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Clinical Study

Risk factors associated with distal catheter migration following ventriculoperitoneal shunt placement

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ABSTRACT

Ventriculoperitoneal (VP) shunt placement is used to treat hydrocephalus. Shunt migration following VP shunt placement has been reported. The risk factors related to this complication have not been previously evaluated to our knowledge. In this retrospective cohort study, we aimed to determine risk factors leading to distal catheter migration and review the literature on the current methods of management and prevention. Adult patients undergoing VP shunt placement from June 2011 to December 2013 at a single institution were identified using electronic health records. The records were reviewed for demographic and procedural information, and subsequent treatment characteristics. The parameters of patients with distal shunt migration were compared to those undergoing new VP shunt placement for the same time period. We identified 137 patients undergoing 157 new VP shunt procedures with an average age of 57.7 ± standard deviation of 18.4 years old. There were 16 distal shunt migrations. Body mass index >30 kg/m^2 and number of previous shunt procedures were found to be independent risk factors for distal catheter migration. Obesity and number of previous shunt procedures were factors for distal catheter migration. Providers and patients should be aware of these possible risk factors prior to VP shunt placement.

1. Introduction

Since first being described in 1908 by Kausch, ventriculoperitoneal shunt (VPS) has become one of the most common procedures performed by neurosurgeons [1]. VPS is placed in patients with hydrocephalus which ranges in etiology from normal pressure hydrocephalus and idiopathic intracranial hydrocephalus to congenital cases such as aqueductal stenosis. During the placement of a VPS, a proximal catheter is placed in the ventricle and is connected to a valve. A distal catheter is connected to the distal end of the valve and then tunneled subcutaneously and placed in the peritoneal cavity, pleural space or atrium. The most common location for distal catheter placement is the abdominal cavity.[2] VPS is thought to be associated with reduced complications compared to ventriculoatrial and ventriculopleural shunts which contributes to its popularity [2–5].

However, complications following VPS shunt are not uncommon and are reported at a rate of 40 to 50% [2,6,7]. Shunt malfunction is reported at a rate of 40%, the majority of which are due to distal shunt failure [2,8–11]. Distal shunt migration where the peritoneal portion of the shunt is extruded from the peritoneal cavity into the subcutaneous soft tissue has also been reported [12–16]. This process leads to cerebrospinal fluid collection in the subcutaneous tissue, building pressure and ultimately resulting in a distal shunt malfunction.

To our knowledge the existing literature on the complication of distal catheter migration is limited to case reports. Here we perform a retrospective review of distal catheter migration to identify the risk factors predisposing to these complications. Additionally, we perform a literature review on the current techniques to eliminate these complications.

2. Method

This is a retrospective review investigating distal catheter migration. All adult patients (⩾18 years old) undergoing a VPS

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placement from June 2011 to December 2013 were identified using electronic health records. Patients who were over 18 years of age at the time of their VPS placement were included. Those who were less than 18 years of age, underwent VPS placement at a different institution, or had incomplete information, were excluded from the study.

University of Iowa's Institutional Review Board approval was obtained for this retrospective chart review. The electronic medical record, including the procedure and follow-up notes, were reviewed for demographic and procedural information, and subsequent treatment characteristics. The parameters of patients with distal shunt migration were compared to those undergoing new VPS placement for the same time period.

2.1. Surgical procedure

In our institution, all distal VPS placements are performed with a small laparotomy. A purse-string suture is placed in the peritoneal layer and tied down around the catheter as it enters the peritoneal cavity. The abdominal content (liver) is identified prior to placement of the catheter in the abdominal cavity.

2.2. Imaging

Following each shunt procedure a shunt series radiograph is obtained to confirm placement of the catheter in the abdominal cavity. All patients presenting with shunt malfunction are evaluated with a shunt series. When there is concern for migration of the distal catheter an abdominal CT scan is obtained to confirm the diagnosis.

2.3. Statistical analysis

Categorical variables are presented as number and percentage. Continuous variables are presented as mean ± standard deviation. Six different factors were proposed as potential predictors of distal shunt migration: age, body mass index (BMI; separated into <25, 25–30, and >30 kg/m^2), sex, presence of liver failure, presence of constipation, and number of prior shunt procedures. For continuous variables, univariate analysis was performed using a two-tailed Student's *t*-test. For nominal variables, univariate two-tailed chi-square analysis was performed. Multivariate analysis to identify possible predictors was conducted using binary logistic regression with the backward stepwise method. Statistical significance was determined as $P < 0.05$ for a 95% confidence interval (CI). All statistical analyses were performed by using the Statistical Package for the Social Sciences version 22.0 (IBM, Armonk, New York).

3. Results

3.1. Demographic

From June 2011 to December 2013 we identified a total of 150 patients who had new shunt placement or shunt revision for distal catheter migration (Fig. 1). Of these there were 137 patients undergoing 157 new VPS procedures with an average age of 57.7 ± 18.4 years. In this same time period there were 68 distal shunt revisions identified. Sixteen (23.5%) of the 68 distal shunt revisions were in 13 patients who had a shunt migration at an average age of 46.6 ± 14.9 years (Table 1). Of the 16 procedures with distal shunt migration, 68.8% were in patients undergoing new shunt revision in this time period. The majority of the shunt malfunctions (68.8%) occurred within 3 months of the initial procedure (Fig. 2).

3.2. BMI

The average BMI at the time of the procedure was 30.0 ± 9.8 kg/m^2 and 39.4 ± 8.7 kg/m^2 ($P < 0.001$) in the control and distal catheter migration group, respectively. The BMI of both groups were divided into normal (<25 kg/m^2), overweight (25–30 kg/m^2) and obese (>30 kg/m^2). In the normal and overweight group, BMI was not a risk factor for shunt migration. In the obese group, BMI was found to be an independent risk factor for shunt migration (odds ratio = 6.38, 95% CI = 1.16–35.21; $P = 0.033$).

3.3. Previous shunt procedures

The number of previous shunt procedures was also recorded in each patient. There were 11 patients with a history of previous shunt placement of the 158 new shunt procedures that were performed, with the total number of previous procedures ranging

Table 1
Demographics of control and distal catheter migration group procedures

	Control group (N = 146)	Distal catheter migration group (N = 16)	*P* value
Age, mean ± SD	57.7 ± 18.4 years	46.6 ± 14.9 years	0.03
Female, N (%)	70 (47.9%)	11 (68.8%)	0.147
BMI, mean ± SD	30 ± 9.8 kg/m^2	39.4 ± 8.7 kg/m^2	<0.001
Liver failure, N (%)	1 (0.01%)	0	0.732
Constipation, N (%)	5 (0.03)	0	0.438
Prior shunt malfunction, N (range)	20 (1–5)	16 (1–6)	<0.001

BMI = body mass index, SD = standard deviation.

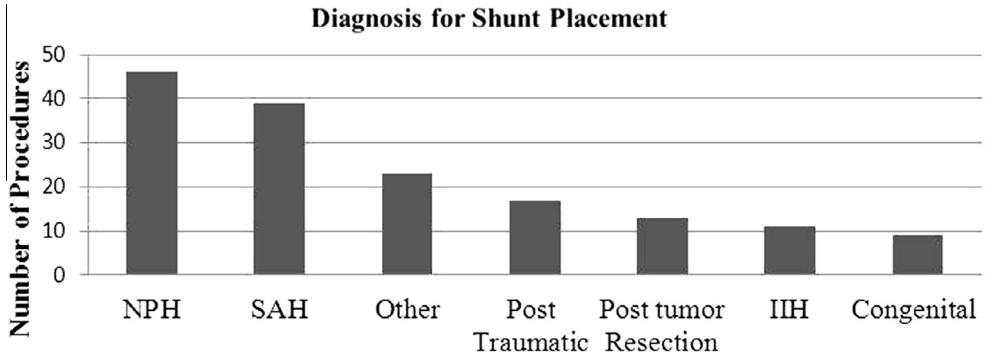

Fig. 1. Etiology of need for ventriculoperitoneal shunt placement. IIH = idiopathic intracranial hypertension, NPH = normal pressure hydrocephalus, SAH = subarachnoid hemorrhage.