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ORIGINAL ARTICLE

Outcomes of push and pull percutaneous endoscopic gastrostomy placements in 854 patients: A single-center study

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Abstract

Background and Aims: Percutaneous endoscopic gastrostomy (PEG) is indicated for prolonged enteral nutrition. This study aimed to analyze the outcome and to identify potential risk factors for complications in PEG procedures.
Methods: A single-center retrospective analysis of the performed PEG procedures during the period January 2010 till January 2020.
Results: A PEG placement procedure was performed in 854 patients (64.1% male) and was successful in 833 (97.5%). In total, 513 push (61.6%) and 320 pull (38.6%) PEGs were placed. The mean age was 60.7 years, and the median follow-up was 267 days. The push PEG was associated with peri-procedural bleeding ($P = 0.002$) and tube dislodgements ($P < 0.001$), while the pull PEG was significantly associated with buried bumpers ($P < 0.001$), infected placement sites ($P = 0.019$), and granulation tissue formation ($P = 0.044$). The PEG-related mortality rate was 0.2%, but the overall 30-day mortality was 4.0%.
Conclusion: The current study showed that the push and pull PEG placements are both safe and feasible procedures, with a low PEG-related mortality. Buried bumpers, infected placement sites, and granulation tissue formation are more often seen in the pull PEG, while the push PEG is associated with periprocedural bleeding and tube dislodgements. These complications should be taken into account and there is a need for a prospective trial to identify superiority between the PEG methods.

Introduction

Percutaneous endoscopic gastrostomy (PEG) is indicated for patients who are in need of prolonged enteral nutrition to ensure adequate intake.[1] Enteral feeding is preferred over parenteral feeding among patients with an adequate working digestive system.

The first PEG placement was described in 1980 by Gauderer and Ponsky.[2] Up till now, it is an established procedure and has replaced the laparotomy for the initial placement of a feeding tube. The PEG placement appears to be a safe and feasible procedure, it only requires the use of an endoscope. Therefore, it is considered as an invasive percutaneous procedure that may contribute to a higher risk for complications.

In the current literature, the complication rate for PEG placement procedures varies between 16 and 70%.[3–5] PEG-related complications can be classified by their severity. Minor complications such as, infected placement site, granulation tissue formation, minor bleeding, tube blockage, leakage, and tube dislodgement occur in most patients. Major complications such as, peritonitis, major (arterial) bleeding, aspiration pneumonia, buried bumper, bowel perforation, sepsis, and PEG-related mortality are more devastating.

The overall 30-day mortality rate after PEG tube placement varies from 2.4 to 23.9%,[6–15] however, PEG-related mortality is much lower.

Both push and pull methods are frequently used, while worldwide the pull PEG is more common. Yet, data concerning outcomes of both procedures, such as complications, unsuccessful placements, and mortality are sparse. We aimed to evaluate the outcome including complications in both the push and pull PEG in patients with initial PEG placement.

Methods

Study design. In this retrospective single-center study, adult patients who underwent PEG placement at the Amsterdam University Medical Centers Location VUmc during the period of January 2010 till January 2020 were included. Patients younger than 18 years and those patients who were mentally incompetent were excluded from this study. This study was reviewed and

approved by the Medical Ethical Review Committee of the Amsterdam UMC, location VUmc.

Data collection. In the endoscopy report database and admission records, eligible patients who underwent PEG placement during the study period were identified.

Electronic medical records were reviewed to collect demographical data, and PEG procedure related outcome including complications and mortality. The following data were collected: age, gender, weight, height, body mass index (BMI), diabetes mellitus (DM), hypertension, chronic pulmonary disease, stroke, malignancies, type of PEG placement, and medication used.

PEG protocol. At this department, PEG placement is being performed via the push and the pull method. Both procedures require an endoscope, which will pass through the oral cavity toward the stomach. There is gastric insufflation to position the stomach to the abdominal wall. With diaphany from the endoscope and indentation of the stomach by finger impression, the position for the puncture site is determined. The pull method introduces a guidewire through the puncture site and this is grasped by the endoscope through the esophagus and oral cavity. Subsequently, a PEG tube is guided over the wire through the oral cavity into the stomach.

The push method follows the same principle by using the endoscope for insufflation and diaphany, however, the push PEG is not guided through the oral cavity. With the aid of two t-fasteners, the gastric wall is attached to the anterior abdominal wall, subsequently, a small incision is made where the tube is directly introduced through the abdominal wall into the stomach.

The PEG method of preference varies in the patient population. Neurological patients with dysphagia are often assigned for pull-type PEGs, while oncologic patients receive often a push-type PEG. In oncologic patients, such as ear-nose-throat (ENT) and esophageal malignancies, the malignancy can be obstructive for the pull-type tube. Several cases of ENT metastasis by pull PEG placement have been described.[16] However, if oncologic treatment with palliative intent or the malignancy is not in contact with the oral tract, pull-type PEG may be considered.

Patients who are assigned for PEG placement receive 1-h prior procedure intravenously prophylactic antibiotics, such as cefuroxime 1.5 g or cefazolin 1 g. Furthermore, patients are sedated with midazolam and fentanyl, however patients with Amyotrophic Lateral Sclerosis are not sedated due to the risk of respiratory complications.

Study objectives. The objective of this study was to analyze the differences in outcome of the push PEG and the pull PEG and to identify complications associated with the type of placement.

Complications, unsuccessful placements and the 30-day mortality were gathered for both procedures.

The definition of minor bleeding is considered mild bleeding after or during the procedure requiring no intervention, whereas major bleeding needed intervention, such as compression, adrenaline injection and surgery.

Statistical analysis. Categorical data are presented as proportions and of continuous data the mean and standard deviation are displayed. For the comparison of patients' demographical data and complications with the technique performed (i.e. push or pull), the Fisher's exact test and independent samples *t*-test were used for categorical and continuous variables, respectively.

All statistical analyses were performed by IBM SPSS Statistics software version 26.[17]

Results

Baseline characteristics. In total, 854 patients underwent initial PEG procedure during the study period. Of the 854 eligible patients, 523 were planned for the push-type PEG and 331 for the pull-type PEG. The clinical characteristics, indication for PEG placement, comorbidities, and the use of medication are summarized in Table 1. The mean age was 60.7 (12.4) years, and the median follow-up time was 267 (range 1–3639) days. There were 572 (66.9%) male patients referred for PEG placement.

The indications for PEG placement were classified in to three groups: malignancy (74%) followed by neurological disease (17.9%), and other dysphagia or malnutrition morbidity (8.1%). Of the malignancy group, head and neck malignancies ($n = 581$) were the most common indication followed by malignancies of the lung ($n = 25$), the esophagus ($n = 20$), the thyroid gland ($n = 2$) metastasis of renal cell carcinoma ($n = 1$), and metastasis to neck lymph nodes with unknown primary tumor ($n = 6$). Three patients had both esophageal and lung malignancies.

The neurological disease group included, stroke ($n = 43$), Amyotrophic Lateral Sclerosis ($n = 16$), neurotrauma ($n = 36$), multiple sclerosis ($n = 8$), Parkinson disease ($n = 4$), and other neurological related indications ($n = 46$).

A total of 211 patients (24.7%) had hypertension, 123 patients (14.4%) chronic pulmonary disease, and 104 patients (12.2%) DM. Proton pump inhibitors (32.1%) were the most used medication, followed by anti-platelets (15.7%) and anticoagulants (14.2%).

Complications. Table 2 summarizes the differences in incidences of complications, unsuccessful placements, and the 30-day mortality between the push-type and pull-type group. For minor bleeding, infected placement site, granulation tissue formation, tube dislodgement, buried bumper, and the 30-day mortality significant differences in incidences were found.

A total of 364 (42.6%) complications were reported in 854 patients. PEG placement was successful in 833 patients (97.5%). The PEG-related mortality was 0.2%, but the overall 30-day mortality was 4.0%.

The most frequent complication was tube dislodgement (8.5%), followed by granulation tissue formation (8.4%) and infected placement site (6.2%). Buried bumpers occurred in 3.0% of the cases, which is described significant more often with the pull method. In two patients, buried bumper occurred twice. Buried bumpers were removed endoscopically ($n = 20$) and in one case surgically replaced for a jejunostomy.

Periprocedural minor bleeding occurred in 43 patients (5.0%) with no additional intervention required. Major bleeding occurred in four cases within 48 h after push PEG placement, while in three cases this occurred within 30 days of placement.

Table 1 Demographics

Variables	Total patients ($n = 854$)	Push PEG ($n = 523$)	Pull PEG ($n = 331$)	*P* value
Age (mean, SD)	60.7 (12.4)	61.4 (9.8)	59.5 (15.9)	0.05
Sex (%), *n*				
Male	572 (66.9%)	368 (70.4%)	203 (61.3%)	0.007
Female	283 (33.1%)	155 (29.6%)	128 (38.7%)	
BMI (mean, SD)	22.9 (4.6)	23.1 (4.5)	22.7 (4.7)	0.27
ASA				
I	35 (4.2%)	27 (5.2%)	8 (2.4%)	<0.001
II	544 (63.7%)	377 (72.1%)	167 (50.5%)	
III	259 (30.3%)	115 (22.0%)	144 (43.5%)	
IV	16 (1.9%)	4 (0.7%)	12 (3.6%)	
Indication for PEG (%), n				
Malignancy	632 (74.0%)	491 (93.9%)	141 (42.6%)	<0.001
Head and neck	581 (61.3%)	466 (89.1%)	115 (34.7%)	
Other	51 (6.0%)	25 (4.8%)	26 (7.9%)	
Neurological disease	153 (17.9%)	14 (2.7%)	139 (42.0%)	
Stroke	43 (5.0%)	1 (0.2%)	42 (12.7%)	
Other	110 (12.9%)	13 (2.5%)	97 (29.3%)	
Other	69 (8.1%)	18 (3.4%)	51 (15.4%)	
Comorbidities (*n*, %)				
DM	104 (12.2%)	53 (10.1%)	51 (15.4%)	0.02
Hypertension	211 (24.7%)	135 (25.8%)	76 (23.0%)	0.37
Chronic pulmonary disease	123 (14.4%)	85 (16.3%)	38 (11.5%)	0.06
Medication (%), *n*				
Anti-platelets	133 (15.6%)	71 (13.6%)	52 (15.7%)	0.63
Anticoagulants	121 (14.2%)	50 (9.6%)	66 (19.9%)	<0.001
PPI	274 (32.1%)	134 (25.6%)	114 (34.4%)	0.01
Prior abdominal surgery (%), *n*	112 (13.1%)	72 (13.8%)	40 (12.1%)	0.60

ASA, American Society of Anesthesiologists; BMI, Body Mass Index; DM, diabetes mellitus; PPI, proton pump inhibitor; SD, standard deviation.

Four cases were treated with epinephrine injections, two cases needed surgical intervention and one patient became hemodynamic instable and was admitted to the intensive care unit, where he recovered through conservative management.

Antiplatelet or anticoagulant therapy was used by 254 patients (29.7%). The anticoagulants, such as coumarin derivatives and direct oral anticoagulants (DOAC), were stopped 3 up to 5 days and 48 h respectively, prior to the intervention. In 13 cases, periprocedural minor bleeding occurred, although major bleeding was not reported in these groups. The periprocedural minor bleeding occurred in seven cases in the antiplatelet group, while in the anticoagulant group six cases were reported. Prior to PEG placement the thrombocytes, activated Partial Thromboplastin Time (APTT) and International Normalized Ratio (INR) were examined. If INR > 1.5, aPTT > 50 s or thrombocytes < 50.000×10^9 the placement was contra-indicated. None of these patients had deviating lab values.

Table 2 Overview of complications

Variables	Total ($n = 854$)	Push PEG ($n = 523$)	Pull PEG ($n = 331$)	*P*-value
Complications	364 (42.6%)	222 (42.4%)	142 (42.9%)	0.943
Minor bleeding	43 (5.0%)	36 (6.9%)	7 (2.1%)	0.002
Infected placement site	53 (6.2%)	24 (4.6%)	29 (8.8%)	0.019
Granulation tissue formation	72 (8.4%)	36 (6.9%)	36 (10.9%)	0.044
Tube blockage	34 (4.0%)	25 (4.8%)	9 (2.7%)	0.152
Tube dislodgement	73 (8.5%)	62 (11.9%)	11 (3.3%)	<0.001
Site leakage	46 (5.4%)	27 (5.2%)	19 (5.7%)	0.757
Major bleeding	7 (0.8%)	6 (1.1%)	1 (0.3%)	0.258
Buried Bumper	26 (3.0%)	2 (0.4%)	24 (7.3%)	<0.001
Aspiration pneumonia	3 (0.4%)	3 (0.6%)	0	0.287
Peritonitis	4 (0.5%)	1 (0.2%)	3 (0.9%)	0.305
Perforation	3 (0.4%)	0	3 (0.9%)	0.058
Unsuccessful placements	21 (2.5%)	10 (1.9%)	11 (3.3%)	0.256
30-day mortality	34 (4.0%)	15 (2.9%)	19 (5.7%)	0.047

Twenty-four hours after the procedure the antiplatelet and/or anticoagulant therapy were resumed.

Within 30 days, the overall mortality was 4.0% ($n = 34$); however, PEG-related death was 0.2% ($n = 2$). Both PEG-related deaths ($n = 2$, 0.2%) received the pull-type PEG. The first patient was 76 years old and presented with nausea, fever, and abdominal pain within a week after pull PEG placement. The abdominal CT scan examination identified that the pull PEG punctured the small bowel, which led to peritonitis, and subsequently to sepsis. Despite surgery and ICU treatment, the patient deceased a week later. The other patient was 60 years old and presented 10 days after pull PEG placement with abdominal tenderness and leakage of feeding. Abdominal CT scan examination revealed internal fluid leakage in the abdominal cavity, due to an increased diameter of the gastrostomy in the stomach wall, which led to poor attachment of the stomach around the tube. Patient was neutropenic, because of received chemotherapy for his Pancoast tumor after the PEG placement. The patient developed a chemical peritonitis and a neutropenic sepsis and died 4 days later.

Other causes of the 30-day mortality were unrelated to the PEG procedure. One patient had a pull PEG-related perforation of the small bowel and underwent laparoscopic surgery, but died a week later from thalamic hemorrhage. Most frequent cause of mortality unrelated to the PEG procedure was due to progression chronic disease ($n = 11$) including lung cancer and Amyotrophic Lateral Sclerosis, followed by pneumonia ($n = 8$).

The PEG procedure was unsuccessful in 21 patients (2.5%), 10 patients were assigned for the push-type PEG, while 11 patients were planned for the pull-type PEG. This was in most cases due to the absence of diaphany ($n = 14$), lack of indentation of the stomach ($n = 3$), absence of needle visualization in the stomach ($n = 4$), hepatomegaly ($n = 1$), and interposed bowel ($n = 1$). Two patients had both absence of diaphany and lack of indentation of the stomach.

Of the unsuccessful placements, patients underwent surgical ($n = 8$), radiologic gastrostomy ($n = 10$), duodenal tube ($n = 1$), and nasogastric tube ($n = 2$) placement.

Discussion

PEG placement is an established procedure for patients who are in need for prolonged nutrition.

In this study, we evaluated 854 patients who were referred for the push-type or pull-type placement and identified complications, which were associated with either the pull-type or push-type PEG. The overall complication rate in the present study was 42.6%, this is in line with previous studies (varying from 16 to 70%).[3–5,18]

The current study analyzed the differences in outcome of the techniques performed. This high-volume center performed 523 push-type and 331 pull-type procedures. Such a large cohort of push-type procedures has not been described earlier. With the push-type significant more bleeding events and dislodgements occurred, while the pull-type is associated with significant more buried bumpers, infected placement site and granulation tissue formation. In addition, this study showed that the pull-type PEG was responsible for two PEG-related deaths.

A study conducted by Köhler *et al*. showed that occlusions and dislodgments occurred significant more with the push-type than the pull-type.[19] The present study showed that the rate of occlusions occurred was higher in the push-type compared to the pull-type (4.8 and 2.7%, respectively), however, the difference of occlusions was not significant. It was expected that due to the smaller size of the push-type more occlusions may be reported. For the tube dislodgements we found similar findings, the occurrence was significant higher with the push-type. This can be explained by its fixation device. Unlike the pull-type, the push-type has a balloon, which is through its shape and nonrigidness easily dislodged.

PEG placement is done by puncturing the abdominal wall; therefore, bleeding is a logical consequence and may be underreported by physicians. Periprocedural minor bleeding is reported significant more with the push-type, which is supported by two other studies.[20,21] Minor bleeding is defined as no intervention was required, whereas major bleeding surgical or endoscopic intervention was needed. The push-type procedure includes the direct insertion of a 15 Fr trocar and the use of two t-fasteners which increases the risk of bleeding.

In this study 254 patients (29.7%) received antiplatelet or anticoagulant therapy. Discontinuation of single antiplatelet therapy was not necessary, although, if a patient used double antiplatelet therapy, one of the antiplatelet medications was discontinued 5 days prior to PEG intervention. Before 2013, our protocol recommended the discontinuation of also single antiplatelet therapy 5 days prior to PEG placement. Minor bleeding occurred in 13 patients, while there was no major bleeding indicating that the PEG procedure is a safe procedure in patients with antiplatelet or anticoagulant therapy.

All patients received a cephalosporin antibiotic prophylaxis, however infected placement sites and granulation tissue formation occurred (resp. 6.2 and 8.4%). We found a significant higher incidence of site infection and granulation formation with the use of the pull-type PEG. This correlates with the results of a meta-analysis of Campoli *et al*., which revealed significant more infections in the pull group than in the push group (17 and 0.8% respectively).[22] The pull-type might be contaminated by the bacterial flora of the oral cavity which could lead to higher incidences of infections.

The incidences of buried bumpers are ranging from 0.3 to 8.8%.[23–26] Most common cause of buried bumpers is the lack of mobilization of the PEG tube. Patients are instructed to loosen and rotate the PEG tube. Also, external traction by pulling the PEG tube can cause a buried bumper. If patient compliance is insufficient, the internal bumper may cause pressure to the gastric wall, which could lead to hyperplastic tissue burying the internal bumper in the gastric wall. The present study reported an incidence of 3.0%. This is often seen in pull-type PEGs, due to their fixation device. Unlike balloon-tips in push-type PEGs, pull-type PEGs have rigid disks that can cause more necrotizing pressure to the gastric wall. However, we have identified two cases of a push-type balloon that were half buried in the gastric wall and required endoscopic intervention. This rarity is earlier described in the literature.[27]

Furthermore, the pull-type procedure was responsible for two PEG-related deaths, both patients developed sepsis and had a fatal outcome. The first PEG-related death was due to the pull

PEG puncturing the small bowel, whereas the other pull-type PEG-related death was due to enlarged stomach hole and therefore, poorly attached around the pull-type PEG, which caused fluid leakage in the abdominal cavity. There were none reported perforations or PEG-related deaths with the push-type method. The push-type procedure may tend to a more controllable setting, because of the use of two t-fasteners which attach the gastric wall to the abdominal wall for adequate and controlled insertion. Furthermore, push-type placements are controlled with the endoscope, where pull-type PEGs are guided "blind" through the oral tract in the stomach.

PEG placement was successful in 97.5% of the patients, which is similar to reported success rates of at least 95%.[4,28,29] Absence of diaphany was the most common reason for aborting the procedure. Most of the patients were referred for surgical or radiological placement after failed PEG procedure.

The strength of our study was the inclusion of a large cohort of push-type and pull-type placements, which increased the power and reliability of our data.

As a tertiary center, patients with severe comorbidities are referred to us, which may not reflect on the general population. Furthermore, the retrospective design of this study is a limitation, because information on complications is retrieved through medical records, which could be subjectively assessed and therefore, affecting the reliability of our data.

Conclusion

In conclusion, the present study showed that the push-type and pull-type PEG placements are both safe and feasible procedures, with a low PEG-related mortality. Push-type PEG is associated with periprocedural bleeding and tube dislodgements, while the pull-type PEG is associated with buried bumpers, infected placement sites, and tissue granulation formation. Physicians should be aware of these complications to improve patient care. In addition, there is a need for a prospective controlled trial comparing the pull-type with the push-type PEG which will further elucidate the patients' outcome.

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