 15%, all in preterm babies.

Discussion/Conclusion – Age, preterm delivery, single/ multiple shunt revision were important risk factors. Majority of the bacterial isolates, both gram positive and gram negative were drug resistant, thus influencing the outcome of infection. Identification of risk factors along with appropriate antimicrobial therapy would reduce the morbidity and mortality.

Keywords: Shunt infections, preterm deliveries, shunt revision

Introduction

Central Nervous System (CNS) shunts are inserted for treating hydrocephalus resulting from a variety of reasons. It is a common surgical procedure and life-saving treatment for many patients. The shunt system drains excess fluid from the brain to another part of the body where the CSF is absorbed [1]. The CSF shunts vary in their appearance but essentially consist of a ventricular tube, a second tube to drain the CSF to another cavity, and a one-way Spitz-Holter valve to control the direction and rate of flow. Some may have a reservoir to allow easy access, sampling of the ventricular CSF and administration of drugs, while others have an inbuilt pressure-sensing device.

Ventriculoperitoneal (VP) shunts are more commonly used than the ventriculoatrial (VA) type [2].

However, CSF shunts are liable to malfunction or infection. Rate of infection of the CSF shunts varies widely in different clinical settings. However, certain important variables play an important role in its development. Of these the age of the patient is considered the most significant host factor. Patients undergoing shunt revision are at an increased risk of infection. In addition, Premature low birth weight infants have been found to be more prone for shunt infections after shunt surgery [3, 4].

Despite advances in the surgical techniques and availability of newer antibiotics, infection continues to be one of the most serious complications of CNS shunts. The present study was therefore undertaken to evaluate various risk factors associated with the development of CNS shunt infections.

Materials & Methods

The prospective study, approved by Institutional Ethics Committee, was conducted on patients admitted for shunt insertion or shunt revision surgery in neurosurgery and paediatric surgery units of a tertiary care teaching hospital. A total of 86 patients with informed consent, admitted in the two surgical units over a period of 19 months were included in the study. Demographic details (age and gender) along with other variables such as preterm delivery was recorded. Clinical condition requiring CNS shunt surgery, previous CNS shunt surgery and prophylactic antibiotic coverage, if any, was also recorded. A total of 86 patients during the study period were included in the study. A total of 176 CSF specimens were collected from 86 patients either by lumbar puncture or percutaneous tapping of the fluid from shunt reservoir. CSF specimen was collected at the time of surgery and an additional specimen of CSF was collected as and when infection was suspected clinically. 44 shunt tips (ventricular or peritoneal end) from 39 patients who underwent shunt revision were also received. Both CSF and shunt tips were processed and standard microbiological protocol applied for isolation and species level identification of the bacteria [5, 6, 7]. Antimicrobial susceptibility testing was performed as per the CLSI guidelines [8]. All Staphylococcal isolates were also tested for methicillin resistance. Minimum Inhibitory Concentration (MIC) for Vancomycin was determined for all methicillin resistant Staphylococci by performing broth macrodilution method [8]. Gram negative isolates of Escherichia coli, Klebsiella and Proteus mirabilis were tested for production of extended spectrum beta lactamases(ESBL) by performing the screening and confirmatory test for ESBL production [8].

Results

20 out of 86 patients developed shunt infection, the infection rate being 23%. Rate of infection in paediatric age group (1-15 years) was 75% (15/20). 40% (9/15) infected paediatric patients were newborns or infants less than one year of age (Table 1).

Of the total 86 patients who underwent the procedure, 39 underwent shunt revision surgery, of which shunt of 29 patients were revised once while remaining, that is, 10 patients had to undergo multiple shunt revisions. It was found that 60% (6/10) of the patients with multiple shunt revisions were infected compared to 48% (14/29) patients with one shunt revision (Table 2).

From 20 infected patients, total 46 isolates were recovered from CSF specimen and shunt tips. Of these 46 isolates, 33 were Gram positive cocci and 13 were Gram negative bacilli (Table 3). Of the 33 Gram positive cocci, Coagulase negative *Staphylococci* (CoNS) was the commonest isolate (64%) followed by *Staphylococcus aureus* (33%). One strain was of Enterococcus faecalis. Methicillin resistance (MRCoNS) was detected in 90% (19/21) of the CoNS isolates. 73% of the strains of *Staphylococcus aureus* were also found to be methicillin resistant. Out of 13 Gram negative bacilli isolated, the most common were *Acinetobacter baumannii* (31%) and *Pseudomonas aeruginosa* (31%). 5 were enteric gram-negative bacilli (EGNB) which included two isolates of *Klebsiella pneumoniae* and one each of *Escherichia coli, Citrobacter koseri and Proteus mirabilis*. ESBL production was detected in 100% of the strains of EGNB (5/13). All the four isolates of *Acinetobacter baumannii* were multidrug resistant strains i.e. were resistant to aminoglycosides and all beta lactams and beta lactam-beta lactamase inhibitor (BLBI) combinations (100%). All four isolates of *Pseudomonas aeruginosa* were resistant to piperacillin, third generation cephalosporins and

Volume 6, Issue 6; November-December 2023; Page No 565-569

aztreonam (100%). One strain was also found to be resistant to cefepime (25%).

Of the 20 patients with shunt infection, 3 died. All 3 patients were pre-term infants. Death in one of them was attributed to septic shock secondary to MRCoNS shunt infection. The cause of death in the second infant was shunt extrusion in rectum followed by septicaemia where shunt was found to be infected with Enterococcus faecalis and Proteus mirabilis. The cause of death in the third infant was underlying congenital heart disease (associated with hydrocephalus). However, methicillin resistant Staphylococcus aureus (MRSA) was isolated from the shunt of this patient.

Tables

Table 1 - Age-wise distribution of patients with shunt infections

Age group (years)	Number of patients [n=86]	Number infected [n=20]	Number not infected [n=66]	% infected
< 1	25	6	19	24
1-15	33	9	24	27.27
16-50	23	4	19	17.39
> 50	5	1	4	20
TOTAL	**86**	**20**	**66**	**23.26**

Table no. 2 – Distribution of patients according to the nature of shunt surgery

Shunt revision	Total number of patients [n=39]	Number of patients infected [n=20]	Number of patients not infected [n=19]	% infected
1 shunt revision	29	14	15	48.28
> 1 shunt revision	10	6	4	60.00

Table 3 – Organisms isolated from shunt infections

Organism Isolated	Total Number [n=46]	Percentage (%)
CoNS	21	72
Staphylococcus aureus	11	
Enterococcus faecalis	1	
Acinetobacter baumannii	4	28
Pseudomonas aeruginosa	4	
Klebsiella pneumoniae	2	
Escherichia coli	1	

Volume 6, Issue 6; November-December 2023; Page No 565-569

Proteus mirabilis	1	
Citrobacter koseri	1	
Total	**46**	**100**

Discussion

Although CSF shunts contribute significantly to the management of hydrocephalus, the procedure is associated with complications such as infections [9]. In the present study, the infection rate was observed to be 23% (20/86). The highest rate was observed in paediatric age group (75%). 40% infected paediatric patients were newborns or infants less than one year of age (Table 1). The higher incidence in this age group, especially in newborns and infants less than 1 year, highlights the importance of age as a risk factor in the development of CSF shunt infections. This can be attributed to the lack of a mature immune response, especially early in life [11, 12, 13].

Of the total 58 paediatric patients undergoing CNS shunt procedure, 25 (43%) were infants (<1 year). Among the 25 infants, 13 (52%) were premature at the time of birth of whom 6 (46%) went on to develop shunt infection, thus underlining the role of prematurity in shunt infections, which again can be attributed to a weaker immune system in these preterm babies [14].

Of the 86 patients operated for shunt insertion surgery, 39 (45.34%) underwent shunt revision surgery. Of these 25.64% (10/39) needed a revision surgery more than once. All patients who had undergone only shunt insertion surgery (47/86) without any revision were not observed to be infected. Of the 39 patients who had undergone shunt revision surgery, 51.28 % (20/39) were found to be infected (Table 2). The infection rate was 60% (6/10) in those who underwent shunt revision more than once. Repeat procedure thus increases the risk of infection manyfold [15]. The major indications of shunt revision surgery were found to be mechanical failure of device (44%) and shunt migration (36%). Others associated were shunt obstruction (10%), shunt infection (8%) and formation of abdominal pseudocyst (3%).

A high degree of drug resistance was observed in both, gram positive as well as gram negative isolates. Methicillin resistance (90% MRCoNS and 73% MRSA) in Staphylococci was high. Similarly, high rate of ESBL production in EGNB (100%), multi-drug resistance in Acinetobacter baumannii (100%) and Pseudomonas aeruginosa (100%) was observed. All these are hospital acquired strains. They prevail in the hospital environment and are known to colonise the skin and respiratory tracts of admitted patients. Additionally, a breach in infection control practices can lead to patients getting colonised and infected with one or more of these drug resistant strains.

Thus, the health care providers and hospital environment, along with the underlying condition of the patient play an important role in influencing the outcome of these patients [16]. In the present study mortality was exclusively observed in patients with infected CSF shunts (15%). On the other hand, 66 non-infected patients of the total of 86 patients who underwent CNS shunt procedure were discharged in a satisfactory condition. Mortality in one case could be directly attributed septic shock secondary to MRCoNS shunt infection in a pre-term. Cause of death in second case was mechanical (shunt extrusion into rectum) followed by shunt infection caused by *Enterococcus faecalis* and *Proteus mirabilis*. This suggests that shunt infection plays a significant role along with the underlying condition (pre-term at birth) in the mortality of patients undergoing shunt surgery for hydrocephalus and outcomes of the patient could better if shunt infections are identified early and managed with appropriate antibiotics. Also, prevention, early detection and immediate treatment of shunt infection, which includes removal of infected shunt, can reduce the morbidity and mortality in patients diagnosed with shunt infection. [17].

Conclusion

CNS shunt infections play a significant role in the outcome of patients with hydrocephalus. Identification of risk factors along with appropriate antimicrobial therapy and strict adherence to infection control practices would reduce the morbidity and mortality in this category of patients.

Volume 6, Issue 6; November-December 2023; Page No 565-569

Developing a tool for surveillance of shunt infections will help in proper management of these infections.

References

1. Tunkel AR, Kaufman BA. Cerebrospinal fluid shunt infections. Chapter 81 in: Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases, 6th ed. Printed in United States of America. 2005;1126-1130.
2. Amani Alnimr. Protocol for Diagnosis and Management of Cerebrospinal Shunt Infections and other Infectious Conditions in Neurosurgical Practice: Journal of basic and clinical Neuroscience, 2012, Volume 3, Number 5.
3. George, Leibrock & Epstein. Long term analysis of CSF shunt infections - a 25-year experience: Journal of Neurosurgery: 1979 Dec;51(6):804-11.
4. Odio, McCracken & Nelson. CSF shunt infections in Paediatrics: A seven-year experience: Am J Dis. Child., 1984 Dec;138(12):1103-8
5. Duguid JP. Staining methods, Chapter 45. In: Mackie and McCartney Practical Medical Microbiology, 14th ed. Collee JG, Fraser AG, Marmion BP, Simmons A, Eds. (Churchill Livingstone) 1996;793-812.
6. Thomson RB and Miller JM. Specimen processing: Bacteriology, Chapter 20. In: Manual of Clinical Microbiology, 9th ed. Murray PR, Baron EJ, Eds. ASM Press, Washington DC. 2007;303-313.
7. Winn WC, Koneman EW, Allen SD, Procop GW, Janda WM, Woods GL. Introduction to Microbiology: Part II: Guidelines for the collection, Transport, Processing, Analysis, and Reporting of Cultures from specific specimen sources, Chapter 2. In: Winn WC, Koneman EW, Allen SD, Procop GW, Janda WM, Woods GL, editors. Koneman's Colour Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams and Wilkins. 2006;67-110.
8. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. Twenty-second informational supplement. CLSI document M100-S21. CLSI, Wayne, PA USA. 2012.
9. Kaufman BA, McLone DG. Infection of cerebrospinal fluid shunts. In: Scheld WM, Whitley RJ, Durack DT, editors. Infection of the Central Nervous System. 2nd ed., Ch. 29. New York: Raven Press; 1997.p. 555-73
10. Tunkel AR, Kaufman BA. Cerebrospinal fluid shunt infections. In: Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases. 6th ed., Ch. 81. United States of America: Churchill Livingstone; 2005. p. 1126-30.
11. Reddy GK, Bollam P, Caldito G. Ventriculoperitoneal shutn surgery and the risk of shunt infection in patients with hydrocephalus: Long term single Institution experience. *World Neurosurgery* 2012; 78:155-163.
12. Lee JK, Seok JY, Lee JH, Choi EH, Phi JH, Kim SK, Wang KC, Lee HJ. Incidence and risk factors of Ventriculoperitoneal shunt infections in children: A study of 333 consecutive shunts in 6 years. *J Korean Med Sci* 2012; 27:1563-1568.
13. Kulkarni AV, Drake JM, Lamberti PM. Cerebrospinal fluid shunt infection: a prospective study of risk factors. *J Neurosurg* 2001;94(2):195-201.
14. Nulsen FE, Spitz EB. Treatment of hydrocephalus by direct shunt from ventricle to jugular vein. *Surg Forum* 1951; 2:399-403
15. Choksey MS, Malik IA. Zero tolerance to shunt infections: can it be achieved? *J Neurol Neurosurg Psychiatry* 2004; 75:87-91
16. Shapiro S, Boaz J, Kleiman M, Kalsbeck J, Mealy J. Origin of organisms infecting ventricular shunts. *Neurosurgery* 1988; 22:868-872.
17. James HE, Walsh JW, Wilson HD, Connor JD, Bean JR, Tibbs PA. Prospective randomized study of therapy in cerebrospinal fluid shunt infection. *Neurosurgery* 1980; 7:459-463.

Volume 6, Issue 6; November-December 2023; Page No 565-569