Systematic review of ventricular peritoneal shunt and percutaneous endoscopic gastrostomy: a safe combination

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OBJECTIVE Various international and national gastrointestinal guidelines take different positions on whether ventriculoperitoneal shunt (VPS) insertion is a contraindication to percutaneous endoscopic gastrostomy (PEG). The objective of this meta-analysis was to try to answer the question of whether VPS insertion is a contraindication to PEG.

METHODS A systematic review of the literature was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Electronic databases PubMed and Embase were searched using variations of the terms “ventriculo-peritoneal shunt” and “percutaneous (endoscopic) gastrostomy.” This search resulted in 70 studies, 9 of which were relevant. These were cross-referenced, and 1 additional study was found, resulting in 10 studies in this systematic review.

RESULTS The 10 relevant studies in adult cohorts included 208 patients. All studies save one were retrospective and, in general, poor quality. Among the studies with relevant data, there were 26 (12.5% of 208 cases) VPS infections and 4 (4.4% of 90 cases) VPSs that malfunctioned. In 137 patients the VPS had been placed before the PEG tube, with a VPS infection rate of 4.4%. More VPS infections occurred among the 55 patients who first had a PEG and a subsequent VPS (21.8%) and in the 16 patients who had simultaneous PEG tube and VPS placement (50%). The heterogeneity of the studies in this analysis prohibited statistical comparisons of the timing of VPS and PEG tube placement.

CONCLUSIONS This systematic review indicated that VPS placement in combination with a PEG has a high but acceptable VPS complication rate. Therefore, VPS insertion should not be considered a contraindication to the placement of a PEG tube. Preferably, a PEG tube should be placed after the VPS. Waiting 7–10 days between VPS insertion and a PEG seems reasonable, but this could not be corroborated in this review.

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KEY WORDS ventriculoperitoneal shunt; gastrostomy; percutaneous endoscopic gastrostomy; hydrocephalus

PERCUTANEOUS endoscopic gastrostomy (PEG) is a safe and frequently performed procedure in patients who are incapable of sufficient oral intake. If more than 6 weeks of nasogastric tube feeding is expected, placement of a PEG tube can be considered.¹³ Neurological disease with concomitant difficulty in or unsafe swallowing is a common indication. Some neurological diseases are accompanied by hydrocephalus, requiring drainage of cerebrospinal fluid (CSF). Ventriculoperitoneal shunting is a widely used method.¹⁷

Some gastrointestinal guidelines consider ventriculoperitoneal shunt (VPS) insertion as a contraindication to PEG.²³ Other guidelines state that VPS placement is a relative contraindication,^{9,11} but they only refer to pediatric

cohorts^{6,19} or have no references at all. Two other guidelines do not consider VPS insertion a contraindication to a PEG,^{12,13} but they only cite a single article in support of this recommendation.⁷ To the best of our knowledge, neurological or neurosurgical guidelines do not have a position on the combination of VPS and PEG tube placement.

Given the conflicting advice contained in the different guidelines and the sparse supporting references cited by the guidelines, we performed a systematic review to better determine whether VPS insertion should be considered a contraindication to PEG. We also posed 2 specific questions: 1) Is the order of placement (first VPS then PEG or first PEG then VPS) related to the VPS complication rate? and 2) Is there a relation between the time interval

ABBREVIATIONS CSF = cerebrospinal fluid; PEG = percutaneous endoscopic gastrostomy; VPS = ventriculoperitoneal shunt.

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TABLE 1. Complications in adults who underwent VPS and PEG tube placement, according to the order of placement

Group	PEG Complication	VPS Infection	VPS Malfunctioning	Overall VPS Complications
All adult patients (N = 208)	7/79 (8.9%)	26/208 (12.5%)	4/90 (4.4%)	30/206 (14.4%)
All adult patients, except those with simultaneous placement (N = 192)	7/79 (8.9%)	18/192 (9.4%)	4/90 (4.4%)	22/192 (11.4%)
VPS then PEG (N = 137)	7/79 (8.9%)	6/137 (4.4%)	4/90 (4.4%)	10/137 (7.3%)
PEG then VPS (N = 55)	0/0	12/55 (21.8%)	0/0	12/55 (21.8%)
Simultaneous placement (N = 16)	NS	8/16 (50%)	NS	8/16 (50%)

N = number of patients; NS = not specified.

Denominators reflect the number of patients from studies reporting a specific outcome.

between VPS and PEG tube placement, and the VPS complication rate.

Methods

We developed a review protocol based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (www.prisma-statement.org). Electronic databases PubMed and Embase were searched (L.H.O. and J.C.F.K.) for the period from database inception up to October 1, 2015. The following terms, as well as synonyms and closely related words, were used as index terms or free-text words: “ventriculo-peritoneal shunt” or “VPS” and “percutaneous (endoscopic) gastrostomy” or “PEG.” The full search strategies for the PubMed and Embase databases can be found in our Supplementary Tables 1 and 2. Duplicate articles were excluded.

Two reviewers (L.H.O. and P.S.) performed the literature search and selected articles. Disagreements between the reviewers were resolved by consensus. Eligibility cri-

teria were that all studies report outcomes in patients who had undergone both PEG tube and VPS insertion, regardless of the order of placement. Non-English language studies were included. Congress abstracts were excluded in the systematic review but were reported to determine if they were a possible source of bias. Case reports were also excluded because of possible bias (probably no case reports of successful VPS and PEG tube placement). We also excluded studies performed in pediatric cohorts to decrease confounding since age is considered a risk factor for VPS infection in some studies.²¹ Our search resulted in 70 publications, 45 of which were excluded because they were not relevant, 12 because they were case reports, and 4 because the studies had been performed in children (Fig. 1). There were 9 relevant studies in adults.^{1,2,7,10,15,18,20,22,24} The references were cross-referenced for further original data, and we identified an additional relevant study.⁸ We found 2 studies that were only published in abstract form.^{3,14}

If possible, we extracted the following information

TABLE 2. Summary of details of 10 studies of adults with VPS and PEG tube placement

Authors & Year	Duration of Study	Type of Study	Time Btwn VPS & PEG Placement	Follow-Up	Control
Graham et al., 1993	1990–1992	Single center prospective	Minimally 1 wk, mean of 2.2 wks	Mean 8.6 mos, range 1–24 mos	None
Grant, 1993	1985–1992	Single center retrospective	NS	“Postoperative follow-up”	None
Taylor et al., 2001	1995–1999	Double center retrospective	Simultaneous	Mean 22.5 mos, range 7–46 mos	0/21 (VPS control)
Baird & Salisidis, 2004	1991–1999	3 centers, retrospective	33 days	Range 3–40 mos	None
Schulman & Sawyer, 2005	1995–2004	Single center retrospective	Mean 43.1 days	NS	None
Nabika et al., 2006	1996–2002	Single center retrospective	All: 29.3 days VPS then PEG: 27.2 days PEG then VPS: 39.2 days	Mean 66 days, range 14–165 days	6/123 (4.9%) p = 0.052 (VPS control)
Roeder et al., 2007	1990–2002	Single center retrospective	NS	Minimally 1 yr	N = 105 (PEG control)
Cairns et al., 2009	2002–2007	Single center retrospective	Median 79.5 days, range 1–943 days	Median 24 mos, range 0.5–60 mos	None
Kim et al., 2009	1999–2006	Single center retrospective	308.7 days, range 65–831 days	Mean 6.4 mos, range 1–15 mos	N = 48 (PEG control)
Vui et al., 2013	18 mos, years not specified	Single center retrospective	61 days, range 1–187 days	140 days, range 20–570 days	None

FIG. 1. Flowchart of systematic search of PubMed and Embase databases, for the period from database inception to October 1, 2015.

from the studies: duration of study, number of patients, order of VPS and PEG tube placement, use of prophylactic antibiotics, type of PEG (pull PEG, push PEG, or surgical placement), interval between placement of VPS and PEG tube, duration of follow-up, PEG complications, VPS infection, VPS malfunction, overall VPS complications, and whether there was a control population. We contacted the corresponding authors if some of the data could not be found in the original articles^{2,7,8,18,20} and the 2 abstracts.^{3,14} Two authors responded, but unfortunately they did not have additional data (J.S. Roth, personal communication, 2014; and R.G. Sawyer, personal communication, 2014).

The studies were summarized with the extracted data. Total number of patients and events (PEG adverse event, VPS infection, VPS malfunction, and overall adverse events) were added to calculate aggregate event rates.

Using Review Manager version 5.3, we made a forest plot for the 3 studies that included patients with both orders of placement (PEG tube then VPS and VPS then PEG tube) for overall VPS-related adverse events.^{2,15,18} Heterogeneity among these 3 studies was also tested with the Review Manager.

Data extracted from the articles were insufficient to investigate our question of whether there is a relation between the time interval between VPS and PEG tube placement, and the VPS infection or malfunction rate. In only 6 studies, comprising 79 patients and 13 VPS infections, were per-patient data reported.^{1,7,10,15,22,23} One of these studies included 8 VPS infections, making these results too heterogeneous to compare. Studies reporting only the average time between VPS and PEG tube placement were also insufficient to analyze the timing between VPS and

TABLE 3. Details of placement method, complications, and prophylactic antibiotics

Authors & Year	No. of Patients	Method of PEG Placement	Order	PEG Complication	VPS Infection	VPS Malfunction	Overall VPS Complications	Antibiotic Prophylaxis
Graham et al., 1993	15	Pull PEG	VPS then PEG	0/15	0/15	1/15 (7%)	1/15 (7%)	Cefazolin
Grant, 1993	11	Pull PEG	VPS then PEG	NS	0/11	0/11	0/11	Cefazolin
Taylor et al., 2001	16	Pull PEG	Simultaneous	NS	8/16 (50%)	0/16	8/16 (50%)	Antibiotic prophylaxis
Baird & Salisidis, 2004	6	Pull PEG	VPS then PEG	0/6	0/6	0/6	0/6	Cefazolin
Schulman & Sawyer, 2005	39	Push PEG	VPS then PEG	4/39 (10%)	2/39 (5%)	2/39 (5%)	4/39 (10%)	Antibiotic prophylaxis
Nabika et al., 2006	23	Pull PEG	11 VPS then PEG 12 PEG then VPS	NS	1/11 (9%) 3/12 (25%)	3/23 (13%)	1/11 (9%) 3/12 (25%)	Cefazolin
Roeder et al., 2007	55	22 surgically, 33 pull PEG	25 VPS then PEG 30 PEG then VPS	NS	2/25 (8%) 5/30 (17%)	NS	2/25 (8%) 5/30 (17%)	Antibiotic prophylaxis
Cairns et al., 2009	24	Pull PEG	11 VPS then PEG 13 PEG then VPS	NS	1/11 (9%) 4/13 (31%)	NS	1/11 (9%) 4/13 (31%)	1.5 g Cefuroxime
Kim et al., 2009	7	Pull PEG	VPS then PEG	1/7 (14%)	0/7	0/7	0/7	Antibiotic prophylaxis
Vui et al., 2013	12	Pull PEG	VPS then PEG	2/12 (17%)	0/12	1/12 (8%)	1/12 (8%)	Cefazolin

PEG tube placement.^{2,20} Other studies did not report any details of time between placement of a VPS and a PEG tube.^{8,18}

Results

We found 10 eligible studies performed in adults, which included 208 patients (Table 1). Nine of the 10 studies were retrospective and most were single center. The PEG tubes were mainly endoscopically placed (89% cases). Tubes in the remaining 11% were surgically placed. In 3 studies some patients did not receive antibiotics. Among the patients who underwent sequential rather than simultaneous VPS and PEG tube placement (192 patients), 18 (9.4% of 192) had VPS infections, 4 (4.4% among the 90 cases with reported data) had VPS malfunctions, 22 (11.4% of 192 patients) had overall VPS complications (infection and malfunction), and 7 had PEG complications (8.9% among the 79 cases with data). Details of the different studies are shown in Tables 2 and 3.

In 137 patients the VPS placement preceded the PEG tube placement, whereas in 55 patients the order of the procedures was reversed. Fewer VPS infections occurred when a VPS was placed before a PEG (6 [4.4%] of 137 cases) as compared with the reverse order (12 [21.8%] of 55). There were also fewer overall complications in patients with VPS placement preceding PEG tube placement (7.3% vs 21.8%). One study with simultaneous VPS and PEG tube placement in 16 patients described a VPS infection rate of 50%.²² Data for each study are shown in Tables 2 and 3. A summary of the 3 studies with both orders of placement is featured in Fig. 2. The forest plot indicates fewer VPS infections in the group that first had a VPS and then a PEG. These 3 studies were comparable and lacked heterogeneity as judged by the high *p* value for heterogeneity (*p* = 0.88) and low *I*² (0%).

Two studies had an appropriate VPS control population (that is, VPS placement without PEG).^{15,22} These 2 studies could not be directly compared, however, because the VPS and PEG tube had been placed simultaneously in the study by Taylor et al.²² In that study none of the 22 patients with a VPS alone (and no PEG) had a VPS infection. In the study by Nabika et al.,¹⁵ 6 VPS infections (5%) were noted in 123 patients with a VPS, as compared with 4 VPS infections (17%) in the 23 patients with a VPS and PEG tube (*p* = 0.052). The higher VPS infection rate in that study was mainly attributable to the 12 patients with PEG tube placement prior to VPS placement (3 [25%] of 12 vs control; *p* = 0.01). In the 11 patients with a VPS prior to PEG tube placement, there was no significant difference (1 [9%] of 11 vs control; *p* = 0.2).¹⁵

Two studies had PEG patients as controls (PEG without VPS). The first study did not show a higher mortality rate 1 year after PEG in the patients with a VPS and PEG tube compared with the patients with only a PEG.¹⁸ The second study did not indicate a greater PEG complication rate in patients with or without a VPS.¹⁰

Time between VPS and PEG placement could not be systematically compared because the data were too heterogeneous. One study reported a higher VPS complication rate if the time between VPS placement and PEG was < 10 days (3 [30%] of 10 cases) compared with ≥ 10 days (2 [14%] of 14; *p* = 0.7). Although this is a clinically relevant difference, it was not a statistically significant difference.

Discussion

Patients with hydrocephalus and a VPS sometimes have an indication for a PEG for adequate feeding. Guidelines provide little, and sometimes even contradictory, evidence on whether a VPS should be considered a contraindication to PEG.^{9,11–13,23} In our analysis of adults with hydrocephalus,

FIG. 2. Forest plot of the 3 studies including both placement orders (VPS then PEG and PEG then VPS). Data were analyzed with Review Manager version 5.3. M-H = Mantel-Haenszel.

lus who had undergone sequential, rather than simultaneous, VPS and PEG tube placement, there were 8.9% PEG complications (7 of the 79 cases with available data), 9.4% VPS infections (18 of 192 cases), and 4.4% malfunctioning VPSs (4 of 90 cases). These data suggest that VPS insertion is not a contraindication to PEG. A VPS infection rate of 4.4% among 137 adults with VPS placement first and then PEG is well within the VPS infection rate of 4%–8% seen in most adult neurosurgical units.^{17,25} Judging from these data, we think that VPS insertion should not be considered a contraindication to PEG tube placement.

All VPS infections are important because of the morbidity associated with them. Mortality in patients with VPS infections was reported as high as 14%.¹⁶ In up to 80% of shunt infections, additional surgical procedures are required. Surgical procedures can include removal with or without temporary external ventricular drainage or VPS revision. Treating VPS infections is time consuming and costly, and every additional procedure has the inherent risks of intracranial bleeding and new infections.^{4,16}

The VPS infection rate is lower if the PEG tube is placed after the VPS (4.4% vs 21.8%). Although the reviewed studies were heterogeneous, we believe that the order of placement can be directly compared because of the clear distinction in the order of placement. Only after combining the results of the 3 studies with both orders of placement was it apparent that the order of placement is important.^{2,15,18}

In the studies included in this systematic review, there were very few PEG complications (8.9% among the 79 patients from reporting studies). This rate is much lower than that reported in the general literature whose PEG complication rate is between 13% and 70%.⁵ A likely explanation for this finding is the retrospective nature of the studies included in our systematic review and the emphasis on VPS complications and not PEG complications.

Unfortunately, it was not possible to analyze the timing between VPS and PEG tube placement in relation to the VPS complication risk. One of the authors we contacted for additional data suggested waiting a minimum of 3 days but preferably 7 days (J.S. Roth, personal communication, 2014). Another author was comfortable waiting only 1 day between VPS and PEG tube placement (R.G. Sawyer, personal communication, 2014). Cairns et al. suggested waiting at least 10 days;² however, their VPS infection rate did not differ if the PEG tube was placed within or after 10 days of VPS insertion. Kim et al. advised waiting 14

days.¹⁰ Others advocated waiting at least 1 month.¹⁵ However, data from our systematic review do not suggest that the VPS complication rate is lower if you wait that long. All PEGs are elective procedures, and tube feeding is a safe alternative while waiting for a safe window for PEG tube placement. Judging from our own experience and the literature, waiting at least 7–10 days is advisable.

The main limitation of this systematic review is inherent to the data that are summarized. All but one of the studies were retrospective, and there are likely many confounders that were not corrected for. One could question whether outcomes of the 10 studies can “just” be added, as we did in Table 1. A subset of 3 studies analyzed with Review Manager gave similar results and indicated little heterogeneity. Nevertheless, this systematic review combines all known data to give the best “evidence-based” advice for clinicians considering the combination of a PEG and VPS insertion. Per-patient data could have made a comparison somewhat better, but that would not have changed the retrospective nature of the data. The retrospective character and short duration of the studies will probably give an underestimation of the complications after VPS and PEG tube placement. We did not find a publication bias per se, as all outcomes are relevant, and there were no “negative” outcomes limiting publication. In the future, large prospective studies are not expected because of the small number of patients who require both a VPS and a PEG tube.

Conclusions

Ventriculoperitoneal shunt placement should not be considered a contraindication to a PEG, though the specific combination should be discussed with patients. In 137 adults with PEG tube placement after VPS insertion, the VPS infection rate was an acceptable 4.4%.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: LH Oterdoom, Scholten. Acquisition of data: LH Oterdoom, Ket. Analysis and interpretation of data: LH Oterdoom, DLM Oterdoom, Ket, Scholten. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: LH Oterdoom. Statistical analysis: LH Oterdoom, Van Dijk. Administrative/technical/material support: LH Oterdoom, DLM Oterdoom. Study supervision: Scholten.

Supplemental Information

Online-Only Content

Supplemental material is available with the online version of the article.

Supplementary Tables 1 and 2. <https://thejns.org/doi/suppl/10.3171/2016.8.JNS152701>.

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