ejpmr, 2023,10(2), 255-259

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

PRIMARY VENTRICULOPERITONEAL SHUNT INFECTION IN TERTIARY NEUROSURGICAL CENTER IN OMAN: A RETROSPECTIVE STUDY

Maya Al Salti[1], Dr. Mohammad Rafiq Khilji[2], Dr. Manoj Malviya[3], Dr. Neeraj Salhotra*[4], Amal Al Jabri[5]

[1]R4, Medical Microbiology Residency Training Program, Oman Medical Specialty Board, Muscat, Oman.
[2]Medical Officer Dept of Neurosurgery Khoula Hospital.
[3]Consultant Neonatologist Khoula Hospital.
[4]Acting Consultant Dept of Neurosurgery Khoula Hospital.
[5]Directorate of Infection Prevention and Control, Khoula Hospital, Muscat, Oman.

***Corresponding Author: Dr. Neeraj Salhotra**

Acting Consultant Dept of Neurosurgery Khoula Hospital.

Article Received on 08/12/2022 **Article Revised on 28/12/2022** **Article Accepted on 18/01/2023**

ABSTRACT

Objectives: To determine the incidence of primary ventriculoperitoneal (VP) shunt infection, causative organisms, underlying risk factors, and outcome in patients undergoing shunt surgery. **Methods**: This is a retrospective, single center, cohort review of all patients who developed primary VP shunt infection. This study was conducted from January 2010 to December 2016 in neurosurgical center at Khoula Hospital, a tertiary hospital in Oman. The primary outcome was shunt infection defined as positive cerebrospinal fluid culture that was associated with compatible symptoms and signs of central nervous system infection or shunt malfunction, surgical incision site infection requiring shunt reinsertion and intra-peritoneal pseudo-cyst formation. Patient with infection were determined and investigated for risk factors. Data was collected in Epi-Data sheet which was created with the help of Epi-Data Manager Program. Analysis was done using IMB SPSS statistics 25.0. **Results**: A primary VP shunt was inserted in 307 patients during the study period with 2.53 years mean duration of follow-up. Among 307 patients, 44 developed primary VP shunt infection with a rate of 14.3% with male to female ratio of 1:1. About half of the infections developed in patients aged less than one month. Among the infected cases, hydrocephalus due to myelomeningocele was the commonest indication (32%). More than half of the patients developed infection within three months post operation. There was no significant association among the factors examined and VP shunt infection. Coagulase negative staphylococcus was the commonest organism (38%) followed by *Staphylococcus aureus* (9%), gram negative organisms (18%), and polymicrobial gram-negative (16%). Multidrug resistance organisms account for eight isolates in which ESBL is the commonest. Modalities of treatment varied; (50%) were treated with one stage revision using external ventricular drainage which complicated by EVD related infection in 50%. The all-cause mortality was 18% with attributable mortality of 4.5%. **Conclusions**: The incidence of primary shunt infection in Khoula Hospital is within the international benchmark for this type of surgery. We describe a high rate of MDRO causing VP infection, this should trigger strict adherence to infection control practices in such high-risk surgery.

I. INTRODUCTION

Different cerebral spinal fluid (CSF) diversion procedures shunt is used to divert accumulated Cerebrospinal fluid (CSF) to other body cavities for absorption. Ventriculoperitoneal (VP) shunt is one type of cerebral shunts and considered the most common. It diverts the CSF from Central Nervous System (CNS) to peritoneal cavity where it gets absorbed to the systemic circulation. It is a permanent catheter where its proximal part is inserted in the cerebral ventricles, subdural space, intra-cranial cysts or in lumbar sub-arachnoid space. The distal component terminates in peritoneal cavity. A pressure-regulating valve is the third component of VP shunt and usually allocates just outside the skull or as part of the distal component. VP shunt is the mainstay treatment for different causes of hydrocephalus including intra-ventricular hemorrhage (IVH), brain tumors, myelomeningocele, aqueduct stenosis, post-trauma, normal pressure hydrocephalus and post-meningitic hydrocephalus. Despite being a well-established procedure in most of neurosurgical centers worldwide, it associates with substantial mortality and morbidity due to the shunt failure.[1] Mechanical mal-functional, infection and hemorrhage are the most common causes of shunt failure.

VP shunt infection is the second most common debilitating complications after mechanical mal-function and it associates with high mortality and morbidity. The rate of VP shunt infection reported in literatures ranged from 3-30%[1,3,6] and this variation is due to many reasons: mainly the differences in study designs,

definition of shunt infection and duration of surveillance after shunt placement.

Several factors may contribute significantly to the shunt infection and these factors can be either patient related factors such as young age, weight at surgery and indication for shunt placement or surgical related factors including hospital volume, antibiotic prophylaxis and surgeons experiences.[2,7]

Four different mechanisms are considered to be responsible for VP shunt infection: intra-operatively which usually presents in first few months post procedure and it is considered the most common mechanism. The second possible routes for acquiring infection is retrograde from abdomen due to either bowel perforation or frequent abdominal surgeries or those patients with myelomeningocele. Thirdly is the direct inoculation from skin during reservoirs manipulation for CSF collection or injection of drugs to ventricles or after catheter erosion. Lastly is the hematogenous seeding.[5]

Signs and Symptoms suggestive of VP shunt infection usually are non-specific making the diagnosis very challenge. These symptoms might include fever, nausea and vomiting, headache, neck stiffness, change in mental status, fontanelle bulging, seizures, abdominal tenderness or surgical site infection.

The majority of causative organism of VP shunt infection are either Coagulase negative staphylococcus (35-69%) or staphylococcus auerus (11-30%), which are the common skin flora.[1,3,6] Generally, gram negative pathogens are less common (10%) but some studies showed higher percentage of about (60%) where Pseudomonas aeurginosa represents 50% of cases. It has medical challenge especially if it is multidrug resistance.[3,4]

The Management of VP shunt infection includes combination of medical and surgical treatment. The surgical approach can be either permanent shunt removal, one stage revision where new shunt placed immediately or two stage where External Ventricular Drainage (EVD) used to drain CSF till the infection resolved and new shunt could be inserted later.[5]

This a retrospective study aimed to examine the rate of VP shunt infection, causative pathogens, risk factors & outcome in patients who have been operated in in Khoula Hospital in Sultanate of Oman.

II. METHODS

We conducted a retrospective computerized cohort review of all patients who underwent primary VP shunt insertion from January 1st 2010 till 31st December 2016 at neurosurgery department at Khoula Hospital. Shunt infection is defined as: (i) Positive CSF culture in a patient presented with clinical CNS infection or shunt mal-functional. The first CSF sample had obtained by a needle aspiration from shunt reservoir not by lumber puncture. (ii) Surgical incision site infection in patient that necessitate shunt reinsertion (even in the absence of positive culture). (iii) Intra-peritoneal pseudo-cyst formation (even in the absence of positive culture). The Minimal duration of follow up was 6 months unless patient developed infection. We excluded shunts that were not inserted in Khoula Hospital, shunts were inserted before the study period; shunt were inserted for primary infectious causes, non-primary shunt infection and when minimal sixth month follow up duration was not meet. The following data were collected retrospectively from patient system record: patients' gender, age and weight at insertion, length of hospital stay before shunt insertion, indication of CSF shunting, type of surgery: elective vs emergency, administration of surgical prophylaxis, prior neurosurgical procedure, number of surgeons, day of infection, biochemical and microbiological study of infected CSF, mode of treatment, attributable mortality and infection relapse. Data were gathered in Epi-data sheet, which was created with help of Epi-Data Manger. Analysis was done by IMB SPSS statistics 25.0.

Univariate comparison of the identified variables in those who developed infection and those who did not were examined.

The study was approved by the ethics committee at Khoula Hospital. The consent was waived as the study was retrospective.

III. RESULTS

Patient population

During the study period, a total of 432 shunt were inserted and 71% (n=307) had operated for non-infectious causes and completed minimal 6 months clinical follow up. The demographic features and surgical variables of all patients are described in Table1. The etiology of hydrocephalus was mainly the association with myelomeningocele 23% (n=71), CNS tumor 16% (n=51) and post-trauma 7% (n=21). Overall, 163 shunts (53%) were placed into male patients. 257 were inserted in less than 12 months old children. Half of the patients received preoperative antibiotics where cefuroxime was used for 33.6% (n=103), cefazolin for 16% (n=49) and other prophylactic antibiotics were given for 1% (n=4).

Rate on VP shunt infection

Out of 307 primary VP shunt infection, 44 patient developed infection with percentage of 14.3%. The incidence fluctuated during the study period with highest proportion seen in 2011 (Figure 1). The median length of hospital stay (from admission to shunting) was 10 days (range, 1 day to 132 days). The male-to-female ratio was 1:1. Half of patients were less than 1 month old (n=22) and 27% (n=12) were aged from 1 month to 12 months. Over than half of the patients (n=25, 57 %) had other CNS surgical procedures previously or at the same time

of insertion. Infected VP shunts were done as emergency setting in 45% (n=20) and the median number of surgeons was 1. None of studied factors were found to be statistically significant. Infection developed within less than three months post insertion in 59% (n=26).

Microbiology

CSF analysis of infected samples showed high WBC for 50% (n=22) and high protein found in 66% (n=29). Organisms were seen in 34 % (n=15) in routine gram stain. Different pathogens were isolated as shown in figure 2.

Characteristics		**Overall (n=307)**	**Non-infected (n=263)**	**Infected (n=44)**	**Univariate analysis**
Gender (male: female)		1:1	1:1	1:1	0.62
Age at time of insertion	*<1 m*	177 (38%)	95 (36%)	22 (50%)	0.07
	1m-12m	80 (26%)	68 (26%)	12 (27%)	0.85
	1-2 years	20 (6%)	20 (8%)	0%	0.26
	3-9 years	16 (5%)	13 (5%)	3 (7%)	
	10-18 years	11 (4%)	10 (4%)	1 (2%)	
	19-49 years	43 (14%)	39 (15%)	4 (9%)	
	>50 years	20 (7%)	18 (7%)	2 (5%)	
Weight at time of surgery		Mean 6.1	Mean 6.6	Mean 3.8	0.05
Indication	Hydrocephalus not specify	110 (36%)	94 (36%)	16 (36%)	0.079
	IVH	27 (9%)	22 (8%)	5(11%)	
	Aqueduct stenosis	16 (5%)	14 (5%)	2 (5%)	
	Post meningitis	5 (2%)	5 (2%)	0	
	myelomeningeocele	71 (23%)	57 (22%)	14 (32%)	
	NPH	6 (2%)	6 (2%)	0	
	Post-trauma	21 (7%)	17 (6%)	4 (9%)	
	Benign CNS tumor	24 (8%)	21 (8%)	3 (7%)	
	Malignant CNS tumor	27 (9%)	27 (10%)	0	
Other CNS procedures	No	166 (54%)	147 (56%)	19 (43%)	0.06
	Previous	77 (25%)	67 (26%)	10 (23%)	
	At same time	64 (21%)	49 (18%)	15 (34%)	
Type of surgery	Elective	184 (60%)	160 (61%)	24 (55%)	0.50
	Emergency	123 (40%)	103 (39%)	20 (45%)	
Surgical prophylaxis	Yes	159 (51%)	137 (52%)	19 (43%)	0.306
	No	22 (7%)	20 (8%)	2 (5%)	
	On anti-biotic	129 (42%)	106 (40%)	23 (52 %)	
Type of surgical prophylaxis	Cefuroxime	103 (34%)	92 (35%)	11 (25%	0.370
	Cefazoline	49 (16%)	41 (16%)	8 (18%)	
	others	4 (1%)	4 (2%)	0	
Admission post-op	Ward	148 (48%)	132 (50%)	16 (36%)	0.221
	ICU	32 (11%)	27 (10%)	5 (11%)	
	SCBU	127 (41%)	104 (40%)	23 (53%)	
Number of surgeons Median (minimum-maximum)		1 (1/4)	1(1/4)	1 (1/3)	0.326
Length of hospital stay in days Mean (minimum-maximum)		9.4 (1-176)	9.3 (1-176)	10 (1-132)	0.818
Duration of follow up in years		2.5	2.5	2.2	0.098

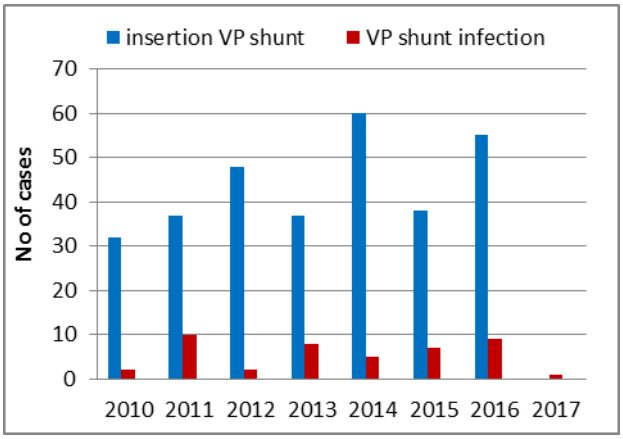

Figure 1: distribution of VP shunt infection over the study period.

VP shunt infection manifested as meningitis or ventriculitis in 50% (n=22), surgical site infection in 22.2% (n=11) and peritonitis in 2.3% (n=1). Coagulase negative staphylococcus was the commonest pathogen isolated in both early 18% (n=9) and late infection 20% (n=9). Other organisms were isolated including staphylococcus auerus (9 %), Pseudomonas aeruginosa (9%), Klebseilla pneumonia (4%), E.Coli (4%), Candida species (2%) and polymicobial pathogens (16%). Six patients (13.6%) had negative CSF culture. Multidrug resistance organisms were identified in 18% (n=5) of isolates mostly during the first 3 months post insertion 75% (n=5) where Extended Spectrum Beta Lactamases (ESBL) was the commonest isolate (63%), and one isolate identified as MRSA, MDRA and AmpC producer.

Outcomes

Two-stage shunt revision was done is 48% (n=21) which complicated with External Ventricular Drainage (EVD) infection in half of the patients. Coagulase negative staphylococcus was again the commonest pathogens (60%). In this study, 30-day all-cause mortality was 18% (n=8) with attributable mortality of 4.5% (n=2). Quarter of the patient with primary VP shunt infection had relapsed within two years.

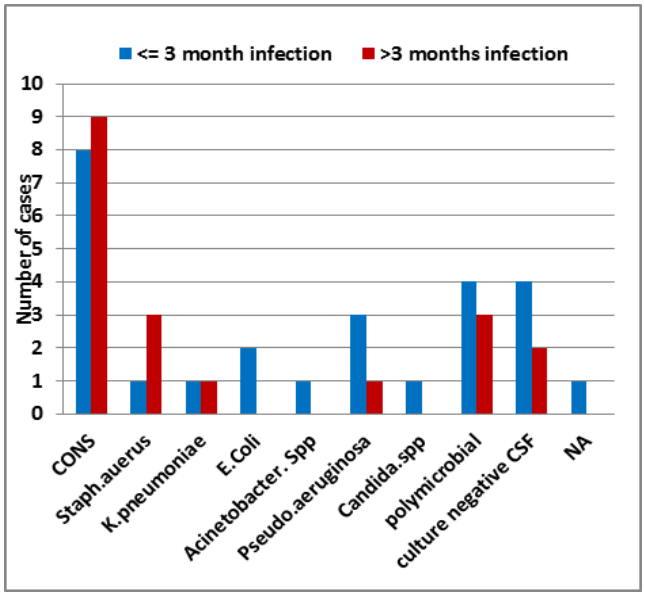

Figure 2: organism identified in early and late infection.

DISCUSSION

Ventriculoperitoneal CSF shunting is a main treatment for patient with hydrocephalus. Although it has reduced the mortality and morbidity of patients, many complications could occur including mal-function, infection and hemorrhage despite improvement in surgical aspects. Infection is considered the second serious complication of CSF shunting with high mortality.[5] Variable rates documented in literatures. In a large longitudinal cohort study across several United State hospitals, infections developed in about 11.7% of children who underwent uncomplicated initial primary shunt placements within 24 months.[2] A study involved 333 consecutive shunts in 6 years done in Korea the infection rate reported was 10%.[3] In multicenter clinical audits conducted in Hong Kong the rate of VP shunt infection reported as 7%[1] and 3.98% in India.[6] Overall rate reported in Saudi Arabia (King Fahad Hofuf

hospital) is about 25.9%.[4] These variations are mainly due to diverse definitions of shunt infection and the patient populations and duration of surveillance.[1] In this retrospective study, the incidence of VP shunt found to be 14% which is comparable with rates from different countries.[1,2,3,4,6,8] In this study, the definition of VP shunt infections was selected based on clinical manifestation was along with CSF chemical and microbiological parameters. Based on the studied risk variables', shunting at young age (less than 12 months) and low weight were significantly associated with VP shunt infection in univariate analysis, however in multivariate analysis this effect diminished. Several other factors not evaluated in this study including skin antiseptic, operation time, type of shunt and level of experience of operated surgeons. These factors were not found to be significant in previous studies.[1] The pathogens shown in this study is in consistence with previous reports however we demonstrate high rate of early VP shunt infection with high proportion of early infection with MDROs as well. This observation should trigger the importance of adherence to the infection control protocol requirements pre-operatively, intra-operatively and post-operatively.

Two-stage revision remains the best approach for VP shunt infection. This study showed high rate of EVD infection of around 50%, which should promote analysis of the reasons and preventive measures.

CONCLUSION

This review is the first national study addressed the rate of VP shunts infection over 7 year's period. It studied several parameters, which will influence on improvement of patient care. However, it has several limitations; including the data was collected retrospective and some of information was missing. In addition, some of confounder factors were not addressed which might have impact consequence on the results. Moreover, inadequate clinical follow up was noted for some of the patients and this could affect 30-day all-cause mortality. Finally, we need a large, prospective study to have more impact on patient management and outcome.

REFERENCES

1. Peter YM Woo *, HT Wong, Jenny KS Pu, WK Wong, Larry YW Wong, Michael WY Lee, KY Yam, WM Lui, WS Poon. Primary ventriculoperitoneal shunting outcomes: a multicentre clinical audit for shunt infection and its risk factors. Hong Kong Med J 2016; 22: 410–9.
2. Tamara D. Simon, M.D., M.S.P.H.1, Matthew Hall, Ph.D.2, Jay Riva-Cambrin, M.D., M.Sc.3, J. Elaine Albert, M.D.4, Howard E. Jeffries, M.D., M.B.A.4, Bonnie LaFleur, Ph.D.5, J. Michael Dean, M.D., M.B.A.6, John R. W. Kestle, M.D., M.Sc.3 Infection rates following initial cerebrospinal fluid shunt placement across pediatric hospitals in the United States. J Neurosurg Pediatr. 2009 August; 4(2): 156–165. doi:10.3171/2009.3.PEDS08215.
3. Joon Kee Lee1 , Joon Young Seok1 , Joon Ho Lee1 , Eun Hwa Choi1 , Ji Hoon Phi2 , Seung-Ki Kim2, Kyu-Chang Wang2 , and Hoan Jong Lee1. 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.
4. Bokhary MM Aly1 and Kamal HM2. Ventriculo-Peritoneal Shunt Infections in Infants and Children. Libyan J Med, AOP: 080104.
5. IDSA guideline.
6. McGirt MJ, Zaas A, Fuchs HE, George TM, Kaye K, Sexton DJ. Risk Factors for Pediatric.
7. Ventriculoperitoneal Shunt Infection and Predictors of Infectious Pathogens. Clin Infect Dis., 2003 Apr; 36(7): 858–62.
8. Qin B, Chen G, Chen J. Shunt infection in a single institute: a retrospective study. Chin Neurosurg J., 2018 Dec; 4(1).