RESEARCH ARTICLE

Relationship between hydrocephalus etiology and ventriculoperitoneal shunt infection in children and review of literature

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Abstract

Objective: The purpose of this retrospective study was to clarify the relationship of shunt infection to childhood hydrocephalus etiology

Methods: We analyzed 1021 patients with childhood hydrocephalus who underwent V-P shunting over a period of approximately 15 years. The etiology of 1021 patients include myelomeningocele (794 patient), congenital (165 patient) and intraventricular haemorrhage (62 patient).

Results: Of the 1021 patients who underwent V-P shunting, 19.32% exhibited shunt infection. Shunt infection developed in 180 (22.67%) of 794 patients with myelomeningocele, 9 (5.45%) of 165 patients with congenital obstructive hydrocephalus, and 9 (14.51%) of 62 patients with intraventricular haemorrhage. Recurrent shunt infection was detected in 54 (27.27%) of 198 patients with a previous shunt infection.

Conclusions: Patients with previous shunt infection as well as those with shunts associated with myelomeningocele were observed to be at a greater risk for shunt infection. Results indicated that patients with congenital obstructive hydrocephalus may be less prone to shunt infections.

Keywords: Hydrocephalus, Shunt infection, Etiology. (JPMA 68: 38; 2018)

Introduction

Ventriculo-peritoneal (V-P) shunting is one of the most frequently performed procedures in neurosurgery. However, incidence of shunt infection secondary to V-P shunting is a serious problem with an infection rate ranging from 0.3% to 40%.[1-12] The risk factors for shunt infection include young age, premature birth, previous shunt infection, long surgical time, presence of various shunt systems, post-operative cerebrospinal fluid leakage, glove holes, manual handling of shunt hardware, contamination of shunt catheter, poor skin condition of the patient, and increased personnel traffic during operation.[1-12,15] The majority of shunt infections were due to skin flora;[3,7] however, few articles have also reported a relationship between shunt infection and hydrocephalus (HCP) aetiology.[1,2,6-9] The current study was planned o delineate the relationship between shunt infection and myelomeningocele, congenital HCP, intra-ventricular haemorrhage, and previous shunt infection.

Patients and Methods

The relationship between shunt infection and childhood HCP etiology was studied. We retrospectively analyzed HCP patients with inserted V-P shunt at our institution between June 2002 and January 2017. Over a period of approximately 15 years, 1021 children with HCP underwent V-P shunt operation. We retrospectively reviewed all hospital records of HCP patients who were treated at the Neurosurgery Clinic of Yuzuncu Yil University in Van, Turkey. Data regarding patients' age at the time of shunt palcement, HCP etiology, and history of previous shunt infection were collected. Risk factors predisposing shunt infection were etiologically evaluated. Age at the time of V-P shunt operation ranged from 2 days to 1 year. Diagnosis of HCP was based on a large head, split sutures, bulging fontanelle, and radiological computed tomography scan. HCP etiology was classified into three groups: group I included 794 patients with myelomeningocelle, group II included 165 patients with congenital HCP, Group III included 62 patients with intraventricular haemorrhage. Also another group included 198 patients with previous shunt infection.

V-P shunts were inserted in all patients.The patients were followed up for a mean of 45.47±37.04 months (range, 3-144 months), but the duration of follow-up was not equal. Shunt placement was performed following the exclusion of clinical meningitis. To avoid V-P shunt infections, a strictly aseptic operation was performed. An antibiotic was given 30 min before operation and the same antibiotic was continuedf or 7 days in most patients. The shunt system was immersed in a solution of saline containing 500 mg vancomycin. When shunt infection was suspected, CSF from shunt reservoir or from ventricular tapping was collected. Once shunt infection

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was confirmed, the shunt was removed and external ventricular drainage (EVD) was inserted until three sequential samples of CSF were confirmed sterile and protein content returned to normal. A new shunt was then inserted. Types of shunts were changed during the period of the study. Anaesthetic time ranged between 35 and 75 min.

Statistical Analysis: Descriptive statistics were presented as count and percentages for the categorical variables. Z test or Fisher's exact probability tests were used for comparison of two proportions of the groups in terms of shunt infection rate. Statistical significance level was considered as 5% and MINITAB (ver: 14) statistical programme was used for all statistical computations.

Results

A total of 1021 patients who underwent V-P shunting were retrospectively analyzed to study the relationship between shunt infection and HCP etiology. A total of 198 shunt infections occurred during a period of approximately 15 years, with an incidence of 19.32%. Shunt infections developed in 180 (22.67%) of 794 patients with myelomeningocele, in 9 (5.45%) of 165 patients with congenital obstructive HCP (without myelomeningocele), in 9 (14.51%) of 62 patients with intraventricular haemorrhage; however, recurrent shunt infection occurred in 54 (27.27%) of 198 patients with a previous shunt infection (Table-1). HCP patients with previous shunt infections and those with myelomeningocele exhibited the highest frequency of shunt infection. Shunt infection was more frequently observed in infants within the first month of life; however, patients' age was not objectively evaluated in the present study. All patients with shunt infection were treated using external ventricular drainage (EVD) and intravenous antibiotics. During treatment period, a mean of 3.69±1.50 (range, 1-9) EVD were performed per patient with shunt infections. EVD was changed 1 time in 3 patients, 2 times in 39 patients, 3 times in 53 patients, 4 times in in 69 patients, 5 times in 14 patients, 6 times in 7 patients, 7 times in 4 patients, 8 times in 5 patients and 9 times in 4 patients, (totally, 732 times). The average duration of EVD was 11.5±3.95 day (range, 5-22 days). Ventriculitis developed in 11 patients; antimicrobial agents, such as vancomycin and gentamycin, were intrathecally administered to these patients through an external

Table-1: Hydrocephalus (HCP) etiologies, shunt infection rates, and statistical analyses (p-values).

	Number of patients with HCP	Number of shunt infection	Rate of infection
HCP with myelomeningocele (1)	794	180	22.67 %
Congenital HCP (2)	165	9	5.450 %
HCP with intraventricular haemorrhage (3)	62	9	14.51 %
HCP with previous shunt infection (4)	198	54	27.27 %
Comparisons	Rate 1	Rate 2	pvalue
1-2	22.67 %	5.450 %	0,001
1-3	22.67 %	14.51 %	0,084
1-4	22.67 %	27.27 %	0,188
2-3	5.450 %	14.51 %	0,060
2-4	5.450 %	27.27 %	0,001
3-4	14.51 %	27.27 %	0,020

Table-2: Incidence of shunt infections based on HCP etiology.

	Myelomeningocele	Congenital	Intraventricular hemorrhage	Previous shunt infection or meningitis
Ammirati et al. (1)	40%	33%	8%	
McGirt et al. (6)	30%	35%	23%	
Serlo et al. (9)		6.8%	178 %	
Sciubba et al. (8)	16%	28%	40%	2.7%
Cotton et al. (2)	17.1%	25.7%	11.4%	
Reddy et al. (7)	23.8%	24.8%	11.9%	
Laeke et al. (4)	24.3%			
Ahn et al. (14)			21%	
Kestle et al. (16)				30%
In the current study	22.67%	5.45%	14.51%	27.27%

drainage system. Staphylococcus epidermidis, Enterococcus fecium, and Escherichia coli were the most frequently identified organisms. S. epidermidis, E. fecium, and E. coli were frequently detected in patients with shunt associated with myelomeningocele.

Statistical differences were observed among the groups (Table-1). A p-value of <0.05 was considered statistically significant.

Discussion

Shunts inserted for the treatment of HCP are vulnerable to bacterial infections. In our study, we observed that shunt infections occurred at a rate of 19.39%. Based on HCP etiology, numerous studies have been performed. The incidence of shunt infection is 16 to 40% for children with myelomeningocelle,[1,2,4,6-8] 11 to 33% for those with intraventricular haemorrhage,[1,2,6,8,9] 6 to 35 % for patients with congenital obstructive HCP,[2,6,8,9] and 27 to 45 for children with recurrent shunt infection[2,8,16] (Table-2). These data suggest that the most important factors contributing to etiological shunt infection are variable. In the present study, shunt infection developed in 180 (22.67%) of 794 patients with myelomeningocele, in 9 (5.45%) of 165 patients with congenital obstructive HCP, in 9 (14.51%) of 62 patients with intracranial haemorrhage, and in 54(27.27%) of 198 patients with previous shunt infections. Our findings differ from those of previous studies. However, in our study, shunt infection rate is significantly high (27.27%) in patients with HCP due to previous shunt infection. Infection rate in patients with congenital HCP was relatively low than that detected in previous studies.

These results indicate that myelomeningocele may facilitate shunt infection. Laeke et al[4] revealed an infection rate that was marginally greater (24.3%) for HCP patients with myelomeningocele HCP. In the present study, the infection rate in HCP patients with myelomeningocele was 22.67%. Our previous study[15] indicated that the simultaneous repair of myelomeningocele and V-P shunt placement (in infant with HCP at birth) was associated with an increased rate (33.3%) for shunt infection. However, patients who underwent shunt placement in separate sessions exhibited a shunt infection rate of 14.29%. We postulate that shunt placement allows CSF to reach the ventricles from the lumbar region by reversing CSF flow, thus facilitating infection. Shunts inserted within the first week of closure of myelomeningocele sac increase the risk of infection. Thus, a recommended 7-day delay after closure of myelomeningocele sac before shunt operation may mitigate this risk. Hence, myelomeningocele sac should be repaired as early as possible.

Germinal matrix haemorrhage is the most common type of intraventricular haemorrhage in premature babies, particularly very low birth weight babies.[14,15] Children with HCP secondary to intraventricular haemorrhage are more vulnerable to develop shunt infections because of congenital immune deficiency. Therefore, intraventricular haemorrhage of newborns is a potential risk factor. Early shunt placement for post haemorrhagic HCP is largely ineffective and associated with an increased risk of infection. A study including 19 premature infants with post haemorrhagic HCP revealed a shunt infection rate of approximately 21%.[14] Temporary measures, such as extraventricular drainage or ventricular tapping, may be undertaken until the patient tolerance increases.

Recent studies have indicated an increasing incidence of recurrent shunt infection (12%-26%).[4,7,12] Inadequately treated children are definitely at a higher risk for developing recurrent shunt infection. McGirt et al.[6] reported that in patients with previous shunt infections, the risk of shunt infection was associated with a four-fold increase, and Kestle et al.[16] observed a 30% rate of infection recurrence. In our study, the presence of previous shunt infections was the strongest risk factor. Considering this high risk and recurrence rate, effective treatment strategies should be evaluated to ensure sufficient treatment and subsequent prevention of shunt infection.

Currently, the optimal duration of antibiotic therapy is unknown. When the treatment of shunt infections with intravenous antibiotics is unsuccessful, antibiotics may be intrathecally administered.[2] Antibiotic-integrated shunts have been reported to decrease the risk of shunt infection.[8,11] Bowel perforation at a delayed stage after V-P shunt operation is a cause of recurrent meningitis, occurring at an incidence of 43%-48%.[13-17] For patients with frequent recurrent meningitis, bowel perforation should be considered.

Age at the time of shunt placement is one of the most important factors in shunt infection.[1,2,4-7,10] Our findings suggest that the majority of patients with shunt infection were <30 days of age at the time of shunt placement. Sciubba et al.[8] reported that V-P shunt placement in premature neonates was associated with approximately five-fold increase in the risk of shunt infections. A retrospective review by Vinchon et al.[17] on the incidence of shunt infections in premature neonates elicited the proposed recommendation that ventricular taps and external ventricular drainage in these children are effective until more definitive treatment with V-P shunt

placement.

Conclusion

Patients with shunt infections should be treated using appropriate antibiotics to prevent the development of recurrent shunt infections. Our study findings indicate that myelomeningocele is associated with shunt infection. Hence, myelomeningocele sac should also be repaired as early as possible and shunts should be inserted approximately 7 days after the closure of myelomeningocele sac.

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Conflict of Interest: None.

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