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Research article

Risk of ventriculoperitoneal shunt infection with coexisting percutaneous endoscopic gastrostomy tube and associated factors

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ABSTRACT

Objectives: Percutaneous endoscopic gastrostomy (PEG) tubes and ventriculoperitoneal shunts (VPS) are commonly placed in neurologically impaired patients. There is concern about safety of VPS coexisting with PEG tubes due to the potential for an increased risk of infection. In this study, we assess the risk of VPS infection and the amount of time between both procedures.

Patients and methods: Retrospective chart review of patients from our institution who had VPS and PEG tubes placed during the same hospitalization between 2014 and 2018. Our primary focus was assessing risk of VPS infection and timing of procedures in this patient population. Additionally, we assessed other factors which may contribute to VPS infection including SIRS criteria at time of VPS placement, comorbidities and other procedures performed. None of the SIRS factors were associated with VPS infection.

Results: 45 patients met inclusion criteria. Our VPS infection rate was found to be 7% (n = 3). These patients had 4, 16, and 36 days between procedures. 89% of our patients had PEG tube placed prior to VPS with 2 of these patients developing a VPS infection. At the time of VPS placement 42% of patients had SIRS. None of the SIRS factors were associated with VPS infection.

Conclusion: Our VPS infection rate remained low even when they were performed during the same hospitalization as a PEG tube placement. SIRS is not associated with the development of VPS infections and is not an absolute contraindication to placing a VPS.

1. Introduction

Placement of a percutaneous endoscopic gastrostomy (PEG) tubes is a mechanism for providing enteral nutrition to patients who are unable to sustain sufficient oral intake for a variety of reasons. Although nasogastric and orogastric tubes provide a means for enteral nutrition, when the need for tube feeding is expected to be greater than 30 days, gastrostomy tubes are preferable [8]. PEG tubes are frequently placed in patients with impaired neurologic function due to various reasons including stroke, traumatic brain injury (TBI), and neurodegenerative disease. Amongst TBI patients, they have been found to be a reliable and cost saving procedure [7]. A proportion of these neurologically injured patients will have suffered from coexisting hydrocephalus which requires management by indwelling ventriculoperitoneal shunt (VPS) placement. There is a concern for increased risk of VPS infections if PEG tubes are simultaneously in place, because the placement of PEG tubes can potentially result in extraluminal contamination of the peritoneal cavity. Infections of VPS are challenging to diagnose and may have severe consequences requiring antibiotic treatment, prolonged hospitalization, and often the need for additional surgical interventions for revision or removal [9]. Systemic Inflammatory Response Syndrome (SIRS) is a marker for increased infection and metabolic rate in patients [10]. Some surgeons consider an elevated white blood count or fever a relative contraindication to placement of a VPS.

The overall rate of VPS infections has been estimated in the literature to be between 4-17% depending on populations assessed and definition of infection used in individual studies [1]. To date, only a small amount of individual studies have been published to determine the safety of PEG tube placement in these patients. The results have been conflicting with variable infection rate of VPS ranging between 0 and 50% when associated with PEG tube placement [3, 4, 5]. One systematic review found PEG tubes and VPS to be a safe combination [11]. However, the total

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number of patients available in the reviewed literature was 208 from 10 separate studies. Therefore, the overall safety of placing gastrostomy tubes in these patients is still poorly defined.

Additionally, when increased infection risk has been found, attempts to determine optimal length of time to allow between procedures have been limited. Cairns et. al concluded it may be wise to delay insertion of PEG tube for at least 10 days in order to reduce VPS infections [2]. Taylor et al. concluded in a study of 16 patients that simultaneous placement of PEG tube and VPS should be avoided during the same hospital admission [4]. An additional study evaluated 23 patients and suggested that the shunts that became infected occurred in patients where time intervals between procedures were shorter than the mean time interval in the overall study population which suggested a possible correlation with PEG tract maturation and led to a recommendation for a 30 day waiting period [6].

Given the low number of individual studies and one systemic review regarding the safety of coexisting PEG tube and VPS we decided to analyze our center's experience with such patients. Our goals were to define the risk of VPS infection and determine if there was a relationship between the time interval between the procedures, the presence of SIRS, and incidence of infection.

2. Patients and methods

Following review and approval of the study by the institutional review board at the Medical University of South Carolina, the billing records from our academic tertiary medical center were used to identify adult patients that received VPS and a PEG tube during the same admission Data was collected retrospectively for patients admitted between July 2014 and October 2018. We evaluated charts for dates of the procedures to determine the order in which they were performed and interval time period, the presence of VPS infection, comorbidities, demographic data, discharge disposition, indication for surgery, perioperative antibiotic use, and patient mortality. Culture results and procedure notes were reviewed after the placement of the VPS to identify patients that had evaluations for infection or repeat operations related to the VPS. We excluded incarcerated, pediatric, and pregnant patients. The incidence of VPS infection was calculated following the placement both the PEG tube and the VPS. Shunt infection was defined as a shunt that had bacterial growth from cerebrospinal fluid culture.

In order to identify other factors which could impact VPS infection after placement, we also assessed SIRS criteria at time of VPS placement. The SIRS criteria included were temperature >38 C or <36 C, heart rate >90/minute, respiratory rate >20/min, WBC >12000/uL or <4000 and SIRS criteria was met when 2 or more of these variables were abnormal. The data regarding SIRS criteria were obtained from the vital signs on the day of surgery.

Descriptive statistics were used to report the incidence of VPS infection. Continuous data was analyzed using Student's t-test if normally distributed or Mann Whitney U if skewed. Dichotomous data were compared using Pearson's Chi-Square of Fishers exact test. All statistical analysis was performed using SPSS version 24.0 (Chicago, IL). Statistical significance was determined using a p-value < 0.05.

3. Results

Over the study period, forty-five patients met inclusion criteria for the project. All of the shunts were placed into the peritoneal cavity and the PEG tubes were placed using the "Pull" method. The "Pull" method consists of placing an angiocatheter transcutaneously into the stomach and withdrawing the wire out of the mouth utilizing an endoscope. A gastrostomy tube is then attached to the wire and brought through the oropharanyx, down the esophagus into the stomach and out through the abdominal wall. It is held in place using a bolster against the stomach wall and skin. This allows scar tissue to form between the stomach and peritoneal lining resulting in a controlled gastrocutaneous fistula. A single dose of Peri-procedural antibiotics (Cefazolin) were given in all cases for both operations. The patients had an average age of 57.0 +/- 15 years and 47% were male. The median Hospital Length of Stay (HLOS) is 45 (28–65) days and the average admission GCS was 9 +/- 4 and the discharge Rankin score was 4.5 +/- 0.9. Comorbidities of the research population were common and listed here: Hypertension 67% Coronary Artery Disease 16%, COPD 9%, Congestive Heart Failure 9%, Diabetes 24%, Asthma 7%, Hyperlipidemia 11%, Stroke 7%, Smoking 2%, Hepatitis C 7%, HIV 4%, Chronic Kidney Disease 11%, Depression 7%, Other 7% (Sjogren's syndrome, Lupus, Gout). An external ventricular drain was in place in 82% of patients with a median time being present of 19 (14–27) days and 67% had a tracheostomy in place at the time of VPS placement.

Regarding timing of the procedures, the median time from admission to placement of PEG and VPS was 12 (9–16) and 28 (20–45) days respectively with the median number days between placement of the PEG and VPS being 14 (7–37) days. The majority of patients (89%) had their PEG tube placed before the VPS was placed. Of the patients that had their PEG tube and VPS placed within 7 and 14 days of each other the VPS infection rate was 13% and 5% respectively. Among patients who had their PEG tube and VPS placed within 7 days of each other the infection rate was 13% and within 14 days of each other the infection rate was 5%.

Overall, VPS infections were uncommon with an overall rate of 7% (n = 3). One patient that developed an infection had the VPS placed prior to the PEG by 36 days. Cultures ultimately revealed an infection from Serratia Marcescenes. The other infections had their PEG placed first at 4 and 16 days prior to VPS and cultures grew Escherichia Coli and Mycobacterium Abscessus, respectively. All of the patients that developed an infection had a previous external ventricular drain (EVD) in place for 3, 17, and 19 days. 81% of patients that did not develop a VPS infection had an EVD in place for a median time of 21 (14–30) days. Nine percent of patients that did not develop an infection had their VPS placed before their PEG tube. Longer term follow-up on the three patients with VPS revealed on in-hospital death and two patients with replacement of ventricular shunts. One was placed in the peritoneum and a second placed in the pleural space. The patient with a pleural drain was readmitted 4 months later with a recurrent Mycobacterium Abscessus infection in CSF and pleural fluid.

At the time of VPS placement 42% of patients had SIRS (2 or greater criteria met). Only one of the patients who ultimately developed a VPS infection had SIRS at the time of placement with 4/4 criteria present. That patient had the VPS placed 4 days after the PEG tube and was HIV and Hepatitis C positive, and had an EVD for 3 days. The other patients who developed infections had 0-1 SIRS criteria present. Of the patients that did not develop a VPS infection, 16% had an elevated temperature, 38% had an elevated heart rate, 40% had an elevated respiratory rate, and 31% had elevated WBCs at the time of VPS placement. The average values for SIRS criteria for patients with and without VPS infections are presented in Table 1.

4. Discussion

This study represents the second largest cohort reported to date on coexisting ventriculoperitoneal shunts and percutaneous endoscopic gastrostomy tubes and the largest study that included evaluation of the timing between the two procedures and their resulting complications. Consistent with previous retrospective studies, our overall infection rate was low at 7%. This fits within the range of widely estimated infection rates of VPS of 4–17% depending on the definition of infection used and the length of time the patient was followed, among other variables.

Among the patients that we assessed, we did not identify any factors that predisposed patients to VPS infections. Our low number of infections made it challenging to identify trends and potential risk factors leading to infections. Of interest, we did assess the order of procedures performed. In our

Table 1. Comparison of average SIRS criteria at time of VPS placement.

SIRS Criteria	NO VPS Infection	VPS Infection	p-Value
Temperature (C)	37.1 +/- 0.6	37.6 +/- 1.0	0.246
Heart Rate	86.3 +/- 14.2	90.0+/- 18.0	0.668
Respiratory Rate	19.4 +/- 3.7	20.3 +/- 5.7	0.681
White Blood Cell Count	10.8 +/- 4.5	10.7 +/- 4.0	0.986

cohort, the large majority of patients had PEG tubes placed prior to VPS placement (89%). This was different than most other studies published which either assessed predominantly patients with VPS placed prior to PEG tubes or had no significant difference between which was performed first. When evaluated in similar studies, the literature has shown that the order of placement may be important as the infection rate was lower if the PEG tube is placed after VPS [11]. Of interest, our infection rate remained low even in patients that had a PEG tube placed before a VPS.

One recently published study proposed simultaneous placement of VPS and PEG tubes could be a safe and potentially cost-saving option when indicated [12]. Another from 2001 found an unacceptably high infection rate of 50% when performed simultaneously [4]. We did not identify any patients at our institution that had the procedures done simultaneously, which was likely due to our institution-specific preference. We did find a 13% infection rate when the procedures were performed within 7 days of each other. This infection was detected in a patient that had their VPS placed 4 days after the PEG. We had no infections in patients with a VPS placed 5–14 days after the PEG. We would suggest proceeding with caution when considering the timing of procedures.

We also elected to assess the pre-operative inflammatory state of patients prior to VPS placement in this cohort of patients by looking at SIRS criteria at the time of operation. 42% of our patients met SIRS criteria at the time of VPS placement and only one patient developed an infection from this group. Unfortunately, this result may be subject to bias as our study would not have identified patients with SIRS who had procedures that were delayed due to concerns of sepsis.

Limitations of this study are similar to those of previous published research including the retrospective nature of the review. Due to the small sample size, we may be underpowered to determine an actual factor associated with the development of a VPS infection. Additionally, we did not obtain a control group of patients with VPS placement without coexisting PEG tube placement. We also could have missed patients that were treated for a post-discharge shunt infection if they were treated at a different hospital. However, we would expect this situation to be extremely rare as the majority of significantly ill neurosurgical patients in our region are treated at our institution.

5. Conclusions

Our VPS infection rate remained low even when placement was performed during the same hospitalization as PEG tube placement. SIRS is not associated with the development of VPS infections and is not an absolute contraindication to placing a VPS. Due to the small number of patients at individual institutions, prospective multicenter studies evaluating the optimal safe timing and order of procedures between VPS and PEG are warranted.

Declarations

Author contribution statement

Kevin Tyler, Stuart M. Leon, Stephen Lowe, Ryan Kellogg, Jonathan Lena, Alicia R. Privette, Evert A. Eriksson: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

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