Research Article

Criteria of ventriculoperitoneal Shunt–related Infections in Iraqi Children patients: A Retrospective study over a 2-Year Period

Mohamed A. Al-Tamimi F .I .C .M .S

Date Submitted: 20/12/2015
Date Accepted:22/2/2016

Address for Correspondence:
Dr. Mohamed A. Al-Tamimi, Department of surgery, College of Medicine, Al-Mustansiriya University, Baghdad, Iraq.
Email:mhmdtamimi88@yahoo.com

Abstract

Background: Ventriculo-peritoneal shunts are usually used to treat hydrocephalus, the swelling of the cerebrum would be either because of overabundance of CSF develop or to deterrent of its waste. If left unchecked, can lead to an increase in intracranial pressure (ICP). Shunts can come in a variety of forms but most of them consist of a valve housing connected to a catheter, the two ends of which are usually placed one in the ventricle and the other in peritoneal cavity. As with any implanted foreign body, infection is a serious and common complication. Factors leading to shunt infection include shunt insertion at a young age (<6 months old) for their low immunity and high skin bacterial densities and the type of hydrocephalus being treated. The symptoms of a shunt infection are very similar to the symptoms seen in hydrocephalus but can also include fever and elevated white blood cell counts.
Aim: To evaluate the Iraqi paediatric patients with infected shunts, analyzing them according to their age, sex, sort of causative microorganism, clinical presentation and time of infection postoperatively teeming with causes of their hydrocephalus, investigating the etiological causes for their infection.
Patients and Methods: In a retrospective study, 23 children 0–12 years of ages who underwent initial CSF ventriculo-peritoneal shunt placement with a discharge dates between January 1, 2001, and December 31, 2002 were identified from Neurosurgical hospital in Baghdad. For every child who developed shunt infection we extracted information from the medical record about patient factors including gender, age at initial shunt placement, sort of infection, causative microorganism and timing between initial CSF shunt and initial infection and analyze them
Results: It was revealed that a higher incidence of infection occurred at a young age (<1 year old). The majority of them were shunted at first due to congenital hydrocephalus (with our without myelomeningocele 39.1% and 21,7% respectively). Most of the infection happened in the first week after shunt insertion (56.5%) presenting themselves mostly with meningitis (52.1%). Staphylococcus Epedermidis and Aureus were the most common isolated causative organism.
Conclusion: patient factors such as age and pathological cause behind hydrocephalus are important predisposing factors for shunt infection and thus failure.

Key words: Hydrocephalus, infected ventriculo-peritoneal shunt system.

INTRODUCTION

Ventriculoperitoneal shunts remain the backbone of hydrocephalus treatment. Around 5%–8% of recently set shunts in kids get to be distinctly infected. Shunt contaminations cause enormous grimness, conceivably passing, and substantial financial expenses to the community and patients [1]. The majority of shunt associated infections are thought to be a result of shunt hardware colonization with nonpathogenic skin flora,particularly gram positive-cocci such as staphylococcus species(epidermidis and aureas)[2]. The neurosurgeons around the world put the prevention of shunt infection as apriority especially when dealing with pediatric age group because they realize well the devastating problems that come as a consequence of

the resultant shunt malfunction like expanding the complexity of the patient's hydrocephalus , cognition impairment, expanded danger of seizures and psychomotor hindrance.[3] In spite of the high occurrence of this complication, the ideal deal with ventriculoperitoneal shunt related infections has yet to be characterized. The current confirmation with respect to the administration of CSF shunt contamination is of poor methodological quality. Thusly, current administration is directed not by confirmation, yet rather by doctor inclination and other potentially pertinent patient-level variables (for instance, tolerant surgical hazard, ventricle size, and multifaceted nature of the shunt framework). It is not amazing that there is huge variety in CSF shunt contamination treatment conventions between centers[4].

PATIENTS AND METHODS

This is a descriptive study conducted to determine factors associated with shunt infection in which we recognized 23 children 0–12 years of ages who had initial ventriculo-peritoneal shunt insertion with subsequent shunt related infections, all had a discharge dates between January 1, 2001, and December 31, 2002 from Neurosurgical hospital in Baghdad. For every case we extracted and analyze data from their medical records regarding patient factors like gender, age at initial shunt placement, causative microorganism and times elapsed between initial CSF shunt and the start of infection together with the type of infection**.**

An infection was regarded to be connected with a ventriculoperitoneal shunt if no less than 1 of the accompanying 2 criteria was satisfied (1) growth of a pathogen in the Cerebrospinal fluid, in surgical wounds of the embedded shunt material (only if the pathogen was regarded as relevant), or on the tip of shunt catheters or device (2) head ache, fever (temperature >38°C), neck rigidity, focal deficit signs of cranial nerve affection, or agitation without another perceived cause; doctor start of a proper antimicrobial treatment for shunt-related contamination; organisms found in blood culture and a laboratory finding of CSF that included the followings (leukocyte count check >5×10^6 cells/L., CSF-to-blood glucose ratio <0.5., Total CSF protein >0.47 g/L., recognition of the causative organisms on CSF Gram stain.

The onset of contamination was defined by the first positive CSF culture , wound swab, or positive contaminated device specimen, the start of a fitting antimicrobial agent, or surgery being offered at the site of the shunt device implantation (whichever happened first). With respect to utilization of prophylactic-anti-infection agents, every patient got antimicrobials aimed at the time of anaesthesia enrolment for their essential shunt surgery.

RESULTS

The sex distribution as given in table (1) showed that males (56.5%) were more common than females (43.5%) in the current study. The age groups of the patients are given in Table (2), in which the majority of the patients were children (their age≤1). Congenital hydrocephalus-myelomeningocele syndrome was the most widely recognized reasons for the etiology of hydrocephalus in shunt contaminated patients in our study with a frequency of (39.1%). Other causes like isolated congenital hydrocephalus and posterior fossa tumor came next with equal frequencies. In our study postmeningitis hydrocephalus was the least in frequency as revealed in table (3). Regarding the causative organism, staphylococci epidermidis and aureus were the highest in frequency as been isolated from infection sites and cultured 39.1% and 21.7% respectively. E coli and proteus and pseudomonous were much less in frequency as shown in table (4). The duration between the essential shunt operation and the appearance of infection stigma is shown in table (5) where the highest frequency of infected shunts occurred within a week from shunt placement (13 cases, 56.5%), another 10 cases (43.5%) were added to them in the next days after shunt placement surgery. Whereas the patient presentations were the bases for table (6), which demonstrates that the majority of the patients had meningitis followed by abdominal skin infection and cephalic skin infection respectively.

Table (1): sex distribution and their percentages in infected shunt operations.

Sex	No. of patients	Percent %
Male	13	56.5
Female	10	43.5
Total	23	100

Table (2): age distribution and their percentages in infected shunt operations

Age	No. of patients	Percent %
0-1 year	14	60.9
1-7 years	7	30.4
7-12 years	2	8.7
Total	23	100

Table (3): Etiology of hydrocephalus in infected shunt group

Causes of hydrocephalus	No. of patients	Percent %
isolated Congenital hydrocephalus	5	21.7
Posterior fossa tumor	5	21.7
Post meningitic hydrocephalus	4	17.4
Post congenital spinal anomaly repair	9	39.1
Total	23	100

Table (4): The causative organism for infected shunt systems, number of patients and their percentages

Organism	No. of patients	Percent %
Staph. Epidermidis	9	39.1
Staph. Aureus	5	21.7
No organism isolated	4	17.4
E. coli	3	13
Proteus	1	4.3
Pseudomonous	1	4.3
Total	23	100

Table (5): Duration between operation and infected shunt, Number of patients and percentages

Duration	No. of patients	Percent %
0-7 days	13	56.5
>8 days	10	43.5
Total	23	100

Table (6): Presentation of patients with infected shunts, Number of patients and percentages

Presentation	No. of patients	Percent %
Meningitis	12	52.1
Abdominal skin infection	6	26.1
Cephalic skin infection	5	21.7
Total	23	100

DISCUSSION

Although the effective management of hydrocephalus is through insertion of ventriculoperitoneal (CSF) shunts, it frequently creates new considerable surgical and medical issues for the patients, their families and caregivers. CSF shunt failure for what so ever the cause is common and necessitates subsequent CSF shunt revision surgery. Ventriculoperitoneal shunt infections, being one of the etiologies of device failure, is commonly managed by removal of contaminated device and insertion of external ventricular drainage system to be followed by a new shunt device implantation two to three weeks after optimum IV antibiotic intake. The underlying empiric antibiotic scope ought to incorporate a wide range of adequacy until the causative microorganism is eradicated. Because of this high morbidity and complexity, it is essential for families and care suppliers to comprehend whether certain children with implanted CSF shunt devices are at most noteworthy hazard for consequent infection. Age, etiology of hydrocephalus, timing of infection postoperatively, kind of causative micro-organism together with sort and site of infection were among the regular elements contributed to some degree to the wide variety in CSF shunt contamination rates, in spite of the fact that other different components can assume a part, while no statistically significant relationship has been found between infection and sex of patient for example.

Having higher rates of ventriculoperitoneal shunt related infections at younger age of shunt implantation especially during the first 7 days identifies the relation between age and contamination rates. Though Contamination during surgery was generally low. There could be more than one explanation for that. First of all is the high preoperative skin bacterial densities of Strains of coagulase-negaive Staphylococcus with high bacterial adherence in younger patients especially in those below one year of age(more commonly found in neonates than in older age groups) and that goes in concordance with a study held by Ian K. Pople et al.[5] who even proposed the presence of more harmful strains of coagulase-negative Staphylococcus on the skin of young age group which needs taking special measures to decrease the possibility of contamination throughout surgery utilizing packs drenched in an antiseptic agent, wound fields clean isolation and glove-altering before device handling which has been reconfirmed in a review held by Joshua M. Beckman etal.[6] More detailed study of the association between small age and higher contamination rates was conceivable in the meningomyelocele and congenital hydrocephalus groups as those are mostly treated in their first days of life with the higher possibility of bacterial access to the CSF pathways. This in fact was the situation in our series where most of the patients were shunted at first for their abnormal anatomical CSF pathways in the form of either post congenital spinal anomaly repair or primary congenital hydrocephalus. This in fact agrees with a study done by Sacar S etal. Which assumed post meningitic hydrocephalus and congenital hydrocephalus-myelomeningocele complex as the commonest cause of hydrocephalus in ventriculoperitoneal shunt infected patients[7].

In addition all the above parameters can even explain the highest frequency of staphylococci related shunt infection in our group of study with lower frequency for E coli and proteus which cultivate on shunts catheters that accidently punctured the gastrointestinal tract. In fact this has been reported before[8]. Newborn and preterm infants especially with fetal distress syndrome or those who suffered acute or chronic otitis media, sinusitis, pharyngitis, pulmonary infections, necrotizing enterocolitis, gastric perforation and consequent ileus tailed by bacteremia, aspiration pneumonitis and septicemia or been delivered for mothers with amnionitis or preterm rapture of amniotic sac, all account for anaerobes a cause for the development of their meningitis. In another group where no organism was isolated stands the possibility of viral infections where CSF biochemistry explained that.

This high vulnerability for earlier infection in our cases mostly 1 month after shunt surgery is now made clear for all the above reasons (abnormal CSF pathways, debilitated general condition with lower immunity, a child with already infected CSF in form of meningitis or infected myelomeningocele wound, high densities of skin more virulent bacteria).

Most of our patients with infected shunts presented clinically having meningitis. This can be ascribed to the way those causative organisms behave where they

ordinarily stick to the gadget surface and shape biofilms that spread along the catheter upper and lower ends to get later access into the cranial ventricles with resultant ventriculitis and meningitis. Coagulase-negative Staphylococcus was unique in that and accounted for the highest number among presentations. This agrees with a study held by Anna Conen etal.[8]. Less patients presented clinically in the form of infected and dehiscent upper end which was related in most of times to the thin overlying scalp and pressure necrosis and infection. The least presentation was with infected lower end with bacterial access (E coli and proteus as a causative microorganism) from pierced GIT or urinary tract especially in trocker guided lower end implantation.

CONCLUSION

Infection is an important cause of revision that faces the surgeon and the patient in shunting procedures. The patients with CSF shunt–associated infections often presented early after shunt placement of which postoperative meningitis was the commonest presentation as cerebrospinal fluid shunts used to control the condition are prone to colonization particularly by Staphylococcus epidermidis. The incidence is very much higher in infancy than in older age groups, and this is probably due to prolonged hospital stay as a result of the underlying pathology, combined with the propensity for a high skin bacterial density with more adherent strains, rather than to any immune immaturity. Although hospital factors (cleaning protocols, surgeon experience, preoperative prophylactic antibiotics) play an important role in determining infection rate, patient factors such as age and pathological cause behind hydrocephalus are still very important to the same degree**.**

RECOMMENDATION

Shunt infection constitute a major source of morbidity, and mortality and despite considerable efforts, have not been elemenated. Well performed researches are still needed to further understand risk factors to reduce burden of infection on patient and society

REFERENCES

1. Daniel H. Fulkerson, Ahilan Sivaganesan, Jason D. Hill etal: Progression of cerebrospinal fluid cell count and differential over a treatment course of shunt infection, J Neurosurg Pediatr 8 : 613-619, 2011.
2. Tuan TJ, Thorell EA, Hamblett NM, Kestle JR, Rosenfeld M, Simon TD: Treatment and microbiology of repeated cerebrospinal fluid shunt infections in children. Pediatr Infect Dis J 30:731–735, 2011
3. Jamjoom AB, Mohammed AA, al-Boukai A, Jamjoom ZA, Rahman N, Jamjoom HT: Multiloculated hydrocephalus related to cerebrospinal fluid shunt infection. *Acta Neurochir (Wien)* 138:714–719, 1996
4. Whitehead WE, Kestle JR: The treatment of cerebrospinal fluid shunt infections. Results from a practice survey of the American Society of Pediatric Neurosurgeons. *Pediatr Neurosurg*35:205–210, 2001
5. Ian K. Pople, Roger Bayston, Richard D. Hayward etal: Infection of cerebrospinal fluid shunts in infants: a study of etiological factors. J Neurosurgery 77: 29-36, 1992
6. JoshuaM. Beckman, MD, ErnestK. Amankwah, Ph D, Lisa L. Tetreault, RN, and Gerald F.Tuite, MD. (2015) Reduction in CSF shunt infection over a 10-year period associated with the application of concentrated topical antibiotic powder directly to surgical wounds prior to closure. *Journal of Neurosurgery: Pediatrics* **0**:0, 1-14
7. Sacar S, Turgut H, Toprak S.etal: A retrospective study of central nervous system **shunt** infections diagnosed in a university hospital during a 4-year period. BMC Infect Dis. 8;6:43,2006
8. Itzhak Brook: Meningitis and shunt infection caused by anaerobic bacteria in children. J Pediatric Neurology 26:99-105,2002
9. Anna Conen, Laura Naemi Walti, Adrian Merlo.etal: Characteristics and Treatment Outcome of Cerebrospinal Fluid Shunt-Associated Infections in Adults: A Retrospective Analysis over an 11-Year Period. Clinical infectious diseases Oxford.J 47:73-82,2006.