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Cerebrospinal fluid contents and risk of shunt exposure in hydrocephalus

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ABSTRACT

Background: Exposure of the shunt is a rare but severe complication after ventriculoperitoneal (VP) shunt placement. It is unclear whether particular levels of cerebrospinal fluids (CSF) protein, glucose, or polymorphonuclears (PMNs) may influence the shunt exposure in high-risk individuals.

This study aims to find the relation between CSF parameters and shunt exposure.

Methods: Examined preoperative CSF characteristics included CSF colour, protein, glucose, and PMNs content in 513 patients with hydrocephalus. Mann-Whitney test was used to determine the correlation between CSF parameters and shunt exposure.

Results: Shunt exposure was detected in 25 cases (4.87%). There was a significant relationship between distal tip exposure with preoperative glucose (p=0.000), protein level (p=0.007), or PMNs count (p=0.043).

Conclusion: Preoperative CSF contents had a significant correlation with shunt exposure in hydrocephalus patients.

Keywords: glucose; protein; polymorphonuclear cells; cerebrospinal fluid; shunt exposure

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INTRODUCTION

Cerebrospinal fluid (CSF) diversion by ventriculoperitoneal (VP) shunt installation is the backbone of hydrocephalus management in pediatric as well as in adult patients. Despite this, VP shunting is still susceptible to some failures. The most common cause of shunt revisions remains to be VP shunt malfunction including obstruction, infection, over drainage, subdural hematoma, and catheter migration.[1,2,10,15]

Exposure of the shunt is a rare but serious complication after VP shunt placement. The site of migration has been reported to be in various hollow organs including small, large intestine and stomach. More rarely, protrusion of catheter's distal tip to rectum, mouth, vagina and fallopian tubes, bladder, and scrotum has been documented.[3-5] The pathophysiology of catheter migration has not been completely understood, with increased intra-abdominal pressure, abdominal wall contraction, malnutrition, poor host condition, weak bowel movement, type of catheter, and shunt insertion procedure considered as potential risk factors.[6,11,18]

It is unclear whether particular levels of protein, glucose, or polymorphonuclear cells (PMNs) in the CSF can influence the shunt exposure in high-risk individuals.[7-9] As the investigation of this matter has not been thoroughly studied, therefore, we conducted this research to investigate whether there is an association between the CSF contents and shunt exposure in hydrocephalus patients in our centre at Kariadi General Hospital, Semarang, Indonesia.

METHODS

We conducted an observational retrospective study to assess the correlation between CSF contents with shunt exposure. Five hundred and thirteen VP shunt installation surgeries performed in our neurosurgical centre in Semarang, Indonesia, from 2010 to 2015. This study has been reviewed and approved by the Ethical Committee of Kariadi General Hospital, Semarang, Indonesia.

We evaluated preoperative CSF analysis performed for each surgery. We compared the level of protein, glucose, and PMNs count between the exposed group and the non-exposed group. Exposure group was defined as the exposure of distal tip of the catheter outside the peritoneal chamber. We recorded the demographic profiles and CSF characteristics in patients with and without shunt migration. Data analysis was performed with SPSS Statistics 19 (IBM, USA). Descriptive data, including sex, age, and CSF colour, were described for each group. We used the Mann-Whitney test to determine the significance between CSF parameters and VP shunt exposure. A significant correlation was determined if p<0.05.

RESULTS

We performed 513 cases of VP shunt installation in our centre in Semarang, Indonesia from 2011 to 2015. The average age at surgery was 13.63± 18.67 years ranged from 5 days old to 52 years old, consisted of 295 (54.8%) male and 243 (45.2%) female patients. The exposed shunt was observed in 25 patients (4.87%) in 15 male and ten female patients respectively, which were divided into retro-auricular exposure in 10 cases (40.0%), anal orifice exposure in 10 cases (40.0%), and abdominal wall exposure in 5 cases (20.0%). Patients' demography and CSF characteristics are presented in Table 1.

We found significant relationships between preoperative CSF contents with shunt exposure incidence. Both protein (p=0.007) and PMNs (p=0.043) count was higher in the exposed group compared to the non-exposed group, while the glucose contents were lower (p=0.000). In the exposed group, the amount of PMNs in CSF was increased on 15 cases, normal on 7 cases, and decreased in 3 cases. The protein level was higher than 150 mg/dL on 23 cases and normal in 2 cases. The glucose level was increased on 3 cases, normal in 8 cases, and decreased in 14 cases (Table 2).

Table 1 Patients demography and CSF characteristics

		Group	
	n (%); Mean ± SD	Malfunctioning (n=25)	Non-malfunctioning (n=513)
Sex			
Male	295 (54.8)	15 (5.1)	280 (94.9)
Female	243 (45.2)	10 (4.1)	233 (95.9)
Age	13.63 ± 18.67	5.33 ± 11.03	15.04 ± 18.88
CSF Color			
Slightly turbid	2 (0.4)	2 (100.0)	0 (0.0)
Brownish red	2 (0.4)	0 (0.0)	2 (100.0)
Clear	380 (70.6)	13 (3.4)	367 (96.6)
Turbid	15 (2.8)	0 (0.0)	15 (100.0)
Yellow	28 (5.2)	0 (0.0)	28 (100.0)
Slightly turbid yellow	4 (0.7)	1 (25.0)	3 (75.0)
Clear yellow	60 (11.2)	3 (5.0)	57 (95.0)
Turbid yellow	17 (3.2)	1 (5.9)	16 (94.1)
Light yellow	7 (1.3)	4 (57.1)	3 (42.9)
Red	15 (2.8)	0 (0.0)	15 (2.9)
Turbid red	1 (0.2)	0 (0.0)	1 (100.0)
Pink	7 (1.3)	1 (14.3)	6 (85.7)
Exposed location			
Retroauricula	10 (40.0)	10 (100.0)	0 (0.0)
Abdomen	5 (20.0)	5 (100.0)	0 (0.0)
Anus	10 (40.0)	10 (100.0)	0 (0.0)

CSF = cerebrospinal fluid; SD = standart deviation

Table 2 Comparison of CSF contents between groups

	Mean count (Range)			
	Malfunctioning (n = 25)	Non-malfunctioning (n = 513)	Normal Range	*P*
Protein	177.5 (0.63 – 727.5)	56.5 (0.3 – 797.1)	15 – 45	0.007
Glucose	49 (2 – 90)	59 (0 – 566)	45 – 80	0.043
PMN	12 (0 – 245)	2 (0 – 293)		0.000

PMN = polymorphonuclear cells; Normal range for protein is measured in mg/dL, glucose in mg/dL, PMN in cell/mm^3

DISCUSSION

Cerebrospinal fluid flow alteration with VP shunt placement has been the pillar of treatment in both adult and pediatric hydrocephalus. However, this procedure is associated with postoperative complication, including mechanical failure, infection, and functional defects.[7,12] Mechanical failure consists of equipment failure, breakage, obstruction, and migration of either proximal or distal catheter tip.

One of the rare complications of VP shunt installation is the migration of the distal catheter leading to distal tip exposure. Several authors have reported the site of shunt exposure including small and large intestine, stomach, rectum, mouth, vagina and fallopian tubes, bladder, breast, and scrotum, although the prevalence was relatively low (0.01%-1.4%).(5,13,18) Our observation-only recorded three sites of exposure in 25 patients, which were retroauricular (40.0%), abdominal wall (40.0%), and anal orifice (20.0%).

Several mechanisms have been suggested to explain the pathogenesis of shunt exposure, including foreign body reaction, localised infection, and local anatomic disadvantage. One of the hypotheses regarding the shunt exposure is the localised infections around the shunt materials, which subsequently create abscess and skin fistula leading to the exposure of shunt's tip outside the skin.[2,6,8] Other explanation is that the continuous stress on the skin may induce localised ischemia and necrosis later, forming an exit port for catheter, especially in susceptible regions with the thinner skin surface and weaker muscle contraction.[9,14,17] The anatomic site differences may explain the different cause of exposure, such as the thinning of the skin because of increased head circumference for retroauricular exposure, increased intra-abdominal pressure and weaker abdominal muscle in abdominal wall exposure, or peristaltic force expulsion leading to anal orifice exposure.

Assumed risk factors for shunt migration, including increased intra-abdominal pressure,

abdominal wall contraction, malnutrition, poor host condition, obesity, weak bowel movement, type of catheter, and shunt insertion procedure.[3,13,14] Besides these established factors, we found that preoperative CSF contents had a significant relationship with shunt exposure in hydrocephalus patients. Our results demonstrated that higher PMNs and protein and lower glucose content were related to shunt exposure, suggesting that preoperative infection of the CSF spaces might contribute to the occurrence of later exposure. The microorganism might spread via the shunt or during surgical insertion, leading to localised infection and subsequent exposure.[16,17]

We also observed that shunt exposure affected younger patients (5.33 ± 11.03 years in the exposure group versus 15.04 ± 18.88 years in the non-exposure group). Although shunt complication is more common in pediatric patients because of their relatively thinner scalp compared to adults and weaker immune system, we also observed a case of shunt exposure in the abdominal wall on a 52-year-old man.

The limitation of this study included the lack of data regarding the cause of hydrocephalus, nutritional statue as malnutrition might lead to poor immunity and propensity to infection, and the type of shunt implanted on each patient in the medical records. We also did not obtain a complete evaluation of the responsible microorganism, causing the infection of the shunt system. A further and more detailed study in the future will bring a better understanding of the factors attributed to VP shunt exposure.

CONCLUSION

Our findings demonstrated that preoperative CSF contents had a significant correlation with shunt exposure in hydrocephalus patients. Higher PMNs and protein and lower glucose content were related to shunt exposure. Consequently, it is imperative to determine the timing of shunt insertion based on CSF characteristics. Such information must be taken into account when neurosurgeons are executing and modifying shunt networks in individuals with altered CSF states.

CONFLICT OF INTEREST

The author declares there is no conflict of interest regarding publication of current study.

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